From:	Jeffrey Delapena
To:	Rebecca Messinger; Heidi Pozzo
Cc:	Oliver Orjiako; Jose Alvarez
Subject:	RE: Comment on the 2025–2045 Comprehensive Plan Update — Cumulative Stormwater Effects in the Whipple Creek and Mill Creek Basins
Date:	Monday, August 17, 2026 2:24:00 PM
Attachments:	image001.png image005.png image006.png image007.png image008.png

Good day, Heidi,

Confirming receipt with Community Planning as well. These will be added to the Comprehensive Plan Index of Record.

Best,

Jeff Delapena
Program Assistant
COMMUNITY PLANNING

564.397.4558

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From: Rebecca Messinger <Rebecca.Messinger@clark.wa.gov>
Sent: Thursday, August 13, 2026 2:26 PM
To: Heidi Pozzo <hcpheidi@yahoo.com>; Sue Marshall <Sue.Marshall@clark.wa.gov>; Glen Yung <Glen.Yung@clark.wa.gov>; Matt Little <Matt.Little@clark.wa.gov>; Michelle Belkot <Michelle.Belkot@clark.wa.gov>; Wil Fuentes <Wil.Fuentes@clark.wa.gov>
Cc: Kathleen Otto <Kathleen.Otto@clark.wa.gov>; April Furth <April.Furth@clark.wa.gov>; Michelle Pfenning <Michelle.Pfenning@clark.wa.gov>; Oliver Orjiako <Oliver.Orjiako@clark.wa.gov>; Jose Alvarez <Jose.Alvarez@clark.wa.gov>; Jeffrey Delapena <Jeffrey.Delapena@clark.wa.gov>
Subject: RE: Comment on the 2025–2045 Comprehensive Plan Update — Cumulative Stormwater Effects in the Whipple Creek and Mill Creek Basins

Good afternoon, Heidi –

This is to confirm receipt of your comments. I'll be sure to add them to the council's record.

Thank you,
Rebecca

Rebecca Messinger
Clerk to the Council
COUNTY MANAGER'S OFFICE

Phone: 564-397-4305
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From: Heidi Pozzo <hcpheidi@yahoo.com>
Sent: Thursday, August 13, 2026 1:22 PM
To: Sue Marshall <Sue.Marshall@clark.wa.gov>; Glen Yung <Glen.Yung@clark.wa.gov>; Matt Little <Matt.Little@clark.wa.gov>; Michelle Belkot <Michelle.Belkot@clark.wa.gov>; Wil Fuentes <Wil.Fuentes@clark.wa.gov>
Cc: Kathleen Otto <Kathleen.Otto@clark.wa.gov>; April Furth <April.Furth@clark.wa.gov>; Rebecca Messinger <Rebecca.Messinger@clark.wa.gov>; Michelle Pfenning <Michelle.Pfenning@clark.wa.gov>; Oliver Orjiako <Oliver.Orjiako@clark.wa.gov>; Jose Alvarez <Jose.Alvarez@clark.wa.gov>; Jeffrey Delapena <Jeffrey.Delapena@clark.wa.gov>
Subject: Comment on the 2025–2045 Comprehensive Plan Update — Cumulative Stormwater Effects in the Whipple Creek and Mill Creek Basins

EXTERNAL: This email originated from outside of Clark County. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Clark County Council and Planning Commissioners,

Attached is my comment on the 2025–2045 Comprehensive Plan Update (Update), titled "Cumulative Stormwater Effects of Added Density in the Whipple Creek and Mill Creek Basins." I ask that it be entered into the record of

this proceeding and included in the materials for the August 20 Planning Commission hearing.

Every acre of the NE and NW 179th Street corridor drains to Whipple Creek or Mill Creek or their tributaries. Each development in the corridor is required to control stormwater on its own site, and each one does. Nothing in the County's system adds those projects together. The only instrument in the County's code that operates at the scale of a whole stream basin is a basin plan, and neither basin has one. The result is that these streams can be degraded by the combined effect of developments that individually and fully comply, and no step in the approval process is required to notice. This Update adds density to both basins.

Clark County has tested that premise twice, in watershed-scale studies its municipal stormwater permit required and that were submitted to the Department of Ecology. Both modeled full build-out with full compliance with the County's stormwater code. Both found it does not hold. Neither study appears in the Final Environmental Impact Statement for this Update. County monitoring since then, and a state incident report at a development being built now, are consistent with what the studies predicted.

The comment also addresses requirements of the Growth Management Act that bear on this decision — the land use element review of drainage, flooding and stormwater runoff, the evaluation of tree canopy coverage, and the inclusion of best available science with special consideration for anadromous fisheries — and the consistency of this Update with the stormwater and salmonid policies it re-adopts.

The request is that the Urban Holding Overlay be reapplied to the corridor and that the density increases assigned to it not be adopted, with vested development proceeding.

The comment cites eighteen exhibits, lettered A through R. Because of their combined file size I am submitting them separately through the County's upload link rather than by email, so that they are in the record without burdening individual inboxes. Retrieval links for the publicly posted exhibits are included in the attachment for convenience.

Please forward this email to the Planning Commissioners.

Thank you for your consideration.

Heidi

COMMENT ON THE 2025–2045 COMPREHENSIVE PLAN UPDATE

Cumulative Stormwater Effects of Added Density in the Whipple Creek and Mill Creek Basins

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To: Clark County Council and Clark County Planning Commission

From: Heidi Pozzo

Date: August 13, 2026

Subject: The cumulative effect of stormwater from development in the NE and NW 179th Street corridor; the County studies bearing on it that do not appear in the environmental analysis; and the consistency of this Update with RCW 36.70A.070, RCW 36.70A.172 and its own adopted policies

EXECUTIVE SUMMARY

This comment examines whether the County's stormwater system is protecting the streams that receive runoff from the NE and NW 179th Street corridor as development goes in. It is not.

The system is built on a single premise: that if every development controls stormwater on its own site to the County standard, the streams will be protected without anyone adding the projects together. Clark County has tested that premise twice, in studies its stormwater permit required, and both times found it does not hold. It has since measured the streams and found them degrading. A state incident report and residents downstream describe the same thing happening at a development being built now. Neither study appears in the environmental analysis for this Update.

Every acre of the corridor drains to one of two small streams, Whipple Creek or Mill Creek. Development is going in across both, and the Update would add more.

What happens to the streams.

Rain that once soaked into the ground now runs off roofs, driveways and roads. A stormwater pond slows that water before releasing it to the creek, but it cannot put the water back into the ground. The creek then rises sharply after every rain and falls again soon after, and each of those swings scours the banks and carries sediment downstream. In summer, with less water stored in the ground to feed it, the creek runs lower and warmer. The eroded material settles on the streambed downstream, where it smothers the gravel and the insects that live in it.

Each development is required to control that water on its own site, and each one does. Nothing is required to add them together. The single tool in the County's code that looks at a whole stream basin is a basin plan, and neither Whipple Creek nor Mill Creek has one. So the streams can be degraded by the combined effect of projects that individually comply, and no step in the approval process is required to notice.

What the County found.

- Whipple Creek, 2017: even if every future development follows every stormwater rule, the flow in the creek stays outside the range that supports a healthy stream. The County tested every strategy it could think of and none of them fixed the flow.
- Mill Creek, 2022: with the required stormwater ponds built, total runoff still rises 27 percent and flows still increase enough to erode the channel. Two-thirds of the forest in that catchment is lost at build-out and hard surface more than doubles.
- Repairing Whipple Creek was estimated at roughly $346 million, exceeding the County six-year stormwater budget by more than $330 million. The flow condition still would not recover.
- Current monitoring confirms it. In water year 2023 Whipple Creek returned the highest Richards-Baker Index — the measure of how sharply a stream rises and falls — of the eight sites monitored in a regional study reported to the Department of Ecology, exceeding a subwatershed with far more development. Section III sets out the qualifications that belong with that result.

Why the rules do not prevent it.

The usual remedy is to soak stormwater into the ground on site, through rain gardens and similar measures. That does not work on this ground. Four developments in the corridor have now had it tested, spanning the range of zoning from the lowest-density residential district to mixed use, and all four reached the same conclusion.

Table 1. Infiltration findings on four corridor developments

Development	Zoning	County or applicant finding	Result
Viers PUD, NE 174th at NE 50th	R1-20	Infiltration not feasible for the site	Onsite detention facilities
North Haven PUD, NW 179th at NW 11th	R1-10	0.0 inches per hour in all three tests	All infiltration practices infeasible; three detention ponds
Three Creeks East, NE 179th east of I-5	OR-22 and R-12	Infiltration not feasible for the site	Onsite detention facilities
Salmon Creek Apartments, 16001 NW 11th	Mixed Use	Lean clay; infiltration not recommended	All seven infiltration practices infeasible; 528-chamber detention

Source: Exhibits G, I, J and K. Each project was reviewed under the County stormwater code.

The County has said the same thing to its regulator. Its 2021 Stormwater Management Program Plan reports that where low impact development is infeasible, it is impossible to use flow control

practices to restore healthy stream flows, and that almost none of the streams in the Vancouver Urban Growth Area are suitable for flow control retrofits.

Why the density is already too high.

The density in this corridor was released in 2019 and 2020, when the Urban Holding Overlay was lifted. The overlay had been applied in 2004 and 2007 because infrastructure lacked the capacity to serve urban development. It was lifted on a criterion that asked only whether transportation improvements were reasonably funded. Storm drainage was within the applicable criterion and was not analyzed.

That matters for what the studies tested. Both models ran full build-out under the designations of the plan this Update replaces. The scenario that failed is therefore the plan as it stands today, before the increases now proposed. In Mill Creek the density released in 2019 is being built now, and the County's 2022 study of that catchment recommended further, more detailed study of the impacts. That study has not been done. This Update would add density on top of both.

Why there will be no later opportunity.

The environmental analysis says impacts will be addressed when individual projects are reviewed. Individual project review applies the same site-by-site rules the County's studies found insufficient, and it cannot weigh the combined effect across a basin. The one tool in the code that operates at basin scale requires an approved basin plan, and neither basin has one.

The County's stormwater permit requires it to tell the Department of Ecology by March 31, 2027 whether receiving water health informed this comprehensive plan update. The County plans to adopt the Update in October 2026. The answer will therefore be written about a decision already final, and cannot change it.

Nothing regulates the clearing.

The forest that absorbs the rain is not protected by anything. The County's stormwater chapter contains no standard of its own; it adopts a manual by reference. Clearing forest for development is approved ministerially, on criteria that do not include hydrology, stream temperature, or how much forest is left standing. No County code requires a development to retain any trees. The County has separately measured what is happening: canopy in the unincorporated urban growth areas fell by 401 acres between 2011 and 2023, and the largest loss of any zoning category was in residential zoning. This Update proposes no change to any of the regulations that govern it.

What the Growth Management Act requires.

The Act does not leave this to the environmental analysis. The land use element must review drainage, flooding and storm water run-off and provide guidance for corrective actions. The park and recreation element must include an evaluation of tree canopy coverage within the urban growth area. Critical areas policies and regulations must include the best available science and give special consideration to measures necessary to preserve or enhance anadromous fisheries, which the

implementing rule ties to stream flows, temperature and migratory access. The County holds its own science on each of those subjects. This Update answers each requirement by pointing somewhere else. Its Commerce checklist reports the stormwater subject as referenced in several locations in the plan and states that no changes are needed to meet the statute. Its critical areas checklist cites a comment response memo and a riparian habitat designation paper. Its park and recreation element reports three rows of canopy acreage and omits the loss the same source measured.

The plan contradicts itself.

This Update re-adopts a policy committing the County to a stormwater program that includes stormwater basin planning, and a policy committing it to develop and implement comprehensive stormwater management plans for all watersheds in the county. Neither Whipple Creek nor Mill Creek has one. It re-adopts a policy to restore and maintain properly functioning ecosystem conditions for salmonids in all county waters. The County's own modeling found that no strategy it evaluated, at any cost, restores Whipple Creek. A comprehensive plan is required to be an internally consistent document.

What this comment asks.

That the Council reapply the Urban Holding Overlay to the corridor, and not adopt the density increases assigned to it, and that the Planning Commission so recommend. Development that is already vested would proceed. What has not yet been approved would wait until the County has resolved whether its stormwater standards can protect these streams at the density now designated — a question its own studies raise and have not answered, and which the work now underway is scheduled to address after this Update is adopted.

I. What the County's Studies Found

Clark County has completed two watershed-scale stormwater studies covering the basins that receive drainage from this corridor. Both were required by the County's National Pollutant Discharge Elimination System Phase I Municipal Stormwater Permit and submitted to the Department of Ecology. Both modeled future development at full build-out with full compliance with the County's stormwater code.

The Whipple Creek Watershed-Scale Stormwater Plan Report (Exhibit A) was completed in September 2017 by the Department of Public Works, Clean Water Division. The watershed covers approximately 12.1 square miles; the upper sub-watershed is 8.8 square miles and includes roughly 4.4 square miles inside the Vancouver Urban Growth Area. The analysis used a hydrologic model calibrated against about a decade of County stream monitoring data. The Mill Creek subwatershed plan for the MIL2 catchment (Exhibit C) was completed in December 2022. That catchment covers approximately 1,400 acres, and the County states that nearly one square mile of it lies inside the unincorporated Vancouver Urban Growth Area and is slated for development in coming years.

Whipple Creek flows westward toward Lake River, so a reach described as above a landmark lies upstream of it, to the east. The Whipple Creek report models the watershed in sub-basins and reports results at a set of points, each receiving drainage from everything upstream. Two of those points receive the corridor's drainage. Their modeled results are set out in Table 2.

Table 2. Modeled stream condition at the two reporting points receiving corridor drainage

Reporting point	Simulated forest	Full build-out	With urban retrofits
WC-7.5, receiving drainage from east of I-5	34	13	15
WC-5, receiving drainage from between I-5 and Whipple Creek Park	34	18	22

Source: Whipple Creek Watershed-Scale Stormwater Plan Report (September 2017), Exhibit A. Values are benthic index of biotic integrity scores on a fifty-point scale, a standard measure of stream biological condition based on the insect community. The County reports scores below 28 as indicating an impaired stream. Six further reporting points are reported in the study; these two receive drainage from the corridor addressed in this comment. The report qualifies its forested baseline, stating that the simulated forested scenario does not unambiguously show that Whipple Creek would fully support salmonid uses even under forested land cover, and that some limitations appear inherent in the watershed's stream sizes, topography and natural substrate. The word unambiguously carries the qualification. Under simulated forested land cover the B-IBI and TQmean metrics place every reporting sub-basin in the partially supporting range, while the high pulse count metric places every one of them in the fully supporting range. Following Ecology's watershed planning guidance, the report then lowered its own bar, adjusting the threshold for fully supporting salmonid uses to ninety percent of the B-IBI attained under the forested baseline — above 31 at WC-7.5 and above 30 at WC-5. Build-out scores of 13 and 18 fail against the adjusted threshold, not only against the forested one.

The report concludes that under full build-out Whipple Creek will achieve neither state water quality standards nor salmonid beneficial uses as the watershed develops under the County's current zoning, development regulations, and stormwater regulations. The same conclusion attributes the water quality result in part to existing development, stating that full build-out mitigates some of the runoff impacts of expected future development but still results in high fecal coliform and high water temperatures due in large part to the adverse impacts of stormwater runoff from existing development. That sentence names the two parameters this comment concedes have remedies. It does not reach the flow condition, which is the parameter that scales with new hard surface and the one for which the report found no remedy. The two parameters that fail are fecal coliform and stream temperature; copper and zinc meet standards. The flow metrics fail across every scenario the County modeled. No modeled strategy restored the watershed. The one sub-basin that reached a fully supporting condition under any scenario required routing more than eighty percent of its drainage area, roughly 400 acres of existing development, into stormwater control or retrofit facilities. The cost of the strategies evaluated is set out in Table 3.

Table 3. Modeled cost of stormwater strategies, Whipple Creek watershed

Strategy	Capital cost	Modeled outcome
Full build-out under current code	No county capital cost	Fails water quality standards
Urban structural retrofits	$263 million	Stream still impaired
Adding rural retrofits	$56 million	Very little benefit
Adding riparian shade	$2.7 million	Nearly eliminates temperature violations; no effect on flow
Adding channel restoration	$23.7 million	Benefit could not be modeled
All strategies combined	Approx. $346 million	Watershed not restored

Source: Whipple Creek Watershed-Scale Stormwater Plan Report (September 2017), Exhibit A. The report states that total one-time capital costs of nearly $346 million exceed the County's Stormwater Capital Program six-year budget by more than $330 million, that the conceptual facilities would occupy nearly one-half square mile, and that implementation would likely require condemnation of private property. Annual operations and maintenance is estimated at $4 million. The shade strategy is reported separately because it addresses only temperature; the report states that shading has no effect on flow metrics or on other water quality parameters. The Channel Restoration strategy — floodplain reconnection, channel and floodplain repair, channel restoration to improve hydrology, and culvert and barrier removal — was priced at $23.68 million for 7.18 miles of main stem. The report states that its benefit cannot be modeled, and its summary of goal attainment records salmonid use under that strategy as non-supporting, assessed by professional judgment rather than modeling. It is the strategy the County's 2021 and 2026 Stormwater Management Program Plans identify as the one it pursued.

One of the two failing parameters is treatable. Adding riparian shade to reaches not already fully shaded reduced modeled temperature violations by more than a thousand over five years, at a cost of $2.7 million, and brought four sub-basins into compliance. The report is equally clear about its limits: shading "has no impact on B-IBI scores or on copper, zinc, and fecal coliform," and "[n]either water quality nor flow metrics are impacted." The County therefore found an inexpensive remedy for stream temperature and none for the flows. It is also a remedy that depends on restoring shade the development removes; existing shade in the affected sub-basins is modeled at 50 percent and the strategy assumes it reaches nearly 100.

The same is true of the other failing parameter. Fecal coliform in this watershed comes substantially from livestock access to the stream and from septic systems, both of which the County's own appendix identifies as sources. Development on public sewer removes septic systems, and residential subdivision generally ends grazing. It is reasonable to expect bacteria loading to improve as these basins urbanize, and this comment does not argue otherwise. The water quality parameters have remedies, and some of them arrive with development itself.

Nothing in the report finds this creek beyond recovery, and this comment does not argue that it is. The report identifies an inexpensive and effective remedy for temperature. It identifies bacteria

sources that development on public sewer largely removes. Under simulated forested land cover its high pulse count metric places every reporting sub-basin in the fully supporting range for salmonid uses, and one sub-basin reaches fully supporting under the modeled strategies. What the County has not found is a way to hold the flow.

The flow condition is different. No strategy the County modeled restores it. Shade does not affect it. Urban retrofits costing $263 million move the reach above Interstate 5 from a score of 13 to 15 and the reach below it from 18 to 22, both still impaired. In the MIL2 catchment the County could only approach existing conditions by changing the flow control standard itself. Flow is also what drives the bank erosion and the sediment that settles on the streambed, which is what buries the gravel that spawning requires. And unlike bacteria and temperature, flow scales directly with the quantity of hard surface. It is the one parameter the County controls through the density it designates, and the one for which it has found no remedy.

The companion appendix on areas warranting special attention (Exhibit B), completed in December 2016, states the ceiling plainly: even to just maintain current degraded conditions within Whipple Creek, new development must meet current county stormwater discharge treatment and hydrologic standards. Full compliance holds degraded conditions in place. It does not improve them.

Both studies also record what the land itself becomes. The Whipple Creek report gives existing cover as 34 percent forested and 12 percent impervious, and states that "[l]oss of historic forests has implications for channel stability, stream temperature, and stream habitat complexity." Its full build-out table projects roughly 24 percent forest and 17 percent hard surface. In the MIL2 catchment the change is sharper: forest falls from 586 acres to 189 and hard surface rises from 163 acres to 370. Two-thirds of the forest is lost and hard surface more than doubles.

Table 4. Land cover at existing conditions and at modeled full build-out

Basin and land cover	Existing	At full build-out
Whipple Creek watershed — forest	34%	24%
Whipple Creek watershed — hard surface	12%	17%
MIL2 catchment, Mill Creek — forest	43%	14%
MIL2 catchment, Mill Creek — hard surface	12%	27%

Sources: Whipple Creek Watershed-Scale Stormwater Plan Report, existing cover from the 2006 watershed assessment and Table 12 future land cover (Exhibit A); MIL2 Catchment Report, Tables 7 and 8 (Exhibit C). MIL2 percentages are calculated from the reported acreages.

The County has since measured the loss.

Table 4 is modeled. The County has since measured what has actually happened. In May 2025 Clark County Public Works, working with the Clark Conservation District and the Washington State Department of Natural Resources, completed an Urban Tree Canopy Assessment of the unincorporated urban growth areas (Exhibit Q). The assessment opens by stating that healthy tree

canopies provide shade for rivers that helps maintain cool water temperatures, benefiting up to five populations of salmonids listed under the Endangered Species Act. Its results for 2011 to 2023 are set out in Table 5.

Table 5. Measured tree canopy in the unincorporated urban growth areas, 2011 to 2023

Measure	Result
Canopy remaining, 2023	9,866 acres, 28 percent
Net canopy loss, all unincorporated urban growth areas	401 acres
Loss in residential zoning	385 acres, the largest of any zoning category
Loss on private property	569 acres; canopy fell from 27 to 25 percent
Loss in the Lower Salmon Creek watershed	187 acres, the largest of any watershed
Loss in the Lake River watershed	40 acres

Source: Urban Tree Canopy Assessment for Clark County, Washington Urban Growth Areas, May 2025 (Exhibit Q). Mill Creek is a tributary of Salmon Creek and lies within the Lower Salmon Creek watershed; Whipple Creek drains to Lake River and lies within the Lake River watershed. The assessment states that the precise causes of canopy loss remain uncertain and that additional site-level investigation is needed to identify them.

The loss is concentrated where this Update adds density. The largest reduction of any zoning category was in residential zoning. The largest reduction by ownership was on private land, which holds 76 percent of the canopy in the unincorporated urban growth areas. Both watersheds that receive the corridor's drainage lost canopy, and the watershed that receives Mill Creek lost more than any other.

This also bears on the one remedy the County found. The riparian shade strategy priced at $2.7 million assumes that shade in the affected sub-basins rises from about 50 percent to nearly 100 percent. The measured trajectory since that model was built runs the other way, and runs the other way most sharply on the private residential land the strategy would have to reach.

The MIL2 study reached the same result on the eastern side. With full implementation of detention basins under current code, the modeled results did not provide stream flow similar to the existing hydrology, with some increase in flows that may erode channels. The County attributes this to soil and geology conditions that will likely make low impact development infeasible. The water balance shows the scale: comparing existing conditions to full build-out, surface runoff rises from 5.0 to 11.2 inches per year, an increase of 122 percent; groundwater and base flow decline by 21 percent; and total runoff increases by 27 percent. The report states that current flow control standards may not adequately manage stormwater runoff from new development at the catchment scale, and identifies the cause as the absence of infiltration practices in low permeability soils.

The County states the conclusion and the cause together: full build-out under current zoning and stormwater control standards "does result in significantly increased runoff volume due to a lack of infiltration BMPs under build out conditions due to LID infeasibility in SG4 soils." SG4 is the County's designation for poorly drained soils, and it is the group mapped across most of this corridor. The goal that build-out failed to meet was not a forested condition. It was, in the report's words, "the study goal of sustaining the existing conditions hydrology in order to support salmonid uses as it develops."

Both studies left the growth question to this proceeding. The Whipple Creek report states that it does not consider updates to the Comprehensive Plan and that future updates may consider actions for managing stormwater impacts related to growth. The MIL2 report includes a twenty-year plan described as one that may inform the Comprehensive Growth Management Plan.

II. Why Compliance With the Code Does Not Prevent It

The mechanism is straightforward. On ground where infiltration is infeasible, a development cannot put its stormwater back into the ground, so it collects the runoff from every roof, driveway and road, holds it in a pond, and pipes it to the creek. The pond satisfies the code, because the code governs how fast that water leaves rather than how much of it there is or whether any of it soaks in. The water therefore still arrives at the creek; it arrives more slowly. Repeat that across a basin and the creek receives more water, more often, with less stored in the ground to feed it in summer. Nothing in the County's system adds those projects together. The one instrument that would is a basin plan, and neither basin has one. The result is that a stream can be degraded by the combined effect of developments that are individually and fully compliant, and no step in the process is required to notice.

The County has described the same circle from the other side. The MIL2 report states that "this Plan does not suggest any immediate changes to the stormwater standards," that the development code "is unlikely to be changed as an immediate result of this study," and that "[w]hile the Comprehensive Plan may consider changes in development patterns in response to stormwater management concerns, the Comprehensive Plan assumes that development standards in Title 40 will protect receiving waters." The comprehensive plan relies on the stormwater code; the stormwater study declines to change the stormwater code; and the study's own modeling found that build-out under that code does not hold the stream.

The County's stormwater code governs one site at a time, and it governs the rate at which water leaves that site rather than the amount. Minimum Requirement #7 requires a project to match developed flow durations to pre-developed durations across a specified range of flows. The premise is that if every site reproduces pre-developed flow durations, the basin is protected without anyone summing the results. The standard contains no requirement to restore infiltration and no limit on runoff volume, so a fully compliant facility still converts water that formerly soaked into the ground into water discharged to the creek. The MIL2 report states one limitation directly: while

the requirement controls flows within its range, flows below that range do not match predevelopment flow, resulting in increased flow in the stream.

The Manual provides a single mechanism operating at basin scale. Where an approved basin plan exists, the land cover condition to be matched is set to achieve a target flow regime identified in that plan. No such plan is in effect for either basin. Table 19 of the Whipple Creek report records that there is currently no basin plan for Whipple Creek. For Mill Creek, the Manual appendix titled Basin Plans contains a substitute pre-developed land cover rather than a plan, and identifies no target flow regime; the County removed that provision effective July 1, 2026. The MIL2 study applied it. The hydrology memorandum prepared for that study states twice that the build-out detention ponds were sized to meet Minimum Requirement #7 using predevelopment land cover taken from the Mill Creek alternative flow control standard, which is 2002 land cover with impervious surface mapped as pasture and field (Exhibit C). The build-out that failed was therefore modeled against a 2002 pasture baseline rather than the forested standard, with existing impervious surface credited as pasture. The County has since removed that standard without re-running the model that relied on it.

The requirement of a basin plan is not a formality, and this County has already been through it. In 2009 the County adopted Ordinance 2009-01-01, which required flow duration for high flows to match existing site conditions rather than historic pre-development conditions — a lesser standard than the one Ecology requires. Ecology issued a notice of violation. The County and Ecology then negotiated Agreed Order No. 7273, under which the County would apply the lesser standard at development sites and mitigate the difference at alternative sites of its own selection. On appeal, the Pollution Control Hearings Board invalidated the Agreed Order, holding that it provided neither equal or similar protection of receiving waters nor equal or similar levels of pollutant control. The Board found it unrebutted that the County had not prepared, adopted, or obtained Ecology approval of a basin plan, and that its Stormwater Needs Assessment Program and Stormwater Capital Improvement Program did not qualify as one. Rosemere Neighborhood Association v. Department of Ecology and Clark County, PCHB No. 10-013 (January 5, 2011) (Exhibit L). The Court of Appeals affirmed in a published opinion, noting that all experts, including the County's own, agreed those two programs did not qualify. No. 41833-9-II (Wash. Ct. App. Div. II, September 25, 2012).

The threshold is specific. The Court described a basin program as one that determines existing land cover and imperviousness, evaluates every stream channel in the basin, evaluates all drainage facilities, and analyzes existing water quality. Nothing in the present record meets that description for either basin.

Two findings in that proceeding bear directly on this comment. Quoting the Independent Science Panel, the Board recorded that the cumulative effect of uncontrolled flows from many small sites can be as damaging as those from a single large site, and that watershed-scale assessment and planning is what allows planners to consider the size and location of proposed developments

throughout a watershed and fully evaluate potential impacts. And on the condition of the receiving waters, the Board found that streams in Clark County are subject to further degradation, recording testimony from Ecology's own witness that nothing about Clark County precludes use of the default flow control standard and that no part of the County qualifies as a highly urbanized area for purposes of applying a lesser standard.

The code does not regulate the conversion of forest.

Both studies attribute the change in flow to the loss of forest. The Whipple Creek report states that loss of historic forests has implications for channel stability, stream temperature and stream habitat complexity. Nothing in the County's code governs that loss.

Chapter 40.386, the stormwater and erosion control chapter, contains no substantive standard. It adopts the Clark County Stormwater Manual by reference as the minimum standard, provides that the more stringent of conflicting Title 40 requirements applies, allows publicly funded linear transportation projects to follow the state Highway Runoff Manual, and states that approvals under the chapter waive nothing else. For definitions it directs the reader to the Department of Ecology's manual. The forested pre-developed condition, the flow control standard and the definition of converted vegetation are therefore not in any ordinance the Council adopts. The periodic update checklist the County submitted to the Department of Commerce with this Update describes the chapter the same way, as adopting the state manual by reference as the minimum standard.

Clearing is approved ministerially. Forest practices are exempt from the stormwater chapter except Class IV general practices that are conversions from timber land to other uses. Those conversions are reviewed under Section 40.260.080, whose standards are the state forest practices rules as modified by the county's wetland and habitat conservation, geologic hazard and shoreline chapters. The code provides that a Class IV general permit shall be approved if the application is consistent with those standards. There is no hydrologic analysis, no retention requirement, no canopy replacement and no consideration of stream temperature. Reforestation appears once, and only for forested wetland buffers under a conversion option harvest plan.

The County once represented the opposite to its regulator. The Agreed Order the Pollution Control Hearings Board invalidated measured the County's mitigation obligation in three categories of land cover: effective impervious area, pasture, and lawn or landscape. Forest was excluded, and the Board recorded the stated reason — that conversion of forest land does not trigger a mitigation obligation because the County Code requires development projects to fully mitigate for the project's cleared forest (Exhibit L). That accounting system was invalidated together with the Agreed Order and nothing replaced it. The County does not track forest loss or its hydrologic consequence anywhere in its stormwater program.

What compliance actually produces is visible in the County's own modeling. In sub-catchment MIL2D the consultant added no future stormwater facility at all, because that sub-catchment has no expected increase in impervious area — only a reduction in forest and a corresponding increase in field and lawn, which the memorandum states will produce a small but measurable increase in

total streamflow (Exhibit C). Forest conversion that does not cross an impervious surface threshold puts more water in the creek and triggers no facility.

The definition that determines whether cleared land is modeled back to forest is itself unsettled. The County's December 2025 briefing on the stormwater code and manual update lists clarification of the converted vegetation definition among the significant changes it submitted to the Department of Ecology in June 2025 (Exhibit H).

The County certifies otherwise to its regulator. Question 36 of its annual report for calendar year 2025, submitted to the Department of Ecology and certified on March 25, 2026, asks whether the County continues to design and implement local development-related codes, rules, standards or other enforceable documents to minimize impervious surfaces, native vegetation loss, and stormwater runoff, where feasible, under permit condition S5.C.6.c.i. The County answered yes. Question 37 asks whether that assessment identified any administrative or regulatory barriers to implementation of low impact development principles or practices. The County answered no (Exhibit R). No provision of Title 40 requires a development to retain vegetation, the County's own assessment measures the loss of 401 acres of canopy, and this Update proposes no amendment to any of the regulations that would govern it.

The 2026 Stormwater Code and Manual update did not change this. That project conformed the County code and Manual to Ecology's 2024 permit and manual. Several of its changes address infiltration testing procedure, but none concerns basin planning, establishes a target flow regime, or addresses cumulative effects. The update does show that basin-scale regulation is available when required: phosphorus control is now required throughout the Vancouver Lake and Lake River watershed, the watershed to which Whipple Creek drains. The County therefore applies a watershed-scale requirement for one pollutant where Ecology directed it to, while applying only the site-by-site standard to flow.

The County has stated the consequence to its regulator.

The County has said as much to its regulator, in each of the last five years. Its 2026 Stormwater Management Program Plan, submitted to Ecology in March 2026, states under the heading Lessons from the Whipple Creek Study: "Clark County found that areas where LID was infeasible are impossible to restore forested stream hydrology using the standard SWMMWW flow control BMPs. Instead, the study suggested the much cheaper option of projects to add channel complexity and reconnect flood plains to manage higher storm flows. This led Clean Water to evaluate streams in the urban area for flow control retrofit suitability. The evaluation found that almost none of the Vancouver UGA streams are suitable for flow control retrofits using detention ponds. This led to a focus on water quality retrofits for high traffic areas and promotion of infiltration retrofits where conditions permit" (Exhibit P). The same passage appears, in substantially the same words, in the County's 2021 Plan (Exhibit M).

Two things follow from that passage. Where infiltration is infeasible, the flow control practices the code requires cannot restore stream hydrology — the County says so directly. And the remedy the County identified is channel work downstream, not control of the flows themselves.

The same document explains that the County chose a catchment other than Whipple Creek for its Stormwater Management Action Plan, reporting that the level of existing development, coupled with basin geology making low impact development largely infeasible, suggested that restoring forested hydrology was unattainable. The basin was set aside from further stormwater planning attention because restoring forested hydrology there was judged unattainable — a conclusion about the feasibility of one objective, and about where the County would spend its capital, rather than a finding that Whipple Creek cannot support salmon. This Update directs additional density into the same basin.

Site testing in the corridor confirms the constraint.

The infiltration conclusion in both studies has since been tested on the ground. Four applications in the corridor, spanning four zoning designations, have each reached the same finding.

The North Haven planned unit development, County file PAC-2019-00183, occupies three parcels at NW 179th Street and NW 11th Avenue and proposes 329 lots. Packard Creek, a tributary of Whipple Creek, runs through the middle of the site, which also carries a Federal Emergency Management Agency floodway and floodway fringe and three wetlands. A geotechnical investigation in January 2019 excavated twelve test pits and conducted infiltration testing in three. All three returned 0.0 inches per hour. The report concludes that infiltration is not recommended, that the low impact development performance standard is not met, and that all low impact development practices are infeasible for the project as a whole (Exhibit G). Flow control is provided by three detention ponds. The developed condition modeled for the largest basin is set out in Table 6.

Table 6. Modeled developed land cover, North Haven PUD Basin 1.3

Surface type	Acres	Share of basin
Rooftops	9.37	37%
Roads	4.57	18%
Driveways	2.93	12%
Sidewalks	1.47	6%
Pond	0.55	2%
Impervious subtotal	18.88	74%
Lawn, poorly drained soils	6.56	26%
Basin total	25.44	100%

Source: North Haven PUD Preliminary Stormwater Technical Information Report, February 2020, Appendix F, WWHM mitigated land use for Dev Basin 1.3 (Exhibit G). Shares are calculated from the acreage figures. The pre-developed condition modeled for the same basin was forested land cover with no impervious surface.

Salmon Creek Apartments, at 16001 NW 11th Avenue, proposes seven apartment buildings on 4.77 acres zoned Mixed Use, with 3.71 acres of impervious surface, or approximately seventy-eight percent of the site. Runoff sheet flows southeast to Whipple Creek. A geotechnical study in April 2025 found the soils to be primarily lean clay and infiltration not recommended, and every low impact development practice evaluated was rejected, five of them expressly for lacking infiltration capacity in the native clay soils (Exhibit K). The Natural Resources Conservation Service maps this site as Hillsboro silt loam, the better-drained of the two soil series present at North Haven, and the report notes that the field results were a different soil composition from the survey.

Three Creeks East proposes to divide 39.34 acres into 200 lots in the OR-22 and R-12 zones. The staff report calculates an overall density of 11.2 dwelling units per acre on the 17.83 acres of net developable area remaining after right-of-way, critical areas and an undevelopable gas easement are subtracted. The staff report states that infiltration of stormwater is not feasible for the site and that stormwater will be routed to onsite detention facilities (Exhibit I). Whipple Creek crosses the southwest corner of the site, with Special Flood Hazard Area, Riparian Priority Habitat and Biodiversity Corridor extending onto the property, a Category II wetland in the northeast corner, a Category I wetland in the southern portion, and additional Category I wetlands associated with the creek. Buffer reductions are proposed for the onsite wetlands and impacts to riparian buffers for required roadways.

The Viers planned unit development, in the R1-20 zone and the Mill Creek Overlay District at NE 174th Street and NE 50th Avenue, proposes 84 lots on 44.47 acres. Its staff report states the same conclusion in the same words: infiltration of stormwater is not feasible for the site (Exhibit J). Mill Creek runs through the eastern end of the site with associated floodplain, fringe wetlands, riparian buffers and shoreline designation, and isolated wetlands are proposed to be filled.

Nothing in this comment suggests any of these designs is not code-compliant. The point is the opposite. This is what compliance consists of on this ground, and it is the condition the County's own analysis found insufficient. The finding does not vary with the zoning designation, because it is a property of the soil rather than of the zone.

III. What the Streams Show Now

The findings above are modeled. The County also takes field measurements and reports them to the Department of Ecology through the Lower Columbia Urban Streams monitoring program, which the Clean Water Division performs under an interagency agreement. Whipple Creek was monitored in water year 2023, after the Urban Holding Overlay was removed. Mill Creek was monitored in the same year, and the MIL2 tributary in water year 2024.

The relevant measure is how sharply a stream rises and falls. The Richards-Baker Index describes that oscillation and rises with urbanization; the report states that values above 0.25 are typically associated with subwatersheds having more than twenty percent hard surface, and that areas with clay soils, where runoff is poorly absorbed, typically show higher values than areas with more permeable soils. Flow reversals count how often the stream switches between rising and falling over the year. TQmean falls as a stream becomes flashier. Results are set out in Table 7.

Table 7. Stream flashiness metrics, Lower Columbia Urban Streams, water year 2023

Monitoring site	TQmean	Richards-Baker Index	Flow reversals
Whipple Creek	0.38	0.33	46
Cougar Creek	0.37	0.30	38
Woodin Creek	0.48	0.16	41
Mill Creek	0.46	0.16	29
Burnt Bridge Creek	0.41	0.13	39
Westover Creek	0.44	0.12	49

Source: Department of Ecology, Lower Columbia Urban Streams Monitoring Annual Status Report, Water Year 2023, Publication 24-10-050, Table 1, prepared by Clark County Public Works, Clean Water Division (Exhibit E). Two of the eight monitored sites, Campen Creek and Brezee Creek, reported no data. Of the sites listed, only Whipple Creek and Mill Creek lie in basins receiving drainage from the corridor; the remainder are shown for comparison. The report states that all sites, including Whipple Creek, had TQmean values at or above the 0.37 threshold it associates with supporting streams, and that no site exceeded the flow reversal threshold of 65.

Whipple Creek returned the highest Richards-Baker Index of any site in the study, exceeding Cougar Creek, which the same report describes as the most heavily developed subwatershed monitored. Its other results are consistent. Stream temperature exceeded the 63.5 degree Fahrenheit aquatic life criterion on 71 of the 93 days in the criteria period. Substrate embeddedness was 67 percent, in the marginal condition category, meaning gravel and cobble are between half and three-quarters buried in fine sediment.

Two qualifications belong with these results. The same report gives Whipple Creek a benthic index of biotic integrity score of 40 on the hundred-point scale used in that program. The report's table places 40 in the "Fair" category, while its text states that streams scoring 40 or less are considered non-supporting for salmon habitat; the source is internally inconsistent on that threshold. Three of the eight sites scored below 40. Whipple Creek is therefore not the worst site in the study on biological condition, and this comment does not present it as such. The flow metrics are the more direct measure of the effect at issue here, which is the volume and timing of runoff rather than the biological community that results from it.

Second, Table 5 of the Water Year 2023 report carries a footnote that site locations were influenced by beaver activity, and Whipple Creek is one of three sites so marked. The hydrology metrics are computed using stage as a surrogate for flow, and beaver dam construction and breaching can produce stage changes independent of runoff. The Whipple Creek result should be read with that in mind. It is also consistent with the modeled prediction, with the 2017 report's attribution of flashiness to soils that do not absorb runoff, and with the water year 2024 result at the MIL2 tributary, which carries no such footnote.

The MIL2 tributary, monitored in water year 2024, returned a Richards-Baker Index of 0.29 and a TQmean of 0.34, both outside the supporting range, at a total hard surface area of thirteen percent. The Ecology report notes this result as anomalous relative to the site's development level. Its biological score was 26, in the poor category, and its substrate embeddedness was 90 percent, the poorest condition category. This is the same catchment the County modeled in 2022 and described as slated for development in coming years (Exhibit F).

A further change is underway that bears on the upper watershed. The Whipple Creek report identifies a full fish passage barrier at Interstate 5, which currently blocks fish moving upstream from reaching any part of the creek above it. The Washington State Department of Transportation's I-5 and NE 179th Street interchange project includes replacing the I-5 bridges over NE 179th Street and addressing nearby fish barriers. WSDOT reports the project in the design phase, with a status of pre-construction, advertisement scheduled for 2028, construction scheduled to begin in 2029 and to be complete in 2031, and construction to take place in several phases. Those dates are WSDOT's current published schedule and have moved before. The reach the County's model identifies as the most degraded at build-out is the reach that project would reopen.

The same is occurring in Mill Creek. The MIL2 report states that Clark County Public Works is planning to replace fish-blocking culverts on the MIL2B reach at the intersection of NE 29th Avenue and NE 179th Street with bridges as part of a project to improve 179th Street. The Washington Department of Fish and Wildlife records winter steelhead and Coho salmon in the MIL2A reach and downstream of NE 179th Street. The road improvements serving the new density are opening the reaches that receive its runoff.

IV. What the Growth Management Act Requires

The question this comment raises is not only an environmental review question. The Growth Management Act imposes duties that reach it directly, and this Update was submitted to the Department of Commerce with checklists certifying that each of them is met. The requirements are set out in Table 8.

Table 8. Growth Management Act requirements bearing on this question

Requirement	Source
The land use element shall review drainage, flooding and storm water run-off in the area and nearby jurisdictions and provide guidance for corrective actions to mitigate or cleanse those discharges that pollute waters of the state	RCW 36.70A.070(1); WAC 365-196-405(2)(e)
The land use element shall designate the proposed general distribution, general location and extent of the uses of land, where appropriate, for open spaces and green spaces, and urban and community forests within the urban growth area	RCW 36.70A.070(1)
The park and recreation element shall include an evaluation of tree canopy coverage within the urban growth area	RCW 36.70A.070(8)(c); WAC 365-196-440
Policies and development regulations protecting critical areas shall include the best available science, and shall give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries	RCW 36.70A.172(1)
Special consideration should be given to habitat protection measures based on the best available science relevant to stream flows, water quality and temperature, spawning substrates, instream structural diversity and migratory access	WAC 365-195-925(3)
The comprehensive plan shall be an internally consistent document	RCW 36.70A.070

Source: Revised Code of Washington and Washington Administrative Code as cited. WAC 365-196-405(2)(e) provides that the water quality information used in the land use element review may be drawn from the planning and regulatory requirements of the municipal stormwater general permit that applies to the county, and from local waters listed under the state's water quality assessment. WAC 365-195-925 is named in the County's own critical areas checklist as the criteria governing the anadromous fisheries requirement.

The review of drainage, flooding and stormwater run-off.

Item o of the periodic update checklist the County submitted to the Department of Commerce addresses this requirement. The County answers that it is in the current plan, citing the Community Framework Plan, Chapter 1 Land Use at page 25, concurrency at page 40, various citations in Chapter 4, and Chapter 6 for infrastructure. To the question of what changes are needed to meet current statute, it answers: None known. Its explanatory note states that Clark County participates in the NPDES municipal stormwater permit program, and that qualifying projects in the County are evaluated for compliance with Ecology's Stormwater Management Manual for Western Washington.

That note is the site-by-site premise. It is the premise the County tested at basin scale in 2017 and again in 2022 and found insufficient, and the premise its Stormwater Management Program Plans have told Ecology for five years cannot restore stream hydrology where low impact development is infeasible. It is offered here as the substantive answer to a statutory duty to provide guidance for corrective actions, followed by a representation that no corrective actions are known to be needed.

The Land Use Element recites the duty and does not perform it. It states that the land use element is to provide for protection of groundwater resources and, where applicable, address drainage, flooding and run-off problems and provide for coordinated solutions. Its remaining references to stormwater are that implementing ordinances contain the appropriate types of stormwater management systems, that level of service standards are adopted for basic services including stormwater, and that green infrastructure such as stormwater management facilities is among the tools encouraging urban and community forests. There is no review of drainage, flooding or run-off in this corridor or in the basins that receive its runoff, and no guidance for corrective actions.

The evaluation of tree canopy coverage.

The Act requires the park and recreation element to include an evaluation of tree canopy coverage within the urban growth area, and Chapter 7 of this Update quotes the requirement. What follows the quotation is one paragraph and one table. The paragraph states that Clark County Public Works collaborated with the Clark Conservation District and the Department of Natural Resources to complete an Urban Tree Canopy Assessment in May 2025. The table reports three figures: existing canopy of 9,866 acres or 28 percent, possible planting area of 11,741 acres or 33 percent, and 14,103 acres or 39 percent unsuitable for planting. A closing sentence directs the reader to the assessment for additional detail and methodology. No goal, policy or target concerning tree canopy appears anywhere in Chapter 7.

Every figure in Table 5 of this comment is drawn from the report cited in the footnote to that table, and none of them appears in the element. The Update reports how much canopy exists and omits that it is declining, that the decline is largest in residential zoning, that it is concentrated on private land, and that the watershed receiving Mill Creek lost more canopy than any other in the study area. It also omits the assessment's recommendation that the County review long-term land use and development plans to include policies protecting mature trees, and create canopy ordinances for new developments.

An inventory of what exists is not an evaluation of coverage in a plan whose subject is how much more development to allow. The figures that bear on that decision are the ones that were left out.

Two points forestall a procedural answer. RCW 36.70A.070(10) provides that requirements to incorporate new or amended elements are null and void until the state appropriates and distributes sufficient funds at least two years before the update is due. Clark County did not treat the canopy requirement as inapplicable. It included a park and recreation element, quoted the statutory requirement in that element including the canopy evaluation, prepared the assessment, cited it, and reported compliance on the checklist it submitted to the Department of Commerce. Having done

so, the element it adopted is subject to the same internal consistency requirement as every other part of the plan.

The second point does not depend on the park and recreation element at all. RCW 36.70A.070(1) requires the land use element to designate the general distribution, location and extent of the uses of land for open spaces and green spaces, and urban and community forests within the urban growth area. The Land Use Element states that requirement and reports 239.91 acres of green space countywide in the unincorporated urban growth areas, 235 of it in the Vancouver urban growth area. It then explains that the metric captures only publicly owned vegetated parcels of less than one acre, and that larger parcels and privately owned property are not captured. That is the entire designation. The metric the element uses structurally excludes the private residential land where the County measured its canopy loss.

Best available science and anadromous fisheries.

The critical areas checklist submitted with this Update asks whether the County's regulations give special consideration to anadromous fisheries. The County answers yes, and identifies the location in the record as a comment response memo and a riparian habitat designation paper. The same comment response memo is the location cited for the documentation of best available science in the review and update of the critical areas regulations.

WAC 365-195-925(3), which that checklist names as the governing criteria, directs that special consideration be given to habitat protection measures based on the best available science relevant to stream flows, water quality and temperature, spawning substrates, instream structural diversity and migratory access. The County holds its own science on flow, on temperature, on substrate and on migratory access, and cites none of it. The Whipple Creek and MIL2 studies address flow. The Lower Columbia Urban Streams monitoring reports record 71 exceedances of the aquatic life temperature criterion in 93 days at Whipple Creek, and substrate embeddedness of 67 percent there and 90 percent at the MIL2 tributary. The Whipple Creek report identifies a complete passage barrier at Interstate 5. None of it appears in the record the checklist cites.

The Update amends no environmental regulation.

The code changes accompanying this Update are the housing code and the traffic impact fee code. Exhibit 3 to Issue Paper 8 lists them: definitions, zoning classifications, minimum and maximum density calculations, the low-density residential, residential and office residential, commercial and mixed use districts, the manufactured home park overlay, co-living housing, compact lots, emergency shelters, manufactured home park standards, multifamily amenity areas, zero lot line development, signs, landscaping, parking, street and road standards, uses subject to review, planned unit development, two design appendices, and the impact fee chapters. Chapter 40.386 appears once in the exhibit, in a cross-reference list identifying where additional definitions are found. No amendment is proposed to the stormwater and erosion control chapter, to the forest practices section, to the critical aquifer recharge chapter, or to the wetland, habitat conservation

and geologic hazard chapters. This Update raises the densities and leaves every regulation that would govern their effect on these streams exactly as it stands.

V. The Update Is Internally Inconsistent

A comprehensive plan is required to be an internally consistent document. This Update re-adopts three policies that the record before the Council and the Planning Commission shows are not being met in these two basins, and assigns density that makes each of them harder to meet. They are set out in Table 9.

Table 9. Adopted policies and the condition of the record

Policy as proposed for adoption	Condition of the record
4.7.1 Minimize impacts to waters of the county through an effective stormwater management program that includes stormwater basin planning and promotion of on-site infiltration and low impact development	No basin plan exists for Whipple Creek or Mill Creek. The Whipple Creek report records that there is no basin plan for that watershed. The Pollution Control Hearings Board found it unrebutted that the County had not prepared, adopted or obtained approval of one.
6.4.3 Develop and implement comprehensive stormwater management plans for all watersheds in the county	The two basins receiving this corridor's drainage have watershed-scale studies. Neither has a comprehensive stormwater management plan, and neither study produced one.
4.5.1 Restore and maintain properly functioning ecosystem conditions for salmonids in all county waters	The Whipple Creek report concludes that no modeled strategy restores the watershed, at a capital cost of approximately $346 million. The MIL2 study found that build-out under current code does not maintain existing hydrology.

Source: Chapter 4 Environmental Element and Chapter 6 Capital Facilities and Utilities Element as proposed for adoption, and the goal and policy proposed amendments table at Exhibit 2 to Issue Paper 8. Policy numbers follow the proposed renumbering. In Policy 4.7.1 the amendment adds low impact development and extends the policy from developed and urbanizing areas to urban and rural areas; the basin planning language is retained without change. In Policy 6.4.3 the only deletion is the phrase "including funding provisions"; the commitment to all watersheds in the county is retained.

The inconsistency is not a drafting problem. Policy 4.7.1 identifies basin planning as a component of an effective stormwater program, and basin planning is also the only mechanism in the County's stormwater manual that operates at basin scale. The manual provides that where an approved basin plan exists, the land cover condition to be matched is set to achieve a target flow regime identified in that plan. Where no such plan exists, the site-by-site standard is all that applies. This Update re-adopts a policy naming the instrument that would address the problem, while adding density in two basins that do not have it.

Policy 4.5.1 is more direct. It commits the County to restore and maintain properly functioning ecosystem conditions for salmonids in all county waters. The County's own modeling of one of

those waters found that nothing it evaluated, at any cost it examined, restores it. Adopting that policy and this density together asserts two things that cannot both be true.

The Environmental Element states the mechanism and omits the measurement.

Summarizing Ecology's manual, Chapter 4 explains that before forests were cleared for farms and towns rainfall was largely absorbed into the ground where it replenished streams as springs and seeps; that as settlement occurs trees are removed and replaced by fields, buildings and roads; that rainwater then runs off rapidly, greatly increasing stream channel erosion and degrading stream habitat; and that during the summer stream flow may be reduced to low levels because less water is available to the springs and seeps that feed the stream. That is the mechanism this comment describes, stated in the chapter proposed for adoption.

The Update adds new text to the same passage stating that sediment allowed to wash into the streambed can smother aquatic creatures, such as salmon eggs. The County's monitoring reports substrate embeddedness of 67 percent in Whipple Creek and 90 percent at the MIL2 tributary, the poorest condition category. The element describes the mechanism and names the consequence, and discloses neither measurement.

One amendment runs against the rest.

In the critical areas discussion of the same chapter, the Update adds temperature to the list of concerns that critical areas limit or mitigate. In the sentence immediately following, it deletes the word retention, so that vegetation protection and enhancement, rather than vegetation retention, is described as critical to protecting streams and riparian habitat necessary for sustaining healthy fish and wildlife populations. The same paragraph retains, unamended, the statement that maintenance of tree cover, natural vegetation and wetlands is critical to the prevention of erosion, flooding, property and habitat damage and the continued functioning of the ecosystem. No provision of county code requires vegetation to be retained on a development site.

The Climate Element defers the remedy and does not date it.

Policy 14.9.2 commits the County to develop and adopt a tree plan and implementing ordinance, and provides that the plan must establish community-wide canopy cover targets, include strategies to address tree loss from development and other site altering activities, build climate resilience, carbon sequestration, ecosystem and watershed health, and align with the tree requirements of the County's Phase I municipal stormwater permit. No date is given. The Update identifies tree loss from development as a problem requiring strategies, defers the strategies to an ordinance that does not yet exist, and adopts the densities now.

VI. What the Analysis for This Update Omits

Neither watershed study appears in the Final Environmental Impact Statement. Neither is cited in the Environmental Element or the Capital Facilities and Utilities Element. The monitoring results described above do not appear. Whipple Creek appears only as a row in the stream mileage tables

and in public comment. The County's own conclusion that the Whipple Creek stream system often does not support its state designated beneficial uses is not disclosed, nor is the Clean Water Act Section 303(d) listing for the creek, although the County's 2020 Stormwater Management Program Plan describes continued bacteria source identification work in the 303(d)-listed Whipple Creek watershed (Exhibit N).

The County itself identifies those studies as inputs to this kind of planning. Its 2026 Stormwater Management Program Plan describes the long-range planning coordination required by the permit as "intended to create a report describing how stormwater management needs and receiving water health are informing comprehensive land use planning under GMA and any other county long-range land use planning efforts," and states that "[s]tormwater planning efforts include the 2017 Whipple Creek study, the 2022 Mill Creek tributary study and Stormwater Structural Controls planning under the permit" (Exhibit P). The two studies absent from the environmental analysis are the two the County names as what should be informing this plan. The coordination report covering calendar year 2026, the year of adoption, is due March 31, 2027.

The County has also certified their use to Ecology. Question 39 of its annual report for calendar year 2025 asks counties whether they have described in their Stormwater Management Program Plan how the watershed-scale stormwater plans developed under the 2013 permit are being used to inform project prioritization and selection under condition S5.C.7. The County answered yes (Exhibit R). The same two studies that the County tells Ecology are informing its capital project selection do not appear in the environmental analysis for the decision that sets how much development those projects would have to serve.

The coordination report is not the only permit product bearing on this decision that arrives after it. Four are set out in Table 10.

Table 10. Permit-required products bearing on this decision, and when they are due

Product	Permit condition	Due
Map tree canopy to support stormwater management on County-owned or operated property	S5.C.2.b.ii	December 31, 2026
Long-range planning coordination report describing how stormwater management needs and receiving water health are informing comprehensive land use planning under the Growth Management Act	S5.C.6.b	March 31, 2027
Stormwater Management Action Plan for the urban and urbanizing area of the Salmon Creek watershed	S5.C.6.d	March 31, 2027

Product	Permit condition	Due
Adopt and implement tree canopy goals and policies to support stormwater management, including maintaining existing mature canopy	S5.C.6.c.ii	December 31, 2028

Source: 2024–2029 Phase I Municipal Stormwater Permit, and Clark County Stormwater Management Program Plan, March 2026 (Exhibit P). Adoption of this Update is targeted for October 2026. The canopy mapping requirement reaches only property the County owns or operates; the Urban Tree Canopy Assessment reports that 76 percent of the canopy in the unincorporated urban growth areas is on private land, and that private land lost 569 acres — more than the 401-acre net figure — offset by a gain of roughly 168 acres on public land (Exhibit Q).

The omission is not incidental. Every water and habitat metric the document reports for the unincorporated Vancouver Urban Growth Area is identical under both alternatives, because the metrics count land area within the Urban Growth Area boundary and that boundary does not change.

Table 11. Reported conditions, unincorporated Vancouver Urban Growth Area

Metric	Alternative 1	Preferred Alternative
Existing impervious surface (acres)	10,479	10,479
Critical aquifer recharge area (acres)	33,538	33,538
Wetlands (acres)	4,831	4,831
Stream miles	61	61
Change in riparian priority habitat (acres)	0	0

Source: Clark County, Final Environmental Impact Statement, Volume 1 (July 24, 2026). The impervious surface table reports existing impervious surface rather than projected impervious surface.

Adding houses to land already inside the boundary does not register in any of these measures. The document does acknowledge that increased impervious area decreases stormwater infiltration and the volume of cold groundwater feeding streams, and characterizes this as a cumulative and unavoidable impact occurring on a site-by-site basis. Having so characterized it, the document applies no measure capable of detecting it and discloses neither watershed study. WAC 197-11-060(4)(e) and WAC 197-11-330(3)(c) provide that several marginal impacts, considered together, may result in a significant adverse impact. That is the question the two studies answer, and it is the question the environmental analysis does not reach.

The modeled density was lower than what is designated today.

Both studies modeled the densities designated when they were prepared. The Whipple Creek report states that its full build-out scenario "assumes that the UGA in the watershed will develop under existing land use designations to full densities allowed under the current Comprehensive Plan, which plans for county growth through 2035." The MIL2 report says the same of its catchment. The scenario that failed is therefore full build-out under the designations of the plan this Update

replaces, and those designations are what the Update changes. The land cover assumptions used to translate designations into runoff are set out in Table 12.

Table 12. Effective impervious area assumptions, Whipple Creek future land cover model

Land use category	Effective impervious	Pervious cover
Urban Low Density Residential	23%	77% lawn
Urban Medium Density Residential	23%	77% lawn
Public Facility	23%	77% lawn
Urban Reserve	23%	77% lawn
Mixed Use	48%	52% lawn
Commercial, Light Industrial, Employment Center	85%	15% lawn

Source: Whipple Creek Watershed-Scale Stormwater Plan Report, Appendix J, Table 3 (January 2017), Exhibit D.

The model contains no residential category above Urban Medium Density Residential, and assigns that category the same twenty-three percent value as low density residential, public facilities and urban reserve land. This Update proposes consolidated multifamily districts at R-24, R-36 and R-50, raised minimum densities in the single-family districts, an unlimited-density exemption for qualifying affordable housing in the Vancouver Urban Growth Area, and mixed use zoning that may be developed as one hundred percent residential. No row in the 2017 model corresponds to those designations. The North Haven basin in Table 6 is modeled at seventy-four percent hard surface and the Salmon Creek Apartments site at approximately seventy-eight percent.

One sub-basin warrants separate note. Table 2 of Appendix J assigns each sub-basin to one of two groups, and future land use for those placed outside the Urban Growth Area was drawn from rural Comprehensive Plan zoning rather than urban designations. Sub-basin PC_2A is placed in the outside group, although it contains land within the Urban Growth Area both north and south of NW 179th Street east of NW 11th Avenue. It is modeled at 3.8 percent impervious under existing conditions and 8.7 percent at full build-out. The North Haven planned unit development lies in PC_2A. Its largest basin alone adds 18.88 acres of new hard surface, against an increase of approximately 19 acres the model projected for that entire 392-acre sub-basin.

The consequence is that the scenario the County modeled and found insufficient is full build-out under the designations now being replaced, using land cover assumptions that top out at twenty-three percent hard surface for residential land. This Update raises those designations.

VII. Request

The County's own modeling establishes three things.

- Build-out of these basins under the densities previously permitted, with full compliance with the stormwater code, does not maintain the flow conditions the streams need.
- The Whipple Creek failing scenario modeled full build-out under the designations this Update replaces, using no residential land cover category above twenty-three percent hard surface. It tested less development than the Update proposes.
- No strategy the County evaluated for Whipple Creek, at any cost it examined, restores the watershed.

The two basins are not in the same position, and the difference matters.

In Whipple Creek, this Update raises designations above those the County already modeled at full build-out and found insufficient. Nothing the County tested there reaches an undegraded condition.

In Mill Creek, the density is not new. It was released when the Urban Holding Overlay was lifted in 2019, and it is being built now. The County studied that catchment in 2022, found that detention under current code would not hold existing hydrology, and recommended further, more detailed study of impacts from planned urbanization. That study has not been completed. What has arrived instead is the development. An Ecology incident report in February 2025 for the Salmon Creek Ridge subdivision describes detention ponds that do not fill, an outlet running to a drainfield producing a constant flow down a hill into Mill Creek, and muddy water in the ponds (Exhibit O). The residents downstream describe sediment deposits along the streambank that mobilize at higher flows.

The County's own program confirms the gap. The County is developing a Stormwater Management Action Plan for the urban and urbanizing area of the Salmon Creek watershed. That project began in early 2024 and is scheduled for completion by spring 2027, with the report due to the Department of Ecology by March 31, 2027. Its first goal is to identify locations in Upper Curtin Creek and urbanized Mill Creek "where infrastructure plans have not been created," and its tasks include studying stream health and existing infrastructure there and modeling runoff to size what is needed. Adoption of this Update is targeted for October 2026.

The recovery planning for this watershed reaches the same conclusion about the remedy. The MIL2 report records that the Lower Columbia Fish Recovery Board Plan "calls for stabilizing Salmon Creek fish populations, rather than restoring them based on the level of planned urbanization in the watershed," and that "[c]onsequently, a key priority in the fish recovery plan is to manage growth to limit habitat degradation." Managing growth is what the recovery plan identifies as the priority. It is what this comment asks the Planning Commission to recommend and the Council to do.

I therefore request the following, and ask the Planning Commission to recommend it to the Council:

- Reapply the Urban Holding Overlay to the corridor. The County applied it here in 2004 and 2007 because infrastructure lacked the capacity to serve urban development, and lifted it in 2019 on a criterion that asked only whether transportation improvements were reasonably funded. Storm drainage was within the applicable criterion and was not analyzed. CCC 40.560.010(G)(5) requires a demonstration that the full range of urban public facilities and services can be adequately provided, and lists storm drainage among them. That demonstration has not been made.
- Not adopt the density increases this Update assigns to the corridor, in any zoning district. The request is not limited to the residential districts; any designation permitting dense residential development, including mixed use, produces the same hard surface and the same effect on the streams.
- Allow vested development to proceed. This request does not reach projects already approved. It reaches what has not yet been approved, and asks that it wait until the question is answered.

One qualification about vesting belongs in the record. Vesting in this corridor can begin before a plat application is filed. Section 40.260.080 provides that residential plat applications submitted following approval of a conversion option harvest plan are subject to the local land development codes in effect on the date that harvest plan was approved, excepting only subsequently enacted critical area amendments related to the recovery of threatened or endangered fish. A landowner may therefore harvest, obtain approval of a harvest plan, and fix the regulations that will apply, before any subdivision application exists. The body of development that would proceed under this request is correspondingly larger than the list of pending applications, which is a further reason to act at this proceeding rather than later.

The reports due to Ecology in March 2027 do not solve this. They are reports. The long-range planning coordination report describes whether receiving water health informed a plan that will already be adopted. The Stormwater Management Action Plan identifies where infrastructure is needed; it does not build it, and it does not set a flow control standard. Neither produces a basin plan for Whipple Creek or Mill Creek, and without one nothing in the County's system evaluates the combined effect of the development being approved. In the meantime every new project collects its runoff, holds it briefly, and releases it to the creek, and each one is approved because it meets a standard the County has told Ecology cannot restore stream hydrology on this ground.

This is not a problem that is being managed. Some of what ails these creeks can be fixed, and should be. The flow cannot, and flow is what scales directly with the amount of hard surface the County allows. Whipple Creek and Mill Creek are being degraded by the ordinary operation of the stormwater system as designed, one compliant project at a time, and the degradation is measured, not predicted. Every additional acre of hard surface approved before that is addressed makes it

worse and is not reversible. Reapplying the Urban Holding Overlay stops the accumulation while the County answers the question its own studies raised.

Thank you for your consideration of these comments.

VIII. Attachments

Exhibit A. Whipple Creek Watershed-Scale Stormwater Plan Report

Clark County Department of Public Works, Clean Water Division, September 2017. Prepared under NPDES Phase I Municipal Stormwater Permit condition S5.C.5.c and submitted to the Department of Ecology.

Available at: https://clark.wa.gov/sites/default/files/dept/files/public-works/Stormwater/Capital_Projects/Whipple%20Creek%20Watershed%20Plan%20FINAL.pdf

Exhibit B. Appendix E — Watershed Areas Appropriate for Special Attention

Clark County Department of Public Works, Clean Water Division, December 2016. Appendix to Exhibit A.

Available at: https://clark.wa.gov/sites/default/files/dept/files/public-works/Stormwater/Capital_Projects/_App%20E%20FINAL%20Areas%20of%20special%20attention%20in%20the%20Whipple%20Creek%20subwatersheds.pdf

Exhibit C. Stormwater Planning in the Mill Creek Subwatershed — MIL2 Catchment Report

Clark County Department of Public Works, Clean Water Division, December 2022. Prepared under the NPDES Phase I Municipal Stormwater Permit.

Available at: https://clark.wa.gov/public-works/stormwater-planning-mill-creek-subwatershed

Exhibit D. Appendix J — Whipple Creek Watershed Existing and Future Land Cover Data

Clark County Department of Public Works, Clean Water Division, January 2017. Appendix to Exhibit A.

Available at: https://clark.wa.gov/sites/default/files/dept/files/public-works/Stormwater/Capital_Projects/_App%20J%20FINAL%20Whipple%20Existing%20and%20Future%20Land%20Cover.pdf

Exhibit E. Lower Columbia Urban Streams Monitoring Annual Status Report, Water Year 2023

Department of Ecology Publication 24-10-050, prepared by Clark County Public Works, Clean Water Division under interagency agreement.

Available at: https://apps.ecology.wa.gov/publications/documents/2410050.pdf

Exhibit F. Lower Columbia Urban Streams Monitoring Annual Status Report, Water Year 2024

Department of Ecology Publication 25-10-071, prepared by Clark County Public Works, Clean Water Division under interagency agreement.

Available at: https://apps.ecology.wa.gov/publications/documents/2510071.pdf

Exhibit G. North Haven PUD Preliminary Stormwater Technical Information Report

Clark County file PAC-2019-00183. Prepared by AKS Engineering and Forestry, LLC, February 2020, including the January 2019 geotechnical investigation by Earth Engineering, Inc. State Environmental Policy Act register number 202002319.

Available at: https://apps.ecology.wa.gov/separ/Main/SEPA/Record.aspx?SEPANumber=202002319

Exhibit H. Stormwater Code and Manual Update — Clean Water Commission Briefing

Clark County Department of Public Works, December 3, 2025.

Available at: https://clark.wa.gov/sites/default/files/2025-11/2025-12-03-stormwater-code-and-manual-brief-for-cwc.pdf

Exhibit I. Three Creeks East — Staff Report and Hearing Examiner Decision

Clark County Community Development, staff report dated January 7, 2026, and decision of the Land Use Hearing Examiner dated March 3, 2026, for parcels on NE 179th Street east of Interstate 5.

Exhibit J. Viers PUD — Staff Report and Recommendation

Clark County Community Development, for an 84-lot planned unit development on 44.47 acres in the R1-20 zone and Mill Creek Overlay District at NE 174th Street and NE 50th Avenue.

Exhibit K. Salmon Creek Apartments Preliminary Technical Information Report

Prepared by C.E.S. NW, Inc., March 2026, for parcels at 16001 NW 11th Avenue. Includes the April 2025 Geotechnical Engineering Study by Soil and Water Technologies, Inc.

Exhibit L. Rosemere Neighborhood Association v. Department of Ecology and Clark County, PCHB No. 10-013

Pollution Control Hearings Board, Findings of Fact, Conclusions of Law, and Order, January 5, 2011. Affirmed, No. 41833-9-II (Wash. Ct. App. Div. II, September 25, 2012).

Available at: https://ecology.wa.gov/getattachment/de865fad-d789-4cf4-9737-71162c185b0a/RosemereVecy_ClarkCoPCHBRulingJanuary52011.pdf

Exhibit M. Clark County Stormwater Management Program Plan, 2021

Clark County Public Works, Clean Water Division, March 2021, submitted to the Department of Ecology.

Available at: https://clark.wa.gov/sites/default/files/media/document/2021-03/2021%20SWMP.pdf

Exhibit N. Clark County Stormwater Management Program Plan, 2020

Clark County Public Works, Clean Water Division, March 2020, submitted to the Department of Ecology.

Available at: https://clark.wa.gov/sites/default/files/dept/files/public-works/Stormwater/Regulations_Codes/2020%20FINAL%20SWMP%20.pdf

Exhibit O. Ecology Environmental Report Tracking System Incident #737260

Washington State Department of Ecology, Southwest Regional Office, Water Quality. Incident reported February 25, 2025 for the Salmon Creek Ridge subdivision, incident date February 22, 2025. Responsible party listed as Rotschy Inc. / Hinton M&H Subdivision.

Exhibit P. Clark County Stormwater Management Program Plan, 2026

Clark County Public Works, Clean Water Division, March 2026, submitted to the Washington State Department of Ecology under the Phase I Municipal Stormwater Permit.

Exhibit Q. Urban Tree Canopy Assessment, Clark County Urban Growth Areas

Prepared by PlanIT Geo, Inc. for the Clark Conservation District and Clark County Public Works, May 2025. Funded through an Urban and Community Forestry grant from the Washington State Department of Natural Resources.

Available at: https://clark.wa.gov/sites/default/files/2025-07/clark-county-wa-urban-tree-canopy-assessment-report-july1_reduced.pdf

Exhibit R. Clark County Annual Report for Calendar Year 2025, Phase I Municipal Stormwater Permit

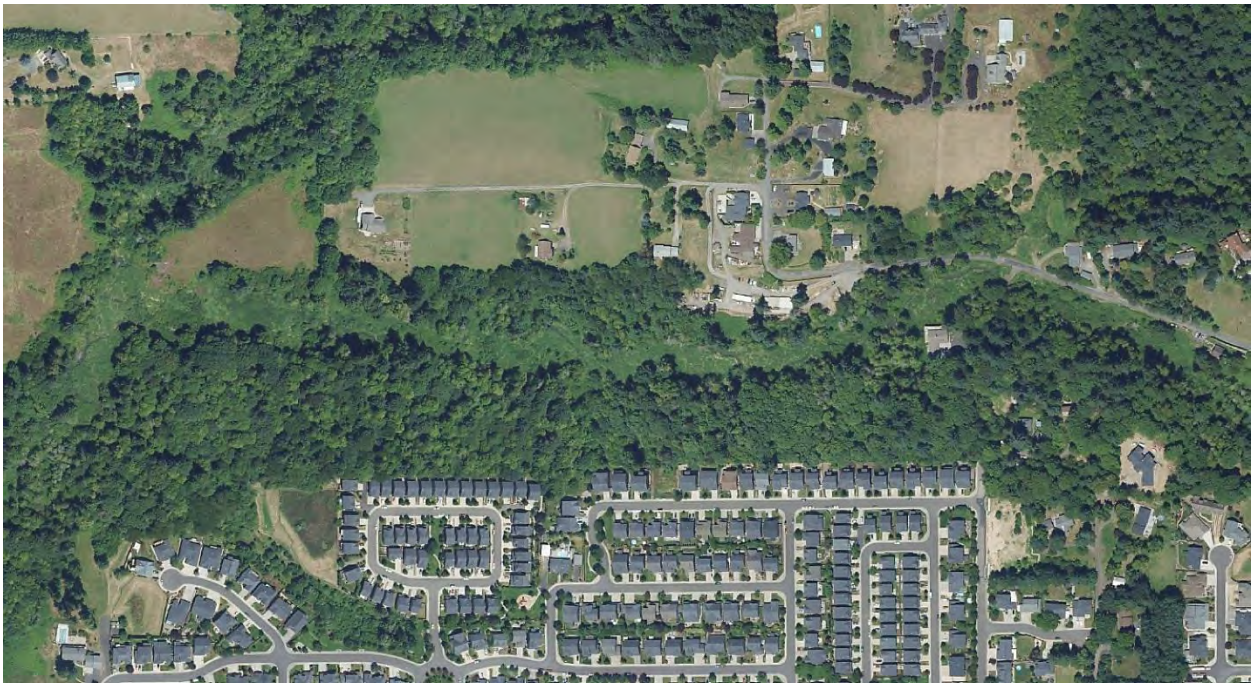
Clark County Public Works, Clean Water Division. Submitted to the Washington State Department of Ecology under permit WAR044001 and certified March 25, 2026. Questions 36, 37 and 39 are cited in this comment.

Exhibit A

Clark County
Whipple Creek Watershed-Scale Stormwater Plan Report

Submitted in Fulfillment of Municipal Stormwater Permit Condition S5.C.5.c

September 2017



Prepared by Clark County with Otak, Inc. and FSC Group



FCS GROUP
Solutions-Oriented Consulting

Foreword

Report Purpose and Budget Impacts

The actions listed in the Whipple Creek Watershed-Scale Stormwater Plan Report (Report) implementation plan are not part of the Clark County Stormwater Program Plan submitted under Permit condition S5.A., which is supported by the current County budget. The Report is created solely to meet Permit requirement S5.C.5.c.

No new actions in the Report are supported by the current County budget approved by the Clark County Board of County Councilors (BOCC). Implementation of any new action in this plan, not currently supported by the County budget, is subject to future budget approval by the BOCC. The Report may only be used to guide county planning for future actions to improve Whipple Creek stream health.

Submittal of this plan to Washington Department of Ecology has no budget impacts.

Submittal for S5.C.5.c: Whipple Creek Watershed-Scale Stormwater Plan Report

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Introduction

A. Summary

The Whipple Creek Watershed-Scale Stormwater Plan Report (Report) is presented to fulfill condition S5.C.5.c of Clark County's National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Stormwater Permit (Permit), issued by the Washington Department of Ecology (Ecology).

The Report documents the results of a high-level conceptual exercise to estimate the magnitude of effort needed to meet state-established water quality standards and in-stream flow conditions for the Whipple Creek watershed. The watershed spans about 12 square miles in southwest Clark County, Washington. It is situated north of Salmon Creek and south of Gee and Flume Creeks. Nearly five square miles of the upper watershed is inside the Vancouver urban growth area (UGA).

The analyses in this Report relied on water quality and hydrology data in the watershed collected by Clark County over the past ten or more years. Observed conditions in the streams were used to calibrate computer models of the watershed, which allowed the County to estimate the effects of future planned land uses on Whipple Creek's water quality and in-stream conditions. Results generated by simulated future land use conditions did not meet some state water quality standards and did not result in in-stream flow conditions that would allow salmon and other aquatic life to thrive.

Numerous watershed-scale management strategies directly supportive of aquatic life were considered and some were simulated in the models. With full implementation throughout the watershed of strategies described in this plan, Whipple Creek would be predicted to meet state water quality standards for dissolved metals and temperature and to have improved (reduced) levels of fecal coliform bacteria. Modeled strategies did not appear capable of providing stream flow similar to a forested watershed that would fully support salmon and other aquatic life; although some improvements compared to current degraded conditions would be expected.

Full implementation could incur capital expenditures of $346 million and ongoing operational costs of $4 million annually.

B. Purpose and Background

Knowledge about the adverse impacts of stormwater runoff on water bodies is changing rapidly. Most stormwater mitigation is applied site-by-site as land is converted from forest or fields to roads, parking lots, buildings, and lawns.

To analyze approaches to protecting streams and lakes, King County studied the predicted effects of alternative strategies in a single watershed. Juanita Creek is an urbanized 6.8 square mile watershed in King County and the City of Kirkland which was developed before current water quality treatment and flow control standards were required in western Washington.

In 2012, King County and partners published the *Stormwater Retrofit Analysis and Recommendations for Juanita Creek Basin in the Lake Washington Watershed* under a grant from Ecology. The retrofit analysis studied numerous stormwater management scenarios in an attempt to find a strategy or combination of

strategies that would improve flow and water quality conditions to support fish use and other aquatic life in the watershed's streams (King County, 2012).

The Juanita Creek study found that if small distributed on-site stormwater management facilities (called low impact development (LID)) were applied to nearly all impervious surfaces and if larger traditional end-of-pipe treatment and detention facilities were constructed to retrofit most impervious surfaces up to contemporary treatment and flow control standards, Juanita Creek's streams would achieve the goals at an estimated cost of $1.4 billion (King County, 2012).

On the heels of the Juanita Creek plan, Ecology began requiring each of the four Phase I western Washington counties – King, Snohomish, Pierce, and Clark – to conduct a similar study on an urban or urbanizing watershed. In its 2013-2018 Permit, Ecology required Clark County to select a watershed and perform watershed-scale stormwater planning as outlined in Permit section S5.C.5.c. The Permit-stated objective was to "identify a stormwater management strategy or strategies that would result in hydrologic and water quality conditions that fully support 'existing uses' and 'designated uses,' as those terms are defined in WAC 173-201A-020, throughout the stream system.[1]"

In June 2014, Clark County submitted a scope of work and schedule outlining its plan to complete the watershed-scale stormwater planning requirement in the Whipple Creek watershed. Ecology approved the County's scope in September 2014 and set a deadline of September 6, 2017 for submittal of a final report. Appendix R includes the approved scope of work.

Clark County's scope of work identified tasks necessary to meet specific sub-requirements of the watershed-scale stormwater planning requirement and to gather sufficient data to simulate Whipple Creek's hydrology and water quality in a computer model. The model, calibrated to Whipple Creek's observed current conditions, would then be used to simulate future development and stormwater management strategies in an attempt to find strategies that would attain designated uses.

Clark County, together with Otak, Inc., implemented the scope of work from 2014 to 2017.

The result is a conceptual watershed-scale stormwater plan report for Whipple Creek presented here to satisfy Permit requirement S5.C.5.c.

C. Regulation

The Clean Water Act (CWA) of 1972 is the principal federal law regulating discharge of pollutants into streams, rivers, and lakes. It controls discharges of pollutants by regulating both industries and government entities, such as cities and counties, which operate storm sewer systems that collect and discharge polluted stormwater runoff from urban and suburban areas. The National Pollutant Discharge Elimination System (NPDES) is the CWA's permitting program.

The CWA relies on the concept of designated uses to set goals for water quality. At a minimum, any existing use that the water body supported in 1974, such as fishing, swimming, or providing drinking water, must be maintained.

[1] WAC means Washington Administrative Code.

The Washington State Water Pollution Control Act (RCW 90.48) similarly protects surface waters of Washington State and ground water from discharge of contaminants, and it tasks Ecology with setting water quality standards.

In Washington, the CWA's NPDES permitting program is delegated by EPA and administered by Ecology. Ecology establishes designated uses, which may equal or exceed the CWA's existing uses, for Washington's surface waters. Ecology sets water quality standards that, if met, would theoretically sustain the designated uses. Ecology issues municipal stormwater permits and state waste discharge permits pursuant to the CWA and RCW 90.48. Clark County's Permit is issued under this program. The Clark County Permit authorizes the discharge of stormwater from the county storm drainage system to waters of the state.

D. Water Quality Goals

Washington Administrative Code (WAC) Chapter 173-201A establishes water quality standards for Waters of the State. Standards are set for each water body based on its existing uses and designated uses.

Ecology has not established individual designated uses for Whipple Creek, so default uses apply. The highest default uses are primary contact recreation and salmonid spawning, rearing, and migration.

This Report analyzes and models those water quality constituents required by the Permit, and provides a cursory analysis of parameters relating to Whipple Creek's designated uses that are not specifically required to be evaluated in this Report by the Permit. Water quality standards used as the basis for analysis are shown in Table 1.

Table 1: Designated Uses and Water Quality Standards for Whipple Creek Discussed in this Report

Parameter	Applicable Designated Use	State WQ Standard Criteria
Temperature	Aquatic Life: salmonid spawning, rearing, and migration	7-Day Average Daily Maximum (7-DADMax) of 17.5°C
Fecal Coliform	Primary contact recreation	< geometric mean of 100 colonies / 100 mL and <10% of samples: 200 colonies / 100 mL
Dissolved Copper	Aquatic Life – most sensitive biota: Toxic substances	Acute and chronic criteria math formulas incorporating water hardness
Dissolved Zinc	Aquatic Life – most sensitive biota: Toxic substances	Acute and chronic criteria math formulas incorporating water hardness

E. In-Stream Hydrology Goals

The ultimate goal of the state is to restore designated uses, chiefly to provide adequate habitat and in-stream flow conditions to ensure the survival and recovery of native salmon.

Hydrology and water quality models, however, do not directly estimate the ability of a stream to support fish populations. To account for this, the Permit requires in-stream flow conditions (hydrology) to be used as a surrogate for stream biologic integrity - a stream's ability to support aquatic life from the bottom of the food chain to the top.

This Report uses four different methods to correlate modeled hydrology to stream biologic integrity, as described below.

i. Relationship of Flow Metrics to B-IBI Score

The Benthic Index of Biological Integrity (B-IBI) is a widely used indicator of stream biologic health in the Pacific Northwest. The index uses a multi-metric analysis of macroinvertebrate taxa (bugs) that are present in gravel riffles of wadeable streams.

The Permit requires the County to use a statistically valid relationship between one or more stream flow metrics reported by the hydrology model and B-IBI score.

The applicability to Whipple Creek of several hydrologic metrics that are commonly used in the Pacific Northwest were evaluated, emphasizing those from research done on Puget Sound lowland streams (DeGasperi *et al*. 2009). Metrics are calculated using daily average flows.

Using Clark County's long-term local monitoring data and statistical regression, three hydrologic metrics were evaluated for use in a correlation to B-IBI score: 1) T_{Qmean}; 2) High Pulse Count (HPC); and 3) High Pulse Range (HPR). Table 2 provides a definition for each metric and for high flow pulse, which is the base observation for two of the calculated metrics.

Table 2: Hydrologic Metric Definitions and Selection Status

Hydrologic Metric	Definition	Selection Status
TQmean *	Fraction of a year that the daily mean discharge rate exceeds the annual mean discharge rate	Selected for use in Report
High Flow Pulse ~	Occurrence of daily average flows that are equal to or greater than a threshold set at twice (two times) the long-term daily average flow rate	N/A – this is a base metric used to calculate HPC and HPR
High Pulse Count (HPC) ~	The number of days each water year that discrete high flow pulses occur	Selected for use in this Report
High Pulse Range (HPR) ~	The range in days between the start of the first high flow pulse and the end of the last high flow pulse during a water year	Not selected for use in this Report

Sources: Booth *et al.* (2001, pp. 19-20) * and DeGasperi *et al.* (2009, pp. 512 and 518) ~

Six Clark County watersheds were eligible for inclusion in the evaluation of a statistically valid relationship between flow metrics and B-IBI. The three criteria for inclusion in the study were similarity to Whipple Creek and presence of sufficient B-IBI and continuous flow monitoring data. Two metrics were selected for use in this Report – T_{Qmean} and HPC, described below. A detailed discussion of the analysis can be found in Appendix H.

T_{Qmean}

The T_{Qmean} metric has previously been used by Clark County and in the Puget Sound area (Booth *et al.*, 2001). All three metrics were used in a more recent Puget Sound lowland study (DeGasperi, *et al.*, 2009).

Linear regression showed that only T_{Qmean} using the equation below had a significant relationship to B-IBI based on local data:

$$\text{Avg B-IBI} = -16.7 + 154 \text{ Avg } T_{Qmean}$$

Further analysis during the effort to calibrate a hydrology model to observed conditions in Whipple Creek (see Chapter II) resulted in adjustments to the equation's coefficients. This Report uses a linear relationship between T_{Qmean} and B-IBI that best fits observed conditions to estimate future B-IBI scores under future planning scenarios in Whipple Creek.

The equation used in this Report for calculating B-IBI from T_{Qmean} is:

$$\text{Avg B-IBI} = -24.1 + 154 \text{ Avg } T_{Qmean}$$

High Pulse Count (HPC)

Although it was not found to have a statistically significant relationship to B-IBI score in Whipple Creek based on local data, this Report also uses the relationship between HPC and B-IBI published by King County in its Juanita Creek basin plan.

The equation used for calculating B-IBI from HPC is:

$$\text{Avg B-IBI} = 53.05 + -30.106 \log_{10} \text{Avg HPC (King County, 2012)}$$

ii. Using Flow Metrics to Estimate Salmonid Use Attainment

As required by the Permit, B-IBI scores are used to estimate future aquatic biologic integrity as described above. This Report also uses two other indicators of whether a stream can support salmonid uses (salmonid use attainment): direct correlations between HPC and salmonid use attainment and between T_{Qmean} and salmonid use attainment.

Context

In 2014, Ecology used B-IBI scores to list streams that did not meet narrative standards for salmonid uses. The criteria ranges Ecology used were: greater than 37 for fully supporting beneficial uses, less than 28 for non-supporting , and 28 through 37 for waters of concern (Ecology, 2014).The B-IBI metric has a top score of 50. Non-supporting streams were listed on the State 303(d) List, which officially records impaired waters under the CWA.

Table 3: Correlation of B-IBI to Salmonid Use Attainment for Ecology's 303(d) Listing

	Salmonid Uses		
	Non-supporting	Partially Supporting	Fully Supporting
B-IBI	<28	28-37	>37

Because sub-watershed-scale pool-riffle sites having both flow data and B-IBI scores are extremely rare in western Washington, statistical conclusions about relationships between flow and B-IBI as described above, are weak. There is scant data and a great deal of scatter in correlating flow metric to B-IBI scores.

B-IBI itself is an indirect indicator of a stream's ability to support salmonid uses. B-IBI is a measure of the health of aquatic macroinvertebrates, not fish. Many stream and watershed conditions other than hydrologic regime influence B-IBI scores. These include channel substrate quality, temperature, and the presence of pollutants from urban runoff and other sources.

High Pulse Count (HPC) and T_{Qmean}

To account for the difficulties with B-IBI, this Report also uses HPC and T_{Qmean} to evaluate whether Whipple Creek will meet standards for salmonid uses under future scenarios.

A review of King County's analysis of flow and water quality targets for a Water Resource Inventory Area 9 planning project (Horner, 2013) reveals that flow metrics can be directly correlated to salmonid use attainment. A discussion of this analysis can be found in Appendix I.

King County recognized HPC as one of the more useful metrics for calculating the B-IBI score. Horner found that sites having HPCs between 3 and 7 generally supported salmon use (using B-IBI score range greater than 35). The report also found that very low B-IBI scores (< 16) were associated with HPCs above 15. B-IBI scores above 25 were associated with HPCs less than 11.

King County published a regression equation for HPC and B-IBI (King County, 2012). Clark County data also showed increasing B-IBI with lower HPC, making it a viable indicator based on local data and the Puget Sound results.

Table 4: Correlation of HPC to Salmonid Use Attainment

	Salmonid Uses		
	Non-supporting	Partially Supporting	Fully Supporting
HPC Range	>11	7-11	<7

The King County analysis also identified T_{Qmean} as a useful metric for calculating the B-IBI score. Evaluation of Clark County data for basins similar to Whipple Creek found a strong correlation. King County published a regression equation for T_{Qmean} and B-IBI (King County, 2012).

Clark County data suggest that a T_{Qmean} of about 25% to 27% is equivalent to the threshold for streams that do not support salmonid uses (non-supporting) and that about 37% is the lower threshold for streams that fully support salmonid uses (fully supporting).

Table 5: Correlation of TQmean to Salmonid Use Attainment

	Salmonid Uses		
	Non-supporting	Partially supporting	Fully Supporting
TQmean	10-27 %	28-37 %	>37 %

High Pulse Range was not used because it was not appropriate for the short time period modeled in Whipple Creek. It would be more appropriate to model results for decades.

Introduction

This Report describes the results of modeled future scenarios in terms of all three indicator metrics: B-IBI, HPC, and T_{Qmean} and correlates each metric to salmonid use attainment as described above.

I. Existing Conditions

A. Watershed Setting

The Whipple Creek Watershed spans about 12 square miles in southwest Clark County, Washington. It is situated north of Salmon Creek and south of Gee and Flume Creeks. Nearly five square miles of the upper watershed is inside the Vancouver urban growth area (UGA).

Whipple Creek flows generally west from headwaters east of Interstate-5 (I-5) between Vancouver and Ridgefield to Lake River. The confluence with Lake River is just six miles upstream of the Columbia River. The watershed includes an area draining directly to Green Lake on the Columbia River floodplain.

Currently, the watershed is moderately developed with rural and agricultural areas in the western portion. The Vancouver UGA in the east is rapidly urbanizing. Suburban and large-lot rural residences are common in the lower watershed outside of the UGA. I-5, a major interstate transportation corridor, traverses nearly two miles of the upper watershed.

The creek is thought to be degraded in terms of hydrology, water quality, and salmon habitat compared to its historic condition.

Data about existing conditions in the watershed were collected and described following Tasks 1 and 2 of The Whipple Creek Watershed-Scale Stormwater Planning Scope of Work and Schedule, June 2014.

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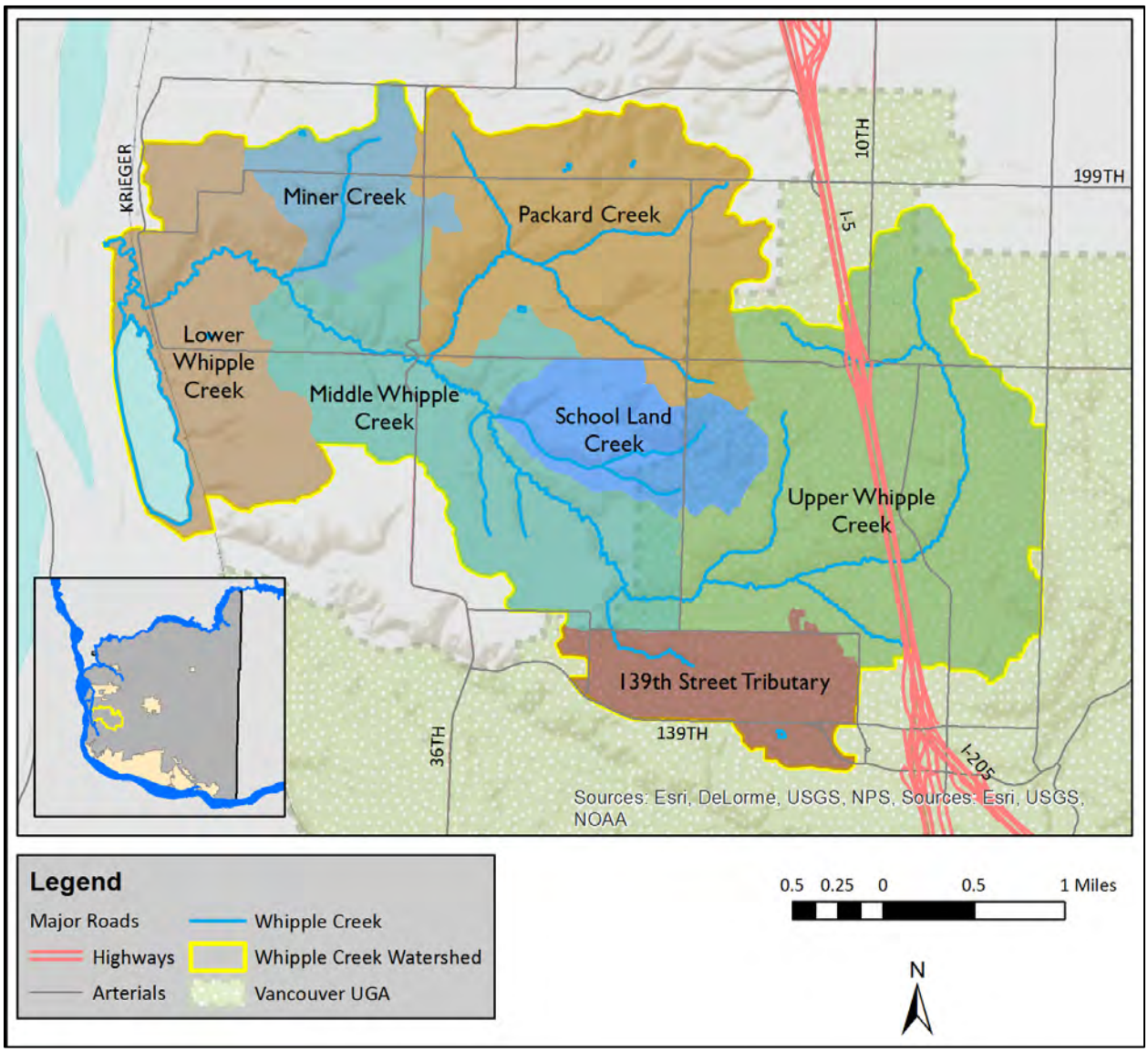
i. Basins

Whipple Creek has several important tributaries and about nine miles of main stem, divided into upper, middle, and lower. See Figure 1.

Figure 1: Whipple Creek Study Area



Lower Whipple Creek

Lower Whipple Creek begins where the creek meets Lake River a few miles upstream of the Columbia River. It includes Green Lake. The lowermost portion of this basin has a broad floodplain and is tidally influenced by the Columbia River. It also includes an area where small streams drain directly to Green Lake on the Columbia River Flood Plain. Further upstream, the creek also flows through a broad floodplain and contains potential salmon spawning habitat. Just below Packard Creek, large trees and good riparian corridors remain. The creek is nearly flat here. The area is characterized by agricultural uses.

Middle Whipple Creek

Middle Whipple Creek has some potential salmon habitat and pool-riffle sequences that have potential for salmon habitat restoration in its lower reaches. An important long-term water quality and stream flow monitoring site is located on the main stem downstream of the confluence with Packard Creek. Near the School Land Creek tributary, beaver ponds are numerous. The creek is nearly flat here. The area is characterized by rural and agricultural uses.

Upper Whipple Creek

The lower reaches of Upper Whipple Creek also have some low gradients and beaver ponds. Most headwater streams in Upper Whipple Creek have high gradients and flow through narrow canyons. All of Upper Whipple Creek is in the Vancouver Urban Growth Area (UGA). The I-5 corridor and the southeast portion of this basin are urbanized already while other areas of future growth are still characterized by open agricultural tracts. There is a full fish passage barrier at I-5.

Miner Creek Tributary

Miner Creek has salmon spawning gravel and the best water quality conditions in the watershed. The stream has good riparian corridors. The area is characterized by agricultural uses.

Packard Creek Tributary

Packard Creek is the largest tributary to Whipple Creek. The creek has gravel channel substrate providing salmon habitat. Stream conditions and water quality are degraded as a result of rural land uses and urbanization in headwaters along I-5. The stream has good riparian corridors. Packard Creek provides an opportunity for salmon habitat restoration. The area is characterized by agricultural uses.

School Land Creek Tributary

The School Land Creek tributary is an area where Clark County has significant land holdings. It has potential salmon habitat that is likely blocked by a culvert. The tributary has good riparian corridors, particularly within Whipple Creek Park.

139 St Tributary

The tributary to Whipple Creek at NW 139th Street drains an urbanized area in the UGA. Stream hydrology is greatly altered due to urban runoff. The area developed over the last 30 years.

ii. Topography

Whipple Creek is a part of the Columbia Slope watershed, which generally falls to the west toward the Columbia River. Upper reaches of the main stem and tributaries originate in rolling hills with a maximum elevation of about 350 feet. The creek ends in a broad wetland floodplain where it meets Lake River at 10 feet above sea level.

Headwater streams tend to flow through deep valleys with little or no room for a floodplain. The lower main stem flows through a broad floodplain as wide at 800 feet in the lowest reaches. Packard Creek also has a wide floodplain in its lower reaches. Floodplains tend to be bounded by deep, steep valleys (Inter-Fluve, 2006).

iii. Geology and Soils

The basin is covered mostly with deposits of sands and silts from the Late Ice Age Missoula Floods or Cataclysmic Floods. These deposits are moderately to poorly drained and have moderate to high erodibility. In some areas of the basin, weathered deposits of the Troutdale Formation gravels are at or near the surface. The weathered Troutdale Formation deposits are rich in clay and have very slow infiltration rates.

Most stream channels are characterized by highly erodible fine sediments, with only a few reaches characterized by coarse sediments (Inter-Fluve, 2006), such as the cobbles and gravels favored for spawning by many species of native fish.

iv. Wildlife

Beaver are known to live and to build dams in the main stem and some tributaries. Extensive sediment deposits can accumulate behind beaver dams and may contribute to filling incised stream channels. Ponds behind beaver dams may suffer from high nutrients, sediment, and high temperatures (Clark County, 2006).

The watershed is also home to deer, raccoon, song-birds, waterfowl, amphibians, and mussels (Clark County, 2006). Invertebrates found in streams form the base of the food chain for native fish.

Clark County staff found no anadromous fish (fish that migrate from freshwater to the ocean and back to spawn, including salmon and steelhead), no crayfish, and few resident fish while conducting fieldwork for the 2006 assessment of Whipple Creek (Clark County, 2006).

v. Vegetation

The Whipple Creek watershed, like most of western Washington, was once mostly forested.

Today, few large tracts of forest remain, and half of the land cover in the watershed is field, meadow, and pasture (Inter-Fluve, 2006). Invasive Himalayan blackberry are common, occurring on stream banks, in floodplains, and at times spanning the channel itself. In its assessment, Clark County staff noted that blackberries encroach to varying degrees from nearly every road crossing and stormwater outfall (2006).

Where riparian coniferous forest cover has been removed along the streams in many locations, fast-growing alders, succeeded by invasive species, now dominate (Inter-Fluve, 2006).

vi. County Storm Sewer Drainage

Clark County operates a municipal separate storm sewer system (MS4) throughout unincorporated Clark County and in the Whipple Creek watershed. The MS4 is a network of pipes and ditches along with water quality treatment and detention facilities.

The MS4 discharges to Whipple Creek and its tributaries through numerous outfalls. In its 2006 assessment, Clark County identified maintenance needs and significant impacts downstream of many of the county's outfalls. Common impacts described include erosion, invasive plant colonization, and trash accumulation (Clark County, 2006).

Many large agricultural lots drain directly to Whipple Creek or a tributary without first passing through the county's storm sewer.

vii. Land Use, Land Cover, and History

The watershed is a moderately developed rural and agricultural area, which is rapidly urbanizing in the UGA. Large-lot rural residences are interspersed with agriculture in the lower watershed outside of the UGA.

Historic dense coniferous forests were cleared by the early 1900s for building materials and agriculture, and the watershed has been home to a saw mill and shingle mill.

In 1978, *The Columbian* characterized Whipple Creek near the intersection of NW 179th Street and NW 41st Avenue as a "lazy, quiet stream" flowing through a traditional farming area (Sara) that was transitioning to rural large-lot development of 5-acre tracts (Columbian Archives, 2006).

Clark County's 2006 assessment records anecdotal accounts of the creek from longtime streamside landowners, which suggest the creek has changed over the past 50 years:

> Several landowners reminisced about the historical presence of steelhead and sea-run cutthroat trout on their properties. Others noted the disappearance of once-abundant crayfish populations…A number of residents commented they had not been near the creek on their property for years, citing impenetrable blackberry thickets as the reason (Clark County, 2006).

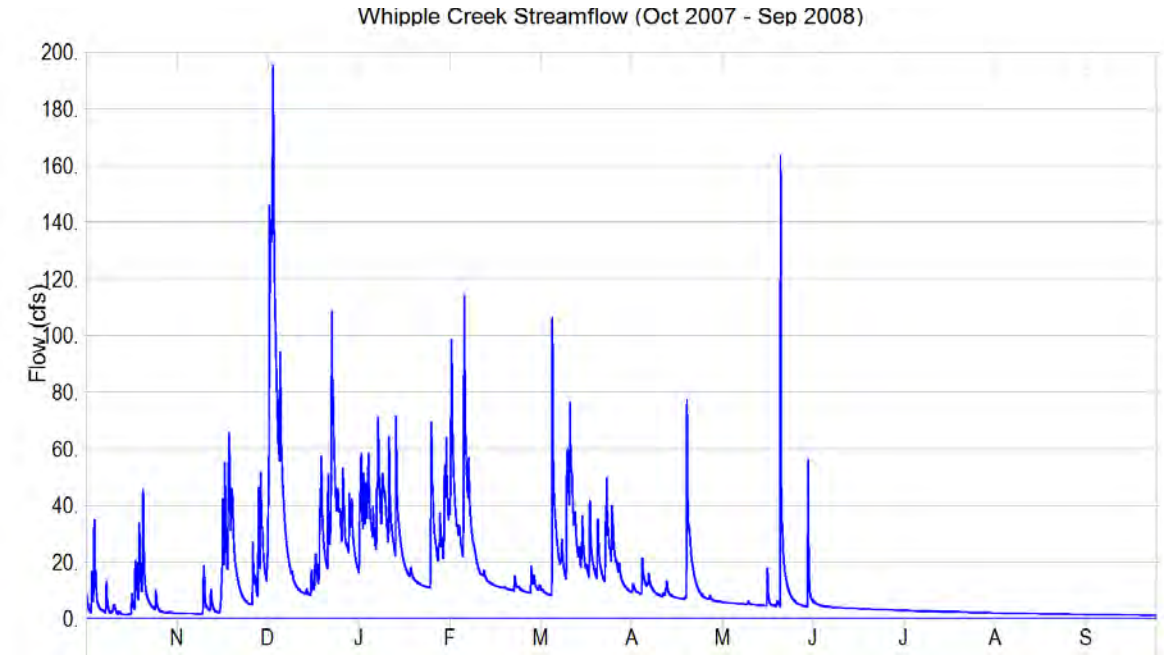
Changes in land use are continuing to impact Whipple Creek. In portions of the watershed that have been urbanizing since the 1980s, County staff observed several cases of downstream impacts such as incision and headcuts that appear to have occurred as a result of recent development projects (Clark County, 2006).

The percentages of land covers include 34% forested, 12% impervious, 51% non-canopy (fields/meadows), and 2% water (Inter-Fluve, 2006). Loss of historic forests has implications for channel stability, stream temperature, and stream habitat complexity. The county's 2006 assessment concluded that Whipple Creek has been heavily impacted by human activity in both rural and urban portions, and degraded areas far outnumber intact areas.

B. Hydrology

Whipple Creek can be described as a flashy stream, which means that the amount of flow in the creek changes quickly in response to rainfall from major storm events. Peak flows rise quickly in the stream channel during storm events and then once the rain stops the flows return to normal or low flow conditions. A graph of stream flow (hydrograph) illustrates these sharp peaks at a stream gage in the lower middle watershed in Figure 2, below.

Figure 2: Whipple Creek Observed Stream Flow at WPL050 Gage (in cubic feet per second (cfs))



This quick response to rainfall is the result of a number of factors.

Many of the soils in the watershed have low infiltration rates. Heavy rainfall does not soak into the ground but instead quickly runs off into the nearest stream. This surface runoff produces high peak flows, and the lack of infiltration produces low base flows. The replacement of forest with impervious surfaces intensifies this pattern.

Another major factor is that the upper portions of the main stem of Whipple Creek and headwater tributaries are relatively steep, as shown in Table 6.

Table 6: Whipple Creek Main Stem Channel Slopes

Channel	Reach	Length (mi)	Elev Change (ft)	Slope (%)
Upper	195	0.283	17.03	1.1%
Upper	190	0.832	20.77	0.5%
Upper	180	1.167	60.58	1.0%
Upper	175	0.194	12.86	1.3%
Upper	170	0.578	19.60	0.6%
Upper	160	0.733	18.40	0.5%
Middle	150	0.608	13.53	0.4%
Middle	140	1.080	14.72	0.3%
Middle	130	1.045	17.43	0.3%
Middle	120	1.095	35.12	0.6%
Lower	110	1.264	10.47	0.2%
Lower	100	0.773	4.08	0.1%
Total/Average		**9.652**	**244.59**	**0.5%**

These steep stream channel slopes produce high stream channel velocities and high peak flows. This, in turn, results in channel erosion through downcutting (also known as incision). Downcutting deepens the channel and prevents flood flows from overtopping the channel banks and spreading out onto the adjacent floodplain.

The stream channel slopes decrease in the middle portion of the main stem of Whipple Creek. This is a section of the stream channel where sediment deposition can occur and where beaver dams further encourage sediment deposition. Erosion that does occur in this section is mainly from the stream channel banks rather than the channel bottom.

The lower portion of Whipple Creek is in the Columbia River floodplain and the stream's bottom slopes are very low (0.1 to 0.2%). In this portion of the channel the stream velocities are lower than in the upper sections and the potential for sediment deposition is greater.

The total distance from the headwaters of Whipple Creek to its downstream confluence with Lake River is approximately 9.6 miles. During major storms the travel time for flood flows to reach the mouth of the creek is less than 24 hours.

Packard Creek, the main tributary to Whipple Creek, presents many of the same hydrologic characteristics. The upper section of Packard Creek's stream channel is steep and the slope flattens out near the confluence with Whipple Creek, as shown in Table 7.

Table 7: Packard Creek Main Stem Channel Bottom Slopes

Channel	Reach	Length (mi)	Elev Change (ft)	Slope (%)
Upper	225	1.266	171.66	2.6%
Middle	219	0.206	13.41	1.2%
Lower	210	1.030	43.66	0.8%
Total/Average		**2.502**	**228.73**	**1.7%**

Overall Packard Creek's stream channel is significantly steeper than Whipple Creek's channel.

In 2006, Clark County's 2006 assessment confirmed the presence of erosion in the watershed, noting that stream scour, incision, and channel instability were common. The county found that deliberate modifications to the channel (e.g. channel straightening, in-line ponds) were relatively infrequent. However, channel crossings from past agricultural activities and driveways are fairly common in tributaries.

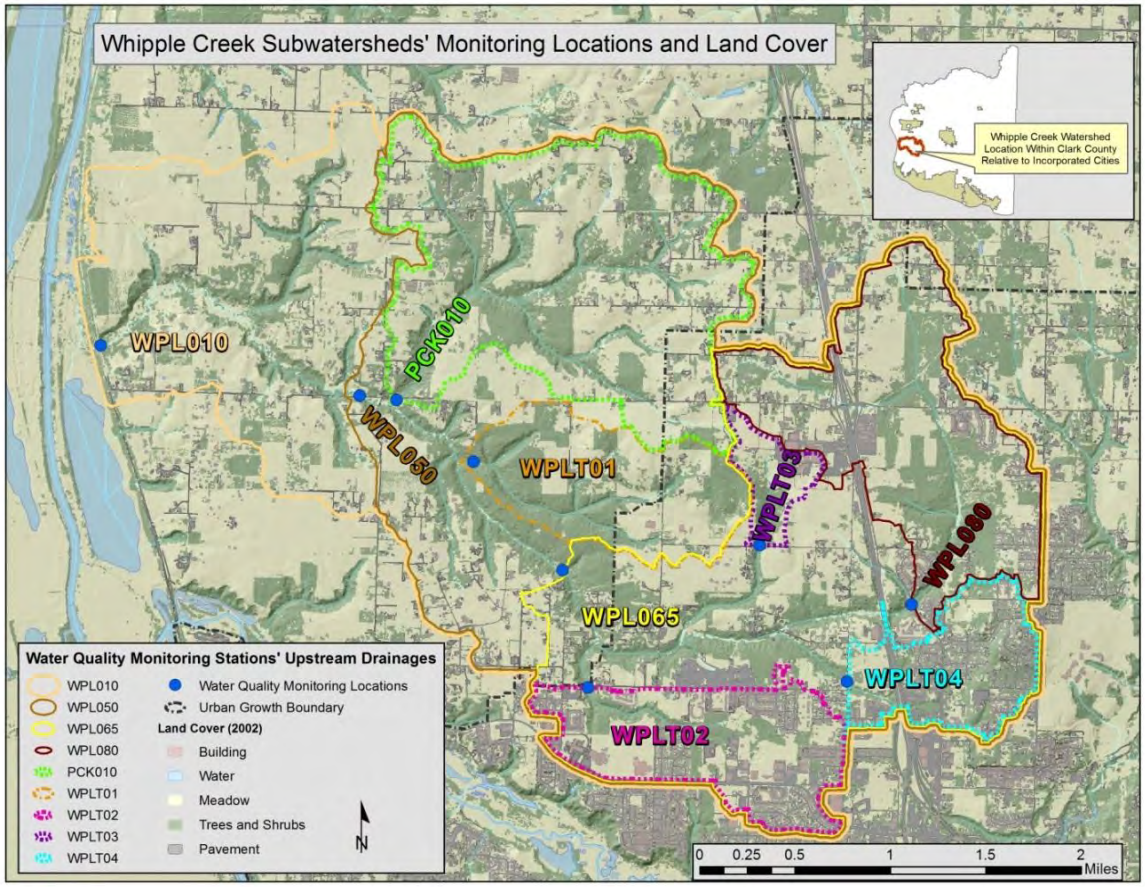
Stream hydrology has been altered as a result of development that occurred over many decades without stormwater detention. In addition, Inter-Fluve noted in its technical memo (2006) that because most development is occurring in the upper watershed, peak flows in the lower main stem could continue to increase significantly.

C. Water Quality

Information about water quality was gathered from several assessments and studies conducted between 2001 and 2015. Figure 3 shows nine stations where water quality data were collected at various times.

Appendix B contains a detailed assessment of Whipple Creek's water quality.

Figure 3: Monitoring Stations and Contributing Basins to Each Station



Water quality in the Whipple Creek watershed is often poor and is impacted by urban and rural development, which channels polluted runoff to the creeks. Ecology includes the lower main stem of Whipple Creek on its 303(d) Category 5 List of polluted waters for fecal coliform bacteria and temperature (Ecology, 2016).

High fecal coliform levels are a watershed-wide issue. The creek frequently exceeds the state's standards for primary contact recreation. Monitoring results suggest there are multiple sources of bacteria in the watershed. Typical sources are urban runoff carrying pet waste; rural non-point pollution from livestock; failing septic systems; and natural contributions from beaver, waterfowl, and other wildlife. Non-stormwater sources of bacteria such as these do not enter streams through the county's storm sewer system.

Long-term monitoring results show that Whipple Creek rarely exceeds state standards for either dissolved copper or dissolved zinc, suggesting that these urban pollutants are not limiting water quality in the watershed.

Table 8 summarizes the water quality parameters considered in the assessment of existing conditions and describes whether Whipple Creek meets state standards based on data collected in 2014 and 2015.

Table 8: Summary Comparison of Whipple Creek Water Quality to State Standards

Water Quality Parameter	State Designated Use Protection: Water Quality Standard Criteria & As Applicable Exceedance Frequency Limit	Met Water Quality Standard	Comments on 2014-2015 Watershed-wide Monitoring Results Exceedance of State Water Quality Standards Criteria
Temperature	Aquatic Life Use: 7-Day Average Daily Maximum (7-DADMax) of 17.5°C (63.5°F) once every 10 years on average	No	Most lower main stem and some tributary sub-watersheds commonly exceeded criteria especially during July & August, up to 87 and 77 times / year, respectively
Fecal Coliform	Primary Contact Recreation Use: < geom. mean of 100 cols./100 mL & < 10% of samples: 200 cols./100 mL Preferable to average by season of < 12 months	No	Except for WPL065 and WPL080 wet season, all of the other sub-watersheds exceeded the state's geometric mean criterion during both seasons. All the stations also exceeded the 10% criterion during both the wet and dry seasons.
Dissolved Copper	Aquatic Life Use: Criteria formula using water hardness Acute: 1 hr. avg. < once every 3 yrs. Chronic: 4 day avg.<once every 3 yrs. Apply both acute & chronic on average over 3 years	Mostly Yes	Only WPLT03 & WPLT04 exceed chronic and acute criteria and for both stations' criteria in only 6% of their respective samples. PCK010 exceeds chronic in 11% and acute in 6% of samples
Dissolved Zinc	Aquatic Life Use: Criteria formula using water hardness Acute: 1 hr. avg. < once every 3 yrs. Chronic: 4 day avg.<once every 3 yrs. Apply both acute & chronic on average over 3 years	Mostly Yes	Only WPLT03 exceeded either criterion but did so for both in only 6% of its samples

Three additional water quality parameters are of concern to Clark County. Dissolved oxygen, turbidity, and pH have standards established in state law to support the designated use of salmonid spawning, rearing, and migration. Whipple Creek is listed as a Category 2 water of concern for dissolved oxygen on the state's 303(d) List.

The Permit does not require consideration of these parameters. They are discussed in Appendix B but are not otherwise discussed in this Report.

D. Temperature

Information on existing conditions for temperature was gathered from the County's long-term temperature monitoring station at WPL050 and from watershed-wide temperature monitoring during the summers of 2014 and 2015.

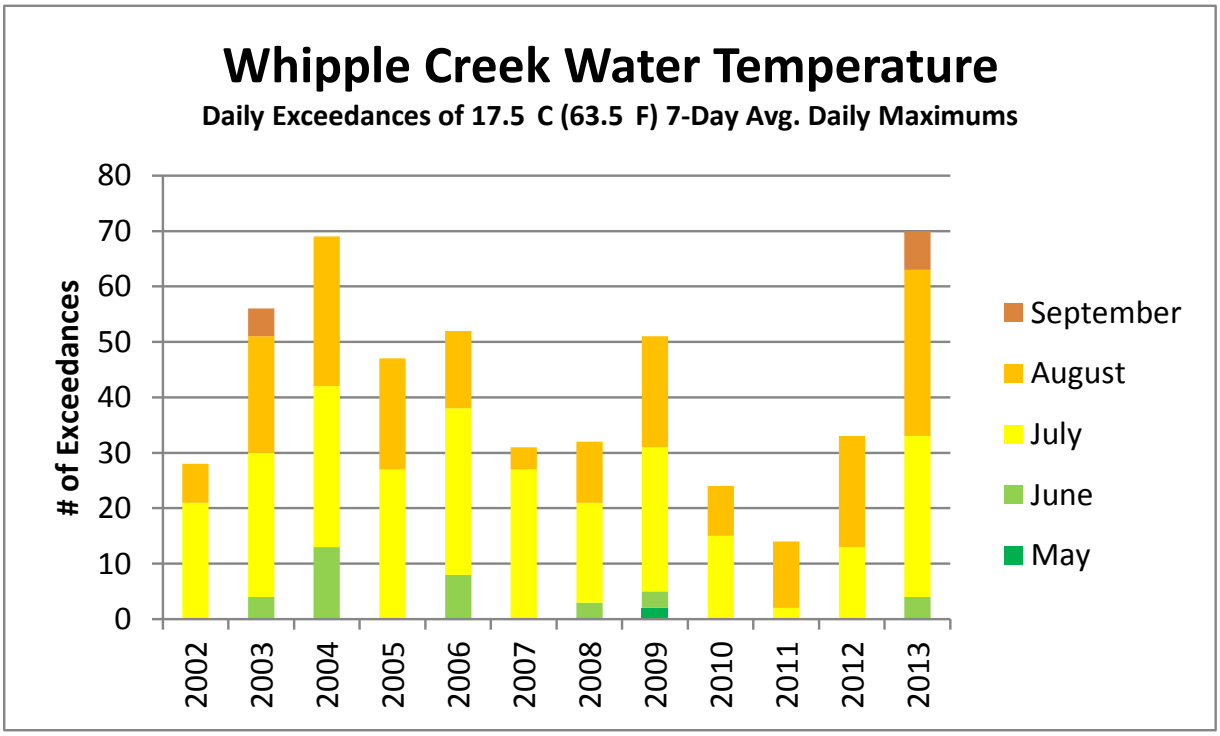
A detailed discussion of Whipple Creek's temperature is in Appendix B.

Whipple Creek is known to be warm and often exceeds temperatures known to kill or stress salmon and steelhead. High summer stream temperatures are frequent, peaking in July and August. Whipple Creek is on the state's 303(d) Category 5 List of polluted waters for temperature.

Long-term monitoring shows that the lower main stem has exceeded the 7-Day Average Daily Maximum temperature of 63.5°F established by the state between 13 and 70 times a year since 2002.

See Figure 4 for long-term exceedances at the WPL050 monitoring station in Middle Whipple Creek.

Figure 4: Lower Whipple Creek WPL050 Main Stem Exceedances of Temperature Criterion



E. Benthic Macroinvertebrates - Biologic Health

Information about existing conditions for biologic integrity was gathered from Clark County's long-term sampling site in the mid-watershed main stem as well as from sampling at four locations during 2014 and 2015.

A more detailed discussion of the macroinvertebrate sampling is in Appendix C.

In the summers of 2014 and 2015, the County sampled four locations to assess stream health based on the B-IBI score.

Whipple Creek appears to have poor biologic health. Low B-IBI scores consistent with streams not supporting salmonid uses were found in the rural Middle Whipple Creek, near the mouth of the rural Packard Creek tributary, and in the urbanized Upper Whipple Creek east of I-5. Miner Creek had B-IBI scores consistent with streams that partially support salmonid uses. Lower Whipple Creek is on the 303(d) Category 5 List of polluted waters for bioassessment.

Table 9: 2014 and 2015 Salmonid Use Attainment Based on B-IBI (Based on Observed Conditions)

Location	2014	2015
Lower Main Stem (WPL050)	Non-Supporting	Non-Supporting
Upper Main Stem (WPL080)	Non-Supporting	Non-Supporting
Miner Creek (MCT010)	Partially Supporting	Partially Supporting
Packard Creek (PCK010)	Non-Supporting	Non-Supporting

Key: Fully Supporting; Partially Supporting; Non-Supporting

F. Fish Distribution and Habitat

Data on fish distribution were gathered from the Statewide Washington Integrated Fish Distribution geodatabase (Washington State Department of Fish and Wildlife [WDFW], 2014) and the SalmonScape web page (WDFW, 2014).

A detailed discussion of fish presence and distribution is in Appendix D.

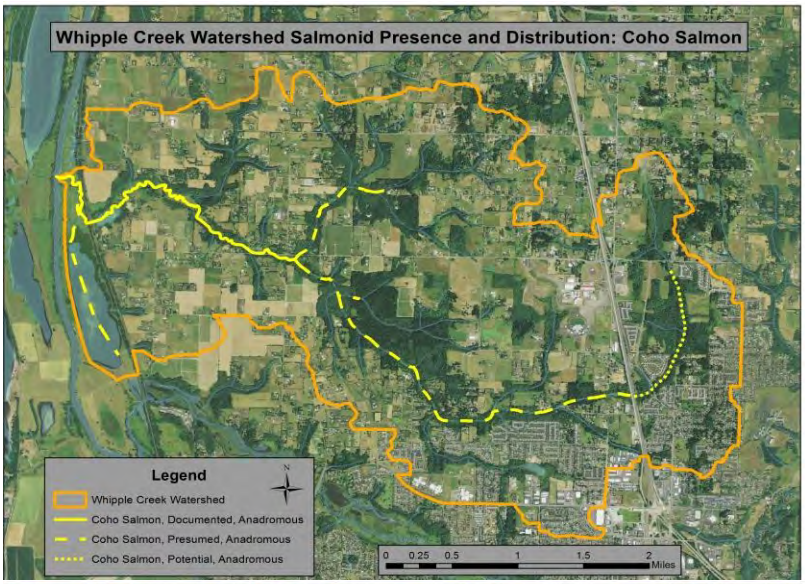
Figure 5 (next page) shows WDFW fish distribution maps for coho salmon, fall chinook salmon, and winter steelhead.

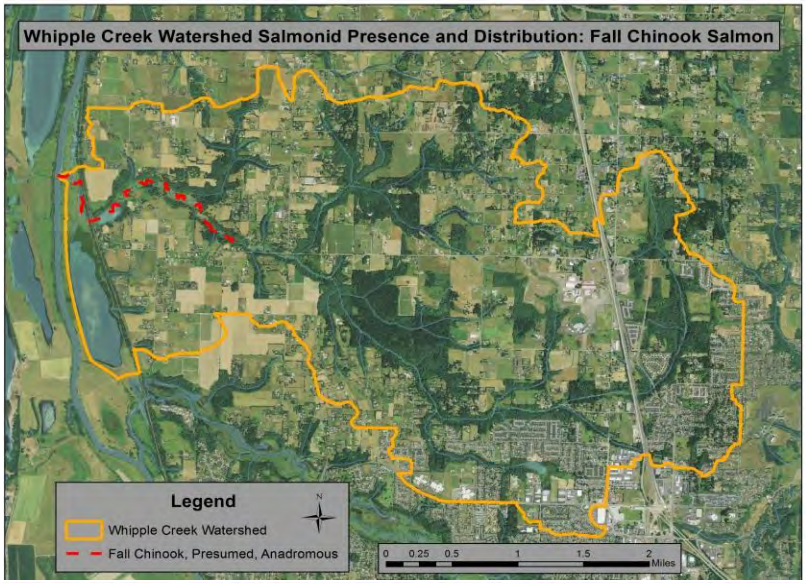
Field observations suggest a lack of spawning habitat for salmonids in the watershed. Low gradient channels are mostly bedded with sand and silt that is unsuitable for spawning, and fish passage barriers limit access to potentially good quality habitat (Inter-Fluve, 2006). The most suitable habitat has been identified in the lower watershed (Inter-Fluve, 2006).

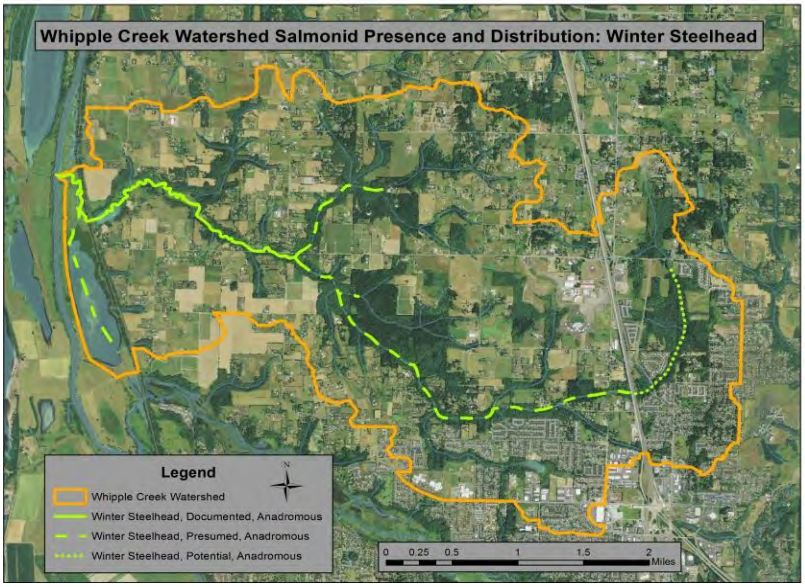
Several partial fish passage barriers exist in the main stem, and there is a complete barrier at I-5. The barrier at I-5 would prevent anadromous fish from using any portion of Whipple Creek upstream of there. There are also barriers in lower Miner Creek and School Land Creek.

Overall, the status of the Whipple Creek watershed's fish community appears degraded. Good quality salmonid habitat is very limited due to small stream sizes, substrate conditions, and passage barriers. Whipple Creek's anadromous fish are listed as Threatened under the Endangered Species Act, including fall Chinook, coho salmon, and winter steelhead.

Figure 5: WDFW Fish Distribution Maps







G. Areas of Special Attention

Information about areas of special attention in Whipple Creek was gather from historic field observations, existing reports, and geographic information system (GIS) data analyses. Such areas include riparian buffers, wetlands, hydric soils, floodplains, steep slopes, forests, valuable habitat zones, and other sensitive resource areas.

A detailed discussion of areas of special attention is in Appendix E.

II. Creating Models of Whipple Creek

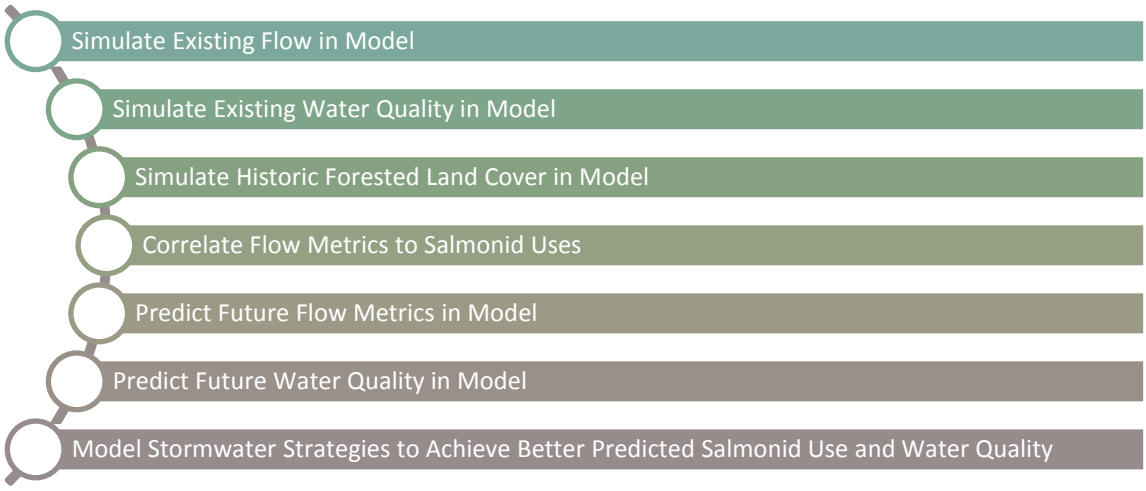
Models were calibrated following Task 3 of The Whipple Creek Watershed-Scale Stormwater Planning Scope of Work and Schedule, June 2014.

A. Purpose of Models

Stream hydrology and water quality change when land cover changes. Modification from forest to agriculture or to urban areas increases runoff and pollutants directed to creeks. As the Whipple Creek watershed develops over time, stream flow, the shape of the stream channel and banks, water quality, and temperature all change as a result of the impacts of stormwater runoff.

Using predictions of future land uses and land covers, this Report estimates future water quality and hydrologic conditions of Whipple Creek and its tributaries. Once the magnitude of potential impact is understood, the models can be used to test the effectiveness of stormwater management strategies and other strategies the County might use to mitigate the impacts of future development.

Figure 6: Purpose of Computer Models of Whipple Creek's Hydrology and Water Quality



Detailed discussions of hydrology model calibration and water quality model calibration are found in Appendices F and G.

B. Calibration Period and Data

Model calibration uses available data about precipitation, land cover, stream flow, pollutant concentrations, and air and stream temperatures in Whipple Creek from the recent past to match observed conditions as much as possible. Once calibrated, the models can be used to estimate hydrology, pollutant concentrations, and stream temperature under different future scenarios of land cover and stormwater management strategies.

The calibration period for both the hydrology and the water quality models was selected based on availability of the best quality stream flow data. The calibration period was for a five-year span beginning October 2003 and continuing through September 2008 (water years 2004 through 2008).

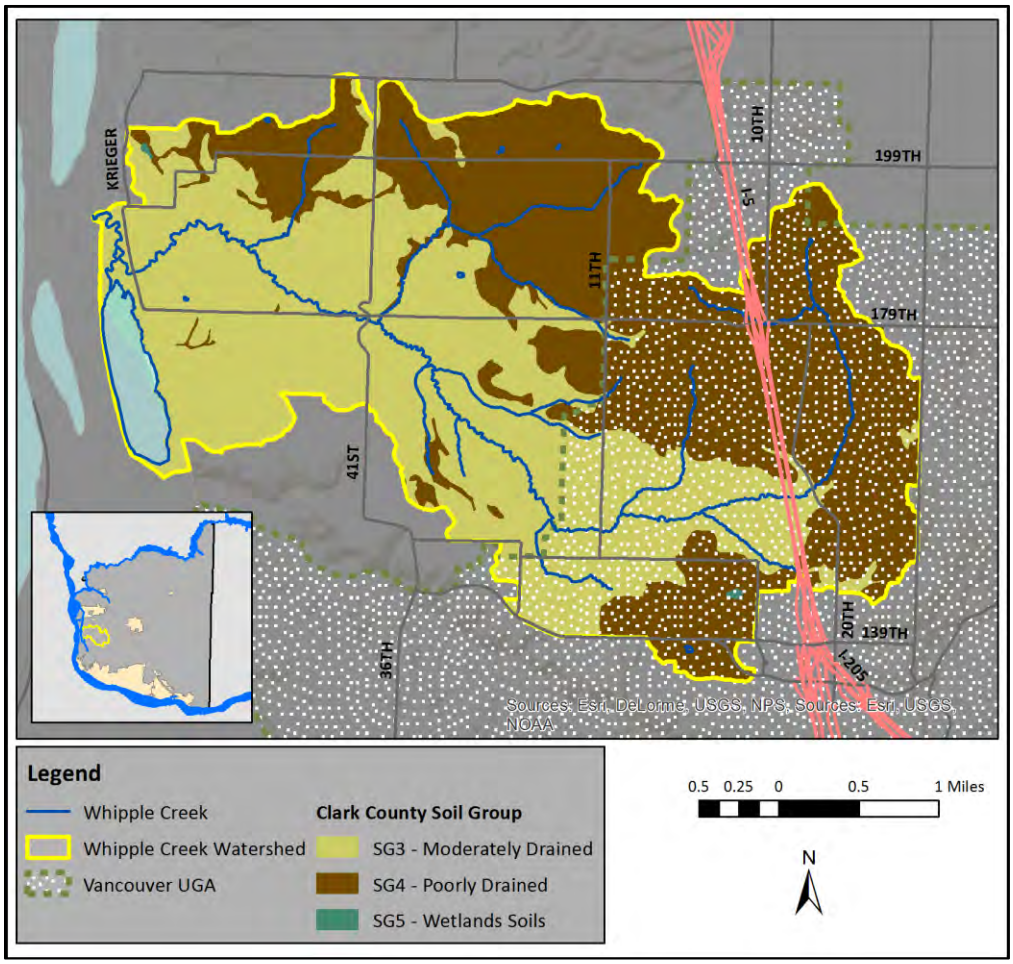
Data included continuous flow monitoring from Clark County's monitoring stations, stream temperature data, pollutant concentrations, and B-IBI collected and calculated as described in the assessment of Whipple Creek's existing conditions in Appendices B and C. The calibration for flow and water quality was at the WPL050 site.

Meteorological data (rainfall, evaporation, air temperature, cloud cover, dew point, temperature, wind speed, and solar radiation) were assembled from local sources for the calibration period.

Using infiltration capacity, soils in Clark County were grouped into five generalized categories. Underlying soils in the Whipple Creek watershed are a mix of moderately drained soils, poorly drained soils, and wetland soils. The following three soil groups were used in the model calibration:

1. SG3: Moderately Drained soils (hydrologic soil groups B & C)
2. SG4: Poorly Drained soils (slowly infiltrating C soils, as well as D soils)
3. SG5: Wetlands soils (mucks)

Figure 7: Whipple Creek Soil Groups

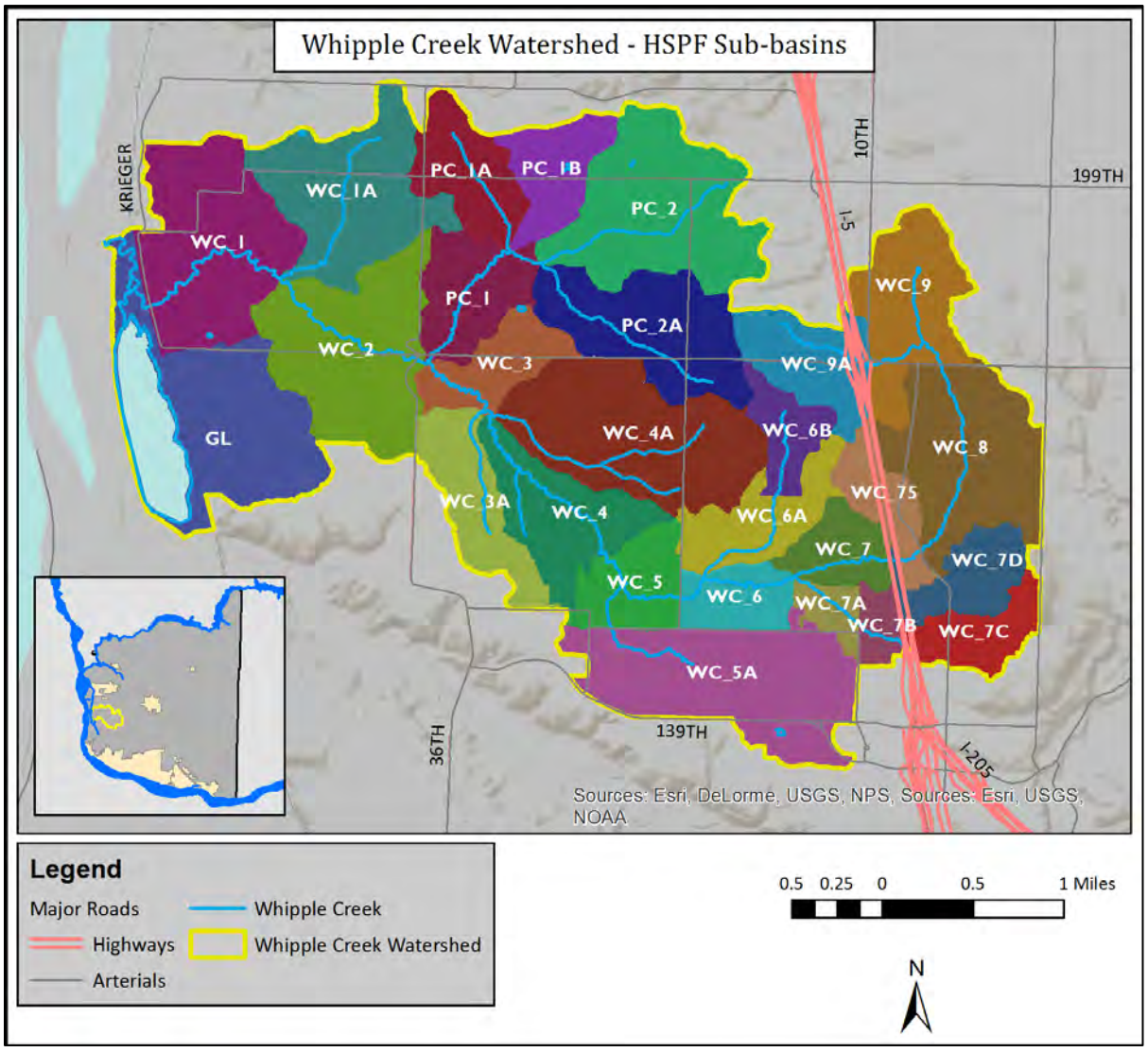


C. Hydrology Model Creation and Calibration

The Whipple Creek watershed hydrology model calibration produced a computer model of the contributing land area rainfall-runoff processes and stream flow routing from the upper end of Whipple Creek and its tributaries.

The hydrology model calibration required first dividing the Whipple Creek watershed into 27 sub-basins. The land area for each sub-basin was divided into bare soil, forest, grass, paved urban, and water land covers. The stream reach boundaries were selected based on topography, confluence with other major reaches, and flow travel time in the stream channel.

Figure 8: Modeled Sub-basin Boundaries



The calibration process is iterative and requires the input and adjustment of hydrologic parameter values and the comparison of simulated and recorded streamflow. Different hydrologic parameters and their values impact or change the timing and distribution of runoff. Some parameters represent

different soil and vegetation characteristics while other parameters represent different runoff processes.

Based on experience in calibrating other hydrology models in western Washington, appropriate hydrologic parameter values were selected for the calibration. The hydrology model computed the simulated stream flow using these values. The results were compared with the recorded (observed) stream flow at the WPL050 gage located on the main stem in Middle Whipple Creek below Packard Creek. The results were compared in terms of hydrograph shape and size for multiple major flood events, annual total runoff volume, and flow duration. Flow duration is the percent of time different size flows occur at the gage site.

After each comparison, the hydrologic parameter values were adjusted with the goal of producing a better fit or comparison with the recorded stream flow data. The calibration process ended when it was decided that the hydrologic parameter values produced the best results and no further adjustment of these parameters would improve the calibration.

Table 10 shows the model performance for each of four comparative measures.

Table 10: Hydrology Model Performance

Calibration Period (WY 2004-2008)	Whipple Creek	Overall Model Performance
Annual Volume Error	Very Good	Very Good
Daily Flow R Squared	Very Good	Very Good
Flow Duration Curves	Excellent	Very Good
Hydrographs	Good to Very Good	Very Good

The calibration provided a sound hydrologic model of Whipple Creek. The resulting model parameters were appropriate for evaluating the impact of hydromodification management strategies and calibrating a water quality model. The calibration results demonstrate a good representation of the observed data.

The specifics of the hydrology calibration, the final selection of hydrologic parameter values, and the comparison of the simulated and recorded streamflow data are described in detail in the hydrology model calibration report in Appendix F.

D. Water Quality Model Creation and Calibration

The Whipple Creek watershed water quality model calibration produced a computer model of the contributing land area pollutant-producing processes and transport of these pollutants from the upper end of Whipple Creek and its tributaries. This water quality model was used to model water quality for both existing land use and future development conditions.

The water quality model calibration followed the completion of the hydrology model calibration. After the hydrology model calibration was finished, then water quality inputs were added for the simulation of copper, zinc, fecal coliform, and water temperature.

The same sub-basins and stream reaches used in the hydrology model calibration were used to calibrate the water quality model. Pollutant loading rates were based on sub-basin impervious area, soil group, and vegetation category. Soil temperature was correlated to air temperature. The movement of the pollutants (copper, zinc, and fecal coliform) and the calculation of water temperature were based on the stream channel characteristics.

The calibration process was iterative and required the input and adjustment of water quality model parameter values and the comparison of simulated and recorded water quality constituents (copper, zinc, fecal coliform, and water temperature). Different water quality parameters and their values impact or change the timing and distribution of each individual constituent. Some parameters represent different soil and vegetation-related pollutant loading rates while other parameters represent different interactions with the meteorological input.

Based on experience in calibrating other water quality models in western Washington, appropriate model parameter values were selected for the calibration of copper, zinc, fecal coliform, and water temperature. The water quality model computed the simulated water quality results in Whipple Creek using these parameter values. The results were compared with the recorded (observed) copper, zinc, and fecal coliform concentrations and water temperature at the WPL050 gage. The results were compared in terms of seasonal and annual values.

After each comparison, the model calibration parameter values were adjusted with the goal of producing a better fit or comparison with the recorded data. The calibration process ended when it was decided that the final selection of model calibration parameter values produced the best results and no further adjustments would improve the calibration.

Table 11 shows the model performance for each constituent.

Table 11: Water Quality Model Performance

Parameter	Model Performance
Temperature	Very Good to Excellent
Dissolved Metals	Appears Good
Fecal Coliform	Good
Overall Performance	**Good to Very Good**

Overall, the water quality calibration is considered good to very good. The water quality calibration model can be used to model water quality for both existing land use and future development conditions and scenarios.

The specifics of the water quality calibration are described in detail in Appendix G.

E. Reporting Model Results

The calibrated models produce simulated conditions for stream reaches in 27 sub-basins. To simplify presentation of model results, flow metrics and B-IBI scores are reported for a set of eight stream reaches.

Reaches were selected to represent the full range of conditions in the watershed and to demonstrate whether strategies will meet the Permit goal of restoring designated uses. Criteria for selection included:

- Presence of actual or potential salmon habitat
- Contribution of a significant part of the watershed
- Importance for modeling future conditions
- Represent areas to preserve/restore or retrofit
- Not subject to Columbia River backwater conditions

Reporting reaches are described below and are represented as sub-basins in Figure 9.

WC-2 – Lowermost Whipple Creek

This reach has a broad floodplain and potential for salmon spawning habitat restoration. It is the lowest Whipple Creek reach not subject to backwater conditions from the Columbia River floodplain. Temperature is a concern here. See Map A in Figure 9.

WC-3 – Whipple Creek at Sara

This reach includes significant potential salmon habitat and pool-riffle channel sequences that have potential for salmon habitat restoration. The lower end of the reach includes the mouth of Packard Creek, and it is the closest point to the county's long-term monitoring site at the Sara gage (WPL050). Temperature is a concern here. See Map B in Figure 9.

WC-5 – Whipple Creek above Whipple Creek Park

This point represents the main stem between I-5 and Whipple Creek Park. This reach has a fairly low gradient and extensive beaver ponds. Temperature is a concern here. See Map C in Figure 9.

WC-7.5 – Whipple Creek above I-5

There is a full fish passage barrier at I-5 making the area above I-5 a single area of interest for delivering flow and pollutants to downstream salmon habitat. See Map D in Figure 9.

WC-1A – Miner Creek Tributary

Miner Creek has spawning gravel and the best water quality conditions in the watershed. It is of interest for preservation and restoration. See Map D in Figure 9.

PC-1 – Packard Creek Tributary

Packard Creek is the largest tributary to Whipple Creek. The creek has gravel channel substrate providing salmon habitat. While it is significantly degraded due to hydrologic modification and rural land uses, Packard Creek provides an opportunity for salmon habitat restoration. See Map D in Figure 9.

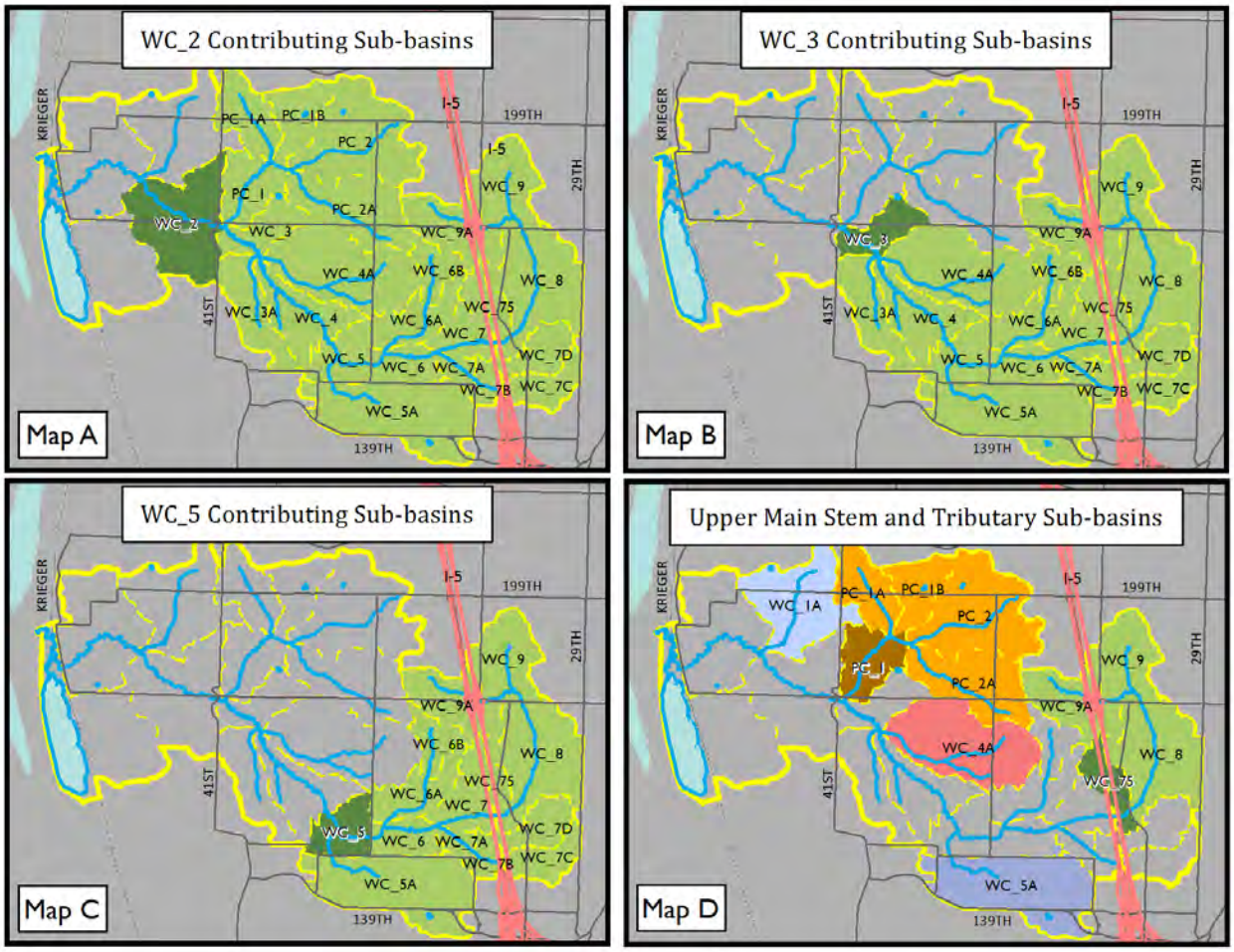
WC-4A – School Land Creek Tributary

School Land Creek drains an area that has potential as salmon habitat and is a sub-basin where Clark County has extensive land holdings as parks and open space. See Map D in Figure 9.

WC-5A – 139 St Tributary

WC-5A is a completely developed urban area built out over the last 30 years. Stream hydrology is greatly altered due to urban runoff and will require extensive retrofitting to restore the tributary's lower reach as salmon habitat. See Map D in Figure 9.

Figure 9: Model Results Reporting Reaches (Shown as Sub-basins) and Contributing Sub-basins



III. Predicting the Future in Whipple Creek

A. Future Development in Whipple Creek

In 2016, Clark County adopted a *Comprehensive Growth Management Plan 2015-2035* (Comp Plan) to guide growth and development for the next 20 years. The Comp Plan's Community Framework Plan describes a vision in which land outside of urban growth areas is predominantly rural with farms, forests, open space, and large lot residences while urban growth areas are targeted for higher densities and a mix of more urban land uses (Clark County, 2016).

i. Land Use

The Whipple Creek watershed contains both the unincorporated Vancouver UGA (nearly 5 sq. mi. in the upper and middle watershed) and rural land throughout the watershed (approximately 7 sq. mi.).

Broadly, the Comp Plan describes a Whipple Creek watershed in which the I-5 corridor will become even more densely developed with industrial and commercial uses, as well as single-family and multi-family homes. The remainder of the UGA will be filled in with lower and medium density residential uses and mixed use. Open spaces will also be present in the UGA outside of the I-5 corridor.

Outside of the UGA, the Comp Plan describes a Whipple Creek watershed that will remain predominantly rural in character, with designations for rural, agriculture, parks/open space, and a small rural commercial area in the traditional unincorporated center of Sara.

Assumptions about future land uses based on Comp Plan designations were used to calculate future land covers. Future land covers form the basis for models that predict water quality and hydrologic conditions in Whipple Creek and its tributaries as the area develops. If all lands in the Whipple Creek watershed were developed to the full densities allowed under the Comp Plan and zoning designations, the watershed would contain the quantities of land covers shown in Table 12.

Table 12: Future Land Cover in Whipple Creek

Land Cover	Residential Impervious	Non-residential Impervious	Forest	Pasture	Lawn	Water
Acres	695	603	1,824	2,284	2,132	185

Land cover from allowed future build-out of the watershed was used to model future development scenarios to predict the effects on water quality and hydrology.

A full discussion of land use assumptions is given in Appendix J.

ii. Development and Engineering Standards

Modeled future scenarios assume that development in Whipple Creek will meet a number of County code chapters and standards that are pertinent to modeling hydrology and water quality. Assumptions are described below. For a chronology of past stormwater-related engineering standards enforced by Clark County, see Appendix N.

Stormwater Code and Manual

Future scenarios assume development will manage stormwater in accordance with Clark County's current Clark County Code Chapter 40.386, Stormwater and Erosion Control, which adopts the *2015 Clark County Stormwater Manual* (CCSM). This code is intended to protect water quality of surface and ground waters for drinking water supply, recreation, fishing, and other beneficial uses. The county manual is equivalent to the Ecology Stormwater Management Manual for Western Washington.

The adopted code and manual meet the requirement to use "all known, available, and reasonable methods of prevention, control, and treatment (AKART)" under the Washington Water Pollution Control Act (RCW 90.48) and reduces discharges to the "maximum extent practicable (MEP)" as required under the Clean Water Act (USC, Title 13, Section 1251 *et seq.*).

LID and County Code

In 2012 and 2015, Clark County revised road standards and development standards in Title 40 to remove barriers to Low Impact Development (LID).

LID is required in the CCSM, and modeled future scenarios assume that the bioretention LID best management practice will be used in development whenever feasible.

Use of other LID techniques such as lot clustering to reduce impervious surfaces could impact future development. County Code allows new subdivisions to cluster lots to preserve open space such as pasture and forest in rural zoned areas. Use of optional lot clustering provisions is difficult to predict and to model at the watershed scale. Considering this, future scenarios assume forested critical areas including both habitat and geologic hazard areas will remain forested.

Areas of Special Concern and County Code

Areas of Special Concern include critical areas where development is regulated under Title 40 to protect the environment, public safety, and public health. These are:

- Critical aquifer recharge areas
- Flood hazard areas
- Geologic hazard areas
- Habitat conservation areas
- Wetland protection areas
- Shorelines of the state

Several critical areas are assumed to remain forested in modeled future scenarios, including:

- Geologic hazards, which are mapped primarily as steep slopes and potential landslide areas;
- Habitat conservation areas; and
- Wetlands that are forested in the existing condition.

Modeled future scenarios do not consider critical aquifer recharge areas (CARAs) or flood hazard areas because they do not influence stream conditions. The entire watershed is a CARA to protect the regional gravel aquifer.

Whipple Creek is a shoreline water body, having regulated shoreline and floodplain from the Columbia River floodplain upstream to near the confluence with Packard Creek. Shorelines are often redundant with wetlands and riparian buffers, which were assumed to remain forested in the future scenarios.

B. Baseline Scenarios

Two baseline scenarios were modeled following Task 4 of The Whipple Creek Watershed-Scale Stormwater Planning Scope of Work and Schedule, June 2014.

i. Forested Land Cover Baseline Scenario

To form a baseline of hydrology for comparing future scenarios, the calibrated hydrology model was used to predict the hydrology of Whipple Creek with simulated historic forest land cover (Baseline Forested Scenario).

Using the modeled flow metrics with the established correlation of flow to B-IBI scores and salmonid uses, the model predicted the ability of the watershed to support salmon and steelhead under forested conditions.

Model Description

The Baseline Forested Scenario assumes a fully forested land cover in each of the modeled sub-basins. A limitation of the model is the inability to recreate pre-disturbance stream structure and drainage patterns, so the Baseline Forested Scenario assumes the forested land cover is applied to the watershed's current stream morphology.

Model Results

The Baseline Forested Scenario simulated stream flow for five water years (2004-2008). Flow metrics including T_{Qmean} and HPC were estimated using reported meteorological data from those years.

Predicted B-IBI scores were calculated from simulated flow metrics as the average annual scores for five years, estimated using the relationships established each for T_{Qmean} and HPC, as described in the Introduction.

Table 13: Predicted B-IBI Under Simulated Forested Land Cover

Sub-basin	Average B-IBI	Standard Salmonid Use Range (B-IBI)
WC-1A	34	Partially Supporting
WC-2	34	Partially Supporting
WC-3	34	Partially Supporting
WC-4A	33	Partially Supporting
WC-5	34	Partially Supporting
WC-5A	35	Partially Supporting
WC-7.5	34	Partially Supporting
PC-1	33	Partially Supporting

Under simulated forested conditions with the watershed's current stream morphology, a B-IBI score of 39 was the highest single score achieved in any reporting sub-basin. This score was calculated from T_{Qmean} and was achieved at WC-2 and at WC-4A in 2007.

Salmonid use attainment ranges were also estimated based on the correlations described in the Introduction for T_{Qmean} and HPC. The metrics and associated ranges are shown in Table 14.

Table 14: Simulated Flow Metrics and Salmonid Use Attainment Under Simulated Forest Land Cover

Sub-basin	Average T_{Qmean}	T_{Qmean} Salmonid Use Range	Average HPC	HPC Salmonid Use Range
WC-1A	34%	Partially Supporting	3	Fully Supporting
WC-2	35%	Partially Supporting	4	Fully Supporting
WC-3	35%	Partially Supporting	3	Fully Supporting
WC-4A	35%	Partially Supporting	4	Fully Supporting
WC-5	35%	Partially Supporting	4	Fully Supporting
WC-5A	36%	Partially Supporting	3	Fully Supporting
WC-7.5	34%	Partially Supporting	3	Fully Supporting
PC-1	34%	Partially Supporting	3	Fully Supporting

Average B-IBI scores and T_{Qmean} calculations suggest that all reporting sub-basins would partially support salmonid uses under forested land cover, while the average of the HPC metric suggests that all reporting sub-basins would fully support salmonid uses under forested land cover.

Adjusting the Fully Supporting B-IBI Score

Ecology's written guidance on watershed planning recommends using the lower of either a B-IBI score of 38 or 90% of the B-IBI score modeled for forested land cover as the threshold for fully supporting salmonid uses in future scenarios (Ecology, March 29, 2016). Following this guidance, the range of B-IBI scores for fully supporting salmonid uses in future scenarios was adjusted as shown in Table 15.

Table 15: Adjusted Salmonid Fully Supporting Use Range (B-IBI) by Reporting Sub-basin

Sub-basin	Average Forested Baseline B-IBI	Adjusted Fully Supporting Range (B-IBI)
WC-1A	34	>31
WC-2	34	>30
WC-3	34	>31
WC-4A	33	>30
WC-5	34	>30
WC-5A	35	>32
WC-7.5	34	>31
PC-1	33	>30

Conclusions

The simulated Forested Baseline Scenario does not unambiguously show that Whipple Creek would fully support salmonid uses even under forested land cover.

Clark County's investigations of the watershed suggest that some of the reasons for these limitations are inherent in the watershed's stream sizes, topography, and natural substrate (see Chapter I, Section F).

For determining fish use attainment predicted for modeled future scenarios, the lower threshold for attaining fully supporting salmonid uses based on B-IBI is adjusted to 90% of the B-IBI attained in the Forested Baseline Scenario.

ii. Full Build-out Baseline Scenario (Future Scenario 1)

Future Scenario 1 (FS1) is the future full build-out of the urban portion of the watershed. FS1 forms the baseline for decision-making in this Report. If the results of FS1 show that the Whipple Creek watershed will not meet water quality standards or attain designated salmonid uses, then the Permit requires Clark County to analyze management strategies it could implement to meet those requirements.

Description of Full Build-out Baseline Scenario

FS1 assumes that the UGA in the watershed will develop under existing land use designations to full densities allowed under the current Comprehensive Plan, which plans for county growth through 2035.

Using the build-out assumptions stated above, FS1 models the impact of land cover changes and the required stormwater controls under the 2015 Title 40 and the CCSM.

Stormwater facilities for full build-out were modeled as a single bioretention facility and a single stormwater detention pond for each sub-basin within the UGA. The bioretention facility included infiltration for Soil Group 3 (SG3), but no infiltration for Soil Group 4 (SG4).

The modeled stormwater facilities were sized using the Western Washington Hydrology Model version 2012 (WWHM2012). The bioretention facilities were sized to meet the water quality treatment standard (Minimum Requirement #6 of the CCSM). Bioretention facilities in sub-basins with SG3 soils were also sized to meet the LID Performance Standard (Minimum Requirement #5 of the CCSM). Stormwater detention ponds were sized to meet the western Washington Flow Control Standard (Minimum Requirement #7 of the CCSM).

Appendix K describes modeling stormwater facilities in FS1 using WWHM2012.

Bioretention facilities and stormwater detention ponds were modeled to reduce copper, zinc, and fecal coliform concentrations in stormwater runoff based on Ecology's watershed planning assumptions guidance (March 29, 2016).

Ecology's recommended pollutant removal rates are shown in Table 16.

Table 16: Pollutant Removal Rates

Runoff Flow Route	Copper	Zinc	Fecal Coliform
Bioretention flow through riser	0%	0%	0%
Bioretention flow through media to underdrain	0%	60%	50%
Bioretention flow to groundwater	100%	100%	100%
Stormwater Detention Pond discharge to stream	0%	0%	50%

These pollutant removal rates were incorporated into all subsequent future scenario water quality models.

Model Results

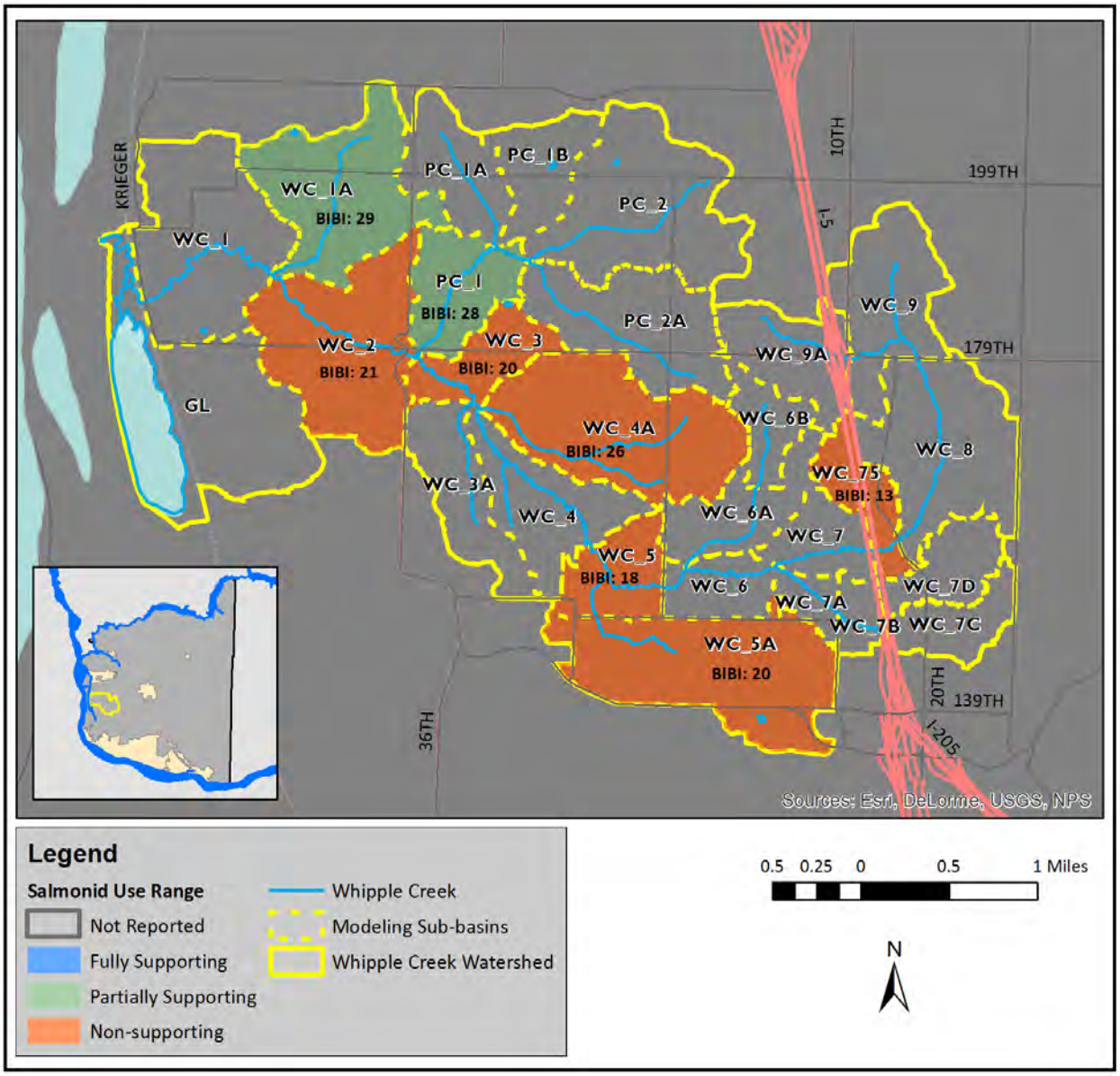
FS1 model results simulated stream flow and water quality parameters for five water years (2004-2008).

Predicted B-IBI scores were calculated from simulated flow metrics as the average annual score for five years, estimated using the relationships established each for T_{Qmean} and HPC. Predicted flow metrics were also directly reported. The B-IBI scores, flow metrics, and related salmonid use ranges are shown in Table 17. Figure 10 is a map of B-IBI scores.

Table 17: Predicted B-IBI, Flow Metrics, and Salmonid Use Ranges for Full Build-out Baseline (FS1)

	B-IBI			T_{Qmean}		HPC	
Sub-basin	Average B-IBI	Adjusted Salmonid Use Range	Adjusted Fully Supporting B-IBI	Average T_{Qmean}	Salmonid Use Range	Average HPC	Salmonid Use Range
WC-1A	29	Partially Supporting	>31	34%	Partially Supporting	6	Fully Supporting
WC-2	21	Non-supporting	>30	32%	Partially Supporting	14	Non-supporting
WC-3	20	Non-supporting	>31	30%	Partially Supporting	15	Non-supporting
WC-4A	26	Non-supporting	>30	33%	Partially Supporting	9	Partially Supporting
WC-5	18	Non-supporting	>30	29%	Partially Supporting	18	Non-supporting
WC-5A	20	Non-supporting	>32	31%	Partially Supporting	17	Non-supporting
WC-7.5	13	Non-supporting	>31	26%	Non-supporting	29	Non-supporting
PC-1	29	Partially Supporting	>30	33%	Partially Supporting	6	Fully Supporting

Figure 10: Map of Predicted B-IBI Scores and Adjusted Salmonid Uses - Full Build-out (FS1)



Based on B-IBI scores, the main stem of Whipple Creek (sub-basins WC-2, WC-3, WC-5, and WC-7.5) likely would not support salmonid use at full build-out. However, based on T_{Qmean}, most main stem and tributaries may partially support salmonid uses. HPC is less optimistic than T_{Qmean} and more optimistic than B-IBI; HPC shows a majority of reaches not supporting salmonid uses under full build-out and two that may fully support.

The water quality results are presented in terms of violations of the state water quality standards for copper, zinc, fecal coliform, and water temperature. The number of violations that occurred in reporting sub-basins during the five-year simulation period are shown below.

Table 18: Predicted Water Quality Violations, Full Build-out Baseline (FS1)

Sub-basin	Copper - Acute	Copper - Chronic	Zinc - Acute	Zinc - Chronic	Fecal Coliform	Water Temperature
WC-1A	0	0	0	0	1263	9
WC-2	0	0	0	0	1352	494
WC-3	0	0	0	0	1365	407
WC-4A	0	0	0	0	1266	2
WC-5	0	0	0	0	1384	413
WC-5A	0	0	0	0	1358	20
WC-75	0	0	0	0	1440	295
PC-1	0	0	0	0	1268	6

Copper and zinc concentrations in Whipple Creek are not predicted to exceed state water quality standards under full build-out. Predicted number of fecal coliform and water temperature violations are quite high in this scenario in all reporting sub-basins.

Estimated Costs

Full build-out is implemented primarily by private developers and has no estimated capital costs for the county.

Conclusions

The full build-out of the Whipple Creek watershed under current land use assumptions and stormwater control standards mitigates some of the stormwater runoff impacts from expected future development in the UGA, but still results in high fecal coliform and high water temperatures due in large part to the adverse impacts of stormwater runoff from existing development.

Predictions of fish use appear to lean to non-supporting based on B-IBI and HPC, with perhaps some basins partially supporting salmonid uses.

Modeled results of FS1 show that Whipple Creek will achieve neither state water quality standards nor salmonid beneficial uses as the watershed develops under the County's current zoning, development regulations, and stormwater regulations.

Recognizing this, Clark County considered numerous strategies, as described in Section C, that might allow Whipple Creek to achieve the required water quality standards and support salmonid uses as it develops.

C. Strategies to Meet Water Quality Goals

The Permit requires the county to consider several types of strategies to restore or protect designated uses if the full build-out scenario predicts that water quality standards will not be met or salmonid uses will not be attained. The Permit also allows other types of management actions to be considered. This Report contemplates a number of these.

i. Modeled Strategies Required by the Permit

The Permit requires Clark County to model the following stormwater management strategies:

- Future structural stormwater control projects; and
- Changes to development-related codes, rules, standards and plans.

Structural Stormwater Retrofits

The Permit requires Clark County to evaluate the potential effect of a structural retrofit program to add detention and water quality treatment to areas of existing development that do not currently have these controls.

Accordingly, structural stormwater retrofits were modeled for urbanized sub-basins in Future Scenario 2. Additional structural retrofits were modeled for the watershed's rural area in Future Scenario 4. See Section D for a discussion of modeled future scenarios.

Changes to Development-related Codes, Rules, Standards, and Plans

The Permit requires the county to evaluate the potential effect of changes to development-related codes, rules, standards, and plans. Because the county's current development and stormwater codes were updated in recent years to remove barriers to LID and to adopt an equivalent version of Ecology's stormwater manual that is considered AKART, this Report does not suggest any additional development-related code changes.

A brief discussion of each item category and its relevance to Clark County is below.

County Stormwater Code

Clark County development code meets the standards of the current Permit and is unlikely to be changed to the point where potential model scenarios could be created. The Clark County Stormwater Manual (CCSM) is considered to be AKART, and it is the standard for the full build-out scenario.

Rules

Clark County does not use administrative rules; all "rules" are adopted as County Code through legislative process.

Standards

Clark County does not use standards separate from County Code; all standards such as those of the CCSM are adopted as County Code through legislative process.

Comprehensive Growth Management Plan

The Clark County Comp Plan is adopted by the Clark County Board of County Councilors pursuant to state law. This Report does not consider updates to the Comp Plan. Future Comp Plan updates may consider actions for managing stormwater impacts related to growth.

ii. Optional Strategies

In addition to the two required strategies, the Permit allows other stormwater management strategies to be modeled, such as:

- Basin-specific stormwater control requirements for new development and redevelopment (per a basin plan); or
- Strategies to encourage redevelopment and infill.

The Permit also allows evaluating other strategies that influence maintenance of existing and designated uses of the stream, including, but not limited to:

- Channel restoration
- In-stream culvert replacement
- Quality of the riparian zone
- Gravel disturbance regime
- Presence and distribution of large woody debris

Consideration of Optional Strategies

During the planning process, optional strategies were evaluated and selected for inclusion in this Report. Selection criteria included benefits to flow, water quality, or other environmental benefits; whether the strategy applied in developed or undeveloped areas; and whether the benefit could be modeled or estimated. Some selected strategies were modeled in future scenarios and some were included as management options although their benefits were not modeled.

Table 19: Optional Management Strategies Considered

Management Strategy	Water Quality	Flow	Other Env Benefits	Notes	Selection Status
Floodplain reconnection to improve hydrology		X	X	Benefit cannot be modeled. Included in Channel Restoration strategy.	Selected
Stream channel and floodplain repair	X		X	Benefit cannot be modeled. Included in Channel Restoration strategy.	Selected
Stream channel restoration to improve hydrology		X	X	Could be a practical and cost effective alternative to improve hydrology, in the absence of space outside stream corridors to build flow control facilities. Benefit cannot be modeled. Included in Channel Restoration strategy.	Selected
Culvert/barrier removal to improve fish habitat access			X	Benefit cannot be modeled. Included in Channel Restoration strategy.	Selected

Management Strategy	Water Quality	Flow	Other Env Benefits	Notes	Selection Status
Reforestation and forest management	X		X	May be a cost effective alternative. Included in Full Shade strategy.	Selected
Riparian vegetation restoration for shade and large woody debris	X			Included in Full Shade strategy.	Selected
Stormwater control requirements under an Approved Basin Plan		X		Currently there is no basin plan for Whipple Creek.	Not Selected
Redevelopment and infill policies (incentives for infill)	X	X		Future Scenario 2 assumes the entire urban area is retrofitted to manual standards.	Not Selected
Regional stormwater facilities for infill and redevelopment	X	X	X	This action is inherent in the Structural Retrofits strategy, but it was not discretely modeled.	Not Selected
Natural resources conservation (critical/sensitive areas protection)	X	X		Critical areas are currently protected under Title 40, and future scenario models recognize some protected areas as undevelopable.	Ongoing
Stream corridor protection (critical/sensitive areas protection, Shoreline Management Areas protection)			X	Shoreline Management Areas are currently protected under Title 40.	Ongoing
General county-wide stormwater program outreach, education, and technical assistance	X		X	Benefit cannot be modeled. Any effects of the ongoing program are inherent in the calibrated models of exiting conditions.	Ongoing
Wetland protection strategies	X	X	X	Wetlands are currently protected under Title 40, and future scenarios models recognize some wetlands as undevelopable.	Ongoing
Roof downspout disconnects (that are not flow control facilities)				Uncertain benefit	Not Selected
Enhanced street sweeping	X			Benefit cannot be modeled.	Not Selected
Enhanced catch basin cleaning	X			Benefit cannot be modeled.	Not Selected
Targeted outreach	X			Benefit cannot be modeled.	Not Selected
Enhanced source control inspections	X			Benefit cannot be modeled.	Not Selected
Enhanced conveyance system cleaning	X			Benefit cannot be modeled.	Not Selected

Optional Strategies Modeled

Two optional strategies were combined into a single strategy for adding shade to reduce stream temperatures, which can be modeled. These are:

- Reforestation and forest management
- Riparian vegetation restoration for shade and large woody debris

See Future Scenario 3 in Section D for more on the Full Shade strategy.

Optional Strategies Not Modeled

Several other optional strategies were selected as management options, although their benefits cannot be modeled in future scenarios.

Four optional strategies were combined into a single strategy of Channel Restoration. These are:

- Floodplain reconnection to improve hydrology
- Stream channel and floodplain repair
- Stream channel restoration to improve hydrology
- Culvert/barrier removal to improve fish habitat access

D. Future Scenario Models

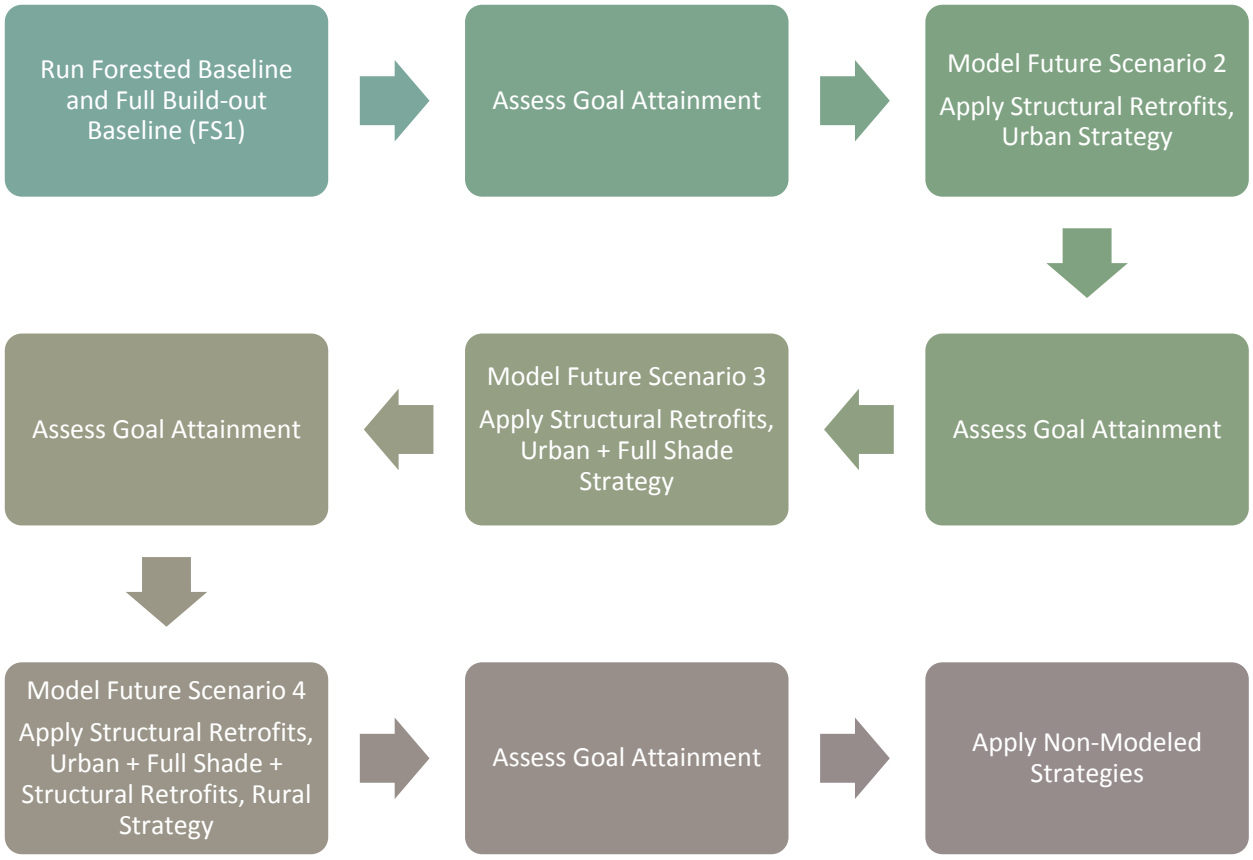
Future scenarios were modeled following Task 5 of The Whipple Creek Watershed-Scale Stormwater Planning Scope of Work and Schedule, June 2014.

To model strategies required or allowed by the Permit, this Report combines strategies into future scenarios.

Future scenarios were modeled sequentially. The results of each future scenario were evaluated to determine if water quality standards were met and if salmonid use goals were attained. If not, additional strategies were contemplated in the subsequent future scenario.

Figure 11 illustrates the sequential modeling of scenarios.

Figure 11: Sequential Scenario Modeling and Strategy Application Concept



i. Future Scenario 2 – Urban Structural Retrofits

Description of Future Scenario 2

Future Scenario 2 (FS2) simulates the effects of providing new water quality treatment and detention facilities for the currently urbanized areas of the Whipple Creek watershed.

FS2 builds on FS1 and includes all of the water quality and detention facilities described for future build-out, as well new structural stormwater retrofits for areas of existing development within the UGA sub-basins.

Structural retrofits were assumed to apply to the land area that is currently designated urban impervious and lawn land cover.

As with FS1, urban structural retrofits were modeled as a single bioretention facility and a single stormwater detention pond for each sub-basin. The bioretention facility included infiltration for Soil Group 3 (SG3), but no infiltration for Soil Group 4 (SG4).

Like facilities modeled in FS1, the retrofit facilities for existing development were sized using the WWHM2012 to the design standards for water quality treatment, LID performance, and flow control described in the CCSM. Pollutant removal rates for facilities were also the same as those used in FS1.

Model Results

FS2 model results simulated stream flow and water quality parameters for five water years (2004-2008).

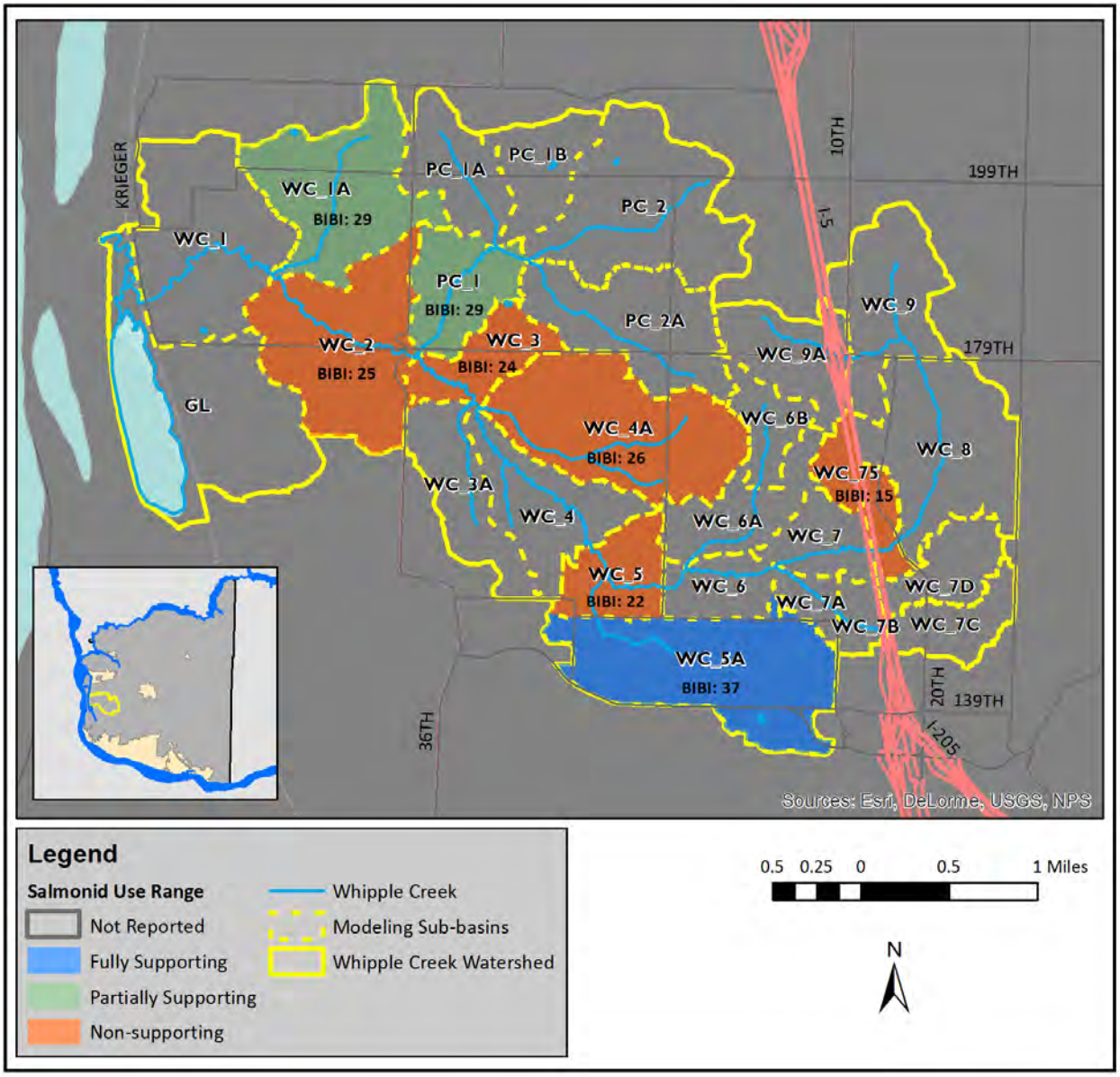
For reporting sub-basins, predicted B-IBI scores were calculated from simulated flow metrics as the average annual scores for five years, estimated using the relationships established each for T_{Qmean} and HPC. Predicted flow metrics were also directly reported.

The B-IBI scores, flow metrics, and related salmonid use ranges are shown in Table 20. Figure 12 is a map of B-IBI scores.

Table 20: Predicted B-IBI, Flow Metrics, and Salmonid Use Ranges - Urban Structural Retrofits (FS2)

	B-IBI			T_{Qmean}		HPC	
Sub-basin	**Average B-IBI**	**Adjusted Salmonid Use Range**	**Adjusted Fully Supporting B-IBI**	**Average T_{Qmean}**	**Salmonid Use Range**	**Average HPC**	**Salmonid Use Range**
WC-1A	29	Partially Supporting	>31	34%	Partially Supporting	6	Fully Supporting
WC-2	25	Non-supporting	>30	34%	Partially Supporting	10	Partially Supporting
WC-3	24	Non-supporting	>31	33%	Partially Supporting	11	Partially Supporting
WC-4A	26	Non-supporting	>30	33%	Partially Supporting	9	Partially Supporting
WC-5	22	Non-supporting	>30	33%	Partially Supporting	15	Non-supporting
WC-5A	37	Fully Supporting	>32	37%	Partially Supporting	3	Fully Supporting
WC-7.5	15	Non-supporting	>31	26%	Partially Supporting	20	Non-supporting
PC-1	29	Partially Supporting	>30	33%	Partially Supporting	7	Partially Supporting

Figure 12: Map of Predicted B-IBI Scores and Adjusted Salmonid Uses - Urban Structural Retrofits (FS2)



With urban structural retrofits, B-IBI scores in the lower main stem improve compared to FS1 but remain low and in the non-supporting range of salmonid use attainment. Tributary WC-5A improves to from a non-supporting score in FS1 to a score fully supporting salmonid uses in FS2. Other tributaries in the rural area are not impacted by structural retrofits in existing urbanized areas.

Under FS2, T_{Qmean} improves slightly in three main stem sub-basins – WC-2, WC-3, and WC-5 – but not enough to move from partially supporting to fully supporting salmonid uses. HPC improves in five sub-basins. WC-2 improves from non-supporting to partially supporting salmonid uses, and WC-5A improves significantly from non-supporting to fully supporting based on HPC.

The water quality results are presented in terms of violations of the state water quality standards for copper, zinc, fecal coliform, and water temperature. The number of violations occurring during the five-year simulation period are shown in Table 21.

Table 21: Water Quality Violations, Urban Structural Retrofits (FS2)

Sub-basin	Copper – Acute Violations	Copper – Chronic Violations	Zinc – Acute Violations	Zinc – Chronic Violations	Fecal Coliform Violations	Water Temperature Violations
WC-1A	0	0	0	0	1263	9
WC- 2	0	0	0	0	1190	468
WC-3	0	0	0	0	1087	371
WC-4A	0	0	0	0	1266	2
WC-5	0	0	0	0	587	287
WC-5A	0	0	0	0	19	0
WC-75	0	0	0	0	938	112
PC-1	0	0	0	0	1268	6

As with FS1, copper and zinc concentrations in Whipple Creek are not predicted to exceed state water quality standards.

Fecal coliform and water temperatures remain high in most reporting sub-basins. Sub-basin WC-5A shows the greatest improvement in reduction of fecal coliform and water temperature violations because 400 acres of existing development, which is more than 80% of the sub-basin total drainage area, is directed into a stormwater control or retrofit facility for water quality treatment.

The best management practice for urban areas that can eliminate fecal coliform in stormwater runoff is infiltration, including infiltration in bioretention facilities. Unfortunately, soil conditions prevent use of infiltration through much of the watershed, so eliminating fecal coliform violations from Whipple Creek's urban sub-basins may not be feasible.

Comparative Benefits

Compared to FS1, FS2 maintains attainment of water quality standards for dissolved metals. FS2 reduces exceedances of standards for temperatures and for concentrations of fecal coliform, but does not meet standards in the reporting sub-basins.

FS2 improves B-IBI scores and flow metrics, and improves one reporting sub-basin from non-supporting to fully supporting salmonid uses.

For these gains, the Urban Structural Retrofits components of FS2 could cost $263 million for capital improvements.

Table 22: Comparative Benefits of FS2

Constituent or Metric	Forested Baseline	FS1	FS2
Dissolved Copper	✔ *	✔	✔
Dissolved Zinc	✔ *	✔	✔
Temperature	✔ *	✘	✘
Fecal Coliform	✘ *	✘	✘
Salmon Use (B-IBI)†	Partially Supporting	Non-supporting	Non-supporting

* These parameters were not modeled, and assessments of goal attainment under the forested baseline scenario were determined using professional judgement.
† Reported as the majority of use ranges associated with average B-IBI within the set of reporting sub-basins

Conclusions

Overall FS2 results in low to moderate B-IBI scores, high fecal coliform, and high water temperatures.

ii. Future Scenario 3 – Adding Riparian Restoration for Full Shade

Description of Future Scenario 3

Future Scenario 3 (FS3) includes all of the stormwater control and retrofit facilities contemplated in FS1 and FS2. In addition, FS3 simulates the effects of increased stream channel shading in stream reaches that are not currently fully shaded.

Shading of the stream channel reduces direct solar radiation on the water surface area and that, in turn, reduces water temperatures. Shading has no impact on B-IBI scores or on copper, zinc, and fecal coliform. In the model, shading is expressed as a percentage of water surface that is fully shaded. All of the tributaries except Packard Creek are assumed to be fully shaded in the base model.

Existing and proposed percentages of stream channel shading for sub-basins that are not fully shaded are shown in Table 23.

Table 23: Existing and Future Shade (in % of Stream Reach Where Base Model was not Fully Shaded)

Sub-basin	Existing % of Reach Surface Area Shaded	FS3 % Shaded
WC-1	50.0%	99.9%
WC-2	50.0%	99.9%
WC-3	50.0%	99.9%
WC-4	50.0%	99.9%
WC-5	50.0%	99.9%
WC-6	50.0%	99.9%
WC-7	50.0%	99.9%
WC-8	50.0%	99.9%
PC-2	90.0%	99.9%
PC-2A	90.0%	99.9%

Model Results

FS3 model results simulated stream temperature for five water years (2004-2008).

The strategy to increase stream shading impacts temperature only. Neither water quality nor flow metrics are impacted by FS3, so they are not reported. Table 24 compares the number of water temperatures violations from FS1 to FS3.

Table 24: Comparison of Water Temperature Violations, FS1 and FS3

Sub-basin	FS1		FS3	
	Water Temperature Violations	Meet State Water Quality Standard?	Water Temperature Violations	Meet State Water Quality Standard?
WC-1A*	9	✗†	9	✗†
WC-2	494	✗	4	✗†
WC-3	407	✗	0	✓
WC-4A*	2	✗†	2	✗†
WC-5	413	✗	0	✓
WC-5A	20	✗	0	✓
WC-7.5	295	✗	0	✓
PC-1	6	✗†	4	✗†

*Note: WC-1A and WC-4A are fully shaded in the base model.
† These very nearly met the standards.

Water temperature violations improve significantly with simulated full shading. Under FS3, violations of the state temperature standard for salmonid uses are reduced by more than 1,000 violations over five years. Four sub-basins meet the standard, and four other sub-basins nearly meet the standard.

Comparative Benefits

Compared to FS2, FS3 nearly eliminates exceedances of standards for temperatures in the reporting sub-basins. FS3 is not intended to have any impact on fecal coliform, B-IBI, or flow metrics.

For these gains, the Full Shade components of FS3 could cost $2.7 million in one-time expenditures.

Table 25: Comparative Benefits of FS3

Constituent or Metric	Forested Baseline	FS1	FS2	FS3
Dissolved Copper	✓ *	✓	✓	✓
Dissolved Zinc	✓ *	✓	✓	✓
Temperature	✓ *	✗	✗	✓
Fecal Coliform	✗ *	✗	✗	✗
Salmon Use (B-IBI)†	Partially Supporting	Non-supporting	Non-supporting	Not reported

* These parameters were not modeled, and assessments of goal attainment under the forested baseline scenario were determined using professional judgement.
† Reported as the majority of use ranges associated with average B-IBI within the set of reporting sub-basins

Conclusions

Increasing the shading to the maximum amount possible eliminates high water temperatures violations in a majority of the sub-basins. Although not all sub-basins reach zero violations, this Report assumes that full shading is effective in supporting salmonid beneficial uses through control of temperature as the watershed recovers from existing impacts and develops to full build-out.

iii. Future Scenario 4 – Adding Rural Area Structural Retrofits

Description of Future Scenario 4

Future Scenario 4 (FS4) includes all of the stormwater control and retrofit facilities of FS1 and FS2 plus the increased shading of the stream channel of FS3. In addition, FS4 simulates the effects of stormwater retrofit facilities to treat runoff from existing impervious surfaces and lawn/landscaping in the rural watershed outside the UGA.

Rural structural retrofits were modeled as a single bioretention facility and a single stormwater detention pond for each sub-basin outside of the UGA. The bioretention facility included infiltration for Soil Group 3 (SG3), but no infiltration for Soil Group 4 (SG4).

As in FS1 and FS2, the retrofit facilities were sized using the WWHM2012 to meet applicable standards under the CCSM and were modeled to remove pollutants at the same rates as facilities modeled in prior future scenarios.

Model Results

FS4 model results simulated stream flow and water quality parameters for five water years (2004-2008).

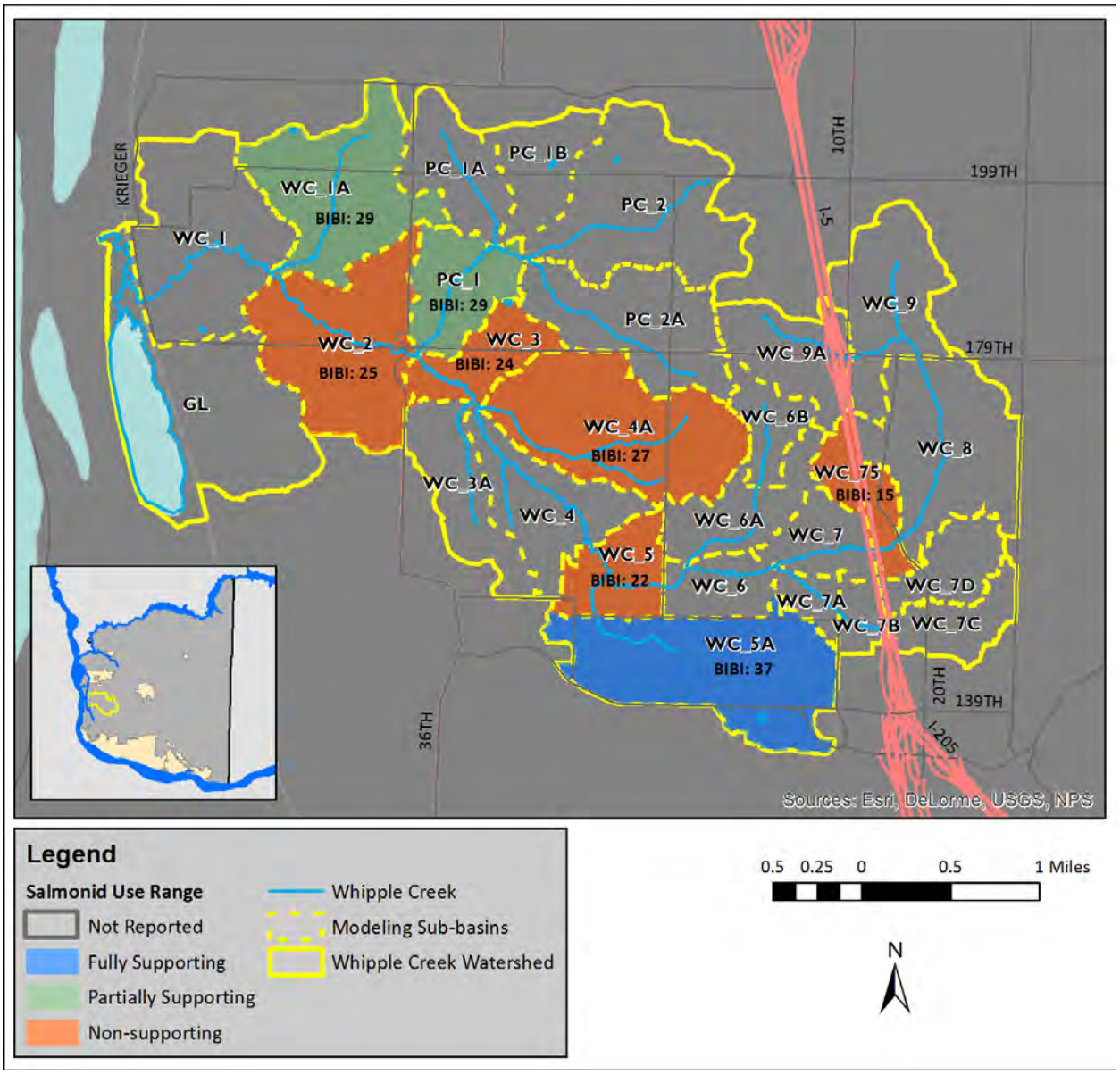
Predicted B-IBI scores were calculated from simulated flow metrics as the average annual scores for five years estimated using the relationships established each for T_{Qmean} and HPC. Predicted flow metrics were also directly reported. The B-IBI scores, flow metrics, and related salmonid use ranges are shown in Table 26. Figure 13 is a map of B-IBI scores.

Table 26: Predicted B-IBI, Flow Metrics, and Salmonid Use Ranges - Adding Rural Structural Retrofits (FS4)

	B-IBI			T_{Qmean}		HPC	
Sub-basin	Average B-IBI	Adjusted Salmonid Use Range	Adjusted Fully Supporting B-IBI	Average T_{Qmean}	Salmonid Use Range	Average HPC	Salmonid Use Range
WC-1A	29	Partially Supporting	>31	34%	Partially Supporting	6	Fully Supporting
WC-2	25	Non-supporting	>30	34%	Partially Supporting	10	Partially Supporting
WC-3	24	Non-supporting	>31	34%	Partially Supporting	12	Partially Supporting
WC-4A	27	Non-supporting	>30	34%	Partially Supporting	9	Partially Supporting
WC-5	22	Non-supporting	>30	33%	Partially Supporting	15	Non-supporting

	B-IBI			T_{Qmean}		HPC	
Sub-basin	Average B-IBI	Adjusted Salmonid Use Range	Adjusted Fully Supporting B-IBI	Average T_{Qmean}	Salmonid Use Range	Average HPC	Salmonid Use Range
WC-5A	37	Fully Supporting	>32	37%	Partially Supporting	3	Fully Supporting
WC-7.5	15	Non-supporting	>31	26%	Non-supporting	20	Non-supporting
PC-1	29	Partially Supporting	>30	33%	Partially Supporting	6	Fully Supporting

Figure 13: Map of Predicted B-IBI Scores and Adjusted Salmonid Uses - Rural Retrofits (FS4)



Based on predicted metrics there is no real improvement in B-IBI scores or salmonid use attainment in comparison to FS2. This is probably because the rural sub-basins do not produce as much stormwater runoff as the urban sub-basins mitigated in FS2 and, thus, the rural structural retrofit facilities do not significantly change the stream flow values in the main stem of Whipple Creek. Another factor is that bioretention is infeasible in large parts of the rural headwaters of Packard Creek and Whipple Creek.

Water quality results are presented in terms of violations of the state water quality standards for fecal coliform and water temperature. Because FS2 eliminated water quality violations for copper and zinc, those results are not shown for FS4. Table 27 compares the number of fecal coliform and temperature violations during the five-year simulation period for FS2, FS3, and FS4.

Table 27: Comparison of Water Quality Violations in Different Scenarios

	Fecal Coliform				Water Temperature	
Sub-basin	Violations (FS1)	Violations (FS2)	Violations (FS4)	% Reduction in Violations from FS1 to FS4	Violations (FS3)	Violations (FS4)
WC-1A	1263	1263	933	26%	9	0
WC-2	1352	1190	993	27%	4	5
WC-3	1365	1087	743	46%	0	0
WC-4A	1266	1266	1034	18%	2	0
WC-5	1384	587	587	58%	0	0
WC-5A	1358	19	19	99%	0	0
WC-75	1440	938	938	35%	0	0
PC-1	1268	1268	945	25%	4	0

Under FS4, fecal coliform remains high in most sub-basins. WC-3 sub-basin fecal coliform violations are reduced by 32%, but they remain high with 743 violations over a five year period. With an 18% reduction in violations, WC-4A still has more than 1,000 violations under FS4. Fecal coliform contributions from forest and pasture provide a significant source of this pollutant in the watershed. These sources generally cannot be controlled with public structural retrofits of the MS4.

Minor improvements in the number of water quality violations shows that all sub-basins except WC 2 would meet water quality standards for temperature under FS4. However, the improvements are extremely small because the violations were nearly eliminated under FS3.

Comparative Benefits

Compared to FS2 and FS3, FS4 has very little benefit.

For these questionable gains, the Rural Structural Retrofits component of FS4 could cost $56 million for capital improvements.

Table 28: Comparative Benefits of FS4

Constituent or Metric	Forested Baseline	FS1	FS2	FS3	FS4
Dissolved Copper	✔ *	✔	✔	✔	✔
Dissolved Zinc	✔ *	✔	✔	✔	✔
Temperature	✔ *	✘	✘	✔	✔
Fecal Coliform	✘ *	✘	✘	N/A	✘
Salmon Use (B-IBI)[†]	Partially Supporting	Non-supporting	Non-supporting	N/A	Non-supporting

* These parameters were not modeled, and assessments of goal attainment under the forested baseline scenario were determined using professional judgement.

[†] Reported as the majority of use ranges associated with average B-IBI within the set of reporting sub-basins

Conclusions

Overall, FS4 does little to reduce the impacts of stormwater runoff from existing and expected future new development in the watershed.

E. Future Scenario Supplemental Strategies (Not Modeled)

i. Channel Restoration

Channel restoration is a strategy that can improve habitat conditions for fish by reducing turbidity, preserving or restoring gravel stream beds used for spawning, restoring access to functioning habitat, and providing refuge for fish and macroinvertebrates from high flows, high temperatures, and predators.

Clark County has experience restoring approximately 1,000 feet of the Whipple Creek main stem just upstream of I-5 using grade controls and channel spanning log jams to create floodplain detention and improve channel hydraulics. See Appendix L for an initial analysis of floodplain detention opportunities.

Description of Channel Restoration Techniques

Channel restoration was selected for consideration in this Report. A discussion of techniques and benefits is below.

Grade Control

Grade control uses obstructions in the stream to slow the flow of water and sometimes to create step-pools. Slowing the flow helps prevent or slow channel lowering. Channel lowering can result from headcuts or incision. Channel lowering can drain wetlands, disconnect a stream from its floodplain, and increase flow rates during storms.

Structural grade controls use large rocks, large logs, or engineered obstructions. These are appropriate for streams subject to high flows. Low-tech grade controls use fascines or wooden posts to span the channel of smaller streams that are not subject to high flows.

Grade controls tend to mimic the natural functions of beaver dams and log jams in a functioning forested stream system.

Stream Bank Stabilization

Stream bank stabilization includes numerous techniques both natural, engineered, or some combination thereof, to protect stream banks from erosion, landslide, and slumping. A few examples are bioengineered slope, brush matting, tree revetments, rock buttressing, and retaining walls.

Protecting stream banks, in turn, helps aquatic habitat by reducing turbidity and protecting gravel spawning beds from being buried by silt or landslide.

Stream Bed Fill and Gravel Enhancement

A stream channel that has already been damaged by erosion, resulting in incision, headcuts, or an undermined toe of a bank can benefit from fill. Rocks, gravel or other materials are placed in the stream channel and the banks. Fill may restore an incised channel, prevent further erosion, protect banks, or restore spawning beds. This technique may improve habitat for aquatic species in an already degraded stream.

Stream Culvert Fish Barrier Removal

In some stream systems, good fish habitat is left unused because culverts or other obstructions block access. Culverts built before modern regulations often did not consider fish passage or did not properly accommodate it. Replacing culverts with new designs or bridges can restore access to good fish habitat.

Comparative Benefits

Degree of improvement in B-IBI score resulting from Channel Restoration cannot be modeled using the tools employed in this Report. Channel Restoration is assumed to have a positive effect on fish habitat in targeted locations, but it is not expected to have a watershed-wide impact on fish use attainment.

Channel Restoration could result in improvements to B-IBI scores, but would in most cases have no effect on dissolved metals, fecal coliform, or flow metrics, and little effect on temperature.

Nonetheless, because of its ability to target improvements in fish habitat, Clark County considers Channel Restoration to be among the most effective strategies for improving fish use attainment in targeted locations and preventing further channel degradation such as bank erosion, even if those gains cannot be estimated through correlation with B-IBI scores or flow metrics.

For these gains, the Channel Restoration strategy could cost $23.7 million for capital improvements.

F. Goal Attainment

The success of strategies contemplated in this Report for reducing copper, zinc, and temperatures in the Whipple Creek watershed is clear. These parameters may be managed using LID and traditional stormwater management techniques appropriate for a large MS4. Modeled scenarios predict the watershed can meet state standards for copper, zinc, and temperature through stormwater management, urban structural retrofits, and riparian restoration techniques.

The success of strategies analyzed for meeting state standards for fecal coliform and salmonid beneficial uses is less clear. Investigations into the existing conditions of the Whipple Creek watershed suggest that watershed conditions may never have reached these standards.

It is possible that background levels of fecal coliform from natural sources and other non-stormwater sources (e.g. beaver, water fowl, livestock, and possibly septic systems) exceed state standards even without discharges of urban runoff from the county's MS4. DNA studies of fecal coliform could reveal the background levels of fecal coliform that cannot be managed using stormwater strategies.

Likewise, information on fish presence in the watershed suggest that some of the reasons for limited salmonid use are inherent in the watershed's stream sizes, topography, and natural substrate (see Chapter I, Section F).

Table 29: Summary of Goal Attainment Under All Strategies

Constituent or Metric	Forested Baseline	FS1	FS2	FS3	FS4	Channel Restoration
Dissolved Copper	✔ *	✔	✔	✔	✔	N/A
Dissolved Zinc	✔ *	✔	✔	✔	✔	N/A
Temperature	✔ *	✘	✘	✔	✔	N/A
Fecal Coliform	✘ *	✘	✘	N/A	✘	N/A
Salmon Use (B-IBI)†	Partially Supporting	Non-supporting	Non-supporting	N/A	Non-supporting	Non-supporting*

* These parameters were not modeled, and assessments of goal attainment under the forested baseline scenario and channel restoration strategy were determined using professional judgement.
† Reported as the majority of use ranges associated with average B-IBI within the set of reporting sub-basins

The Implementation Plan (Chapter IV) discusses potential future actions to implement strategies modeled in future scenarios.

i. Stream Temperature

Implementing the riparian Full Shade strategy modeled in FS3 would essentially eliminate violations of state stream temperature standards.

ii. Dissolved Metals

Whipple Creek would not exceed state water quality standards for dissolved metals under the baseline full build-out scenario. This suggests that continuing to implement the current stormwater management program plan would maintain compliance with state water quality standards for dissolved metals.

iii. Fecal Coliform

No modeled strategy evaluated in this Report would completely eliminate fecal coliform violations. This result suggests stormwater management alone would not be effective in attaining compliance with standards. Activities outside the scope of the Permit would be needed.

Investigations into existing patterns of fecal coliform counts indicate that wildlife, livestock, or failing septic systems may contribute to baseline conditions in several tributaries. In addition, soils with low permeability throughout the watershed inhibit the use of LID or other infiltration techniques to manage contributions of fecal coliform from urban runoff.

iv. Aquatic Life as Defined by B-IBI

No modeled strategy evaluated in this Report makes an unambiguous improvement to stream flow conditions to the point where resulting B-IBI scores suggest the stream would fully support aquatic life. Of the eight reporting sub-basins, only the WC-5A sub-basin may achieve a B-IBI score indicating full support of salmonid uses using the Urban Retrofit strategy modeled in FS2.

Table 30: Best B-IBI-Correlated Salmonid Use Ranges Achieved Under Modeled Scenarios

Sub-basin	Adjusted Salmonid Use Range (B-IBI)
WC-1A	Partially Supporting
WC-2	Non-supporting
WC-3	Non-supporting
WC-4A	Non-supporting
WC-5	Non-supporting
WC-5A	Fully Supporting
WC-7.5	Non-supporting
PC-1	Partially Supporting

IV. Implementation Plan

An Implementation Plan is a Permit-required component of the Whipple Creek Watershed-Scale Stormwater Plan Report. The Permit requires an implementation plan and schedule to include:

- Potential future actions to implement the identified stormwater management strategies;
- Responsible parties;
- Estimated costs; and
- Potential funding mechanisms.

Potential actions are based on the results of the modeling exercise and the recognition that existing budgets are insufficient to begin implementation of the strategies evaluated in this Report.

A. Scope and Limitations

This Report's strategies to improve water quality and in-stream conditions in Whipple Creek are conceptual-level considerations based on broad evaluations of existing conditions and future land uses. The described undertakings are massive in scope and, by necessity, imprecise at a sub-basin-scale.

Structural facilities modeled in the Report provide one illustration.

Modeled structural facilities are purely hypothetical. Models simulate the facility size needed to achieve desired results using only one water quality facility and one detention facility per sub-basin. Facilities may not be realistically designed or constructed as modeled.

Further development of a capital program to support the state's goals would include intensive capital planning to identify feasible locations, developing individual planning-level project designs, and prioritizing projects. Capital project development furthermore would be subject to the availability of capital funding and the acquisition of land and rights-of-way (including likely actions to condemn private property under the county's eminent domain authorities in both urban and rural areas), engineering design, and construction.

In aggregate, land area required for conceptual structural facilities and riparian restoration in this Report is nearly 0.5 square miles and exceeds 4% of the watershed's land area. Total one-time capital costs of nearly $346 million exceed the county's Stormwater Capital Program's six-year budget by more than $330 million dollars.

This Implementation Plan is intended as long-term guidance that may assist in meeting Permit objectives. It is not intended to recommend or prioritize particular capital projects, strategies, or management actions.

B. Responsible Parties

Clark County is responsible for enforcing its development and stormwater codes, operating and maintaining its MS4, and for meeting Permit requirements.

This Report assumes certain actions by private land owners and land developers that are part of the current program, such as maintaining private stormwater facilities and developing land under the standards of the CCSM.

FS1 describes the full build-out of the Vancouver UGA in Whipple Creek. These activities are carried out principally by private developers who convert forest or pasture to developed residential or commercial properties and redevelop urban areas. Landowners and developers acting to build in Whipple Creek, as everywhere in the county, are required to comply with the Title 40 and zoning, including assumptions for densities, critical areas protection, and stormwater and erosion control requirements.

This Report assumes other public entities and quasi-governmental organizations operating in the Whipple Creek watershed continue their actions to benefit water quality and in-stream conditions in the watershed.

For example, Washington Department of Transportation (WSDOT) is also subject to a NPDES municipal stormwater permit, and it expands and replaces roads and operates transportation facilities and associated stormwater facilities in the watershed.

As another example, the Clark County Conservation District has programs that help the watershed by preserving the productivity of agricultural lands through reducing soil erosion, helping with manure management plans, and restoring riparian buffers. These activities also reduce transport of eroded soils to Whipple Creek and its tributaries and benefit water quality and fish habitat in the stream.

C. Estimated Costs

Conceptual-level cost estimates were prepared for each modeled strategy and the Channel Restoration strategy based on model outputs of hypothetical facilities to estimate the relative magnitude of costs for each strategy. Capital cost estimates rely on the county's recent historical costs for land, engineering design, construction, and operation & maintenance.

Costs are estimated independently for each strategy. Costs for each future scenario would include the costs of the component strategies. The sum of one-time capital costs for all modeled strategies and the Channel Restoration strategy is nearly $347 million. Operation and maintenance of structural facilities is estimated at $4 million annually once fully built.

All costs are in 2017 dollars.

Detailed cost estimates are given in Appendix O.

i. Costs of FS1, Full Build-out Baseline

FS1, the full build-out baseline, is implemented by private developers and has no new costs for the county.

ii. Costs of Urban Structural Retrofits Strategy

The Urban Structural Retrofits strategy is modeled as a component of FS2, FS3, and FS4. It results in 29 acres of bioretention (at pond surface) and 38 acres of detention pond (at pond surface). Additional land would be needed.

A conceptual-level cost estimate, below, does not include capital planning to identify and study feasibility of individual projects, nor does it attempt to anticipate a realistic number of facilities that would provide the modeled treatment and hydrology performance.

Table 31: Conceptual Cost Estimate of Urban Structural Retrofits

Modeled Facility Size		Capital Costs ($Millions)				O&M Costs ($Millions)
Bioretention Surface Area (ac)	Detention Pond Surface Area (ac)	Bioretention	Detention	Land Acquisition	Total One-Time Capital Costs	Annual
29	38	$62.23	$11.54	$189.69	$263.46	$2.70

iii. Costs of Full Shade Strategy

The Full Shade strategy is modeled as a component of FS3 and FS4. It assumes riparian restoration spans 75 feet on each side of an unshaded stream channel. 3.79 miles of channel are assumed to be eligible for riparian restoration.

A conceptual-level cost estimate of the Full Shade strategy, below, includes capital planning to identify and study feasibility of individual projects, easement costs, and three years of anticipated maintenance for plant establishment as a one-time capital cost.

Table 32: Conceptual Cost Estimate for Full Shade Strategy

Stream Length with Shade BMP Applied (mi)	Total Cost ($ Millions)
3.79	$2.65

iv. Costs of Adding Rural Structural Retrofits

The Rural Structural Retrofits strategy is modeled as a component of FS4. It results in 14 acres of bioretention (at pond surface) and 21 acres of detention pond (at pond surface). Additional land would be required.

A conceptual-level cost estimate, below, does not include capital planning to identify and study feasibility of individual projects, nor does it attempt to anticipate a realistic number of facilities that would provide the modeled treatment and hydrology performance.

Table 33: Conceptual Cost Estimate for Adding Rural Structural Retrofits Strategy

Modeled Facility Size		Capital Costs ($Millions)				O&M Costs ($Millions)
Bioretention Surface Area (ac)	Detention Pond Surface Area (ac)	Bio-retention	Detention	Land Acquisition	Total One-Time Capital Costs	Annual
14	21	$30.41	$6.21	$19.36	$55.98	$1.34

v. Costs of Channel Restoration Strategy

The Channel Restoration strategy could consider channel restoration on approximately 7 miles of main stem Whipple Creek. A conceptual-level cost estimate, below, does not include capital planning to identify and study benefits and feasibility of individual projects. Only stream miles on the main stem are included.

Table 34: Conceptual Cost Estimate for the Channel Restoration Strategy

Channel Restoration Stream Length (mi)	Capital Costs ($ Millions)
7.18	$23.68

vi. Other Costs

The cost estimate does not include ongoing Stormwater Management Program actions, even when program elements are anticipated to benefit Whipple Creek.

Initial costs of implementing strategies discussed in this Report are not itemized. Initial costs would be anticipated to include recommended studies such as a Use Attainability Study, a detailed revenue requirements and financial study, and initiation of a capital planning protocol for Whipple Creek.

vii. Total Costs by Sub-basin

Capital and annual operation & maintenance costs are summarized by sub-basin in Table 35 and Table 36.

By a factor of three, WC-5A is the costliest sub-basin for capital projects, at $85 million. On the other hand, WC-5A is also the only reporting sub-basin that appears to improve sufficiently to fully support salmonid uses.

Three sub-basins in the Packard Creek tributary are estimated to cost less than $2 million each for capital projects, solely for rural structural retrofits. Reporting sub-basin PC-1 remains in the partially supporting salmonid use range under all modeled future scenarios and shows a 25% decrease in violations of fecal coliform standards. For PC-1, violations of temperature standards drop from six to zero.

Table 35: Total Conceptual Capital Costs by Sub-basin

Total Capital Costs ($ Millions)					
Sub-basin	**Urban Retrofits (FS2)**	**Full Shade (FS3)**	**Rural Retrofits (FS4)**	**Channel Restoration**	**Total**
WC-5	$19.53	$0.21		$2.01	$21.75
WC-5A	$85.01	$0.00		$0.00	$85.01
WC-6	$24.68	$0.26		$2.42	$27.35
WC-6A	$22.28	$0.00		$0.00	$22.28
WC-6B	$10.54	$0.00		$0.00	$10.54
WC-7	$9.38	$0.20		$1.91	$11.49
WC-7A	$6.96	$0.00		$0.00	$6.96
WC-7B	$10.96	$0.00		$0.00	$10.96
WC-7C	$9.72	$0.00		$0.00	$9.72
WC-7D	$11.75	$0.00		$0.00	$11.75
WC-75	$9.39	$0.00		$0.00	$9.39
WC-8	$18.41	$0.41		$0.00	$18.82
WC-9	$11.10	$0.00		$0.00	$11.10
WC-9A	$13.76	$0.00		$0.00	$13.76
GL		$0.00	$6.33	$2.55	$8.88
WC-1		$0.44	$10.01	$4.17	$14.62
WC-1A		$0.00	$3.96	$0.00	$3.96
WC-2		$0.38	$7.72	$3.61	$11.72
WC-3		$0.37	$1.91	$3.45	$5.73
WC-3A		$0.00	$3.64	$0.00	$3.64
WC-4		$0.38	$3.11	$3.56	$7.05
WC-4A		$0.00	$3.87	$0.00	$3.87
PC-1		$0.00	$1.22	$0.00	$1.22
PC-1A		$0.00	$1.88	$0.00	$1.88
PC-1B		$0.00	$1.24	$0.00	$1.24
PC-2		$0.00	$4.75	$0.00	$4.75
PC-2A		$0.00	$6.34	$0.00	$6.34
Total	**$263.46**	**$2.65**	**$55.98**	**$23.68**	**$345.77**

Table 36: Total Conceptual Annual O&M by Sub-basin at Full Implementation

Total Annual O&M Costs ($Millions)					
Sub-basin	**Urban Retrofits (FS2)**	**Full Shade (FS3)**	**Rural Retrofits (FS4)**	**Channel Restoration**	**Total**
WC-5	$0.15	N/A		N/A	$0.15
WC-5A	$0.91	N/A		N/A	$0.91
WC-6	$0.21	N/A		N/A	$0.21
WC-6A	$0.20	N/A		N/A	$0.20
WC-6B	$0.11	N/A		N/A	$0.11
WC-7	$0.07	N/A		N/A	$0.07
WC-7A	$0.05	N/A		N/A	$0.05
WC-7B	$0.11	N/A		N/A	$0.11
WC-7C	$0.13	N/A		N/A	$0.13
WC-7D	$0.14	N/A		N/A	$0.14
WC-75	$0.11	N/A		N/A	$0.11
WC-8	$0.25	N/A		N/A	$0.25
WC-9	$0.12	N/A		N/A	$0.12
WC-9A	$0.14	N/A		N/A	$0.14
GL		N/A	$0.14	N/A	$0.14
WC-1		N/A	$0.21	N/A	$0.21
WC-1A		N/A	$0.10	N/A	$0.10
WC-2		N/A	$0.19	N/A	$0.19
WC-3		N/A	$0.04	N/A	$0.04
WC-3A		N/A	$0.08	N/A	$0.08
WC-4		N/A	$0.07	N/A	$0.07
WC-4A		N/A	$0.11	N/A	$0.11
PC-1		N/A	$0.03	N/A	$0.03
PC-1A		N/A	$0.05	N/A	$0.05
PC-1B		N/A	$0.04	N/A	$0.04
PC-2		N/A	$0.13	N/A	$0.13
PC-2A		N/A	$0.16	N/A	$0.16
Total	**$2.70**	**$ -**	**$1.34**	**$ -**	**$4.04**

D. Financial Analysis

A high-level financial study was completed to determine capital and operational costs of strategies over 30 years.

See Appendix P for a summary of the financial analysis.

i. Cost Summary

The cost summary reflects the assumption that Future Scenarios 2, 3, and 4, as well as the Channel Restoration strategy projects, would be implemented over a 30-year span.

Capital implementation is assumed to occur on a straight-line basis, with 1/30th of capital costs, plus construction cost inflation, anticipated for each year. Operational costs are assumed to occur over a 25-year period beginning in Year 6 of implementation. In each subsequent year, operational costs are assumed to increase by 1/25th of the estimated annual operating costs, plus general cost inflation. Industry-standard cost inflation factors were used to project cost increases over time.

Table 37 summarizes projected costs over 30 years.

Table 37: Cost Summary

Year from Start	1	2	3	4	5	10	20	30
	2018	2019	2020	2021	2022	2027	2037	2047
Base Revenue	$534,844	$543,035	$551,352	$559,797	$568,370		$613,249	$713,916
Additional O&M Cost	0	0	0	0	0	962,962	3,442,929	6,838,717
Additional Capital Cost	11,862,591	12,209,400	12,566,348	12,933,731	13,311,856	15,374,903	20,509,732	27,359,464
Adjusted Revenue	12,397,435	12,752,435	13,117,700	13,493,528	13,880,226	16,951,114	24,666,578	35,029,289
Percentage Increase	2218%	2248%	2279%	2310%	2342%	2664%	3355%	4115%

ii. Stormwater Fee Revenue

The revenue summary assumes that all revenues for actions considered in this Report would be generated from stormwater fees within the Whipple Creek watershed itself.

Equivalent residential units (ERUs) are the basis for calculating stormwater fees. One ERU is 3,500 square feet of hard surface (roof, driveway, roadway, etc.).

In 2017, the Whipple Creek watershed has 10,626 ERUs generating approximately $525,000 annually. If the watershed were fully built-out to maximum densities allowed under the Comp Plan, then the number of ERUs was estimated to be 16,765.

The financial analysis estimates the impact to stormwater fee rates in the watershed over time.

Table 38 shows potential increases in annual stormwater fees over 30 years.

Table 38: Annual Stormwater Fee Increase per ERU

Year from Start	1	2	3	4	5	10	20	30
	2018	2019	2020	2021	2022	2027	2037	2047
Base ERU Rate	$49.83	$50.08	$50.34	$50.59	$50.84	$52.08	$54.39	$56.56
Additional O&M Cost	$0.00	$0.00	$0.00	$0.00	$0.00	$81.77	$262.31	$465.40
Additional Capital Cost	$1,105	$1,126	$1,147	$1,168	$1,190	$1,305	$1,562	$1,861
Adjusted ERU Rate	$1,155	$1,176	$1,197	$1,219	$1,241	$1,439	$1,879	$2,383
Percentage Increase	2218%	2248%	2279%	2310%	2342%	2664%	3355%	4115%

iii. Other Potential Revenue

Beyond stormwater fee revenue from developed properties within the Whipple Creek watershed, other potential funding mechanisms could include stormwater fees generated county-wide (Clean Water Fund), the county's Legacy Lands Fund, the County Road Fund, state grants, and partnerships with quasi-governmental organization such as the Clark Conservation District or non-profit organizations such as Fish First.

E. Adaptive Management

As long-term guidance that may assist in meeting Permit objectives, this Report is not readily implementable. Yet, there are actions that can be taken to set foundations for actions in the Whipple Creek watershed.

Adaptive management would allow goals and methods to change in response to new information, feedback on progress, changing technologies, and new or updated regulatory and community goals. Key elements of the adaptive management program would include a Use Attainability Analysis and future data gathering.

i. Assess Where Designated Uses are Attainable

The objective of the CWA is to restore and maintain the integrity of the nation's waters in terms of chemical composition, physical form, and aquatic life. Unless other uses are designated, water quality must support fishing and swimming (Copeland, 2016). The law allows a designated use that has been assigned to a water body to be removed if evidence shows that attaining the use is not feasible. Six conditions must be met and demonstrated through a Use Attainability Analysis to remove a use (Ecology, 2005).

This Report recommends studying attainability of salmonid uses for Whipple Creek. Historic accounts indicate that anadromous fish once used Whipple Creek in greater numbers than they do today, but the magnitude of historic fish use is unclear given what is known about the geology of the watershed.

Current fish use is clearly limited, although due to Whipple Creek's low priority for salmon recovery, almost no field data exist. To illustrate this point, Whipple Creek is such a low priority for salmon recovery that is it not evaluated in the Lower Columbia Fish Recovery Plan (LCFRB, 2010).

Also recommended is a study of attainability of the primary contact recreation designated use. A large portion of the Whipple Creek watershed is rural in nature and, as is common for streams in rural and forested areas, hosts wildlife populations that contribute fecal coliform directly and indirectly to streams. Whipple Creek's urbanized and urbanizing areas largely have soil conditions that are incompatible with the use of infiltration to remove bacteria from runoff. Given these limitations, it may be infeasible for some reaches in the watershed to attain the primary contact recreation designated use.

This Report considers a Use Attainability Analysis as precursor to any other strategy or action contemplated for the Whipple Creek watershed, but not as an effort to update state standards under WAC 173-201A.

See Appendix M for an initial discussion of use attainability in Whipple Creek.

ii. Modify the Stormwater Capital Program

The county has been formally planning stormwater capital improvements since 2007. Current planning allocates approximately $9.8 million for the 2013-2018 Stormwater Capital Program, which covers the entire Permit area.

A 2019-2024 plan is currently under development. At the time of writing, 17 structural projects are under consideration in the Whipple Creek watershed, comprised of nine channel restoration projects, one facility repair, two retrofits where treatment and detention are currently lacking, and five retrofits of existing facilities to increase treatment and/or detention capabilities.

This Report suggests considering that capital projects prioritized for Whipple Creek be incorporated into the county's Stormwater Capital Program for planning and construction as funding allows.

iii. Prioritization Categories

An adaptive management approach could consider a number of prioritization strategies in contemplating management actions in the Whipple Creek watershed.

Table 39 (next page) lists potential prioritization categories in a Whipple Creek adaptive management approach.

Table 39: Prioritization Categories

Category	Description	Prioritization
Goal Attainment by Sub-basin	Some sub-basins come much closer to meeting water quality standards and attaining beneficial fish uses than others. Other sub-basins remain degraded under all future scenarios. Sub-basins with best overall goal attainment for all variables should be prioritized if further study of the sub-basin indicates that strategies are feasible in the area. Factors such as land availability, availability of capital funding, and availability of operational funding help determine feasibility. A capital planning process should take predictions of sub-basin goal attainment into account both when prioritizing investigations to identify potential projects (locations and designs) and when prioritizing projects.	Consider prioritizing sub-basins with the best potential for goal attainment, as determined through further study. Consider incorporating analysis of predicted goal attainment into capital planning procedures for Whipple Creek.
Channel Restoration	Channel restoration, such as grade controls, stream bank stabilization, floodplain detention, and stream bed fill, could help preserve or restore pockets of viable salmon habitat in the Whipple Creek main stem. Fish passage barrier removal can restores access to currently inaccessible stream channels that may have good salmon habitat.	Consider prioritizing channel restoration.
Areas of Special Attention	Areas include regulated critical areas such as wetlands and habitat conservation areas and areas characterized by stream channel erosion, floodplain disconnection, suitable salmon spawning habitat, low temperatures suitable for thermal refugia for salmon, complete lack of stormwater detention, complete lack of stormwater treatment, and degraded riparian conditions on public land. (See Appendix E for a discussion of these areas.) A capital planning process could take areas of special attention into account both when prioritizing investigations to identify potential projects (locations and designs) and when prioritizing projects..	Consider incorporating areas of special attention into capital planning procedures for Whipple Creek.
Planned Projects	The county's Stormwater Capital Program may include projects in Whipple Creek watershed.	Take advantage of existing planned capital investments in the watershed.
Land Availability	Project feasibility due to access to land is likely a concern for most capital projects that would be proposed in the Whipple Creek watershed.	Incorporate land availability into capital planning procedures for Whipple Creek.
MS4 Nexus	Numerous factors outside of discharges from the MS4 impact water quality and in-stream conditions. Some strategies discussed in this Report, such as the riparian Full Shade strategy (see FS3) and the Channel Restoration strategy, operate outside the boundaries of Clark County's MS4. These strategies may be the most cost-effective strategies for progressing toward achieving beneficial uses. On the other hand, riparian and channel restoration projects do not assist Clark County in meeting the regulatory requirements of its Permit.	Prioritize the most cost-effective projects for protecting or restoring beneficial uses, regardless of relationship to MS4.

iv. Whipple Creek Monitoring

In following its scope of work for writing this Report, Clark County expanded elements of its ongoing county-wide monitoring program to focus on Whipple Creek.

An adaptive management approach could continue the targeted data collection effort in Whipple Creek to include continuous flow monitoring, temperature monitoring, water quality sampling, and macroinvertebrate sampling. Special projects could look for problem areas such as bacteria sources. Data and analyses could contribute to the Use Attainability Study, capital planning, modeling, and prioritization of management options.

v. Continue Model Development

The hydrology model is well-calibrated at the watershed scale, but additional work could improve the accuracy at the sub-basin scale based on data collected in Packard Creek and upper Whipple Creek. Continued model development could lead to detailed modeling of UGA sub-basins as part of an effort to plan effective restoration or protection plans.

vi. Other Prioritization Tools

Recently, the Washington Department of Commerce released a guidance document titled *Building Cities in the Rain – Watershed Prioritization for Stormwater Retrofits.* The aim is to most effectively deploy scarce resources to protect and restore receiving waters for stormwater runoff by prioritizing areas for stormwater retrofitting. The guidance relies heavily on companion guidance by Ecology for elaborate GIS-based watershed characterization and the newer proposed stormwater control transfer program that would promote placing restorative stormwater controls where there is the greatest benefit.

An adaptive management approach could classify subareas for protection, restoration or development based on hydrologic modeling, water quality modeling, and areas of special interest such as salmon bearing stream reaches.

An assessment of the *Building Cities in the Rain* methodology is included in Appendix Q.

F. Schedule

This Report uses a 30-year planning horizon.

By 2040, the median prediction for population of Clark County nears 600,000, up from 425,000 in 2010 (State of Washington Office of Financial Management, 2012). Population in the entire Vancouver UGA (not limited to Whipple Creek) is predicted to rise from 315,000 to 372,000 by 2035 (Clark County, 2016). It seems likely that the Vancouver UGA could continue to expand west into the Whipple Creek watershed as decades pass.

Land use assumptions are based on the 20-year Comp Plan through 2035. No land cover conversions beyond full build-out at 20 years are anticipated in this Report.

A start date has not been established. Actions are conceptually scheduled from Year 1.

Table 40: Conceptual Schedule

Years 1 - 5	• Implement the contemporaneous Clark County Stormwater Management Program and Stormwater Capital Program • Continue Whipple Creek targeted monitoring studies • Initiate a Use Attainability Analysis
Years 6 - 15	• Implement the contemporaneous Clark County Stormwater Management Program • Adaptive Management • High Priority Capital Projects as Funding Allows
Years 16 - 30	• Implement the contemporaneous Clark County Stormwater Management Program • Adaptive Management • Medium Priority Capital Projects as Funding Allows

V. Public Review Process

Clark County published a web page about the watershed planning process in 2015 at https://www.clark.wa.gov/public-works/whipple-creek-watershed-plan. The draft report was available online and in public libraries for public comment for a two week period from August 21 to September 1, 2017.

Figure 14: Screenshot of Whipple Creek Watershed Assessment Web Page

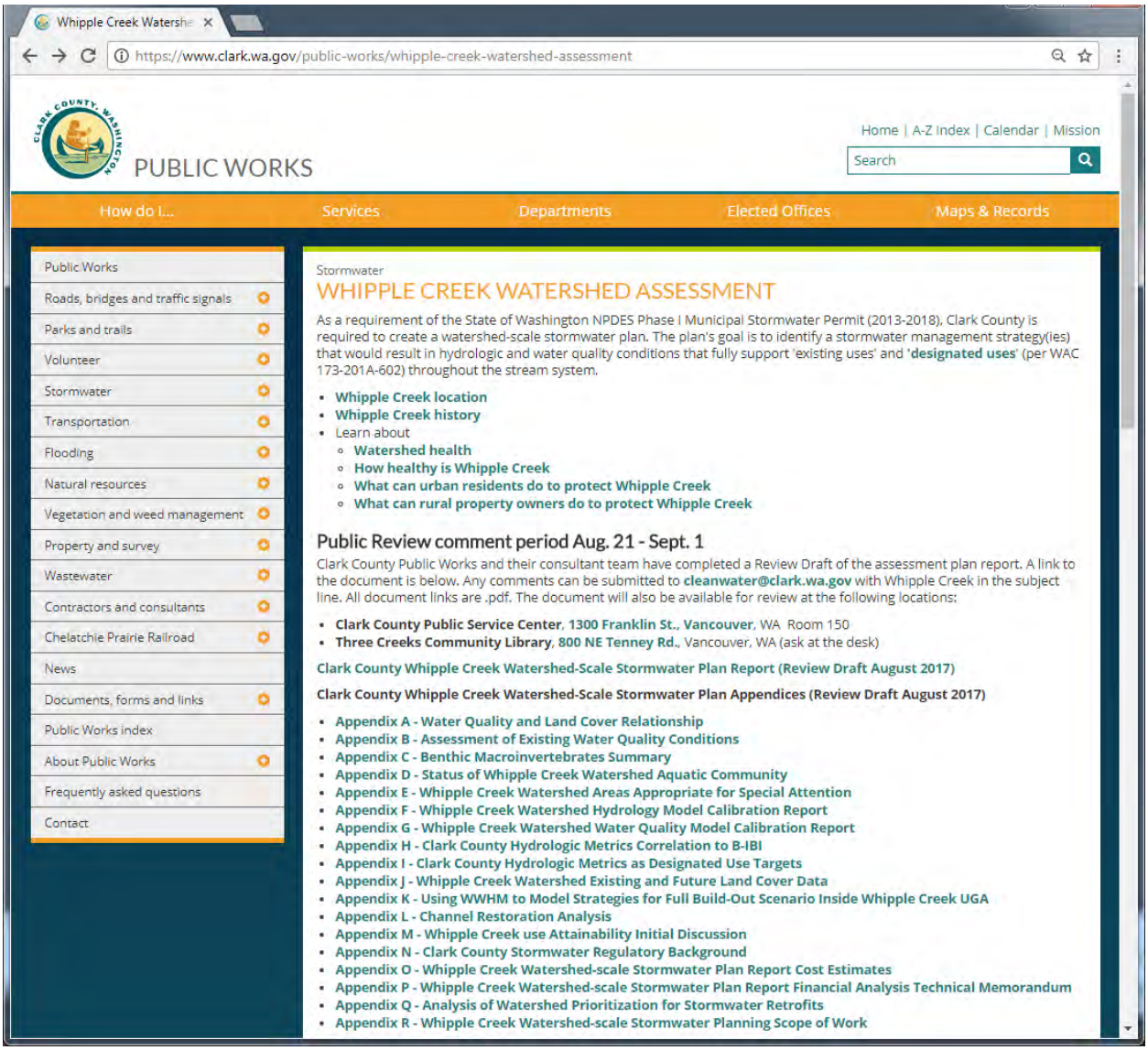


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Exhibit B

Appendix E

Whipple Creek Watershed-Scale Stormwater Plan Report

Watershed Areas Appropriate for Special Attention in Regard to Hydrologic and Water Quality Impacts

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December 2016

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Introduction

Whipple Creek watershed is located in southwest Clark County, draining west from low hills to the Columbia River flood plain (**Error! Reference source not found.**). The watershed's land use was once dominated by rural and agricultural land uses. Currently the watershed is moderately developed with a mix of rural lands, as well as urban and urbanizing areas at the northern edge of the unincorporated Vancouver Urban Growth Area (UGA). The 8.8 square mile upper sub-watershed (including Packard Creek) has approximately 4.4 square miles inside the UGA while the 3.3 square mile lower subwatershed is entirely outside the UGA. Historic land clearing and development impacts have degraded stream habitat and caused areas of severe channel instability and erosion. Impacts on channel stability, water quality, and overall ecological function from urbanization within the watershed are consistent with those documented elsewhere around Washington State.

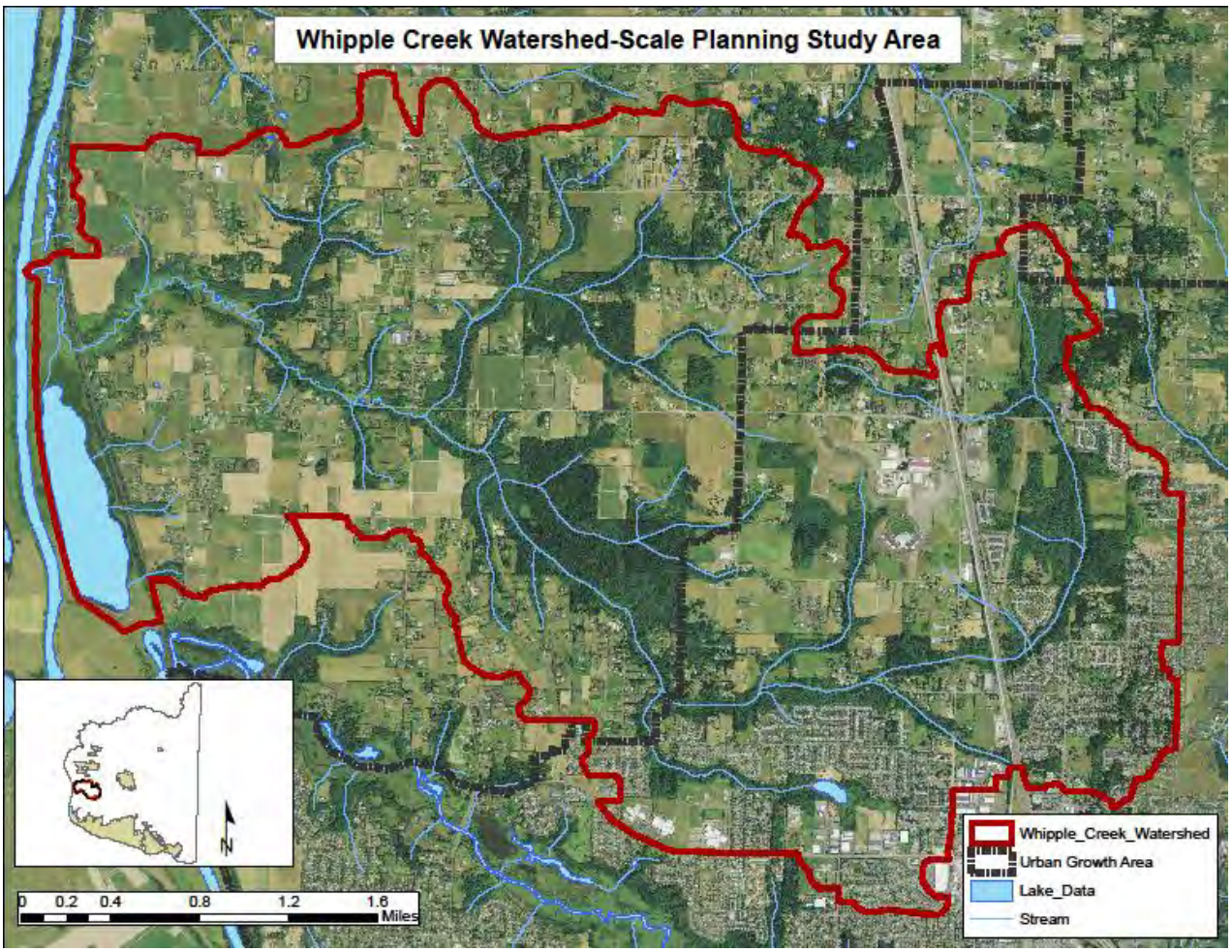

Figure 1 Whipple Creek watershed area map

The Whipple Creek stream system's designated beneficial uses are for: 1) aquatic life use of salmonid spawning, rearing, and migration; and, 2) human use of primary contact recreation and swimming (WAC 173-201A-020). However, it is degraded due to historical clearing and development. Additionally, the Whipple Creek watershed is predicted to become increasingly developed under future conditions, especially within the UGA and along the Interstate 5 corridor.

This chapter presents a review of Whipple Creek watershed historic field observations, existing reports, and geographic information system (GIS) data analyses to identify areas appropriate for special attention in regard to hydrologic and water quality impacts for watershed planning.

This analysis is designed to help address Clark County's 2013-2018 NPDES Phase I Municipal Stormwater Permit (Permit) section S5.C.5.c.ii.2 watershed-scale stormwater planning requirements (WA Dept. of Ecology, 2012). Specifically, areas appropriate for special attention in regard to hydrologic and water quality impacts are identified and mapped. Such areas include riparian buffers, wetlands, hydric soils, floodplains, steep slopes, forests, valuable habitat zones, and other sensitive resource areas. Human caused disturbances and impacts in and around these areas of special attention should be avoided. If disturbance or impacts are unavoidable, they should be minimized through stormwater best management practices to reduce further impacts on channel stability, water quality, and overall ecological function.

Methods

Review of reports of data for stream reconnaissance was conducted by Clark County Clean Water Division from December 2004 through May 2005. County staff assessed about 25 miles of Whipple creek and its tributaries. Stream reaches were assessed for stormwater impacts and stream enhancement opportunities. The assessment of stream reaches utilized the Unified Stream Assessment (USA) protocol designed by the Center for Watershed Protection (March 2004) for EPA's Office of Water Management. The USA is part of a larger set of protocols developed by the Center as an integrated framework for improving and rehabilitating small urban watersheds. Assessments focused first on the more heavily developed upper watershed stream reaches, followed by the more rural Packard Creek tributary. Stream reconnaissance data were recorded and mapped in the field, then transferred digitally to a shapefile using ESRI ArcMap software.

The current Whipple Creek watershed planning GIS analysis included utilizing existing shapefile data and creating new shapefiles to identify and map areas appropriate for special attention in regard to hydrologic and water quality impacts within the Whipple Creek watershed. Shapefiles were then extracted and a new feature class created as new shapefiles that are within the watershed using the Clip Feature function in ArcMap.

Review of existing county reports fulfills requirements under section S5.C.5.c.ii.1 of the county's Permit which includes Assessments of Existing Conditions (Clark County 2014), Clark County Stream B-IBI Versus Hydrologic Metrics Relationships (Clark County 2015), Status of Whipple Creek Watershed Aquatic Community (Clark County 2015), Water Quality and Land Cover (Clark County 2015). Additionally, the Whipple Creek Hydrology and Hydraulic Modeling (Clark County 2005), Whipple Creek Stormwater Needs Assessment (Clark County 2006) and the Whipple Creek Technical Memo (Inter-Fluve 2006).

Results

The following figures and associated text identify areas appropriate for special attention in regard to hydrologic and water quality impacts.

Regulated Critical Areas (Title 40)

Title 40 of the Clark County Code includes limitations on development in critical areas associated with certain natural features. Title 40 includes chapters 40.420 Flood Hazard Areas, 40.430 Geologic Hazard Areas, and 40.440 Habitat Conservation, 40.450 Wetland Protection. Since critical areas are already protected by county code (Figure 2), these areas were not the main focus in the analysis of areas of special attention for Whipple Creek watershed stormwater planning. Instead, areas of special attention were derived from a combination of documented field observations during stream reconnaissance, GIS exploration, and analysis of existing water quality data.

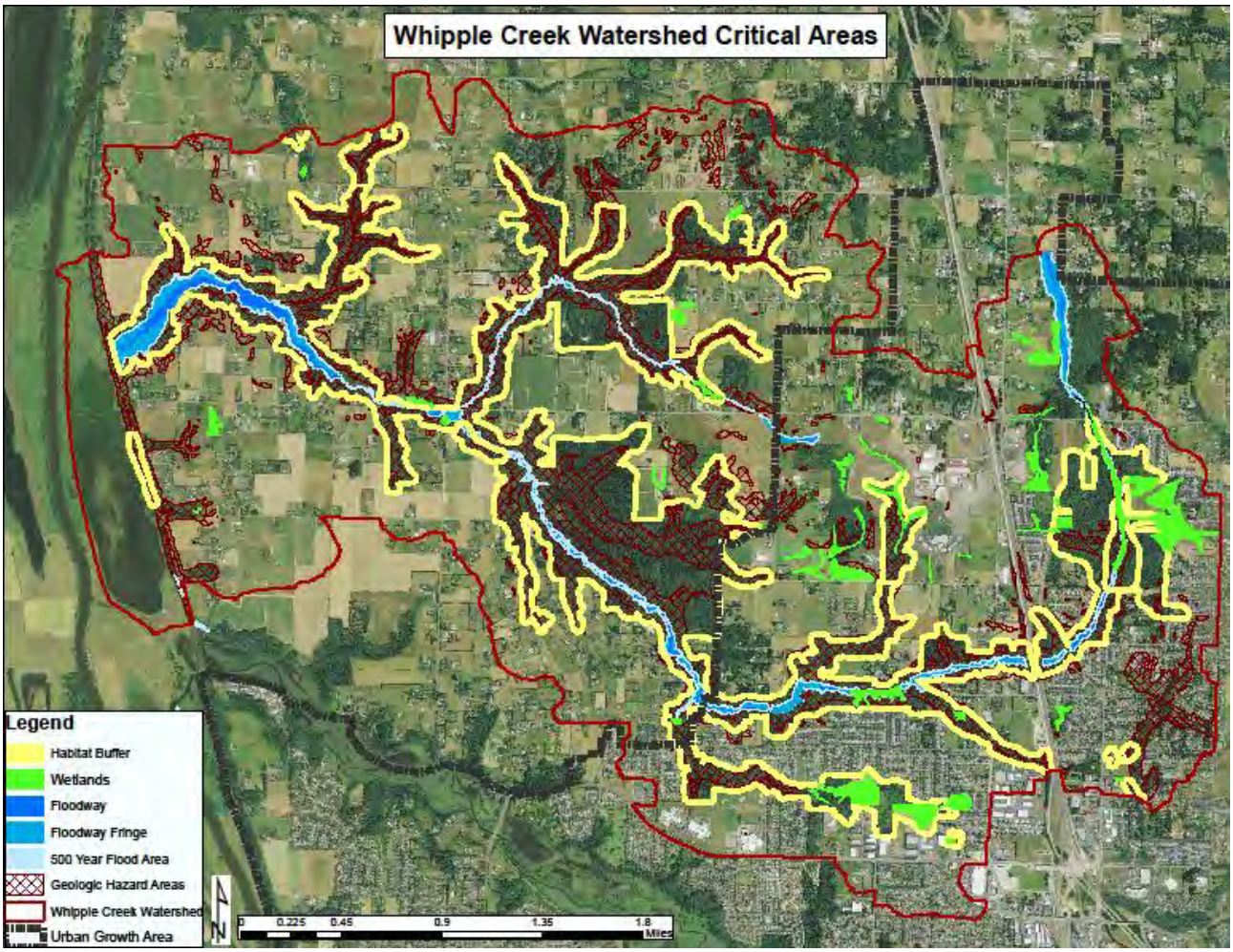

Figure 2 Whipple Creek critical areas as defined by Clark County Code 40.420 through 40.450.

Stream Channel Erosion and Floodplain Disconnection

Within the stream reconnaissance assessed reaches, degraded areas far exceeded those that remained intact. In many assessed reaches, it was evident that increased runoff from historical clearing and development led to substantial stream channel incision, streambank scour, and floodplain disconnection (Clark County, 2006). Observed stream channel erosion reaches mapped during stream reconnaissance efforts are considered one important category for areas of special attention (Figure 3). These areas should be revisited and further assessed for channel enhancement or restoration opportunities.

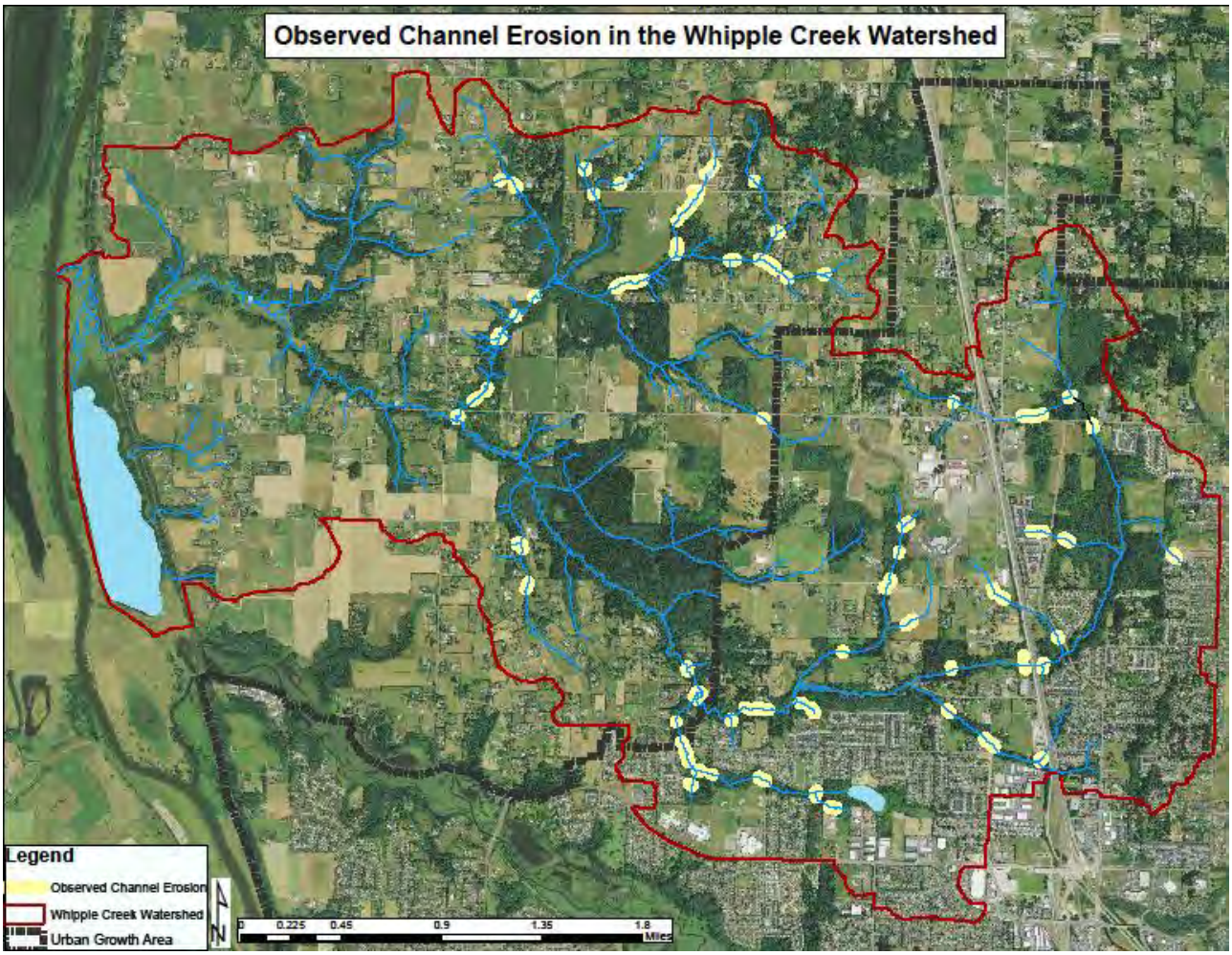

Figure 3 Areas of observed stream channel erosion within the Whipple Creek watershed

Developed Catchments with No Stormwater Detention

Streambank erosion is a natural process. However, human activities can induce acceleration of this natural process which can cause excessive channel erosion leading to disproportionate sediment supply, stream channel instability, habitat loss, channel incision and other degraded conditions. The effects of excessive channel erosion are pervasive throughout Whipple Creek and most of its tributaries. Poor water quality and impaired biological communities are due, in large part, to the erosion and subsequent habitat degradation caused by urbanization and altered hydrology. Fine sediment from eroded soil and channels gets suspended in the water column which subsequently can degrade habitat by impeding oxygenated flow through salmonid spawning substrate and covering riffle habitat for invertebrates that are an important source of food for many fish.

Channel incision also greatly reduces instream habitat. Since incised channels are straighter, steeper and often wider, larger flows are contained within the channel (as opposed to spilling over into the floodplain) leading to flashier flows and reduced hydraulic retention. As channel incision occurs, stream flood plain interaction is eliminated or greatly reduced, and floodplain wetlands are often dewatered, cleared, filled or destroyed by channel erosion (Shields et. al, 2009). Within Whipple Creek, channel

incision has reduced overbank flooding, ultimately disconnecting floodplains in multiple stream reaches and has reduced channel migration (Inter-Flueve, 2006).

Developed catchments within the Urban Growth Area having no stormwater detention best management practices were identified as areas of special attention (Figure 4). These areas of special attention should be evaluated for stormwater flow control retrofit and low impact development (LID) opportunities; especially in areas upstream of observed channel erosion areas.

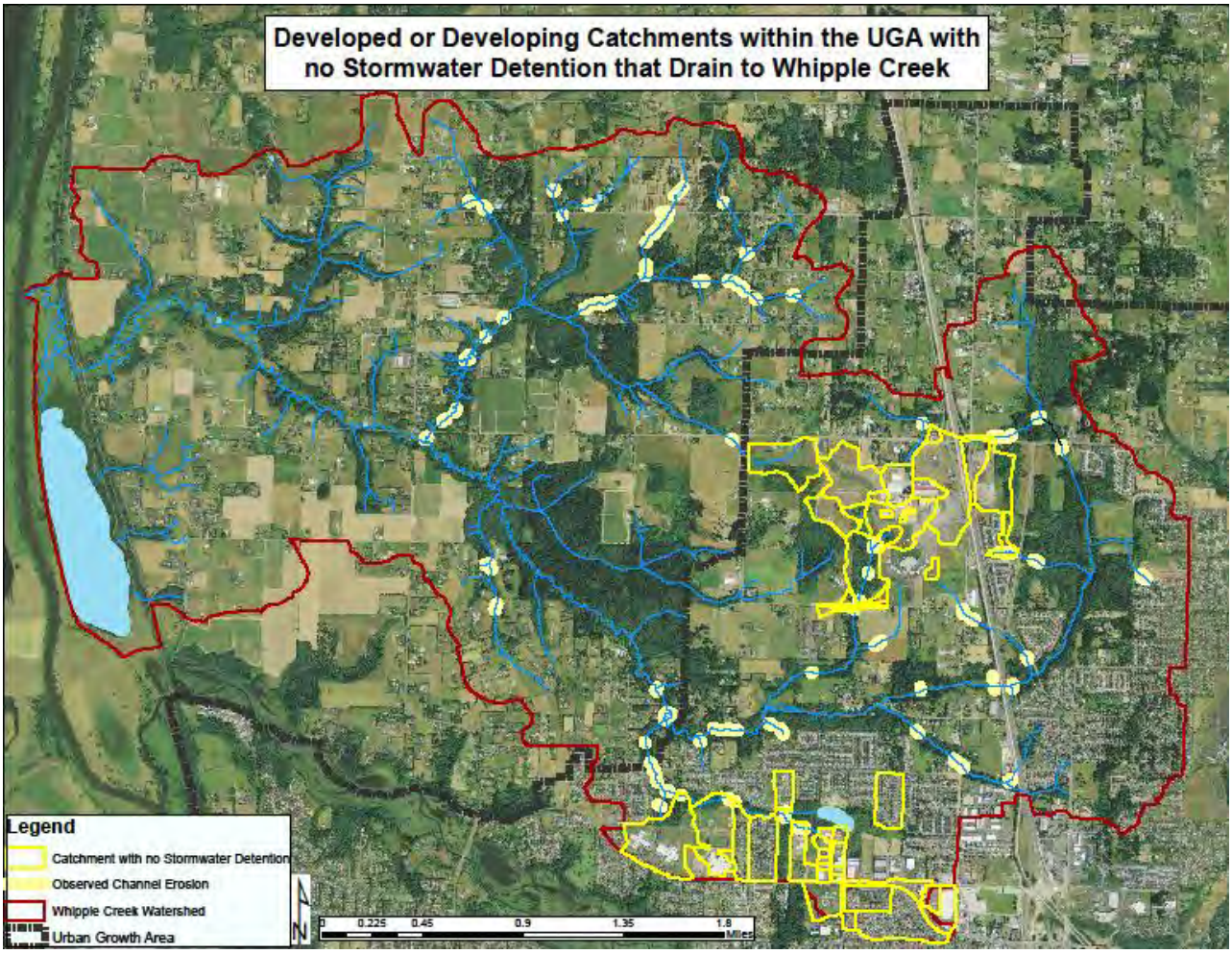

Figure 4 Catchments with no stormwater runoff detention best management practices within the UGA of the Whipple Creek watershed

Suitable Salmon Spawning Habitat and Wetlands of Concern

Within the Whipple Creek watershed, field observations suggest spawning habitat is the greatest limiting factor for salmonids. Importantly, salmonid spawning habitat is already substantially limited due to occurring stream size, topography, and substrate (Inter-Fluve, 2006). Within the basin, channels below 0.5% gradient contain sand and silt substrate that is unsuitable for spawning which leaves only a few isolated areas where conditions are potentially suitable. Protecting observed suitable spawning habitat within the Whipple Creek watershed from the effects of channel erosion will need to be a high priority.

Stream channel incision has already put several wetlands at risk of being drained from migrating headcuts that can deepen and widen the stream channel leading to transporting stored sediment downstream and covering suitable spawning habitat (Inter-Fluve, 2006). Protecting existing wetlands is important because wetlands can slow the velocity of water down which allows for floodplain sediments to settle out of the water column. Suitable spawning habitat for salmonids, wetlands, and wetlands at risk are considered areas of special attention (Figure 5).

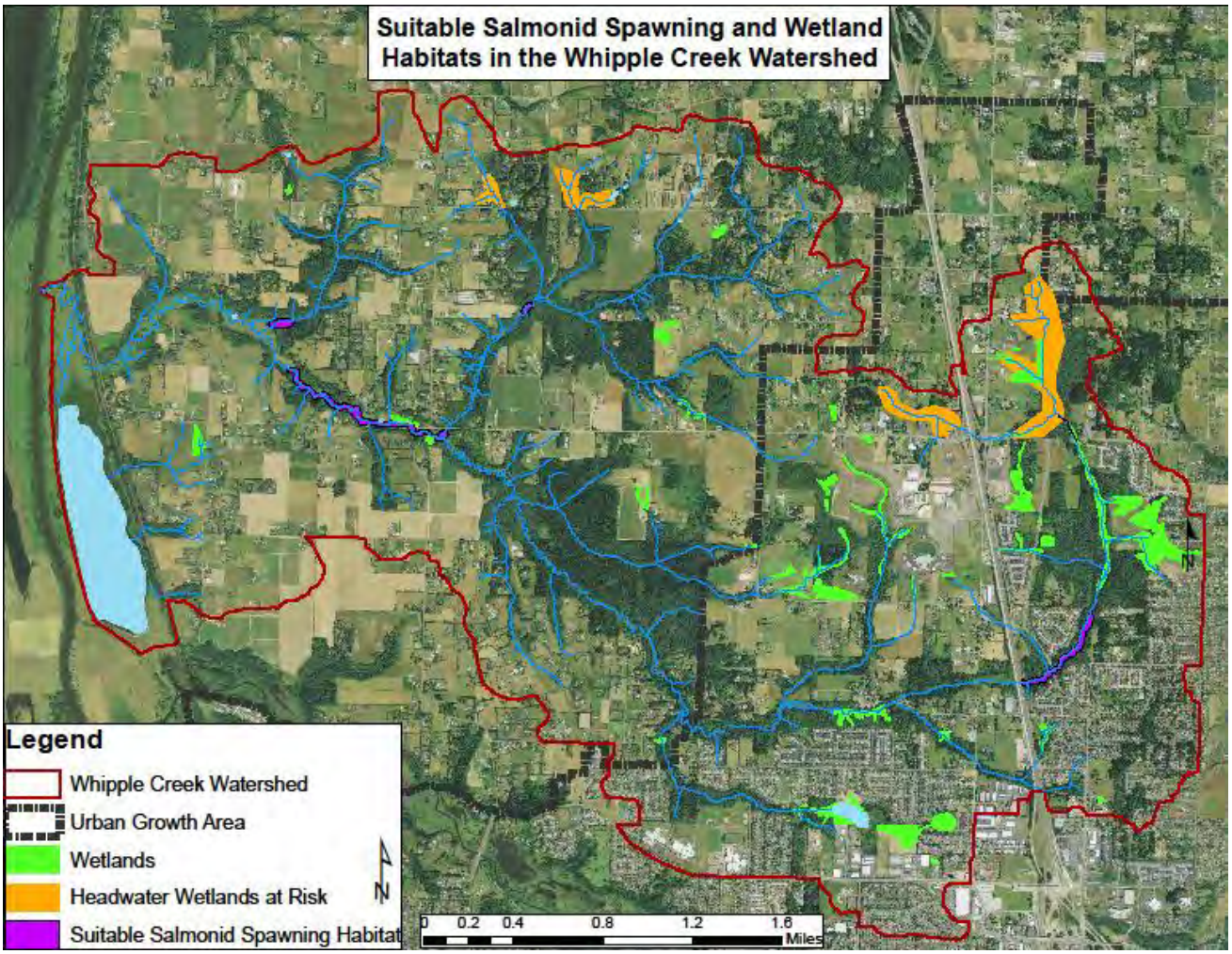

Figure 5 Field observations of wetlands, headwater wetlands at risk due to channel erosion, and suitable salmonid spawning habitat in the Whipple Creek watershed

Whipple Creek Stream Temperatures and Possible Sources of Thermal Refugia

Stream temperature is one of the most important environmental influences on salmon biology. Under the state water quality stream standards, Whipple Creek is designated Salmonid Spawning, Rearing, and Migration and has the Aquatic Life Temperature Criteria Highest 7DADMax temperature of 17.5°C (63.5°F). Continuous summer stream temperature data collected approximately at river mile 3.1 of Whipple Creek (WPL050) show that the 17.5°C criterion is often exceeded; especially in the hotter months of July and August (Figure 6).

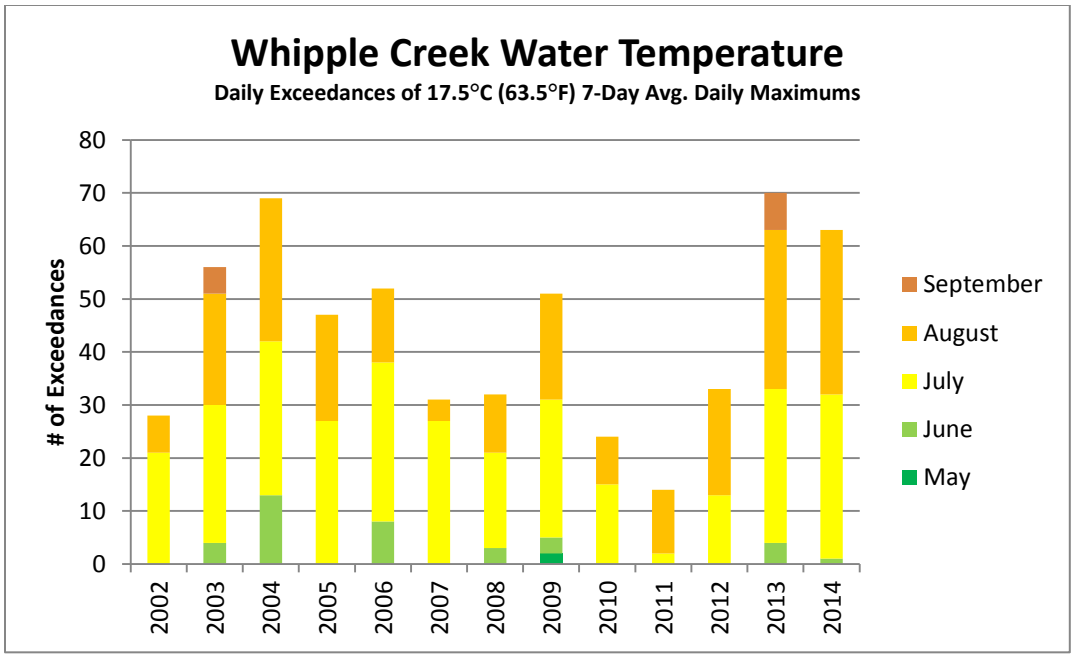

Figure 6 Whipple Creek station WPL050 water temperature exceedances 2002 through 2014

Continuous summer stream temperature data collected from May 2014 through June 22, 2015 at four unnamed tributary stations (WPLT01, WPLT02, WPLT03, and WPLT04), Packard Creek (PCK010), and four Whipple Creek mainstem stations (WPL080, WPL065, WPL050, and WPL010) show that Packard Creek and all mainstem sites exceeded the 17.5°C criterion (Figure 7). Additionally, based on logged daily minimum water temperatures, monitoring stations WPL065 had 26 days where continuous temperature loggers show that the stream temperature never got below the *maximum* 63.5°F: PCK010 - 10 days, WPL050 - 7 days: and WPL010 had 2 days.

When stream temperatures exceed the 17.5°C criterion, thermal refugia can provide important habitat conditions for salmonids survival. Salmonids that are exposed to stressful or lethal temperatures for part of the day can effectively block migration, stress fish, affect reproduction, inhibit smoltification, create disease problems, and alter competitive dominance (Carter, 2005). Tributaries of Whipple Creek may provide thermal refugia for salmonids during the hotter months of summer. Tributaries WPLT01, WPLT02 and WPLT03 did not exceed the 17.5°C criterion during the monitoring timeframe (May 2014 through June 22,). These same tributaries also have relatively intact forested riparian areas. It is possible that other unnamed tributaries not monitored for continuous stream temperature also provide thermal refugia during the hotter months. Stream temperatures and summer base flows from unmonitored tributaries should be further evaluated for areas of special attention that help provide thermal refugia for salmonids.

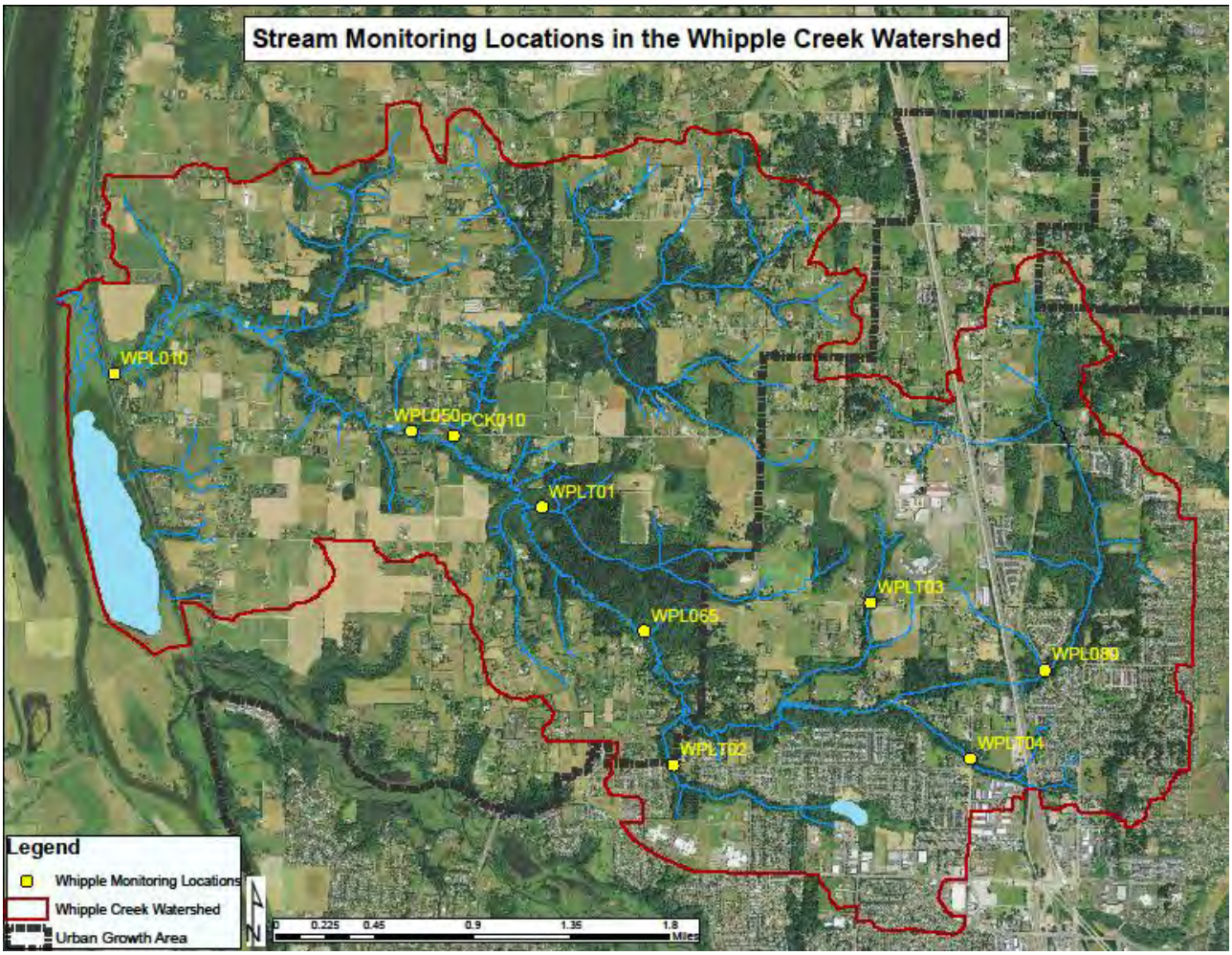

Figure 7 Stream monitoring location within the Whipple Creek Watershed

County Owned Properties with Stream/Riparian Enhancement Opportunities

County owned properties should be evaluated as areas of special attention that may provide opportunities for riparian and stream channel restoration and enhancement opportunities. Parcels that the county or other regional partners own are considered areas of special attention because they alter beneficial opportunities for implementing stormwater planning (Figure 8). Solar radiation is the primary driver of water temperature. Increasing riparian tree coverage within the Whipple Creek watershed would enhance shading and help reduce sunlight impacted stream temperature. In many areas of the Whipple Creek watershed, invasive species are preventing the natural succession to shade producing coniferous riparian forest (Inter-Flueve, 2006). Riparian restoration activities should include removal of invasive species, planting of native shrubs and trees, fencing where appropriate to prevent livestock access to the creek, and protecting plantings from beaver activity. Channel and habitat enhancement should include large woody debris structures for grade control, recreating historical channel morphologies, reconnection of channels to floodplains, and gravel supplementation where appropriate.

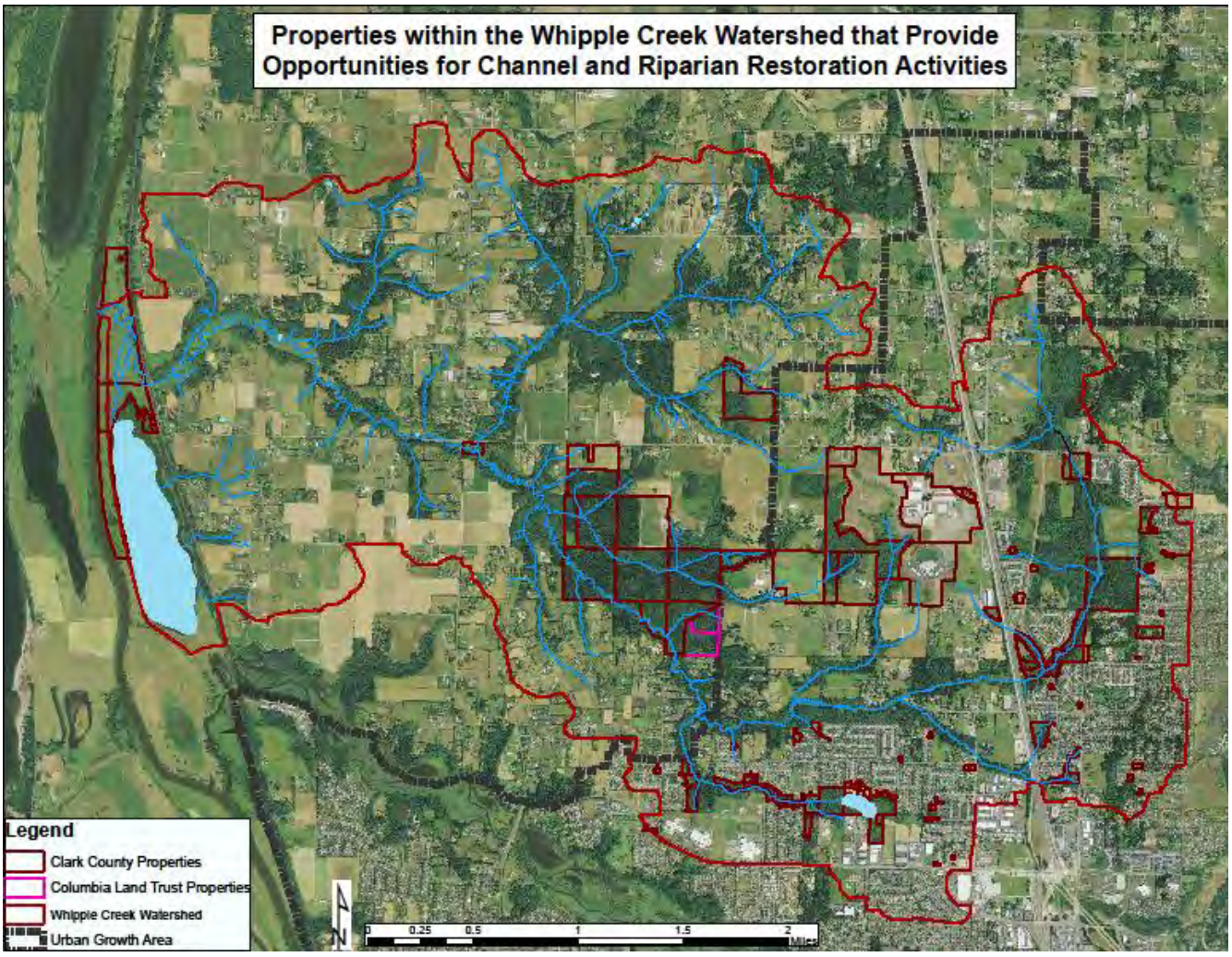

Figure 8 Whipple Creek monitoring locations and associated drainage catchments

Urban Catchments Lacking Stormwater Treatment

Monthly water quality data collected from a Whipple Creek monitoring site (WPL050) since 2003 indicate that water quality in Whipple Creek is often poor as summarized by the Oregon Water Quality Index (Clark County, 2010, Clark County, 2014). The Oregon Water Quality Index (OWQI) was developed as a way to improve the understanding of water quality issues by integrating multiple characteristics and calculating a score that describes water quality status (Cude, 2001). The OWQI integrates eight water quality variables: temperature; dissolved oxygen; biochemical oxygen demand; pH; ammonia + nitrate nitrogen; total phosphorus; total solids; and fecal coliform. For each sampling event, individual subindex scores and an overall index score are calculated. Index scores are aggregated into low flow (June – September) and high flow (October – May) seasons and seasonal mean values are then calculated with the lower of the two scores utilized as the overall water year OWQI score.

Of the four water year 2012 overall OWQI results for multiple stations in Whipple Creek, three were classified as poor and one as very poor. The order from highest to lowest water year 2012 overall seasonal OWQI scores were: WPL080 (74.6, poor), WPL010 (61.3, poor), WPL050 (60.8, poor), and PCK010 (45.0, very poor). Except for WPL080's excellent fecal coliform (91.8) and fair ammonia and

nitrate nitrogen (82.5) subindex scores, all of the water year 2012 overall OWQI scores were pulled down by very poor total solids and nutrients and poor to very poor fecal coliform subindex scores (Clark County, 2014).

In addition to monthly stream data collection, base and storm flow water quality was monitored from July 2014 to October 2015 and compared to land cover data for each catchment (Table 1). These parameters included water temperature, turbidity, pH, fecal coliform, and dissolved zinc and dissolved copper. In general, water temperature and pH median values were similar for both base and storm flow. As expected, turbidity median values were higher during storm flow compared to base flow. This was also true for median fecal coliform values with the exception of WPLT02. The median base flow fecal coliform values for WPLT02 were 780 (CFU/100mL) compared to a storm flow median value of 665 (CFU/100mL).

Table 1 Whipple Creek mainstem and tributary station water quality data from base and storm flows

Whipple Creek Mainstem Catchment Water Quality Medians																
Station	WPL010 Medians				WPL050 Medians				WPL065 Medians				WPL080 Medians			
Land Use	Impervious	Forest	Pasture	Grass	Impervious	Forest	Pasture	Grass	Impervious	Forest	Pasture	Grass	Impervious	Forest	Pasture	Grass
Percentage	11	30	34	25	12	31	31	26	20	26	19	35	16	32	22	30
Flow Type	Base		Storm		Base		Storm		Base		Storm		Base		Storm	
Sample Size *	12		18		12		18		12		18		12		18	
Parameter (units)																
Water Temperature (degrees C)	11		13.1		11		13.2		11.4		13.4		10.8		13.3	
Tubidity (NTU)	8.9		26.8		7.6		30.2		7.6		16.6		6.2		15.3	
pH	7.48		7.4		7.89		7.53		7.52		7.46		7.54		7.33	
Total Suspended Solides (mg/L)	5		28		5		29.25		5		22.25		5		13.5	
Dissolved Copper (ug/L)	0.71		1.23		0.76		1.23		0.9		1.55		0.96		1.48	
Dissolved Zinc (ug/L)	1.5		0.82		1		1		1.5		2.14		1.4		2.76	
Fecal Coliform (CFU/100 mL)	340		720		262		1865		203		445		57		440 (17)	

Whipple Creek Tributary Catchment Water Quality Medians																
Station	PCK010 Medians				WPLT01 Medians				WPLT02 Medians				WPLT03 Medians				WPLT04 Medians			
Monitoring Period	WY12 Monthly, July'14-May '15				July '14 - May '15				July '14 - May '15				July '14 - May '15				July '14 - May '15			
Land Use	Impervious	Forest	Pasture	Grass	Impervious	Forest	Pasture	Grass	Impervious	Forest	Pasture	Grass	Impervious	Forest	Pasture	Grass	Impervious	Forest	Pasture	Grass
Flow Type	Base		Storm		Base		Storm		Base		Storm		Base		Storm		Base		Storm	
Sample Size *	12		18		12		18		12		18		8		18		12		18	
Parameter (units)																				
Water Temperature (degrees C)	10.8		13		10.5		12.7		11.1		12.9		6.1		12.2		11.5		13.65	
Tubidity (NTU)	9.6		46.2		11.7		25.8		4.6		25.7		9.9		30.4		9.6		32.4	
pH	7.69		7.6		7.89		7.65		7.65		7.44		7.46		7.52		7.2		7.37	
Total Suspended Solides (mg/L)	5		45.25		5		16		5		21.85		5		31		5		29.9	
Dissolved Copper (ug/L)	0.82		1.49		0.67		0.79		0.74		1.93		1.15		1.85		0.66		2.39	
Dissolved Zinc (ug/L)	0.8		1		0.5		0.49		1.7		6.1		2.4		2.9		2.1		8	
Fecal Coliform (CFU/100 mL)	395		3100 (17)		485		1170		780		880 (16)		31		660		71		870	

* Common sample size across all parameters unless noted otherwise in parentheses after median value

The high base flow fecal coliform values at WPLT02 suggests that there may be some ongoing issues within the WPTLT02 catchment that are elevating fecal coliform levels. Such issues may include leaking sewage/septic leaks to the stream or direct wildlife or livestock access to the stream. This catchment should be identified as an area of special attention regarding water quality. Efforts should be made to conduct stream reconnaissance within this catchment to detect potential sources of fecal coliform discharging to the stream.

Median dissolved copper and dissolved zinc values were generally higher for storm flow. Also, analysis of these data via linear regression specifically showed that as developed areas (land cover

impervious/grass) approach 25% of the subwatershed's total area, storm flow dissolved zinc median values were significantly higher than those for base flow. Based on the significance of these findings, developed areas within the UGA lacking stormwater treatment are considered areas of special attention, for adding stormwater treatment Best Management Practices (BMP's) to reduce potential impacts from untreated stormwater discharging to Whipple Creek (Figure 9).

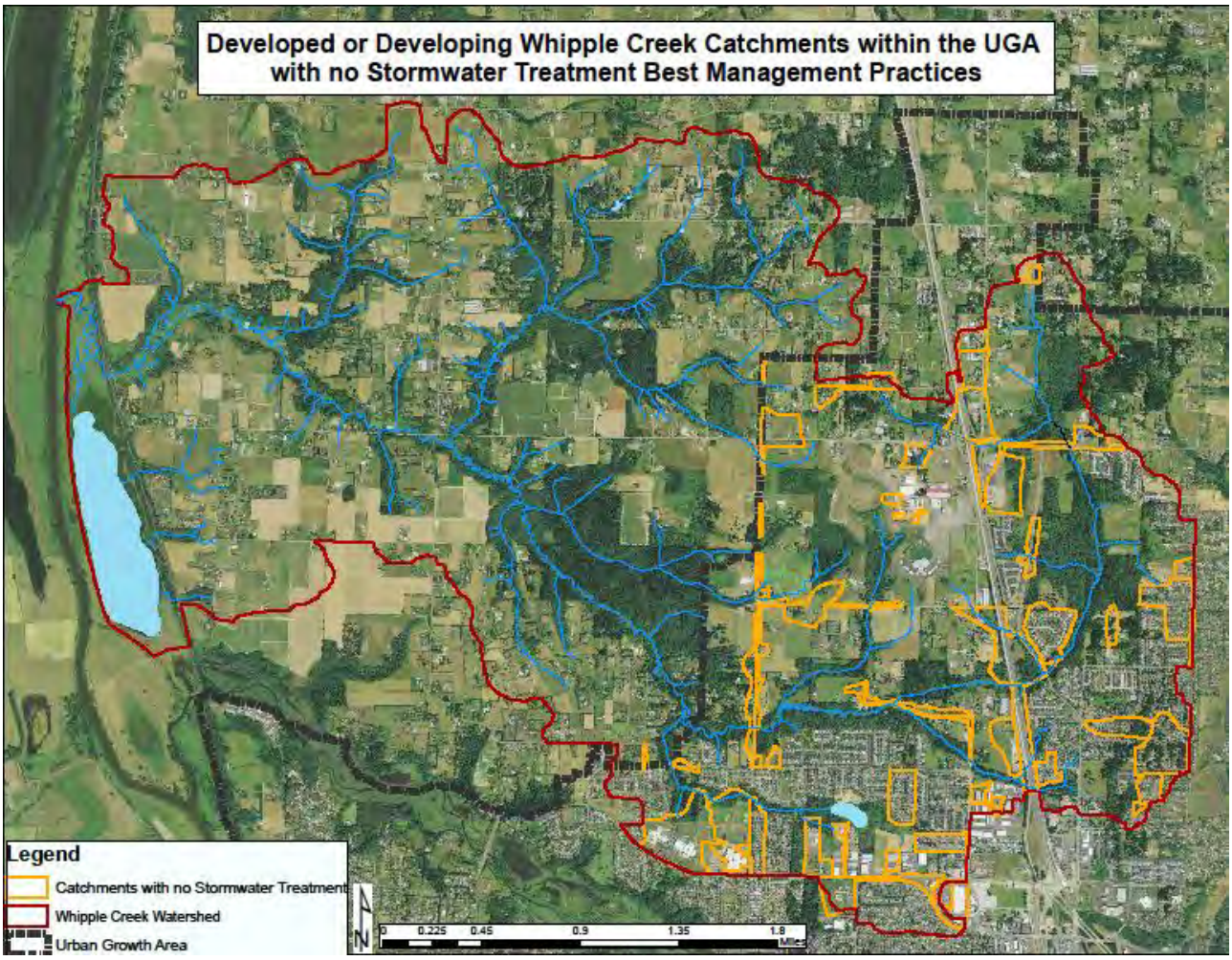

Figure 9 Urbanized catchments with no stormwater runoff treatment best management practices within the UGA of the Whipple Creek watershed

Discussion

This report addresses Clark County's 2013-2018 NPDES Phase I Municipal Stormwater Permit (Permit) section S5.C.5.c.ii.2 watershed-scale stormwater planning requirements to map areas within the Whipple Creek watershed appropriate for special attention in regard to hydrologic and water quality impacts.

Stream hydrology and water quality have been altered dramatically in the Whipple Creek watershed as a result of development that occurred over many decades without stormwater BMPs or with stormwater BMPs that were not designed to today's standards. As a result, the Whipple Creek stream system often

does not support its state designated beneficial uses for 1) aquatic life use of salmonid spawning, rearing, and migration and 2) human use for primary contact recreation and swimming (WAC 173-201A-020).

The Whipple Creek watershed is predicted to become increasingly developed in the future, especially within the UGA and along the Interstate 5 corridor. Even to just maintain current degraded conditions within Whipple Creek, new development must meet current county stormwater discharge treatment and hydrologic standards. However, the objective of watershed-scale stormwater planning is to identify a stormwater management strategy or strategies that will result in hydrologic and water quality conditions that fully support for 1) aquatic life use of salmonid spawning, rearing, and migration and 2) human use of primary contact recreation and swimming. To obtain this more stringent objective, watershed restoration strategies will need to be developed, prioritized and implemented that address stormwater flow control, water quality, stream temperature, and degraded stream habitat issues.

Clark County has identified and mapped specific areas within the Whipple Creek watershed appropriate for special attention in regard to hydrologic and water quality impacts where watershed restoration strategies can be implemented, these areas include:

- Observed stream reaches with channel erosion and floodplain disconnection
- Developed catchments with no stormwater detention
- Suitable salmon spawning habitat and wetlands of concern
- Possible sources of thermal refugia for salmonids
- County owned properties with stream/riparian enhancement opportunities
- Urban catchments lacking stormwater treatment

The purpose of restoration strategies within the Whipple Creek watershed is to provide a framework for prioritization, decision making and implementation of stormwater and restoration strategies that help address each area of special attention identified in this document to support the objective of watershed-scale stormwater planning.

Recommendations

Priority strategies should first focus on restoring hydrologic conditions in the Whipple Creek watershed, especially in areas of special attention identified as “developed catchments with no stormwater detention” and “observed stream reaches with channel erosion and floodplain disconnection”. Stormwater strategies needed to address stormwater for catchments with no detention facilities include Low Impact Development (LID), stormwater retrofits to adhere to current standards, and the building of new stormwater hydrologic BMPs and/or regional stormwater facilities. Restoration strategies for observed stream reaches with channel erosion and floodplain disconnection should include channel grade control, stream bank stabilization, installation of large woody debris (LWD), riparian plantings, wetland restoration, and floodplain reconnection. Additional site-specific investigations and tools are needed to identify appropriate restoration activities in these areas of special attention.

The secondary priority should be improving water quality in the Whipple Creek system. Urban catchments lacking stormwater treatment were identified as areas of special attention regarding water quality and should be further screened for stormwater treatment BMP feasibility. Stormwater strategies that will need to be implemented to treat stormwater include Low Impact Development (LID), stormwater retrofits to adhere to current standards, and the building of new stormwater facilities

and/or regional stormwater facilities. Additionally, stream reconnaissance and IDDE efforts should be conducted in stream site catchments that had high fecal coliform values to determine potential sources of fecal coliform pollution.

The third priority should be preserving suitable salmonid spawning habitat and enhance stream, riparian and wetland habitats. Additional investigations and tools are needed to specifically identify appropriate restoration activities, but generally should focus on enhancement/restoration projects in the identified areas of special attention that include county owned properties with stream/riparian enhancement opportunities and suitable salmon spawning habitat and/or wetlands of concern. Further efforts include conducting additional stream temperature studies on unmonitored tributaries to Whipple Creek to assess specific sources and flow volumes for thermal loads of thermal refugia for salmonids.

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Exhibit C

Clark County
MIL2 Catchment-Scale Stormwater Plan Report

Submitted in Fulfillment of Municipal Stormwater Permit Condition S5.C.6.d.

December 2022

Prepared by Clark County

Foreword

Report Purpose and Budget Impacts

The actions listed in the MIL2 Catchment-Scale Stormwater Plan Report (Report) are not part of the Clark County Stormwater Management Program Plan submitted under Permit condition S5.A., which is supported by the current County budget. This Report is created solely to meet Permit requirement S5.C.6.d.

Limited new actions in the Report are supported by the current county budget, predominately with revenue from the Clark County Clean Water Fee. Implementation of any new action in this plan, not supported by the current county budget, is subject to future budget approval by the Clark County Council. The Report may only be used to guide county planning for future actions to improve MIL2 under existing budget.

Submittal of this plan to Washington Department of Ecology has no budget impacts.

Submittal for S5.C.6.d:
Mil2 Catchment-Scale Stormwater Plan Report

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Introduction

A. Summary

The MIL2 Catchment-Scale Stormwater Plan Report (Report) is presented to fulfill condition S5.C.6.d of Clark County's National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Stormwater Permit (Permit), issued by the Washington Department of Ecology (Ecology).

The Report documents the results of an exercise to estimate the magnitude of effort needed to meet the goal of maintaining existing hydrology for the MIL2 stream channel. The catchment spans about 1400 acres in southwest Clark County, Washington. It is a tributary to Mill Creek, which is a salmon-bearing tributary to Salmon Creek. Nearly one square mile of the upper catchment rural land is inside the unincorporated Vancouver Urban Growth Area (UGA). Figure 1 shows the MIL2 catchment and Figure 2 shows the location of MIL2 in Salmon Creek watershed.

The hydrologic analysis in this Report relied on hydrology models created using the WWHM-SWMM model of Clear Creek Solutions, Inc., and Clean Water (Appendix A), and using parameters from a HSPF model calibrated for the Mill Creek subwatershed by Otak, Inc. (2010). No water quality model was created based on results from an earlier study in the Whipple Creek watershed showing that the build-out scenario met water quality standards, except for bacteria, which are only possible to remove from stormwater runoff by infiltration to ground water. The hydrologic modeling allowed Clark County to estimate the effects of future planned land use (as zoning) on stream hydrology.

Results generated by simulated future land use conditions did not result in in-stream flow conditions that would allow salmon and other aquatic life to thrive.

With full implementation of detention basins under current code, the modeled results did not provide stream flow similar to the existing hydrology. This is due to soil and geology conditions that make Low Impact Development (LID) infeasible under state and county standards.

Several stormwater management strategies and best management practices (BMPs) were considered with a focus on managing runoff from development using models created by Clark County and Clear Creek Solutions, Inc. These strategies focused on limited infiltration from permeable pavement and bioretention BMPs, allowing limited infiltration from stormwater ponds and increasing detention pond size by changing flow control standards.

The report includes a description of ongoing activities to manage stormwater in the MIL2 catchment, a six-year plan that may be considered for inclusion in the annual Stormwater Management Plan, and a twenty-year plan that may inform the Comprehensive Growth Management Plan.

B. Purpose and Background

Knowledge about the adverse impacts of stormwater runoff on water bodies has changed significantly over the last decade. Most stormwater mitigation is applied site-by-site as land is converted from forest or fields to roads, parking lots, buildings, and lawns.

The 2013 permit study in Whipple Creek found that the stated goal of returning hydrology to that similar to a forest was not possible without widespread use of infiltration BMPs such as LID BMPs to meet the LID Performance Standard. The Whipple Creek study also found that water quality treatment using bioretention generally met water quality goals for bacteria.

Clark County's MIL2 scope of work identified tasks necessary to meet specific requirements of the SMAP catchment-scale stormwater planning requirement under NPDES Phase I Municipal Stormwater Permit requirement S5.C.6.d. The primary tool is a hydrology model using calibrated parameters from the Mill Creek HSPF model.

In 2010, Ecology approved an alternative flow control standard for most of the Mill Creek subwatershed downstream of Battle Ground city area, including the MIL2 catchment Report area. The 2010 study included hydraulic analysis of the MIL2 channel stability and other parts of Mill Creek. The study found that stream channels were stable under existing conditions; this suggests that a catchment plan to sustain the existing channel hydrology should be protective of beneficial uses and designated uses.

C. Regulation

The Clean Water Act (CWA) of 1972 is the principal federal law regulating the discharge of pollutants into streams, rivers, and lakes. It controls discharges of pollutants by regulating both industries and government entities, such as cities and counties, which operate storm sewer systems that collect and discharge stormwater runoff from urban and suburban areas. The National Pollutant Discharge Elimination System (NPDES) is the CWA's permitting program.

The CWA relies on the concept of designated uses to set goals for water quality. At a minimum, any existing use that the water body supported in 1974, such as fishing, swimming, or providing drinking water, must be maintained.

The Washington State Water Pollution Control Act (RCW 90.48) similarly protects surface waters of Washington State and ground water from discharge of contaminants, and it tasks Ecology with setting water quality standards.

In Washington, the CWA's NPDES permitting program is delegated by EPA and administered by Ecology. Ecology establishes designated uses, which may equal or exceed the CWA's existing uses, for Washington's surface waters. Ecology sets water quality standards that, if met, would theoretically sustain the designated uses. Ecology issues municipal stormwater permits, and state waste discharge permits pursuant to the CWA and RCW 90.48. Clark County's Permit is issued under this program. The Clark County Permit authorizes the discharge of stormwater from the county storm drainage system to waters of the state, which includes groundwater.

D. Water Quality Goals

Washington Administrative Code (WAC) Chapter 173-201A establishes water quality standards for the Waters of the State. Standards are set for each water body based on its existing uses and designated uses.

Ecology has established designated uses for the Salmon Creek watershed, so these uses apply to MIL2 as well. The highest uses are contact recreation and core summer salmon habitat. It is notable that summer flows in MIL2 are so low that only a small part of the tributary has perennial flow.

The designated use and associated water quality standard for temperature discussed in this report is shown in Table 1.

Table 1: Designated Uses and Water Quality Standards for MIL2 Discussed in this Report

Parameter	Applicable Designated Use	State WQ Standard Criteria
Temperature	Core summer salmonid habitat	7-Day Average Daily Maximum (7-DADMax) of 16°C (60.8°F)

E. Stream Hydrology Goals

The goal is to protect and restore designated uses, chiefly to provide adequate habitat and in-stream flow conditions to ensure the survival and recovery of native salmon. This means limiting the duration of erosive flows to those of existing conditions.

Hydrology models do not directly estimate the ability of a stream to support fish populations. To account for this, the 2013 Phase I Permit's Whipple Creek approach required stream flow conditions (hydrology) to be used as a surrogate for stream biologic integrity - a stream's ability to support aquatic life from the bottom of the food chain to the top.

i. Relationship of Flow Metrics to Biologic Integrity (B-IBI Score)

The Benthic Index of Biological Integrity (B-IBI) is a widely used indicator of stream biologic health in the Pacific Northwest. The index uses a multi-metric analysis of macroinvertebrate taxa (bugs) that are present in wadable streams.

The 2013 Permit required the County to use a statistically valid relationship between one or more stream flow metrics reported by the hydrology model and B-IBI score.

The applicability to Whipple Creek of several hydrologic metrics that are commonly used in the Pacific Northwest was evaluated, emphasizing those from research done on Puget Sound lowland streams (DeGasperi *et al*. 2009). All metrics were calculated using daily average flows.

Using Clark County's long-term local monitoring data and statistical regression, two hydrologic metrics were found to be appropriate for use in a correlation to B-IBI score (Table 2) in the Whipple Creek study: 1) TQ_{mean}; and 2) High Pulse Count (HPC). Modeling in MIL2 found that, in that basin, TQ_{mean} was insensitive to changes in modeled hydrology between existing conditions and changes due to unincorporated Vancouver UGA build-out. This modeling also showed that HPCs were sensitive to hydrology changes due to changing land cover and stormwater management strategies.

Literature on using hydrologic metrics in the Pacific Northwest is not completely consistent in the definition of HPC. Table 2 provides the definition for the HPC metric used for this report and the TQ_{mean}.

Table 2: Hydrologic Metric Definitions and Selection Status

Hydrologic Metric	Definition	Selection Status
High Pulse Count (HPC)	The number of times each water year that discrete high flow pulses occur (high pulses are flows twice the mean daily flow)	Selected for use in this Report
TQ_{mean}	Fraction of a year that the daily mean discharge rate exceeds the annual mean discharge rate	Not Selected for use in this Report due to lack of significant changes with alternative

ii. Using Flow Metrics to Estimate Salmonid Use Attainment Related to High Flows

This Report uses HPC as an indicator of whether a stream hydrology can support salmonid uses based on direct previous correlations between HPC and salmonid use attainment.

Context

In 2014, Ecology used B-$IBI_{(10-50)}$ scores in its 303(d) listing for streams that did not meet narrative standards for salmonid uses. The criteria ranges Ecology used were: greater than 37 for fully supporting beneficial uses, less than 28 for non-supporting, and 28 through 37 for waters of concern (Ecology, 2014). Non-supporting streams are included on the state 303(d) List, which officially records impaired waters under the Clean Water Act (Table 3).

Table 3: Correlation of B-IBI (10-50) to Salmonid Use Attainment for Ecology's 303(d) Listing as Used in the Whipple Creek Study

	Salmonid Uses		
	Non-supporting	Partially Supporting	Fully Supporting
B-IBI	<28	28-37	>37

In this Report, the HPC hydrologic metric is used in place of a B-IBI score derived from the hydrology metric in the Whipple Creek study. This is because the B-IBI itself is an indirect indicator of a stream's ability to support salmonid uses. B-IBI is a measure of the health of aquatic macroinvertebrates, not fish. Many stream and watershed conditions other than hydrologic regime influence low B-IBI scores. These include channel substrate quality, temperature, and the presence of pollutants from urban runoff and other sources. Conversely, high B-IBI scores are associated with good quality stream conditions supporting salmon use where those conditions support good habitat.

High Pulse Count (HPC)

To account for the difficulties with B-IBI scores, the Whipple Creek report also used HPC and TQ_{mean} to evaluate whether Whipple Creek will meet standards for salmonid uses under future scenarios.

King County recognized HPC as one of the more useful metrics for calculating the B-IBI score and found that sites having HPCs between 3 and 7 generally supported salmon use and had B-IBI scores over 35 (using B-IBI score range greater than 35 as the threshold). The report also found that very low B-IBI scores (< 16) were associated with HPCs above 15. B-IBI scores above 25 were associated with HPCs less than 11 (Table 4).

King County published a regression equation for HPC and B-IBI (King County, 2012). Clark County data also showed increasing B-IBI with lower HPC, making it a viable indicator based on local data and the Puget Sound results.

Table 4: Correlation of HPC to Salmonid Use Attainment

	Salmonid Uses		
	Non-supporting	Partially Supporting	Fully Supporting
HPC Range	>11	7-11	<7

iii. Using Flow Metrics to Assess Low Flow Conditions

Maintaining low flow is important for supporting fish use, minimizing temperature exceedances, and maintaining base flow to Mill Creek. Field observations during 2021 and modeling results suggest that summer flows in MIL2 are very low to non-existent above MIL2A reach.

I. Existing Conditions

A. Watershed Setting

The MIL2 catchment covers about 1,400 acres in southwest Clark County, Washington. It is the lowermost tributary to Mill Creek, which in turn, is tributary to Salmon Creek (See Figures 1 and 2). The catchment land use falls into three main categories: a) developed residential in the lowermost area in MIL2A, b) undeveloped rural lands zoned for urban uses within the Vancouver UGA in the mid-catchment in MIL2B and MIL2C, and c) zoned rural area in the headwaters in MIL2D. There are nearly 500 acres of currently rural residential, buildable land in the UGA.

MIL2 creek flows southward from headwaters south of 219th St to a confluence with Mill Creek near the WSU Vancouver campus.

The catchment is largely rural residences on several acre, rural suburban lots. Outside the UGA, almost all lots are developed as residences, and most are at the five-acre zoning size or somewhat smaller. The Vancouver UGA is poised for development as suburban neighborhoods according to zoning.

Little data exists to describe the creek hydrology, water quality, and salmon habitat compared to its historic condition. Limited hydrology data is available.

Coho salmon and winter steelhead are documented as present downstream of 179th St by the Washington Department of Fish and Wildlife.

No water quality data is available other than temperature data near the Mill Creek confluence, collected for water year 2021 at the MIL2A stream gauge site.

Figure 1: MILS Catchment Study Area

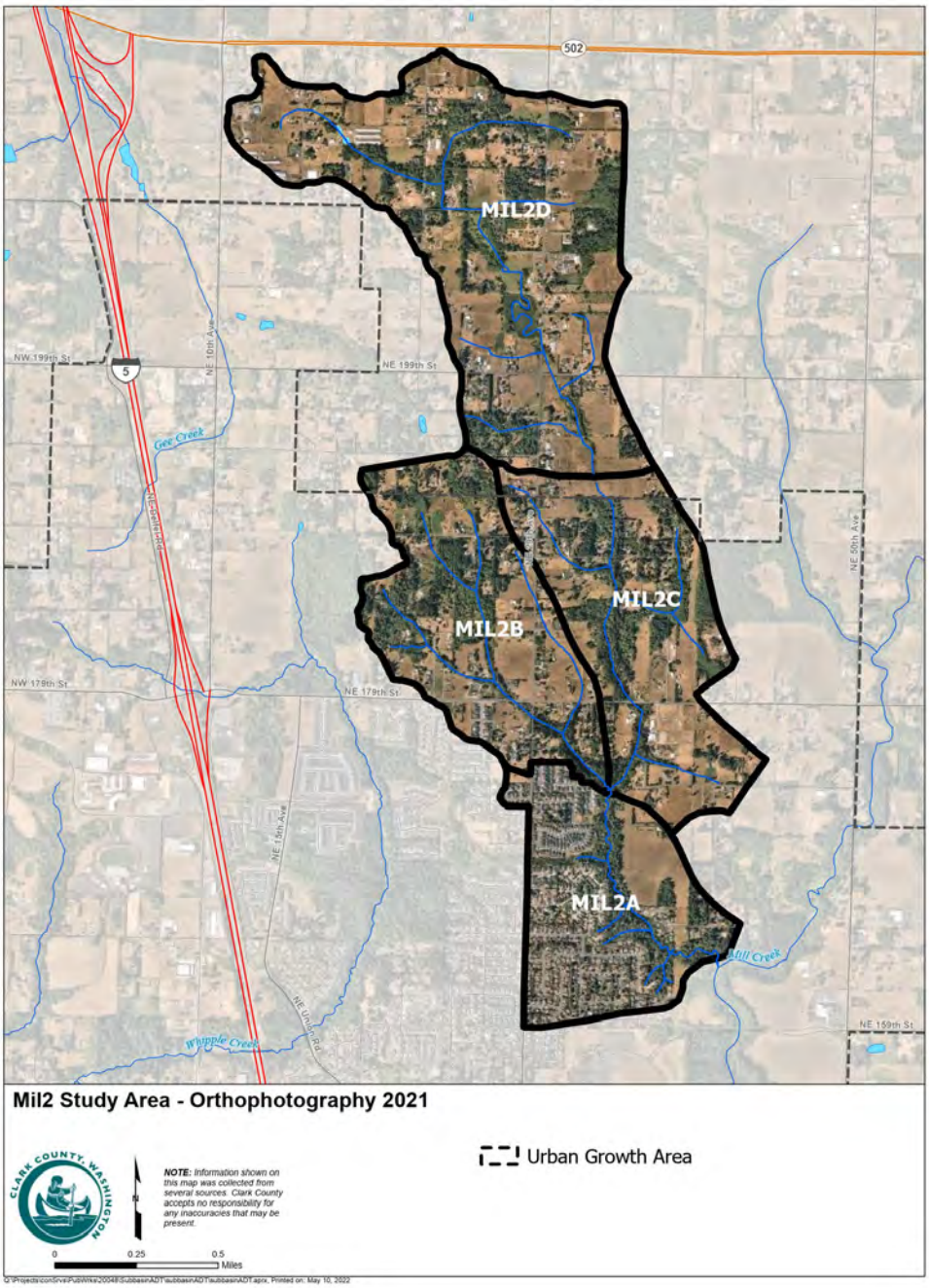
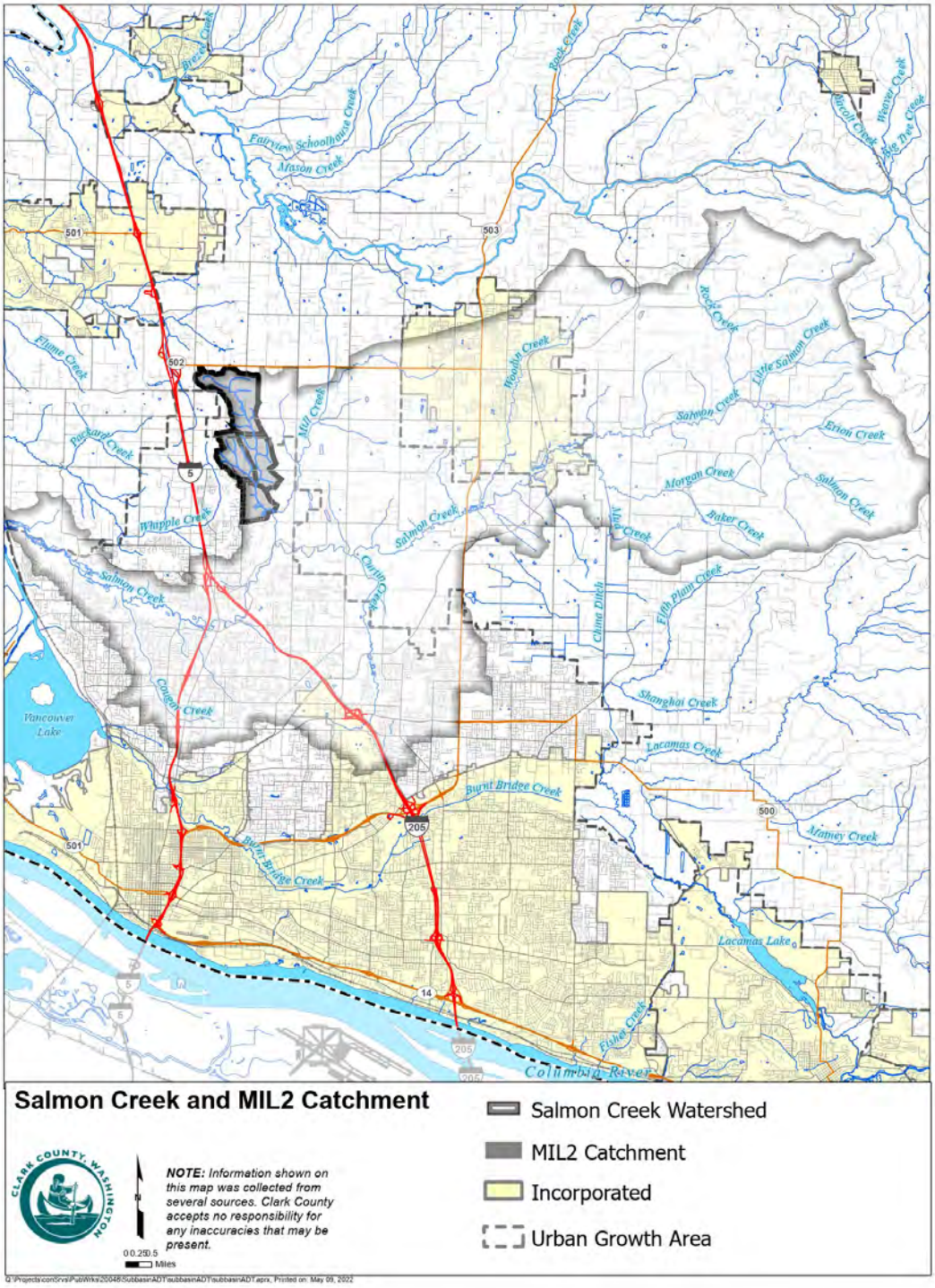


Figure 2: MIL2 Catchment Location in Salmon Creek Watershed



i. Sub Catchments

MIL2A

MIL2A is the lowermost part of the study area where the creek meets Mill Creek just above the Mill Creek confluence with Salmon Creek. The lowermost portion of this reach has a flood plain that may be backwatered by Mill Creek during high flows in Mill Creek. The area is almost entirely built out with suburban single-family residence subdivisions.

MIL2B

MIL2B reach is a small stream, tributary to the MIL2A reach. It is currently rural residences typically on five acre lots; however, most of this basin is zoned for urban residential development over the next 20 years. The sub-catchment has a relatively steep gradient (2-3%) channel that lacks a significant flood plain.

MIL2C

MIL2C is currently rural residential lots, many of them are at least partially wooded. As with MIL2B, much of the sub-catchment is zoned for suburban residential development over the next 20 years. The MIL2C reach has a shallower gradient of about 0.8 percent.

MIL2D

MIL2D is the headwaters and is in rural residential land use. Unlike MIL2B and MIL2C, MIL2D is completely zoned for five-acre residential lot development, and is largely built out, which should produce little change in stream hydrology over the next 20 years. The uppermost part of the sub-catchment is relatively flat with significant amounts of wetland that appear to be partially drained by manmade ditches. The overall gradient in MIL2D is 0.5 percent. A more natural channel forms downstream of NE 199th St. Public Works owns significant amounts of land along the creek between NE 199th St. and the north edge of the UGA at about NE 192nd St.

ii. Topography

MIL2 is generally flat to low rolling hills, with land surface generally between 260 and 290 feet above sea level, with the exception of the Mt Vista area of MIL2A, where the peak is at 450 feet.

The headwater channel in MIL2D resembles a ditch through a patchwork of wetlands. The creek begins to form a valley at the upper end of the MIL2C reach, which continues to deepen downstream, forming a relatively deep canyon near 179th St that continues to the Mill Creek confluence. MIL2B tributary also forms a valley near 179th St. that deepens downstream. A topographic flood plain begins to form on the mainstem upstream of 179th St.

iii. Geology and Soils

The Mt Vista area is underlain by ancestral Columbia River sediments that are deeply weathered to clay that has very low infiltration rates. The remainder of the catchment is underlain by fine-grained sediment laid by late Ice Age cataclysmic floods of the Columbia River. None of the MIL2 reaches contain coarse sediment such as the gravels favored for spawning by many species of native fish.

Soils are poorly drained throughout the study area. Stream channels are characterized by erodible fine sediments.

iv. Wildlife

Beaver are not prominent in MIL2 Catchment; evidence of beaver activity is observed by Clean Water Division staff upstream of the stream gauge in lower MIL2A.

The Washington State Department of Fish and Wildlife has documented the presence of Coho salmon and winter steelhead in the catchment, but not spawning or rearing.

v. Vegetation

The MIL2 catchment, like most of western Washington, was once mostly forested, and likely a significant part of the headwaters were forested wetlands.

Today, due to clearing for agriculture in the early 20th Century and urbanization, few significant tracts of forest remain, and much of the land cover is field, meadow, and pasture.

Riparian areas are generally forested where occurring in canyons.

vi. County Storm Sewer Drainage

Clark County operates a municipal separate storm sewer system (MS4) throughout unincorporated Clark County, including MIL2 catchment. The MS4 is a drainage system of pipes and ditches along with water quality treatment and flow control facilities. In MIL2, the piped drainage is almost entirely within the developed area of MIL2A. Rural ditches make up the MS4 in the remaining catchment areas.

The MS4 discharges to the MIL2 channels through mainly rural ditch outfalls. The county stormwater inventory has 63 ditch outfalls and one piped outfall in MIL2B, MIL2C and MIL2D catchments. There is one ditch outfall and nine urban piped conveyance outfalls in MIL2A.

Many rural lots drain directly to MIL2 channels without first passing through the county's storm sewer. As MIL2B and MIL2C build out the number of outfalls will increase greatly.

vii. Land Use, Land Cover, and History

The catchment is a moderately developed rural residential area, which is urbanizing inside the UGA in the Mt Vista area north of WSU Vancouver.

Historic coniferous forests were cleared by the early 1900s for building materials and agriculture. Comparing 1955 aerial photos to 2020 images shows that most of MIL2A sub-catchment was cleared fields in 1955 and that developed areas tend to follow the patterns of the cleared area outside the stream valleys. MIL2B was largely cleared for fields in the lower, southern half but mostly forested in the upper half. Much of this forest has remained as the land converted to large lot rural residential land use. The same development pattern appears in MIL2C where 1955 forest area largely remain as the area converted to rural residential lots with a mix of forest and yards. MIL2D was a patchwork of wooded lots and cleared areas in 1955, with larger rural lots retaining forest.

The percentages of land cover include 43% forested, 12% impervious, 39% field, and 6% lawn based on the GIS 2020 land cover map for MIL2. Nearly half of the existing forest is in MIL2B and MIL2C, and much of it could be lost during development; however, much of the remaining forest is in riparian areas provided protection by county habitat regulations.

B. Hydrology and Hydraulics

There was no field hydrology data for MIL2 when the project began in 2020. A temporary stream gauging station was established in October 2020 near the confluence with Mill Creek. A more permanent gauge was built by West Consultants in summer 2021. This gauge setup provides limited flow data for WY 2021.

Table 5 shows main reach length and slopes.

Table 5: MIL2 Reach Channel Slopes

Reach	Length (ft)	Elev Change (ft)	Slope (%)
MIL2D	5900	30	0.5%
MIL2C	5600	45	0.8%
MIL2B	4080	88	2%
MIL2A	3910	26	0.7%
MIL2A	**3910**	**26**	**0.7%**

The stream channel slopes produce relatively moderate stream velocities and peak flows and allows flood plain formation in a previously incised channel at MIL2A.

There are limited modifications to the channel (e.g. channel straightening, in-line ponds). However, channel crossings from past agricultural activities and driveways are found in small tributaries.

A 2010 a Clark County study commissioned (Otak 2010) to establish an alternative flow control standard for parts of Mill Creek with stable channel conditions evaluated MIL2 hydraulic conditions in MIL2A reach near the Mill Creek confluence.

The study completed a hydraulic assessment to determine stream flow velocity that initiates bank erosion. The analysis involved calculating shear stresses in the stream associated with a range of flows and evaluating bank material erosion. Analysis was performed for an existing conditions flow regime and a forested conditions flow regime. The hydraulic analysis was supported by site visits and channel bank erosivity testing to characterize erosion/mobilization resistance of the bank and bed material. Erosivity testing included the use of a jet-testing procedure to evaluate cohesive bed and bank material.

The study found the MIL2A reach site to be stable and adjusting to land cover change from forest to rural. The forest and 2002 land cover modeling showed moderate hydrology change due to changes from a forested catchment to a largely rural residential catchment.

The study noted that large woody debris is prevalent along the MIL2A study reach and plays a key role in channel stability by providing some bed control and controlling hydraulics to cause flood waters onto the active flood plain.

The stream bed had unconsolidated, fine-grained sediment indicating that current incision rates were very low to nonexistent.

Channel morphology is described as an inset flood plain, suggesting re-stabilization after incision caused by the conversion from forest to rural land uses. The inset flood plain is vegetated with mature trees, woody shrubs and grasses. The report noted it is inundated annually. The study noted the presence of a terrace flood plain that would have been the channel flood plain before incision due deforestation.

The study concluded that the catchment land use change from agriculture to rural residential land use have not affected the stabilized channel morphology.

C. Water Quality

Information about water quality is almost non-existent for MIL2. The focus of this study is on managing hydrology as development occurs, with the underlying assumption that applying the Clark County Stormwater Manual will protect water quality in receiving waters.

Water quality in Mill Creek subwatershed is generally fair to poor and is impacted by urban and rural development. Ecology includes the lower main stem of Mill Creek on its 303(d) Category 5 List of polluted waters for fecal coliform bacteria and temperature (Ecology, 2016). Presumably, MIL2 has similar water quality to lower Mill Creek. Mill Creek is part of the Salmon Creek TMDLs for bacteria, turbidity and temperature.

High fecal coliform levels are a county-wide issue in urban and rural areas. Typical sources are urban runoff carrying pet waste; rural non-point pollution from livestock; failing septic systems; and natural contributions from beaver, waterfowl, and other wildlife.

Considering the lack of data and TMDLs for bacteria, temperature and turbidity in Mill Creek sub-basin, the six-year and perhaps 20-year plans should include a monitoring element.

viii. Temperature

The only information for temperature is from a stage and temperature gauge deployed in lower MIL2A in October 2020. The results are shown in Table 6

Table 6: Summary Comparison of MIL2 Temperature to State Standards

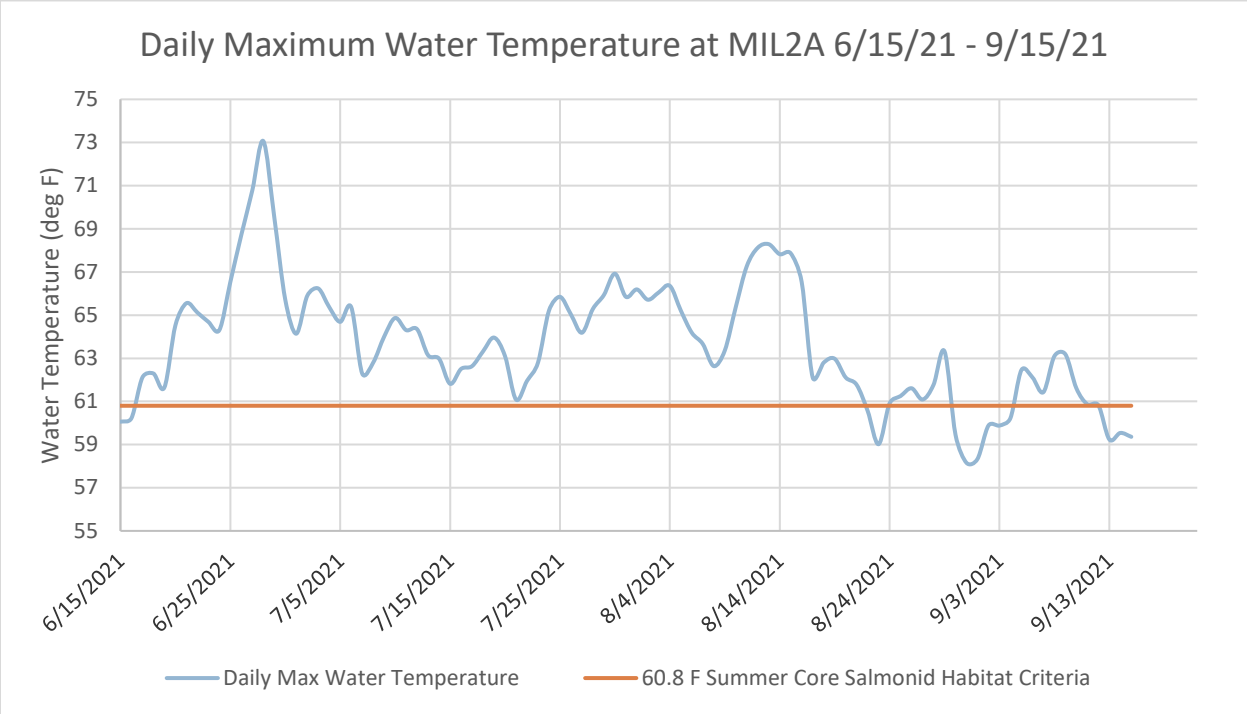
Water Quality Parameter	State Designated Use Protection: Water Quality Standard Criteria & As Applicable Exceedance Frequency Limit	Met Water Quality Standard?	Comments on Monitoring Results Exceedance of State Water Quality Standards Criteria
Temperature	Aquatic Life Use: 7-Day Average Daily Maximum (7-DADMax) of 16°C (60.8°F) once every 10 years on average	No	Continue to monitor MIL2 and consider upstream monitoring

Mill Creek is known to be warm and often exceeds temperatures known to stress salmon and steelhead. High summer stream temperatures are frequent, peaking in July and August. Mill Creek is on the state's 303(d) Category 5 List of polluted waters for temperature.

2021 monitoring shows that the MIL2A exceeded the core salmon habitat standard of a daily high of 60.8 degrees Fahrenheit 82 times. The salmon migration and rearing standard of 63.6 was exceeded 44 times. The Portland and Vancouver area had an exceptional heat wave in late June with temperatures reaching 115 degrees. The maximum hit 73 degrees during this period. During the rest of the summer, it was generally below 66-67 degrees.

See Figure 3 for 2021 exceedances at the MIL2A monitoring station.

Figure 3: MIL2A Water Year 2021 Temperature



D. Benthic Macroinvertebrates - Biologic Health

MIL2 is a sand bottomed stream, completely lacking the gravel substrate associated with scores that indicate good biological habitat. Also, summer flows are very low to non-existent. At the time of the study, it was not deemed necessary to produce benthic macroinvertebrate metrics. The six-year and 20-year plans should establish an ongoing benthic macroinvertebrate monitoring site at MIL2A to track trends in the catchment.

E. Fish Distribution and Habitat

Data on fish distribution were gathered from Washington Department of Fish and Wildlife SalmonScape web page. SalmonScape showed the documented presence of winter steelhead and Coho salmon, primarily in reach MIL2A. There is no documented spawning or rearing (WDFW, 2014). The area of distribution is the entire MIL2A reach and downstream of NE 179th St. in MIL2B and MIL2C. Cutthroat trout are presumed present at the same reaches.

August 2021 observations saw that there was no flow in uppermost MIL2A just downstream of 179th Street and just a trickle of flow near the confluence with Mill Creek, suggesting that dry season fish use is minimal under the current climate regime of the summer dry season beginning in May or June.

The Lower Columbia Fish Recovery Board Plan includes a chapter on Salmon Creek watershed. The plan calls for stabilizing Salmon Creek fish populations, rather than restoring them based on the level of planned urbanization in the watershed. Consequently, a key priority in the fish recovery plan is to manage growth to limit habitat degradation.

In contrast to the relatively low priority in salmon recovery planning, Salmon Creek watershed is listed as core summer habitat under state water quality law in Chapter 173-201A Washington Administrative Code.

Clark County Public Works is planning to replace fish-blocking culverts on the MIL2B reach at the intersection of NE 29th Ave. and NE 179th St. with bridges as part of a project to improve 179th St.

F. Critical Areas of Special Interest

Areas of special interest are defined as headwater wetlands and flood plains, whether they are active flood plains or flood plains disconnected due channel incision. Areas of special interest also include-properties owned by Public Works. Clark County code protects Growth Management Act Critical Areas. Protected areas are places where Clark County prohibits development to protect habitat and public welfare. These include wetland, riparian buffers, state designated habitat and geologically hazardous areas due to landslide potential.

II. Creating Hydrologic Models of MIL2 Catchment

Models were developed following a scope of work and schedule for Clark County and Clear Creek Solutions, Inc.

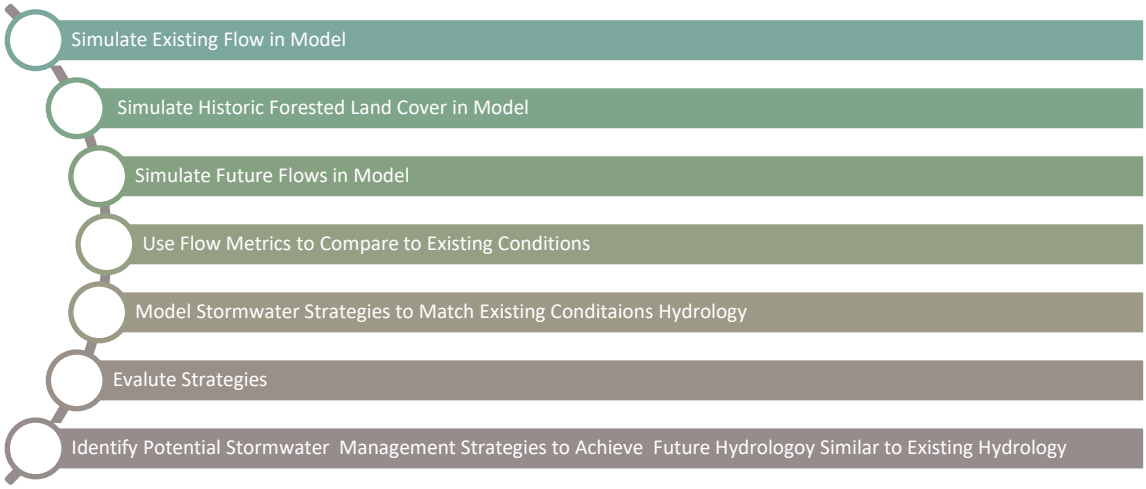
A. Purpose of Models

Stream hydrology changes when land cover changes. Modification from forest to agriculture or to urban areas increases runoff directed to creeks. As the MIL2 catchment was converted from forest to agriculture and rural residential land use, the stream channel cut down and stabilized in its current configuration. A model helps understand how future urbanization will alter the hydrology in ways that may degrade the stream channel and its use as fish habitat.

A full description of model development and analyses is in Appendix A.

Using predictions of future land uses and land covers, this Report estimates future hydrologic conditions of MIL2 catchment streams. Once the magnitude of potential impact is understood, the model can be used to test the effectiveness of stormwater management strategies Clark County might use to mitigate the impacts of future development. Figure 4 provides a schematic of modeling steps and purpose.

Figure 4: Purpose of Computer Models of MIL2 Hydrology



Detailed discussion of hydrology model development is in Appendix A.

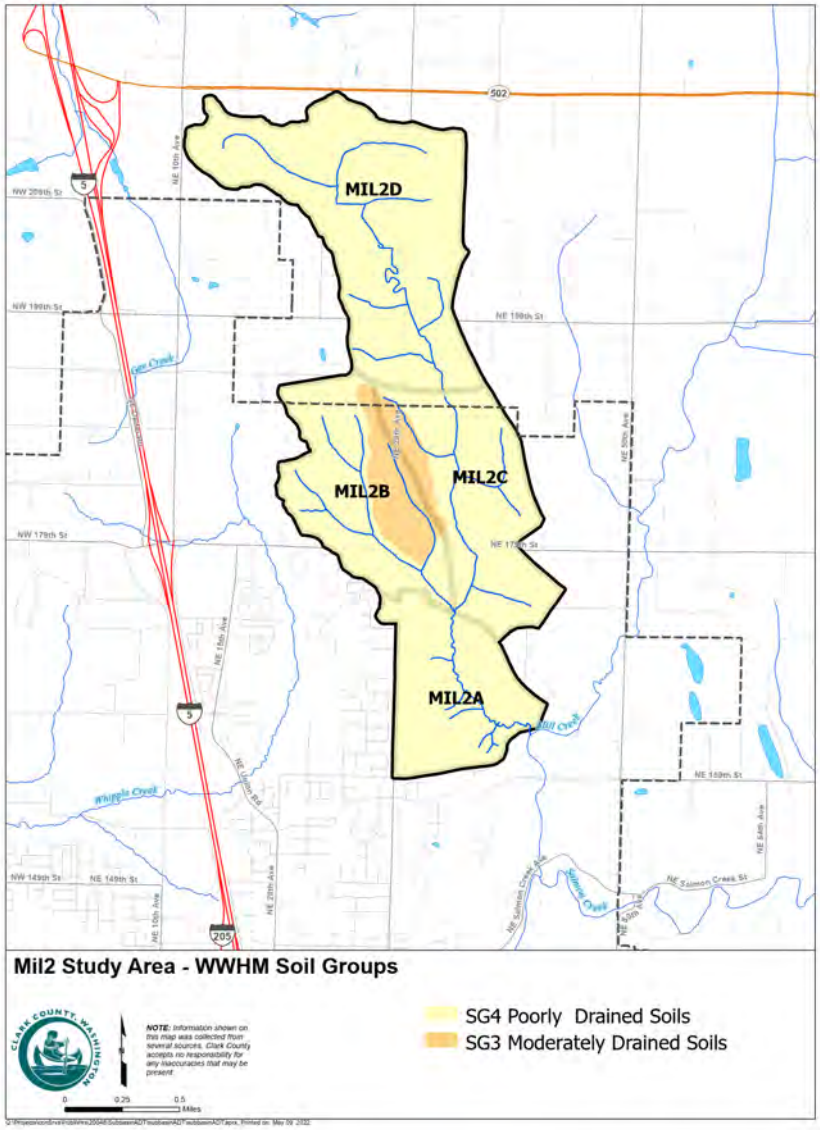
Clark County opted to not model water quality after considering the level of effort and the relatively low value of the water quality model for parameters of interest, bacteria and temperature. Bacteria can only be treated by infiltration into soil. A temperature model is considered of little value because adding riparian shade is the only effective tool to address temperature.

B. Model Period and Data

Model development used the calibrated Mill Creek model parameters to build the model using the WWHM-SWMM model (Clear Creek Solutions, Inc.). The model then used the 60-year rainfall time series of the WWHM model (1948-2008) to run the model for 60 individual years to produce a statistically robust set of annual hydrology conditions. Once built, the model can be used to estimate hydrology under different future scenarios of land cover and stormwater management strategies.

Using infiltration capacity, soils in Clark County are grouped into five generalized categories. Underlying soils in MIL2 are a mix of moderately drained soils (SG3) and poorly drained soils (SG4), with SG4 the predominant soil type (Figure 5).

Figure 5: MIL2 Model Soil Groups



C. Hydrology Model Creation and Validation

The MIL2 catchment model development produced a computer model of rainfall-runoff processes and stream flow routing using the WWHM-SWMM software developed by Clear Creek Solutions, Inc. The model uses model soil parameters from the 2010 calibrated Mill Creek subwatershed model (Otak and Clear Creek Solutions, 2010). Appendix A has the complete description of Clark County and Clear Creek Solutions model work.

The hydrology model divided the catchment into four sub-catchments (Figure 1). The land area for each sub-catchment was divided into forest, lawn, paved, and field land covers. The stream reach boundaries were selected based on topography, confluence with other significant reaches, and locations of interest for reporting model results.

A detailed description of existing conditions model development is in Appendix A.

Since no stream flow data was available to create a calibrated model specific to MIL2 catchment, Clark County opted to complete a model validation exercise using data collected as the model was being completed. Stage data was collected by Clark County between October 2020 and September 30, 2021, near the confluence with Mill Creek in lowermost MIL2A reach. This stage data was then converted to flow data using a synthetic rating curve created by West Consultants using channel cross sections, a HEC-RAS model, and limited flow measurements.

Clear Creek Solutions completed a model validation using stream flow and rainfall data for water year 2021. The validation showed the model to be a sound representation of MIL2 hydrology and that the resulting model parameters are appropriate for evaluating the impact of hydromodification management strategies.

D. Reporting Model Results

The model produces simulated conditions for stream reaches in 4 sub-catchments corresponding to the four main reaches in MIL2 catchment.

Reaches were selected to represent the developed (MIL2A), developing (MIL2B and MIL2C) and rural (MIL2D) areas and to demonstrate whether strategies will meet the study goal of maintaining existing conditions hydrology.

MIL2A Lowermost MIL2 Reach

This reach reporting point is for the entire MIL2 catchment. The lowest part of this reach may be subject to backwatering from Mill Creek during high flows. This reach is largely build-out with late 20th Century and more recent subdivisions. Reporting includes flow from all upstream reaches.

MIL2B – Tributary to MIL2A

This reach is the highest gradient reach and does not have salmon or steelhead use. Almost the entire area draining to this reach is zoned for urban development.

MIL2C - Upstream of MIL2A

This reach has a low-gradient and is the middle reach of MIL2. It represents the main stem and includes the area where most of the land draining to it will be developed as residential subdivisions. Reporting for reach MIL2C includes flow from MIL2D

MIL2D – Rural MIL2 Tributary Outside the Vancouver UGA

MIL2D reach is the longest reach and will remain rural, with large lot residential development filling in remaining larger lots.

Existing Conditions Model Results

The Existing Conditions model produced flood flow rates for the lowermost point in each reach as the location of interest (LOI). It also provides flow duration information for the 100-time steps in the WWHM-SWMM model. The average daily flow is used to calculate high pulse counts for model scenarios. This information can then be used to compare to the Build-Out model under current county code and test the efficacy of various alternatives to achieve the goal of maintaining existing hydrology under build out conditions. More information on the existing conditions model is in the next chapter on evaluating the future in MIL2 creek.

III. Evaluating the Future in MIL2 Creek

A. Future Development in MIL2 Catchment

In 2016, Clark County adopted a *Comprehensive Growth Management Plan 2015-2035* (Comprehensive Plan) to guide growth and development for the next 20 years. The Comprehensive Plan's Community Framework Plan describes a vision in which land outside of urban growth areas is predominantly rural with farms, forests, open space, and large lot residences while urban growth areas are targeted for higher densities and a mix of more urban land uses (Clark County, 2016). The Comprehensive Plan generally guides the zoning in Clark County Code Title 40.

i. Land Use

Broadly, the zoning describes a catchment where development will be mainly urban residential lots inside the UGA and typically 5-acre rural residential lots in the rural area outside the UGA. Open spaces as protected habitat areas and wetlands are present in the UGA and are mapped.

Zoning based on the Comprehensive Plan designations was used to calculate future land covers. Future land covers form the basis for the models that predict hydrologic conditions after the area is developed. If all lands were developed to the full densities allowed under current zoning designations, the catchment would contain the quantities of land covers shown in Table 8. For comparison, Table 7 describes the land cover in the existing conditions model Table 7.

Table 7:Existing (2020) Land Cover in MIL2 in Acres

Sub-Catchment	Impervious	Forest	Pasture	Lawn
MIL2A	73	83	37	43
MIL2B	28	144	104	16
MIL2C	19	138	133	16
MIL2D	43	221	267	12
Total MIL2	163	586	541	87

Table 8: Future Land Cover in MIL2 in Acress Based on Zoning

Sub-Catchment	Impervious	Forest	Pasture	Lawn
MIL2A	88	34	5	110
MIL2B	132	37	28	95
MIL2C	107	47	32	120
MIL2D	43	71	351	78
Total MIL2	370	189	416	403

Land cover from zoned future build-out was used to model future development scenarios to predict the effects on hydrology.

ii. Development and Engineering Standards Applied to Build Out

Modeled build-out development in MIL2 will meet a number of county code chapters and standards pertinent to modeling hydrology. Assumptions are described below.

Stormwater Code and Manual

Future scenarios assume development will manage stormwater in accordance with Clark County's current Clark County Code Chapter 40.386, Stormwater and Erosion Control, which adopts the *2021 Clark County Stormwater Manual* (CCSM). This code is intended to protect water quality of surface and ground waters for drinking water supply, recreation, fishing, and other beneficial uses. The county manual is equivalent to the Ecology Stormwater Management Manual for Western Washington and approved for use by Ecology in modifications to the 2019 NPDES Phase I Municipal Stormwater Permit Appendix 10 in October 2021.

The adopted code and manual meet the requirement to use "all known, available, and reasonable methods of prevention, control, and treatment (AKART)" under the Washington Water Pollution Control Act (RCW 90.48) and reduce pollutant discharges to the "maximum extent practicable (MEP)" as required under the Clean Water Act (USC, Title 13, Section 1251 *et seq.*).

LID and County Code

In 2012 and 2015, Clark County revised road standards and development standards in Title 40 to remove barriers to Low Impact Development (LID). LID is required in the CCSM; however, initial analysis suggests LID BMPs may be deemed infeasible in much of MIL2 due to low permeability soils that often have permeabilities of less than 0.3 inches per hour, which is a manual infeasibility threshold. While LID BMPs are not required where any infeasibility criterion is present, BMPs may still be used to reduce runoff and consequently the size of stormwater control facilities.

Use of LID techniques such as lot clustering to reduce impervious surfaces could impact future development. County Code allows new subdivisions to cluster lots to preserve open space such as pasture and forest in rural zoned areas. Use of optional lot clustering provisions is not modeled because is difficult to predict at the scale considered for this study.

Critical Areas Protection Under County Code

Critical areas defined under the state Growth Management Act include areas where development is regulated under Title 40 to protect the environment, public safety, and public health and are mapped at planning scale. Future models assume forested critical areas will remain forested and remaining critical areas will remain field/pasture. Ones that occur in MIL2 catchment and are relevant to modeling are:

- Geologic hazard areas
- Habitat conservation areas
- Wetland protection areas

B. Baseline Scenarios

Baseline scenarios include the existing conditions, build out and forested condition models.

i. Existing Conditions Model

To form a baseline of hydrology for comparing future models, the existing calibrated Mill Creek hydrology model parameters were used to simulate MIL2 catchment hydrology for existing land cover and stormwater flow control facilities as the existing conditions model. See Appendix A for a detailed description of the existing conditions model.

Using modeled flow metrics with established correlation of flow to B-IBI scores and salmonid use created for the 2017 Whipple Creek study, the model predicted the ability of the catchment to support salmon and steelhead under existing conditions. The model also produced flood flows and flow duration data.

Model Description

The existing conditions model uses the land cover revised from detailed 2002 land cover mapping using 2020 ortho photos. This work was completed by the Clark County GIS group.

Model Results

The existing conditions model simulated stream flow for 60 water years (1948-2008). Flow metrics including TQ_{mean} and HPC were calculated using the modeled daily discharge for each year. TQ_{mean} was found to be 25 or 26 for each location of interest in both the Existing Conditions model and the Build Out model and was subsequently dropped for use to assess hydrology strategies. A TQ_{mean} of 25 is generally associated with poor to fair stream habitat.

The ratio of the 10-year forested flow to the 2-year existing conditions flow are from 1.4 to 1.9, suggesting a stable channel. Channels generally become unstable below a ratio of 1, as the 2-year developed flow exceeds the 10-year forested flow.

High Pulse Count is in a range where King County estimated salmon habitat would be degraded but still support use (Table 9).

In addition to flashiness metrics, flood flows are produced by the model to compare existing condition to build out conditions. That information is discussed in the section where future strategies are modeled.

Table 9: Predicted Salmon Support Under Simulated Existing Land Cover

Sub-catchment	Average HPC	HPC Salmonid Use Range
MIL2A	14	Borderline Non-Supporting
MIL2B	13	Borderline Non-Supporting
MIL2C	12	Borderline Non-Supporting
MIL2D	12	Borderline Non-Supporting

Conclusions

The simulated Existing Conditions model suggests MIL2 hydrology is altered from a forested condition to a rural land cover condition. Consequently, HPC is near the border between partially and non-supporting salmon uses. Actual salmon use is limited to channels downstream of 179th St. at this time, which is largely the MIL2A reach. Additional description of Existing Conditions model flow metrics are included in Build Out model discussion.

ii. Forested Conditions Model

While the study goal is to maintain current hydrology, the project team created a forested conditions model as another reference point and to be able to calculate existing conditions and future build out model metrics (ratio of the 10-year forested flow to the 2-year developed flow) that consider forested hydrology. See Appendix A for a more detailed description of the forested conditions model.

Model Description

The forested condition model was made by replacing urban and rural land cover with forest land cover for the entire model area. Channel routing remains the same as in the existing conditions model.

Model Results

The forested condition model demonstrates that catchment hydrology was less flashy than the existing conditions model and has a HPC associated with marginal support for salmon habitat based on King County HPC analysis (Table 10).

Table 10: Forested Model High Pulse Counts

Sub-catchment	Average HPC	HPC Salmonid Use Range
MIL2A	9	Partially Supporting
MIL2B	8	Partially Supporting
MIL2C	9	Partially Supporting
MIL2D	10	Partially Supporting

Conclusions

The forested condition model suggests that the catchment hydrology is comparable to that which partially supports salmon habitat.

iii. Build-out Model

The Build-Out model simulates full development of the urban-zoned parts of the catchment. This model forms the baseline for decision-making in this Report. If the Build-Out model shows that MIL2 will not produce hydrology compatible with designated salmonid uses and existing conditions, then the study will examine and analyze management strategies that Clark County could implement to meet the project hydrology goal. See Appendix C for a detailed description of the build out model.

Description of the Build-Out Model

Clear Creek Solutions, Inc. created the Build Out model. Using the assumptions stated above, the build-out model simulates the hydrology of land cover changes and the required stormwater controls under the 2021 Clark County Stormwater Manual and critical areas protections under Clark County Title 40.

A copy of the technical memo describing the Build Out model is included as Appendix C.

Stormwater facilities for full build-out were modeled as a single detention facility for each sub-catchment. There were no infiltration or LID BMPs modeled for Soil Group 4 (SG4).

The modeled stormwater facilities were sized using the Western Washington Hydrology Model version 2012 (WWHM2012) to meet Minimum Requirement #7 of the Clark County Stormwater Manual.

Model Results

The build out model results simulated stream flow for 60 water years (1948-2008). The change in runoff volume, high pulse count, average annual duration time of erosive flows, and the ratio of the forested 10-year flow to the developed 2-year flow are presented below.

Change in Runoff (Steam Flow) Volume

There is a significant increase in runoff volume as measured in acre feet, with a 26 percent increase at the MIL2A location of interest, 57 percent increase in MIL2B, and a 21 percent increase at the MIL2C location of interest (see Table 11). This change in runoff volume is attributed to increased impervious area, increased landscaped area, decreased forest and decreased pasture conditions where rainfall is lost to evapotranspiration and infiltration to ground water.

Stream flow includes runoff, interflow and groundwater seeps.

Table 11: Stream Flow Volume for Existing and Build Out Models in Acre Feet

Sub Catchment LOI	Annual Runoff (acre feet) Existing	Annual Runoff (acre feet) Build Out
MIL2A	2,210	2,790
MIL2B	440	690
MIL2C	1,290	1,560
MIL2D	830	890

Change in High Pulse Count

Based on the HPC values, MIL2A hydrology would not be equal to that supporting salmonid use at full build-out. The HPC and predicted salmonid use ranges are shown in Table 12. Note that the ranges are based on conditions in the Puget Sound Region and may not be ideal for categorizing habitat in MIL2.

Table 12: Predicted Salmon Support Under Simulated Build Out Models in Acre Feet

Sub-Catchment LOI	Average HPC Existing	Average HPC Build Out	Build Out HPC Salmonid Use Range
MIL2A	14	19	Non-Supporting
MIL2B	13	25	Non-Supporting
MIL2C	12	16	Non-Supporting
MIL2D	12	12	Borderline Non-Supporting

Change in the Ratio of the 10-Year Forested Flow to the 2-Year Developed Flow

The ratio of the 10-year forested flow to the 2-year developed flow for existing and build out conditions is used to suggest whether the existing hydrology and build out hydrology are conducive to a stable stream channel. Generally, streams with ratios over 1 have stable channels and those below 1 tend toward unstable channels. Table 13 shows the ratios based on the 60 years of model results. While all reaches are above one, some are very close to a value of one, in particular reach MIL2B.

Table 13: The Ratio of the 10-year Forested Flow to the 2-year Developed Flow for Existing Conditions and Build Out

Sub Catchment LOI	10-Year Forest to 2-Year Existing	10-Year Forest to 2-Year Build Out
MIL2A	1.4	1.2
MIL2B	1.7	1.1
MIL2C	1.9	1.4
MIL2D	1.8	1.7

Change in Duration of Erosive Flows

The HSPF model produces a table containing number of flow duration time steps for each of the 100 flow increments from ½ of the 2-year flow to the 50-year flow. The number of 15-minute time steps for the 60-year model period can be used to calculate the number of hours per year each flood event is equaled or exceeded. Table 14 shows the existing conditions model and build out model flow duration for the ½ of the 2-year flood event. The build out durations are based on the existing conditions ½ of the 2-year flow.

While there are increases at each reach, the most significant increase is in MIL2B where nearly the entire sub-catchment area that is not preserved critical habitat is converted from rural to urban land cover. The greater times of erosive flows in MIL2B may also be attributed to its steeper gradient. The MIL2 mainstem, MIL2A, MIL2C and MIL2D flows are somewhat mitigated compared to MIL2B by flows from rural headwaters. Table 14 includes the average annual duration of erosive flow in hours.

Table 14: Erosive Flow Duration in Hours per Year for Existing and Build Out Models

Catchment LOI	Existing Conditions Hours per Year at or Greater Than ½ 2-Year flow	Build Out Hours per Year at or Greater Than ½ 2-Year Flow	Existing Conditions Hours per Year at or Greater Than 2-Year flow	Build Out Hours per Year at or Greater Than 2-Year Flow
MIL2A	75	150	7	18
MIL2B	50	207	5	34
MIL2C	162	235	20	34
MIL2D	186	210	26	31

Conclusions

The full build-out of the MIL2 catchment under current zoning and stormwater control standards mitigates some of the stormwater runoff impacts from expected future development. It does result in significantly increased runoff volume due to a lack of infiltration BMPs under build out conditions due to LID infeasibility in SG4 soils.

Recognizing this, Clark County considered numerous strategies, as described in Section C, that might allow the creek to achieve the study goal of sustaining the existing conditions hydrology in order to support salmonid uses as it develops.

C. Strategies to Meet the Study Goal

The Permit requires the SMAP to include descriptions of strategies that can be modeled by the WWHM2012 and several strategies that are not possible to model. This Report contemplates a number of these.

The overall goal is to protect existing fish habitat in the lower reaches of MIL2 and the downstream habitat in Mill Creek.

i. Strategies

Required Strategies

The Permit requires Clark County to consider strategies that can be modeled using the WWHM2012 model. These are:

- Stormwater facility retrofits needed including BMP type and preferred location. This can include renovating existing facilities.
- Land management/development strategies and/or actions identified for water quality management

Structural Stormwater Retrofits

The Permit requires Clark County to describe a structural retrofit program for areas of existing development. Currently, most of the built-out areas in MIL2 have some degree of treatment and flow control BMPs. This, along with hilly topography, lack of undeveloped land, and clay soils make retrofitting with facilities such as bioretention cells in county roads generally not practical for managing hydrology.

Clark County's Stormwater Capital Program evaluated existing facilities in MIL2 for retrofitting in summer 2021. The review found no facilities suitable for enhanced detention or water quality performance.

Land Management and Development-Strategies or Actions

The Permit requires the county to describe land management strategies and/or actions identified for water quality management. Because the county's current development and stormwater codes were updated in recent years to remove barriers to LID and to adopt an equivalent version of Ecology's stormwater manual that is considered AKART, this Plan does not suggest any immediate changes to the stormwater standards.

Zoning in MIL2 is established through a planning process under the state Growth Management Act. The Comprehensive Growth Management Plan is adopted by the County Council and guides zoning regulations in County Code. One of the purposes of the Comprehensive Plan is to plan for expected Clark County population growth estimated by the state. While the Comprehensive Plan may consider changes in development patterns in response to stormwater management concerns, the Comprehensive Plan assumes that development standards in Title 40 will protect receiving waters.

A brief discussion of each land management code category and its relevance is below.

County Stormwater Code

Clark County development code meets the standards of the current Permit and is unlikely to be changed as an immediate result of this study. The Clark County Stormwater Manual (CCSM) is approved as AKART, and is the standard for the full build-out scenario.

Modeling build out condition hydrology identified the need for further evaluation of the current stormwater flow control approaches in MIL2. Section D of this chapter evaluates several hypothetical changes to stormwater requirements and implementation design approaches that can help bring build out hydrology closer to existing hydrology.

Clark County Critical Areas Code under the State Growth Management Act
During the 1990s, Clark County adopted land use regulations aimed at protecting critical areas and managing growth in hazard areas. These regulations are in Clark County Code Title 40.

Code sections relevant to managing water quality in MIL2 include:

Chapter 40.430 Geologic Hazard Areas, regulates development on steep slopes and potential landslide area, avoidance generally leaves areas in forested condition.

Chapter 40.440 Habitat Protection, regulates development in habitat areas and is intended to use avoidance of development as the first and best option, followed by mitigation on or off site. The primary habitat areas in MIL2 are riparian areas.

Chapter 40.450 Wetland Protection, regulates development in wetlands and wetland buffers using avoidance as the preferred option followed by mitigation on or off site. This code has the direct effect of protecting basin hydrology along with habitat.

Zoning in Title 40 Pursuant to the Comprehensive Growth Management Plan
The Clark County Comprehensive Plan is adopted by the Clark County Councilors pursuant to state law. Zoning regulations following from the Comprehensive Plan are in County Code Title 40. This Report does not consider updates to the Comp Plan and zoning. Future Comprehensive Plan updates may consider actions for managing stormwater impacts related to growth.

Other Land Management Strategies or Actions

The study can also consider strategies or actions not specific to meeting a Permit requirement, including, but not limited to:

- Floodplain reconnection
- Channel restoration
- Riparian vegetation restoration and large woody debris placement
- In-stream culvert replacement
- Open space acquisition

The most appropriate place for these actions is in the 20-Year Stormwater Capital Plan. Currently, opportunities for in-stream projects are very limited in MIL2 due to land ownership and higher priorities in other areas where county land acquisition and salmon restoration are much higher priorities.

Targeted, Enhanced or Customized Actions under the Stormwater Management Program

The Permit requirements include evaluating enhancements of ongoing permit activities such as:

- IDDE field screening
- Prioritized source control inspections
- O and M inspections and enhanced maintenance
- Public Education and Outreach behavior change program

These actions can be considered in the Plan.

D. Hypothetical Future Scenario Models

Future scenarios were modeled following Task 7 of Clear Creek Solutions, Inc. Scope of Work.

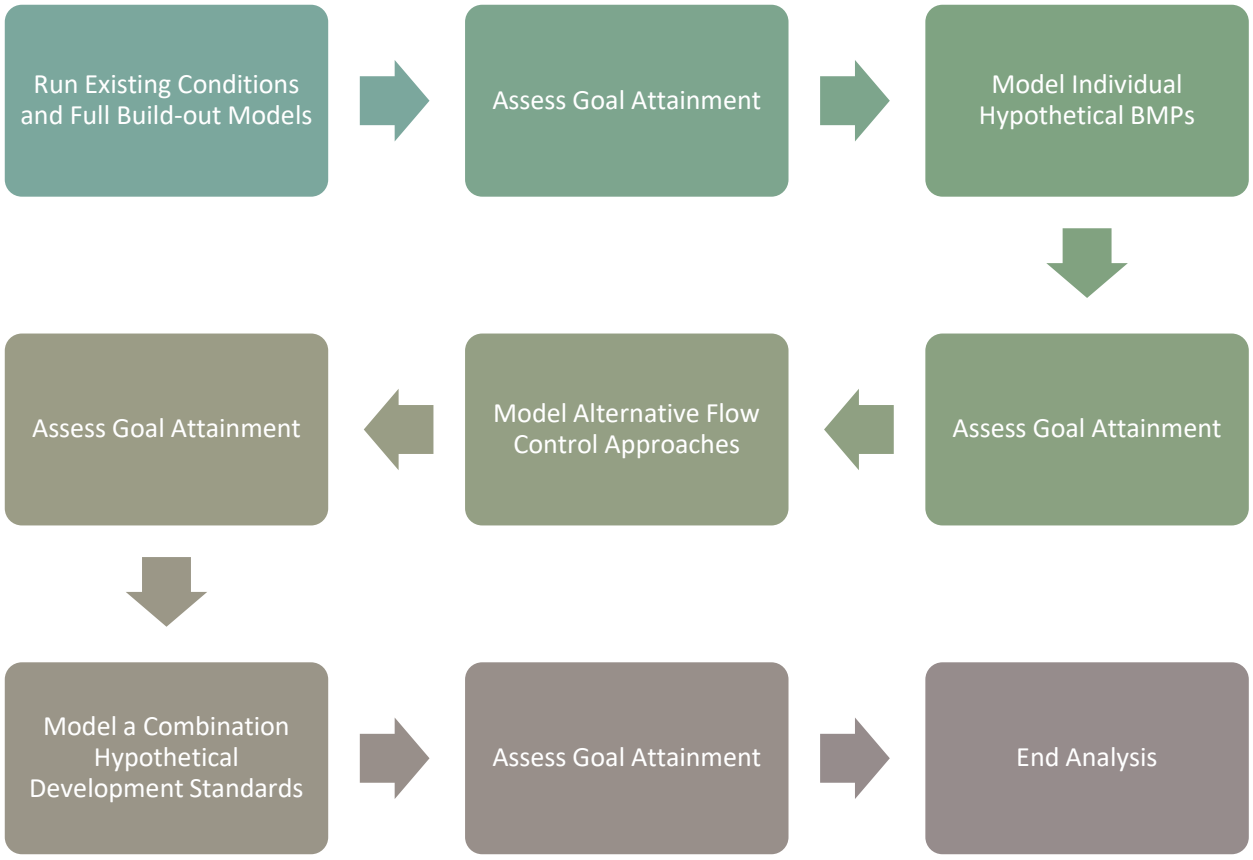
To model strategies, this study models changes to stormwater management practices that may be accomplished individually or collectively to make progress toward the water quality goal. Appendix C includes the technical memo by Clear Creek Solutions, Inc. on the modeling results.

Future scenarios were modeled sequentially, beginning with a set of hypothetical development regulation for stormwater controls. The results of each future scenario were evaluated to determine if there is a significant improvement in flow compared to the build out model hydrology.

Ultimately, there are combined strategy scenarios including several regulatory flow control strategies.

Figure 6 illustrates the sequential modeling of scenarios.

Figure 6: Sequential Scenario Modeling and Strategy Application Concept



i. Development Regulation Strategy Scenarios

This section examines several stormwater management strategies that may be implemented through code or facility modeling revisions. Strategy scenario models provide a tool to assess whether the strategy will be effective at increasing ground water recharge and reducing erosive flows.

Once the individual strategies are modeled, they were reviewed to assess whether proposing them for code revisions is appropriate.

Hypothetical Permeable Pavement (Scenario 1)

While permeable pavement is deemed infeasible in most of MIL2 catchment because soil infiltration rates are generally less than 0.3 inches per hour, it is possible to model permeable pavement using soil infiltration rates of less than 0.3 inches per hour.

All paved surfaces on areas sloping less than 5 percent were assumed to be permeable pavement. Any rainfall not infiltrated is assumed to run into the Build Out model detention basin. Considering the slope limitations, only 42 acres of permeable pavement were modeled, 25 acres in MIL2B and 17 in MIL2C.

Two soil permeability rates were model based on available geotechnical reports for development projects in the MIL2 vicinity: 0.15 inches per hour and 0.25 inches per hour.

Results

Notably, the results were not influenced to any significant degree by using two different soil infiltration rates. Mandatory permeable pavement does make a small difference in the future flow durations at the lower flows. Using permeable pavement appears to have the largest influence in MIL2B. The reason may be related to the proportion of the sub-catchment where permeable pavement has slopes less than 5 percent and the complete rural to urban conversion.

Table 15: Build Out Model Flow Duration in Hours per Year for ½ of the 2 Year Developed Flow for Existing Conditions and Build Out

Reach LOI	Existing Conditions Model	Build Out Model	0.15 Inches/Hour Infiltration	0.25 Inches/Hour Infiltration
MIL2A	75	150	136	136
MIL2B	50	207	164	164
MIL2C	162	233	223	223
MIL2D	186	210	210	210

Table 16: Build Out Model 2-Year Flows (cubic feet per second) with Permeable Pavement

Reach LOI	Existing Conditions Model	Build Out Model	Infiltration at 0.15 Inches/Hour Infiltration	Infiltration at a0.25 Inches/Hour Infiltration
MIL2A	70	88	83	83
MIL2B	17	26	22	22
MIL2C	31	42	40	40
MIL2D	18	20	20	20

Hypothetical Bioretention with Infiltration Sumps (Scenario 2)

While bioretention is deemed infeasible in most of MIL2 catchment because soil infiltration rates are generally less than 0.3 inches per hour, it is possible to model bioretention with a gravel-filled infiltration sump using soil infiltration rates of less than 0.3 inches per hour.

All paved surfaces and lawn on areas sloping less than 15 percent were assumed to have runoff routed to bioretention. Any rainfall not infiltrated is assumed to run into the build out model detention basin. A total of 340 acres was routed to bioretention cells, with 68 acres in MIL2A, 127 acres in MIL2B and 145 acres in MIL2C.

As with permeable pavement, two soil permeability rates were model based on available geotechnical reports for development projects in the MIL2 vicinity: 0.15 inches per hour and 0.25 inches per hour.

Results

Mandatory bioretention with a gravel filled sump does make a difference in each developed sub-catchment. The ability to use bioretention on slopes up to 15 percent makes it a more effective tool than permeable pavement. Also, because landscaped areas are routed to bioretention as the treatment BMP, it infiltrates runoff from a larger area. The results were not influenced to any significant degree by using two different soil infiltration rates.

Table 17: Build Out Model Flow Duration in Hours per Year Using Bioretention with Infiltration Gallery

Reach LOI	Existing Conditions Model	Build Out Model	Infiltration at 0.15 Inches/Hour Infiltration	Infiltration at 0.25 Inches/Hour Infiltration
MIL2A	75	150	88	85
MIL2B	50	207	105	99
MIL2C	162	233	158	160
MIL2D	186	210	210	210

Table 18: Build Out Model 2-Year Flow (cubic feet per second) using Bioretention with Infiltration Gallery

Reach LOI	Existing Conditions Model	Build Out Model	Infiltration at 0.15 Inches/Hour Infiltration	Infiltration at 0.25 Inches/Hour Infiltration
MIL2A	70	88	75	75
MIL2B	17	26	19	19
MIL2C	31	42	36	35
MIL2D	18	20	20	20

Model Leaky Detention Ponds (Scenario 3)

Detention ponds modeled for the build out model were assumed to have no infiltration losses. In actual practice, there will be some losses to groundwater through pond bottom and sides. This model scenario assumes the same soil infiltration rate as the permeable pavement and bioretention scenarios.

Results

Allowing leaky detention ponds did not provide a significant benefit. Erosive flow durations were shortened a tiny bit but there was no reduction in peak discharges. This is probably due to the relatively small footprint of detention ponds in the SG4 soil type.

Table 19: Scenario 3 Build Out Model ½ 2-year Flow Duration in Hours per Year with Leaky Detention Ponds

Reach LOI	Existing Conditions Model	Build Out Model	Infiltration at 0.15 Inches/Hour Infiltration	Infiltration at 0.25 Inches/Hour Infiltration
MIL2A	75	150	146	143
MIL2B	50	207	195	188
MIL2C	162	233	229	227
MIL2D	186	210	210	210

Table 20: Build Out Model 2-Year Flow (cubic feet per second) with Leaky Detention Ponds

Reach LOI	Existing Conditions Model	Build Out Model	Infiltration at 0.15 Inches/Hour Infiltration	Infiltration at a 0.25 Inches/Hour Infiltration
MIL2A	70	88	87	87
MIL2B	17	26	25	25
MIL2C	31	42	42	42
MIL2D	18	20	20	20

Leaky Wetpond/Detention Facilities (Scenario 5)

In areas having clayey soils, it is common to combine the dead storage of a treatment wetland or standard treatment pond with the live storage as detention above. Normally, ponds are lined to maintain the surface elevation of the pond. In this case, the pond will be unlined and capable of some degree of infiltration. It is anticipated that ponds will go dry during summer months. The ponds are sized to meet Minimum Requirement #6 and detention facilities remain the same as in the build out model. As with the other infiltration scenarios, 0.15 and 0.25 inch per hour infiltration rates will be modeled.

Results

As was the case with leaky detention facilities, little is gained by assuming leaky wet ponds are used to increase infiltration.

Table 21: Build Out Model ½ 2-Year Duration in hours per Year with Leaky Wet Ponds

Reach LOI	Existing Conditions Model	Build Out Model	Infiltration at 0.15 Inches/Hour Infiltration	Infiltration at a0.25 Inches/Hour Infiltration
MIL2A	75	150	136	125
MIL2B	50	207	152	129
MIL2C	162	233	227	229
MIL2D	186	210	210	210

Table 22: Build Out Model 2-Year Flow (cubic feet per second) with Leaky Detention Ponds

Reach LOI	Existing Conditions Model	Build Out Model	Infiltration at 0.15 Inches/Hour Infiltration	Infiltration at a0.25 Inches/Hour Infiltration
MIL2A	70	88	90	89
MIL2B	17	26	25	25
MIL2C	31	42	43	43
MIL2D	18	20	20	20

Increased Detention Requirements Along with Infiltration (Scenario 4)

Detention ponds for the majority of MIL2 are designed to meet predevelopment flows for the low infiltration rate SG4 soils, resulting in relatively small facilities compared to facilities in moderately drained SG3. The project goal to maintain existing hydrology is not possible to meet with significant amounts of infiltration. However, it is possible to decrease the duration of erosive flows using larger detention facilities.

For 4A., the pond is sized to meet both the Minimum Requirement #5 LID Performance Standard and Minimum Requirement #7 Flow Control standard. The LID Performance Standard matches predeveloped flow durations from 8 percent of the 2-year peak flow to 50 percent of the 2-year peak flow. The Flow Control standard matches predeveloped flow durations from 50 percent of the 2-year peak flow to the full 50-year peak flow. The bioretention facilities have infiltration as in Scenario 2 and the pond leaks at 0.15 inches per hour.

For 4C, the pond is sized to meet the forested predevelopment standard, along with bioretention infiltration and a leaky pond as in 4A.

Results

Using the LID Performance Standard and some bioretention infiltration produced 2-year flows and erosive flow durations which are much lower than the existing conditions model. Using some bioretention and detention to meet the forested standard produced 2-year flows similar to existing conditions and longer erosive flow durations for developed areas. Notably, MIL2B erosive flow duration nearly doubled.

Table 23: Build Model with Bigger Ponds Flow Durations Greater Than or Equal to ½ 2-Year Flow in Hours per Year

Reach LOI	Existing Conditions Model	Build Out Model	4A Using LID Performance Standard	4C Forested and Bioretention
MIL2A	75	150	54	85
MIL2B	50	207	16	94
MIL2C	162	233	149	156
MIL2D	186	210	210	210

Table 24: Build Out Model with Bigger Ponds 2-Year Flow (cubic feet per second)

Reach LOI	Existing Conditions Model	Build Out Model	4A Using LID Performance Standard	4C Forested Standard and Bioretention
MIL2A	70	88	53	72
MIL2B	17	26	8	17
MIL2C	31	42	28	36
MIL2D	18	20	20	20

ii. Combined Strategies (Scenario 6)

Scenario 6 tests a combination of effective strategies. The modeled strategies included bioretention (Run 2A), leaky detention ponds (Run 3A), and a lower flow duration standard threshold. Run 6A used a lower flow duration threshold of 15 percent of the predevelopment 2-year flow and Run 6B used 30 percent of the predevelopment 2-year flow. Both runs used a native soil infiltration rate of 0.15 inches per hour.

Permeable pavement was not considered for several reasons. Permeable pavement had limited effect on moving build out hydrology toward existing conditions due to small amount of area where it can be used on slopes less than 5 percent. The most common permeable pavement is not allowed for county

right-of-way due to a history of poor performance as a road surface and a stormwater BMP in Clark County.

The scenarios use higher flow duration thresholds than the LID Performance Standard modeled in Scenario 4A to in an attempt to more closely match existing conditions model hydrology. Low levels of infiltration were modeled due to the likelihood that designers would include some degree of infiltration in designs to meet the flow duration standard.

Results

Both Run 6A and 6B approached or surpassed existing conditions for the 2-year flow and duration of erosive flow, and produced significant improvements over the Build Out model for MIL2B and MIL2A where the stream is most impacted by development driven hydrology changes. High Pulse Counts calculated for Scenario 6 results were fairly close to the Existing Conditions model for 6A. 6B HPC results were closer to the Build Out model with the most reduction in MIL2B.

The determining factor in each run was the selection of the lower flow duration standard threshold. A lower low flow duration threshold appears to be the most significant factor in reducing future full build-out flows to existing flow conditions considering the limited ability to deploy fully effective LID infiltration BMPs.

Table 25: Combined Strategy Flow Duration over ½ 2-Year Flow in Hours per Year

Reach LOI	Existing Conditions Model	Build Out Model	6A Threshold – 15% 2-Year	6B Threshold - 30% 2-Year
MIL2A	75	150	70	83
MIL2B	50	207	49	85
MIL2C	162	233	152	156
MIL2D	186	210	210	210

Table 26: Combined Strategy 2-Year Flow (cubic feet per second)

Reach LOI	Existing Conditions Model	Build Out Model	6A Threshold – 15% 2-Year	6B Threshold - 30% 2-Year
MIL2A	70	88	58	67
MIL2B	17	26	11	15
MIL2C	31	42	31	34
MIL2D	18	20	20	20

Table 27: Combined Strategy High Pulse Counts

Reach LOI	Existing Conditions Model	Build Out Model	6A HPC	6B HPC
MIL2A	14	19	15	17
MIL2B	13	25	15	18
MIL2C	12	16	14	14
MIL2D	12	12	13	13

Pond Volume

Several scenarios increased pond volume from that of the build out model. Table 28 shows pond volume and change from the build out model for scenarios that resulted in a change in volume from the Build Out Model.

The LID Performance Standard scenario produces large ponds, even with the assumption that some bioretention infiltration is present.

The forested scenario produces a pond size very similar to the alternative flow control standard of pasture and forest predevelopment land cover used for the Build Out model.

The leaky combined wetpond and detention models produce large ponds due to the combined detention and treatment pond volume.

The reduced flow duration threshold model scenarios produced markedly differing pond sizes. The 15 percent of the 2-year threshold using some bioretention infiltration model produced ponds about two thirds the size of the LID performance model and about twice the size of the Build Out model. The 30 percent of the 2-year threshold model using some bioretention infiltration has ponds almost the exact same size as the Build Out model ponds.

Table 28: Pond Size Analysis Compared to Build Out Model Ponds

Reach LOI	MIL2A Acre Ft	MIL2A Percent change	MIL2B Acre Ft	MIL2B Percent change	MIL2C Acre Ft	MIL2C Percent change
Build Out	4.6	0	22.4	0	13.8	0
4A LID Performance Std. and bioretention	13.2	186	55.4	147	34.9	152
4B Forested	5.6	122	20.3	(9)	14.3	4
4C Forest and bioretention	4.6	0	7.1	(68)	13.1	(5)
5 Leaky Wetpond	16	249	50.8	127	42.7	209
6A Threshold 15% Q2 plus bioretention	8.5	85	35.4	58	25.1	82
6B Threshold 30% Q2 plus bioretention	5.4	17	20.7	(8)	13.8	0

iii. Overall Results

The development regulation scenarios evaluated hypothetical regulatory approaches to preserve existing conditions hydrology. The key is to optimize ground water infiltration and minimize runoff while using feasible strategies to limit land lost to detention ponds.

Lowering the flow control standard threshold in an attempt to meet some part of the LID Performance Standard using dispersed infiltration BMPs appears to be a feasible option to meet the study goal of maintaining the exiting stream hydrology.

E. Goal Attainment

iv. Hydrology

The success of strategies analyzed for meeting salmonid beneficial uses is not clear. The modeled forested condition HPC of 9 suggests that catchment hydrology may never have matched that of high-quality salmon streams base on the analysis completed by King County that placed the threshold for fully supporting at HPC less than 7.

Likewise, information on fish presence suggests that some of the reasons for limited salmonid use are inherent in the catchment due to stream size, topography, and natural sandy substrate.

The Implementation Plan (Chapter IV) discusses potential future actions considering the evaluation of modeled strategies, permit-mandated strategies and ongoing county programs.

i. Stream Temperature

Data from summer 2021 showed that the stream generally fails to meet the core summer salmon habitat standard. This is common for rural Clark County streams. During summer 2021, only the lowermost reach, MIL2A had flow; it was at only a fraction of a cubic foot per second. The stream channels are shaded in all reaches, either due to forest canopy in canyons and wetlands or tall grass in fields.

Continued monitoring at MIL2A and field checks of continuous loggers at MIL2B and MIL2C should provide a better understanding of the extent of summer flow and temperatures.

ii. Dissolved Metals

Based on modeling performed in Whipple Creek, MIL2 catchment would not exceed state water quality standards for dissolved metals under the build-out scenario. This suggests that continuing to implement the current regulations and stormwater management program would maintain compliance with state water quality standards for dissolved metals.

iii. Fecal Bacteria

Full infiltration was the only modeled strategy previously evaluated in Whipple Creek that could eliminate fecal bacteria violations in urban streams. This result suggests stormwater management alone would not be effective in attaining compliance with standards. Activities outside the scope of the Permit would be needed to reduce bacteria to acceptable levels.

IV. Stormwater Management Action Plan

The permit requires completion of a Stormwater Management Action Plan with a proposed schedule and budget source. The Plan must include short-term activities for the first six years and a long-term plan for the following 14 years, or a six-year plan and a 20-year plan.

A. Scope and Limitations

This Report's strategies to manage in-stream conditions are conceptual-level considerations based on broad evaluations of existing conditions and future land use. The described actions are consequently imprecise at the site development scale and stream reach scale.

Modeled build out facilities, development standards and facility functions are purely hypothetical. Models simulate the facility size needed to meet current standards or hypothetical conditions using only one flow control facility per sub-catchment.

This Report is intended as long-term guidance to assist in meeting SMAP objectives. It is not intended to recommend or prioritize particular capital projects, strategies, or management actions.

Potential actions are based on the results of the modeling exercise and the recognition that budgets based on the countywide stormwater fee are the revenue sources for implementation. The proposed actions also recognize that updates to development regulations are the purview of elected officials. In addition, the modeling analysis for this Report is limited to hydrologic conditions and does not consider channel hydraulics of future conditions as the catchment is developed.

B. Six-Year Plan

Clark County is responsible for enforcing its development and stormwater codes, operating and maintaining its MS4, and for meeting Permit requirements. The Six-Year Plan considers each of the actions listed in S5.C.6.d.

iv. Stormwater Retrofit Facilities

Clark County does not anticipate using its Stormwater Capital Program to build retrofit facilities under the Six-Year Plan. It is possible that retrofit facilities could be considered for inclusion in the 20-Year Plan as opportunistic sites arise.

Any projects would be funded by the Clean Water Division Stormwater Capital Program budget and potentially by grants from Ecology.

v. Land Management, Development Strategies and Other Actions

Development regulations are the primary tool for managing stormwater runoff due to planned Urban Growth Area development under state growth management law.

This Report assumes certain actions by private landowners and land developers that are part of the current program, such as maintaining private stormwater facilities and developing land under the standards of the CCSM will continue.

The Build-Out Scenario describes the full build-out of the Vancouver UGA in MIL2 catchment. These activities are carried out principally by private developers who convert rural forest or pasture to developed residential or commercial properties. Landowners and developers are required to comply with development standards and zoning in Clark County Code Title 40, including assumptions for densities, critical areas protection, and stormwater and erosion control requirements.

This Report also assumes other public entities and quasi-governmental organizations will continue their actions to benefit water quality and in-stream conditions in the watershed.

County programs to apply county code to development projects are funded by fees paid by development projects. Any project to update county code would require new budget allocations by the Clark County Council using revenue collected by the Clean Water Fee.

vi. Targeted, Enhanced, or Customized SWMP Elements

The SMAP language asks permittees to consider revisions to their SWMP in the areas of IDDE screening, prioritized source control inspections, O and M inspections and maintenance, and Education and Outreach efforts to change behavior.

Illicit Discharge Screening Program

Non-stormwater discharges to the MS4 or directly to waterbodies are likely to be rare in MIL2 catchment. Clark County will review aerial photographs to identify outdoor activities that could be pollutant generating. The inventoried sites will then be visited by the source control technical assistance specialists.

Clark County may perform wet season bacteria monitoring to identify potential areas of higher bacteria loading.

Funding is from the ongoing Clean Water Division Monitoring and Assessment Program budget.

Prioritized Source Control Inspections

Clark County finds that source control inspections and follow up visits to remove pollutant sources are effective tools. Clark County will visit all sites that are potential pollutant generators identified by the source control program. These will tend to be rural businesses such as sites with excavating equipment, nurseries, and trucking businesses and a few urban area businesses as the area develops.

Funding for source control work is from the Clean Water Division NPDES Compliance Program budget.

Enhanced MS4 Operation and Maintenance

The primary maintenance activity in the catchment is currently ditch maintenance in the rural area. Urbanized parts of MIL2 include stormwater control facilities, catch basins and piped conveyance systems. Clark County will ensure that all county-owned and private facilities are maintained to permit standards as a part of the SWMP.

Enhanced maintenance is within Clark County's current capabilities. Work could involve ensuring the roadside ditches are not sources of sediment due to resident activities or county operations.

Funding for O and M activities is from the Clean Water Division Operations and Maintenance Budget and the Clark County Road Fund.

Education and Outreach Program for Behavior Change

Education and outreach tend to focus on regional messages and targeted stewardship opportunities. These include programs such as the WSU Vancouver Extension Small Acreage Program.

In an effort to raise awareness of MIL2 Creek, Clean Water will seek participation from the community to name the creek using inclusive engagement strategies.

The work is funded by the Clark County Clean Water Division Education and Outreach Program budget.

vii. Long-Range Plan Revisions

Long-range plan revisions would include primarily the Clark County Comprehensive Growth Management Plan.

The primary growth management planning goal for Clark County capital planning is to provide safe and effective transportation systems. There is no stormwater capital planning for growth because all private and public development projects construct needed stormwater conveyance and water quality facilities. If Clark County had a program to build regional facilities for development, that type of capital planning would be included in the Comprehensive Plan capital planning for growth component.

Capital planning for expanding water distribution systems and sewage collection and treatment systems are maintained by special purpose utility districts.

viii. Monitoring

There are several activities that should be performed to assess stream conditions over time and provide feedback on activity effectiveness.

The monitoring work will come from the Clean Water Division Monitoring and Assessment budget and could require Council approval of additional budget from Clean Water Fee revenue.

Stream Flow Monitoring

The Report suggests actions aimed at reducing hydrologic impact to the creek due to development. Modeling was completed using limited flow data. Added stream flow data is needed to both track basin hydrology and ensure the model parameters are accurate for higher flows.

One gauge will continue at MIL2A to measure the entire catchment. Another gauge may be added at MIL2B to track flows at this tributary.

Rainfall Monitoring

There is no continuous rainfall gauge in MIL2. Modeling for this study used a nearby rain gauge in uppermost Packard Creek basin. Open fields on county property near NE 29th Avenue and 199th Street provide a good location to add a gauge in the study area.

Stream Temperature Monitoring

Summer flows are so low in MIL2 that it is unlikely to have significant fish use above the lowermost reaches. Resident trout and young steelhead and Coho salmon should be present near Mill Creek. The Plan does not specifically call for riparian plantings to shade the creek because it is largely shaded, riparian critical areas protected by county code. Temperature monitoring at MIL2A gauge site will provide data to track compliance with water quality standards.

ix. Detailed Hydraulic and Hydrologic Investigation

Initial modeling results show the build out scenario will increase the magnitude of flows such as the 2-year flood, and duration of flows greater than the flow control threshold of ½ of the 2-year flood.

This implies that current flow control standards may not adequately manage stormwater runoff from new development at the catchment scale. Modeling shows that the main cause is the lack of infiltration BMPs in areas modeled as low permeability SG4 WWHM soils. Normally, project designers deem LID BMPs as infeasible when soil permeability is less than 0.3 inches per hour. Also, LID BMPs are not pursued as a tool to reduce pond size in these areas because of the relatively small ponds required to meet the flow control requirements for SG4 due to high predevelopment runoff rates.

Clark County Clean Water Division has a baseline budget for professional services that could be used to develop a more accurate hydrologic model and a hydraulic model for MIL2.

Detailed basin study of Hydraulics and Hydrology

A detailed hydrologic model will lead to better understanding of basin hydrology and provide a basis for hydraulic analysis of build out effects on stream channels. This analysis would be the first step toward considering catchment-specific flow control standards.

The standard WWHM approach makes assumptions about stream hydrology as it relates to habitat protection at a regional scale. Clark County has locally calibrated the WWHM with an underlying regional assumption that the flow duration curve match should begin at ½ of the predevelopment two-year flow and extend to the 50-year flow. The other regional assumption is that matching the predevelopment curve hydrology at the project scale will result in protecting stream habitat at the basin scale.

Another major assumption is that LID is usually feasible and will limit the amount of increased runoff from urbanization. This assumption is not valid in MIL2 and similar areas of Clark County. While there is some infiltration capacity in shallow soils in MIL2 based on available data, there is not sufficient information to rely on LID projects to infiltrate higher flows into sediment layers below topsoil.

Performing this work will likely require revisions to the current Clean Water Division budget.

Receiving Waters and Stormwater Catchment Mapping

Under the Phase I Municipal Permit, receiving waters are defined as naturally occurring or reconstructed naturally occurring surface water bodies such as creeks, streams, rivers, lakes, lakes, wetlands, estuaries, and marine waters or ground water, to which the MS4 discharges. Water bodies can include ephemeral streams that only flow during the wet season or during rainfall.

Clark County recently acquired high-quality 2019 Lidar topographic contours that allow detailed mapping of small ephemeral drainageways that will become receiving waters as the catchment urbanizes over the next 20 years. In addition, some of these small streams are sometimes converted into roadside ditches that are also part of the MS4.

Stormwater outfall catchments are mapped for the urbanized area. Outfall catchments can vary in size from a few acres to over 100 acres. Receiving water catchments can be defined for groups of outfall catchments draining to the same receiving water. This will continue as the UGA is built out over the long term.

Hydrologic Model Creation

Clark County will consider creating a hydrologic model capable of modeling the drainage area to each receiving water reach. The model would provide hydrologic data to allow hydraulic analysis at the reach level for locations of interest in the current MIL2 hydrologic model and any reaches of concern based on detailed receiving waters mapping.

Hydraulic Model Creation

Clark County may create a hydraulic model at the same reach scale as the hydrologic model. The hydraulic model could be capable of modeling channel shear stress to estimate flows where channel bank becomes eroded. Bank material can be based on field observations. In areas of concern, more detailed field testing may be required.

Analysis for a Protective Flow Control Standard

The hydrologic model created for this Report is a useful tool for assessing the likely ability of current stormwater requirements for managing stormwater during build out. It is not sufficiently accurate to model flow control requirement effectiveness at the receiving water scale or to propose a new flow control standard.

The hydrologic and hydraulic model could provide a technically valid tool to evaluate the need for alternative MIL2 flow control standards.

Any alternative to the current county standard will require extensive public review, a Planning Commission hearing, an ordinance adopted by the Clark County Council, and Ecology approval. Such a project will require a significant budget allocation by the Clark County Council, most likely from Clean Water Fee revenue.

C. 20-Year Plan

x. Continue Ongoing Six-Year Plan Activities

Ongoing six-year plan activities to be continued into the future include:

- Stream monitoring
- Rainfall monitoring
- Temperature monitoring
- Receiving water catchment mapping
- Model maintenance

xi. Clark County 20-Year Stormwater Capital Plan

Clark County developed a 20-Year Capital Plan in 2020. Any projects or actions that affect MIL2 are included by reference.

xii. Comprehensive Plan Update for Stormwater Capital Projects to Mitigate Development Impacts

Clark County may consider stormwater control facilities built specifically to help mitigate development impacts on MIL2 receiving waters. Such a program would be included in the Comprehensive Growth Management Plan Capital Facilities Plan.

D. Revenue Sources

The primary source of revenue to operate the Clark County Stormwater Management Program in MIL2 will be the Clean Water Fee assessed on each residence and other developed property in unincorporated Clark County.

An analysis of the current and build-out fee was completed. The current fee is based on existing developed parcels billed in the study area.

The relatively small amount of current and future fee revenue in the MIL2 catchment suggests that a plan would rely heavily on existing programs and grants.

i. MIL2 Clean Water Fee

While there is not a separate fee area for MIL2, all Clean Water fees assessed per parcel countywide for the Clean Water Fund are known, making it possible to estimate the fee for the specific area of MIL2. The current fee billed in MIL2 is approximately $38,000 per year, generated by 902 equivalent residential units (ERUs).

Equivalent residential units are the basis for calculating stormwater fees. One ERU is 3,500 square feet of hard surface (roof, driveway, roadway, etc.). The stormwater fee rate is based on a property's land use category and location in or out of the Urban Growth Area.

If the watershed were fully built out to maximum densities allowed under current zoning land uses, the number of ERUs is estimated to be 5,032 resulting in billed fee revenue of $322,290.

Table 29 shows potential increase in annual stormwater fees to full build out based on compound average growth rates 2000-2022 of the fee rates forecast 20 years. Year one of implementation is assumed to be 2024. Using the current ERU count and billed fee revenue in MIL2, a projected 2024 annual bill per ERU is $50.24. The annual bill per ERU increases to $64.05at full build out.

The estimate does not consider projected inflation because the fee is set by County Council as county policy.

Table 29: Annual Stormwater Fee Increase

Year from Start	1	2	3	4	5	10	20
	2024	2025	2026	2027	2028	2033	2043
Base ERU Rate	$50.24	$52.69	$54.57	$56.06	$57.27	$60.98	$64.05
ERUs	1,295	1,492	1,689	1,885	2,082	3,065	5,032
Billed Fee Revenue	$65,083	$78,621	$92,158	$105,695	$119,232	$186,918	$322,290

Possible MIL2 Fee Revenue Distribution

Based on historical fee distribution to program areas such as the Stormwater Capital Program, Monitoring and Assessment and an estimate of likely Operation and Maintenance costs considering a three percent as the catchment builds out, it is possible to make an estimate of how the probable MIL2 stormwater fee could be budgeted.

Stormwater facility O and M costs are estimated for existing and build out stormwater facilities including a three percent inflation rate over 20 years. The remaining fee for selected years is shown in Table 30. Not including countywide program administration and permit compliance activities, which are about 20 percent of the Clean Water Division budget, leaves an amount that can fund ongoing monitoring and assessment, any MIL2-specific regulatory changes, and several small capital projects during the 20-year window.

Table 30. Future O and M Costs and Remaining Fee

Year from Start	5	10	20
	2028	2033	2043
Billed Fee Revenue	$119,232	$186,918	$322,290
Estimated Annual O and M	45,500	65,100	126,200
Remaining Fee Revenue	73,732	121,816	196,090

ii. County-Wide Clean Water Fees

Larger priority activities and capital projects can be funded by the countywide Clean Water Fee. Priority projects could include channel and flood plain restoration in lower MIL2A, headwater wetland retention and restoration, and additional stream modeling to refine the need for updated development regulations.

iii. Other Potential Local Revenue

Beyond stormwater fee revenue from developed properties within MIL2, other potential funding mechanisms could include the county's Legacy Lands Fund, the County Road Fund, and partnerships with quasi-governmental organizations such as the Clark Conservation District, Clark Public Utilities, or non-profit organizations.

iv. Grants

Grants from the state Department of Ecology are a principal source of revenue for larger stormwater capital projects and stream restoration projects. Significant grants from fish restoration funding sources are not anticipated for work in Mill Creek basin due to its relatively low priority in lower Columbia River salmon recovery planning compared to non-urbanizing watersheds.

v. A Local Fee in MIL2 for Regional Facilities to Mitigate for Growth

There is currently no mechanism to charge a local fee to pay for regional facilities to mitigate for added runoff from growth. Implementing such a fee would first require a capital plan to include in the Comprehensive Growth Management Plan. Such a plan could be part of the 20-year plan.

E. Adaptive Management

Adaptive management would allow goals and methods to change in response to new information, feedback on progress, changing technologies, and new or updated regulatory and community goals. Key elements of the adaptive management program could include future data gathering and evaluating fish use attainment base on temperature under current and likely future climate conditions.

vi. Monitoring

An adaptive management approach could include targeted data collection efforts and special projects to look for problem areas such as bacteria sources. Data and analyses could contribute to capital planning, modeling, and prioritization of management options.

F. Schedule

This Report uses a 20-year horizon. Items identified for the six-year plan would be projects designed to be completed within that timeframe. The 20-year element will include activities for the next 14 years after the first six-years.

Land use assumptions are based on the 20-year Comp Plan-based zoning. No land cover conversions beyond full build-out at 20 years are considered.

V. Public Review Process

Actions described in this Report require action by the Clark County Council as part of annual budget review and approval. Any action to change county development code must follow the public involvement process required by the Growth Management Act, including Planning Commission review and adoption by the Clark County Council to implement. Public involvement will occur as those actions are considered by the public, Planning Commission and Clark County Council.

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Clark County

Mill Creek Tributary Catchment-Scale Stormwater Planning

Appendix A
Hydrology Modeling Report

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Clark County Public Works

July 2022

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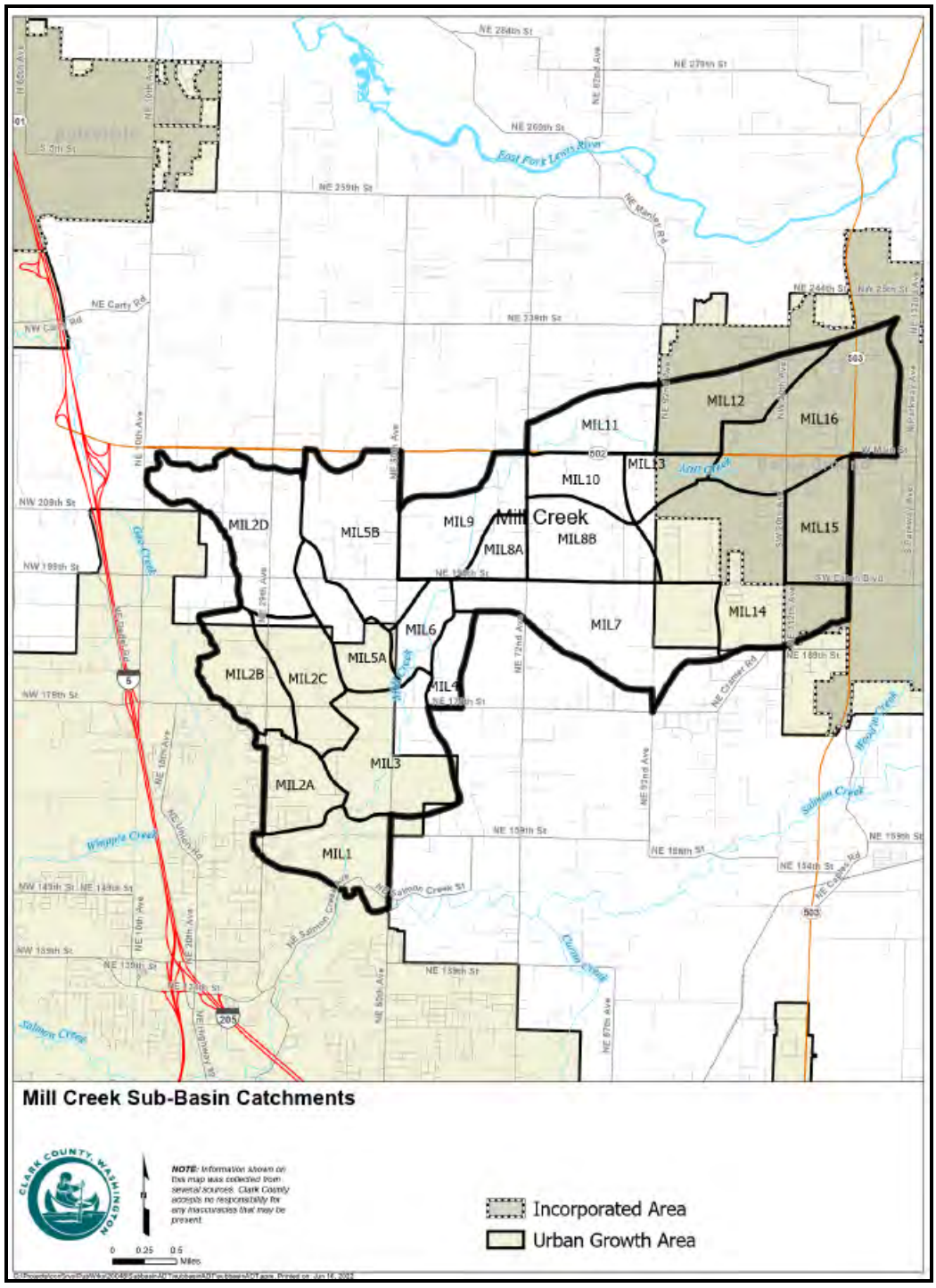
INTRODUCTION

The Washington State Department of Ecology issued a 2019-2024 Phase I Municipal Stormwater Permit on August 1, 2019, that requires the four Phase I counties including Clark County to select a catchment and perform catchment-scale stormwater planning as outlined in Permit section S5.C.6.d. Clark County has identified Mill Creek as a priority sub-basin due to its location in Salmon Creek watershed, its relatively low level of development in the unincorporated area, presence of salmon populations, and development pressure in the Vancouver urban growth area. Within Mill Creek, an unnamed tributary stream catchment is selected for catchment-scale stormwater planning. In Otak's modeling analysis (2009), this tributary was labeled MIL2. West Consultants named the creek Tributary 1 and 1A in their 2008 modeling report. The focus of this project will be hydrologic model development and planned scenarios to address hydrology concerns.

MILL CREEK BASIN

Mill Creek basin is in south-central Clark County and is a major tributary to Salmon Creek that is designed as core summer salmon habitat under state water quality standards. Mill Creek drains west from the city of Battle Ground to Dollars Corner, then south to Salmon Creek near the Washington State University Vancouver campus (Figure 1). Mill Creek watershed, which was once dominated by rural and agricultural land uses is currently moderately developed. It has a mix of rural, urban, and urbanizing areas at the northern edge of the Vancouver Urban Growth Area and the western edge of Battle Ground. The basin drainage area is approximately 11.9 square miles, and the elevation ranges from approximately 134 feet NGVD at the Salmon Creek confluence to about 446 feet NGVD at the ridge along the western boundary of the watershed near the City of Battleground. The watershed is subject to winter storms in which precipitation is mainly in the form of rain, and high flows typically occur during the winter months (West Consultants, 2008).

Figure 1: Mill Creek basin

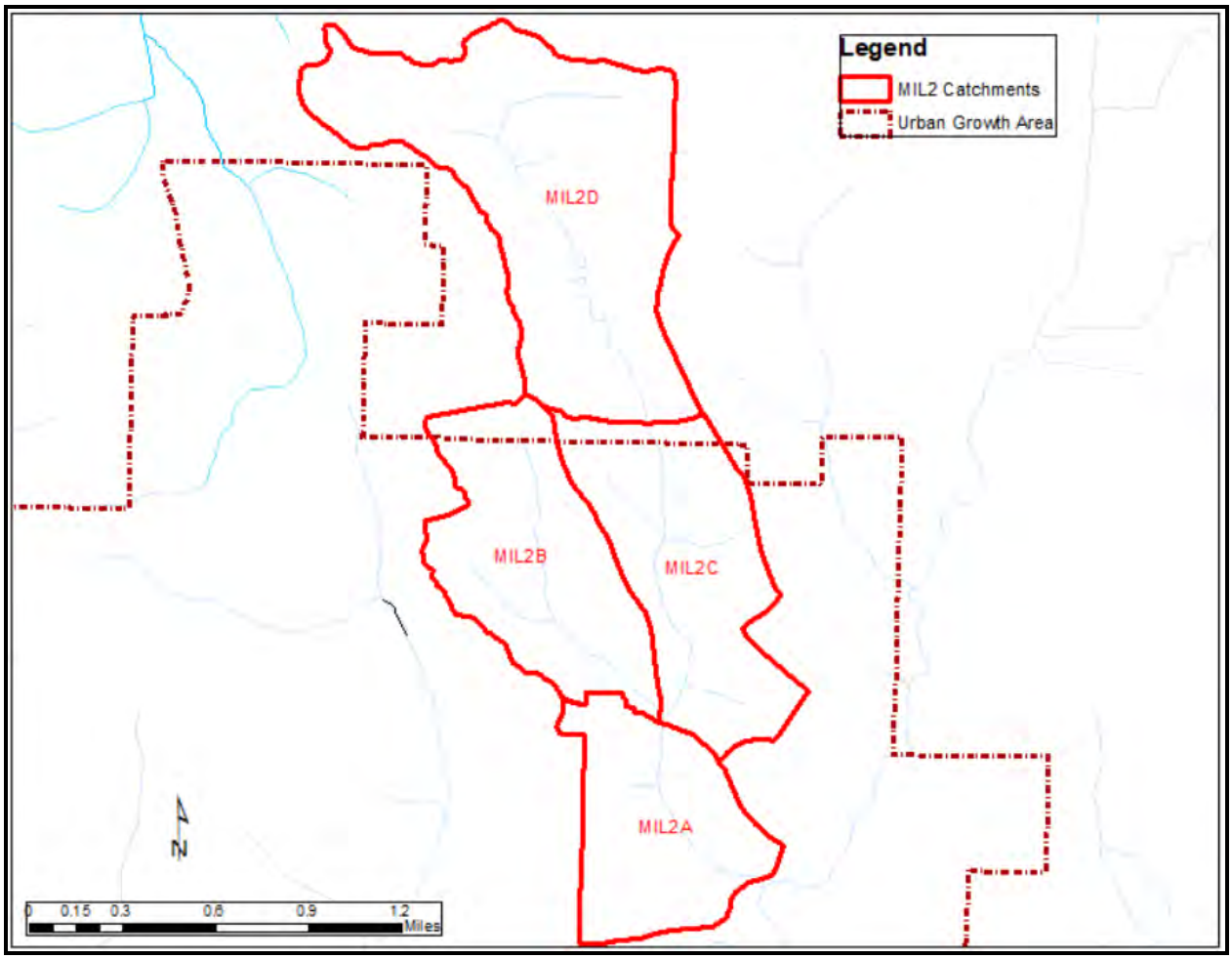


MIL2 CATCHMENT

MIL2 Catchment is approximately 1380 acres in area and is made up of four smaller sub-catchments labeled as MIL2A, MIL2B, MIL2C, and MIL2D in the county GIS layers (Figure 2). Initially, there were only three sub-catchments but MIL2C was split to create MIL2D, which is outside the urban growth area (UGA).

MIL2D sub-catchment, the uppermost part of the study area, is entirely rural and outside the UGA. MIL2B and MIL2C sub-catchments are within the UGA and beginning to develop. MIL2A sub-catchment is almost entirely developed and includes late 20th century development on Mount Vista.

Figure 2: MIL2 catchments



MODEL DEVELOPMENT

As mandated by the National Pollutant Discharge Elimination System (NPDES) Phase I Permit issued by the Washington State Department of Ecology (Ecology), the Clark County Stormwater Manual requires the use of a continuous hydrologic model to design flow control and runoff treatment facilities. That model is a locally calibrated version of the Western Washington Hydrologic Model (WWHM).

Clark County chose to use an HSPF-based continuous runoff model for this project. That model is the WWHM-SWMM (Clear Creek Solutions, Inc.). HSPF models simulate the full flow regime, including low flows, high flows, dry periods, and back-to-back storm events. A continuous hydrologic model can be used to identify whether the future development will significantly increase the time a channel experiences erosive flows on an annual or seasonal basis (Otak, 2008).

Clark County possesses a calibrated HSPF model for Mill Creek (Otak, 2009). The project used calibrated parameters from the calibrated Mill Creek model to construct a model for MIL2 catchment. Measured flow data collected by the Clean Water Division was used to validate the model.

Land Use Data

The land cover data for the catchment was developed from County GIS information. The land cover types reflected in orthophotographs for various years were used to compare and establish HSPF land covers. Table 1 shows a correlation between the GIS land cover and HSPF model land use types.

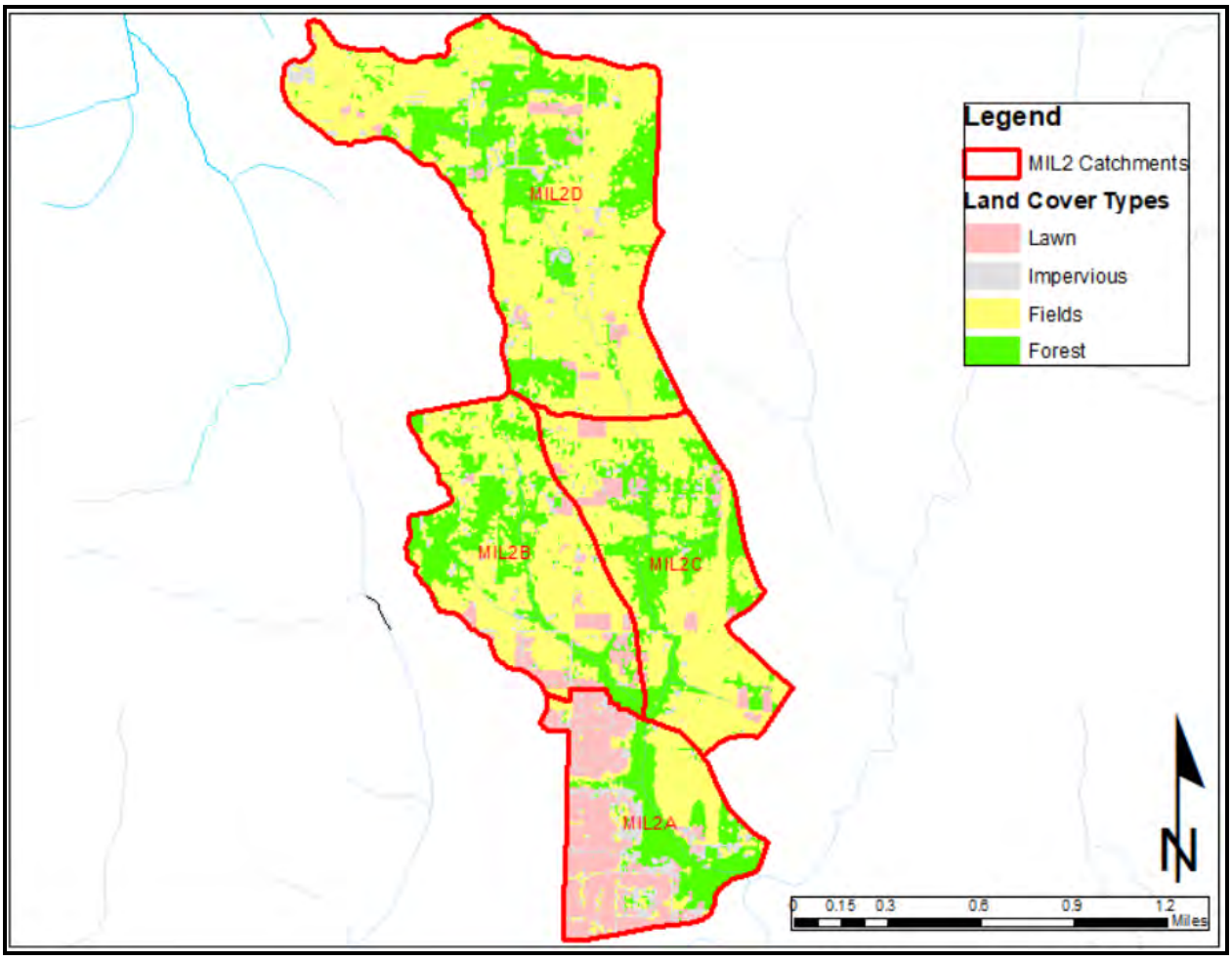
Table 1: GIS Land Covers and HSPF Land Use Types

GIS Land Cover	HSPF Model Land Use
Grass/Lawns	Lawns
Agricultural land, pastures	Field
Trees	Forest
Buildings/structures	Impervious
Paved surfaces (concrete, asphalt, etc.)	Impervious

Existing Conditions Land Cover

Clark County GIS has 6-inch orthophoto taken during summer 2020. Existing land cover detail was created by digitizing 2020 orthophoto. The digitized land cover information was obtained from GIS as ArcGIS shape files. Figure 3 shows the land cover for the existing conditions.

Figure 3: MIL2 Land Cover Details (2020 Conditions)



Future (Full Build-out) Land Cover Based on Zoning

Full build-out land cover was prepared using county's zoning land uses. Zoning land use was preferred over the Comprehensive Plan based on the recommendation from staff in the Clark County Community Planning Department. The assumption is that full build-out land cover will most likely follow zoning in county code. It was also assumed that mapped critical areas such as riparian habitats and wetlands will continue to stay as they are today. The undeveloped critical area land cover was taken from the 2020 orthophoto. Zoning land uses were used to prepare future land cover for the remaining areas. Figure 4 shows the land cover detail for the critical areas based on 2020 orthophoto and Figure 5 shows zoning land uses for the non-critical areas within MIL2 sub-basin.

Impervious area percentages for most of the zoning types were established using projects reviewed by Clark County Development Engineering Section from the multiple development review projects approved over recent years. For the zoning types with unavailable or insufficient

data, book values from the past projects were used. Table 2 shows the land cover breakdowns for each zoning types within the MIL2 sub-basin.

Figure 4: MIL2 Critical Areas Land Cover Map

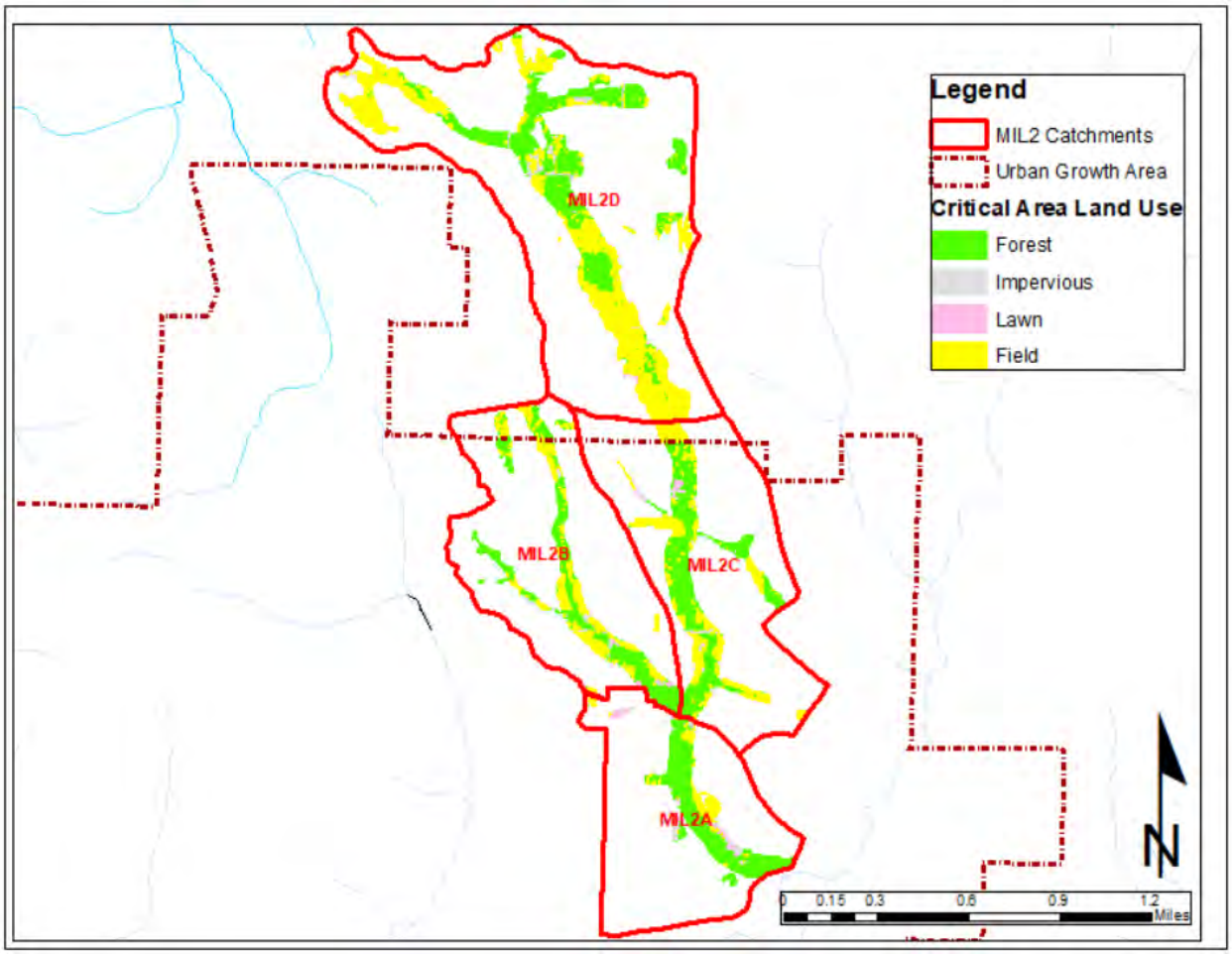


Figure 5: MIL2 Zoning Types (Non-Critical Areas) Map

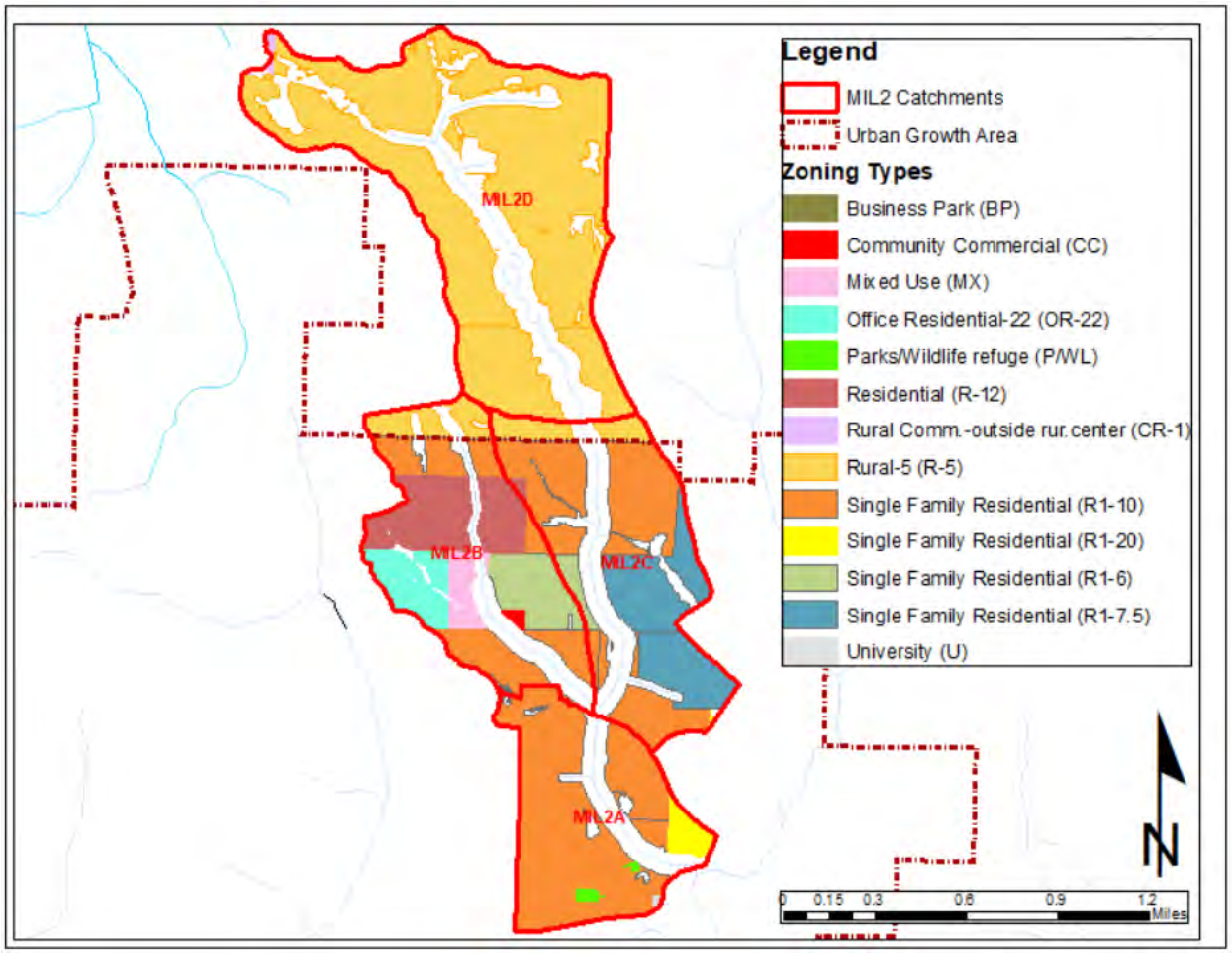


Table 2: MIL2 Zoning Land Use Types and HSPF Land Cover Percentages

Description	Zoning Abbreviation	EIA %	Forest %	Pasture %	Lawn %
Urban Low Density Res	R1-6	63	0	0	37
Urban Low Density Res	R1-7.5	49	0	0	51
Urban Low Density Res	R1-10	45	0	0	55
Urban Low Density Res	R1-20	23	0	0	77
Medium Density Res	R-12	65	0	0	35
Office Residential	OR-22	67	0	0	33
Community Commercial	CC	85	0	0	15
Business Park	BP	85	0	0	15
Public Facility/University	PF/U	39	0	0	61
Rural 5	R-5	6	0	75	19
Park, Wildlife Refuge	P/WL	18	21	21	40
Rural Commercial	CR-1	85	0	0	15
Mixed Use	MX	65	0	0	35

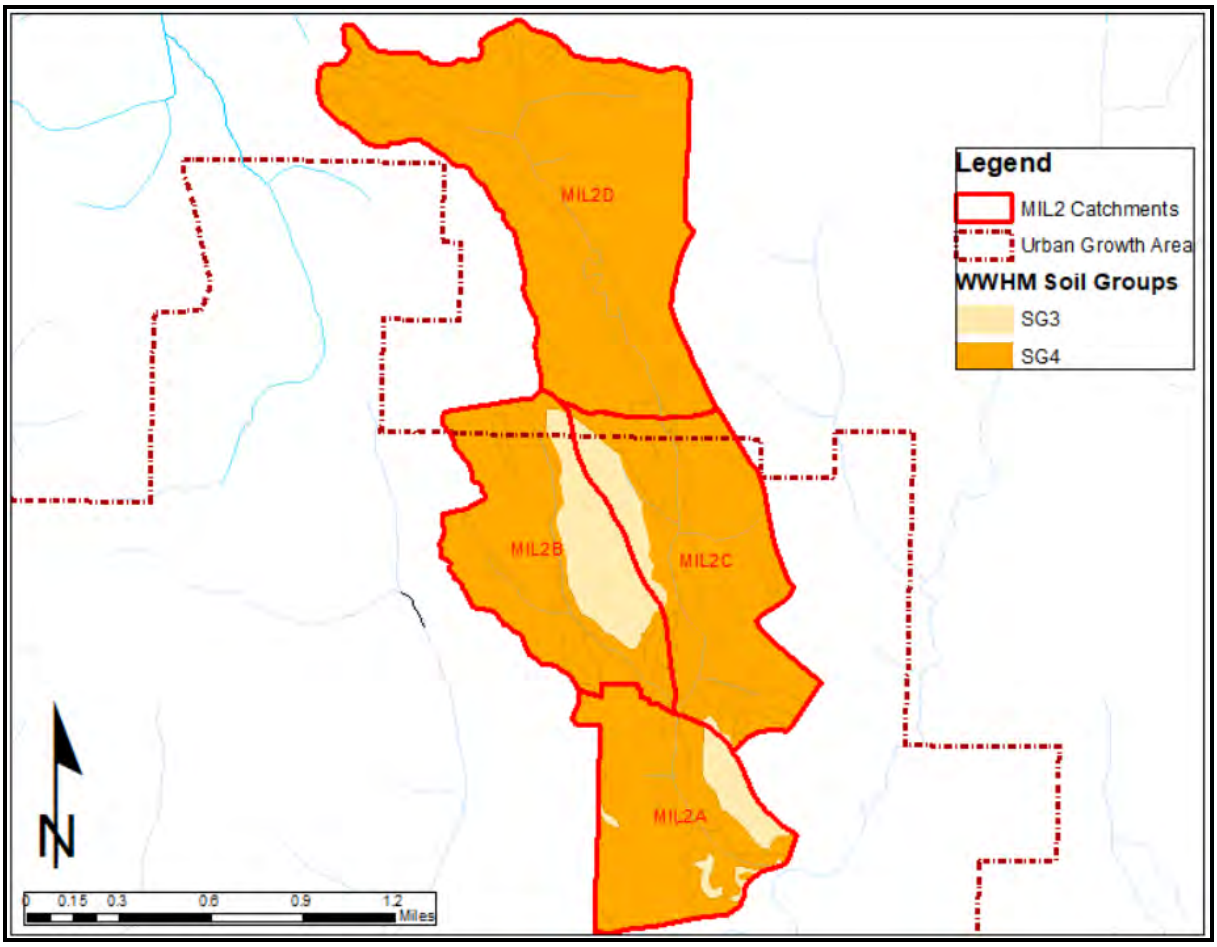
Soil Data

Mapped soils are one of the key features in model development. Clark County PERLNDs use soil maps as a surrogate for hydrogeologic setting. Clark County soils are classified into five different groups based on soil characteristics from a hydrologic model perspective. The Clark County Soil Groups Map was prepared by Otak in 2010. The various NRCS soil types available within Clark County were grouped together primarily based on their permeability capabilities. The soil groups range from Group 1 (SG1) with high infiltration rates to Group 4 (SG4) with low to almost no infiltration. Soil Group 5 is wetland muck soil.

The five soil groups in Clark County are:
1. SG1: Excessively Drained soils (hydrologic soil groups A & B)
2. SG2: Well Drained Soils (hydrologic soil group B)
3. SG3: Moderately Drained soils (hydrologic soil groups B & C)
4. SG4: Poorly Drained soils (slowly infiltrating C soils, as well as D soils)
5. SG5: Wetlands soils (mucks)

Figure 6 shows the soil groups distribution within MIL2 catchment. The predominant soil type within the MIL2 catchment is SG4, which is characterized by a very low permeability. SG1, SG2 and SG5 are not present in the study area.

Figure 6: MIL2 Soil Groups Map



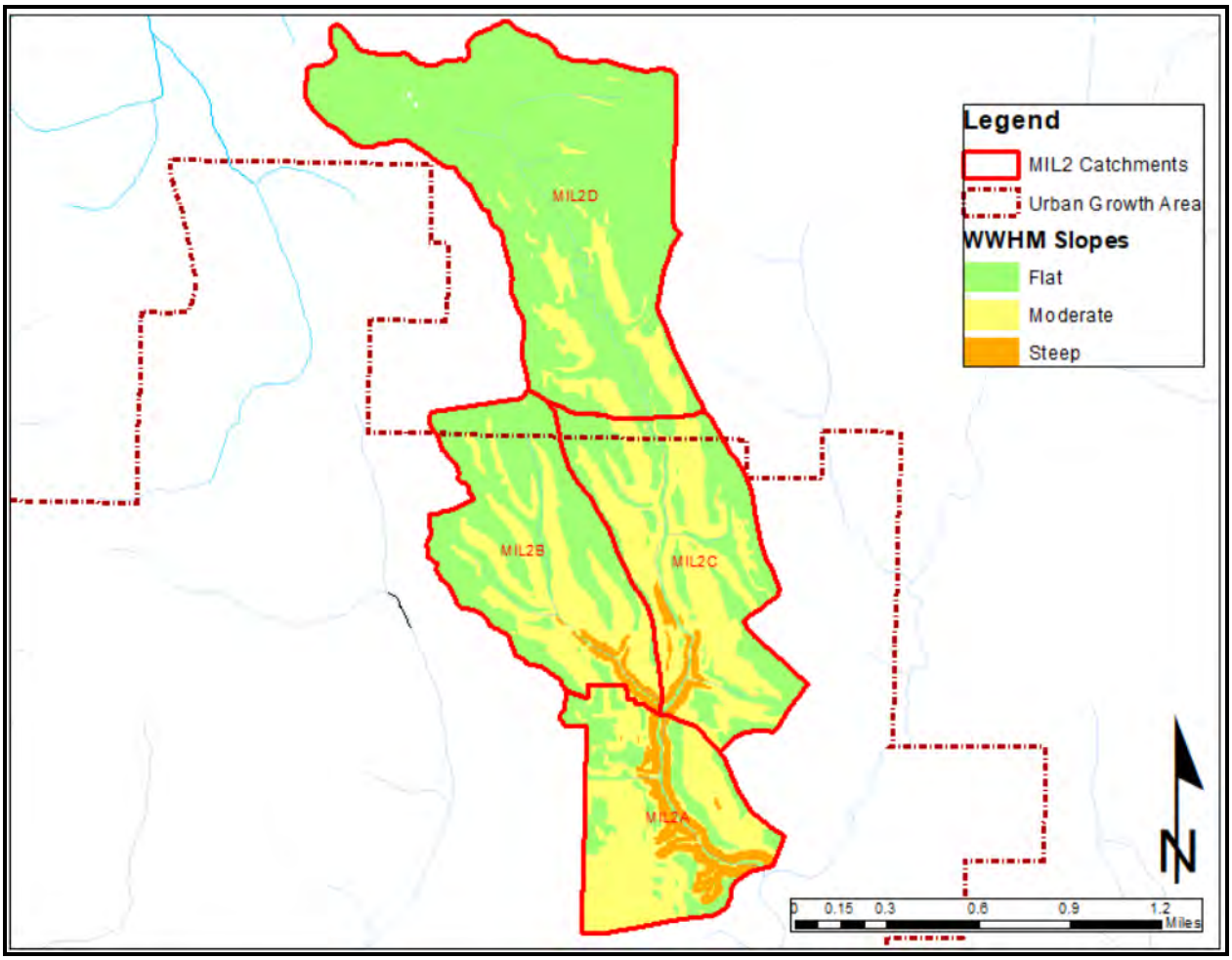
Slope Data

The slope data for the MIL2 sub-basin was derived from recently acquired (2019) LiDAR-derived contour data. For WWHM modeling, slope data are grouped into three different categories:

Flat: slopes ranging from 0 percent to 5 percent
Moderate: slopes ranging from 5 percent to 15 percent
Steep: slopes greater than 15 percent

The distribution of these slope categories within MIL2 sub-basin is shown in Figure 7.

Figure 7: MIL2 Slopes Map



HSPF Parameters

There are two slightly different Mill Creek models. One is the original model calibrated by Clear Creek Solutions and the other is in the Clark County version of the WWHM2012 that includes some parameters averaged from the Gee Creek model.

Clark County has decided to use the original Mill Creek HSPF parameters values for both the existing and future conditions models. The original Mill Creek HSPF calibrated parameters values were determined by Clear Creek Solutions in 2009 as part of a study done as a subconsultant to Otak, Inc. These values are different from those published in the WWHM2012 model, which are regionalized based on two calibrated models. The following Mill Creek calibrated HSPF parameter values are different from the published WWHM2012 values:

- LZSN: Lower Zone Storage Nominal
- INFILT: Infiltration Index
- AGWRC: Active Groundwater Recession Constant
- DEEPFR: Deep Fraction of Groundwater
- UZSN: Upper Zone Storage Nominal

- INTFW: Interflow Index

The values for all these parameters are shown in Table 3. The values that are different are in bold letter.

Table 3: HSPF Parameters (WWHM2012 vs Mill Creek Calibration)

Hydrologic Land Cover Types		HSPF Parameters					
		LZSN	INFILT	AGWRC	DEEPFR	UZSN	INTFW
SG3 Forest Flat	WWHM2012 values	9.00	0.08	0.96	0.00	1.00	4.00
	Mill Creek values	9.00	0.08	**0.86**	**0.50**	**1.30**	4.00
SG3 Forest Mod	WWHM2012 values	9.00	0.08	0.96	0.00	1.00	4.00
	Mill Creek values	9.00	0.08	**0.86**	**0.50**	**1.30**	4.00
SG3 Forest Steep	WWHM2012 values	9.00	0.08	0.96	0.00	1.00	4.00
	Mill Creek values	9.00	0.08	**0.86**	**0.50**	**1.30**	4.00
SG3 Field Flat	WWHM2012 values	9.00	0.06	0.96	0.00	1.00	4.00
	Mill Creek values	9.00	0.06	**0.86**	**0.50**	**1.30**	4.00
SG3 Field Mod	WWHM2012 values	9.00	0.06	0.96	0.00	1.00	4.00
	Mill Creek values	9.00	0.06	**0.86**	**0.50**	**1.30**	4.00
SG3 Field Steep	WWHM2012 values	9.00	0.06	0.96	0.00	1.00	4.00
	Mill Creek values	9.00	0.06	**0.86**	**0.50**	**1.30**	4.00
SG3 Lawn Flat	WWHM2012 values	9.00	0.05	0.96	0.00	0.80	4.00
	Mill Creek values	9.00	0.05	**0.86**	**0.50**	**1.10**	4.00
SG3 Lawn Mod	WWHM2012 values	9.00	0.05	0.96	0.00	0.80	4.00
	Mill Creek values	9.00	0.05	**0.86**	**0.50**	**1.10**	4.00
SG3 Lawn Steep	WWHM2012 values	9.00	0.05	0.96	0.00	0.80	4.00
	Mill Creek values	9.00	0.05	**0.86**	**0.50**	**1.10**	4.00
SG4 Forest Flat	WWHM2012 values	6.00	0.04	0.96	0.00	0.40	2.00
	Mill Creek values	**8.00**	**0.06**	**0.86**	**0.50**	**1.20**	**5.00**
SG4 Forest Mod	WWHM2012 values	6.00	0.04	0.96	0.00	0.40	2.00
	Mill Creek values	**8.00**	**0.06**	**0.86**	**0.50**	**1.20**	**5.00**
SG4 Forest Steep	WWHM2012 values	6.00	0.04	0.96	0.00	0.40	2.00
	Mill Creek values	**8.00**	**0.06**	**0.86**	**0.50**	**1.20**	**5.00**
SG4 Field Flat	WWHM2012 values	6.00	0.03	0.96	0.00	0.40	2.00
	Mill Creek values	**8.00**	**0.04**	**0.86**	**0.50**	**1.20**	**5.00**
SG4 Field Mod	WWHM2012 values	6.00	0.03	0.96	0.00	0.40	2.00
	Mill Creek values	**8.00**	**0.04**	**0.86**	**0.50**	**1.20**	**5.00**
SG4 Field Steep	WWHM2012 values	6.00	0.03	0.96	0.00	0.40	2.00
	Mill Creek values	**8.00**	**0.04**	**0.86**	**0.50**	**1.20**	**5.00**
SG4 Lawn Flat	WWHM2012 values	6.00	0.02	0.96	0.00	0.20	2.00
	Mill Creek values	**8.00**	**0.03**	**0.86**	**0.50**	**1.00**	**5.00**
SG4 Lawn Mod	WWHM2012 values	6.00	0.02	0.96	0.00	0.20	2.00
	Mill Creek values	**8.00**	**0.03**	**0.86**	**0.50**	**1.00**	**5.00**
SG4 Lawn Steep	WWHM2012 values	6.00	0.02	0.96	0.00	0.20	2.00
	Mill Creek values	**8.00**	**0.03**	**0.86**	**0.50**	**1.00**	**5.00**

Sub-basins/Reaches

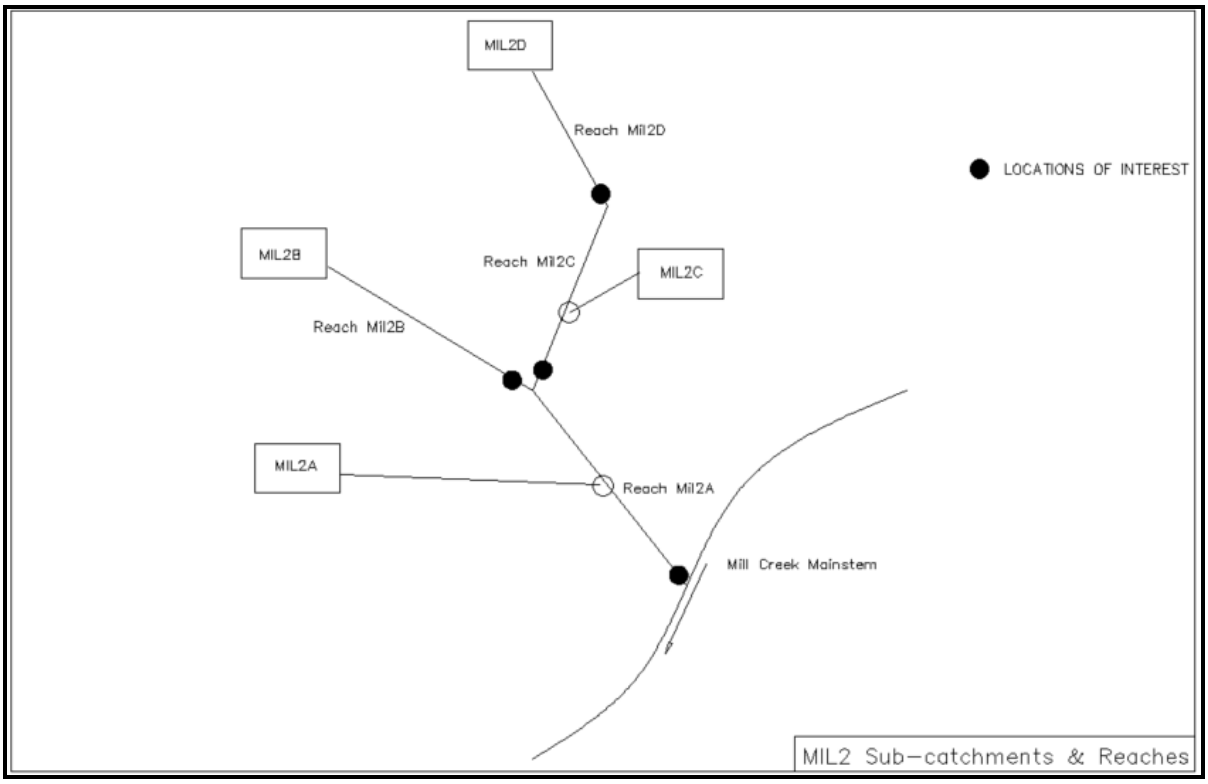
MIL2 catchment was divided into four sub-catchments based on topography, hydrologic control points, locations of interest for model results, and a fair representation of stream reaches. In the original Mill Creek HSPF model, MIL2 had three sub-catchments. To make this model, sub-catchment MIL2C was split into two, by creating MIL2D as the fourth sub-catchment. MIL2D is primarily rural and completely outside the Urban Growth Area where urban development will occur during the next twenty years. It is anticipated that MIL2D will remain rural for the foreseeable future, while the other three sub-catchments will continue to develop.

The downstream end of each modeled reach was designated as a location of interest (LOI) and assigned a point of compliance (POC) number in the hydrology model. Table 4 and Figure 8 show the sub-catchments within the MIL2 sub-basin and corresponding reaches.

Table 4: MIL2 Sub-catchments and Reaches

Sub-catchments	Area (acres)	Stream Reach	LOI/POC#
MIL2D	543.73	Reach MIL2D	4
MIL2C	306.62	Reach MIL2C	3
MIL2B	291.98	Reach MIL2B	2
MIL2A	236.36	Reach MIL2A	1

Figure 8: MIL2 Sub-catchments and Reaches



Flow Routing

Hydraulic routing of stormwater runoff through stream channels is performed by the HSPF model using Ftables (hydraulic function tables). Ftables are input tables that define the stage-storage-discharge relationship for a given stream reach. These tables account for flow attenuation and stream routing processes within the HSPF model (Otak Inc., 2009). Since there are no existing HEC-RAS or any other hydraulic models available for MIL2 tributary of Mill Creek, Ftables information from a previous HSPF model (West Consultant 2008, Otak 2009) were used in this study.

In order to address anticipated increase in discharges, Ftables were extended for reaches MIL2A and MIL2C using the flow rating (stage-discharge) curves and existing stage-storage data. Since the discharge in reach MIL2D is controlled by a culvert located under 193rd Circle, the stage-discharge curve was created by using Federal Highway Administration's culvert analysis program HY-8 and the existing stage-storage data was used to manually extend the FTable.

Closed Depressions

The MIL2 study area is comprised of rolling terrain along the southern part while the northern part is flat. There are no significant closed depressions to model.

Effective Impervious Area

For modeling purpose, it was assumed that the effective impervious area (EIA) is equal to the total impervious area (TIA). In other words, it was assumed that all the impervious areas within the sub-basin are hydraulically connected to the stream reaches.

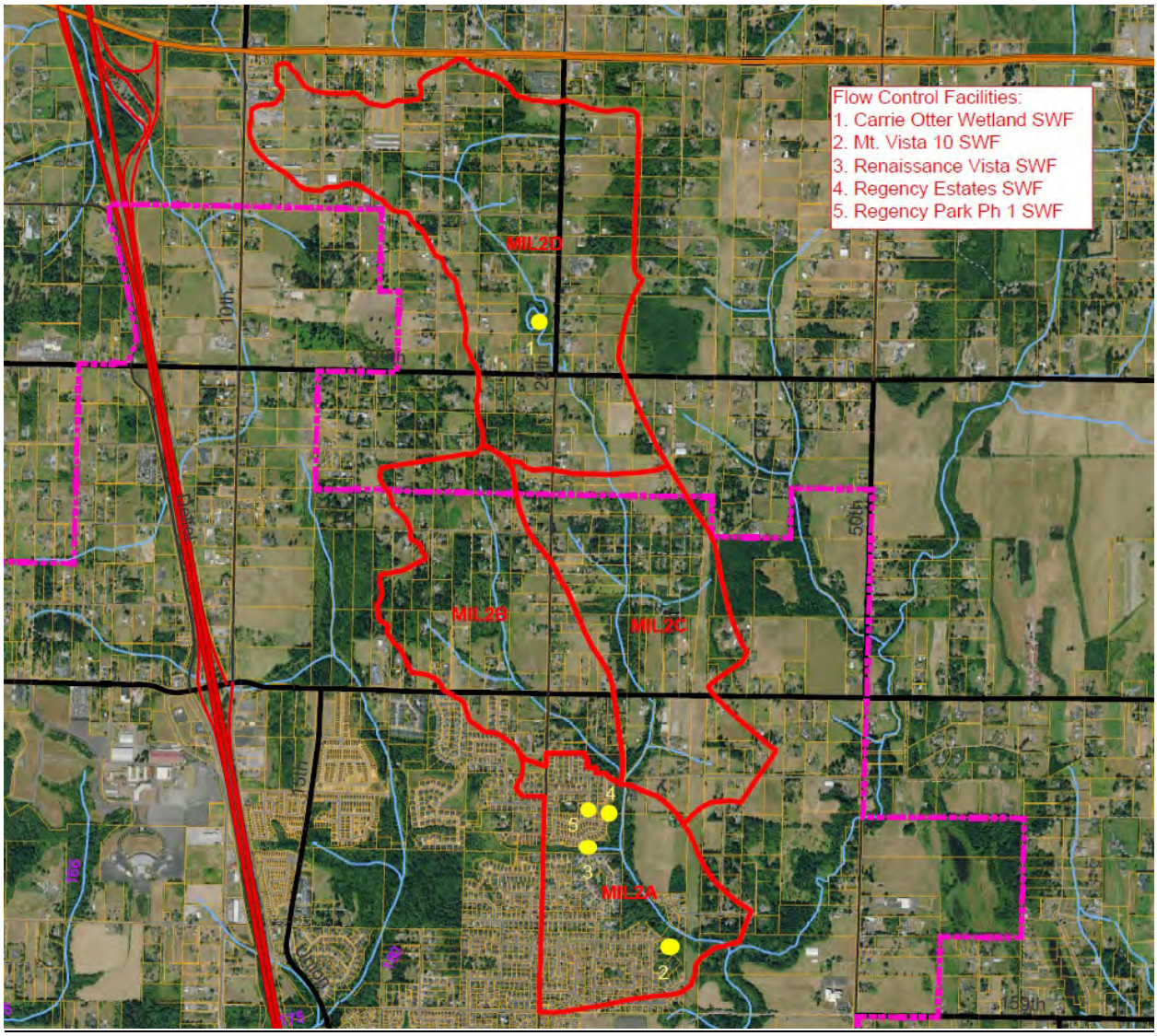
Existing Stormwater Facilities

There are a dozen stormwater facilities within MIL2 sub-basin, almost all are located in MIL2A. Out of these stormwater facilities, five significant stormwater control facilities were included in the existing conditions hydrology model. Pond hydraulics tables (SSD Tables, which are the same as HSPF Ftables) were developed for each stormwater facility using the available information in as-built drawings and/or Technical Information Reports (TIRs) submitted with the project engineering review report. The SSD tables were input in the model to represent the stormwater facilities. The flow control facilities are shown in Table 5 below. Figure 9 shows the locations of these stormwater control facilities.

Table 5: MIL2 Existing Stormwater Flow Control Facilities

Stormwater Facility Name	Drainage Area (acres)	Sub-catchment
Carrie Otter SWF	347.99	MIL2D
Mt. Vista 10 SWF	53.59	MIL2A
Renaissance Vista SWF	11.51	MIL2A
Regency Estates SWF	17.49	MIL2A
Regency Park Ph 1 SWF	9.39	MIL2A

Figure 9: Locations of Stormwater Flow Control Facilities



Weather (Precipitation/Evaporation) Data

The WWHM-SWMM software is pre-loaded with 60 years (October 1948 to September 2008) of precipitation and evaporation data.

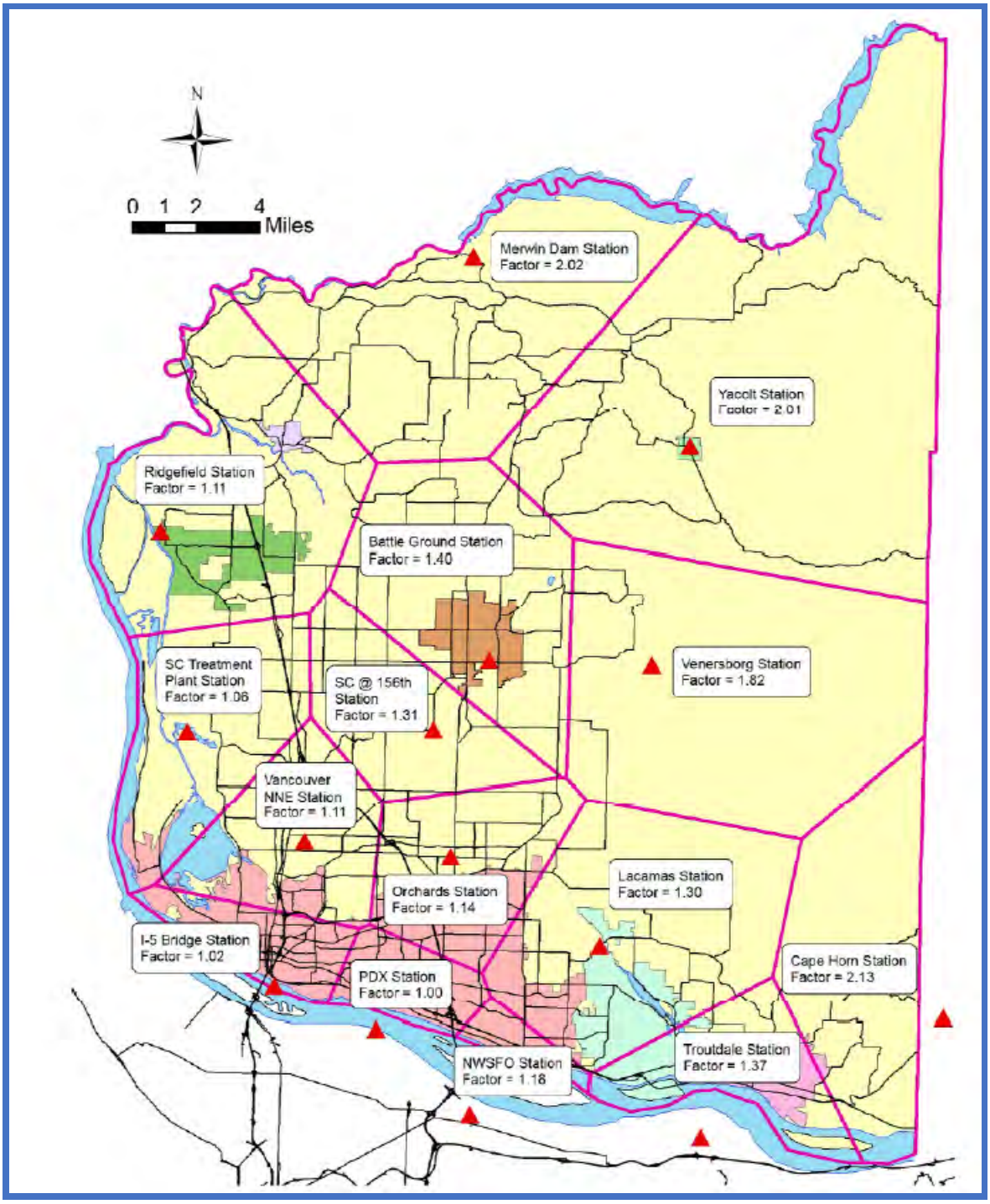
The Clark County version of the WWHM that is incorporated into the WWHM-SWMM uses long-term pan evaporation data from the Oregon State University Aurora weather station in Aurora, Oregon, just south of the Portland Metropolitan Area.

The standard version of the WWHM uses hourly precipitation data from the weather station at the Portland International Airport (PDX) as the default precipitation time series data for Clark County. This precipitation data spans a period beginning in October 1948 and ending in

September 1999. The Clark County version of the WWHM incorporates this same hourly precipitation data, and supplements with nine years of additional hourly precipitation data recorded at PDX from October 1999 to September 2008.

The WWHM-SWMM uses precipitation data recorded at Clark County rain gage stations to produce precipitation scaling factors that account for spatial variations in precipitation quantities. The scaling factors are applied to PDX precipitation data to appropriately scale the data based on geographic locations within the county. The WWHM incorporates these scaling factors and assigns the appropriate factor based on the development project location. For MIL2 sub-catchment, the WWHM uses precipitation scaling factor of 1.31 based on Salmon Creek @ 156th St. rain gage station. The rain gage stations are shown in Figure 10 along with the corresponding Thiessen polygons and the precipitation scaling factors.

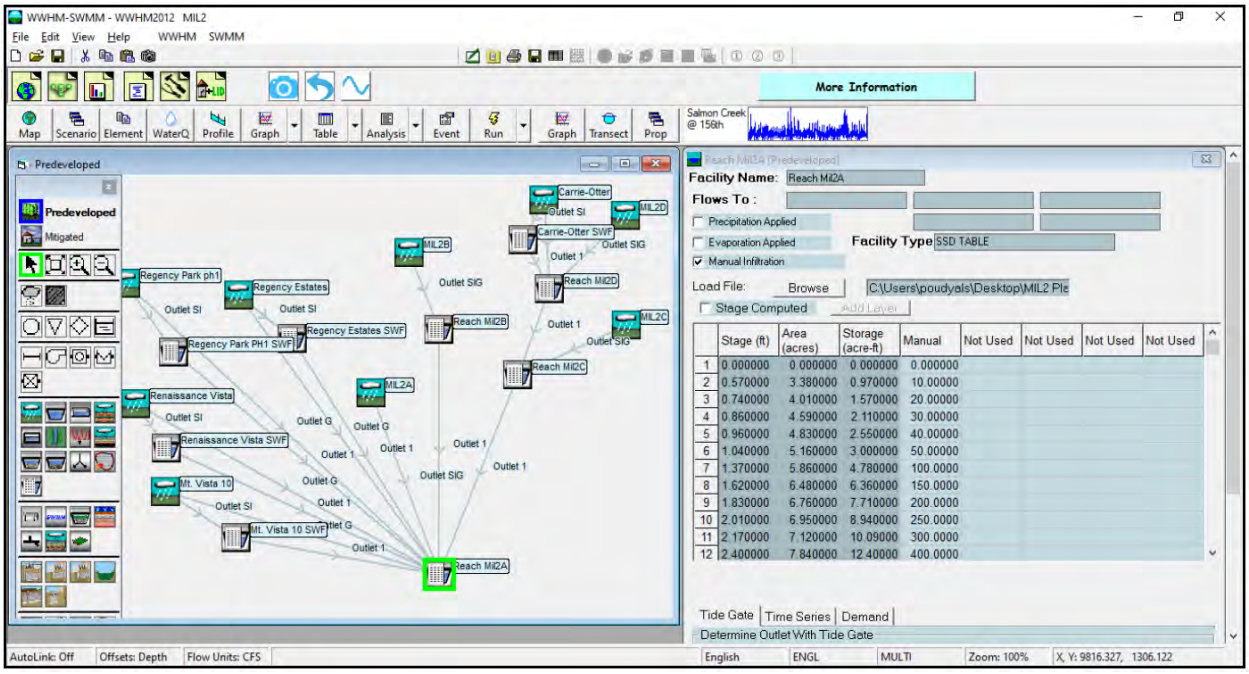
Figure 10: Clark County Rain Gage Stations and the Precipitations Scaling Factors (Otak, 2010)



EXISTING CONDITIONS MODEL

The MIL2 existing conditions hydrology model includes four sub-catchments that are labeled from downstream to upstream as MIL2A, MIL2B, MIL2C, and MIL2D. In addition to the four sub-catchments, five significant stormwater control facilities as previously mentioned were also included in the model. The drainage area for the stormwater control facilities were separated from the drainage areas that drain directly to the sub-catchment stream channel. Surface runoff and interflow from the stormwater control facilities' drainage areas were directed to the stormwater control facility; groundwater was connected directly to the sub-catchment stream channel. The downstream end of each sub-catchment stream channel was designated as a location of interest (LOI) and was assigned a point of compliance (POC) number. Figure 11 shows a schematic of the WWHM-SWMM MIL2 existing conditions hydrology model.

Figure 11: WWHM-SWMM MIL2 Existing Conditions Hydrology Model Schematic



MODEL VALIDATION

The MIL2 model simulated streamflow results were compared with estimated streamflow data for water year 2021 at the downstream end of MIL2 sub-basin. The comparison of model results with estimated data were used to validate the WWHM-SWMM model of MIL2.

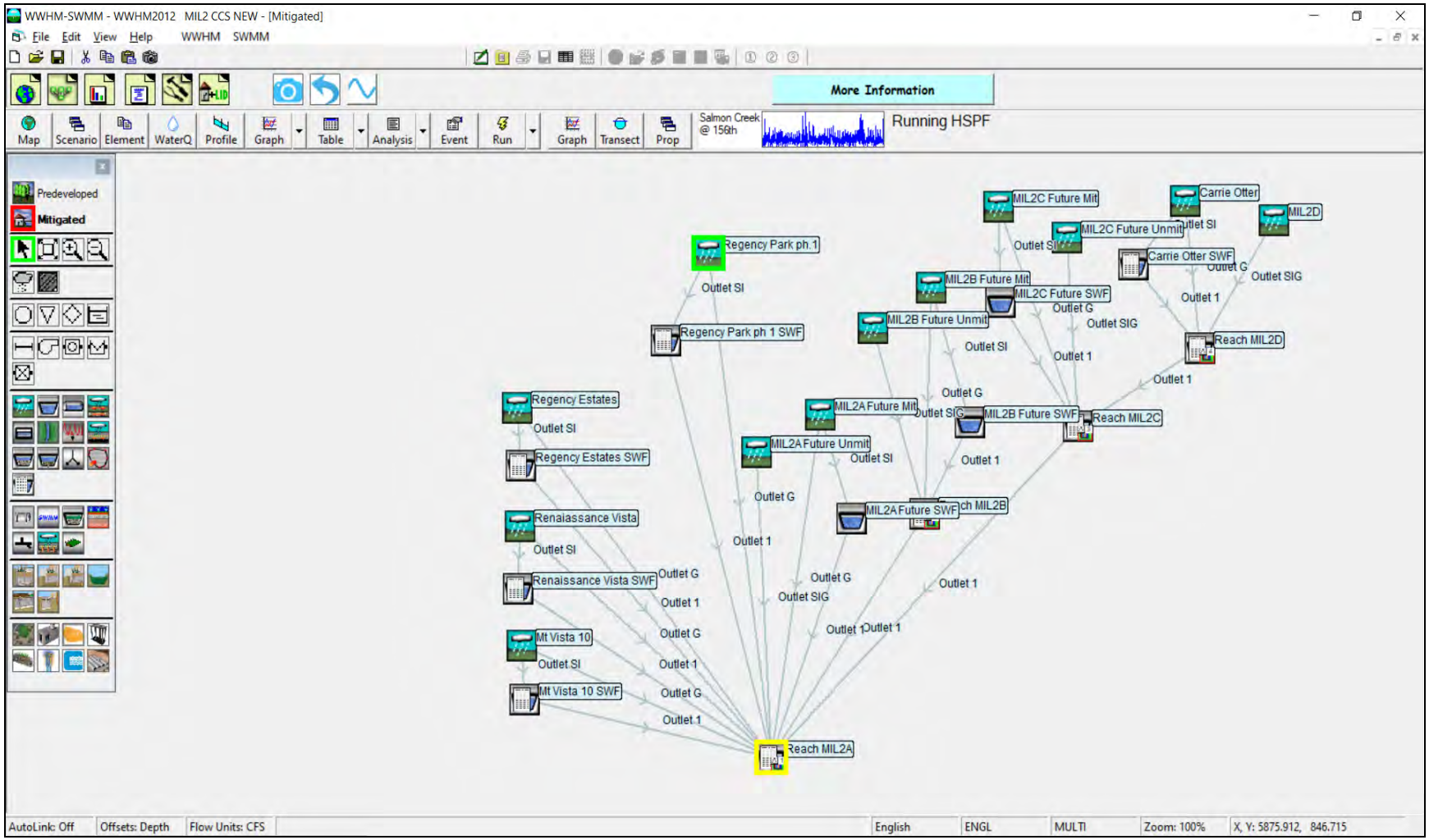
The validation showed a good match between the simulated and observed flows in the low flow ranges up to about ½ 2-Year flows, above that flow, the rating curve was unreliable. The detailed description of the validation process and results are presented in the Clear Creek Solutions Tech Memo included in Appendix B.

FULL BUILD-OUT CONDITIONS MODEL

The MIL2 future full build-out hydrology model was prepared by Clear Creek Solutions (Appendix C) using the existing conditions model info and the full build-out land cover details. In addition to the five existing stormwater control facilities included in the existing conditions model, three future stormwater control facilities were added in the model. The three future stormwater control facilities were sized to represent the potential facilities constructed to mitigate the impacts of build out land use changes in MIL2A, MIL2B, and MIL2C. These facilities were designed to meet Clark County Stormwater Manual detention facility standards under MR #7.

A single stormwater pond was sized to mitigate the land use changes in each of sub-catchments MIL2A, MIL2B, and MIL2C. In sub-catchment MIL2A, the land use changes were assumed to occur outside of the drainage areas to the four existing stormwater facilities and in the portion of the sub-catchment that is currently undeveloped. Future stormwater ponds were sized using the auto-sizing feature in WWHM2012. The predevelopment land cover for the build out stormwater facilities is from the Mill Creek alternative flow control standard, which is 2002 land cover with impervious mapped as pasture/field. As with the existing stormwater control facilities, the surface runoff and interflow from the future stormwater pond's drainage areas were directed to the stormwater control facility and the groundwater was connected directly to the corresponding stream channel. There was no future stormwater control facility added to MIL2D because there is no expected increase in impervious area within this sub-catchment. However, there is a reduction in forest and a corresponding increase in field and lawn within MIL2D sub-catchment based on the use of book values for build out land cover, which is expected to result in a small but measurable increase in total streamflow from the sub-catchment. Figure 12 shows a schematic of the WWHM-SWMM MIL2 future build-out hydrology model.

Figure 12: WWHM-SWMM MIL2 Future Full Build-Out Hydrology Model Schematic



MODEL RESULTS

Both the existing conditions and the future conditions scenarios were run for the full simulation period at a 15-minute time step. The simulation period was for the period of October 1948 through September 2008 (water years 1949-2008).

Water Balance

The average annual water balance for each hydrologic land type was computed by the model (Table 6). The water balance includes average annual precipitation (inches) for the simulation period, evaporation (or actual evapotranspiration), surface runoff, interflow (shallow subsurface runoff), active groundwater (groundwater to the stream), total runoff, and inactive groundwater. The total runoff is the sum of surface runoff, interflow, and active groundwater. The inactive groundwater goes to deep groundwater leaving the basin and doesn't contribute to streamflow. Active and inactive groundwater are equal because the DEEPFR parameter is set to 0.5.

Table 6: MIL2 Average Annual Water Balance (inches)

Hydrologic Land Type	Precipitation	Evapo-transpiration	Surface Runoff	Interflow	Active GW	Total Runoff	Inactive GW
SG3 Forest Flat	48.017	28.772	0.110	6.674	6.268	13.052	6.268
SG3 Forest Moderate	48.017	28.772	0.127	6.661	6.266	13.054	6.266
SG3 Forest Steep	48.017	28.771	0.139	6.651	6.265	13.055	6.265
SG3 Field Flat	48.017	26.045	0.197	9.325	6.242	15.764	6.242
SG3 Field Moderate	48.017	26.044	0.236	9.293	6.239	15.768	6.239
SG3 Field Steep	48.017	26.042	0.255	9.284	6.235	15.774	6.235
SG3 Lawn Flat	48.017	22.239	0.384	12.815	6.276	19.475	6.276
SG3 Lawn Moderate	48.017	22.238	0.465	12.747	6.271	19.483	6.271
SG3 Lawn Steep	48.017	22.237	0.520	12.701	6.257	19.478	6.257
SG4 Forest Flat	48.017	27.778	0.153	9.311	5.423	14.887	5.423
SG4 Forest Moderate	48.017	27.777	0.182	9.287	5.421	14.890	5.421
SG4 Forest Steep	48.017	27.777	0.202	9.271	5.419	14.892	5.419
SG4 Field Flat	48.017	25.459	0.342	12.307	4.977	17.626	4.977
SG4 Field Moderate	48.017	25.457	0.413	12.248	4.972	17.633	4.972
SG4 Field Steep	48.017	25.455	0.461	12.208	4.969	17.638	4.969
SG4 Lawn Flat	48.017	22.052	0.769	15.988	4.601	21.358	4.601
SG4 Lawn Moderate	48.017	22.049	0.913	15.865	4.592	21.370	4.592
SG4 Lawn Steep	48.017	22.046	1.008	15.784	4.586	21.378	4.586
Impervious Flat	48.017	8.097	39.919	0.000	0.000	39.919	0.000
Impervious Moderate	48.017	7.516	40.503	0.000	0.000	40.503	0.000
Impervious Steep	48.017	6.395	41.622	0.000	0.000	41.622	0.000

The annual water balance table demonstrates that evapotranspiration and soil infiltration decrease with increased urbanization while the surface runoff increases.

The major sources of runoff in the MIL2 drainage area are obtained by using the information in Table 6 and the contributing area of each hydrologic land type. Table 7 shows the average surface runoff, interflow, and active groundwater runoff by hydrologic land type for existing conditions. Table 8 shows the same information for future full build-out conditions.

Table 7: MIL2 Existing Weighted Average Annual Runoff by Runoff Component

Hydrologic Land Type	Existing Total (ac)	Surface Runoff (in)	Interflow (in)	Active GW (in)	Existing Total Runoff (in)
SG3 Forest Flat	22.63	0.002	0.110	0.103	0.214
SG3 Forest Moderate	21.77	0.002	0.105	0.099	0.206
SG3 Forest Steep	3.08	0.000	0.015	0.014	0.029
SG3 Field Flat	30.78	0.004	0.208	0.139	0.352
SG3 Field Moderate	44.44	0.008	0.300	0.201	0.508
SG3 Field Steep	0.05	0.000	0.000	0.000	0.001
SG3 Lawn Flat	4.77	0.001	0.044	0.022	0.067
SG3 Lawn Moderate	6.59	0.002	0.061	0.030	0.093
SG3 Lawn Steep	0.01	0.000	0.000	0.000	0.000
SG4 Forest Flat	**326.27**	**0.036**	**2.203**	**1.283**	**3.523**
SG4 Forest Moderate	170.50	0.023	1.148	0.670	1.841
SG4 Forest Steep	42.86	0.006	0.288	0.168	0.463
SG4 Field Flat	**320.62**	**0.080**	**2.862**	**1.157**	**4.099**
SG4 Field Moderate	142.32	0.043	1.264	0.513	1.820
SG4 Field Steep	2.87	0.001	0.025	0.010	0.037
SG4 Lawn Flat	27.90	0.016	0.324	0.093	0.432
SG4 Lawn Moderate	46.98	0.031	0.541	0.156	0.728
SG4 Lawn Steep	0.63	0.000	0.007	0.002	0.010
Impervious Flat	91.54	2.650	0.000	0.000	2.650
Impervious Moderate	70.84	2.081	0.000	0.000	2.081
Impervious Steep	1.25	0.038	0.000	0.000	0.038
Total Area	**1378.70**	**5.024**	**9.506**	**4.663**	**19.194**
Percent of Total		**26%**	**50%**	**24%**	**100%**

For the existing conditions, 26% of the total annual runoff is from surface runoff (primarily impervious surfaces), 50% is from interflow (shallow subsurface runoff from pervious areas), and 24% from active groundwater (in the form of base flow). The largest single sources of total runoff are SG4 Field Flat (4.10 inches of total runoff per year) and SG4 Forest Flat (3.52 inches

per year) – both shown in **bold** in the table. Both SG4 Forest Flat and SG4 Field Flat produce mostly interflow (shallow subsurface runoff) and active groundwater (base flow); they generate very little surface runoff.

Table 8: MIL2 Future Weighted Average Annual Runoff by Runoff Component

Hydrologic Land Type	Future Total (ac)	Surface Runoff (in)	Interflow (in)	Active GW (in)	Future Total Runoff (in)
SG3 Forest Flat	1.09	0.000	0.005	0.005	0.010
SG3 Forest Moderate	0.87	0.000	0.004	0.004	0.008
SG3 Forest Steep	1.17	0.000	0.006	0.005	0.011
SG3 Field Flat	4.73	0.001	0.032	0.021	0.054
SG3 Field Moderate	2.18	0.000	0.015	0.010	0.025
SG3 Field Steep	0.00	0.000	0.000	0.000	0.000
SG3 Lawn Flat	28.20	0.008	0.262	0.128	0.398
SG3 Lawn Moderate	35.79	0.012	0.331	0.163	0.506
SG3 Lawn Steep	1.11	0.000	0.010	0.005	0.016
SG4 Forest Flat	99.13	0.011	0.669	0.390	1.070
SG4 Forest Moderate	52.32	0.007	0.352	0.206	0.565
SG4 Forest Steep	34.26	0.005	0.230	0.135	0.370
SG4 Field Flat	332.16	0.082	2.965	1.199	4.247
SG4 Field Moderate	75.53	0.023	0.671	0.272	0.966
SG4 Field Steep	1.51	0.001	0.013	0.005	0.019
SG4 Lawn Flat	176.81	0.099	2.050	0.590	2.739
SG4 Lawn Moderate	155.11	0.103	1.785	0.517	2.404
SG4 Lawn Steep	6.33	0.005	0.072	0.021	0.098
Impervious Flat	**182.39**	**5.281**	**0.000**	**0.000**	**5.281**
Impervious Moderate	**181.61**	**5.335**	**0.000**	**0.000**	**5.335**
Impervious Steep	6.37	0.192	0.000	0.000	0.192
Total Area	1378.69	11.165	9.475	3.677	24.316
Percent of Total Runoff		**46%**	**39%**	**15%**	**100%**
Change from Existing		**6.141**	**-0.032**	**-0.986**	**5.122**
Change from Existing		**122%**	**-0.3%**	**-21%**	**27%**

For the future full build-out conditions, 46% of the total annual runoff is from surface runoff (primarily impervious surfaces), 39% is from interflow (shallow subsurface runoff from pervious areas), and 15% from groundwater (in the form of base flow). The largest single sources of total runoff are Impervious Moderate (5.34 inches of total runoff per year) and Impervious Flat (5.28 inches per year) – both shown in **bold** in the table. Both Impervious Flat and Impervious

Moderate produce only surface runoff, which in turn increase peak stream flows and potential flooding.

Because of the increase in impervious surfaces (primarily roads and roofs) surface runoff increases from 5.0 inches per year to 11.2 inches per year. Runoff more than doubles with an increase of 122%. Interflow slightly decreases (-0.3%). Active groundwater/base flow decreases by 21%. Total runoff will increase by 27%.

Future stormwater control facilities will mitigate some of the effects of this increase in surface runoff but, as discussed below, flood frequency values will increase for the more frequent flood events (2-year, 5-year, and 10-year flood events).

Flow Frequency

Flow frequency analysis looks at the peak flow rates that have various chances of occurring in a given year. Flow frequency was computed for the 2-, 5-, 10-, 25-, 50-, and 100-year flood events from the annual peak flows at the downstream end of each of the four WWHM-SWMM stream reaches. The existing and future flood frequency results for various reaches are shown in tables 9 and 10.

Table 9: Existing Conditions Flood Frequency (cfs)

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Table 10: Future Full Build-Out Conditions Flood Frequency (cfs)

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	87.75	122.24	148.57	186.08	217.28	251.43
MIL2B	25.59	35.30	42.81	53.62	62.70	72.71
MIL2C	42.13	59.44	72.51	90.97	106.19	122.73
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Peak flows increased with full build out of the basin as expected. The largest percent change in the flood frequency values occurred in the smaller flood events (2-year, 5-year, and for MIL2C and MIL2D the 10-year event). As described above in the water balance results discussion, there

was an increase in total average annual runoff from existing to future full build-out conditions because of the increase in impervious areas and the increase in surface runoff.

The flow frequency results were calculated using the Log Pearson Type III methodology included in WWHM2012. Log Pearson Type III uses the log of the annual peak values to compute mean, standard deviation, and skew. An increase in annual peak flows in the 2- to 5-year frequency range can change the standard deviation and skew and decrease the computed 100-year peak flow value. That was observed in the MIL2A, MIL2B, and MIL2C 100-year results when comparing the future and existing values.

Flow Duration

Flow duration analysis looks at how often a given flow rate will be met or exceeded in a stream reach. Flow durations for flows in the range of one-half of the 2-year flow to the 50-year existing conditions flow were computed for the flows in the four subbasins. This is the standard used by the Department of Ecology to evaluate stormwater impacts (permit Appendix 1, Minimum Requirement #7). The results are expressed as the total number of 15-minute time steps in the entire simulation period a specific flow level would exceed.

The results showed that at the downstream end of all four subbasins, flows in the erosive range of 50% of 2-year flow to the 50-year flow increase. The higher flows are due to an increase in total amount of runoff from new impervious surfaces. While MR #7 controls flows from ½ 2-year to the 50-year predevelopment rate, flows beneath ½-2- year do not match predevelopment flow, resulting in an increase flow in the stream.

The results were also looked at the low flow range (zero to 10 cfs). In MIL2A, low flows below 1 cfs slightly decreased in the number of occurrences for the future full build-out condition compared to existing conditions. Flows above 1 cfs increased in terms of how often they occurred. In MIL2B, low flows below 0.5 cfs slightly decreased in the number of occurrences for the future full build-out condition compared to existing conditions. Flows above 0.5 cfs increased in terms of how often they occurred. In MIL2C and MIL2D, there was no decrease in low flows. In the subbasins where there is a decrease in the lowest of the low flows (less than 1 cfs) with the future full build-out condition, the decrease is due to loss of forest and field acreage.

More details on the full build-out model results are included in the tech memo in Appendix C.

Full Build-out Hydrologic Modeling Conclusion

The full build-out hydrologic modeling of the MIL2 basin shows that future development in the basin is likely to increase stream flows. Based on the model results, the increases in peak flows and flow durations are most evident in the stream reaches MIL2A, MIL2B, and MIL2C.

This modeling suggests that further study should be made to assess whether the use of the low flow control threshold of ½-2-year is protective of channel stability or if changes in flow control standards should be examined.

MODELING THE SRATEGY SCENARIOS

This section describes several scenarios to model hypothetical strategies to reduce the duration of erosive flow due to build out.

The WWHM-SWMM modeling was run for various strategy scenarios that were identified as the potential mitigation measures to address the effect of hydrologic changes in the watershed as a result of future developments. The results of all the scenario models were compared against the existing conditions as well as the full build-out hydrology model results. MIL2D was excluded in this exercise as this sub-basin is not anticipated to have any significant land cover changes.

Six different strategy scenarios were modeled, and these scenarios are briefly discussed below. Details on each scenario model, including all the assumptions and results are included in the Clear Creek Solutions tech memo in Appendix D.

Model Scenario 1: Permeable Pavement

The purpose of this model scenario is to test the effectiveness of permeable pavement towards addressing the hydrologic changes in the watershed. All the future impervious surfaces (roofs excluded) with land slopes less than or equal to 5% were modeled as permeable pavement. Soil infiltration rate was assumed to be 0.15 inches per hour and 0.25 inches per hour in two separate model runs (1A and 1B) under this scenario.

Model Scenario 2: Bioretention

This scenario is intended to test the effectiveness of bioretention in addressing the effect of hydrologic changes. All the future impervious surfaces (roofs excluded) and landscape (lawn) areas with land slope less than or equal to 15% were routed to bioretention facility. Soil infiltration rate was assumed to be 0.15 inches per hour and 0.25 inches per hour in two separate model runs (2A and 2B) under this scenario. Each bioretention facility was sized to meet Minimum Requirement#6 (Water Quality) by filtering at least 91% of the total runoff volume entering the facility.

Model Scenario 3: Infiltration Ponds

This scenario is a test of effectiveness of infiltration ponds in addressing the hydrology changes due to the future developments. An Infiltration component was added to the future stormwater detention ponds in the full build-out model. No additional ponds were added. Side infiltration

was allowed for ponds with 3:1 or shallower side slopes. Soil infiltration rate was assumed to be 0.15 inches per hour and 0.25 inches per hour in two separate model runs (3A and 3B) under this scenario.

Model Scenario 4: Increase Detention Pond Size/Flow Control Standards

Scenario 4 tests different detention pond sizing standards to control flows to the degree needed to match existing conditions model flows. The following three separate sub-scenarios were run under this:

Run 4A: The lower threshold flow duration standard for sizing the subbasin detention ponds was lowered from 50% of the 2-year peak flow to the LID Performance Standard threshold of 8% of the 2-year peak flow. The subbasin detention ponds were then resized using the new flow control standard of 8% of Q2 to Q50. Native soil infiltration rate of 0.15 inches per hour was used in the model. The bioretention facilities sized in scenario 2 were also included in this model run.

Run 4B: The lower threshold flow duration standard for sizing the subbasin detention ponds was maintained at the current standard of 50% of the 2-year peak flow (0.50Q2). The predevelopment subbasin drainage area to each pond was assumed to be forested instead of the current standard of existing land use. The subbasin detention ponds were then resized using the new forest predevelopment standard runoff, but without routing through the downstream bioretention facility. Used a native soil infiltration rate of 0.15 inches per hour. The bioretention facilities sized in scenario 2 were also included in this model run.

Run 4C: Run 4C was identical to Run 4B with the use of forest vegetation as the standard for calculating predevelopment standard runoff but with the addition of the routing through the upstream bioretention facilities (originally sized in Run 2) and the addition of the infiltration assumptions in Run 3 to size the Run 4C subbasin detention ponds. Used a native soil infiltration rate of 0.15 inches per hour.

Model Scenario 5: Dead Storage as Leaky Wet Ponds

The purpose of scenario 5 is to test the effectiveness of dead storage in the bottom of the subbasin detention ponds. Dead storage was added to the detention ponds sized under full build-out model to allow them to act as leaky wet ponds. Soil infiltration rates of 0.15 inches per hour and 0.25 inches per hour were used in two separate model runs (5A and 5B) under this scenario.

Model Scenario 6: Various Strategies Combined

Under this scenario, various previous strategies were combined based on their effectiveness as seen in the corresponding model results. The following two sub-scenarios were run under this.

Run 6A: This was a combination of strategies that included bioretention (Run 2A), infiltration ponds (Run 3A), and a lower flow duration standard (similar but not identical to Run 4A). The

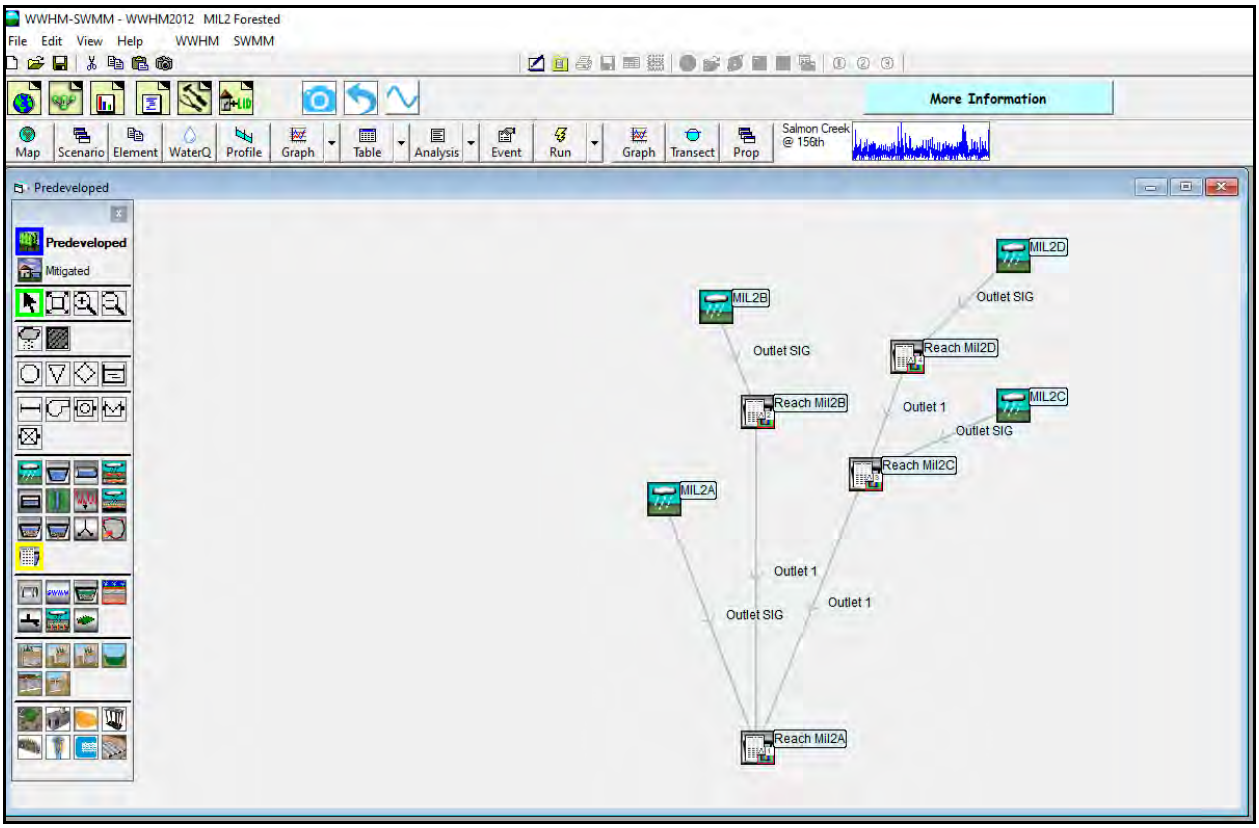
lower flow duration threshold was lowered to 15% of the 2-year peak flow (0.15Q2). Native soil infiltration rate of 0.15 inches per hour was used.

Run 6B: This was a combination of strategies that included bioretention (Run 2A), infiltration ponds (Run 3A), and a lower flow duration standard (similar but not identical to Run 4A). The lower flow duration threshold was lowered to 30% of the 2-year peak flow (0.30Q2). Native soil infiltration rate of 0.15 inches per hour was used.

FORESTED CONDITIONS MODEL

Beside the existing condition and full build-out hydrology model, an additional model scenario was also run for a fully forested condition. The purpose of the forest conditions model was to be used for calculating several flow metrics and provide an alternative baseline to existing conditions. The forested conditions model was developed from the existing conditions model by changing all the land cover types to forested land cover and eliminating the existing stormwater facilities from it.

Figure 13: WWHM-SWMM MIL2 Forested Conditions Hydrology Model Schematic



FLOW METRICS COMPUTATION

This section presents and discusses the comparison of various metrics between the three modeled scenarios (i.e., forested conditions, existing conditions, and full build-out conditions). The daily average flows derived as the WWHM-SWMM model output were used to compute various metrics outside of the model. The results of the following metrics were compared and analyzed:

Minimum Flow Metrics

- 7-day Annual Minimum Flow – Minimum mean flow rate over a 7-day period for each water year
- 30 Annual Minimum Flows – Average of 30 lowest flows for each water year

Flashiness Metrics

- TQ_{mean} – Fraction of the time in each water year that the daily time-step hydrograph exceeds annual mean daily discharge for the same water year

Stream Stability Metrics

- Q10: Q2 Ratio – Ratio of a 10-year return period discharge in a forested condition to a 2-year return period discharge in an existing or future land use conditions

Pulse Metrics

- High Pulse Count (HPC) – Number of times that the daily time-step hydrograph pulses above the high-flow threshold for each water year, threshold set at twice (2 times) the mean daily flow rate over the full period of record

The computed values of various metrics were averaged for the period of record (i.e., 60 years). The period of record spans from water year 1949 to water year 2008. Table 11 shows the calculated Q10:Q2 ratio for three different modeled scenarios. Stream channels are generally considered stable when this ratio is greater than one, and unstable when less than one. The results of the calculated Q10:Q2 ratio suggests a fairly stable stream reaches for all the modeled scenarios. The results of the other averaged flow metrics at the downstream end of the MIL2 basin (Reach MIL2A) are presented in Table 12 and also in graphical format (Figure 14 through 17).

The metric TQ_{mean} was found to be insensitive to the land cover changes in the watershed, while high pulse count (HPC) results show the increasing level of instability (flashiness) in the stream with the increases in impervious land covers. The graphs for the low flow metrics suggest very low summer base flows within the MIL2 stream reaches for all three modeled scenarios. Downstream end of reach MIL2A has a year-round flow, however these numbers functionally approach zero and are not significant.

Table 11: Q10:Q2 Ratio for MIL2 Reaches

	Q10 (Forested) cfs	Existing Conditions		Full Build-out Conditions	
		Q2 (cfs)	Q10:Q2 Ratio	Q2 (cfs)	Q10:Q2 Ratio
MIL2A	100.76	70.08	1.4	87.75	1.2
MIL2B	28.00	17.02	1.7	25.59	1.1
MIL2C	57.62	31.17	1.9	42.13	1.4
MIL2D	33.63	18.38	1.8	20.1	1.7

Table 12: MIL2A Flow Metrics Comparison (Averaged over 60 years)

Metrics	Modeled Scenarios		
	Forested	Existing Conditions	Full Build-out
7-Day Average Minimum Discharge (cfs)	0.000642	0.001162	0.001244
Averaged 30 Minimum Daily Discharges (cfs)	0.002242	0.004162	0.005716
TQ_{mean} (%)	25	26	26
High Pulse Count	9	14	19

Figure 14: 7-Day Average Minimum Discharge Comparison

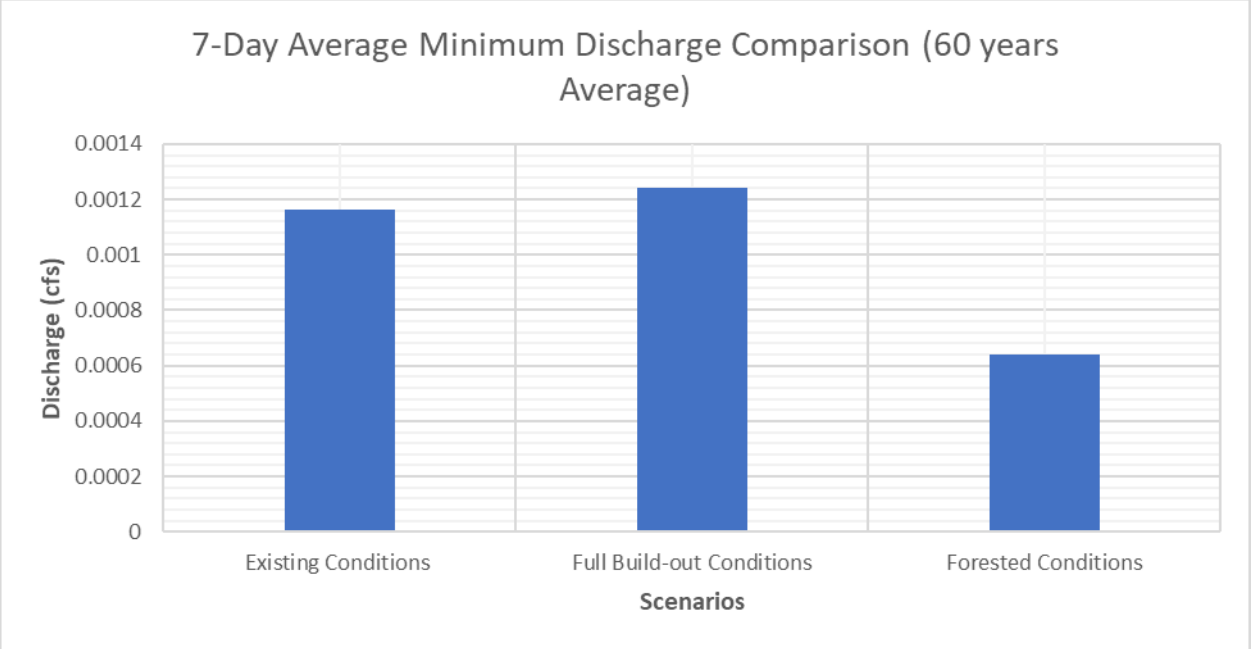


Figure 15: Averaged 30 Minimum Daily Discharges Comparison

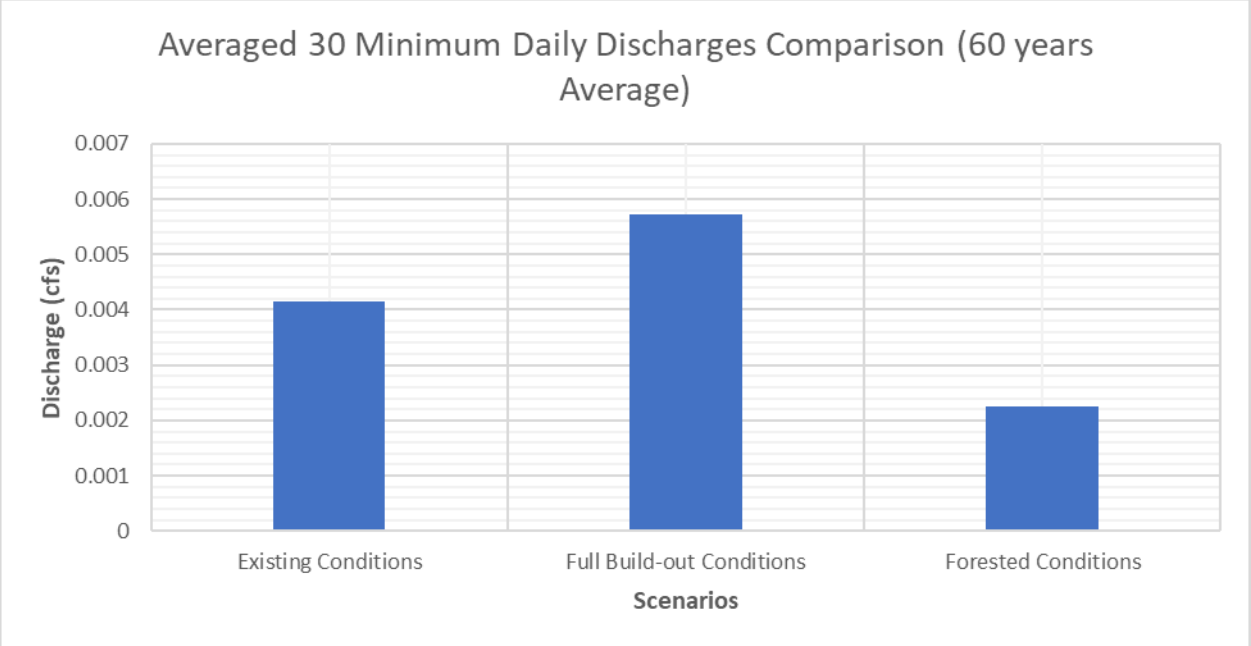


Figure 16: TQmean Comparison

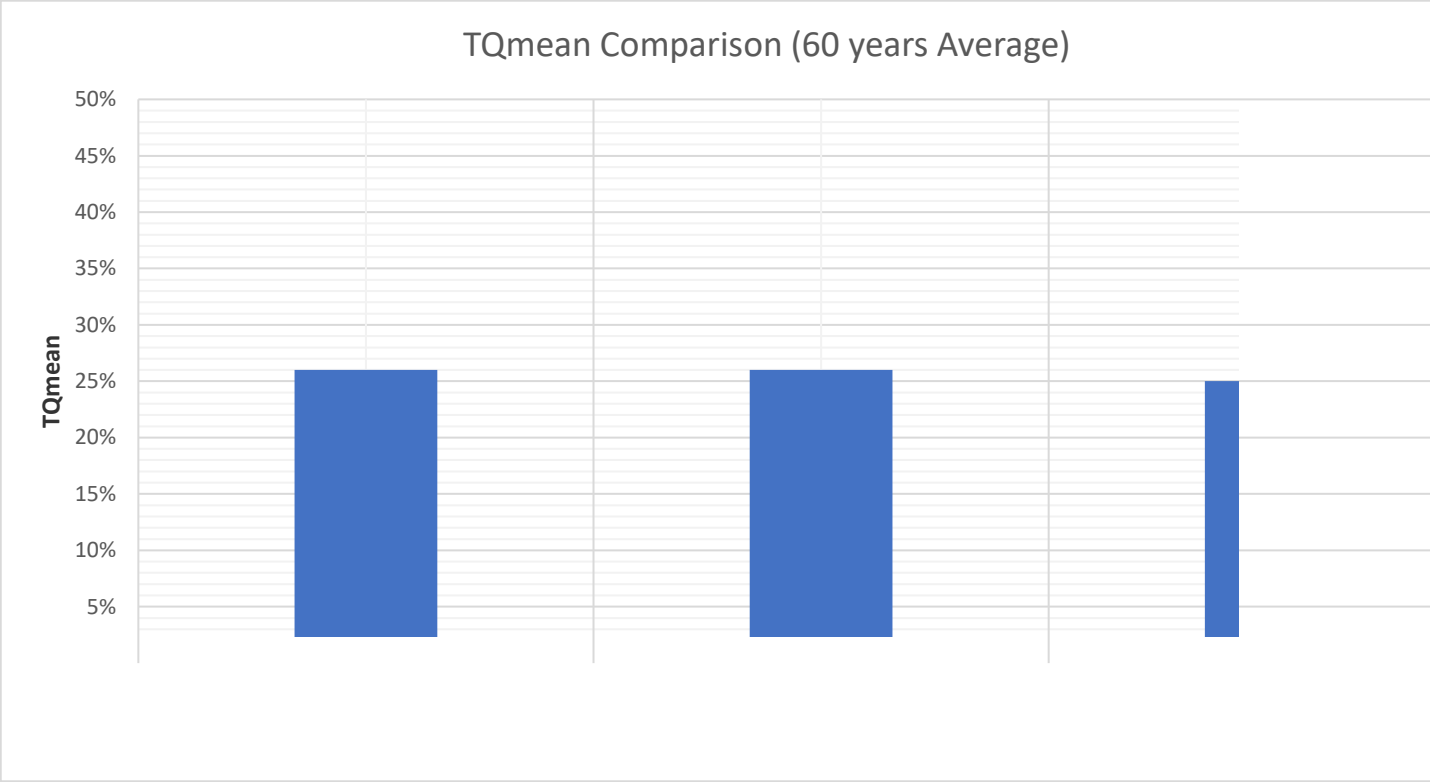
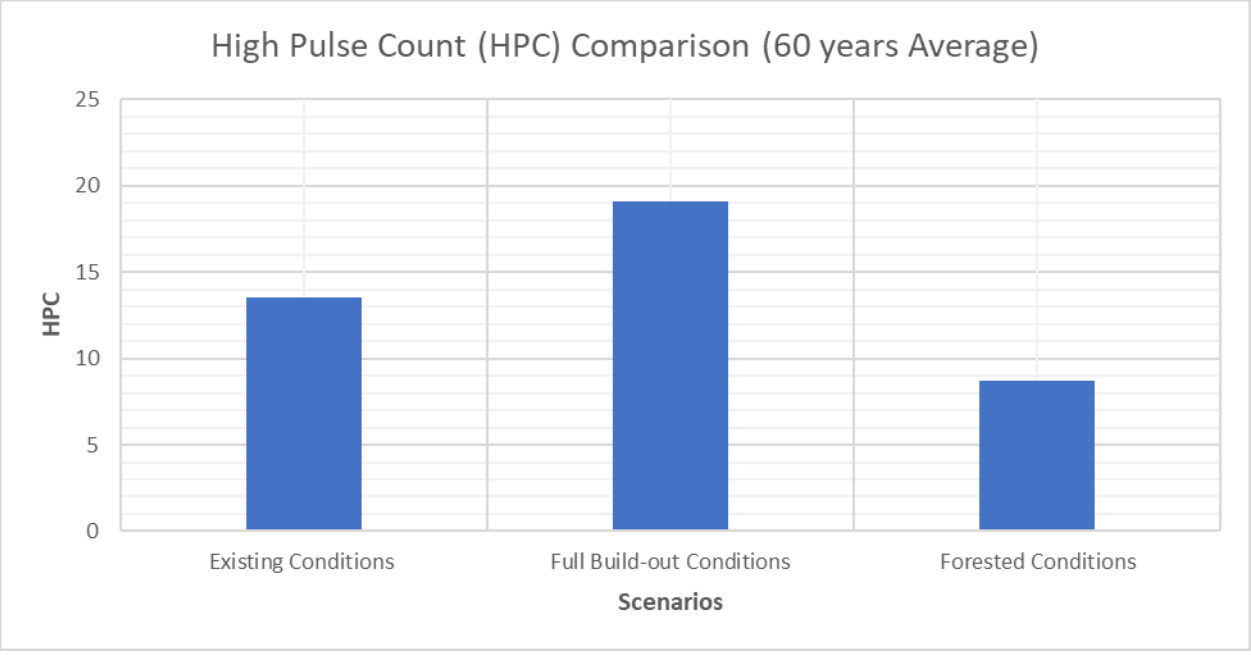


Figure 17: High Pulse Count (HPC) Comparison



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Clark County

Mill Creek Tributary Catchment-Scale Stormwater Planning

Appendix B
Model Validation Memo

Prepared by

Doug Beyerlein, P.E.
Clear Creek Solutions, Inc.

Dec. 2021

CLEAR CREEK SOLUTIONS, INC.

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MEMO

DATE: 29 December 2021

TO: Rod Swanson, Program Manager II, Clark County Public Works

CC: Subhash Poudyal, P.E., Stormwater Engineer, Clark County Public Works
Joe Brascher, President, Clear Creek Solutions, Inc.

FROM: Doug Beyerlein, PE

SUBJECT: MIL2 Task 6 Model Validation UPDATED

The purpose of this memo is to compare MIL2 model simulated streamflow results with estimated streamflow data for water year 2021 (October 2020 through September 2021) at the downstream end of the MIL2 watershed (at MIL2A). The comparison of model results with estimated data can be used to validate the WWHM-SWMM model of MIL2 or identify possible model problems that need further examination. This memo updates my prior memo on this subject dated 7 December 2021.

Clark County provided rainfall and streamflow data for MIL2 for water year 2021. The rainfall data was provided on 10/18/21 in file "LDR010_15-min_precip_WY2021.csv". The streamflow data was originally provided on 11/9/21 and then later updated on 11/29/21. The updated streamflow file is "Discharge.SQ@MIL2.EntireRecord.csv". The data from both of these files were added to the WWHM-SWMM MIL2 model.

The WWHM-SWMM MIL2 model was run for the period of 1 October 2020 through 30 September 2021 (water year 2021). The simulated and estimated flow hydrographs are shown in Figure 1 (entire water year) and Figure 2 (December-March).

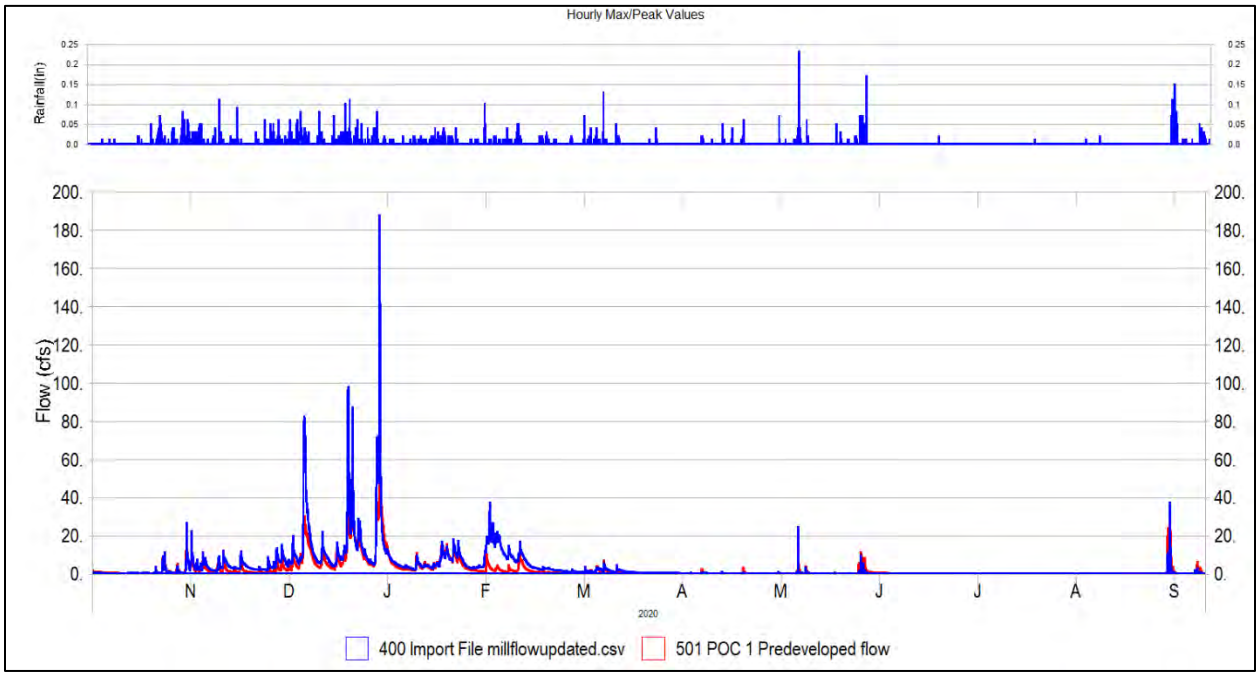

Figure 1. MIL2 Simulated and Estimated Streamflow (Water Year 2021)

The estimated hourly streamflow is in blue; the simulated streamflow is in red. The hourly rainfall is above in blue.

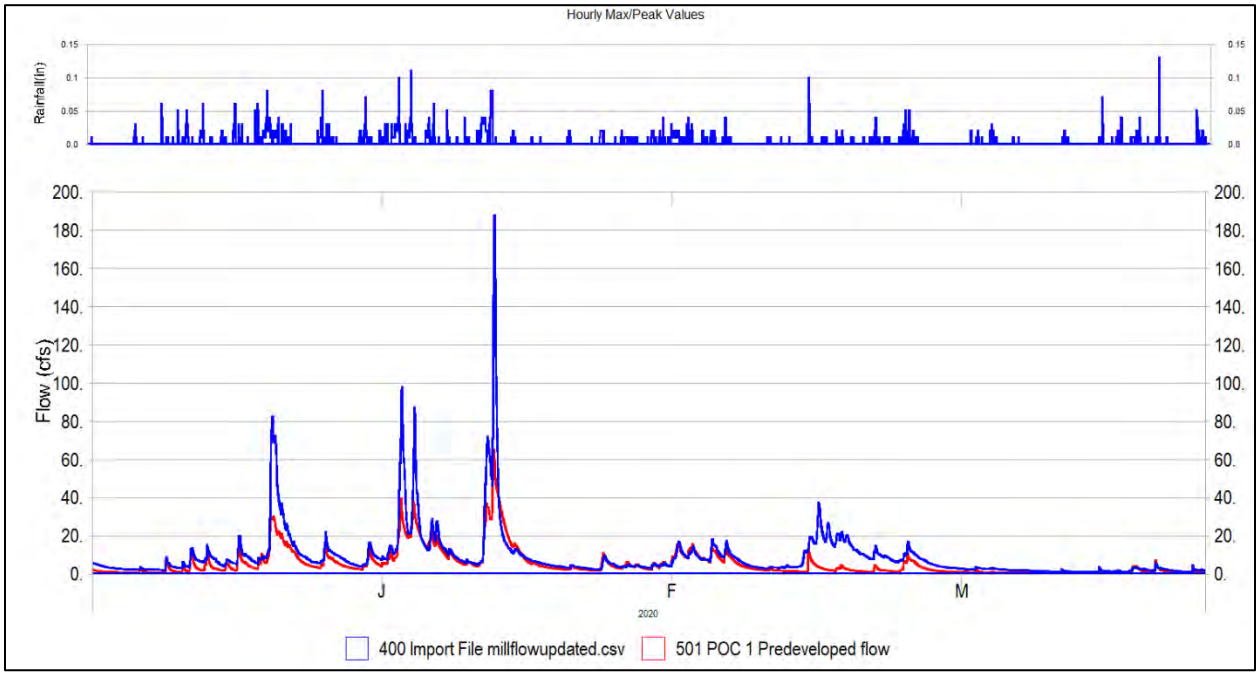

Figure 2. MIL2 Simulated and Estimated Streamflow (Dec 2020 through Mar 2021)

The estimated hourly streamflow is in blue; the simulated streamflow is in red. The hourly rainfall is above in blue.

As shown in both figures, the estimated peak flows are consistently higher than the simulated peak flows. Visually comparing the peak flows with the rainfall data that produced them it is difficult to understand why the recorded peaks are so large in the winter of 2020-2021. There are three possible reasons: (1) It is possible that the rainfall data at the gage site does not accurately represent the rainfall over the entire MIL2 drainage area. (2) The estimated peak flows are over estimated. Or (3) that the simulated peak flows are low and do not accurately represent the hydrology of the MIL2 watershed.

Rainfall Data

The MIL2 rainfall data (LDR010) were compared with the nearby Salmon Creek Treatment Plant rain gage. As shown in Table 1, the MIL2 monthly rainfall totals are greater than the Salmon Creek gage monthly totals. This is expected (due to the rain shadow effect from the Portland Hills at the Salmon Creek gage site) and demonstrates that the rainfall data at the LDR1010 gage site does accurately represent the rainfall over the entire MIL2 drainage area.

Table 1. Monthly Rainfall Comparison

Year	Month	LDR010	SCTP
2020	Oct	2.63	1.50
2020	Nov	9.72	5.29
2020	Dec	8.51	5.32
2021	Jan	11.21	7.26
2021	Feb	5.15	3.81
2021	Mar	2.49	1.23
2021	Apr	0.69	0.43
2021	May	2.23	1.51
2021	Jun	2.74	2.08
2021	Jul	0.04	0.00
2021	Aug	0.10	0.02
2021	Sep	5.11	3.65
WY2021	Total	50.62	32.10

Estimated Peak Flows

The estimated peak flows may be over estimated. Jeffery Budnick of River Measurement, who supplied the estimated streamflow data to Clark County, stated in his email of 11/9/21:

Since the rating is developed from modeling (and is not calibrated), I have grade it as estimated, with the lower to middle section estimated as Fair and the upper section of the curve estimated as Poor. A few other notes about grades:

- 20 – estimated fair, most of the rating curve
- 10 – estimated poor, upper end of the rating curve
- 5 – estimated no confidence, MIL2 data severely crossing MIL008
- 1 – unverified, basically suspect data. I think the peaks are too high compared to MIL008, but not too high to completely throw them out. Likely caused by debris in channel downstream of the gage.

The estimated peak flows are graded as 10 (estimated poor). This may explain why they are so much higher than the simulated peak flows and don't seem to accurately reflect the rainfall data.

The MIL2 rating curve used to calculate the estimated MIL2 streamflow data is based on just three field measurements. The highest flow measured in the field was only 5.9 cfs. The rating curve was then extrapolated to higher flows using a HEC-RAS model of the MIL2 stream channel. This lack of higher flow measurements is the reason why higher flows are estimated as poor by Jeffery Budnick of River Measurement. These issues with the estimated streamflow data are possible (and likely) indications that the estimated peak flows are over estimated.

Simulated Peak Flows

The other possibility is that the simulated peak flows are low and do not accurately represent the hydrology of the MIL2 watershed. The lower peak flows (flows in the range of 5 to 20 cfs) were compared and showed a better match between the simulated flows and the estimated flows (see Figures 3 and 4). Note that this lower peak flow range is in the range of one-half of the two-year flow and is representative of the lower threshold for the streamflow protection flow duration standard.

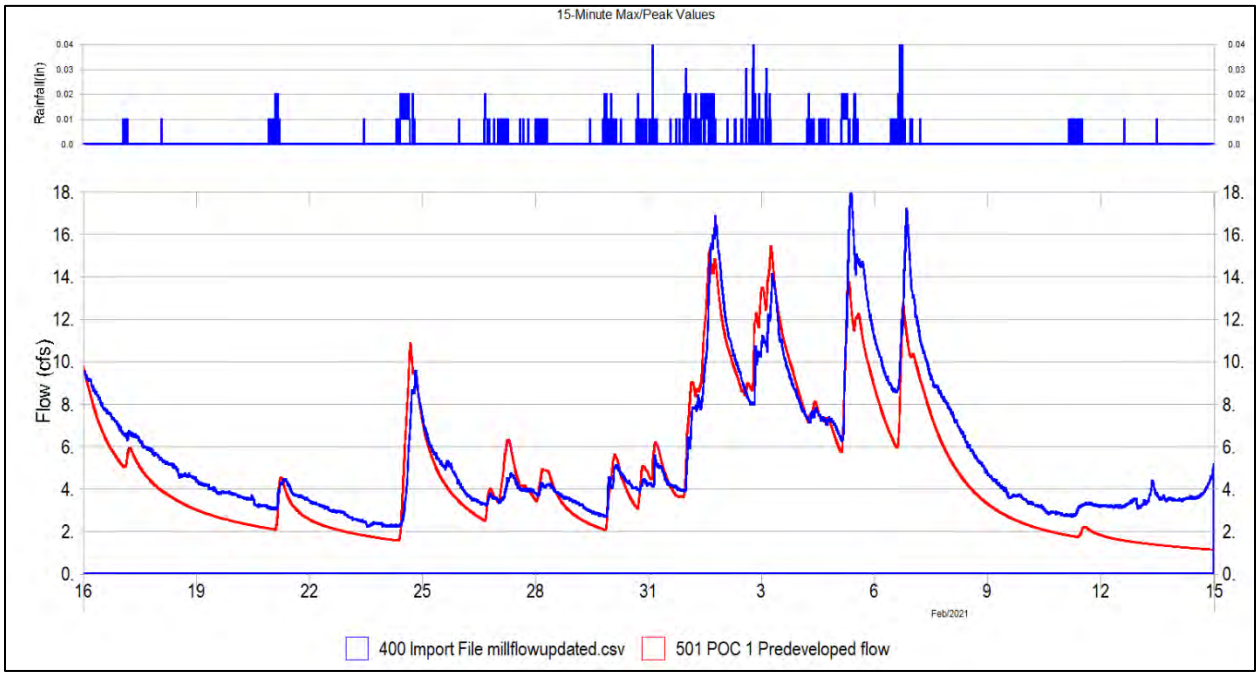

Figure 3. MIL2 Simulated and Estimated Streamflow (Jan 2021 through Feb 2021)

The estimated 15-minute streamflow is in blue; the simulated streamflow is in red. The 15-minute rainfall is above in blue.

There is a good match between the simulated and estimated streamflow in this lower peak flow range.

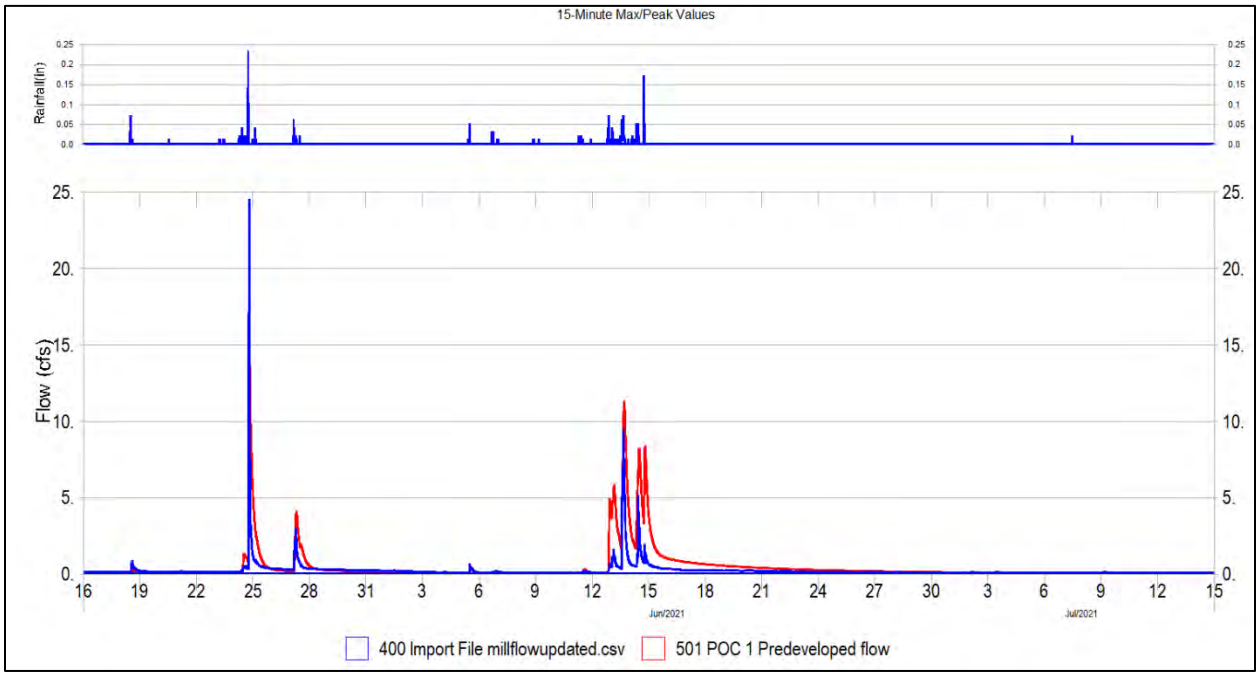

Figure 4. MIL2 Simulated and Estimated Streamflow (May 2021 through Jun 2021)

The estimated 15-minute streamflow is in blue; the simulated streamflow is in red. The 15-minute rainfall is above in blue.

There is a good match between the simulated and estimated streamflow in this lower peak flow range.

As an additional check I went back and compared the simulated and recorded streamflow from the original HSPF calibration of Mill Creek.

The simulated peak flows were computed using the original HSPF calibration that I conducted for the entire Mill Creek watershed in 2008-2009. I still have the model results from that original calibration and was able to find the calibration figures from that study. Figures 5, 6, and 7 show representative hydrographs from that original calibration.

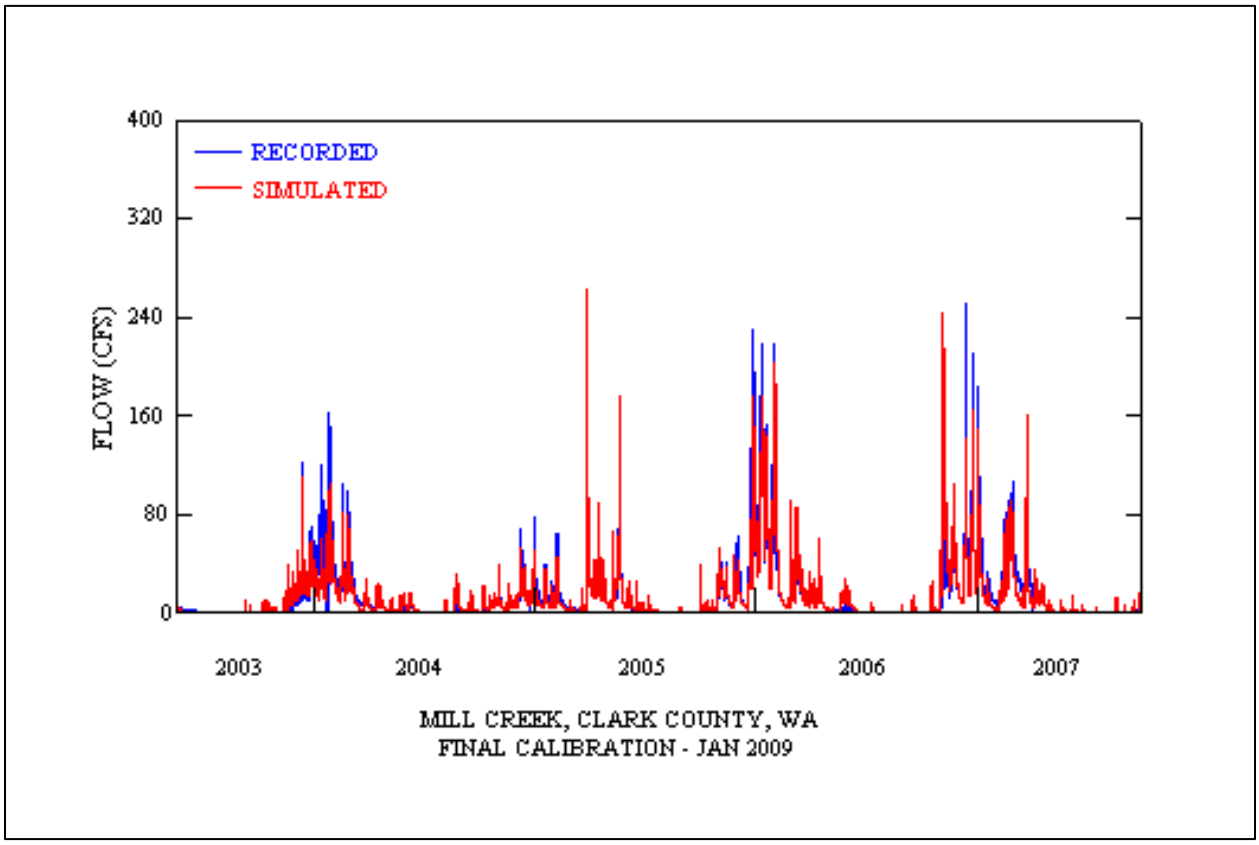

Figure 5. Entire Mill Creek Watershed Simulated and Recorded Streamflow (water years 2003-2007)

The recorded hourly streamflow is in blue; the simulated streamflow is in red.

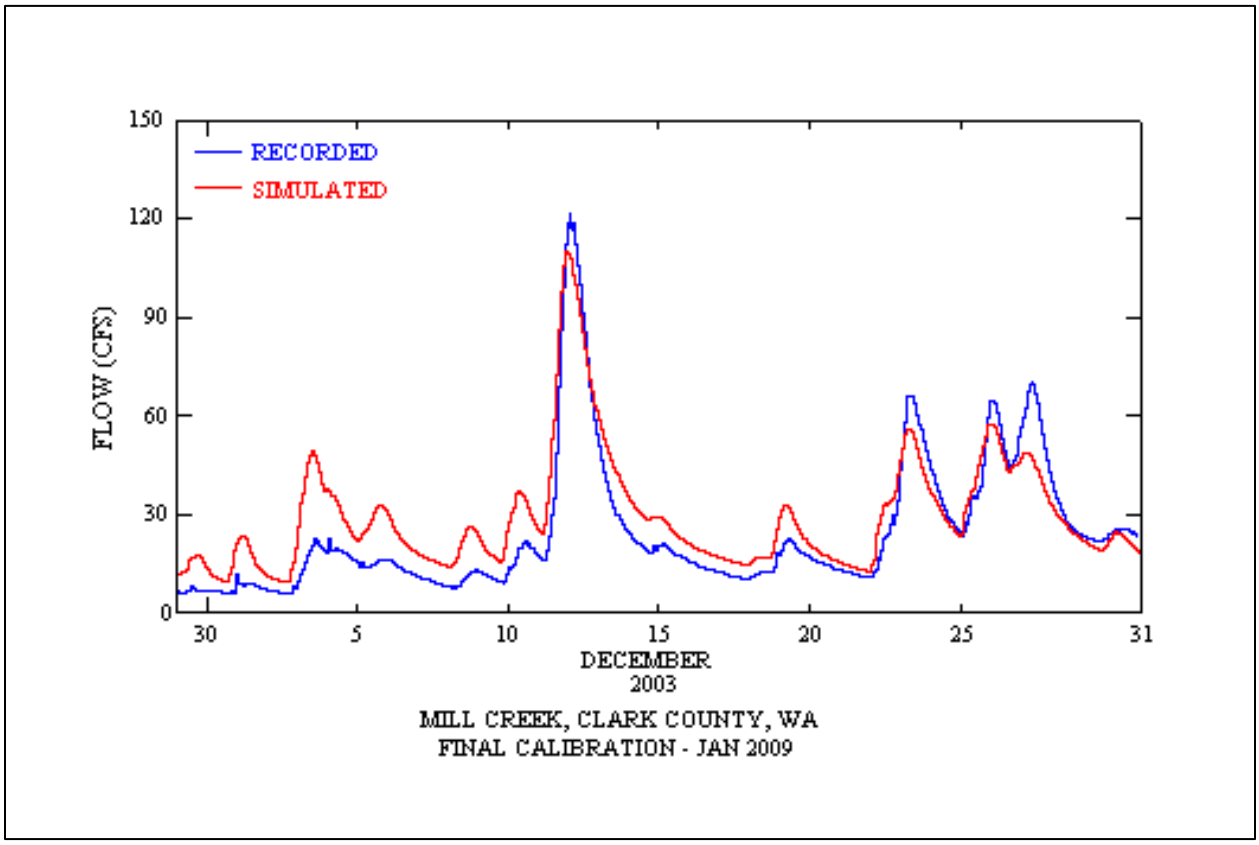

Figure 6. Entire Mill Creek Watershed Simulated and Recorded Streamflow (December 2003)

The recorded hourly streamflow is in blue; the simulated streamflow is in red.

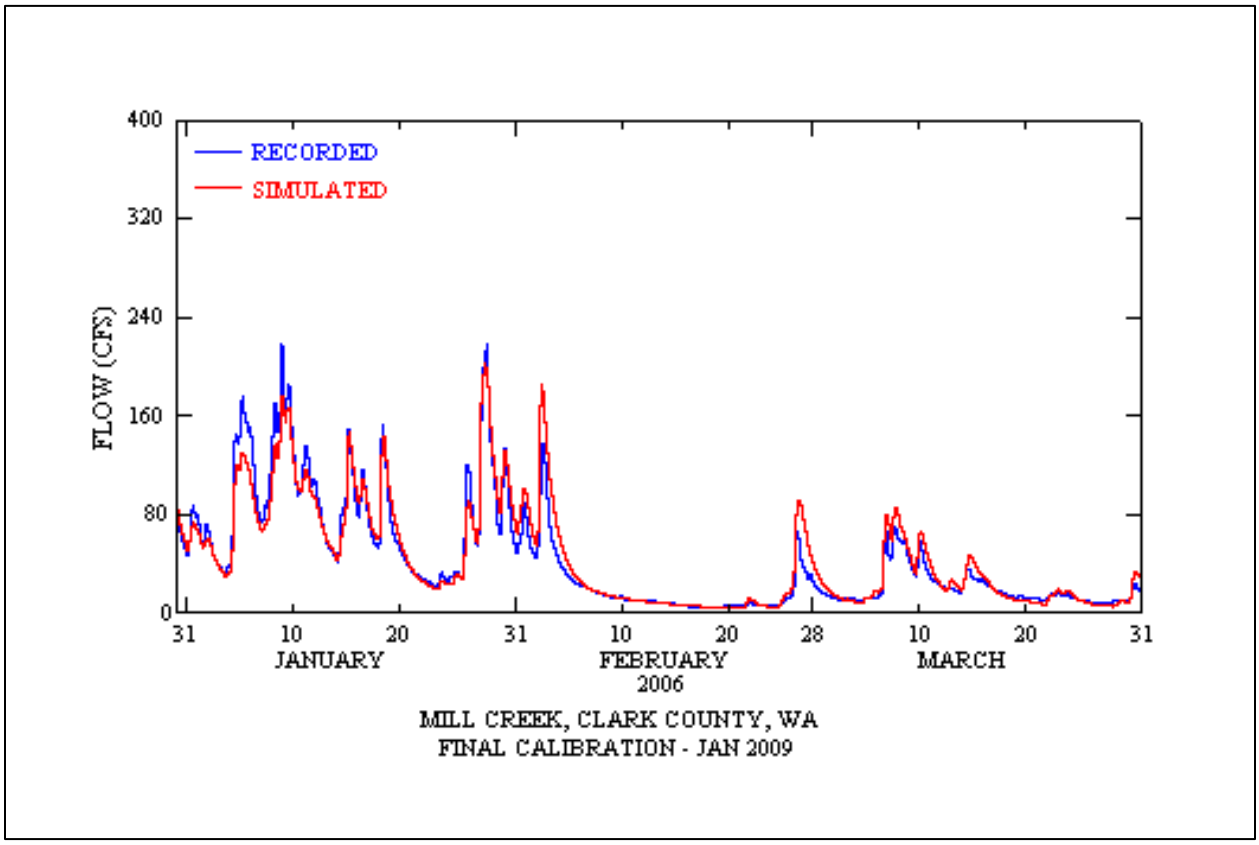

Figure 7. Entire Mill Creek Watershed Simulated and Recorded Streamflow (January through March 2006)

The recorded hourly streamflow is in blue; the simulated streamflow is in red.

These original calibration results demonstrate that the HSPF calibrated parameter values do produce accurate peak flows.

Conclusion

Based on all of the above evidence it appears that the estimated peak flows for water year 2021 are artificially high and are not accurate. The lower flows match well. This validates the HSPF calibration parameter values used in the WWHM-SWMM MIL2 model.

Clark County

Mill Creek Tributary Catchment-Scale Stormwater Planning

Appendix C
Build Out Model Memo

Prepared by

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Oct. 2021

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MEMO

DATE: 13 October 2021

TO: Rod Swanson, Program Manager II, Clark County Public Works

CC: Subhash Poudyal, P.E., Stormwater Engineer, Clark County Public Works
Joe Brascher, President, Clear Creek Solutions, Inc.

FROM: Doug Beyerlein, PE

SUBJECT: MIL2 Task 5B Documentation of Future Full Build-Out Scenario Model UPDATED

INTRODUCTION

This is an update and replacement of my 23 September 2021 memo.

The purpose of this memo is to document the construction of the WWHM-SWMM MIL2 future full build-out hydrology model. The MIL2 future full build-out hydrology model was constructed by Doug Beyerlein with model input provided by Subhash Poudyal.

Four major subbasins were identified in the MIL2 drainage area. These subbasins have been labeled from downstream to upstream as MIL2A, MIL2B, MIL2C, and MIL2D. The downstream end of each subbasin is at a confluence or urban growth area boundary.

MODEL SET-UP AND CONSTRUCTION

The MIL2 future full build-out hydrology model includes all of the Mill Creek tributary drainage area upstream of confluence with the main stem of Mill Creek in the vicinity of NE 158th Street. Figure 1 shows the location and boundaries of the four major subbasins.

The location of interest (LOI) for each subbasin is the downstream end of the MIL2 stream reach in that particular subbasin. These are the locations where all of the runoff and streamflow results are reported.

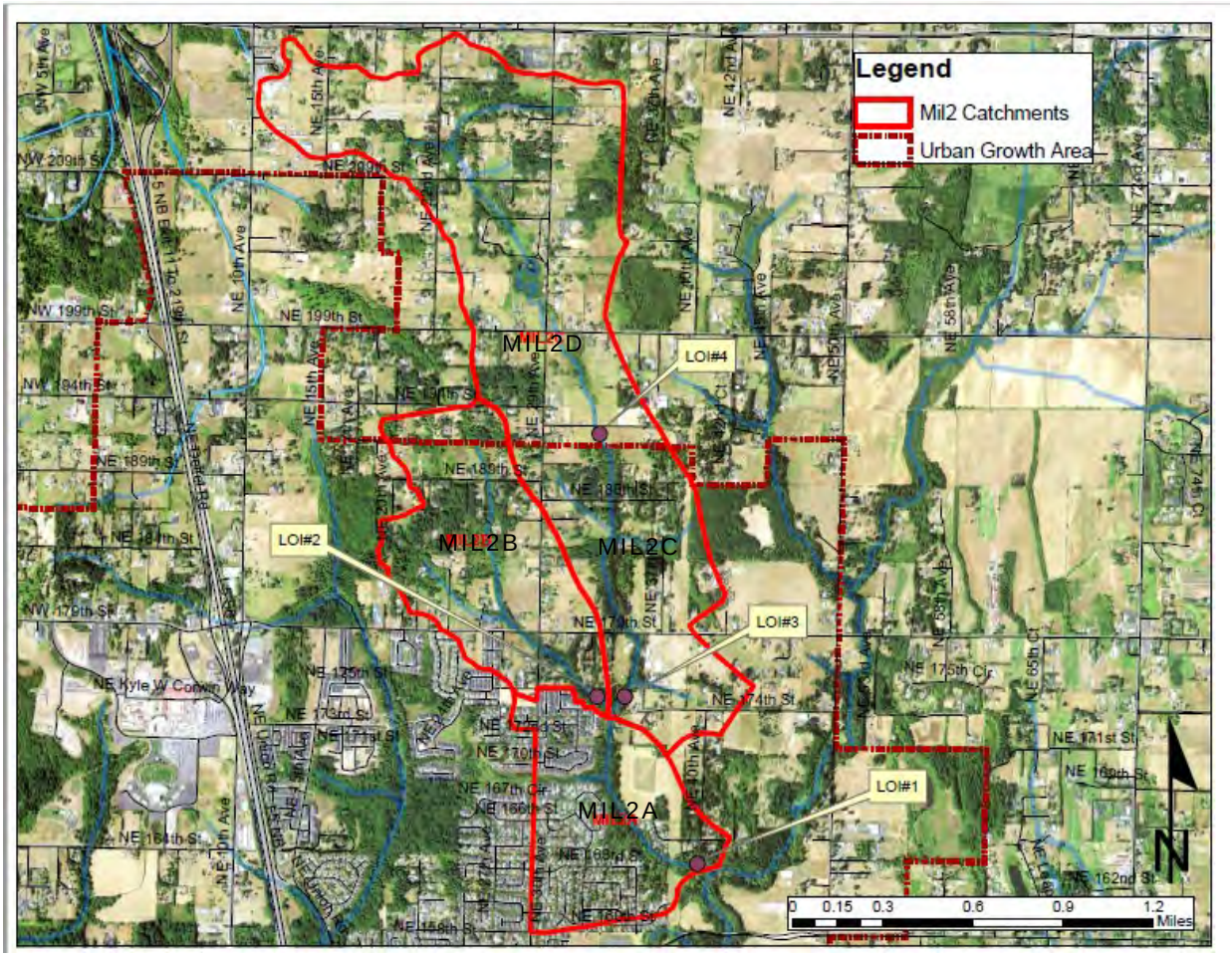

Figure 1. MIL2 Subbasins

In addition to the five existing significant stormwater control facilities included in the future full build-out hydrology model, three future stormwater control facilities were added. These five existing stormwater control facilities are: Carrie Otter (in subbasin MIL2D); and Regency Estates SWF, Regency Park PH1 SWF, Renaissance Vista SWF, and Mt. Vista 10 SWF (all in subbasin MIL2A). The three future stormwater control facilities were sized by Doug Beyerlein to represent the potential facilities that may be constructed to mitigate the impacts of land use change in MIL2A, MIL2B, and MIL2C. There was no future stormwater control facility added to MIL2D because there is no expected increase in impervious area in this subbasin.

The drainage areas for the stormwater control facilities were separated from the drainage areas that drained directly to the subbasin stream channel. Surface runoff and interflow from the stormwater control facilities' drainage areas were directed to the stormwater control facility. Groundwater, flowing deeper underground, bypasses the municipal stormwater collection system and the stormwater control facilities. Active groundwater was connected directly to the downstream subbasin stream channel; inactive groundwater does not contribute

flow to the subbasin stream channel but flows to an adjacent watershed, deep aquifer, or downstream of the study area. In the MIL2 drainage half of the groundwater becomes inactive groundwater (this is based on the calibrated HSPF parameter DEEPER, described below).

Clark County provided the future full build-out land cover for each subbasin. Tables 1 through 4 show the distribution of drainage area by pervious and impervious land type for subbasins MIL2A, MIL2B, MIL2C, and MIL2D, respectively, as assembled by Clark County.

Table 1. Subbasin MIL2A (acres)

Hydrologic Land Type	Existing Regency Estates	Existing Regency Park Ph 1	Existing Renaissance Vista	Existing Mt Vista 10	Existing Unmitigated	Existing Total	Future with Existing Mitigated	Future to Pond 2A	Future Unmitigated	Future Total
SG3 Forest Flat	0.00	0.00	0.00	0.54	4.09	4.63	0.54	0.00	0.00	0.54
SG3 Forest Moderate	0.00	0.00	0.00	0.45	8.37	8.82	0.45	0.00	0.00	0.45
SG3 Forest Steep	0.00	0.00	0.00	0.26	2.49	2.75	0.26	0.00	0.91	1.17
SG3 Field Flat	0.00	0.00	0.00	0.00	3.17	3.17	0.00	0.01	0.00	0.01
SG3 Field Moderate	0.00	0.00	0.00	0.10	13.47	13.57	0.10	0.00	0.00	0.10
SG3 Field Steep	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
SG3 Lawn Flat	0.00	0.00	0.00	0.13	0.35	0.48	0.13	5.31	0.10	5.54
SG3 Lawn Moderate	0.00	0.00	0.00	0.10	0.18	0.28	0.10	13.53	0.30	13.93
SG3 Lawn Steep	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.65	0.26	0.91
SG4 Forest Flat	0.53	0.09	0.10	1.71	9.24	11.67	2.43	0.00	1.04	3.47
SG4 Forest Moderate	1.01	0.11	0.24	5.82	21.84	29.02	7.18	0.00	2.35	9.53
SG4 Forest Steep	0.37	0.01	0.06	0.30	25.84	26.58	0.74	0.00	17.91	18.65
SG4 Field Flat	1.44	0.04	0.09	0.35	8.03	9.95	1.92	0.00	0.60	2.52
SG4 Field Moderate	0.51	0.36	0.22	0.89	7.51	9.49	1.98	0.00	0.00	1.98
SG4 Field Steep	0.01	0.04	0.02	0.00	0.58	0.65	0.07	0.00	0.31	0.38
SG4 Lawn Flat	1.85	1.68	1.33	1.04	3.63	9.53	5.90	10.93	10.53	27.36
SG4 Lawn Moderate	1.65	2.34	1.67	18.01	8.25	31.92	23.67	10.61	22.38	56.66
SG4 Lawn Steep	0.11	0.23	0.11	0.00	0.18	0.63	0.45	3.43	1.48	5.36
Impervious Flat	5.25	2.20	3.83	4.04	11.39	26.71	15.32	4.57	6.82	26.71
Impervious Moderate	4.47	2.28	3.77	19.86	15.02	45.40	30.38	12.83	12.63	55.84
Impervious Steep	0.29	0.01	0.07	0.00	0.73	1.10	0.37	2.62	2.27	5.26
Total Area	17.49	9.39	11.51	53.60	144.39	236.38	91.99	64.49	79.89	236.37

Mitigated is defined as areas draining to a stormwater control facility (“to Pond”); unmitigated are areas not draining to a stormwater facility but contributing runoff directly to the stream reach for that subbasin.

SG3 and SG4 are Clark County soil groups 3 and 4, respectively.

Land slope categories are: Flat (0-5%), Moderate (5-15%), and Steep (>15%).

Table 2. Subbasin MIL2B (acres)

Hydrologic Land Type	Existing Total	Future to Pond 2B	Future Unmitigated	Future Total
SG3 Forest Flat	13.46	0.00	0.52	0.52
SG3 Forest Moderate	7.45	0.00	0.29	0.29
SG3 Forest Steep	0.33	0.00	0.00	0.00
SG3 Field Flat	20.57	2.68	0.35	3.04
SG3 Field Moderate	21.02	0.00	1.30	1.30
SG3 Field Steep	0.03	0.00	0.00	0.00
SG3 Lawn Flat	2.83	16.03	0.00	16.03
SG3 Lawn Moderate	3.90	12.59	0.00	12.59
SG3 Lawn Steep	0.00	0.20	0.00	0.20
SG4 Forest Flat	67.83	0.00	16.64	16.64
SG4 Forest Moderate	48.30	0.00	13.02	13.02
SG4 Forest Steep	6.86	0.00	6.75	6.75
SG4 Field Flat	36.39	12.64	4.46	17.10
SG4 Field Moderate	25.97	0.79	5.73	6.53
SG4 Field Steep	0.24	0.00	0.24	0.24
SG4 Lawn Flat	3.83	36.52	0.16	36.68
SG4 Lawn Moderate	5.18	28.77	0.35	29.11
SG4 Lawn Steep	0.00	0.06	0.00	0.06
Impervious Flat	16.34	70.83	0.40	71.23
Impervious Moderate	11.35	59.05	1.27	60.32
Impervious Steep	0.10	0.24	0.08	0.31
Total Area	291.98	240.40	51.57	291.98

Mitigated is defined as areas draining to a stormwater control facility (“to Pond”); unmitigated are areas not draining to a stormwater facility but contributing runoff directly to the stream reach for that subbasin.

SG3 and SG4 are Clark County soil groups 3 and 4, respectively.

Land slope categories are: Flat (0-5%), Moderate (5-15%), and Steep (>15%).

Table 3. Subbasin MIL2C (acres)

Hydrologic Land Type	Existing Total	Future to Pond 2C	Future Unmitigated	Future Total
SG3 Forest Flat	4.54	0.00	0.03	0.03
SG3 Forest Moderate	5.50	0.00	0.13	0.13
SG3 Forest Steep	0.00	0.00	0.00	0.00
SG3 Field Flat	7.04	1.50	0.18	1.68
SG3 Field Moderate	9.85	0.00	0.77	0.77
SG3 Field Steep	0.00	0.00	0.00	0.00
SG3 Lawn Flat	1.46	6.57	0.07	6.64
SG3 Lawn Moderate	2.41	9.27	0.00	9.27
SG3 Lawn Steep	0.00	0.00	0.00	0.00
SG4 Forest Flat	50.35	0.00	12.54	12.54
SG4 Forest Moderate	68.19	0.00	25.08	25.08
SG4 Forest Steep	9.42	0.00	8.86	8.86
SG4 Field Flat	50.31	8.77	6.27	15.05
SG4 Field Moderate	64.18	5.88	8.01	13.89
SG4 Field Steep	1.98	0.00	0.90	0.90
SG4 Lawn Flat	5.28	46.95	0.14	47.09
SG4 Lawn Moderate	6.92	56.49	0.06	56.55
SG4 Lawn Steep	0.00	0.91	0.00	0.91
Impervious Flat	11.12	46.53	0.54	47.08
Impervious Moderate	8.01	58.12	1.25	59.37
Impervious Steep	0.05	0.76	0.04	0.79
Total Area	306.61	241.76	64.86	306.62

Mitigated is defined as areas draining to a stormwater control facility (“to Pond”); unmitigated are areas not draining to a stormwater facility but contributing runoff directly to the stream reach for that subbasin.

SG3 and SG4 are Clark County soil groups 3 and 4, respectively.

Land slope categories are: Flat (0-5%), Moderate (5-15%), and Steep (>15%).

Table 4. Subbasin MIL2D (acres)

Hydrologic Land Type	Existing Carrie Otter	Existing Unmitigated	Existing Total	Future Carrie Otter	Future Unmitigated	Future Total
SG3 Forest Flat	0.00	0.00	0.00	0.00	0.00	0.00
SG3 Forest Moderate	0.00	0.00	0.00	0.00	0.00	0.00
SG3 Forest Steep	0.00	0.00	0.00	0.00	0.00	0.00
SG3 Field Flat	0.00	0.00	0.00	0.00	0.00	0.00
SG3 Field Moderate	0.00	0.00	0.00	0.00	0.00	0.00
SG3 Field Steep	0.00	0.00	0.00	0.00	0.00	0.00
SG3 Lawn Flat	0.00	0.00	0.00	0.00	0.00	0.00
SG3 Lawn Moderate	0.00	0.00	0.00	0.00	0.00	0.00
SG3 Lawn Steep	0.00	0.00	0.00	0.00	0.00	0.00
SG4 Forest Flat	141.60	54.82	196.42	66.48	0.00	66.48
SG4 Forest Moderate	9.08	15.91	24.99	4.69	0.00	4.69
SG4 Forest Steep	0.00	0.00	0.00	0.00	0.00	0.00
SG4 Field Flat	151.02	72.95	223.97	169.72	127.78	297.49
SG4 Field Moderate	9.78	32.90	42.68	4.33	48.80	53.13
SG4 Field Steep	0.00	0.00	0.00	0.00	0.00	0.00
SG4 Lawn Flat	7.03	2.23	9.26	63.45	2.23	65.68
SG4 Lawn Moderate	0.34	2.62	2.96	10.17	2.62	12.79
SG4 Lawn Steep	0.00	0.00	0.00	0.00	0.00	0.00
Impervious Flat	28.41	8.96	37.37	28.41	8.96	37.37
Impervious Moderate	0.74	5.34	6.08	0.74	5.34	6.09
Impervious Steep	0.00	0.00	0.00	0.00	0.00	0.00
Total Area	348.00	195.73	543.73	348.00	195.72	543.73

Mitigated is defined as areas draining to a stormwater control facility (“to Pond”); unmitigated are areas not draining to a stormwater facility but contributing runoff directly to the stream reach for that subbasin.

SG3 and SG4 are Clark County soil groups 3 and 4, respectively.

Land slope categories are: Flat (0-5%), Moderate (5-15%), and Steep (>15%).

Subbasin MIL2D has no increase in impervious area but does have a reduction in forest vegetation and a corresponding increase in field and lawn vegetation. This will result in a small, but measurable, increase in total streamflow from this subbasin.

For the future full build-out model a single subbasin stormwater pond was sized to mitigate the land use changes in each of subbasins MIL2A, MIL2B, and MIL2C. The build out facilities were designed to meet Clark County Stormwater Manual detention facility standards under MR #7. The predevelopment land cover is from the Mill Creek alternative flow control standard, which is 2002 land cover with impervious mapped as pasture/field.

In subbasin MIL2A the land use changes were assumed to occur outside of the drainages to the existing four stormwater facilities and in the portion of the subbasin that is currently unmitigated. Clark County provided in an email attachment dated 9/29/21 the breakdown of predevelopment and future land cover for the portion of MIL2A that is currently unmitigated. These land cover acreages were used to size the model's MIL2A pond.

Future subbasin stormwater ponds were sized using the auto-sizing feature in WWHM2012. Default WWHM2012 AutoPond pond depth, riser height, and side slopes values were used in the auto-sizing procedure.

A screenshot of each future pond is shown below in figures 2 through 4.



Figure 2. Future Subbasin MIL2A Stormwater Pond

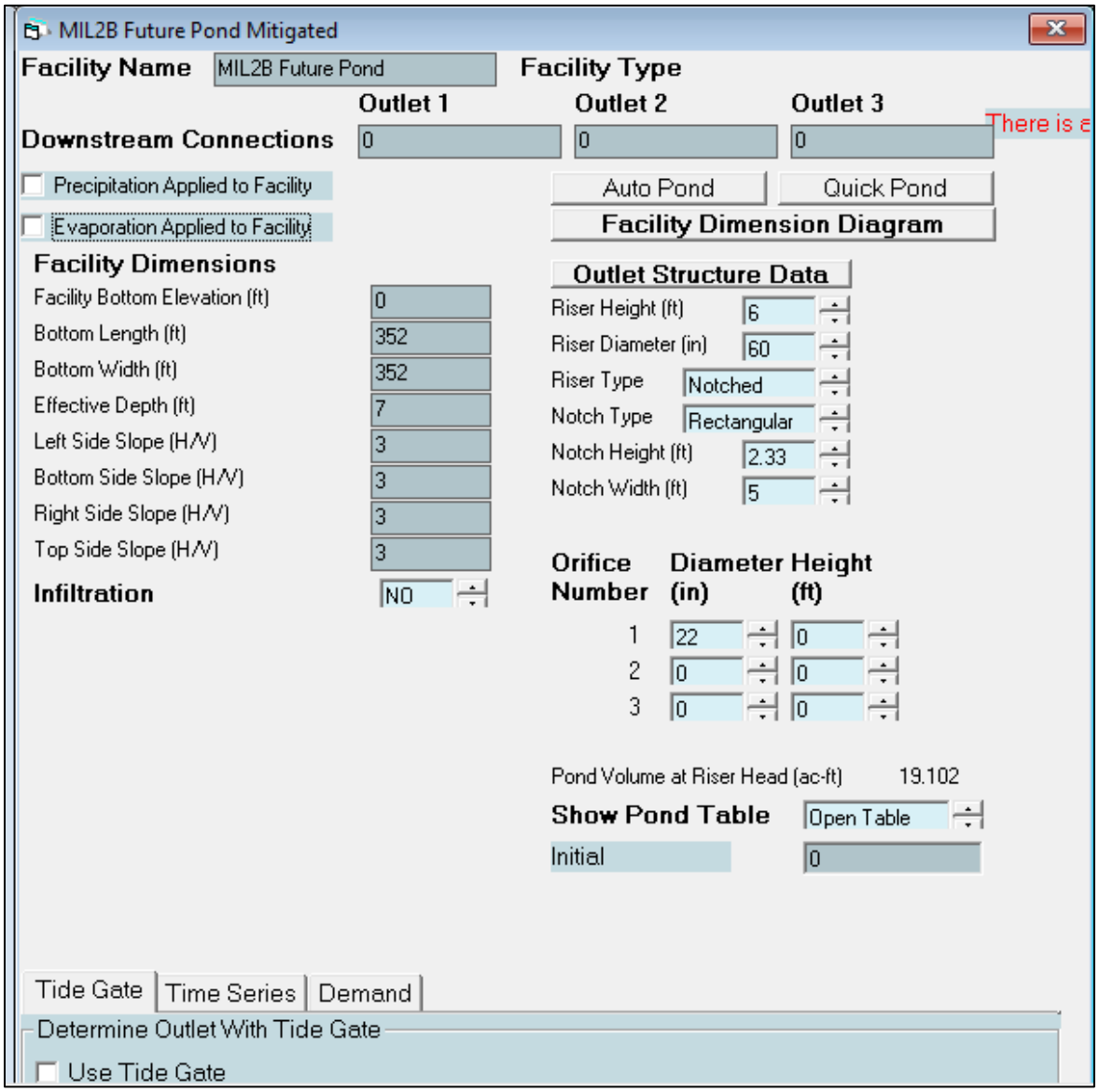

Figure 3. Future Subbasin MIL2B Stormwater Pond

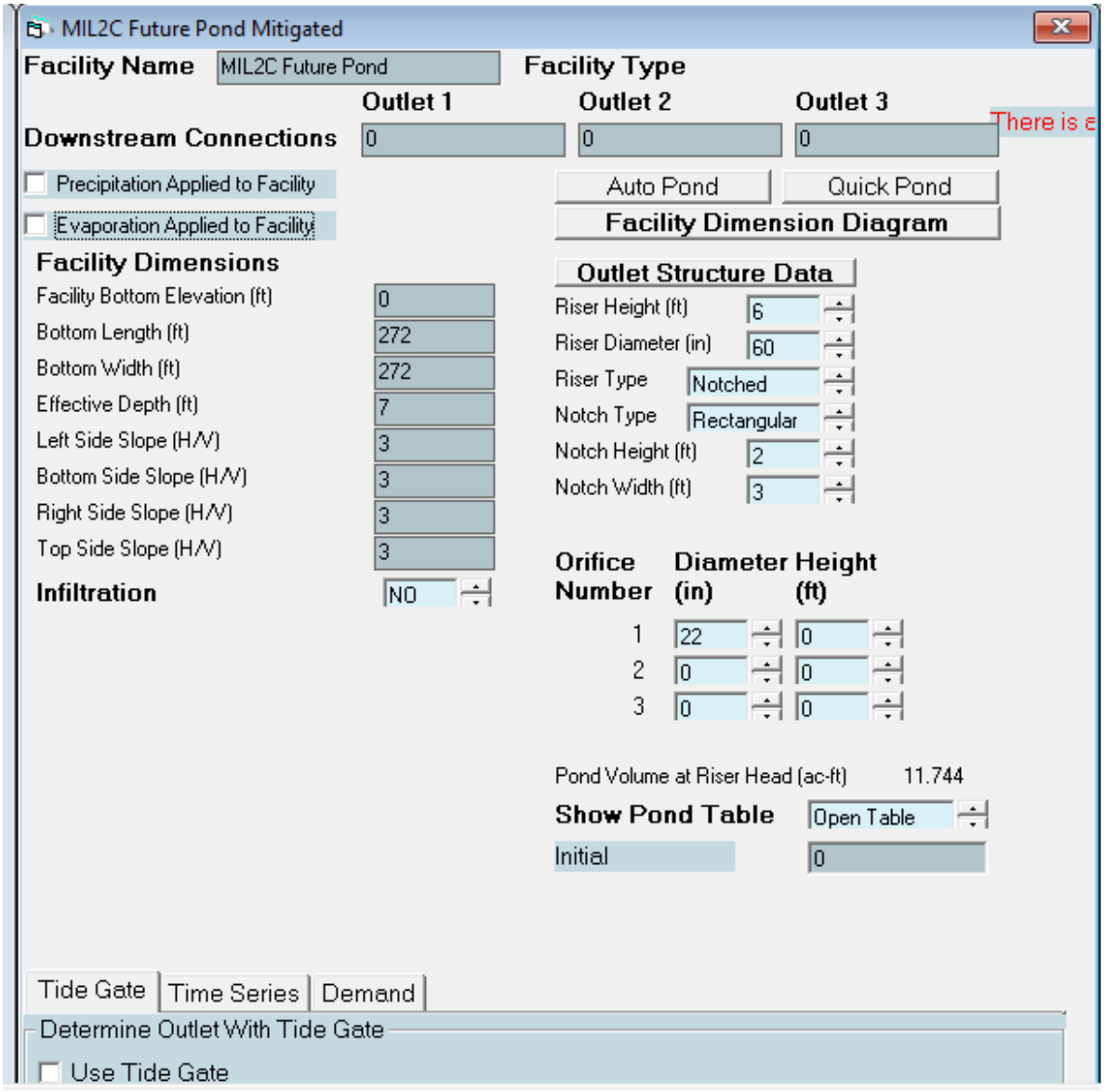

Figure 4. Future Subbasin MIL2C Stormwater Pond

As with the existing stormwater facilities, the surface runoff and interflow from the stormwater ponds' drainage areas were directed to the stormwater control facility; groundwater was connected directly to the subbasin stream channel.

The downstream end of each subbasin stream channel is designated as a Location of Interest (LOI) and assigned a Point of Compliance (POC) number. The subbasin streamflow at these locations are stored in the WWHM-SWMM WDM database file.

A schematic of the WWHM-SWMM MIL2 future full build-out hydrology model is shown in Figure 5.

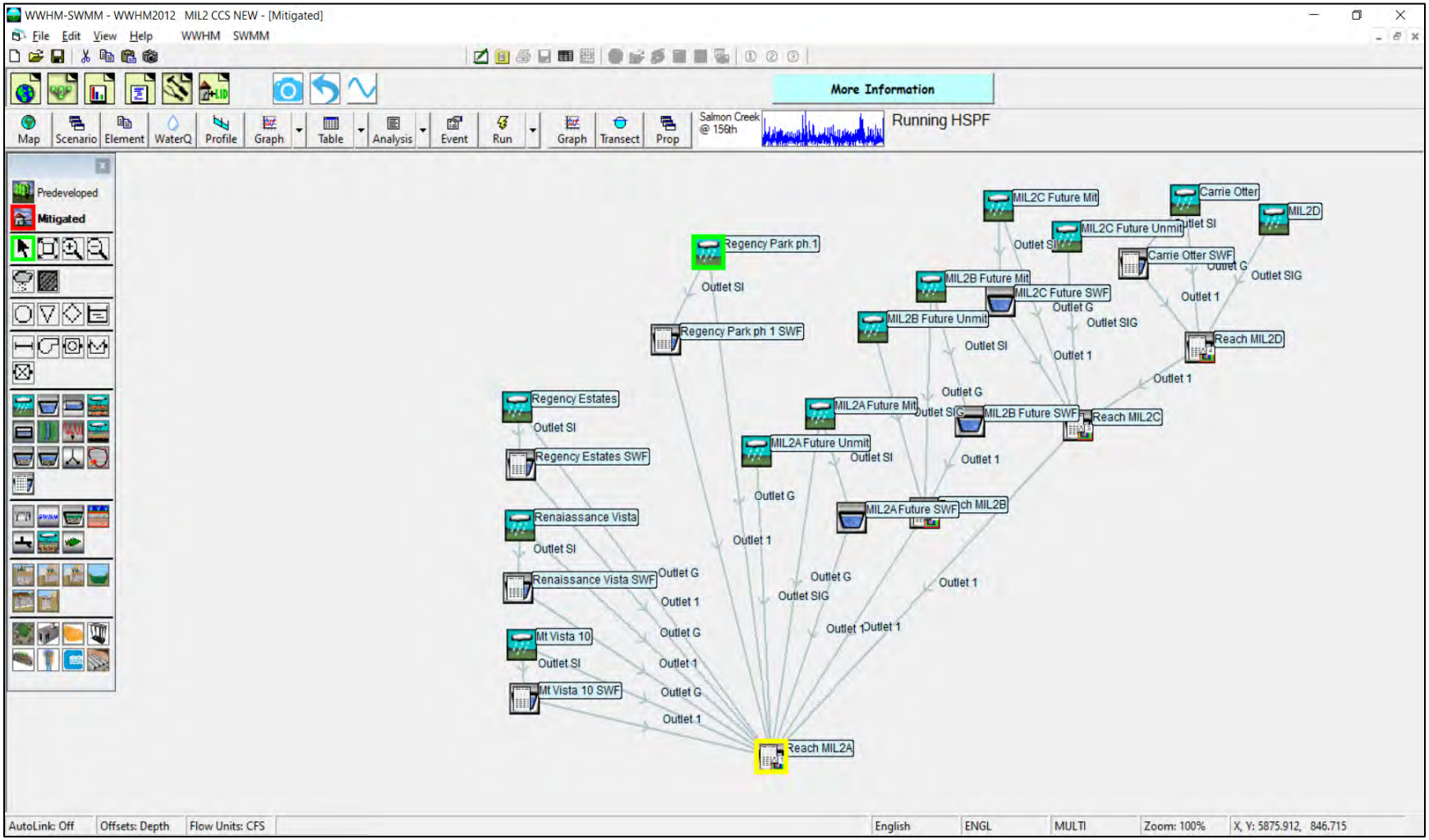

Figure 5. MIL2 Future Full Build-Out Hydrology Model Schematic

One additional change was made to both the existing and future conditions models. On 29 July 2021 Subhash Poudyal provided a drawing of the Carrie Otter stormwater control structure (see Figure 5). From this drawing a revised stage-storage-discharge table was created for this facility. This revised table replaces the original Carrie Otter SSD table in the existing conditions model and is also in the future full build-out conditions model. The revised table is shown in Table 5.

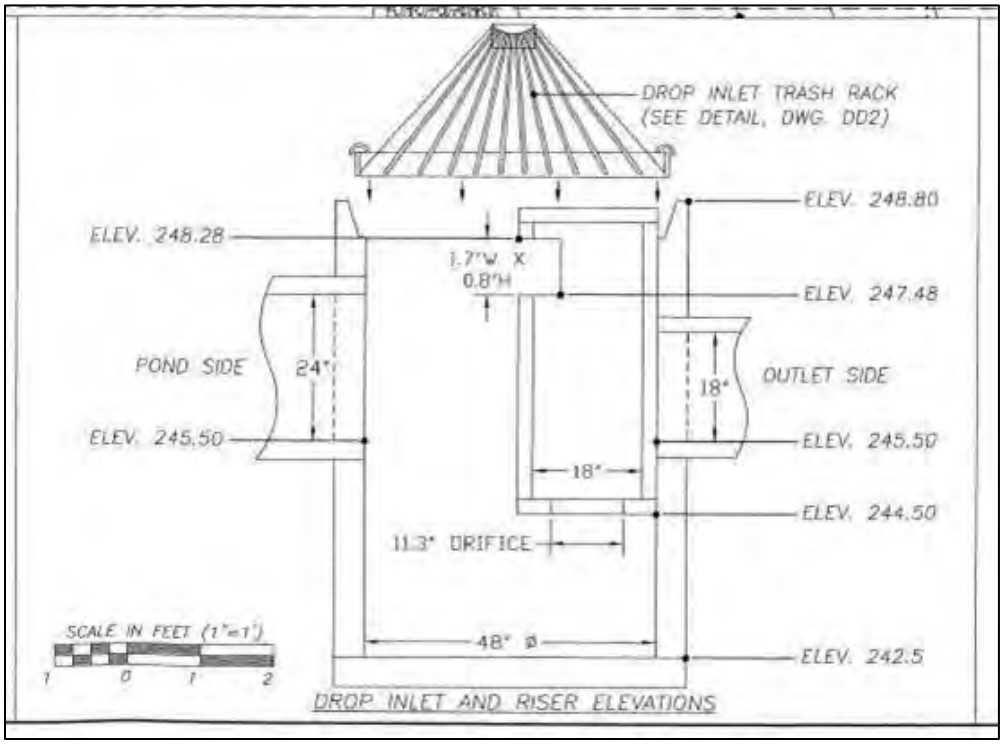

Figure 5. Carrie Otter Stormwater Control Structure

Table 5. Carrie Otter Stormwater Control Structure SSD Table

Stage (ft)	Area (ac)	Vol (ac-ft)	Discharge (cfs)
0.0	0.13	0.00	0.00
3.0	1.06	3.09	0.00
3.5	1.42	3.71	0.00
4.0	1.78	4.51	2.45
4.5	2.78	5.65	3.47
5.0	3.47	7.21	4.24
5.5	3.75	9.02	4.92
6.0	4.04	10.97	7.60
6.5	4.35	13.07	11.83
6.8	4.54	14.42	14.88
7.0	4.67	15.32	18.86
8.0	5.00	20.00	64.25
9.0	7.00	25.00	91.46

Note that the Carrie Otter Stormwater Control Structure SSD Table has been extended beyond the maximum stage of 7.0 feet to allow for the routing of extreme peak flows.

Clark County has decided to use the original Mill Creek HSPF calibrated parameters values for both the existing and future conditions models rather than the parameter values incorporated in WWHM2012. The original Mill Creek HSPF calibrated parameters values were determined by Doug Beyerlein in 2009 as part of a study done as a subconsultant to Otak, Inc. The original Mill Creek HSPF calibrated parameters values are from HSPF UCI file MC47 (1/16/2009). Note that these values are not the same as the values reported in "Hydrologic Modeling of Clark County Watersheds with the U.S. EPA Hydrologic Simulation Program – FORTRAN (HSPF)", dated 17 April 2009. The values listed in that report are the average of both the Mill Creek and Gee Creek calibrations. For this modeling study we are using just the specific Mill Creek HSPF calibrated parameters values.

Compared to the HSPF values in WWHM2012 only the following parameter values are different:

- LZSN: Lower Zone Storage Nominal
- INFILT: Infiltration Index
- AGWRC: Actual Groundwater Recession Constant
- DEEPFR: Deep Fraction of Groundwater
- UZSN: Upper Zone Storage Nominal
- INTFW: Interflow Index

The WWHM2012 and Mill Creek calibrated values for each HSPF parameter are shown in tables 6 through 11.

Table 6. LZSN Values

Hydrologic Land Type	WWHM2012	Mill Creek Calibrated
SG3 Forest Flat	9.00	9.00
SG3 Forest Moderate	9.00	9.00
SG3 Forest Steep	9.00	9.00
SG3 Field Flat	9.00	9.00
SG3 Field Moderate	9.00	9.00
SG3 Field Steep	9.00	9.00
SG3 Lawn Flat	9.00	9.00
SG3 Lawn Moderate	9.00	9.00
SG3 Lawn Steep	9.00	9.00
SG4 Forest Flat	6.00	8.00
SG4 Forest Moderate	6.00	8.00
SG4 Forest Steep	6.00	8.00
SG4 Field Flat	6.00	8.00
SG4 Field Moderate	6.00	8.00
SG4 Field Steep	6.00	8.00
SG4 Lawn Flat	6.00	8.00
SG4 Lawn Moderate	6.00	8.00
SG4 Lawn Steep	6.00	8.00

LZSN relates to the water storage in the lower soil layer. Using a larger value of 8.00 for SG4 soils decreases stormwater runoff (surface runoff and interflow). This means that peak flood flows are smaller than those calculated by WWHM2012 standard LZSN values.

Table 7. INFILT Values

Hydrologic Land Type	WWHM2012	Mill Creek Calibrated
SG3 Forest Flat	0.08	0.08
SG3 Forest Moderate	0.08	0.08
SG3 Forest Steep	0.08	0.08
SG3 Field Flat	0.06	0.06
SG3 Field Moderate	0.06	0.06
SG3 Field Steep	0.06	0.06
SG3 Lawn Flat	0.05	0.05
SG3 Lawn Moderate	0.05	0.05
SG3 Lawn Steep	0.05	0.05
SG4 Forest Flat	0.04	0.06
SG4 Forest Moderate	0.04	0.06
SG4 Forest Steep	0.04	0.06
SG4 Field Flat	0.03	0.04
SG4 Field Moderate	0.03	0.04
SG4 Field Steep	0.03	0.04
SG4 Lawn Flat	0.02	0.03
SG4 Lawn Moderate	0.02	0.03
SG4 Lawn Steep	0.02	0.03

INFILT relates to the water infiltration rate in the lower soil layer. Using larger values for SG4 soils decreases stormwater runoff (surface runoff and interflow). This means that peak flood flows are smaller than those calculated by WWHM2012 standard INFILT values.

Table 8. AGWRC Values

Hydrologic Land Type	WWHM2012	Mill Creek Calibrated
SG3 Forest Flat	0.96	0.86
SG3 Forest Moderate	0.96	0.86
SG3 Forest Steep	0.96	0.86
SG3 Field Flat	0.96	0.86
SG3 Field Moderate	0.96	0.86
SG3 Field Steep	0.96	0.86
SG3 Lawn Flat	0.96	0.86
SG3 Lawn Moderate	0.96	0.86
SG3 Lawn Steep	0.96	0.86
SG4 Forest Flat	0.96	0.86
SG4 Forest Moderate	0.96	0.86
SG4 Forest Steep	0.96	0.86
SG4 Field Flat	0.96	0.86
SG4 Field Moderate	0.96	0.86
SG4 Field Steep	0.96	0.86
SG4 Lawn Flat	0.96	0.86
SG4 Lawn Moderate	0.96	0.86
SG4 Lawn Steep	0.96	0.86

AGWRC relates to the discharge of groundwater to the stream as base flow. Using smaller values for both SG3 and SG4 soils increases the release of active groundwater to the stream as base flow. This release initially increases low flows, but as the amount of available active groundwater decreases so does the release to base flow and the size of the low flows. This means that peak flood flows are slightly larger than those calculated by WWHM2012 standard AGWRC values, but dry period base flows are slightly smaller.

Table 9. DEEPFR Values

Hydrologic Land Type	WWHM2012	Mill Creek Calibrated
SG3 Forest Flat	0.00	0.50
SG3 Forest Moderate	0.00	0.50
SG3 Forest Steep	0.00	0.50
SG3 Field Flat	0.00	0.50
SG3 Field Moderate	0.00	0.50
SG3 Field Steep	0.00	0.50
SG3 Lawn Flat	0.00	0.50
SG3 Lawn Moderate	0.00	0.50
SG3 Lawn Steep	0.00	0.50
SG4 Forest Flat	0.00	0.50
SG4 Forest Moderate	0.00	0.50
SG4 Forest Steep	0.00	0.50
SG4 Field Flat	0.00	0.50
SG4 Field Moderate	0.00	0.50
SG4 Field Steep	0.00	0.50
SG4 Lawn Flat	0.00	0.50
SG4 Lawn Moderate	0.00	0.50
SG4 Lawn Steep	0.00	0.50

DEEPFR determines the amount of groundwater that becomes active groundwater and discharges to the stream as base flow. A DEEPFR value of 0.50 for both SG3 and SG4 soils decreases active groundwater to the stream by 50 percent. The remaining groundwater drains elsewhere (outside of the watershed, deep aquifer, or downstream of the model study area).

This means that peak flood flows are slightly smaller than those calculated by WWHM2012 standard AGWRC values and dry period base flows are 50 percent smaller. It should be noted that the value of DEEPFR is watershed-dependent and was determined through the calibration process to produce simulated low flow values that most accurately matched field-measured base flows.

Table 10. UZSN Values

Hydrologic Land Type	WWHM2012	Mill Creek Calibrated
SG3 Forest Flat	1.00	1.30
SG3 Forest Moderate	1.00	1.30
SG3 Forest Steep	1.00	1.30
SG3 Field Flat	1.00	1.30
SG3 Field Moderate	1.00	1.30
SG3 Field Steep	1.00	1.30
SG3 Lawn Flat	0.80	1.10
SG3 Lawn Moderate	0.80	1.10
SG3 Lawn Steep	0.80	1.10
SG4 Forest Flat	0.40	1.20
SG4 Forest Moderate	0.40	1.20
SG4 Forest Steep	0.40	1.20
SG4 Field Flat	0.40	1.20
SG4 Field Moderate	0.40	1.20
SG4 Field Steep	0.40	1.20
SG4 Lawn Flat	0.20	1.00
SG4 Lawn Moderate	0.20	1.00
SG4 Lawn Steep	0.20	1.00

UZSN relates to the water storage in the upper soil layer. Using larger values for both SG3 and SG4 soils decreases stormwater runoff (surface runoff and interflow). This means that peak flood flows are smaller than those calculated by WWHM2012 standard UZSN values.

Table 11. INFTW Values

Hydrologic Land Type	WWHM2012	Mill Creek Calibrated
SG3 Forest Flat	4.00	4.00
SG3 Forest Moderate	4.00	4.00
SG3 Forest Steep	4.00	4.00
SG3 Field Flat	4.00	4.00
SG3 Field Moderate	4.00	4.00
SG3 Field Steep	4.00	4.00
SG3 Lawn Flat	4.00	4.00
SG3 Lawn Moderate	4.00	4.00
SG3 Lawn Steep	4.00	4.00
SG4 Forest Flat	2.00	5.00
SG4 Forest Moderate	2.00	5.00
SG4 Forest Steep	2.00	5.00
SG4 Field Flat	2.00	5.00
SG4 Field Moderate	2.00	5.00
SG4 Field Steep	2.00	5.00
SG4 Lawn Flat	2.00	5.00
SG4 Lawn Moderate	2.00	5.00
SG4 Lawn Steep	2.00	5.00

INTFW relates to the relative portion of interflow compared to surface runoff. Using a larger value of 5.00 for SG4 soils decreases surface runoff and increases interflow. This means that peak flood flows are smaller than those calculated by WWHM2012 standard INTFW values.

MODEL RESULTS

Following the construction of the future full build-out hydrology model both the existing conditions and the future conditions scenarios were run for the full simulation period at a 15-minute time step. The simulation period was for the period of October 1948 through September 2008 (water years 1949-2008).

Water Balance

The average annual water balance for each hydrologic land type was computed by the model (Table 12). The water balance includes average annual precipitation (inches) for the simulation period, evaporation (or actual evapotranspiration), surface runoff, interflow (shallow subsurface runoff), active groundwater (groundwater to the stream), total runoff (the sum of

surface runoff, interflow, and active groundwater), and inactive groundwater (groundwater that does not contribute to streamflow).

Table 12. MIL2 Average Annual Water Balance (inches)

Hydrologic Land Type	Precip	Evap	Surface	Interflow	Active GW	Total Runoff	Inactive GW
SG3 Forest Flat	48.017	28.772	0.110	6.674	6.268	13.052	6.268
SG3 Forest Moderate	48.017	28.772	0.127	6.661	6.266	13.054	6.266
SG3 Forest Steep	48.017	28.771	0.139	6.651	6.265	13.055	6.265
SG3 Field Flat	48.017	26.045	0.197	9.325	6.242	15.764	6.242
SG3 Field Moderate	48.017	26.044	0.236	9.293	6.239	15.768	6.239
SG3 Field Steep	48.017	26.042	0.255	9.284	6.235	15.774	6.235
SG3 Lawn Flat	48.017	22.239	0.384	12.815	6.276	19.475	6.276
SG3 Lawn Moderate	48.017	22.238	0.465	12.747	6.271	19.483	6.271
SG3 Lawn Steep	48.017	22.237	0.520	12.701	6.257	19.478	6.257
SG4 Forest Flat	48.017	27.778	0.153	9.311	5.423	14.887	5.423
SG4 Forest Moderate	48.017	27.777	0.182	9.287	5.421	14.890	5.421
SG4 Forest Steep	48.017	27.777	0.202	9.271	5.419	14.892	5.419
SG4 Field Flat	48.017	25.459	0.342	12.307	4.977	17.626	4.977
SG4 Field Moderate	48.017	25.457	0.413	12.248	4.972	17.633	4.972
SG4 Field Steep	48.017	25.455	0.461	12.208	4.969	17.638	4.969
SG4 Lawn Flat	48.017	22.052	0.769	15.988	4.601	21.358	4.601
SG4 Lawn Moderate	48.017	22.049	0.913	15.865	4.592	21.370	4.592
SG4 Lawn Steep	48.017	22.046	1.008	15.784	4.586	21.378	4.586
Impervious Flat	48.017	8.097	39.919	0.000	0.000	39.919	0.000
Impervious Moderate	48.017	7.516	40.503	0.000	0.000	40.503	0.000
Impervious Steep	48.017	6.395	41.622	0.000	0.000	41.622	0.000

As shown in the table, impervious surfaces produce 2 to 3 times as much total runoff (per acre) as pervious land types.

When the contributing area of each hydrologic land type in the MIL2 drainage area is multiplied by the runoff produced by that land type it is possible to identify the major sources of runoff in the watershed. This has been done in Table 13 below for both existing land conditions and future full build-out conditions.

Table 13. MIL2 Existing and Future Weighted Average Annual Runoff Summary

Hydrologic Land Type	Existing Total (ac)	Future Total (ac)	Surface Runoff (in)	Interflow (in)	Active GW (in)	Total Runoff (in)	Existing Weighted (in)	Future Weighted (in)
SG3 Forest Flat	22.63	1.09	0.110	6.674	6.268	13.052	0.214	0.010
SG3 Forest Moderate	21.77	0.87	0.127	6.661	6.266	13.054	0.206	0.008
SG3 Forest Steep	3.08	1.17	0.139	6.651	6.265	13.055	0.029	0.011
SG3 Field Flat	30.78	4.73	0.197	9.325	6.242	15.764	0.352	0.054
SG3 Field Moderate	44.44	2.18	0.236	9.293	6.239	15.768	0.508	0.025
SG3 Field Steep	0.05	0.00	0.255	9.284	6.235	15.774	0.001	0.000
SG3 Lawn Flat	4.77	28.20	0.384	12.815	6.276	19.475	0.067	0.398
SG3 Lawn Moderate	6.59	35.79	0.465	12.747	6.271	19.483	0.093	0.506
SG3 Lawn Steep	0.01	1.11	0.520	12.701	6.257	19.478	0.000	0.016
SG4 Forest Flat	326.27	99.13	0.153	9.311	5.423	14.887	3.523	1.070
SG4 Forest Moderate	170.50	52.32	0.182	9.287	5.421	14.890	1.841	0.565
SG4 Forest Steep	42.86	34.26	0.202	9.271	5.419	14.892	0.463	0.370
SG4 Field Flat	320.62	332.16	0.342	12.307	4.977	17.626	4.099	4.247
SG4 Field Moderate	142.32	75.53	0.413	12.248	4.972	17.633	1.820	0.966
SG4 Field Steep	2.87	1.51	0.461	12.208	4.969	17.638	0.037	0.019
SG4 Lawn Flat	27.90	176.81	0.769	15.988	4.601	21.358	0.432	2.739
SG4 Lawn Moderate	46.98	155.11	0.913	15.865	4.592	21.370	0.728	2.404
SG4 Lawn Steep	0.63	6.33	1.008	15.784	4.586	21.378	0.010	0.098
Impervious Flat	91.54	182.39	39.919	0.000	0.000	39.919	2.650	5.281
Impervious Moderate	70.84	181.61	40.503	0.000	0.000	40.503	2.081	5.335
Impervious Steep	1.25	6.37	41.622	0.000	0.000	41.622	0.038	0.192
Total Area	1378.70	1378.69					19.19	24.32

As shown in the table, the existing MIL2 total area mean annual runoff is approximately 19.2 inches per year. In the future with full build-out conditions this will increase to 24.3 inches per year. This is a 27% increase in total runoff volume. The major source of the increase is the increase in impervious area.

The weighted average surface runoff, interflow, and active groundwater runoff is broken down by hydrologic land type for existing conditions (Table 14) and future full build-out conditions (Table 15).

Table 14. MIL2 Existing Weighted Average Annual Runoff by Runoff Component

Hydrologic Land Type	Existing Total (ac)	Surface Runoff (in)	Interflow (in)	Active GW (in)	Existing Total Runoff (in)
SG3 Forest Flat	22.63	0.002	0.110	0.103	0.214
SG3 Forest Moderate	21.77	0.002	0.105	0.099	0.206
SG3 Forest Steep	3.08	0.000	0.015	0.014	0.029
SG3 Field Flat	30.78	0.004	0.208	0.139	0.352
SG3 Field Moderate	44.44	0.008	0.300	0.201	0.508
SG3 Field Steep	0.05	0.000	0.000	0.000	0.001
SG3 Lawn Flat	4.77	0.001	0.044	0.022	0.067
SG3 Lawn Moderate	6.59	0.002	0.061	0.030	0.093
SG3 Lawn Steep	0.01	0.000	0.000	0.000	0.000
SG4 Forest Flat	**326.27**	**0.036**	**2.203**	**1.283**	**3.523**
SG4 Forest Moderate	170.50	0.023	1.148	0.670	1.841
SG4 Forest Steep	42.86	0.006	0.288	0.168	0.463
SG4 Field Flat	**320.62**	**0.080**	**2.862**	**1.157**	**4.099**
SG4 Field Moderate	142.32	0.043	1.264	0.513	1.820
SG4 Field Steep	2.87	0.001	0.025	0.010	0.037
SG4 Lawn Flat	27.90	0.016	0.324	0.093	0.432
SG4 Lawn Moderate	46.98	0.031	0.541	0.156	0.728
SG4 Lawn Steep	0.63	0.000	0.007	0.002	0.010
Impervious Flat	91.54	2.650	0.000	0.000	2.650
Impervious Moderate	70.84	2.081	0.000	0.000	2.081
Impervious Steep	1.25	0.038	0.000	0.000	0.038
Total Area	1378.70	5.024	9.506	4.663	19.194
Percent of Total Runoff		26%	50%	24%	100%

For the existing conditions 26% of the total annual runoff is from surface runoff (primarily impervious surfaces), 50% is from interflow (shallow subsurface runoff from pervious areas), and 24% from groundwater (in the form of base flow). The largest single sources of total runoff are SG4 Field Flat (4.099 inches of total runoff per year) and SG4 Forest Flat (3.523 inches per year) – both shown in **bold** in the table. Note: SG4 is a Clark County hydrologic soil group and Flat is a land surface slope between zero and 5%. Field and Forest refer to vegetation groups.

Both SG4 Forest Flat and SG4 Field Flat produce mostly interflow (shallow subsurface runoff) and groundwater (base flow); they generate very little surface runoff.

Table 15. MIL2 Future Weighted Average Annual Runoff by Runoff Component

Hydrologic Land Type	Future Total (ac)	Surface Runoff (in)	Interflow (in)	Active GW (in)	Future Total Runoff (in)
SG3 Forest Flat	1.09	0.000	0.005	0.005	0.010
SG3 Forest Moderate	0.87	0.000	0.004	0.004	0.008
SG3 Forest Steep	1.17	0.000	0.006	0.005	0.011
SG3 Field Flat	4.73	0.001	0.032	0.021	0.054
SG3 Field Moderate	2.18	0.000	0.015	0.010	0.025
SG3 Field Steep	0.00	0.000	0.000	0.000	0.000
SG3 Lawn Flat	28.20	0.008	0.262	0.128	0.398
SG3 Lawn Moderate	35.79	0.012	0.331	0.163	0.506
SG3 Lawn Steep	1.11	0.000	0.010	0.005	0.016
SG4 Forest Flat	99.13	0.011	0.669	0.390	1.070
SG4 Forest Moderate	52.32	0.007	0.352	0.206	0.565
SG4 Forest Steep	34.26	0.005	0.230	0.135	0.370
SG4 Field Flat	332.16	0.082	2.965	1.199	4.247
SG4 Field Moderate	75.53	0.023	0.671	0.272	0.966
SG4 Field Steep	1.51	0.001	0.013	0.005	0.019
SG4 Lawn Flat	176.81	0.099	2.050	0.590	2.739
SG4 Lawn Moderate	155.11	0.103	1.785	0.517	2.404
SG4 Lawn Steep	6.33	0.005	0.072	0.021	0.098
Impervious Flat	**182.39**	**5.281**	**0.000**	**0.000**	**5.281**
Impervious Moderate	**181.61**	**5.335**	**0.000**	**0.000**	**5.335**
Impervious Steep	6.37	0.192	0.000	0.000	0.192
Total Area	1378.69	11.165	9.475	3.677	24.316
Percent of Total Runoff		46%	39%	15%	100%
Change from Existing (in)		6.141	-0.032	-0.986	5.122
Change from Existing (%)		122%	-0.3%	-21%	27%

For the future full build-out conditions 46% of the total annual runoff is from surface runoff (primarily impervious surfaces), 39% is from interflow (shallow subsurface runoff from pervious areas), and 15% from groundwater (in the form of base flow). The largest single sources of total runoff are Impervious Moderate (5.335 inches of total runoff per year) and Impervious Flat (5.281 inches per year) – both shown in **bold** in the table. Note: Flat is a land surface slope between zero and 5%; Moderate is a land surface slope between 5 and 15%.

Both Impervious Flat and Impervious Moderate produce only surface runoff, which in turn increase peak streamflows and potential flooding.

Because of the increase in impervious surfaces (primarily roads and roofs) surface runoff increases from 5.024 inches per year to 11.165 inches per year. This is an increase of 122%. Interflow slightly decreases (-0.3%). Active groundwater/base flow decreases by 21%. Total runoff will increase by 27%.

Future stormwater control facilities will mitigate some of the effects of this increase in surface runoff but, as discussed below, flood frequency values will increase for the more frequent flood events (2-year, 5-year, and 10-year flood events).

Flow Frequency

Flow frequency was computed for the 2-, 5-, 10-, 25-, 50-, and 100-year flood events from the annual peak flows at the downstream end of each of the four WWHM-SWMM stream reaches.

The existing and future flood frequency results are shown in tables 16 through 19.

Table 16. Existing Flood Frequency (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Table 17. Future Full Build-Out Flood Frequency (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	87.75	122.24	148.57	186.08	217.28	251.43
MIL2B	25.59	35.30	42.81	53.62	62.70	72.71
MIL2C	42.13	59.44	72.51	90.97	106.19	122.73
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Table 18. Flood Frequency Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	17.67	9.73	0.67	-15.95	-32.65	-53.57
MIL2B	8.57	4.19	-1.56	-13.21	-25.91	-42.86
MIL2C	10.96	9.19	7.32	4.22	1.39	-1.87
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Table 19. Flood Frequency Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	25%	9%	0%	-8%	-13%	-18%
MIL2B	50%	13%	-4%	-20%	-29%	-37%
MIL2C	35%	18%	11%	5%	1%	-2%
MIL2D	9%	7%	6%	4%	2%	1%

MIL2A frequency results include all of the upstream flow from subbasins MIL2B, MIL2C, and MIL2D in addition to the runoff from the MIL2A subbasin.

MIL2B frequency results include only the runoff from the MIL2B subbasin.

MIL2C frequency results include the upstream flow from subbasin MIL2D and the runoff from the MIL2C subbasin.

MIL2D frequency results include only the runoff from the MIL2D subbasin.

The flow frequency results were calculated using the Log Pearson Type III methodology included in WWHM2012. Log Pearson Type III uses the log of the annual peak values to compute mean, standard deviation, and skew. An increase in annual peak flows in the 2- to 5-year frequency range can change the standard deviation and skew and decrease the computed 100-year peak flow value. That can be observed in the MIL2A, MIL2B, and MIL2C 100-year results when comparing the future and existing values.

The largest percent change in the flood frequency values occurs in the smaller flood events (2-year, 5-year, and for MIL2C and MIL2D the 10-year event). As described above in the water balance results discussion, there is an increase in total average annual runoff from existing to future full build-out conditions because of the increase in impervious areas and the increase in surface runoff. Stormwater control facilities are designed to reduce the impact of this increase in total average annual runoff but there are limits to their effectiveness. This mainly affects the smaller flood events.

Flow Duration

A better way to compare existing and future flow results is to look at flow durations. This is the standard used by the Department of Ecology to evaluate stormwater impacts (Minimum Requirement #7). Flow durations for flows in the range of one-half of the 2-year flow to the 50-year existing conditions flow have been computed for the flows in the four subbasins. These results are shown in tables 20 through 23.

The results show the total number of 15-minute time steps in the entire simulation period a specific flow level was exceeded. The percent change is the increase or decrease in the amount of time the future flows will occur compared to existing flows.

Table 20. MIL2A Flow Duration (0.5Q2 to Q50)

Frequency	Flow (cfs)	Existing	Future	Change (%)
0.5Q2	35.04	18076	35892	99%
	37.21	15207	31347	106%
	39.38	12779	27308	114%
	41.55	10761	23794	121%
	43.72	9145	20780	127%
	45.89	7700	18095	135%
	48.06	6553	15863	142%
	50.24	5525	13774	149%
	52.41	4738	12101	155%
	54.58	4098	10603	159%
	56.75	3522	9232	162%
	58.92	3131	8087	158%
	61.09	2781	7176	158%
	63.26	2506	6312	152%
	65.43	2255	5624	149%
	67.60	2014	5016	149%
	69.77	1804	4420	145%
Q2	70.08	1777	4344	144%
	71.94	1618	3890	140%
	74.11	1418	3425	142%
	76.28	1221	3051	150%
	78.45	1018	2695	165%
	80.62	884	2394	171%
	82.79	783	2085	166%
	84.97	697	1871	168%
	87.14	631	1641	160%
	89.31	570	1430	151%
	91.48	474	1267	167%
	93.65	398	1135	185%
	95.82	352	996	183%
	97.99	317	869	174%
	100.16	297	769	159%
	102.33	269	667	148%

	104.50	239	570	138%
	106.67	217	506	133%
	108.84	191	444	132%
	111.01	166	395	138%
Q5	112.52	152	371	144%
	113.18	146	360	147%
	115.35	132	323	145%
	117.52	115	294	156%
	119.70	105	264	151%
	121.87	96	233	143%
	124.04	87	208	139%
	126.21	81	192	137%
	128.38	71	175	146%
	130.55	63	164	160%
	132.72	58	147	153%
	134.89	54	131	143%
	137.06	50	125	150%
	139.23	47	119	153%
	141.40	46	114	148%
	143.57	44	110	150%
	145.74	43	106	147%
Q10	147.91	40	102	155%
	150.08	36	96	167%
	152.26	35	92	163%
	154.43	33	90	173%
	156.60	32	84	163%
	158.77	30	78	160%
	160.94	27	75	178%
	163.11	27	72	167%
	165.28	26	71	173%
	167.45	26	68	162%
	169.62	25	65	160%
	171.79	22	62	182%
	173.96	20	60	200%
	176.13	20	58	190%
	178.30	19	55	189%
	180.47	19	48	153%
	182.64	17	48	182%
	184.81	15	44	193%
	186.99	15	39	160%

	189.16	15	36	140%
	191.33	15	33	120%
	193.50	15	31	107%
	195.67	15	30	100%
	197.84	15	27	80%
	200.01	14	25	79%
Q25	202.18	14	23	64%
	204.35	13	20	54%
	206.52	12	18	50%
	208.69	11	17	55%
	210.86	10	17	70%
	213.03	10	16	60%
	215.20	10	14	40%
	217.37	9	13	44%
	219.54	9	13	44%
	221.72	8	13	63%
	223.89	8	12	50%
	226.06	8	12	50%
	228.23	8	12	50%
	230.40	8	12	50%
	232.57	7	12	71%
	234.74	7	10	43%
	236.91	6	9	50%
	239.08	6	9	50%
	241.25	6	9	50%
	243.42	6	9	50%
	245.59	6	8	33%
	247.76	6	8	33%
Q50	249.93	6	7	17%

For MIL2A the existing 50% of the 2-year peak flow (0.5Q2) value is equaled or exceeded 18076 15-minute time steps out of the entire simulation period of 2.1 million time steps (60 years). That is equal to 0.9% of the time. For the future full build-out conditions that existing 0.5Q2 value is exceeded 1.7% of the time. The reason for the increase is because of the increase in the total amount of runoff.

Table 21. MIL2B Flow Duration (0.5Q2 to Q50)

Frequency	Flow (cfs)	Existing	Future	Change (%)
0.5Q2	8.51	11979	49609	314%
	9.32	8830	40015	353%
	10.13	6173	31999	418%
	10.94	4980	27813	458%
	11.75	4044	24026	494%
	12.56	3305	20546	522%
	13.37	2687	17458	550%
	14.17	2236	14813	562%
	14.98	1893	12497	560%
	15.79	1576	10580	571%
	16.60	1247	8861	611%
Q2	17.02	1141	8090	609%
	17.41	1042	7376	608%
	18.22	843	6107	624%
	19.03	654	5030	669%
	19.84	524	4098	682%
	20.65	428	3377	689%
	21.46	369	2819	664%
	22.27	320	2310	622%
	23.07	281	1900	576%
	23.88	248	1598	544%
	24.69	218	1260	478%
	25.50	192	1029	436%
	26.31	174	859	394%
	27.12	163	695	326%
	27.93	140	539	285%
	28.74	130	447	244%
	29.55	116	377	225%
	30.36	100	319	219%
Q5	31.11	93	292	212%
	31.17	93	290	212%
	31.97	77	261	239%
	32.78	71	237	234%
	33.59	66	216	227%
	34.40	64	198	209%
	35.21	56	185	230%
	36.02	51	176	245%

	36.83	45	162	260%
	37.64	41	153	273%
	38.45	37	141	281%
	39.26	36	137	281%
	40.07	35	127	263%
	40.88	30	122	307%
	41.68	27	115	326%
	42.49	26	105	304%
	43.30	25	94	276%
	44.11	25	85	240%
Q10	44.37	24	83	247%
	44.92	22	80	264%
	45.73	21	74	252%
	46.54	21	66	214%
	47.35	20	61	205%
	48.16	20	59	195%
	48.97	19	58	205%
	49.78	19	53	179%
	50.58	17	50	194%
	51.39	17	48	182%
	52.20	16	45	181%
	53.01	15	44	193%
	53.82	14	41	193%
	54.63	12	38	217%
	55.44	12	36	200%
	56.25	10	33	230%
	57.06	10	30	200%
	57.87	10	29	190%
	58.68	10	25	150%
	59.48	10	23	130%
	60.29	10	21	110%
	61.10	10	18	80%
	61.91	10	17	70%
	62.72	10	16	60%
	63.53	9	15	67%
	64.34	9	15	67%
	65.15	8	15	88%
	65.96	7	13	86%
Q25	66.77	7	12	71%
	67.58	6	12	100%

	68.38	6	12	100%
	69.19	6	12	100%
	70.00	5	10	100%
	70.81	5	10	100%
	71.62	5	10	100%
	72.43	5	10	100%
	73.24	5	9	80%
	74.05	5	9	80%
	74.86	5	8	60%
	75.67	4	8	100%
	76.48	4	7	75%
	77.28	4	7	75%
	78.09	4	7	75%
	78.90	4	5	25%
	79.71	4	5	25%
	80.52	4	3	-25%
	81.33	4	3	-25%
	82.14	4	2	-50%
	82.95	4	2	-50%
	83.76	4	2	-50%
	84.57	4	2	-50%
	85.38	4	2	-50%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

For MIL2B the existing 50% of the 2-year peak flow (0.5Q2) value is equaled or exceeded 11979 15-minute time steps out of the entire simulation period of 2.1 million time steps (60 years). That is equal to 0.6% of the time. For the future full build-out conditions that existing 0.5Q2 value is exceeded 2.4% of the time. The reason for the increase is because of the increase in the total amount of runoff.

Table 22. MIL2C Flow Duration (0.5Q2 to Q50)

Frequency	Flow (cfs)	Existing	Future	Change (%)
0.5Q2	15.58	38984	55941	43%
	16.48	33998	49693	46%
	17.39	29412	44265	50%
	18.29	25562	39447	54%
	19.19	22048	35050	59%
	20.09	18695	31011	66%
	20.99	16454	27939	70%
	21.89	14453	24973	73%
	22.79	12848	22343	74%
	23.69	11443	20016	75%
	24.60	10288	17942	74%
	25.50	9295	16164	74%
	26.40	8321	14582	75%
	27.30	7467	13145	76%
	28.20	6675	11796	77%
	29.10	6023	10563	75%
	30.00	5419	9459	75%
	30.90	4830	8577	78%
Q2	31.17	4683	8340	78%
	31.80	4325	7761	79%
	32.71	3842	7004	82%
	33.61	3421	6337	85%
	34.51	3124	5733	84%
	35.41	2872	5230	82%
	36.31	2682	4715	76%
	37.21	2489	4254	71%
	38.11	2272	3840	69%
	39.01	2085	3486	67%
	39.92	1922	3183	66%
	40.82	1781	2935	65%
	41.72	1686	2716	61%
	42.62	1571	2518	60%
	43.52	1446	2339	62%
	44.42	1350	2169	61%
	45.32	1238	2006	62%
	46.22	1121	1865	66%
	47.13	970	1723	78%

	48.03	848	1560	84%
	48.93	748	1405	88%
	49.83	695	1282	84%
Q5	50.25	660	1231	87%
	50.73	620	1174	89%
	51.63	573	1064	86%
	52.53	528	973	84%
	53.43	480	905	89%
	54.34	452	847	87%
	55.24	404	792	96%
	56.14	350	731	109%
	57.04	307	678	121%
	57.94	284	611	115%
	58.84	252	556	121%
	59.74	225	505	124%
	60.64	200	464	132%
	61.54	182	422	132%
	62.45	168	394	135%
	63.35	152	363	139%
	64.25	140	338	141%
Q10	65.15	115	317	176%
	66.05	101	293	190%
	66.95	90	269	199%
	67.85	82	256	212%
	68.75	67	244	264%
	69.66	59	230	290%
	70.56	50	215	330%
	71.46	43	200	365%
	72.36	39	188	382%
	73.26	36	173	381%
	74.16	32	150	369%
	75.06	29	137	372%
	75.96	28	126	350%
	76.87	25	118	372%
	77.77	24	111	363%
	78.67	24	105	338%
	79.57	22	102	364%
	80.47	22	95	332%
	81.37	21	91	333%
	82.27	20	86	330%

	83.17	19	81	326%
	84.08	19	78	311%
	84.98	17	72	324%
	85.88	17	70	312%
Q25	86.78	17	68	300%
	87.68	16	64	300%
	88.58	15	62	313%
	89.48	15	59	293%
	90.38	14	57	307%
	91.29	13	52	300%
	92.19	13	50	285%
	93.09	11	47	327%
	93.99	11	45	309%
	94.89	11	39	255%
	95.79	11	37	236%
	96.69	10	34	240%
	97.59	10	31	210%
	98.49	10	27	170%
	99.40	10	23	130%
	100.30	10	19	90%
	101.20	9	15	67%
	102.10	8	13	63%
	103.00	8	13	63%
	103.90	8	12	50%
Q50	104.80	8	12	50%

For MIL2C the existing 50% of the 2-year peak flow (0.5Q2) value is equaled or exceeded 38984 15-minute time steps out of the entire simulation period of 2.1 million time steps (60 years). That is equal to 1.9% of the time. For the future full build-out conditions that existing 0.5Q2 value is exceeded 2.7% of the time. The reason for the increase is because of the increase in the total amount of runoff.

Table 23. MIL2D Flow Duration (0.5Q2 to Q50)

Frequency	Flow (cfs)	Existing	Future	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%
	37.01	307	378	23%

	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

For MIL2D the existing 50% of the 2-year peak flow (0.5Q2) value is equaled or exceeded 44707 15-minute time steps out of the entire simulation period of 2.1 million time steps (60 years). That is equal to 2.1% of the time. For the future full build-out conditions that existing 0.5Q2 value is exceeded 2.4% of the time. The reason for the increase is because of the increase in the total amount of runoff.

The results show that at the downstream end of all four subbasins that flows in the erosive range of 50% of 2-year flow to the 50-year flow increase. The only exception is subbasin MIL2B flows where the flows above 80 cfs decrease in number of occurrences from existing to future full build-out conditions.

Another view of the results is to look at the low flow range (zero to 10 cfs). Tables 24-27 present the flow durations in the low flow range.

Table 24 MIL2A Flow Duration (Low Flow Range)

Flow (cfs)	Existing	Future	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1480893	0%
0.20	1309640	1305853	0%
0.30	1205711	1197716	-1%
0.40	1127658	1119664	-1%
0.50	1065805	1057811	-1%
0.60	1013630	1005636	-1%
0.70	967556	960824	-1%
0.80	926531	921061	-1%
0.90	889083	884244	-1%
1.00	854790	851214	0%
1.10	823233	821339	0%
1.20	793779	794620	0%
1.30	766850	770005	0%
1.40	741604	746863	1%
1.50	718251	725614	1%
1.60	696581	706049	1%
1.70	675753	688166	2%
1.80	656398	671756	2%
1.90	638095	656188	3%
2.00	620633	641882	3%
2.10	604433	628417	4%
2.20	589075	615584	5%
2.30	574559	603381	5%
2.40	560673	591810	6%
2.50	547419	580870	6%
2.60	534796	570561	7%
2.70	522594	560673	7%
2.80	511023	551206	8%
2.90	500083	542370	8%
3.00	489774	533744	9%
3.10	479676	525329	10%
3.20	470208	517124	10%
3.30	461162	509550	10%
3.40	452115	502187	11%
3.50	443700	495034	12%
3.60	435495	488091	12%

3.70	427711	481359	13%
3.80	419926	474626	13%
3.90	412563	468104	13%
4.00	405200	462003	14%
4.10	398047	455692	14%
4.20	391104	449801	15%
4.30	384582	443910	15%
4.40	378060	438230	16%
4.50	371959	432760	16%
4.60	365858	427500	17%
4.70	359967	422241	17%
4.80	354076	417402	18%
4.90	348606	412353	18%
5.00	343136	407514	19%
5.10	337877	402675	19%
5.20	332827	398047	20%
5.30	327778	393628	20%
5.40	322939	389210	21%
5.50	318311	384792	21%
5.60	313683	380585	21%
5.70	309054	376587	22%
5.80	304846	372590	22%
5.90	300428	368593	23%
6.00	296221	364806	23%
6.10	292223	361019	24%
6.20	288226	357442	24%
6.30	284439	353866	24%
6.40	280652	350289	25%
6.50	276865	346923	25%
6.60	273289	343557	26%
6.70	269712	340191	26%
6.80	266346	336825	26%
6.90	262980	333669	27%
7.00	259614	330513	27%
7.10	256458	327358	28%
7.20	253302	324202	28%
7.30	250147	321046	28%
7.40	247201	317890	29%
7.50	244256	314734	29%
7.60	241310	311789	29%

7.70	238575	308844	29%
7.80	235630	305898	30%
7.90	232895	302953	30%
8.00	230160	300008	30%
8.10	227635	297273	31%
8.20	224900	294327	31%
8.30	222376	291382	31%
8.40	219851	288647	31%
8.50	217116	285912	32%
8.60	214802	282966	32%
8.70	212277	280231	32%
8.80	209816	277496	32%
8.90	207397	274762	32%
9.00	205082	272027	33%
9.10	202684	269292	33%
9.20	200286	266557	33%
9.30	197950	263822	33%
9.40	195552	261087	34%
9.50	193238	258352	34%
9.60	190902	255617	34%
9.70	188546	252882	34%
9.80	186106	249936	34%
9.90	183623	247201	35%

In MIL2A low flows below 1 cfs slightly decrease in the number of occurrences for the future full build-out condition compared to existing conditions. Flows above 1 cfs increase in terms of how often they occur.

Table 25. MIL2B Flow Duration (Low Flow Range)

Flow (cfs)	Existing	Future	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	997010	-6%
0.20	849741	791254	-7%
0.30	714043	675543	-5%
0.40	615373	602750	-2%
0.50	540897	550575	2%
0.60	481569	509760	6%
0.70	435074	476309	9%
0.80	396784	448118	13%
0.90	363754	423503	16%
1.00	335142	402254	20%
1.10	310527	383530	24%
1.20	288436	366279	27%
1.30	269081	350921	30%
1.40	251619	336614	34%
1.50	236051	323571	37%
1.60	221534	311368	41%
1.70	208301	299797	44%
1.80	196099	289278	48%
1.90	185096	279180	51%
2.00	174850	269923	54%
2.10	165362	261087	58%
2.20	156547	252882	62%
2.30	148321	244887	65%
2.40	140831	237524	69%
2.50	133909	230370	72%
2.60	127409	223428	75%
2.70	121328	216906	79%
2.80	115690	210805	82%
2.90	110262	204788	86%
3.00	105234	199023	89%
3.10	100374	193553	93%
3.20	95851	188315	96%
3.30	91496	183181	100%
3.40	87541	178321	104%
3.50	83796	173609	107%
3.60	80240	169107	111%

3.70	76853	164731	114%
3.80	73698	160439	118%
3.90	70710	156273	121%
4.00	67765	152171	125%
4.10	64946	148216	128%
4.20	62274	144450	132%
4.30	59875	140810	135%
4.40	57498	137297	139%
4.50	55205	133846	142%
4.60	52975	130543	146%
4.70	50913	127345	150%
4.80	48977	124169	154%
4.90	47189	121076	157%
5.00	45401	118173	160%
5.10	43697	115375	164%
5.20	42056	112661	168%
5.30	40499	109968	172%
5.40	38963	107275	175%
5.50	37511	104666	179%
5.60	36102	102184	183%
5.70	34798	99722	187%
5.80	33493	97303	191%
5.90	32294	94967	194%
6.00	31158	92632	197%
6.10	30106	90486	201%
6.20	29033	88319	204%
6.30	27981	86173	208%
6.40	26908	84175	213%
6.50	25940	82176	217%
6.60	24952	80219	221%
6.70	24026	78326	226%
6.80	23037	76411	232%
6.90	22153	74497	236%
7.00	21291	72625	241%
7.10	20481	70963	246%
7.20	19736	69174	250%
7.30	19008	67470	255%
7.40	18312	65871	260%
7.50	17609	64335	265%
7.60	16963	62737	270%

7.70	16343	61201	274%
7.80	15728	59686	279%
7.90	15108	58192	285%
8.00	14533	56720	290%
8.10	13978	55247	295%
8.20	13441	53879	301%
8.30	12941	52470	305%
8.40	12476	51144	310%
8.50	12019	49756	314%
8.60	11580	48451	318%
8.70	11171	47231	323%
8.80	10738	46032	329%
8.90	10347	44812	333%
9.00	9964	43655	338%
9.10	9583	42498	343%
9.20	9236	41340	348%
9.30	8887	40225	353%
9.40	8552	39131	358%
9.50	8224	38058	363%
9.60	7862	36986	370%
9.70	7488	35892	379%
9.80	7115	34776	389%
9.90	6743	33682	400%

In MIL2B low flows below 0.5 cfs slightly decrease in the number of occurrences for the future full build-out condition compared to existing conditions. Flows above 0.5 cfs increase in terms of how often they occur.

Table 26. MIL2C Flow Duration (Low Flow Range)

Flow (cfs)	Existing	Future	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1356346	1%
0.20	1175415	1180885	0%
0.30	1065805	1073379	1%
0.40	982493	992592	1%
0.50	914329	927793	1%
0.60	854790	870990	2%
0.70	802615	821550	2%
0.80	756120	779052	3%
0.90	714885	741814	4%
1.00	678068	708153	4%
1.10	644827	678068	5%
1.20	614111	651559	6%
1.30	586130	627575	7%
1.40	560673	606116	8%
1.50	537531	586130	9%
1.60	515651	567826	10%
1.70	495454	550365	11%
1.80	476730	534375	12%
1.90	459479	519228	13%
2.00	443700	504922	14%
2.10	428342	491667	15%
2.20	414667	478834	15%
2.30	401623	466842	16%
2.40	389000	455271	17%
2.50	377219	444331	18%
2.60	366068	433601	18%
2.70	355339	423503	19%
2.80	345240	413825	20%
2.90	335562	404568	21%
3.00	326306	395732	21%
3.10	317469	387317	22%
3.20	309264	379112	23%
3.30	301270	371117	23%
3.40	293696	363544	24%
3.50	286543	356180	24%
3.60	279390	349237	25%

3.70	272868	342716	26%
3.80	266346	336194	26%
3.90	260245	329882	27%
4.00	254565	323991	27%
4.10	248884	318101	28%
4.20	243625	312420	28%
4.30	238575	306950	29%
4.40	233526	301691	29%
4.50	228898	296431	30%
4.60	224480	291382	30%
4.70	220272	286543	30%
4.80	216275	282125	30%
4.90	212277	277496	31%
5.00	208533	273078	31%
5.10	204830	268871	31%
5.20	201232	264663	32%
5.30	197656	260455	32%
5.40	194248	256668	32%
5.50	190902	252671	32%
5.60	187578	248674	33%
5.70	184402	244887	33%
5.80	181393	241100	33%
5.90	178490	237313	33%
6.00	175755	233526	33%
6.10	172999	229739	33%
6.20	170285	226163	33%
6.30	167613	222586	33%
6.40	164983	219220	33%
6.50	162416	215644	33%
6.60	159955	212277	33%
6.70	157409	208911	33%
6.80	154885	205503	33%
6.90	152507	202221	33%
7.00	150151	198918	32%
7.10	147858	195678	32%
7.20	145544	192480	32%
7.30	143166	189346	32%
7.40	140831	186358	32%
7.50	138559	183223	32%
7.60	136245	180173	32%

7.70	133909	177080	32%
7.80	131637	174072	32%
7.90	129428	171105	32%
8.00	127303	168181	32%
8.10	125136	165341	32%
8.20	123012	162459	32%
8.30	120866	159681	32%
8.40	118741	156904	32%
8.50	116763	154169	32%
8.60	114786	151498	32%
8.70	112808	148910	32%
8.80	110830	146364	32%
8.90	108916	143755	32%
9.00	107064	141210	32%
9.10	105255	138664	32%
9.20	103425	136076	32%
9.30	101531	133468	31%
9.40	99722	130943	31%
9.50	97955	128397	31%
9.60	96103	125894	31%
9.70	94231	123348	31%
9.80	92295	120760	31%
9.90	90339	118215	31%

In MIL2C there is no decrease in low flows.

Table 27. MIL2D Flow Duration (Low Flow Range)

Flow (cfs)	Existing	Future	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%

3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%
4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%

7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

In MIL2D there is no decrease in low flows.

In the subbasins where there is a decrease in the lowest of the low flows (less than 1 cfs) with the future full build-out condition the decrease is due to loss of forest and field acreage. Other than reforestation, there is no stormwater mitigation strategy that will change this low flow decrease. However, it should be noted that with the modeled mitigation strategy provided by Clark County that the higher low flows (5-10 cfs) will increase.

SUMMARY

A WWHM-SWMM HSPF continuous simulation hydrologic model was constructed for the MIL2 drainage area. The model included four subbasins: MIL2A, MIL2B, MIL2C, and MIL2D.

Both existing and future full build-out land conditions were modeled, using land cover and type data provided by Clark County. Existing conditions included existing significant stormwater control facilities. Future conditions included both existing stormwater control facilities and representative future facilities based on Clark County Stormwater Manual detention facility

standards under MR #7. Using those standards, the predevelopment land cover is from the Mill Creek alternative flow control standard, which is 2002 land cover with impervious mapped as pasture/field.

Water balance, flow frequency, and flow durations were computed for both existing and future conditions based on the simulation period of water year 1949 through 2008 using a 15-minute time step.

Water balance results show a 27% increase in total annual water volume in MIL2 due to land use changes from existing land conditions to future full build-out conditions.

Flow frequency results show a general increase in size of the 2-year and 5-year flood flows but a decrease in the 100-year flood flows for the streamflow in MIL2A, MIL2B, and MIL2C. MIL2D was the exception due to no expected increase in impervious area, but a reduction in forest area.

Flow duration results show a general increase in the occurrence of (or number of) flows in the 50% of the 2-year peak flow to the 50-year peak flow. This is due to a general increase in total runoff volume, as shown in the water balance results. Low flows are also increased, except for the lowest flows (flows less than 1 cfs). This is caused by the reduction in the groundwater contribution to the stream reaches due to an increase in impervious surfaces in subbasins MIL2A and MIL2B.

Clark County

Mill Creek Tributary Catchment-Scale Stormwater Planning

Appendix D
Strategy Analysis Memo

Prepared by

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Clear Creek Solutions, Inc.

April. 2022

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MEMO

DATE: 4 April 2022

TO: Rod Swanson, Program Manager II, Clark County Public Works

CC: Subhash Poudyal, P.E., Stormwater Engineer, Clark County Public Works
Joe Brascher, President, Clear Creek Solutions, Inc.

FROM: Doug Beyerlein, PE

SUBJECT: MIL2 Task 7 Modeling Results

INTRODUCTION

The purpose of this memo is to present the modeling results of the WWHM-SWMM future modeling scenarios based on the Task 4 strategies discussed in the MIL2 Task 4 Modeling Scenarios memo and updated based on your and your staff's comments following preliminary review of the results. The modeling scenarios were the template for the model runs. The model results have been compared with the Task 5 existing scenario model results.

SUMMARY

Six different future full build-out condition scenarios were modeled. The model results were summarized in terms of total runoff volume, flood frequency, low flow durations (0.0 to 9.9 cfs), and erosive flow duration hours (0.5Q2).

The conversion from impervious pavement to permeable pavement had an insignificant effect on subbasin flows because the amount of permeable pavement (number of acres) was extremely small compared to the total MIL2 drainage area.

Bioretention, infiltration ponds, and leaky wet ponds all performed similarly depending on the underlying native soil infiltration rates. Due to the dominance of SG4 soils found in the MIL2 subbasins relatively low infiltration rates were used in the models. This produced some benefit by decreasing peak flows and increasing low flows.

The largest benefit in managing subbasin future flows to mimic existing flows was produced by the selection of lower low flow duration threshold than the current county standard (0.50Q2). The lower the low flow duration threshold for sizing detention ponds the greater the benefit that is achieved in reducing future full build-out flows to existing flow conditions.

MODEL SCENARIOS

Model Scenario 1: Permeable Pavement

Scenario 1 tests the effectiveness of permeable pavement. Run 1A assumed soil permeability/infiltration rate as 0.15 inches per hour. Run 1B assumed a soil infiltration rate of 0.25 inches per hour.

Run 1A: Impervious surfaces were replaced with permeable pavement, where appropriate. Used a native soil infiltration rate of 0.15 inches per hour.

Assumptions:

1. For model input Clark County provided the number of acres of permeable pavement in subbasin 2A, 2B, and 2C. The surface runoff from the permeable pavement areas drains to the previously-size susbbasin stormwater detention facilities modeled in Task 5b.
2. The permeable pavement areas have a bottom slope of 0.00%.
3. The permeable pavement layer is 6 inches; with a porosity of 0.25.
4. The gravel layer under the permeable pavement is 12 inches; with a porosity of 0.40.
5. There is no underdrain.
6. Sheet flow on the surface of the permeable pavement occurs when/if surface ponding exceeds 0.01 feet.

Run 1B: Same as Run 1A, except with a native soil infiltration rate of 0.25 inches per hour.

Assumptions: Same as for Run 1A.

Model Scenario 2: Bioretention

Scenario 2 tests the effectiveness of bioretention. Run 2A assumes soil permeability/infiltration rate as 0.15 inches per hour. Run 2B assumes a soil infiltration rate of 0.25 inches per hour.

Run 2A: Bioretention facilities were added, where appropriate. Used a native soil infiltration rate of 0.15 inches per hour (infiltration reduction factor 1.00).

Assumptions:

1. For model input Clark County provided the number of acres of impervious and landscape (lawn) in subbasin 2A, 2B, and 2C that drains to each subbasin bioretention facility. The surface discharge (riser and underdrain flow) from the subbasin

bioretention facility drains to the previously-size subbasin stormwater detention facility modeled in Task 5b.
2. Each bioretention facility was sized to meet MR #6 (Water Quality) by filtering at least 91% of the total runoff volume entering the bioretention facility.
3. The bioretention facilities have a bottom slope of 0.00%.
4. The bioretention facilities have a freeboard height of 1 foot above the top of the riser.
5. The bioretention facilities have a riser height of 6 inches above the bioretention ponding surface.
6. The top bioretention soil layer is the standard Ecology soil mix (SMMWW 12 in/hr); soil layer depth is 18 inches.
7. Under the top layer is a gravel layer 24 inches in depth.
8. There is a perforated pipe collection system and underdrain located at the top of the gravel layer (24 inches above the bottom).
9. The bioretention facilities have vertical side slopes both subsurface and above the surface.

Run 2B: Same as Run 2A, except with a native soil infiltration rate of 0.25 inches per hour (infiltration reduction factor 1.00).

Assumptions: Same as for Run 2A.

Model Scenario 3: Infiltration Ponds

Scenario 3 tests the effectiveness of infiltration ponds. Run 3A assumes soil permeability/ infiltration rate as 0.15 inches per hour. Run 3B assumes a soil infiltration rate of 0.25 inches per hour.

Run 3A: Infiltration was added to the future full build-out model subbasin stormwater ponds. Used a native soil infiltration rate of 0.15 inches per hour.

Assumptions:

1. No new ponds were added to the future full build-out model.
2. Infiltration was allowed through the pond side slopes if they are 3 to 1 or shallower.

Run 3B: Same as Run 3A, except with a native soil infiltration rate of 0.25 inches per hour.

Assumptions: Same as for Run 3A.

Model Scenario 4: Increase Detention Pond Size/Standards

Scenario 4 tests different detention pond sizing standards to control flows to the degree needed to match existing conditions model flows without benefit of LID BMPs. It should be noted that the detention ponds in the future full build-out model have been sized to match

existing conditions model flows for flow duration in the range of half of the 2-year peak flow (0.50Q2) to the 50-year peak flow (Q50).

Run 4A: The lower threshold flow duration standard for sizing the subbasin detention ponds was lower from 50% of the 2-year peak flow to 8% of the 2-year peak flow. The subbasin detention ponds were then resized using the new flow control standard of 8% of Q2 to Q50. Used a native soil infiltration rate of 0.15 inches per hour.

Assumptions:

1. No new ponds were added to the future full build-out model.
2. Infiltration was allowed through the pond side slopes if they are 3 to 1 or shallower.

Run 4B: The lower threshold flow duration standard for sizing the subbasin detention ponds was maintained at the current standard of 50% of the 2-year peak flow (0.50Q2). The predevelopment subbasin drainage area to each pond was assumed to be forested instead of the current standard of existing land use. The subbasin detention ponds were then resized using the new forest predevelopment standard runoff. Used a native soil infiltration rate of 0.15 inches per hour.

Assumptions: Same as for Run 4A.

Run 4C: Run 4C was identical to Run 4B with the use of forest vegetation as the standard for calculating predevelopment standard runoff but with the addition of the upstream bioretention facilities from Run 2 and the addition of the infiltration assumptions in Run 3 in the sizing of the Run 4C subbasin detention ponds. Used a native soil infiltration rate of 0.15 inches per hour.

Assumptions: Same as for Run 4A.

Model Scenario 5: Dead Storage as Leaky MR #6 Wet Ponds

Scenario 5 tests the effectiveness of dead storage in the bottom of the subbasin detention ponds. Run 5A assumes soil permeability/infiltration rate as 0.15 inches per hour. Run 5B assumes a soil infiltration rate of 0.25 inches per hour.

Run 5A: Dead storage was added to the subbasin detention ponds in the future full build-out model to allow them to act as leaky wet ponds. Used native soil infiltration rate of 0.15 inches per hour.

Assumptions:

1. No new ponds were added to the future full build-out model.
2. Infiltration was allowed through the pond side slopes if they are 3 to 1 or shallower.

3. The volume of dead storage added to the subbasin detention ponds was calculated to meet MR #6 (Water Quality) by providing 24-hour water quality volume (as calculated by WWHM2012) below the height of the bottom orifice in each pond.

Run 5B: Same as Run 5A, except with a native soil infiltration rate of 0.25 inches per hour.

Assumptions: Same as for Run 5A.

Model Scenario 6: All Strategies Combined

Scenario 6 tests a combination of effective strategies, as determined by Clark County, following the preliminary review of the model results from scenarios 1 through 5.

Run 6A: This was a combination of strategies that included bioretention (Run 2A), infiltration ponds (Run 3A), and a lower flow duration standard (similar but not identical to Run 4A). The lower flow duration threshold was lowered to 15% of the 2-year peak flow (0.15Q2). Used native soil infiltration rate of 0.15 inches per hour.

Assumptions: As previously described above for the model runs on which this scenario is based.

Run 6B: This was a combination of strategies that included bioretention (Run 2A), infiltration ponds (Run 3A), and a lower flow duration standard (similar but not identical to Run 4A). The lower flow duration threshold was lowered to 30% of the 2-year peak flow (0.30Q2). Used native soil infiltration rate of 0.15 inches per hour.

Assumptions: As previously described above for the model runs on which this scenario is based.

MODEL RESULTS BY METRIC

The model results for all 13 of the computer model runs of the future full build-out condition with the implementation of the above described scenario strategies were compared with the Task 5 existing scenario model results in terms of the following streamflow metrics: total runoff volume, flood frequency, low flow durations (0.0 to 9.9 cfs), and erosive flow duration hours (0.5Q2). The model results are summarized below; the entire set of results is presented in the attached appendices.

Total Runoff Volume

Total runoff volume was calculated at the downstream end of each subbasin both as an average annual value and as average monthly values (in units of acre-feet of water). Note that Subbasin 2A includes the upstream flows from subbasins 2B, 2C, and 2D; Subbasin 2C includes the upstream flows from Subbasin 2D.

All future model scenarios produce more total runoff volume than the existing land use conditions. The increase in average annual runoff volume at the downstream of MIL2 (at the downstream end of Subbasin 2A) varies from 19 to 27 percent, depending on the scenario. The reason for the increase in average annual runoff volume from the existing land use conditions is because of the decrease in forest vegetation and the increase in impervious surfaces resulting from future full build-out land changes, especially in subbasins 2A, 2B, and 2C. This land use change decreases evapotranspiration and increases runoff.

Table 1 shows the increase in average annual runoff volume at the downstream end of each subbasin. Subbasin 2B has the largest increase in average annual runoff volume of the four subbasins. This is because it has the largest percent change in land use from existing to future full build-out conditions of the four subbasins. Subbasin 2D has the smallest increase in percent change because it is located outside of the Urban Growth Area and there is no expected in impervious area in the subbasin. The reason for the 7 percent increase in average annual runoff volume in Subbasin 2D is solely because of the expected reduction in forest area in the subbasin.

Table 1. Average Annual Runoff Volume Increase

Model Run	Description	MIL2A	MIL2B	MIL2C	MIL2D
Future	Full Build-out Baseline	27%	57%	21%	7%
Run 1A	Porous Pavement (0.15 in/hr)	26%	55%	21%	7%
Run 1B	Porous Pavement (0.25 in/hr)	26%	55%	21%	7%
Run 2A	Bioretention (0.15 in/hr)	19%	58%	12%	7%
Run 2B	Bioretention (0.25 in/hr)	20%	58%	12%	7%
Run 3A	Pond Infiltration (0.15 in/hr)	27%	57%	21%	7%
Run 3B	Pond Infiltration (0.25 in/hr(	27%	57%	21%	7%
Run 4A	Pond Size 0.08Q2	19%	58%	12%	7%
Run 4B	Pond Size Forest	19%	58%	12%	7%
Run 4C	Pond Size Forest+Bioretention	19%	58%	12%	7%
Run 5A	WQ Leaky Wet Pond (0.15 in/hr)	21%	46%	17%	7%
Run 5B	WQ Leaky Wet Pond (0.25 in/hr)	21%	46%	16%	7%
Run 6A	Pond Size 0.15Q2 (0.15 in/hr)	19%	58%	12%	7%
Run 6B	Pond Size 0.30Q2 (0.15 in/hr)	19%	58%	12%	7%

Appendix A shows all of the average annual and monthly runoff volumes for each subbasin.

Flood Frequency

Flood frequency was calculated at the downstream end of each subbasin for the 2-, 5-, 10-, 25-, 50-, and 100-year flow (in units of cubic feet per second). Note that Subbasin 2A includes the upstream flows from subbasins 2B, 2C, and 2D; Subbasin 2C includes the upstream flows from Subbasin 2D.

Flood frequency is calculated using the USGS Log Pearson Type III methodology. This method uses the mean, standard deviation, and skew of the log of the annual peak flow values to compute the 2-, 5-, 10-, 25-, 50-, and 100-year flow values. Changes in the lower annual peak flows can change the standard deviation and the skew, which in turn can change the 100-year flow value even if the higher annual peak flows do not change from one scenario to the next. For this reason it is more important to evaluate the changes in the 2-year flow values than the 100-year flow values.

Table 2 shows the percent change in the 2-year peak flow value at the downstream end of each subbasin for each model run. The only scenario model runs that decrease the 2-year flood frequency value for subbasins 2A, 2B, and 2C are runs 4A, 6A, and 6B. Each of these model runs use a lower low flow threshold for sizing the subbasin detention ponds (0.08Q2, 0.15Q2, and 0.30Q2, respectively) than the existing standard (0.50Q2). Bioretention (runs 2A and 2B) and the forest predevelopment standard (runs 4B and 4C) also do a reasonably good job in reducing the future 2-year peak flow value back to the existing conditions value.

Table 2. 2-Year Flood Frequency Value Changes

Model Run	Description	MIL2A	MIL2B	MIL2C	MIL2D
Future	Full Build-out Baseline	25%	50%	35%	9%
Run 1A	Porous Pavement (0.15 in/hr)	19%	32%	29%	9%
Run 1B	Porous Pavement (0.25 in/hr)	19%	32%	29%	9%
Run 2A	Bioretention (0.15 in/hr)	6%	14%	15%	9%
Run 2B	Bioretention (0.25 in/hr)	6%	9%	11%	9%
Run 3A	Pond Infiltration (0.15 in/hr)	25%	49%	35%	9%
Run 3B	Pond Infiltration (0.25 in/hr(	24%	48%	34%	9%
Run 4A	Pond Size 0.08Q2	-25%	-52%	-9%	9%
Run 4B	Pond Size Forest	2%	1%	13%	9%
Run 4C	Pond Size Forest+Bioretention	3%	1%	15%	9%
Run 5A	WQ Leaky Wet Pond (0.15 in/hr)	28%	49%	37%	9%
Run 5B	WQ Leaky Wet Pond (0.25 in/hr)	26%	46%	37%	9%
Run 6A	Pond Size 0.15Q2 (0.15 in/hr)	-17%	-36%	-1%	9%
Run 6B	Pond Size 0.30Q2 (0.15 in/hr)	-5%	-12%	9%	9%

Appendix B shows all of the flood frequency values for each subbasin.

Low Flow Durations

Low flow durations were calculated at the downstream end of each subbasin for range of low flows from 0.0 cfs to 9.9 cfs (cubic feet per second). Note that Subbasin 2A includes the upstream flows from subbasins 2B, 2C, and 2D; Subbasin 2C includes the upstream flows from Subbasin 2D. This range of low flows was selected because it represents dry weather flows that are fed by groundwater inflow to the stream. These dry weather flows support and promote aquatic and riparian environments in Mill Creek and its tributaries.

For the purposes of comparison, all scenario run low flow duration results were calculated for a low flow of 1.0 cfs. All future model scenarios increase the 1.0 cfs low flow durations (number of hours that those flows are equaled or exceeded) when compared to the existing land use conditions for the majority of the subbasins. The increase in the low flow durations at the downstream of MIL2 (at the downstream end of Subbasin 2A) varies from 3 to 40 percent, depending on the scenario. The greatest increase in low flows is shown in the water quality leaky wet pond with an infiltration of 0.25 inches per hour (Run 5B). The constant supply of groundwater from infiltration through the bottom of the leaky wet pond increases the 1.0 cfs low flows by 40 percent at the downstream end of MIL2A. The same scenario run (Run 5B) shows a decrease in the 1.0 cfs low flows at MIL2B. This is because most of the low flows from MIL2B are smaller than 1.0 cfs, due to the relatively small size of the MIL2B subbasin drainage

area. At flows less than 1.0 cfs in MIL2B there is actually a large increase in durations. More details are available in Appendix C.

Table 3 shows the percent change in 1.0 cfs low flow durations at the downstream end of each subbasin.

Table 3. Low Flow Duration Percent Changes

Model Run	Description	MIL2A	MIL2B	MIL2C	MIL2D
Future	Full Build-out Baseline	0%	20%	4%	4%
Run 1A	Porous Pavement (0.15 in/hr)	6%	30%	8%	4%
Run 1B	Porous Pavement (0.25 in/hr)	6%	30%	8%	4%
Run 2A	Bioretention (0.15 in/hr)	18%	65%	14%	4%
Run 2B	Bioretention (0.25 in/hr)	18%	64%	14%	4%
Run 3A	Pond Infiltration (0.15 in/hr)	3%	22%	6%	4%
Run 3B	Pond Infiltration (0.25 in/hr(	5%	25%	7%	4%
Run 4A	Pond Size 0.08Q2	30%	97%	20%	4%
Run 4B	Pond Size Forest	20%	70%	15%	4%
Run 4C	Pond Size Forest+Bioretention	20%	70%	15%	4%
Run 5A	WQ Leaky Wet Pond (0.15 in/hr)	18%	-14%	0%	4%
Run 5B	WQ Leaky Wet Pond (0.25 in/hr)	40%	-4%	9%	4%
Run 6A	Pond Size 0.15Q2 (0.15 in/hr)	25%	85%	17%	4%
Run 6B	Pond Size 0.30Q2 (0.15 in/hr)	21%	73%	15%	4%

Appendix C shows all of the low flow durations from 0.0 to 9.9 cfs for each subbasin.

Erosive Flow Duration Hours

Erosive flow duration hours were calculated at the downstream end of each subbasin for the existing condition flow equal to one-half of the 2-year peak flow (0.50Q2). Note that Subbasin 2A includes the upstream flows from subbasins 2B, 2C, and 2D; Subbasin 2C includes the upstream flows from Subbasin 2D. This flow level was selected because it represents the streamflow rate at which erosive flows typically occur in Western Washington streams, according to the Washington Department of Ecology.

For the purposes of comparison, all scenario run 0.50Q2 flow duration results were calculated based on the existing condition flows at the downstream end of each subbasin. The only scenario runs that decreased the average number of hours that 0.50Q2 flows occur per year compared with the existing conditions were the scenarios where the lower flow threshold for pond sizing was decreased from 0.50Q2 to 0.08Q2 (Run 4A) or 0.15Q2 (Run 6A). In all other scenarios there was an increase in the average number of hours that 0.50Q2 flows occur per year.

Table 4 shows the average number of hours that 0.50Q2 flows occur per year at the downstream end of each subbasin. Table 5 shows the percent change in the 0.50Q2 flow hours per year at the downstream end of each subbasin.

Table 4. 0.50Q2 Flow Hours per Year

Model Run	Description	MIL2A	MIL2B	MIL2C	MIL2D
Existing	Existing Land Use Conditions	75	50	162	186
Future	Full Build-out Baseline	150	207	233	210
Run 1A	Porous Pavement (0.15 in/hr)	136	164	223	210
Run 1B	Porous Pavement (0.25 in/hr)	136	164	223	210
Run 2A	Bioretention (0.15 in/hr)	88	105	158	210
Run 2B	Bioretention (0.25 in/hr)	85	99	160	210
Run 3A	Pond Infiltration (0.15 in/hr)	146	195	229	210
Run 3B	Pond Infiltration (0.25 in/hr(	143	188	227	210
Run 4A	Pond Size 0.08Q2	54	16	149	210
Run 4B	Pond Size Forest	85	94	156	210
Run 4C	Pond Size Forest+Bioretention	85	94	156	210
Run 5A	WQ Leaky Wet Pond (0.15 in/hr)	136	152	227	210
Run 5B	WQ Leaky Wet Pond (0.25 in/hr)	125	129	220	210
Run 6A	Pond Size 0.15Q2 (0.15 in/hr)	70	49	152	210
Run 6B	Pond Size 0.30Q2 (0.15 in/hr)	83	85	156	210

Table 5. 0.50Q2 Flow Hours Percent Changes

Model Run	Description	MIL2A	MIL2B	MIL2C	MIL2D
Future	Full Build-out Baseline	100%	314%	44%	13%
Run 1A	Porous Pavement (0.15 in/hr)	81%	228%	38%	13%
Run 1B	Porous Pavement (0.25 in/hr)	81%	228%	38%	13%
Run 2A	Bioretention (0.15 in/hr)	17%	110%	-2%	13%
Run 2B	Bioretention (0.25 in/hr)	13%	98%	-1%	13%
Run 3A	Pond Infiltration (0.15 in/hr)	95%	290%	41%	13%
Run 3B	Pond Infiltration (0.25 in/hr(	91%	276%	40%	13%
Run 4A	Pond Size 0.08Q2	-28%	-68%	-8%	13%
Run 4B	Pond Size Forest	13%	88%	-4%	13%
Run 4C	Pond Size Forest+Bioretention	13%	88%	-4%	13%
Run 5A	WQ Leaky Wet Pond (0.15 in/hr)	81%	204%	40%	13%
Run 5B	WQ Leaky Wet Pond (0.25 in/hr)	67%	158%	36%	13%
Run 6A	Pond Size 0.15Q2 (0.15 in/hr)	-7%	-2%	-6%	13%
Run 6B	Pond Size 0.30Q2 (0.15 in/hr)	11%	70%	-4%	13%

Appendix D shows all of the erosive flow durations from 0.50Q2 to Q50 for each subbasin.

MODEL RESULTS BY SCENARIO

The model results for all 13 of the computer model runs of the future full build-out condition with the implementation of the above described scenario strategies are summarized below. The entire set of results is presented in the attached appendices.

Model Scenario 1: Permeable Pavement

Scenario 1 tests the effectiveness of permeable pavement. Run 1A assumed soil permeability/infiltration rate as 0.15 inches per hour. Run 1B assumed a soil infiltration rate of 0.25 inches per hour.

The conversion of future impervious pavement to permeable pavement had a very minor effect on streamflows. For both Run 1A and 1B 100 percent of the rain that fell on the permeable pavement infiltrated into the underlying native soil and in the process changed from surface runoff to groundwater. This is a positive effect on the overall streamflow. The reason why this conversion from impervious pavement to pervious pavement had such a small effect was because the amount of land (number of acres) was so small compared to the total MIL2 drainage area. The total number of acres converted to permeable pavement is only 42 acres in the total MIL2 drainage area of 1379 acres; this is approximately 3 percent of the total area. However, at a local level permeable pavement can play a major role in reducing surface runoff and increasing groundwater.

Model Scenario 2: Bioretention

Scenario 2 tests the effectiveness of bioretention. Run 2A assumed soil permeability/ infiltration rate as 0.15 inches per hour. Run 2B assumed a soil infiltration rate of 0.25 inches per hour.

Bioretention with infiltration included reduces peak flows and provides water quality treatment. The bioretention facility in each subbasin was sized to treat 91 percent of the total runoff volume entering the facility (Ecology Minimum Requirement #6). Q2 values were only 6 to 15 percent higher than existing condition Q2 values for the streamflow at the downstream end of each subbasin. Low flows were increased, most notedly in Subbasin 2B where the bioretention surface area was approximately 6 percent of the total subbasin area.

Model Scenario 3: Infiltration Ponds

Scenario 3 tests the effectiveness of infiltration ponds. Run 3A assumed soil permeability/ infiltration rate as 0.15 inches per hour. Run 3B assumed a soil infiltration rate of 0.25 inches per hour.

The MIL2A, 2B, and 2C subbasin detention ponds do not include infiltration in the future full build-out model. Runs 3A and 3B added infiltration to these subbasin future ponds. The addition of infiltration decreased the downstream peak flows and increased low flows, but not as effectively as bioretention. This is because the footprints of these detention ponds are relatively small in comparison to their drainage area. If the subbasin soils had higher infiltration rates than assumed for Run 3A (0.15 in/hr) and Run 3B (0.25 in/hr) then the effectiveness of the infiltration ponds would be increased proportionally.

Model Scenario 4: Increase Detention Pond Size/Standards

Scenario 4 tests different detention pond sizing standards to control flows to the degree needed to match existing conditions model flows without benefit of LID BMPs. It should be noted that the detention ponds in the future full build-out model have been sized to match existing conditions model flows for flow duration in the range of half of the 2-year peak flow (0.50Q2) to the 50-year peak flow (Q50).

Three different model runs were used to evaluate the effectiveness of different standards in sizing detention ponds. Of the three modeled, Run 4A was the most effective in reducing peak flows and increasing low flows. Run 4A was based on sizing the ponds to a flow duration range of 0.08Q2 to Q50. This produced relatively large detention ponds with small bottom orifices (the bottom orifice diameter controls the flow durations in the range of the lower limit (in this case 0.08Q2) to Q2. This lower flow duration threshold (0.08Q2) is the same as the Ecology lower flow duration threshold value for Minimum Requirement #5 (LID flow control).

Model runs 4B and 4C maintain 0.50Q2 as the lower limit for the stream protection flow duration range but use forest vegetation as the predevelopment land use condition. Run 4C also included upstream bioretention and infiltration in the sizing of the detention ponds. Both 4B and 4C produce relatively similar results and neither was as effective in reducing future condition streamflows back to existing conditions.

One issue that comes into consideration when using a lower low flow threshold for sizing detention ponds is the size of the detention pond outlet control structure bottom orifice diameter. Using Clark County's current standard (0.50Q2 to Q50) on SG4 soils in the MIL2 drainage area for a conversion of 1 acre of field vegetation to impervious surfaces, the required bottom orifice diameter size is 1.7 inches. Changing the standard from 0.50Q2 to 0.08Q2 reduces the bottom orifice diameter to 0.6 inches. The diameter is considerably smaller when sizing a detention pond for only 5000 square feet of impervious surfaces.

Model Scenario 5: Dead Storage as Leaky MR #6 Wet Ponds

Scenario 5 tests the effectiveness of dead storage in the bottom of the subbasin detention ponds. Run 5A assumed soil permeability/infiltration rate as 0.15 inches per hour. Run 5B assumed a soil infiltration rate of 0.25 inches per hour.

The wet pond dead storage volume was added to the subbasin detention ponds below the height of the bottom orifice in each subbasin detention pond. This dead storage provided a continuous source of groundwater from each subbasin pond. The dead storage groundwater increased the low flows in subbasins 2A, 2B, and 2C (in Subbasin 2B the increase was in flows less than 1.0 cfs) somewhat similar to the results for bioretention (Scenario 2) and pond infiltration (Scenario 3). Dead storage was less successful in reducing the average number of hours that 0.50Q2 flows occur per year and the results were very similar to pond infiltration (Scenario 3), which is expected as they are both providing similar detention pond discharges to the stream.

Model Scenario 6: All Strategies Combined

Scenario 6 tests a combination of effective strategies. Clark County decided that the effective strategies included bioretention (Run 2A), infiltration ponds (Run 3A), and a lower flow duration standard (similar but not identical to Run 4A). Run 6A used a lower flow duration threshold of 0.15Q2; Run 6B used 0.30Q2. Both runs used a native soil infiltration rate of 0.15 inches per hour.

Both Run 6A and 6B produced results similar to Run 4A. Neither was as effective in reducing high flows and increasing low flows as Run 4A. The determining factor in each run was the selection of the lower flow duration standard. Run 4A (0.08Q2) was more effective than Run 6A (0.15Q2) which, in turn, was more effective than Run 6B (0.30Q2). A lower low flow duration threshold appears to be the most significant factor in reducing future full build-out flows to existing flow conditions.

RESULTS SUMMARY

Six different future full build-out condition scenarios were modeled. The model results were summarized in terms of total runoff volume, flood frequency, low flow durations (0.0 to 9.9 cfs), and erosive flow duration hours (0.5Q2).

The conversion from impervious pavement to permeable pavement had an insignificant effect on subbasin flows because the amount of permeable pavement (number of acres) was extremely small compared to the total MIL2 drainage area.

Bioretention, infiltration ponds, and leaky wet ponds all performed similarly depending on the underlying native soil infiltration rates. Due to the dominance of SG4 soils found in the MIL2 subbasins relatively low infiltration rates were used in the models. This produced some benefit by decreasing peak flows and increasing low flows.

The largest benefit in managing subbasin future flows to mimic existing flows was produced by the selection of lower low flow duration threshold than the current county standard (0.50Q2).

The lower the low flow duration threshold for sizing detention ponds the greater the benefit that is achieved in reducing future full build-out flows to existing flow conditions.

APPENDIX A: Total Runoff Volume

MIL2A	ac-ft		
Month	Existing	Future	Change
Jan	521.6	590.7	13%
Feb	376.2	416.5	11%
Mar	280.9	317.9	13%
Apr	133.0	159.0	20%
May	72.9	99.8	37%
Jun	42.1	62.2	48%
Jul	10.7	17.3	62%
Aug	13.3	27.8	109%
Sep	24.0	51.4	114%
Oct	62.6	128.1	105%
Nov	223.3	362.2	62%
Dec	444.5	560.6	26%
Annual	2205.1	2793.5	27%

MIL2B	ac-ft		
Month	Existing	Future	Change
Jan	106.7	134.8	26%
Feb	77.1	94.0	22%
Mar	57.5	73.7	28%
Apr	26.9	38.9	45%
May	14.5	27.3	88%
Jun	8.2	17.9	118%
Jul	2.0	5.3	159%
Aug	2.4	9.3	287%
Sep	4.3	17.2	300%
Oct	11.3	40.9	261%
Nov	42.6	98.9	132%
Dec	88.8	134.4	51%
Annual	442.3	692.5	57%

MIL2C	ac-ft		
Month	Existing	Future	Change
Jan	315.8	348.9	10%
Feb	228.9	247.8	8%
Mar	169.1	186.2	10%
Apr	78.2	89.9	15%
May	40.2	52.0	29%
Jun	22.3	31.1	39%
Jul	5.2	8.1	54%
Aug	5.7	12.1	111%
Sep	10.1	22.3	120%
Oct	28.3	58.0	105%
Nov	120.8	187.8	55%
Dec	263.4	320.2	22%
Annual	1288.1	1564.4	21%

MIL2D	ac-ft		
Month	Existing	Future	Change
Jan	203.4	212.0	4%
Feb	147.5	151.9	3%
Mar	108.9	112.0	3%
Apr	50.5	51.8	3%
May	26.1	26.8	3%
Jun	14.5	14.9	3%
Jul	3.4	3.5	2%
Aug	3.9	4.3	11%
Sep	6.8	7.7	13%
Oct	18.8	22.4	19%
Nov	78.9	94.4	20%
Dec	170.3	186.3	9%
Annual	832.9	887.8	7%

MIL2A	ac-ft		
Month	Existing	Run 1A	Change
Jan	521.6	590.3	13.2%
Feb	376.2	416.7	10.8%
Mar	280.9	317.9	13.2%
Apr	133.0	158.8	19.4%
May	72.9	98.9	35.7%
Jun	42.1	62.0	47.3%
Jul	10.7	17.6	64.5%
Aug	13.3	26.9	101.9%
Sep	24.0	50.4	109.5%
Oct	62.6	125.6	100.8%
Nov	223.3	359.0	60.8%
Dec	444.5	560.0	26.0%
Annual	2205.1	2784.0	26.3%

MIL2B	ac-ft		
Month	Existing	Run 1A	Change
Jan	106.7	134.5	26.1%
Feb	77.1	94.1	22.1%
Mar	57.5	73.6	28.1%
Apr	26.9	38.8	43.9%
May	14.5	26.8	84.8%
Jun	8.2	17.8	116.3%
Jul	2.0	5.5	167.5%
Aug	2.4	8.7	264.6%
Sep	4.3	16.6	285.4%
Oct	11.3	39.4	248.1%
Nov	42.6	97.0	127.8%
Dec	88.8	134.0	50.9%
Annual	442.3	686.8	55.3%

MIL2C	ac-ft		
Month	Existing	Run 1A	Change
Jan	315.8	348.7	10.4%
Feb	228.9	247.9	8.3%
Mar	169.1	186.2	10.1%
Apr	78.2	89.8	14.8%
May	40.2	51.7	28.5%
Jun	22.3	31.0	39.0%
Jul	5.2	8.2	56.5%
Aug	5.7	11.8	104.9%
Sep	10.1	21.8	115.9%
Oct	28.3	57.0	101.7%
Nov	120.8	186.5	54.3%
Dec	263.4	320.0	21.5%
Annual	1288.1	1560.5	21.1%

MIL2D	ac-ft		
Month	Existing	Run 1A	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 1B	Change
Jan	521.6	590.3	13.2%
Feb	376.2	416.7	10.8%
Mar	280.9	317.9	13.2%
Apr	133.0	158.8	19.4%
May	72.9	98.9	35.7%
Jun	42.1	62.0	47.3%
Jul	10.7	17.6	64.5%
Aug	13.3	26.9	102.0%
Sep	24.0	50.4	109.6%
Oct	62.6	125.7	100.8%
Nov	223.3	359.0	60.8%
Dec	444.5	560.0	26.0%
Annual	2205.1	2784.2	26.3%

MIL2B	ac-ft		
Month	Existing	Run 1B	Change
Jan	106.7	134.5	26.2%
Feb	77.1	94.1	22.1%
Mar	57.5	73.6	28.1%
Apr	26.9	38.8	44.0%
May	14.5	26.8	85.0%
Jun	8.2	17.8	116.5%
Jul	2.0	5.5	167.8%
Aug	2.4	8.7	264.8%
Sep	4.3	16.6	285.6%
Oct	11.3	39.4	248.3%
Nov	42.6	97.0	127.8%
Dec	88.8	134.0	50.9%
Annual	442.3	686.9	55.3%

MIL2C	ac-ft		
Month	Existing	Run 1B	Change
Jan	315.8	348.7	10.4%
Feb	228.9	247.9	8.3%
Mar	169.1	186.2	10.1%
Apr	78.2	89.8	14.8%
May	40.2	51.7	28.5%
Jun	22.3	31.0	39.0%
Jul	5.2	8.2	56.6%
Aug	5.7	11.8	104.9%
Sep	10.1	21.8	116.0%
Oct	28.3	57.1	101.7%
Nov	120.8	186.5	54.3%
Dec	263.4	320.0	21.5%
Annual	1288.1	1560.6	21.2%

MIL2D	ac-ft		
Month	Existing	Run 1B	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 2A	Change
Jan	521.6	553.6	6.1%
Feb	376.2	392.9	4.4%
Mar	280.9	302.1	7.5%
Apr	133.0	153.5	15.4%
May	72.9	95.6	31.2%
Jun	42.1	61.2	45.5%
Jul	10.7	18.1	68.8%
Aug	13.3	25.5	91.1%
Sep	24.0	49.3	105.2%
Oct	62.6	121.5	94.2%
Nov	223.3	335.3	50.2%
Dec	444.5	526.0	18.4%
Annual	2205.1	2634.5	19.5%

MIL2B	ac-ft		
Month	Existing	Run 2A	Change
Jan	106.7	136.8	28.3%
Feb	77.1	96.9	25.7%
Mar	57.5	76.6	33.2%
Apr	26.9	40.8	51.5%
May	14.5	27.2	87.3%
Jun	8.2	18.3	122.4%
Jul	2.0	5.7	179.8%
Aug	2.4	8.2	242.4%
Sep	4.3	16.4	282.2%
Oct	11.3	39.2	246.8%
Nov	42.6	95.9	125.3%
Dec	88.8	136.3	53.4%
Annual	442.3	698.3	57.9%

MIL2C	ac-ft		
Month	Existing	Run 2A	Change
Jan	315.8	320.8	1.6%
Feb	228.9	229.0	0.0%
Mar	169.1	172.8	2.2%
Apr	78.2	84.6	8.1%
May	40.2	49.1	22.1%
Jun	22.3	30.1	35.3%
Jul	5.2	8.4	60.0%
Aug	5.7	11.1	92.7%
Sep	10.1	21.2	109.4%
Oct	28.3	54.2	91.7%
Nov	120.8	170.2	40.9%
Dec	263.4	294.1	11.7%
Annual	1288.1	1445.5	12.2%

MIL2D	ac-ft		
Month	Existing	Run 2A	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 2B	Change
Jan	521.6	553.9	6.2%
Feb	376.2	392.9	4.4%
Mar	280.9	302.1	7.6%
Apr	133.0	153.4	15.3%
May	72.9	95.7	31.3%
Jun	42.1	61.3	45.8%
Jul	10.7	18.2	69.3%
Aug	13.3	25.6	92.1%
Sep	24.0	49.4	105.6%
Oct	62.6	121.6	94.3%
Nov	223.3	335.5	50.3%
Dec	444.5	525.7	18.3%
Annual	2205.1	2635.3	19.5%

MIL2B	ac-ft		
Month	Existing	Run 2B	Change
Jan	106.7	137.1	28.5%
Feb	77.1	97.0	25.8%
Mar	57.5	76.6	33.2%
Apr	26.9	40.7	51.2%
May	14.5	27.2	87.5%
Jun	8.2	18.3	122.9%
Jul	2.0	5.7	181.1%
Aug	2.4	8.3	245.7%
Sep	4.3	16.5	283.3%
Oct	11.3	39.3	247.2%
Nov	42.6	96.0	125.5%
Dec	88.8	136.0	53.1%
Annual	442.3	698.6	57.9%

MIL2C	ac-ft		
Month	Existing	Run 2B	Change
Jan	315.8	320.8	1.6%
Feb	228.9	229.0	0.0%
Mar	169.1	172.9	2.2%
Apr	78.2	84.6	8.1%
May	40.2	49.1	22.2%
Jun	22.3	30.2	35.5%
Jul	5.2	8.4	60.5%
Aug	5.7	11.1	93.6%
Sep	10.1	21.2	109.8%
Oct	28.3	54.3	91.9%
Nov	120.8	170.3	40.9%
Dec	263.4	294.0	11.6%
Annual	1288.1	1445.9	12.3%

MIL2D	ac-ft		
Month	Existing	Run 2B	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 3A	Change
Jan	521.6	590.8	13.3%
Feb	376.2	417.0	10.8%
Mar	280.9	318.5	13.4%
Apr	133.0	159.7	20.0%
May	72.9	100.0	37.2%
Jun	42.1	62.5	48.4%
Jul	10.7	17.6	64.2%
Aug	13.3	27.6	107.1%
Sep	24.0	51.2	113.2%
Oct	62.6	127.4	103.7%
Nov	223.3	360.9	61.6%
Dec	444.5	560.4	26.1%
Annual	2205.1	2793.6	26.7%

MIL2B	ac-ft		
Month	Existing	Run 3A	Change
Jan	106.7	134.8	26.4%
Feb	77.1	94.2	22.2%
Mar	57.5	74.0	28.6%
Apr	26.9	39.3	45.8%
May	14.5	27.5	89.4%
Jun	8.2	18.1	119.8%
Jul	2.0	5.4	166.5%
Aug	2.4	9.2	281.8%
Sep	4.3	17.1	297.5%
Oct	11.3	40.5	257.7%
Nov	42.6	98.2	130.6%
Dec	88.8	134.3	51.2%
Annual	442.3	692.5	56.6%

MIL2C	ac-ft		
Month	Existing	Run 3A	Change
Jan	315.8	348.9	10.5%
Feb	228.9	248.0	8.3%
Mar	169.1	186.4	10.2%
Apr	78.2	90.1	15.2%
May	40.2	52.1	29.6%
Jun	22.3	31.2	39.8%
Jul	5.2	8.2	55.8%
Aug	5.7	12.1	110.0%
Sep	10.1	22.2	119.6%
Oct	28.3	57.8	104.4%
Nov	120.8	187.3	55.0%
Dec	263.4	320.2	21.6%
Annual	1288.1	1564.4	21.4%

MIL2D	ac-ft		
Month	Existing	Run 3A	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 3B	Change
Jan	521.6	590.9	13.3%
Feb	376.2	417.2	10.9%
Mar	280.9	318.9	13.5%
Apr	133.0	160.1	20.3%
May	72.9	100.2	37.5%
Jun	42.1	62.6	48.8%
Jul	10.7	17.8	65.7%
Aug	13.3	27.5	106.2%
Sep	24.0	51.1	112.7%
Oct	62.6	127.0	103.0%
Nov	223.3	360.1	61.3%
Dec	444.5	560.3	26.1%
Annual	2205.1	2793.6	26.7%

MIL2B	ac-ft		
Month	Existing	Run 3B	Change
Jan	106.7	134.9	26.5%
Feb	77.1	94.4	22.4%
Mar	57.5	74.2	29.0%
Apr	26.9	39.5	46.6%
May	14.5	27.6	90.0%
Jun	8.2	18.1	120.9%
Jul	2.0	5.5	171.2%
Aug	2.4	9.1	278.9%
Sep	4.3	17.0	295.9%
Oct	11.3	40.2	255.5%
Nov	42.6	97.8	129.6%
Dec	88.8	134.3	51.2%
Annual	442.3	692.5	56.6%

MIL2C	ac-ft		
Month	Existing	Run 3B	Change
Jan	315.8	349.0	10.5%
Feb	228.9	248.1	8.4%
Mar	169.1	186.5	10.3%
Apr	78.2	90.2	15.4%
May	40.2	52.2	29.7%
Jun	22.3	31.2	40.0%
Jul	5.2	8.2	56.8%
Aug	5.7	12.0	109.3%
Sep	10.1	22.2	119.3%
Oct	28.3	57.7	103.9%
Nov	120.8	187.0	54.8%
Dec	263.4	320.1	21.5%
Annual	1288.1	1564.4	21.5%

MIL2D	ac-ft		
Month	Existing	Run 3B	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 4A	Change
Jan	521.6	554.1	6.2%
Feb	376.2	396.1	5.3%
Mar	280.9	304.6	8.4%
Apr	133.0	155.6	17.0%
May	72.9	96.0	31.8%
Jun	42.1	62.7	48.9%
Jul	10.7	19.5	81.9%
Aug	13.3	24.4	83.2%
Sep	24.0	47.8	99.0%
Oct	62.6	118.0	88.6%
Nov	223.3	330.1	47.8%
Dec	444.5	525.4	18.2%
Annual	2205.1	2634.5	19.5%

MIL2B	ac-ft		
Month	Existing	Run 4A	Change
Jan	106.7	137.4	28.8%
Feb	77.1	98.7	28.0%
Mar	57.5	78.1	35.8%
Apr	26.9	42.1	56.2%
May	14.5	27.4	89.0%
Jun	8.2	19.1	132.0%
Jul	2.0	6.5	219.3%
Aug	2.4	7.6	217.1%
Sep	4.3	15.6	263.1%
Oct	11.3	37.2	228.8%
Nov	42.6	92.8	118.1%
Dec	88.8	135.8	52.9%
Annual	442.3	698.3	57.9%

MIL2C	ac-ft		
Month	Existing	Run 4A	Change
Jan	315.8	320.8	1.6%
Feb	228.9	230.2	0.5%
Mar	169.1	173.6	2.6%
Apr	78.2	85.3	9.0%
May	40.2	49.2	22.4%
Jun	22.3	30.6	37.4%
Jul	5.2	8.8	68.6%
Aug	5.7	10.8	87.1%
Sep	10.1	20.7	104.3%
Oct	28.3	53.1	87.8%
Nov	120.8	168.6	39.5%
Dec	263.4	294.0	11.6%
Annual	1288.1	1445.5	12.2%

MIL2D	ac-ft		
Month	Existing	Run 4A	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 4B	Change
Jan	521.6	553.5	6.1%
Feb	376.2	393.2	4.5%
Mar	280.9	302.3	7.6%
Apr	133.0	153.7	15.5%
May	72.9	95.6	31.2%
Jun	42.1	61.3	45.7%
Jul	10.7	18.3	70.3%
Aug	13.3	25.3	89.5%
Sep	24.0	49.0	104.0%
Oct	62.6	120.8	93.1%
Nov	223.3	334.5	49.8%
Dec	444.5	525.8	18.3%
Annual	2205.1	2633.4	19.4%

MIL2B	ac-ft		
Month	Existing	Run 4B	Change
Jan	106.7	136.8	28.3%
Feb	77.1	97.2	26.1%
Mar	57.5	76.8	33.6%
Apr	26.9	41.0	52.3%
May	14.5	27.2	87.8%
Jun	8.2	18.4	123.7%
Jul	2.0	5.8	186.1%
Aug	2.4	8.1	238.6%
Sep	4.3	16.3	279.5%
Oct	11.3	38.9	244.0%
Nov	42.6	95.4	124.2%
Dec	88.8	136.2	53.4%
Annual	442.3	698.3	57.9%

MIL2C	ac-ft		
Month	Existing	Run 4B	Change
Jan	315.8	320.8	1.6%
Feb	228.9	229.1	0.1%
Mar	169.1	172.9	2.2%
Apr	78.2	84.7	8.3%
May	40.2	49.1	22.2%
Jun	22.3	30.2	35.5%
Jul	5.2	8.5	61.2%
Aug	5.7	11.0	91.9%
Sep	10.1	21.1	108.9%
Oct	28.3	54.0	91.1%
Nov	120.8	170.0	40.7%
Dec	263.4	294.1	11.7%
Annual	1288.1	1445.5	12.2%

MIL2D	ac-ft		
Month	Existing	Run 4B	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 4C	Change
Jan	521.6	553.5	6.1%
Feb	376.2	393.2	4.5%
Mar	280.9	302.3	7.6%
Apr	133.0	153.7	15.5%
May	72.9	95.7	31.3%
Jun	42.1	61.3	45.7%
Jul	10.7	18.3	70.2%
Aug	13.3	25.3	89.7%
Sep	24.0	49.1	104.1%
Oct	62.6	120.9	93.2%
Nov	223.3	334.6	49.8%
Dec	444.5	525.9	18.3%
Annual	2205.1	2633.6	19.4%

MIL2B	ac-ft		
Month	Existing	Run 4C	Change
Jan	106.7	136.8	28.3%
Feb	77.1	97.2	26.1%
Mar	57.5	76.8	33.6%
Apr	26.9	41.0	52.3%
May	14.5	27.2	87.8%
Jun	8.2	18.4	123.7%
Jul	2.0	5.8	186.1%
Aug	2.4	8.1	238.6%
Sep	4.3	16.3	279.5%
Oct	11.3	38.9	244.0%
Nov	42.6	95.4	124.2%
Dec	88.8	136.2	53.4%
Annual	442.3	698.3	57.9%

MIL2C	ac-ft		
Month	Existing	Run 4C	Change
Jan	315.8	320.8	1.6%
Feb	228.9	229.1	0.1%
Mar	169.1	172.9	2.2%
Apr	78.2	84.7	8.3%
May	40.2	49.1	22.2%
Jun	22.3	30.2	35.5%
Jul	5.2	8.4	61.0%
Aug	5.7	11.0	92.0%
Sep	10.1	21.1	109.0%
Oct	28.3	54.1	91.2%
Nov	120.8	170.0	40.7%
Dec	263.4	294.1	11.7%
Annual	1288.1	1445.5	12.2%

MIL2D	ac-ft		
Month	Existing	Run 4C	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 5A	Change
Jan	521.6	585.8	12.3%
Feb	376.2	409.8	8.9%
Mar	280.9	308.3	9.8%
Apr	133.0	155.9	17.2%
May	72.9	94.9	30.2%
Jun	42.1	58.1	38.0%
Jul	10.7	21.9	104.2%
Aug	13.3	18.4	38.0%
Sep	24.0	30.4	26.6%
Oct	62.6	91.3	45.8%
Nov	223.3	336.5	50.7%
Dec	444.5	554.5	24.8%
Annual	2205.1	2665.8	20.9%

MIL2B	ac-ft		
Month	Existing	Run 5A	Change
Jan	106.7	133.5	25.1%
Feb	77.1	92.0	19.4%
Mar	57.5	70.6	22.7%
Apr	26.9	40.3	49.6%
May	14.5	27.7	90.9%
Jun	8.2	17.5	112.6%
Jul	2.0	7.3	259.3%
Aug	2.4	3.6	51.0%
Sep	4.3	7.6	76.8%
Oct	11.3	24.6	117.5%
Nov	42.6	88.4	107.5%
Dec	88.8	132.7	49.5%
Annual	442.3	645.8	46.0%

MIL2C	ac-ft		
Month	Existing	Run 5A	Change
Jan	315.8	346.3	9.7%
Feb	228.9	244.3	6.7%
Mar	169.1	181.4	7.3%
Apr	78.2	86.4	10.4%
May	40.2	47.8	19.0%
Jun	22.3	27.9	25.4%
Jul	5.2	9.7	85.2%
Aug	5.7	8.6	49.9%
Sep	10.1	12.5	23.9%
Oct	28.3	41.3	45.9%
Nov	120.8	177.7	47.1%
Dec	263.4	318.0	20.7%
Annual	1288.1	1502.0	16.6%

MIL2D	ac-ft		
Month	Existing	Run 5A	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 5B	Change
Jan	521.6	585.3	12.2%
Feb	376.2	409.8	8.9%
Mar	280.9	310.2	10.4%
Apr	133.0	162.3	22.0%
May	72.9	97.4	33.7%
Jun	42.1	59.3	41.0%
Jul	10.7	18.2	69.3%
Aug	13.3	15.8	18.3%
Sep	24.0	30.8	28.2%
Oct	62.6	91.8	46.7%
Nov	223.3	328.5	47.1%
Dec	444.5	550.1	23.8%
Annual	2205.1	2659.3	20.6%

MIL2B	ac-ft		
Month	Existing	Run 5B	Change
Jan	106.7	134.1	25.8%
Feb	77.1	92.8	20.4%
Mar	57.5	73.1	27.2%
Apr	26.9	43.1	59.9%
May	14.5	26.7	84.0%
Jun	8.2	17.6	113.8%
Jul	2.0	5.1	148.9%
Aug	2.4	3.5	45.4%
Sep	4.3	7.9	82.7%
Oct	11.3	25.9	128.9%
Nov	42.6	85.4	100.6%
Dec	88.8	131.8	48.3%
Annual	442.3	646.8	46.2%

MIL2C	ac-ft		
Month	Existing	Run 5B	Change
Jan	315.8	345.8	9.5%
Feb	228.9	244.2	6.7%
Mar	169.1	181.1	7.1%
Apr	78.2	89.7	14.6%
May	40.2	50.8	26.3%
Jun	22.3	28.9	29.7%
Jul	5.2	8.8	68.3%
Aug	5.7	6.9	19.6%
Sep	10.1	12.8	26.2%
Oct	28.3	40.5	43.2%
Nov	120.8	173.7	43.8%
Dec	263.4	315.7	19.9%
Annual	1288.1	1498.9	16.4%

MIL2D	ac-ft		
Month	Existing	Run 5B	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 6A	Change
Jan	521.6	553.4	6.1%
Feb	376.2	394.9	5.0%
Mar	280.9	303.2	8.0%
Apr	133.0	154.6	16.2%
May	72.9	95.8	31.5%
Jun	42.1	62.0	47.3%
Jul	10.7	18.8	75.8%
Aug	13.3	25.0	87.3%
Sep	24.0	48.5	101.6%
Oct	62.6	119.7	91.4%
Nov	223.3	332.6	49.0%
Dec	444.5	525.9	18.3%
Annual	2205.1	2634.5	19.5%

MIL2B	ac-ft		
Month	Existing	Run 6A	Change
Jan	106.7	136.8	28.3%
Feb	77.1	98.0	27.1%
Mar	57.5	77.3	34.4%
Apr	26.9	41.4	53.9%
May	14.5	27.3	88.1%
Jun	8.2	18.7	127.7%
Jul	2.0	6.1	201.3%
Aug	2.4	7.9	230.2%
Sep	4.3	15.9	270.7%
Oct	11.3	38.2	237.8%
Nov	42.6	94.3	121.6%
Dec	88.8	136.1	53.3%
Annual	442.3	698.3	57.9%

MIL2C	ac-ft		
Month	Existing	Run 6A	Change
Jan	315.8	320.6	1.5%
Feb	228.9	229.7	0.3%
Mar	169.1	173.1	2.4%
Apr	78.2	85.0	8.6%
May	40.2	49.2	22.3%
Jun	22.3	30.4	36.3%
Jul	5.2	8.6	64.4%
Aug	5.7	10.9	90.0%
Sep	10.1	20.9	106.7%
Oct	28.3	53.7	89.7%
Nov	120.8	169.4	40.2%
Dec	263.4	294.1	11.7%
Annual	1288.1	1445.5	12.2%

MIL2D	ac-ft		
Month	Existing	Run 6A	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

MIL2A	ac-ft		
Month	Existing	Run 6B	Change
Jan	521.6	553.5	6.1%
Feb	376.2	393.7	4.6%
Mar	280.9	302.5	7.7%
Apr	133.0	153.9	15.7%
May	72.9	95.8	31.4%
Jun	42.1	61.5	46.1%
Jul	10.7	18.4	71.5%
Aug	13.3	25.3	89.6%
Sep	24.0	49.0	103.9%
Oct	62.6	120.8	93.1%
Nov	223.3	334.3	49.7%
Dec	444.5	525.9	18.3%
Annual	2205.1	2634.5	19.5%

MIL2B	ac-ft		
Month	Existing	Run 6B	Change
Jan	106.7	136.7	28.2%
Feb	77.1	97.4	26.3%
Mar	57.5	76.8	33.6%
Apr	26.9	41.1	52.5%
May	14.5	27.2	87.8%
Jun	8.2	18.4	124.2%
Jul	2.0	5.9	188.3%
Aug	2.4	8.1	237.7%
Sep	4.3	16.2	277.7%
Oct	11.3	38.8	243.2%
Nov	42.6	95.3	123.8%
Dec	88.8	136.2	53.4%
Annual	442.3	698.3	57.9%

MIL2C	ac-ft		
Month	Existing	Run 6B	Change
Jan	315.8	320.8	1.6%
Feb	228.9	229.2	0.1%
Mar	169.1	172.9	2.3%
Apr	78.2	84.7	8.3%
May	40.2	49.1	22.2%
Jun	22.3	30.2	35.6%
Jul	5.2	8.5	61.5%
Aug	5.7	11.0	91.7%
Sep	10.1	21.1	108.6%
Oct	28.3	54.0	90.9%
Nov	120.8	169.9	40.6%
Dec	263.4	294.0	11.6%
Annual	1288.1	1445.5	12.2%

MIL2D	ac-ft		
Month	Existing	Run 6B	Change
Jan	203.4	212.0	4.2%
Feb	147.5	151.9	3.0%
Mar	108.9	112.0	2.9%
Apr	50.5	51.8	2.6%
May	26.1	26.8	2.7%
Jun	14.5	14.9	2.6%
Jul	3.4	3.5	1.8%
Aug	3.9	4.3	10.8%
Sep	6.8	7.7	12.7%
Oct	18.8	22.4	18.7%
Nov	78.9	94.4	19.6%
Dec	170.3	186.3	9.4%
Annual	832.9	887.8	6.6%

APPENDIX B: Flood Frequency

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Full Build-Out (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	87.75	122.24	148.57	186.08	217.28	251.43
MIL2B	25.59	35.30	42.81	53.62	62.70	72.71
MIL2C	42.13	59.44	72.51	90.97	106.19	122.73
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	17.67	9.73	0.67	-15.95	-32.65	-53.57
MIL2B	8.57	4.19	-1.56	-13.21	-25.91	-42.86
MIL2C	10.96	9.19	7.32	4.22	1.39	-1.87
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	25%	9%	0%	-8%	-13%	-18%
MIL2B	50%	13%	-4%	-20%	-29%	-37%
MIL2C	35%	18%	11%	5%	1%	-2%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 1A (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	83.34	115.18	138.85	171.82	198.72	227.68
MIL2B	22.42	29.74	35.23	42.93	49.24	56.08
MIL2C	40.10	56.28	68.19	84.67	97.99	112.26
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	13.26	2.66	-9.06	-30.20	-51.22	-77.32
MIL2B	5.40	-1.37	-9.14	-23.91	-39.37	-59.49
MIL2C	8.94	6.03	3.00	-2.09	-6.81	-12.35
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	19%	2%	-6%	-15%	-20%	-25%
MIL2B	32%	-4%	-21%	-36%	-44%	-51%
MIL2C	29%	12%	5%	-2%	-6%	-10%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 1B (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	83.39	115.25	138.93	171.93	198.84	227.82
MIL2B	22.47	29.80	35.30	43.02	49.35	56.21
MIL2C	40.13	56.31	68.23	84.71	98.05	112.32
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	13.31	2.73	-8.97	-30.10	-51.09	-77.18
MIL2B	5.44	-1.31	-9.07	-23.81	-39.26	-59.36
MIL2C	8.96	6.06	3.04	-2.04	-6.75	-12.28
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	19%	2%	-6%	-15%	-20%	-25%
MIL2B	32%	-4%	-20%	-36%	-44%	-51%
MIL2C	29%	12%	5%	-2%	-6%	-10%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 2A (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	74.62	103.62	124.36	152.35	174.51	197.80
MIL2B	19.42	25.67	30.16	36.24	41.09	46.20
MIL2C	35.72	50.19	60.18	73.25	83.30	93.61
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	4.54	-8.89	-23.54	-49.68	-75.43	-107.21
MIL2B	2.40	-5.44	-14.21	-30.59	-47.53	-69.37
MIL2C	4.55	-0.06	-5.01	-13.50	-21.51	-31.00
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	6%	-8%	-16%	-25%	-30%	-35%
MIL2B	14%	-17%	-32%	-46%	-54%	-60%
MIL2C	15%	0%	-8%	-16%	-21%	-25%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 2B (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	74.62	103.62	124.36	152.35	174.51	197.80
MIL2B	18.64	24.27	28.35	33.92	38.38	43.11
MIL2C	34.59	48.56	58.42	71.55	81.83	92.53
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	4.54	-8.89	-23.54	-49.68	-75.43	-107.21
MIL2B	1.62	-6.84	-16.02	-32.91	-50.23	-72.46
MIL2C	3.43	-1.69	-6.78	-15.20	-22.97	-32.08
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	6%	-8%	-16%	-25%	-30%	-35%
MIL2B	9%	-22%	-36%	-49%	-57%	-63%
MIL2C	11%	-3%	-10%	-18%	-22%	-26%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 3A (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	87.35	121.70	147.92	185.27	216.34	250.34
MIL2B	25.36	34.92	42.30	52.90	61.80	71.60
MIL2C	41.96	59.24	72.29	90.72	105.93	122.46
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	17.27	9.18	0.02	-16.76	-33.60	-54.66
MIL2B	8.34	3.80	-2.08	-13.93	-26.81	-43.97
MIL2C	10.80	8.99	7.10	3.97	1.12	-2.15
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	25%	8%	0%	-8%	-13%	-18%
MIL2B	49%	12%	-5%	-21%	-30%	-38%
MIL2C	35%	18%	11%	5%	1%	-2%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 3B (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	87.08	121.34	147.49	184.75	215.74	249.67
MIL2B	25.21	34.67	41.96	52.44	61.22	70.89
MIL2C	41.85	59.11	72.14	90.56	105.76	122.28
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	17.00	8.82	-0.41	-17.28	-34.19	-55.33
MIL2B	8.18	3.55	-2.41	-14.40	-27.39	-44.68
MIL2C	10.69	8.85	6.95	3.81	0.96	-2.33
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	24%	8%	0%	-9%	-14%	-18%
MIL2B	48%	11%	-5%	-22%	-31%	-39%
MIL2C	34%	18%	11%	4%	1%	-2%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 4A (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	52.59	78.12	98.18	127.43	152.23	179.81
MIL2B	8.20	14.00	19.17	27.57	35.40	44.80
MIL2C	28.48	43.09	53.76	68.31	79.89	92.09
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	-17.50	-34.40	-49.72	-74.60	-97.70	-125.19
MIL2B	-8.82	-17.12	-25.20	-39.27	-53.21	-70.77
MIL2C	-2.69	-7.16	-11.43	-18.44	-24.92	-32.52
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	-25%	-31%	-34%	-37%	-39%	-41%
MIL2B	-52%	-55%	-57%	-59%	-60%	-61%
MIL2C	-9%	-14%	-18%	-21%	-24%	-26%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 4B (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	71.50	99.99	120.47	148.22	170.26	193.51
MIL2B	17.24	23.01	27.19	32.89	37.44	42.28
MIL2C	35.16	49.27	59.00	71.70	81.46	91.46
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	1.42	-12.53	-27.43	-53.81	-79.67	-111.50
MIL2B	0.22	-8.10	-17.18	-33.95	-51.17	-73.29
MIL2C	3.99	-0.98	-6.19	-15.05	-23.34	-33.15
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	2%	-11%	-19%	-27%	-32%	-37%
MIL2B	1%	-26%	-39%	-51%	-58%	-63%
MIL2C	13%	-2%	-9%	-17%	-22%	-27%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 4C (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	72.45	101.31	122.06	150.17	172.50	196.03
MIL2B	17.24	23.01	27.19	32.89	37.44	42.28
MIL2C	35.86	50.51	60.64	73.90	84.11	94.60
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	2.37	-11.21	-25.84	-51.86	-77.44	-108.97
MIL2B	0.22	-8.10	-17.18	-33.95	-51.17	-73.29
MIL2C	4.70	0.26	-4.55	-12.85	-20.69	-30.01
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	3%	-10%	-17%	-26%	-31%	-36%
MIL2B	1%	-26%	-39%	-51%	-58%	-63%
MIL2C	15%	1%	-7%	-15%	-20%	-24%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 5A (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	89.68	128.84	156.96	194.93	224.98	256.54
MIL2B	25.41	36.12	44.59	57.02	67.64	79.52
MIL2C	42.76	61.42	75.12	93.97	109.16	125.34
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	19.60	16.32	9.06	-7.10	-24.95	-48.46
MIL2B	8.39	5.00	0.21	-9.82	-20.98	-36.05
MIL2C	11.59	11.17	9.93	7.22	4.35	0.73
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	28%	15%	6%	-4%	-10%	-16%
MIL2B	49%	16%	0%	-15%	-24%	-31%
MIL2C	37%	22%	15%	8%	4%	1%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 5B (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	88.53	130.38	159.63	198.07	227.70	258.12
MIL2B	24.85	36.60	45.39	57.66	67.67	78.44
MIL2C	42.71	61.84	75.65	94.40	109.29	124.97
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	18.45	17.87	11.73	-3.96	-22.24	-46.89
MIL2B	7.83	5.48	1.01	-9.18	-20.94	-37.13
MIL2C	11.54	11.58	10.46	7.65	4.49	0.37
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	26%	16%	8%	-2%	-9%	-15%
MIL2B	46%	18%	2%	-14%	-24%	-32%
MIL2C	37%	23%	16%	9%	4%	0%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 6A (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	58.29	85.30	105.85	134.98	159.08	185.32
MIL2B	10.89	17.83	23.84	33.33	41.98	52.16
MIL2C	30.71	45.52	56.41	71.38	83.41	96.19
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	-11.79	-27.21	-42.05	-67.05	-90.86	-119.68
MIL2B	-6.13	-13.28	-20.53	-33.50	-46.63	-63.40
MIL2C	-0.45	-4.73	-8.78	-15.37	-21.40	-28.42
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	-17%	-24%	-28%	-33%	-36%	-39%
MIL2B	-36%	-43%	-46%	-50%	-53%	-55%
MIL2C	-1%	-9%	-13%	-18%	-20%	-23%
MIL2D	9%	7%	6%	4%	2%	1%

Flood Frequency: Existing (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	70.08	112.52	147.90	202.03	249.93	305.00
MIL2B	17.02	31.11	44.37	66.83	88.61	115.57
MIL2C	31.17	50.25	65.19	86.75	104.80	124.61
MIL2D	18.38	27.20	33.24	41.03	46.92	52.87

Flood Frequency: Future Task 7 Run 6B (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	66.71	95.33	116.69	146.56	170.95	197.26
MIL2B	14.98	21.79	27.16	35.03	41.73	49.21
MIL2C	34.12	48.53	58.57	71.79	82.02	92.55
MIL2D	20.10	29.18	35.15	42.61	48.09	53.49

Change (cfs)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	-3.37	-17.19	-31.21	-55.47	-78.98	-107.74
MIL2B	-2.04	-9.33	-17.21	-31.81	-46.88	-66.35
MIL2C	2.95	-1.72	-6.62	-14.96	-22.79	-32.05
MIL2D	1.72	1.98	1.91	1.58	1.17	0.62

Change (%)

Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
MIL2A	-5%	-15%	-21%	-27%	-32%	-35%
MIL2B	-12%	-30%	-39%	-48%	-53%	-57%
MIL2C	9%	-3%	-10%	-17%	-22%	-26%
MIL2D	9%	7%	6%	4%	2%	1%

APPENDIX C: Low Flow Durations

MIL2A 100.0% 100.0%

Flow (cfs)	Existing	Future	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1480893	0%
0.20	1309640	1305853	0%
0.30	1205711	1197716	-1%
0.40	1127658	1119664	-1%
0.50	1065805	1057811	-1%
0.60	1013630	1005636	-1%
0.70	967556	960824	-1%
0.80	926531	921061	-1%
0.90	889083	884244	-1%
1.00	854790	851214	0%
1.10	823233	821339	0%
1.20	793779	794620	0%
1.30	766850	770005	0%
1.40	741604	746863	1%
1.50	718251	725614	1%
1.60	696581	706049	1%
1.70	675753	688166	2%
1.80	656398	671756	2%
1.90	638095	656188	3%
2.00	620633	641882	3%
2.10	604433	628417	4%
2.20	589075	615584	5%
2.30	574559	603381	5%
2.40	560673	591810	6%
2.50	547419	580870	6%
2.60	534796	570561	7%
2.70	522594	560673	7%
2.80	511023	551206	8%
2.90	500083	542370	8%
3.00	489774	533744	9%
3.10	479676	525329	10%
3.20	470208	517124	10%
3.30	461162	509550	10%
3.40	452115	502187	11%
3.50	443700	495034	12%
3.60	435495	488091	12%
3.70	427711	481359	13%
3.80	419926	474626	13%
3.90	412563	468104	13%
4.00	405200	462003	14%
4.10	398047	455692	14%
4.20	391104	449801	15%
4.30	384582	443910	15%
4.40	378060	438230	16%
4.50	371959	432760	16%
4.60	365858	427500	17%
4.70	359967	422241	17%

MIL2B 100.0% 100.0%

Flow (cfs)	Existing	Future	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	997010	-6%
0.20	849741	791254	-7%
0.30	714043	675543	-5%
0.40	615373	602750	-2%
0.50	540897	550575	2%
0.60	481569	509760	6%
0.70	435074	476309	9%
0.80	396784	448118	13%
0.90	363754	423503	16%
1.00	335142	402254	20%
1.10	310527	383530	24%
1.20	288436	366279	27%
1.30	269081	350921	30%
1.40	251619	336614	34%
1.50	236051	323571	37%
1.60	221534	311368	41%
1.70	208301	299797	44%
1.80	196099	289278	48%
1.90	185096	279180	51%
2.00	174850	269923	54%
2.10	165362	261087	58%
2.20	156547	252882	62%
2.30	148321	244887	65%
2.40	140831	237524	69%
2.50	133909	230370	72%
2.60	127409	223428	75%
2.70	121328	216906	79%
2.80	115690	210805	82%
2.90	110262	204788	86%
3.00	105234	199023	89%
3.10	100374	193553	93%
3.20	95851	188315	96%
3.30	91496	183181	100%
3.40	87541	178321	104%
3.50	83796	173609	107%
3.60	80240	169107	111%
3.70	76853	164731	114%
3.80	73698	160439	118%
3.90	70710	156273	121%
4.00	67765	152171	125%
4.10	64946	148216	128%
4.20	62274	144450	132%
4.30	59875	140810	135%
4.40	57498	137297	139%
4.50	55205	133846	142%
4.60	52975	130543	146%
4.70	50913	127345	150%

4.80	354076	417402	18%
4.90	348606	412353	18%
5.00	343136	407514	19%
5.10	337877	402675	19%
5.20	332827	398047	20%
5.30	327778	393628	20%
5.40	322939	389210	21%
5.50	318311	384792	21%
5.60	313683	380585	21%
5.70	309054	376587	22%
5.80	304846	372590	22%
5.90	300428	368593	23%
6.00	296221	364806	23%
6.10	292223	361019	24%
6.20	288226	357442	24%
6.30	284439	353866	24%
6.40	280652	350289	25%
6.50	276865	346923	25%
6.60	273289	343557	26%
6.70	269712	340191	26%
6.80	266346	336825	26%
6.90	262980	333669	27%
7.00	259614	330513	27%
7.10	256458	327358	28%
7.20	253302	324202	28%
7.30	250147	321046	28%
7.40	247201	317890	29%
7.50	244256	314734	29%
7.60	241310	311789	29%
7.70	238575	308844	29%
7.80	235630	305898	30%
7.90	232895	302953	30%
8.00	230160	300008	30%
8.10	227635	297273	31%
8.20	224900	294327	31%
8.30	222376	291382	31%
8.40	219851	288647	31%
8.50	217116	285912	32%
8.60	214802	282966	32%
8.70	212277	280231	32%
8.80	209816	277496	32%
8.90	207397	274762	32%
9.00	205082	272027	33%
9.10	202684	269292	33%
9.20	200286	266557	33%
9.30	197950	263822	33%
9.40	195552	261087	34%
9.50	193238	258352	34%
9.60	190902	255617	34%
9.70	188546	252882	34%
9.80	186106	249936	34%
9.90	183623	247201	35%

4.80	48977	124169	154%
4.90	47189	121076	157%
5.00	45401	118173	160%
5.10	43697	115375	164%
5.20	42056	112661	168%
5.30	40499	109968	172%
5.40	38963	107275	175%
5.50	37511	104666	179%
5.60	36102	102184	183%
5.70	34798	99722	187%
5.80	33493	97303	191%
5.90	32294	94967	194%
6.00	31158	92632	197%
6.10	30106	90486	201%
6.20	29033	88319	204%
6.30	27981	86173	208%
6.40	26908	84175	213%
6.50	25940	82176	217%
6.60	24952	80219	221%
6.70	24026	78326	226%
6.80	23037	76411	232%
6.90	22153	74497	236%
7.00	21291	72625	241%
7.10	20481	70963	246%
7.20	19736	69174	250%
7.30	19008	67470	255%
7.40	18312	65871	260%
7.50	17609	64335	265%
7.60	16963	62737	270%
7.70	16343	61201	274%
7.80	15728	59686	279%
7.90	15108	58192	285%
8.00	14533	56720	290%
8.10	13978	55247	295%
8.20	13441	53879	301%
8.30	12941	52470	305%
8.40	12476	51144	310%
8.50	12019	49756	314%
8.60	11580	48451	318%
8.70	11171	47231	323%
8.80	10738	46032	329%
8.90	10347	44812	333%
9.00	9964	43655	338%
9.10	9583	42498	343%
9.20	9236	41340	348%
9.30	8887	40225	353%
9.40	8552	39131	358%
9.50	8224	38058	363%
9.60	7862	36986	370%
9.70	7488	35892	379%
9.80	7115	34776	389%
9.90	6743	33682	400%

MIL2C	100.0%	100.0%	
Flow (cfs)	Existing	Future	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1356346	1%
0.20	1175415	1180885	0%
0.30	1065805	1073379	1%
0.40	982493	992592	1%
0.50	914329	927793	1%
0.60	854790	870990	2%
0.70	802615	821550	2%
0.80	756120	779052	3%
0.90	714885	741814	4%
1.00	678068	708153	4%
1.10	644827	678068	5%
1.20	614111	651559	6%
1.30	586130	627575	7%
1.40	560673	606116	8%
1.50	537531	586130	9%
1.60	515651	567826	10%
1.70	495454	550365	11%
1.80	476730	534375	12%
1.90	459479	519228	13%
2.00	443700	504922	14%
2.10	428342	491667	15%
2.20	414667	478834	15%
2.30	401623	466842	16%
2.40	389000	455271	17%
2.50	377219	444331	18%
2.60	366068	433601	18%
2.70	355339	423503	19%
2.80	345240	413825	20%
2.90	335562	404568	21%
3.00	326306	395732	21%
3.10	317469	387317	22%
3.20	309264	379112	23%
3.30	301270	371117	23%
3.40	293696	363544	24%
3.50	286543	356180	24%
3.60	279390	349237	25%
3.70	272868	342716	26%
3.80	266346	336194	26%
3.90	260245	329882	27%
4.00	254565	323991	27%
4.10	248884	318101	28%
4.20	243625	312420	28%
4.30	238575	306950	29%
4.40	233526	301691	29%
4.50	228898	296431	30%
4.60	224480	291382	30%
4.70	220272	286543	30%
4.80	216275	282125	30%

MIL2D	100.0%	100.0%	
Flow (cfs)	Existing	Future	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	277496	31%
5.00	208533	273078	31%
5.10	204830	268871	31%
5.20	201232	264663	32%
5.30	197656	260455	32%
5.40	194248	256668	32%
5.50	190902	252671	32%
5.60	187578	248674	33%
5.70	184402	244887	33%
5.80	181393	241100	33%
5.90	178490	237313	33%
6.00	175755	233526	33%
6.10	172999	229739	33%
6.20	170285	226163	33%
6.30	167613	222586	33%
6.40	164983	219220	33%
6.50	162416	215644	33%
6.60	159955	212277	33%
6.70	157409	208911	33%
6.80	154885	205503	33%
6.90	152507	202221	33%
7.00	150151	198918	32%
7.10	147858	195678	32%
7.20	145544	192480	32%
7.30	143166	189346	32%
7.40	140831	186358	32%
7.50	138559	183223	32%
7.60	136245	180173	32%
7.70	133909	177080	32%
7.80	131637	174072	32%
7.90	129428	171105	32%
8.00	127303	168181	32%
8.10	125136	165341	32%
8.20	123012	162459	32%
8.30	120866	159681	32%
8.40	118741	156904	32%
8.50	116763	154169	32%
8.60	114786	151498	32%
8.70	112808	148910	32%
8.80	110830	146364	32%
8.90	108916	143755	32%
9.00	107064	141210	32%
9.10	105255	138664	32%
9.20	103425	136076	32%
9.30	101531	133468	31%
9.40	99722	130943	31%
9.50	97955	128397	31%
9.60	96103	125894	31%
9.70	94231	123348	31%
9.80	92295	120760	31%
9.90	90339	118215	31%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 1A	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1572620	7%
0.20	1309640	1398633	7%
0.30	1205711	1281659	6%
0.40	1127658	1194771	6%
0.50	1065805	1126606	6%
0.60	1013630	1069592	6%
0.70	967556	1019942	5%
0.80	926531	976603	5%
0.90	889083	938313	6%
1.00	854790	903599	6%
1.10	823233	871621	6%
1.20	793779	842378	6%
1.30	766850	815659	6%
1.40	741604	791044	7%
1.50	718251	768322	7%
1.60	696581	746863	7%
1.70	675753	726666	8%
1.80	656398	708153	8%
1.90	638095	690480	8%
2.00	620633	674070	9%
2.10	604433	658712	9%
2.20	589075	644406	9%
2.30	574559	630942	10%
2.40	560673	617898	10%
2.50	547419	605696	11%
2.60	534796	593914	11%
2.70	522594	582764	12%
2.80	511023	572034	12%
2.90	500083	561725	12%
3.00	489774	552048	13%
3.10	479676	543001	13%
3.20	470208	533955	14%
3.30	461162	525539	14%
3.40	452115	517545	14%
3.50	443700	509550	15%
3.60	435495	501976	15%
3.70	427711	494402	16%
3.80	419926	487039	16%
3.90	412563	480096	16%
4.00	405200	473154	17%
4.10	398047	466421	17%
4.20	391104	459899	18%
4.30	384582	453378	18%
4.40	378060	447276	18%
4.50	371959	441175	19%
4.60	365858	435284	19%
4.70	359967	429604	19%
4.80	354076	423924	20%

MIL2B

Flow (cfs)	Existing	Run 1A	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1209498	14%
0.20	849741	963348	13%
0.30	714043	814186	14%
0.40	615373	712781	16%
0.50	540897	637464	18%
0.60	481569	579608	20%
0.70	435074	533113	23%
0.80	396784	495244	25%
0.90	363754	463686	27%
1.00	335142	436126	30%
1.10	310527	411511	33%
1.20	288436	389631	35%
1.30	269081	370276	38%
1.40	251619	352814	40%
1.50	236051	337035	43%
1.60	221534	322308	45%
1.70	208301	308423	48%
1.80	196099	295590	51%
1.90	185096	283808	53%
2.00	174850	272658	56%
2.10	165362	262349	59%
2.20	156547	252461	61%
2.30	148321	243204	64%
2.40	140831	234368	66%
2.50	133909	226163	69%
2.60	127409	218168	71%
2.70	121328	210594	74%
2.80	115690	203610	76%
2.90	110262	196940	79%
3.00	105234	190545	81%
3.10	100374	184465	84%
3.20	95851	178595	86%
3.30	91496	173041	89%
3.40	87541	167529	91%
3.50	83796	162374	94%
3.60	80240	157304	96%
3.70	76853	152528	98%
3.80	73698	147879	101%
3.90	70710	143398	103%
4.00	67765	139043	105%
4.10	64946	134898	108%
4.20	62274	130859	110%
4.30	59875	127072	112%
4.40	57498	123453	115%
4.50	55205	119856	117%
4.60	52975	116405	120%
4.70	50913	113123	122%
4.80	48977	109926	124%

4.90	348606	418454	20%
5.00	343136	413405	20%
5.10	337877	408355	21%
5.20	332827	403096	21%
5.30	327778	398257	22%
5.40	322939	393418	22%
5.50	318311	388579	22%
5.60	313683	384161	22%
5.70	309054	379743	23%
5.80	304846	375325	23%
5.90	300428	370907	23%
6.00	296221	366910	24%
6.10	292223	362702	24%
6.20	288226	358705	24%
6.30	284439	354918	25%
6.40	280652	351131	25%
6.50	276865	347554	26%
6.60	273289	343978	26%
6.70	269712	340401	26%
6.80	266346	336825	26%
6.90	262980	333459	27%
7.00	259614	330092	27%
7.10	256458	326726	27%
7.20	253302	323571	28%
7.30	250147	320415	28%
7.40	247201	317259	28%
7.50	244256	314103	29%
7.60	241310	310948	29%
7.70	238575	307792	29%
7.80	235630	304636	29%
7.90	232895	301480	29%
8.00	230160	298535	30%
8.10	227635	295590	30%
8.20	224900	292644	30%
8.30	222376	289699	30%
8.40	219851	286964	31%
8.50	217116	284018	31%
8.60	214802	281073	31%
8.70	212277	278338	31%
8.80	209816	275393	31%
8.90	207397	272658	31%
9.00	205082	269712	32%
9.10	202684	266977	32%
9.20	200286	264242	32%
9.30	197950	261507	32%
9.40	195552	258772	32%
9.50	193238	256037	32%
9.60	190902	253302	33%
9.70	188546	250357	33%
9.80	186106	247622	33%
9.90	183623	244677	33%

4.90	47189	106896	127%
5.00	45401	103888	129%
5.10	43697	101005	131%
5.20	42056	98144	133%
5.30	40499	95451	136%
5.40	38963	92800	138%
5.50	37511	90318	141%
5.60	36102	87814	143%
5.70	34798	85458	146%
5.80	33493	83207	148%
5.90	32294	80956	151%
6.00	31158	78747	153%
6.10	30106	76538	154%
6.20	29033	74455	156%
6.30	27981	72435	159%
6.40	26908	70437	162%
6.50	25940	68543	164%
6.60	24952	66713	167%
6.70	24026	64903	170%
6.80	23037	63241	175%
6.90	22153	61516	178%
7.00	21291	59854	181%
7.10	20481	58192	184%
7.20	19736	56614	187%
7.30	19008	55079	190%
7.40	18312	53501	192%
7.50	17609	52112	196%
7.60	16963	50660	199%
7.70	16343	49230	201%
7.80	15728	47820	204%
7.90	15108	46579	208%
8.00	14533	45317	212%
8.10	13978	44075	215%
8.20	13441	42876	219%
8.30	12941	41719	222%
8.40	12476	40646	226%
8.50	12019	39510	229%
8.60	11580	38479	232%
8.70	11171	37406	235%
8.80	10738	36333	238%
8.90	10347	35302	241%
9.00	9964	34314	244%
9.10	9583	33325	248%
9.20	9236	32315	250%
9.30	8887	31347	253%
9.40	8552	30400	255%
9.50	8224	29475	258%
9.60	7862	28549	263%
9.70	7488	27623	269%
9.80	7115	26656	275%
9.90	6743	25709	281%

MIL2C

Flow (cfs)	Existing	Run 1A	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1417988	5%
0.20	1175415	1232640	5%
0.30	1065805	1116298	5%
0.40	982493	1029830	5%
0.50	914329	960403	5%
0.60	854790	902968	6%
0.70	802615	851634	6%
0.80	756120	807033	7%
0.90	714885	767691	7%
1.00	678068	732347	8%
1.10	644827	700579	9%
1.20	614111	671756	9%
1.30	586130	645879	10%
1.40	560673	622526	11%
1.50	537531	601277	12%
1.60	515651	581291	13%
1.70	495454	562777	14%
1.80	476730	545315	14%
1.90	459479	529116	15%
2.00	443700	513758	16%
2.10	428342	499452	17%
2.20	414667	485987	17%
2.30	401623	473154	18%
2.40	389000	461162	19%
2.50	377219	449380	19%
2.60	366068	438230	20%
2.70	355339	427500	20%
2.80	345240	417191	21%
2.90	335562	407303	21%
3.00	326306	398047	22%
3.10	317469	388790	22%
3.20	309264	380164	23%
3.30	301270	371959	23%
3.40	293696	364175	24%
3.50	286543	356390	24%
3.60	279390	349027	25%
3.70	272868	342084	25%
3.80	266346	335142	26%
3.90	260245	328620	26%
4.00	254565	322308	27%
4.10	248884	316207	27%
4.20	243625	310316	27%
4.30	238575	304426	28%
4.40	233526	298956	28%
4.50	228898	293486	28%
4.60	224480	288436	28%
4.70	220272	283387	29%
4.80	216275	278759	29%

MIL2D

Flow (cfs)	Existing	Run 1A	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	274130	29%
5.00	208533	269712	29%
5.10	204830	265294	30%
5.20	201232	261087	30%
5.30	197656	256879	30%
5.40	194248	252671	30%
5.50	190902	248674	30%
5.60	187578	244887	31%
5.70	184402	240890	31%
5.80	181393	237103	31%
5.90	178490	233526	31%
6.00	175755	229739	31%
6.10	172999	226373	31%
6.20	170285	222797	31%
6.30	167613	219220	31%
6.40	164983	215854	31%
6.50	162416	212277	31%
6.60	159955	208911	31%
6.70	157409	205482	31%
6.80	154885	202074	30%
6.90	152507	198708	30%
7.00	150151	195363	30%
7.10	147858	192123	30%
7.20	145544	188904	30%
7.30	143166	185769	30%
7.40	140831	182719	30%
7.50	138559	179731	30%
7.60	136245	176744	30%
7.70	133909	173735	30%
7.80	131637	170853	30%
7.90	129428	167907	30%
8.00	127303	165025	30%
8.10	125136	162227	30%
8.20	123012	159471	30%
8.30	120866	156694	30%
8.40	118741	154043	30%
8.50	116763	151350	30%
8.60	114786	148636	29%
8.70	112808	145943	29%
8.80	110830	143356	29%
8.90	108916	140726	29%
9.00	107064	138138	29%
9.10	105255	135698	29%
9.20	103425	133215	29%
9.30	101531	130754	29%
9.40	99722	128292	29%
9.50	97955	125810	28%
9.60	96103	123327	28%
9.70	94231	120781	28%
9.80	92295	118278	28%
9.90	90339	115606	28%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 1B	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1573041	7%
0.20	1309640	1398843	7%
0.30	1205711	1281870	6%
0.40	1127658	1194771	6%
0.50	1065805	1126817	6%
0.60	1013630	1069592	6%
0.70	967556	1019942	5%
0.80	926531	976603	5%
0.90	889083	938313	6%
1.00	854790	903599	6%
1.10	823233	871621	6%
1.20	793779	842378	6%
1.30	766850	815659	6%
1.40	741604	791044	7%
1.50	718251	768322	7%
1.60	696581	746863	7%
1.70	675753	726666	8%
1.80	656398	707942	8%
1.90	638095	690480	8%
2.00	620633	674070	9%
2.10	604433	658712	9%
2.20	589075	644406	9%
2.30	574559	630942	10%
2.40	560673	617898	10%
2.50	547419	605696	11%
2.60	534796	593914	11%
2.70	522594	582764	12%
2.80	511023	572034	12%
2.90	500083	561725	12%
3.00	489774	552048	13%
3.10	479676	542791	13%
3.20	470208	533955	14%
3.30	461162	525539	14%
3.40	452115	517545	14%
3.50	443700	509550	15%
3.60	435495	501976	15%
3.70	427711	494402	16%
3.80	419926	487039	16%
3.90	412563	480096	16%
4.00	405200	473154	17%
4.10	398047	466421	17%
4.20	391104	459899	18%
4.30	384582	453378	18%
4.40	378060	447276	18%
4.50	371959	441175	19%
4.60	365858	435284	19%
4.70	359967	429394	19%
4.80	354076	423924	20%

MIL2B

Flow (cfs)	Existing	Run 1B	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1209918	14%
0.20	849741	963348	13%
0.30	714043	813976	14%
0.40	615373	712571	16%
0.50	540897	637464	18%
0.60	481569	579398	20%
0.70	435074	532903	22%
0.80	396784	495034	25%
0.90	363754	463476	27%
1.00	335142	435916	30%
1.10	310527	411511	33%
1.20	288436	389421	35%
1.30	269081	370276	38%
1.40	251619	352814	40%
1.50	236051	337035	43%
1.60	221534	322308	45%
1.70	208301	308423	48%
1.80	196099	295590	51%
1.90	185096	283808	53%
2.00	174850	272658	56%
2.10	165362	262349	59%
2.20	156547	252461	61%
2.30	148321	243204	64%
2.40	140831	234368	66%
2.50	133909	226163	69%
2.60	127409	218168	71%
2.70	121328	210594	74%
2.80	115690	203610	76%
2.90	110262	196940	79%
3.00	105234	190524	81%
3.10	100374	184465	84%
3.20	95851	178595	86%
3.30	91496	173062	89%
3.40	87541	167529	91%
3.50	83796	162374	94%
3.60	80240	157304	96%
3.70	76853	152549	98%
3.80	73698	147900	101%
3.90	70710	143398	103%
4.00	67765	139064	105%
4.10	64946	134919	108%
4.20	62274	130880	110%
4.30	59875	127093	112%
4.40	57498	123453	115%
4.50	55205	119877	117%
4.60	52975	116427	120%
4.70	50913	113145	122%
4.80	48977	109947	124%

4.90	348606	418454	20%
5.00	343136	413405	20%
5.10	337877	408355	21%
5.20	332827	403096	21%
5.30	327778	398257	22%
5.40	322939	393418	22%
5.50	318311	388579	22%
5.60	313683	384161	22%
5.70	309054	379743	23%
5.80	304846	375325	23%
5.90	300428	370907	23%
6.00	296221	366699	24%
6.10	292223	362702	24%
6.20	288226	358705	24%
6.30	284439	354918	25%
6.40	280652	351131	25%
6.50	276865	347554	26%
6.60	273289	343978	26%
6.70	269712	340401	26%
6.80	266346	336825	26%
6.90	262980	333459	27%
7.00	259614	330092	27%
7.10	256458	326726	27%
7.20	253302	323571	28%
7.30	250147	320415	28%
7.40	247201	317259	28%
7.50	244256	314103	29%
7.60	241310	310948	29%
7.70	238575	307792	29%
7.80	235630	304636	29%
7.90	232895	301480	29%
8.00	230160	298535	30%
8.10	227635	295590	30%
8.20	224900	292644	30%
8.30	222376	289699	30%
8.40	219851	286964	31%
8.50	217116	284018	31%
8.60	214802	281073	31%
8.70	212277	278338	31%
8.80	209816	275393	31%
8.90	207397	272658	31%
9.00	205082	269712	32%
9.10	202684	266977	32%
9.20	200286	264242	32%
9.30	197950	261507	32%
9.40	195552	258772	32%
9.50	193238	256037	32%
9.60	190902	253302	33%
9.70	188546	250357	33%
9.80	186106	247622	33%
9.90	183623	244677	33%

4.90	47189	106917	127%
5.00	45401	103909	129%
5.10	43697	101026	131%
5.20	42056	98165	133%
5.30	40499	95472	136%
5.40	38963	92821	138%
5.50	37511	90339	141%
5.60	36102	87835	143%
5.70	34798	85458	146%
5.80	33493	83228	148%
5.90	32294	80977	151%
6.00	31158	78768	153%
6.10	30106	76559	154%
6.20	29033	74476	157%
6.30	27981	72456	159%
6.40	26908	70458	162%
6.50	25940	68564	164%
6.60	24952	66734	167%
6.70	24026	64925	170%
6.80	23037	63241	175%
6.90	22153	61537	178%
7.00	21291	59875	181%
7.10	20481	58192	184%
7.20	19736	56635	187%
7.30	19008	55100	190%
7.40	18312	53522	192%
7.50	17609	52133	196%
7.60	16963	50682	199%
7.70	16343	49272	201%
7.80	15728	47841	204%
7.90	15108	46600	208%
8.00	14533	45338	212%
8.10	13978	44096	215%
8.20	13441	42897	219%
8.30	12941	41740	223%
8.40	12476	40667	226%
8.50	12019	39531	229%
8.60	11580	38500	232%
8.70	11171	37427	235%
8.80	10738	36354	239%
8.90	10347	35323	241%
9.00	9964	34335	245%
9.10	9583	33346	248%
9.20	9236	32336	250%
9.30	8887	31368	253%
9.40	8552	30422	256%
9.50	8224	29496	259%
9.60	7862	28570	263%
9.70	7488	27644	269%
9.80	7115	26656	275%
9.90	6743	25730	282%

MIL2C

Flow (cfs)	Existing	Run 1B	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1418199	5%
0.20	1175415	1232850	5%
0.30	1065805	1116298	5%
0.40	982493	1030040	5%
0.50	914329	960403	5%
0.60	854790	902968	6%
0.70	802615	851634	6%
0.80	756120	807033	7%
0.90	714885	767691	7%
1.00	678068	732347	8%
1.10	644827	700579	9%
1.20	614111	671756	9%
1.30	586130	645879	10%
1.40	560673	622526	11%
1.50	537531	601277	12%
1.60	515651	581291	13%
1.70	495454	562567	14%
1.80	476730	545315	14%
1.90	459479	529116	15%
2.00	443700	513758	16%
2.10	428342	499452	17%
2.20	414667	485987	17%
2.30	401623	473154	18%
2.40	389000	460951	18%
2.50	377219	449380	19%
2.60	366068	438230	20%
2.70	355339	427500	20%
2.80	345240	417191	21%
2.90	335562	407303	21%
3.00	326306	398047	22%
3.10	317469	388790	22%
3.20	309264	380164	23%
3.30	301270	371959	23%
3.40	293696	364175	24%
3.50	286543	356390	24%
3.60	279390	349027	25%
3.70	272868	342084	25%
3.80	266346	335142	26%
3.90	260245	328620	26%
4.00	254565	322308	27%
4.10	248884	316207	27%
4.20	243625	310316	27%
4.30	238575	304426	28%
4.40	233526	298956	28%
4.50	228898	293486	28%
4.60	224480	288436	28%
4.70	220272	283387	29%
4.80	216275	278759	29%

MIL2D

Flow (cfs)	Existing	Run 1B	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	274130	29%
5.00	208533	269712	29%
5.10	204830	265294	30%
5.20	201232	261087	30%
5.30	197656	256879	30%
5.40	194248	252882	30%
5.50	190902	248674	30%
5.60	187578	244887	31%
5.70	184402	240890	31%
5.80	181393	237103	31%
5.90	178490	233526	31%
6.00	175755	229739	31%
6.10	172999	226373	31%
6.20	170285	222797	31%
6.30	167613	219220	31%
6.40	164983	215854	31%
6.50	162416	212277	31%
6.60	159955	208911	31%
6.70	157409	205482	31%
6.80	154885	202095	30%
6.90	152507	198708	30%
7.00	150151	195363	30%
7.10	147858	192123	30%
7.20	145544	188904	30%
7.30	143166	185769	30%
7.40	140831	182719	30%
7.50	138559	179731	30%
7.60	136245	176744	30%
7.70	133909	173735	30%
7.80	131637	170853	30%
7.90	129428	167907	30%
8.00	127303	165025	30%
8.10	125136	162227	30%
8.20	123012	159471	30%
8.30	120866	156694	30%
8.40	118741	154043	30%
8.50	116763	151350	30%
8.60	114786	148657	30%
8.70	112808	145943	29%
8.80	110830	143356	29%
8.90	108916	140726	29%
9.00	107064	138138	29%
9.10	105255	135698	29%
9.20	103425	133215	29%
9.30	101531	130775	29%
9.40	99722	128292	29%
9.50	97955	125810	28%
9.60	96103	123327	28%
9.70	94231	120781	28%
9.80	92295	118278	28%
9.90	90339	115627	28%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 2A	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1640995	11%
0.20	1309640	1498144	14%
0.30	1205711	1393373	16%
0.40	1127658	1313007	16%
0.50	1065805	1244632	17%
0.60	1013630	1185935	17%
0.70	967556	1134811	17%
0.80	926531	1090210	18%
0.90	889083	1049185	18%
1.00	854790	1011106	18%
1.10	823233	976182	19%
1.20	793779	943993	19%
1.30	766850	913908	19%
1.40	741604	885927	19%
1.50	718251	859839	20%
1.60	696581	836066	20%
1.70	675753	813134	20%
1.80	656398	791254	21%
1.90	638095	770637	21%
2.00	620633	751281	21%
2.10	604433	732557	21%
2.20	589075	714674	21%
2.30	574559	697844	21%
2.40	560673	681644	22%
2.50	547419	666286	22%
2.60	534796	651559	22%
2.70	522594	637464	22%
2.80	511023	623999	22%
2.90	500083	610955	22%
3.00	489774	598332	22%
3.10	479676	586130	22%
3.20	470208	574348	22%
3.30	461162	563198	22%
3.40	452115	552258	22%
3.50	443700	541949	22%
3.60	435495	532061	22%
3.70	427711	522383	22%
3.80	419926	512916	22%
3.90	412563	503659	22%
4.00	405200	494823	22%
4.10	398047	486408	22%
4.20	391104	478203	22%
4.30	384582	470208	22%
4.40	378060	462634	22%
4.50	371959	454850	22%
4.60	365858	447487	22%
4.70	359967	440334	22%
4.80	354076	433391	22%

MIL2B

Flow (cfs)	Existing	Run 2A	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1391690	31%
0.20	849741	1186145	40%
0.30	714043	1040980	46%
0.40	615373	929477	51%
0.50	540897	841115	56%
0.60	481569	766008	59%
0.70	435074	702051	61%
0.80	396784	645879	63%
0.90	363754	596859	64%
1.00	335142	552258	65%
1.10	310527	512285	65%
1.20	288436	476520	65%
1.30	269081	445173	65%
1.40	251619	415719	65%
1.50	236051	389000	65%
1.60	221534	364595	65%
1.70	208301	342084	64%
1.80	196099	321467	64%
1.90	185096	302322	63%
2.00	174850	284229	63%
2.10	165362	266977	61%
2.20	156547	251619	61%
2.30	148321	237524	60%
2.40	140831	224480	59%
2.50	133909	212277	59%
2.60	127409	201295	58%
2.70	121328	191176	58%
2.80	115690	181814	57%
2.90	110262	173356	57%
3.00	105234	165446	57%
3.10	100374	158146	58%
3.20	95851	151371	58%
3.30	91496	144976	58%
3.40	87541	139085	59%
3.50	83796	133594	59%
3.60	80240	128397	60%
3.70	76853	123601	61%
3.80	73698	119035	62%
3.90	70710	114596	62%
4.00	67765	110283	63%
4.10	64946	106223	64%
4.20	62274	102436	64%
4.30	59875	98775	65%
4.40	57498	95241	66%
4.50	55205	91980	67%
4.60	52975	88677	67%
4.70	50913	85753	68%
4.80	48977	82765	69%

4.90	348606	426659	22%
5.00	343136	419926	22%
5.10	337877	413615	22%
5.20	332827	407303	22%
5.30	327778	401202	22%
5.40	322939	395312	22%
5.50	318311	389631	22%
5.60	313683	383951	22%
5.70	309054	378481	22%
5.80	304846	373221	22%
5.90	300428	368382	23%
6.00	296221	363333	23%
6.10	292223	358705	23%
6.20	288226	353866	23%
6.30	284439	349237	23%
6.40	280652	344819	23%
6.50	276865	340401	23%
6.60	273289	335983	23%
6.70	269712	331986	23%
6.80	266346	327778	23%
6.90	262980	323571	23%
7.00	259614	319573	23%
7.10	256458	315576	23%
7.20	253302	311789	23%
7.30	250147	308213	23%
7.40	247201	304636	23%
7.50	244256	300849	23%
7.60	241310	297273	23%
7.70	238575	293696	23%
7.80	235630	290330	23%
7.90	232895	286753	23%
8.00	230160	283387	23%
8.10	227635	280231	23%
8.20	224900	276865	23%
8.30	222376	273710	23%
8.40	219851	270554	23%
8.50	217116	267398	23%
8.60	214802	264242	23%
8.70	212277	261297	23%
8.80	209816	258352	23%
8.90	207397	255406	23%
9.00	205082	252461	23%
9.10	202684	249515	23%
9.20	200286	246570	23%
9.30	197950	243625	23%
9.40	195552	240679	23%
9.50	193238	237734	23%
9.60	190902	234789	23%
9.70	188546	231843	23%
9.80	186106	228687	23%
9.90	183623	225532	23%

4.90	47189	79925	69%
5.00	45401	77295	70%
5.10	43697	74728	71%
5.20	42056	72246	72%
5.30	40499	69869	73%
5.40	38963	67575	73%
5.50	37511	65366	74%
5.60	36102	63178	75%
5.70	34798	61180	76%
5.80	33493	59181	77%
5.90	32294	57224	77%
6.00	31158	55457	78%
6.10	30106	53753	79%
6.20	29033	52007	79%
6.30	27981	50345	80%
6.40	26908	48809	81%
6.50	25940	47273	82%
6.60	24952	45864	84%
6.70	24026	44454	85%
6.80	23037	43108	87%
6.90	22153	41803	89%
7.00	21291	40457	90%
7.10	20481	39152	91%
7.20	19736	37953	92%
7.30	19008	36712	93%
7.40	18312	35555	94%
7.50	17609	34419	95%
7.60	16963	33304	96%
7.70	16343	32294	98%
7.80	15728	31326	99%
7.90	15108	30422	101%
8.00	14533	29496	103%
8.10	13978	28633	105%
8.20	13441	27729	106%
8.30	12941	26908	108%
8.40	12476	26046	109%
8.50	12019	25246	110%
8.60	11580	24426	111%
8.70	11171	23689	112%
8.80	10738	22890	113%
8.90	10347	22132	114%
9.00	9964	21396	115%
9.10	9583	20698	116%
9.20	9236	20062	117%
9.30	8887	19429	119%
9.40	8552	18768	119%
9.50	8224	18120	120%
9.60	7862	17481	122%
9.70	7488	16860	125%
9.80	7115	16248	128%
9.90	6743	15653	132%

MIL2C

Flow (cfs)	Existing	Run 2A	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1498144	11%
0.20	1175415	1319108	12%
0.30	1065805	1195192	12%
0.40	982493	1103043	12%
0.50	914329	1027095	12%
0.60	854790	961034	12%
0.70	802615	904862	13%
0.80	756120	856052	13%
0.90	714885	811661	14%
1.00	678068	772109	14%
1.10	644827	735923	14%
1.20	614111	702893	14%
1.30	586130	673018	15%
1.40	560673	645458	15%
1.50	537531	620212	15%
1.60	515651	596859	16%
1.70	495454	574769	16%
1.80	476730	554151	16%
1.90	459479	535217	16%
2.00	443700	517124	17%
2.10	428342	500293	17%
2.20	414667	484935	17%
2.30	401623	469998	17%
2.40	389000	456113	17%
2.50	377219	442858	17%
2.60	366068	430025	17%
2.70	355339	417823	18%
2.80	345240	406252	18%
2.90	335562	395101	18%
3.00	326306	384372	18%
3.10	317469	374273	18%
3.20	309264	364806	18%
3.30	301270	355970	18%
3.40	293696	347344	18%
3.50	286543	338929	18%
3.60	279390	330934	18%
3.70	272868	323150	18%
3.80	266346	315786	19%
3.90	260245	308633	19%
4.00	254565	301901	19%
4.10	248884	295379	19%
4.20	243625	289278	19%
4.30	238575	283387	19%
4.40	233526	277707	19%
4.50	228898	272237	19%
4.60	224480	266977	19%
4.70	220272	261718	19%
4.80	216275	256879	19%

MIL2D

Flow (cfs)	Existing	Run 2A	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	252040	19%
5.00	208533	247412	19%
5.10	204830	242994	19%
5.20	201232	238575	19%
5.30	197656	234368	19%
5.40	194248	230370	19%
5.50	190902	226163	18%
5.60	187578	221955	18%
5.70	184402	218168	18%
5.80	181393	214171	18%
5.90	178490	210216	18%
6.00	175755	206429	17%
6.10	172999	202642	17%
6.20	170285	198939	17%
6.30	167613	195278	17%
6.40	164983	191744	16%
6.50	162416	188188	16%
6.60	159955	184654	15%
6.70	157409	181204	15%
6.80	154885	177922	15%
6.90	152507	174598	14%
7.00	150151	171358	14%
7.10	147858	168076	14%
7.20	145544	164836	13%
7.30	143166	161680	13%
7.40	140831	158587	13%
7.50	138559	155537	12%
7.60	136245	152570	12%
7.70	133909	149541	12%
7.80	131637	146701	11%
7.90	129428	143819	11%
8.00	127303	140957	11%
8.10	125136	138243	10%
8.20	123012	135529	10%
8.30	120866	132815	10%
8.40	118741	130144	10%
8.50	116763	127514	9%
8.60	114786	124863	9%
8.70	112808	122296	8%
8.80	110830	119645	8%
8.90	108916	117079	7%
9.00	107064	114512	7%
9.10	105255	112029	6%
9.20	103425	109652	6%
9.30	101531	107296	6%
9.40	99722	104940	5%
9.50	97955	102667	5%
9.60	96103	100269	4%
9.70	94231	97955	4%
9.80	92295	95620	4%
9.90	90339	93158	3%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 2B	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1640785	11%
0.20	1309640	1496882	14%
0.30	1205711	1391480	15%
0.40	1127658	1310692	16%
0.50	1065805	1241476	16%
0.60	1013630	1182568	17%
0.70	967556	1131656	17%
0.80	926531	1086844	17%
0.90	889083	1046029	18%
1.00	854790	1007739	18%
1.10	823233	972816	18%
1.20	793779	940627	18%
1.30	766850	910963	19%
1.40	741604	883192	19%
1.50	718251	857315	19%
1.60	696581	833541	20%
1.70	675753	810399	20%
1.80	656398	788730	20%
1.90	638095	768322	20%
2.00	620633	748757	21%
2.10	604433	730243	21%
2.20	589075	712571	21%
2.30	574559	695740	21%
2.40	560673	679751	21%
2.50	547419	664393	21%
2.60	534796	649666	21%
2.70	522594	635780	22%
2.80	511023	622316	22%
2.90	500083	609272	22%
3.00	489774	596859	22%
3.10	479676	584657	22%
3.20	470208	572876	22%
3.30	461162	561725	22%
3.40	452115	550996	22%
3.50	443700	540687	22%
3.60	435495	530799	22%
3.70	427711	521121	22%
3.80	419926	511864	22%
3.90	412563	502818	22%
4.00	405200	493982	22%
4.10	398047	485566	22%
4.20	391104	477572	22%
4.30	384582	469577	22%
4.40	378060	461793	22%
4.50	371959	454429	22%
4.60	365858	446856	22%
4.70	359967	439913	22%
4.80	354076	432970	22%

MIL2B

Flow (cfs)	Existing	Run 2B	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1389166	31%
0.20	849741	1181096	39%
0.30	714043	1035510	45%
0.40	615373	924217	50%
0.50	540897	835435	54%
0.60	481569	760959	58%
0.70	435074	697002	60%
0.80	396784	641671	62%
0.90	363754	593283	63%
1.00	335142	549313	64%
1.10	310527	509760	64%
1.20	288436	474206	64%
1.30	269081	443279	65%
1.40	251619	415298	65%
1.50	236051	389842	65%
1.60	221534	367120	66%
1.70	208301	346082	66%
1.80	196099	326726	67%
1.90	185096	308844	67%
2.00	174850	292223	67%
2.10	165362	276655	67%
2.20	156547	262349	68%
2.30	148321	249095	68%
2.40	140831	236892	68%
2.50	133909	225321	68%
2.60	127409	214592	68%
2.70	121328	204514	69%
2.80	115690	194816	68%
2.90	110262	185727	68%
3.00	105234	176891	68%
3.10	100374	168854	68%
3.20	95851	161301	68%
3.30	91496	153896	68%
3.40	87541	147016	68%
3.50	83796	140663	68%
3.60	80240	134751	68%
3.70	76853	129113	68%
3.80	73698	123895	68%
3.90	70710	118909	68%
4.00	67765	114154	68%
4.10	64946	109589	69%
4.20	62274	105318	69%
4.30	59875	101216	69%
4.40	57498	97303	69%
4.50	55205	93558	69%
4.60	52975	89897	70%
4.70	50913	86699	70%
4.80	48977	83459	70%

4.90	348606	426238	22%
5.00	343136	419926	22%
5.10	337877	413405	22%
5.20	332827	407303	22%
5.30	327778	401413	22%
5.40	322939	395522	22%
5.50	318311	390052	23%
5.60	313683	384372	23%
5.70	309054	379112	23%
5.80	304846	373852	23%
5.90	300428	368803	23%
6.00	296221	363964	23%
6.10	292223	359336	23%
6.20	288226	354497	23%
6.30	284439	350079	23%
6.40	280652	345451	23%
6.50	276865	341243	23%
6.60	273289	336825	23%
6.70	269712	332827	23%
6.80	266346	328620	23%
6.90	262980	324623	23%
7.00	259614	320625	24%
7.10	256458	316838	24%
7.20	253302	313051	24%
7.30	250147	309264	24%
7.40	247201	305688	24%
7.50	244256	302111	24%
7.60	241310	298535	24%
7.70	238575	295169	24%
7.80	235630	291592	24%
7.90	232895	288226	24%
8.00	230160	284860	24%
8.10	227635	281494	24%
8.20	224900	278338	24%
8.30	222376	275182	24%
8.40	219851	272027	24%
8.50	217116	268871	24%
8.60	214802	265925	24%
8.70	212277	262770	24%
8.80	209816	259824	24%
8.90	207397	256879	24%
9.00	205082	253933	24%
9.10	202684	251198	24%
9.20	200286	248253	24%
9.30	197950	245518	24%
9.40	195552	242573	24%
9.50	193238	239627	24%
9.60	190902	236892	24%
9.70	188546	233737	24%
9.80	186106	230791	24%
9.90	183623	227635	24%

4.90	47189	80451	70%
5.00	45401	77484	71%
5.10	43697	74728	71%
5.20	42056	72099	71%
5.30	40499	69616	72%
5.40	38963	67281	73%
5.50	37511	64946	73%
5.60	36102	62631	73%
5.70	34798	60527	74%
5.80	33493	58466	75%
5.90	32294	56509	75%
6.00	31158	54574	75%
6.10	30106	52764	75%
6.20	29033	50976	76%
6.30	27981	49272	76%
6.40	26908	47673	77%
6.50	25940	46095	78%
6.60	24952	44601	79%
6.70	24026	43129	80%
6.80	23037	41740	81%
6.90	22153	40415	82%
7.00	21291	39068	83%
7.10	20481	37806	85%
7.20	19736	36544	85%
7.30	19008	35323	86%
7.40	18312	34208	87%
7.50	17609	33051	88%
7.60	16963	31957	88%
7.70	16343	30947	89%
7.80	15728	29959	90%
7.90	15108	29012	92%
8.00	14533	28086	93%
8.10	13978	27203	95%
8.20	13441	26277	95%
8.30	12941	25435	97%
8.40	12476	24594	97%
8.50	12019	23752	98%
8.60	11580	22932	98%
8.70	11171	22153	98%
8.80	10738	21375	99%
8.90	10347	20607	99%
9.00	9964	19881	100%
9.10	9583	19212	100%
9.20	9236	18531	101%
9.30	8887	17929	102%
9.40	8552	17289	102%
9.50	8224	16732	103%
9.60	7862	16075	104%
9.70	7488	15461	106%
9.80	7115	14857	109%
9.90	6743	14220	111%

MIL2C

Flow (cfs)	Existing	Run 2B	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1496882	11%
0.20	1175415	1317214	12%
0.30	1065805	1192877	12%
0.40	982493	1100939	12%
0.50	914329	1024991	12%
0.60	854790	959351	12%
0.70	802615	903599	13%
0.80	756120	854790	13%
0.90	714885	810610	13%
1.00	678068	771057	14%
1.10	644827	735082	14%
1.20	614111	702472	14%
1.30	586130	672387	15%
1.40	560673	645037	15%
1.50	537531	619791	15%
1.60	515651	596439	16%
1.70	495454	574559	16%
1.80	476730	553941	16%
1.90	459479	535007	16%
2.00	443700	516913	17%
2.10	428342	500293	17%
2.20	414667	484935	17%
2.30	401623	469998	17%
2.40	389000	456113	17%
2.50	377219	442858	17%
2.60	366068	430235	18%
2.70	355339	418033	18%
2.80	345240	406462	18%
2.90	335562	395312	18%
3.00	326306	384792	18%
3.10	317469	374694	18%
3.20	309264	365227	18%
3.30	301270	356390	18%
3.40	293696	347765	18%
3.50	286543	339349	18%
3.60	279390	331355	19%
3.70	272868	323781	19%
3.80	266346	316207	19%
3.90	260245	309054	19%
4.00	254565	302322	19%
4.10	248884	295800	19%
4.20	243625	289699	19%
4.30	238575	283808	19%
4.40	233526	278128	19%
4.50	228898	272868	19%
4.60	224480	267398	19%
4.70	220272	262349	19%
4.80	216275	257510	19%

MIL2D

Flow (cfs)	Existing	Run 2B	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	252671	19%
5.00	208533	248043	19%
5.10	204830	243625	19%
5.20	201232	239207	19%
5.30	197656	234999	19%
5.40	194248	230791	19%
5.50	190902	226794	19%
5.60	187578	222797	19%
5.70	184402	218799	19%
5.80	181393	214802	18%
5.90	178490	210805	18%
6.00	175755	207018	18%
6.10	172999	203273	17%
6.20	170285	199507	17%
6.30	167613	195910	17%
6.40	164983	192354	17%
6.50	162416	188820	16%
6.60	159955	185306	16%
6.70	157409	181856	16%
6.80	154885	178595	15%
6.90	152507	175334	15%
7.00	150151	172094	15%
7.10	147858	168833	14%
7.20	145544	165614	14%
7.30	143166	162459	13%
7.40	140831	159408	13%
7.50	138559	156357	13%
7.60	136245	153391	13%
7.70	133909	150404	12%
7.80	131637	147605	12%
7.90	129428	144765	12%
8.00	127303	141946	12%
8.10	125136	139232	11%
8.20	123012	136581	11%
8.30	120866	133888	11%
8.40	118741	131280	11%
8.50	116763	128692	10%
8.60	114786	126125	10%
8.70	112808	123516	9%
8.80	110830	120971	9%
8.90	108916	118362	9%
9.00	107064	115837	8%
9.10	105255	113355	8%
9.20	103425	110935	7%
9.30	101531	108621	7%
9.40	99722	106265	7%
9.50	97955	103972	6%
9.60	96103	101637	6%
9.70	94231	99301	5%
9.80	92295	96966	5%
9.90	90339	94526	5%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 3A	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1532858	4%
0.20	1309640	1354031	3%
0.30	1205711	1240214	3%
0.40	1127658	1157322	3%
0.50	1065805	1092524	3%
0.60	1013630	1038245	2%
0.70	967556	991329	2%
0.80	926531	950936	3%
0.90	889083	913908	3%
1.00	854790	880036	3%
1.10	823233	848899	3%
1.20	793779	820498	3%
1.30	766850	794831	4%
1.40	741604	770847	4%
1.50	718251	748546	4%
1.60	696581	727718	4%
1.70	675753	708363	5%
1.80	656398	690480	5%
1.90	638095	673439	6%
2.00	620633	658081	6%
2.10	604433	643565	6%
2.20	589075	629890	7%
2.30	574559	616846	7%
2.40	560673	604433	8%
2.50	547419	592652	8%
2.60	534796	581501	9%
2.70	522594	570772	9%
2.80	511023	560673	10%
2.90	500083	550996	10%
3.00	489774	541739	11%
3.10	479676	532903	11%
3.20	470208	524487	12%
3.30	461162	516282	12%
3.40	452115	508498	12%
3.50	443700	500714	13%
3.60	435495	493350	13%
3.70	427711	486197	14%
3.80	419926	479255	14%
3.90	412563	472522	15%
4.00	405200	465790	15%
4.10	398047	459268	15%
4.20	391104	452957	16%
4.30	384582	446856	16%
4.40	378060	440965	17%
4.50	371959	435074	17%
4.60	365858	429604	17%
4.70	359967	424134	18%
4.80	354076	418875	18%

MIL2B

Flow (cfs)	Existing	Run 3A	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1110617	5%
0.20	849741	880878	4%
0.30	714043	745180	4%
0.40	615373	653242	6%
0.50	540897	586971	9%
0.60	481569	536690	11%
0.70	435074	496506	14%
0.80	396784	463476	17%
0.90	363754	435074	20%
1.00	335142	410459	22%
1.10	310527	389000	25%
1.20	288436	369855	28%
1.30	269081	352814	31%
1.40	251619	337246	34%
1.50	236051	322939	37%
1.60	221534	309475	40%
1.70	208301	297062	43%
1.80	196099	285491	46%
1.90	185096	274551	48%
2.00	174850	264663	51%
2.10	165362	255406	54%
2.20	156547	246570	58%
2.30	148321	238365	61%
2.40	140831	230581	64%
2.50	133909	223007	67%
2.60	127409	215854	69%
2.70	121328	209227	72%
2.80	115690	202726	75%
2.90	110262	196520	78%
3.00	105234	190650	81%
3.10	100374	185201	85%
3.20	95851	179899	88%
3.30	91496	174808	91%
3.40	87541	169801	94%
3.50	83796	165067	97%
3.60	80240	160502	100%
3.70	76853	156105	103%
3.80	73698	151771	106%
3.90	70710	147753	109%
4.00	67765	143692	112%
4.10	64946	139842	115%
4.20	62274	136203	119%
4.30	59875	132689	122%
4.40	57498	129302	125%
4.50	55205	125978	128%
4.60	52975	122780	132%
4.70	50913	119645	135%
4.80	48977	116658	138%

4.90	348606	413615	19%
5.00	343136	408566	19%
5.10	337877	403727	19%
5.20	332827	398678	20%
5.30	327778	394049	20%
5.40	322939	389421	21%
5.50	318311	385003	21%
5.60	313683	380585	21%
5.70	309054	376377	22%
5.80	304846	372169	22%
5.90	300428	367962	22%
6.00	296221	363964	23%
6.10	292223	360177	23%
6.20	288226	356390	24%
6.30	284439	352604	24%
6.40	280652	349027	24%
6.50	276865	345661	25%
6.60	273289	342084	25%
6.70	269712	338718	26%
6.80	266346	335352	26%
6.90	262980	331986	26%
7.00	259614	328620	27%
7.10	256458	325464	27%
7.20	253302	322308	27%
7.30	250147	319153	28%
7.40	247201	315997	28%
7.50	244256	312841	28%
7.60	241310	309896	28%
7.70	238575	306950	29%
7.80	235630	303794	29%
7.90	232895	300849	29%
8.00	230160	297904	29%
8.10	227635	294958	30%
8.20	224900	292013	30%
8.30	222376	289068	30%
8.40	219851	286122	30%
8.50	217116	283387	31%
8.60	214802	280652	31%
8.70	212277	277707	31%
8.80	209816	274972	31%
8.90	207397	272237	31%
9.00	205082	269502	31%
9.10	202684	266767	32%
9.20	200286	264032	32%
9.30	197950	261297	32%
9.40	195552	258562	32%
9.50	193238	255827	32%
9.60	190902	253092	33%
9.70	188546	250147	33%
9.80	186106	247412	33%
9.90	183623	244677	33%

4.90	47189	113923	141%
5.00	45401	111146	145%
5.10	43697	108411	148%
5.20	42056	105760	151%
5.30	40499	103151	155%
5.40	38963	100690	158%
5.50	37511	98228	162%
5.60	36102	95893	166%
5.70	34798	93558	169%
5.80	33493	91328	173%
5.90	32294	89119	176%
6.00	31158	87036	179%
6.10	30106	85058	183%
6.20	29033	82996	186%
6.30	27981	81061	190%
6.40	26908	79146	194%
6.50	25940	77211	198%
6.60	24952	75360	202%
6.70	24026	73550	206%
6.80	23037	71762	212%
6.90	22153	70121	217%
7.00	21291	68417	221%
7.10	20481	66755	226%
7.20	19736	65177	230%
7.30	19008	63620	235%
7.40	18312	62126	239%
7.50	17609	60591	244%
7.60	16963	59076	248%
7.70	16343	57603	252%
7.80	15728	56194	257%
7.90	15108	54805	263%
8.00	14533	53395	267%
8.10	13978	52091	273%
8.20	13441	50724	277%
8.30	12941	49398	282%
8.40	12476	48178	286%
8.50	12019	47021	291%
8.60	11580	45759	295%
8.70	11171	44622	299%
8.80	10738	43486	305%
8.90	10347	42371	310%
9.00	9964	41277	314%
9.10	9583	40246	320%
9.20	9236	39152	324%
9.30	8887	38101	329%
9.40	8552	37112	334%
9.50	8224	36081	339%
9.60	7862	35050	346%
9.70	7488	33998	354%
9.80	7115	32925	363%
9.90	6743	31915	373%

MIL2C

Flow (cfs)	Existing	Run 3A	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1381171	3%
0.20	1175415	1201082	2%
0.30	1065805	1090631	2%
0.40	982493	1008160	3%
0.50	914329	942100	3%
0.60	854790	885296	4%
0.70	802615	835224	4%
0.80	756120	791675	5%
0.90	714885	753385	5%
1.00	678068	718882	6%
1.10	644827	687956	7%
1.20	614111	660185	8%
1.30	586130	635570	8%
1.40	560673	613059	9%
1.50	537531	592441	10%
1.60	515651	573296	11%
1.70	495454	555203	12%
1.80	476730	538583	13%
1.90	459479	522804	14%
2.00	443700	508288	15%
2.10	428342	494402	15%
2.20	414667	481359	16%
2.30	401623	468946	17%
2.40	389000	457164	18%
2.50	377219	445804	18%
2.60	366068	434864	19%
2.70	355339	424555	19%
2.80	345240	414667	20%
2.90	335562	405200	21%
3.00	326306	396153	21%
3.10	317469	387317	22%
3.20	309264	378902	23%
3.30	301270	370907	23%
3.40	293696	363123	24%
3.50	286543	355759	24%
3.60	279390	348606	25%
3.70	272868	341874	25%
3.80	266346	335142	26%
3.90	260245	328830	26%
4.00	254565	322729	27%
4.10	248884	316838	27%
4.20	243625	311158	28%
4.30	238575	305478	28%
4.40	233526	300218	29%
4.50	228898	294958	29%
4.60	224480	289909	29%
4.70	220272	285070	29%
4.80	216275	280442	30%

MIL2D

Flow (cfs)	Existing	Run 3A	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	276024	30%
5.00	208533	271395	30%
5.10	204830	267188	30%
5.20	201232	262980	31%
5.30	197656	258772	31%
5.40	194248	254775	31%
5.50	190902	250778	31%
5.60	187578	246991	32%
5.70	184402	242994	32%
5.80	181393	239207	32%
5.90	178490	235420	32%
6.00	175755	231633	32%
6.10	172999	228056	32%
6.20	170285	224690	32%
6.30	167613	221114	32%
6.40	164983	217537	32%
6.50	162416	214171	32%
6.60	159955	210594	32%
6.70	157409	207270	32%
6.80	154885	203904	32%
6.90	152507	200622	32%
7.00	150151	197361	31%
7.10	147858	194037	31%
7.20	145544	190923	31%
7.30	143166	187789	31%
7.40	140831	184675	31%
7.50	138559	181603	31%
7.60	136245	178511	31%
7.70	133909	175460	31%
7.80	131637	172473	31%
7.90	129428	169548	31%
8.00	127303	166624	31%
8.10	125136	163742	31%
8.20	123012	160923	31%
8.30	120866	158125	31%
8.40	118741	155432	31%
8.50	116763	152739	31%
8.60	114786	150109	31%
8.70	112808	147479	31%
8.80	110830	144870	31%
8.90	108916	142262	31%
9.00	107064	139716	30%
9.10	105255	137170	30%
9.20	103425	134562	30%
9.30	101531	131974	30%
9.40	99722	129512	30%
9.50	97955	126967	30%
9.60	96103	124463	30%
9.70	94231	122002	29%
9.80	92295	119435	29%
9.90	90339	116847	29%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 3B	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1559366	6%
0.20	1309640	1381381	5%
0.30	1205711	1264618	5%
0.40	1127658	1179413	5%
0.50	1065805	1112931	4%
0.60	1013630	1057811	4%
0.70	967556	1009843	4%
0.80	926531	967977	4%
0.90	889083	930949	5%
1.00	854790	896867	5%
1.10	823233	865099	5%
1.20	793779	836276	5%
1.30	766850	809558	6%
1.40	741604	785153	6%
1.50	718251	762221	6%
1.60	696581	740972	6%
1.70	675753	720986	7%
1.80	656398	702472	7%
1.90	638095	685010	7%
2.00	620633	668600	8%
2.10	604433	653453	8%
2.20	589075	639147	9%
2.30	574559	625472	9%
2.40	560673	612638	9%
2.50	547419	600436	10%
2.60	534796	588865	10%
2.70	522594	577714	11%
2.80	511023	566985	11%
2.90	500083	556886	11%
3.00	489774	547209	12%
3.10	479676	538162	12%
3.20	470208	529326	13%
3.30	461162	520911	13%
3.40	452115	512706	13%
3.50	443700	504922	14%
3.60	435495	497137	14%
3.70	427711	489774	15%
3.80	419926	482621	15%
3.90	412563	475468	15%
4.00	405200	468736	16%
4.10	398047	462003	16%
4.20	391104	455271	16%
4.30	384582	448959	17%
4.40	378060	443069	17%
4.50	371959	436968	17%
4.60	365858	431077	18%
4.70	359967	425607	18%
4.80	354076	420137	19%

MIL2B

Flow (cfs)	Existing	Run 3B	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1170997	11%
0.20	849741	930318	9%
0.30	714043	787047	10%
0.40	615373	687535	12%
0.50	540897	613690	13%
0.60	481569	556886	16%
0.70	435074	511864	18%
0.80	396784	475468	20%
0.90	363754	444541	22%
1.00	335142	417612	25%
1.10	310527	394049	27%
1.20	288436	373432	29%
1.30	269081	355339	32%
1.40	251619	338508	35%
1.50	236051	323571	37%
1.60	221534	309264	40%
1.70	208301	296221	42%
1.80	196099	283808	45%
1.90	185096	272658	47%
2.00	174850	262349	50%
2.10	165362	252461	53%
2.20	156547	243204	55%
2.30	148321	234789	58%
2.40	140831	226584	61%
2.50	133909	219010	64%
2.60	127409	211646	66%
2.70	121328	204725	69%
2.80	115690	198119	71%
2.90	110262	191828	74%
3.00	105234	185958	77%
3.10	100374	180341	80%
3.20	95851	175018	83%
3.30	91496	169801	86%
3.40	87541	164731	88%
3.50	83796	160039	91%
3.60	80240	155411	94%
3.70	76853	150993	96%
3.80	73698	146743	99%
3.90	70710	142682	102%
4.00	67765	138643	105%
4.10	64946	134898	108%
4.20	62274	131301	111%
4.30	59875	127829	113%
4.40	57498	124484	117%
4.50	55205	121244	120%
4.60	52975	118089	123%
4.70	50913	115101	126%
4.80	48977	112240	129%

4.90	348606	414877	19%
5.00	343136	409618	19%
5.10	337877	404568	20%
5.20	332827	399519	20%
5.30	327778	394680	20%
5.40	322939	389842	21%
5.50	318311	385213	21%
5.60	313683	380795	21%
5.70	309054	376377	22%
5.80	304846	372169	22%
5.90	300428	367962	22%
6.00	296221	363754	23%
6.10	292223	359757	23%
6.20	288226	355970	24%
6.30	284439	352183	24%
6.40	280652	348606	24%
6.50	276865	345030	25%
6.60	273289	341453	25%
6.70	269712	338087	25%
6.80	266346	334511	26%
6.90	262980	331144	26%
7.00	259614	327778	26%
7.10	256458	324412	26%
7.20	253302	321256	27%
7.30	250147	318101	27%
7.40	247201	315155	27%
7.50	244256	311999	28%
7.60	241310	308844	28%
7.70	238575	305688	28%
7.80	235630	302743	28%
7.90	232895	299587	29%
8.00	230160	296641	29%
8.10	227635	293696	29%
8.20	224900	290751	29%
8.30	222376	287805	29%
8.40	219851	284860	30%
8.50	217116	282125	30%
8.60	214802	279180	30%
8.70	212277	276445	30%
8.80	209816	273710	30%
8.90	207397	270975	31%
9.00	205082	268029	31%
9.10	202684	265294	31%
9.20	200286	262559	31%
9.30	197950	259824	31%
9.40	195552	257089	31%
9.50	193238	254354	32%
9.60	190902	251619	32%
9.70	188546	248884	32%
9.80	186106	245939	32%
9.90	183623	242994	32%

4.90	47189	109484	132%
5.00	45401	106749	135%
5.10	43697	104077	138%
5.20	42056	101573	142%
5.30	40499	99049	145%
5.40	38963	96671	148%
5.50	37511	94252	151%
5.60	36102	91980	155%
5.70	34798	89771	158%
5.80	33493	87646	162%
5.90	32294	85605	165%
6.00	31158	83565	168%
6.10	30106	81629	171%
6.20	29033	79651	174%
6.30	27981	77716	178%
6.40	26908	75843	182%
6.50	25940	74013	185%
6.60	24952	72288	190%
6.70	24026	70563	194%
6.80	23037	68901	199%
6.90	22153	67281	204%
7.00	21291	65640	208%
7.10	20481	64125	213%
7.20	19736	62610	217%
7.30	19008	61096	221%
7.40	18312	59581	225%
7.50	17609	58129	230%
7.60	16963	56698	234%
7.70	16343	55352	239%
7.80	15728	53985	243%
7.90	15108	52617	248%
8.00	14533	51292	253%
8.10	13978	49966	257%
8.20	13441	48725	263%
8.30	12941	47568	268%
8.40	12476	46348	271%
8.50	12019	45190	276%
8.60	11580	44054	280%
8.70	11171	42960	285%
8.80	10738	41887	290%
8.90	10347	40793	294%
9.00	9964	39784	299%
9.10	9583	38753	304%
9.20	9236	37743	309%
9.30	8887	36754	314%
9.40	8552	35765	318%
9.50	8224	34798	323%
9.60	7862	33725	329%
9.70	7488	32757	337%
9.80	7115	31747	346%
9.90	6743	30758	356%

MIL2C

Flow (cfs)	Existing	Run 3B	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1395687	4%
0.20	1175415	1213285	3%
0.30	1065805	1101150	3%
0.40	982493	1017838	4%
0.50	914329	950936	4%
0.60	854790	894132	5%
0.70	802615	843429	5%
0.80	756120	799459	6%
0.90	714885	760538	6%
1.00	678068	725614	7%
1.10	644827	694267	8%
1.20	614111	665865	8%
1.30	586130	640409	9%
1.40	560673	617477	10%
1.50	537531	596439	11%
1.60	515651	576873	12%
1.70	495454	558570	13%
1.80	476730	541318	14%
1.90	459479	525329	14%
2.00	443700	510392	15%
2.10	428342	496296	16%
2.20	414667	483042	16%
2.30	401623	470419	17%
2.40	389000	458427	18%
2.50	377219	446856	18%
2.60	366068	435705	19%
2.70	355339	425186	20%
2.80	345240	415088	20%
2.90	335562	405620	21%
3.00	326306	396363	21%
3.10	317469	387527	22%
3.20	309264	378902	23%
3.30	301270	370907	23%
3.40	293696	363123	24%
3.50	286543	355549	24%
3.60	279390	348186	25%
3.70	272868	341453	25%
3.80	266346	334721	26%
3.90	260245	328199	26%
4.00	254565	322098	27%
4.10	248884	315997	27%
4.20	243625	310316	27%
4.30	238575	304636	28%
4.40	233526	299166	28%
4.50	228898	294117	28%
4.60	224480	288857	29%
4.70	220272	284018	29%
4.80	216275	279390	29%

MIL2D

Flow (cfs)	Existing	Run 3B	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	274972	30%
5.00	208533	270554	30%
5.10	204830	266136	30%
5.20	201232	261928	30%
5.30	197656	257931	30%
5.40	194248	253723	31%
5.50	190902	249726	31%
5.60	187578	245939	31%
5.70	184402	241942	31%
5.80	181393	238155	31%
5.90	178490	234368	31%
6.00	175755	230791	31%
6.10	172999	227215	31%
6.20	170285	223638	31%
6.30	167613	220062	31%
6.40	164983	216696	31%
6.50	162416	213119	31%
6.60	159955	209669	31%
6.70	157409	206282	31%
6.80	154885	202957	31%
6.90	152507	199654	31%
7.00	150151	196330	31%
7.10	147858	193111	31%
7.20	145544	189851	30%
7.30	143166	186737	30%
7.40	140831	183686	30%
7.50	138559	180594	30%
7.60	136245	177480	30%
7.70	133909	174514	30%
7.80	131637	171547	30%
7.90	129428	168560	30%
8.00	127303	165656	30%
8.10	125136	162795	30%
8.20	123012	159976	30%
8.30	120866	157241	30%
8.40	118741	154611	30%
8.50	116763	151897	30%
8.60	114786	149267	30%
8.70	112808	146596	30%
8.80	110830	143945	30%
8.90	108916	141357	30%
9.00	107064	138790	30%
9.10	105255	136203	29%
9.20	103425	133636	29%
9.30	101531	131111	29%
9.40	99722	128671	29%
9.50	97955	126104	29%
9.60	96103	123685	29%
9.70	94231	121181	29%
9.80	92295	118593	28%
9.90	90339	116048	28%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 4A	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1718417	17%
0.20	1309640	1592817	22%
0.30	1205711	1497934	24%
0.40	1127658	1418619	26%
0.50	1065805	1350665	27%
0.60	1013630	1293020	28%
0.70	967556	1240845	28%
0.80	926531	1193508	29%
0.90	889083	1150800	29%
1.00	854790	1111459	30%
1.10	823233	1075693	31%
1.20	793779	1041822	31%
1.30	766850	1010264	32%
1.40	741604	980389	32%
1.50	718251	952408	33%
1.60	696581	925900	33%
1.70	675753	900864	33%
1.80	656398	877091	34%
1.90	638095	854369	34%
2.00	620633	832700	34%
2.10	604433	812082	34%
2.20	589075	792306	35%
2.30	574559	773792	35%
2.40	560673	755910	35%
2.50	547419	738658	35%
2.60	534796	722038	35%
2.70	522594	705838	35%
2.80	511023	690480	35%
2.90	500083	675753	35%
3.00	489774	661447	35%
3.10	479676	647772	35%
3.20	470208	634097	35%
3.30	461162	621054	35%
3.40	452115	608431	35%
3.50	443700	596018	34%
3.60	435495	584026	34%
3.70	427711	572244	34%
3.80	419926	560884	34%
3.90	412563	549733	33%
4.00	405200	539004	33%
4.10	398047	528905	33%
4.20	391104	518807	33%
4.30	384582	508919	32%
4.40	378060	499241	32%
4.50	371959	489984	32%
4.60	365858	481148	32%
4.70	359967	472522	31%
4.80	354076	463897	31%

MIL2B

Flow (cfs)	Existing	Run 4A	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1540432	45%
0.20	849741	1345406	58%
0.30	714043	1205500	69%
0.40	615373	1090210	77%
0.50	540897	992171	83%
0.60	481569	908859	89%
0.70	435074	836276	92%
0.80	396784	771899	95%
0.90	363754	714043	96%
1.00	335142	660606	97%
1.10	310527	612849	97%
1.20	288436	568878	97%
1.30	269081	528274	96%
1.40	251619	490826	95%
1.50	236051	455481	93%
1.60	221534	422241	91%
1.70	208301	392366	88%
1.80	196099	364806	86%
1.90	185096	339139	83%
2.00	174850	316207	81%
2.10	165362	294538	78%
2.20	156547	274762	76%
2.30	148321	256879	73%
2.40	140831	240259	71%
2.50	133909	224269	67%
2.60	127409	209963	65%
2.70	121328	196225	62%
2.80	115690	183497	59%
2.90	110262	171884	56%
3.00	105234	161112	53%
3.10	100374	151182	51%
3.20	95851	141904	48%
3.30	91496	133489	46%
3.40	87541	125599	43%
3.50	83796	118152	41%
3.60	80240	111525	39%
3.70	76853	105066	37%
3.80	73698	98775	34%
3.90	70710	93305	32%
4.00	67765	88067	30%
4.10	64946	83018	28%
4.20	62274	78515	26%
4.30	59875	74139	24%
4.40	57498	70100	22%
4.50	55205	66313	20%
4.60	52975	62526	18%
4.70	50913	58697	15%
4.80	48977	54847	12%

4.90	348606	455692	31%
5.00	343136	447276	30%
5.10	337877	439282	30%
5.20	332827	431708	30%
5.30	327778	424134	29%
5.40	322939	416981	29%
5.50	318311	409618	29%
5.60	313683	402675	28%
5.70	309054	395943	28%
5.80	304846	389421	28%
5.90	300428	383109	28%
6.00	296221	377008	27%
6.10	292223	370907	27%
6.20	288226	365016	27%
6.30	284439	359336	26%
6.40	280652	353866	26%
6.50	276865	348396	26%
6.60	273289	343136	26%
6.70	269712	337877	25%
6.80	266346	332827	25%
6.90	262980	327778	25%
7.00	259614	323150	24%
7.10	256458	318521	24%
7.20	253302	313893	24%
7.30	250147	309475	24%
7.40	247201	305267	23%
7.50	244256	301060	23%
7.60	241310	296852	23%
7.70	238575	292855	23%
7.80	235630	288857	23%
7.90	232895	284860	22%
8.00	230160	281073	22%
8.10	227635	277076	22%
8.20	224900	273289	22%
8.30	222376	269712	21%
8.40	219851	266136	21%
8.50	217116	262559	21%
8.60	214802	258983	21%
8.70	212277	255617	20%
8.80	209816	252250	20%
8.90	207397	249095	20%
9.00	205082	245729	20%
9.10	202684	242573	20%
9.20	200286	239417	20%
9.30	197950	236261	19%
9.40	195552	233105	19%
9.50	193238	230160	19%
9.60	190902	227004	19%
9.70	188546	223849	19%
9.80	186106	220903	19%
9.90	183623	217537	18%

4.90	47189	51418	9%
5.00	45401	48241	6%
5.10	43697	45254	4%
5.20	42056	42561	1%
5.30	40499	39889	-2%
5.40	38963	37259	-4%
5.50	37511	35029	-7%
5.60	36102	32841	-9%
5.70	34798	30779	-12%
5.80	33493	28970	-14%
5.90	32294	27308	-15%
6.00	31158	25562	-18%
6.10	30106	23647	-21%
6.20	29033	21817	-25%
6.30	27981	20199	-28%
6.40	26908	18714	-30%
6.50	25940	17405	-33%
6.60	24952	16075	-36%
6.70	24026	14763	-39%
6.80	23037	13627	-41%
6.90	22153	12596	-43%
7.00	21291	11586	-46%
7.10	20481	10700	-48%
7.20	19736	9819	-50%
7.30	19008	9000	-53%
7.40	18312	8266	-55%
7.50	17609	7687	-56%
7.60	16963	7090	-58%
7.70	16343	6669	-59%
7.80	15728	6229	-60%
7.90	15108	5775	-62%
8.00	14533	5419	-63%
8.10	13978	5104	-63%
8.20	13441	4675	-65%
8.30	12941	4395	-66%
8.40	12476	4140	-67%
8.50	12019	3863	-68%
8.60	11580	3631	-69%
8.70	11171	3393	-70%
8.80	10738	3175	-70%
8.90	10347	3002	-71%
9.00	9964	2872	-71%
9.10	9583	2752	-71%
9.20	9236	2640	-71%
9.30	8887	2556	-71%
9.40	8552	2493	-71%
9.50	8224	2432	-70%
9.60	7862	2346	-70%
9.70	7488	2251	-70%
9.80	7115	2171	-69%
9.90	6743	2103	-69%

MIL2C

Flow (cfs)	Existing	Run 4A	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1562522	16%
0.20	1175415	1385168	18%
0.30	1065805	1260831	18%
0.40	982493	1163424	18%
0.50	914329	1084740	19%
0.60	854790	1017207	19%
0.70	802615	957247	19%
0.80	756120	904441	20%
0.90	714885	857315	20%
1.00	678068	814817	20%
1.10	644827	776107	20%
1.20	614111	740762	21%
1.30	586130	708153	21%
1.40	560673	678278	21%
1.50	537531	650297	21%
1.60	515651	624209	21%
1.70	495454	599805	21%
1.80	476730	577294	21%
1.90	459479	556045	21%
2.00	443700	535848	21%
2.10	428342	517124	21%
2.20	414667	499241	20%
2.30	401623	482621	20%
2.40	389000	466632	20%
2.50	377219	451905	20%
2.60	366068	437388	19%
2.70	355339	424134	19%
2.80	345240	410880	19%
2.90	335562	398678	19%
3.00	326306	386896	19%
3.10	317469	375746	18%
3.20	309264	365227	18%
3.30	301270	355128	18%
3.40	293696	345451	18%
3.50	286543	336194	17%
3.60	279390	327358	17%
3.70	272868	318942	17%
3.80	266346	310737	17%
3.90	260245	303163	16%
4.00	254565	295590	16%
4.10	248884	288226	16%
4.20	243625	281494	16%
4.30	238575	274972	15%
4.40	233526	268871	15%
4.50	228898	262770	15%
4.60	224480	256879	14%
4.70	220272	251409	14%
4.80	216275	246360	14%

MIL2D

Flow (cfs)	Existing	Run 4A	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	241521	14%
5.00	208533	236682	13%
5.10	204830	232054	13%
5.20	201232	227635	13%
5.30	197656	223217	13%
5.40	194248	219010	13%
5.50	190902	215012	13%
5.60	187578	211015	12%
5.70	184402	207102	12%
5.80	181393	203252	12%
5.90	178490	199465	12%
6.00	175755	195825	11%
6.10	172999	192165	11%
6.20	170285	188630	11%
6.30	167613	185117	10%
6.40	164983	181814	10%
6.50	162416	178637	10%
6.60	159955	175523	10%
6.70	157409	172452	10%
6.80	154885	169401	9%
6.90	152507	166372	9%
7.00	150151	163342	9%
7.10	147858	160355	8%
7.20	145544	157346	8%
7.30	143166	154317	8%
7.40	140831	151392	7%
7.50	138559	148594	7%
7.60	136245	145901	7%
7.70	133909	143166	7%
7.80	131637	140431	7%
7.90	129428	137738	6%
8.00	127303	135045	6%
8.10	125136	132353	6%
8.20	123012	129786	6%
8.30	120866	127345	5%
8.40	118741	124947	5%
8.50	116763	122612	5%
8.60	114786	120298	5%
8.70	112808	118025	5%
8.80	110830	115753	4%
8.90	108916	113502	4%
9.00	107064	111272	4%
9.10	105255	109126	4%
9.20	103425	107022	3%
9.30	101531	104876	3%
9.40	99722	102709	3%
9.50	97955	100627	3%
9.60	96103	98481	2%
9.70	94231	96440	2%
9.80	92295	94399	2%
9.90	90339	92253	2%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 4B	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1655091	12%
0.20	1309640	1514765	16%
0.30	1205711	1410625	17%
0.40	1127658	1329837	18%
0.50	1065805	1261673	18%
0.60	1013630	1202345	19%
0.70	967556	1150590	19%
0.80	926531	1105358	19%
0.90	889083	1064333	20%
1.00	854790	1026253	20%
1.10	823233	990698	20%
1.20	793779	957878	21%
1.30	766850	927793	21%
1.40	741604	899392	21%
1.50	718251	872673	21%
1.60	696581	848268	22%
1.70	675753	825336	22%
1.80	656398	803036	22%
1.90	638095	781997	23%
2.00	620633	762221	23%
2.10	604433	743287	23%
2.20	589075	725194	23%
2.30	574559	707942	23%
2.40	560673	691532	23%
2.50	547419	675753	23%
2.60	534796	660606	24%
2.70	522594	646510	24%
2.80	511023	632625	24%
2.90	500083	619160	24%
3.00	489774	606327	24%
3.10	479676	593914	24%
3.20	470208	581922	24%
3.30	461162	570351	24%
3.40	452115	559201	24%
3.50	443700	548261	24%
3.60	435495	537952	24%
3.70	427711	528064	23%
3.80	419926	518386	23%
3.90	412563	508919	23%
4.00	405200	499872	23%
4.10	398047	491036	23%
4.20	391104	482621	23%
4.30	384582	474626	23%
4.40	378060	466421	23%
4.50	371959	458637	23%
4.60	365858	451063	23%
4.70	359967	443700	23%
4.80	354076	436547	23%

MIL2B

Flow (cfs)	Existing	Run 4B	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1423248	34%
0.20	849741	1217492	43%
0.30	714043	1071696	50%
0.40	615373	957247	56%
0.50	540897	867203	60%
0.60	481569	790833	64%
0.70	435074	724773	67%
0.80	396784	667338	68%
0.90	363754	616215	69%
1.00	335142	570772	70%
1.10	310527	528905	70%
1.20	288436	491247	70%
1.30	269081	457585	70%
1.40	251619	426869	70%
1.50	236051	399098	69%
1.60	221534	373011	68%
1.70	208301	349658	68%
1.80	196099	327778	67%
1.90	185096	307792	66%
2.00	174850	289068	65%
2.10	165362	271816	64%
2.20	156547	254985	63%
2.30	148321	239838	62%
2.40	140831	226163	61%
2.50	133909	213329	59%
2.60	127409	201401	58%
2.70	121328	190650	57%
2.80	115690	180488	56%
2.90	110262	171210	55%
3.00	105234	162627	55%
3.10	100374	154590	54%
3.20	95851	147479	54%
3.30	91496	140810	54%
3.40	87541	134793	54%
3.50	83796	129134	54%
3.60	80240	123811	54%
3.70	76853	118783	55%
3.80	73698	114133	55%
3.90	70710	109610	55%
4.00	67765	105276	55%
4.10	64946	101195	56%
4.20	62274	97261	56%
4.30	59875	93663	56%
4.40	57498	90107	57%
4.50	55205	86783	57%
4.60	52975	83586	58%
4.70	50913	80640	58%
4.80	48977	77779	59%

4.90	348606	429604	23%
5.00	343136	422661	23%
5.10	337877	416140	23%
5.20	332827	409828	23%
5.30	327778	403517	23%
5.40	322939	397205	23%
5.50	318311	391314	23%
5.60	313683	385634	23%
5.70	309054	380164	23%
5.80	304846	374694	23%
5.90	300428	369645	23%
6.00	296221	364595	23%
6.10	292223	359757	23%
6.20	288226	354707	23%
6.30	284439	350079	23%
6.40	280652	345451	23%
6.50	276865	340822	23%
6.60	273289	336404	23%
6.70	269712	331986	23%
6.80	266346	327778	23%
6.90	262980	323781	23%
7.00	259614	319573	23%
7.10	256458	315576	23%
7.20	253302	311789	23%
7.30	250147	307792	23%
7.40	247201	304005	23%
7.50	244256	300428	23%
7.60	241310	296641	23%
7.70	238575	293065	23%
7.80	235630	289488	23%
7.90	232895	286122	23%
8.00	230160	282756	23%
8.10	227635	279390	23%
8.20	224900	276024	23%
8.30	222376	272868	23%
8.40	219851	269712	23%
8.50	217116	266346	23%
8.60	214802	263401	23%
8.70	212277	260455	23%
8.80	209816	257300	23%
8.90	207397	254565	23%
9.00	205082	251619	23%
9.10	202684	248674	23%
9.20	200286	245518	23%
9.30	197950	242573	23%
9.40	195552	239627	23%
9.50	193238	236682	22%
9.60	190902	233737	22%
9.70	188546	230791	22%
9.80	186106	227635	22%
9.90	183623	224480	22%

4.90	47189	75044	59%
5.00	45401	72393	59%
5.10	43697	69869	60%
5.20	42056	67470	60%
5.30	40499	65219	61%
5.40	38963	62989	62%
5.50	37511	60864	62%
5.60	36102	58781	63%
5.70	34798	56762	63%
5.80	33493	54931	64%
5.90	32294	53143	65%
6.00	31158	51397	65%
6.10	30106	49756	65%
6.20	29033	48115	66%
6.30	27981	46621	67%
6.40	26908	45169	68%
6.50	25940	43676	68%
6.60	24952	42203	69%
6.70	24026	40772	70%
6.80	23037	39468	71%
6.90	22153	38227	73%
7.00	21291	37007	74%
7.10	20481	35807	75%
7.20	19736	34629	75%
7.30	19008	33493	76%
7.40	18312	32441	77%
7.50	17609	31431	78%
7.60	16963	30464	80%
7.70	16343	29496	80%
7.80	15728	28549	82%
7.90	15108	27560	82%
8.00	14533	26677	84%
8.10	13978	25793	85%
8.20	13441	24952	86%
8.30	12941	24152	87%
8.40	12476	23353	87%
8.50	12019	22616	88%
8.60	11580	21859	89%
8.70	11171	21186	90%
8.80	10738	20525	91%
8.90	10347	19913	92%
9.00	9964	19322	94%
9.10	9583	18712	95%
9.20	9236	18118	96%
9.30	8887	17550	97%
9.40	8552	16949	98%
9.50	8224	16370	99%
9.60	7862	15798	101%
9.70	7488	15263	104%
9.80	7115	14672	106%
9.90	6743	14127	110%

MIL2C

Flow (cfs)	Existing	Run 4B	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1508874	12%
0.20	1175415	1329627	13%
0.30	1065805	1205290	13%
0.40	982493	1112300	13%
0.50	914329	1035931	13%
0.60	854790	969449	13%
0.70	802615	912435	14%
0.80	756120	863206	14%
0.90	714885	818604	15%
1.00	678068	778421	15%
1.10	644827	742024	15%
1.20	614111	708573	15%
1.30	586130	678278	16%
1.40	560673	650297	16%
1.50	537531	624420	16%
1.60	515651	600646	16%
1.70	495454	578346	17%
1.80	476730	557518	17%
1.90	459479	537952	17%
2.00	443700	519438	17%
2.10	428342	502607	17%
2.20	414667	486618	17%
2.30	401623	471681	17%
2.40	389000	457375	18%
2.50	377219	443700	18%
2.60	366068	430866	18%
2.70	355339	418664	18%
2.80	345240	406883	18%
2.90	335562	395312	18%
3.00	326306	384582	18%
3.10	317469	374484	18%
3.20	309264	364806	18%
3.30	301270	355549	18%
3.40	293696	346713	18%
3.50	286543	338508	18%
3.60	279390	330303	18%
3.70	272868	322519	18%
3.80	266346	315155	18%
3.90	260245	307792	18%
4.00	254565	301060	18%
4.10	248884	294538	18%
4.20	243625	288226	18%
4.30	238575	282335	18%
4.40	233526	276655	18%
4.50	228898	271185	18%
4.60	224480	265715	18%
4.70	220272	260455	18%
4.80	216275	255617	18%

MIL2D

Flow (cfs)	Existing	Run 4B	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	250778	18%
5.00	208533	246149	18%
5.10	204830	241731	18%
5.20	201232	237313	18%
5.30	197656	233105	18%
5.40	194248	228898	18%
5.50	190902	224690	18%
5.60	187578	220693	18%
5.70	184402	216696	18%
5.80	181393	212909	17%
5.90	178490	208890	17%
6.00	175755	205103	17%
6.10	172999	201380	16%
6.20	170285	197761	16%
6.30	167613	194100	16%
6.40	164983	190545	15%
6.50	162416	187052	15%
6.60	159955	183581	15%
6.70	157409	180194	14%
6.80	154885	176870	14%
6.90	152507	173546	14%
7.00	150151	170264	13%
7.10	147858	167024	13%
7.20	145544	163805	13%
7.30	143166	160712	12%
7.40	140831	157620	12%
7.50	138559	154590	12%
7.60	136245	151624	11%
7.70	133909	148720	11%
7.80	131637	145859	11%
7.90	129428	142998	10%
8.00	127303	140200	10%
8.10	125136	137486	10%
8.20	123012	134751	10%
8.30	120866	132058	9%
8.40	118741	129428	9%
8.50	116763	126819	9%
8.60	114786	124106	8%
8.70	112808	121560	8%
8.80	110830	118888	7%
8.90	108916	116321	7%
9.00	107064	113818	6%
9.10	105255	111356	6%
9.20	103425	108958	5%
9.30	101531	106581	5%
9.40	99722	104266	5%
9.50	97955	102015	4%
9.60	96103	99659	4%
9.70	94231	97345	3%
9.80	92295	94946	3%
9.90	90339	92569	2%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 4C	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1654249	12%
0.20	1309640	1513923	16%
0.30	1205711	1409783	17%
0.40	1127658	1328996	18%
0.50	1065805	1260831	18%
0.60	1013630	1201503	19%
0.70	967556	1149538	19%
0.80	926531	1104516	19%
0.90	889083	1063491	20%
1.00	854790	1025412	20%
1.10	823233	989857	20%
1.20	793779	957247	21%
1.30	766850	926952	21%
1.40	741604	898550	21%
1.50	718251	872042	21%
1.60	696581	847427	22%
1.70	675753	824495	22%
1.80	656398	802194	22%
1.90	638095	781366	22%
2.00	620633	761590	23%
2.10	604433	742656	23%
2.20	589075	724562	23%
2.30	574559	707311	23%
2.40	560673	690901	23%
2.50	547419	675122	23%
2.60	534796	660185	23%
2.70	522594	645879	24%
2.80	511023	631994	24%
2.90	500083	618739	24%
3.00	489774	605906	24%
3.10	479676	593493	24%
3.20	470208	581291	24%
3.30	461162	569930	24%
3.40	452115	558780	24%
3.50	443700	547840	23%
3.60	435495	537531	23%
3.70	427711	527643	23%
3.80	419926	517965	23%
3.90	412563	508709	23%
4.00	405200	499662	23%
4.10	398047	490826	23%
4.20	391104	482411	23%
4.30	384582	474206	23%
4.40	378060	466211	23%
4.50	371959	458427	23%
4.60	365858	450853	23%
4.70	359967	443489	23%
4.80	354076	436336	23%

MIL2B

Flow (cfs)	Existing	Run 4C	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1423248	34%
0.20	849741	1217492	43%
0.30	714043	1071696	50%
0.40	615373	957247	56%
0.50	540897	867203	60%
0.60	481569	790833	64%
0.70	435074	724773	67%
0.80	396784	667338	68%
0.90	363754	616215	69%
1.00	335142	570772	70%
1.10	310527	528905	70%
1.20	288436	491247	70%
1.30	269081	457585	70%
1.40	251619	426869	70%
1.50	236051	399098	69%
1.60	221534	373011	68%
1.70	208301	349658	68%
1.80	196099	327778	67%
1.90	185096	307792	66%
2.00	174850	289068	65%
2.10	165362	271816	64%
2.20	156547	254985	63%
2.30	148321	239838	62%
2.40	140831	226163	61%
2.50	133909	213329	59%
2.60	127409	201401	58%
2.70	121328	190650	57%
2.80	115690	180488	56%
2.90	110262	171210	55%
3.00	105234	162627	55%
3.10	100374	154590	54%
3.20	95851	147479	54%
3.30	91496	140810	54%
3.40	87541	134793	54%
3.50	83796	129134	54%
3.60	80240	123811	54%
3.70	76853	118783	55%
3.80	73698	114133	55%
3.90	70710	109610	55%
4.00	67765	105276	55%
4.10	64946	101195	56%
4.20	62274	97261	56%
4.30	59875	93663	56%
4.40	57498	90107	57%
4.50	55205	86783	57%
4.60	52975	83586	58%
4.70	50913	80640	58%
4.80	48977	77779	59%

4.90	348606	429394	23%
5.00	343136	422451	23%
5.10	337877	415929	23%
5.20	332827	409618	23%
5.30	327778	403096	23%
5.40	322939	397205	23%
5.50	318311	391314	23%
5.60	313683	385423	23%
5.70	309054	379954	23%
5.80	304846	374694	23%
5.90	300428	369645	23%
6.00	296221	364385	23%
6.10	292223	359546	23%
6.20	288226	354707	23%
6.30	284439	350079	23%
6.40	280652	345451	23%
6.50	276865	340822	23%
6.60	273289	336404	23%
6.70	269712	331986	23%
6.80	266346	327778	23%
6.90	262980	323781	23%
7.00	259614	319573	23%
7.10	256458	315576	23%
7.20	253302	311579	23%
7.30	250147	307792	23%
7.40	247201	304005	23%
7.50	244256	300428	23%
7.60	241310	296852	23%
7.70	238575	293275	23%
7.80	235630	289699	23%
7.90	232895	286122	23%
8.00	230160	282756	23%
8.10	227635	279390	23%
8.20	224900	276024	23%
8.30	222376	272868	23%
8.40	219851	269712	23%
8.50	217116	266557	23%
8.60	214802	263401	23%
8.70	212277	260455	23%
8.80	209816	257300	23%
8.90	207397	254565	23%
9.00	205082	251619	23%
9.10	202684	248674	23%
9.20	200286	245729	23%
9.30	197950	242573	23%
9.40	195552	239627	23%
9.50	193238	236682	22%
9.60	190902	233737	22%
9.70	188546	230791	22%
9.80	186106	227635	22%
9.90	183623	224480	22%

4.90	47189	75044	59%
5.00	45401	72393	59%
5.10	43697	69869	60%
5.20	42056	67470	60%
5.30	40499	65219	61%
5.40	38963	62989	62%
5.50	37511	60864	62%
5.60	36102	58781	63%
5.70	34798	56762	63%
5.80	33493	54931	64%
5.90	32294	53143	65%
6.00	31158	51397	65%
6.10	30106	49756	65%
6.20	29033	48115	66%
6.30	27981	46621	67%
6.40	26908	45169	68%
6.50	25940	43676	68%
6.60	24952	42203	69%
6.70	24026	40772	70%
6.80	23037	39468	71%
6.90	22153	38227	73%
7.00	21291	37007	74%
7.10	20481	35807	75%
7.20	19736	34629	75%
7.30	19008	33493	76%
7.40	18312	32441	77%
7.50	17609	31431	78%
7.60	16963	30464	80%
7.70	16343	29496	80%
7.80	15728	28549	82%
7.90	15108	27560	82%
8.00	14533	26677	84%
8.10	13978	25793	85%
8.20	13441	24952	86%
8.30	12941	24152	87%
8.40	12476	23353	87%
8.50	12019	22616	88%
8.60	11580	21859	89%
8.70	11171	21186	90%
8.80	10738	20525	91%
8.90	10347	19913	92%
9.00	9964	19322	94%
9.10	9583	18712	95%
9.20	9236	18118	96%
9.30	8887	17550	97%
9.40	8552	16949	98%
9.50	8224	16370	99%
9.60	7862	15798	101%
9.70	7488	15263	104%
9.80	7115	14672	106%
9.90	6743	14127	110%

MIL2C

Flow (cfs)	Existing	Run 4C	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1507191	12%
0.20	1175415	1328154	13%
0.30	1065805	1203817	13%
0.40	982493	1111038	13%
0.50	914329	1034669	13%
0.60	854790	968398	13%
0.70	802615	911383	14%
0.80	756120	862154	14%
0.90	714885	817763	14%
1.00	678068	777579	15%
1.10	644827	741183	15%
1.20	614111	707942	15%
1.30	586130	677647	16%
1.40	560673	649666	16%
1.50	537531	623999	16%
1.60	515651	600226	16%
1.70	495454	577925	17%
1.80	476730	557097	17%
1.90	459479	537531	17%
2.00	443700	519438	17%
2.10	428342	502397	17%
2.20	414667	486618	17%
2.30	401623	471471	17%
2.40	389000	457164	18%
2.50	377219	443700	18%
2.60	366068	430866	18%
2.70	355339	418664	18%
2.80	345240	406883	18%
2.90	335562	395522	18%
3.00	326306	384792	18%
3.10	317469	374484	18%
3.20	309264	365016	18%
3.30	301270	355759	18%
3.40	293696	346923	18%
3.50	286543	338718	18%
3.60	279390	330513	18%
3.70	272868	322729	18%
3.80	266346	315366	18%
3.90	260245	308002	18%
4.00	254565	301270	18%
4.10	248884	294748	18%
4.20	243625	288436	18%
4.30	238575	282546	18%
4.40	233526	276865	19%
4.50	228898	271395	19%
4.60	224480	265925	18%
4.70	220272	260876	18%
4.80	216275	255827	18%

MIL2D

Flow (cfs)	Existing	Run 4C	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	250988	18%
5.00	208533	246360	18%
5.10	204830	241942	18%
5.20	201232	237524	18%
5.30	197656	233316	18%
5.40	194248	229108	18%
5.50	190902	224900	18%
5.60	187578	220903	18%
5.70	184402	216906	18%
5.80	181393	213119	17%
5.90	178490	209122	17%
6.00	175755	205293	17%
6.10	172999	201590	17%
6.20	170285	197887	16%
6.30	167613	194290	16%
6.40	164983	190713	16%
6.50	162416	187221	15%
6.60	159955	183686	15%
6.70	157409	180299	15%
6.80	154885	177038	14%
6.90	152507	173693	14%
7.00	150151	170411	13%
7.10	147858	167150	13%
7.20	145544	163931	13%
7.30	143166	160796	12%
7.40	140831	157767	12%
7.50	138559	154758	12%
7.60	136245	151708	11%
7.70	133909	148805	11%
7.80	131637	145964	11%
7.90	129428	143124	11%
8.00	127303	140284	10%
8.10	125136	137528	10%
8.20	123012	134814	10%
8.30	120866	132121	9%
8.40	118741	129512	9%
8.50	116763	126883	9%
8.60	114786	124211	8%
8.70	112808	121623	8%
8.80	110830	118993	7%
8.90	108916	116405	7%
9.00	107064	113860	6%
9.10	105255	111419	6%
9.20	103425	109021	5%
9.30	101531	106644	5%
9.40	99722	104308	5%
9.50	97955	102057	4%
9.60	96103	99701	4%
9.70	94231	97366	3%
9.80	92295	95030	3%
9.90	90339	92590	2%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 5A	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1906710	29%
0.20	1309640	1704110	30%
0.30	1205711	1600181	33%
0.40	1127658	1514344	34%
0.50	1065805	1407259	32%
0.60	1013630	1298490	28%
0.70	967556	1207815	25%
0.80	926531	1131445	22%
0.90	889083	1066857	20%
1.00	854790	1009002	18%
1.10	823233	956616	16%
1.20	793779	909490	15%
1.30	766850	866361	13%
1.40	741604	825968	11%
1.50	718251	788940	10%
1.60	696581	755699	8%
1.70	675753	725194	7%
1.80	656398	696792	6%
1.90	638095	670704	5%
2.00	620633	646720	4%
2.10	604433	624840	3%
2.20	589075	604854	3%
2.30	574559	586340	2%
2.40	560673	569089	2%
2.50	547419	552889	1%
2.60	534796	537952	1%
2.70	522594	524277	0%
2.80	511023	511444	0%
2.90	500083	499662	0%
3.00	489774	488512	0%
3.10	479676	477992	0%
3.20	470208	468104	0%
3.30	461162	458637	-1%
3.40	452115	449591	-1%
3.50	443700	441175	-1%
3.60	435495	432970	-1%
3.70	427711	425186	-1%
3.80	419926	417823	-1%
3.90	412563	410670	0%
4.00	405200	403937	0%
4.10	398047	397626	0%
4.20	391104	391314	0%
4.30	384582	385213	0%
4.40	378060	379533	0%
4.50	371959	374063	1%
4.60	365858	368593	1%
4.70	359967	363333	1%
4.80	354076	358284	1%

MIL2B

Flow (cfs)	Existing	Run 5A	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1602285	51%
0.20	849741	1488677	75%
0.30	714043	1317004	84%
0.40	615373	980810	59%
0.50	540897	669021	24%
0.60	481569	475889	-1%
0.70	435074	375325	-14%
0.80	396784	327778	-17%
0.90	363754	303374	-17%
1.00	335142	287174	-14%
1.10	310527	273710	-12%
1.20	288436	261507	-9%
1.30	269081	250778	-7%
1.40	251619	240890	-4%
1.50	236051	231633	-2%
1.60	221534	222797	1%
1.70	208301	214802	3%
1.80	196099	207144	6%
1.90	185096	200054	8%
2.00	174850	193490	11%
2.10	165362	187179	13%
2.20	156547	181120	16%
2.30	148321	175355	18%
2.40	140831	169822	21%
2.50	133909	164647	23%
2.60	127409	159639	25%
2.70	121328	155074	28%
2.80	115690	150740	30%
2.90	110262	146511	33%
3.00	105234	142451	35%
3.10	100374	138517	38%
3.20	95851	134709	41%
3.30	91496	130964	43%
3.40	87541	127388	46%
3.50	83796	123832	48%
3.60	80240	120319	50%
3.70	76853	116910	52%
3.80	73698	113649	54%
3.90	70710	110494	56%
4.00	67765	107548	59%
4.10	64946	104666	61%
4.20	62274	101931	64%
4.30	59875	99280	66%
4.40	57498	96735	68%
4.50	55205	94315	71%
4.60	52975	91938	74%
4.70	50913	89603	76%
4.80	48977	87351	78%

4.90	348606	353445	1%
5.00	343136	348817	2%
5.10	337877	344399	2%
5.20	332827	339981	2%
5.30	327778	335773	2%
5.40	322939	331776	3%
5.50	318311	327568	3%
5.60	313683	323781	3%
5.70	309054	319994	4%
5.80	304846	316418	4%
5.90	300428	312841	4%
6.00	296221	309475	4%
6.10	292223	306109	5%
6.20	288226	302953	5%
6.30	284439	299587	5%
6.40	280652	296431	6%
6.50	276865	293486	6%
6.60	273289	290330	6%
6.70	269712	287385	7%
6.80	266346	284439	7%
6.90	262980	281494	7%
7.00	259614	278759	7%
7.10	256458	276024	8%
7.20	253302	273078	8%
7.30	250147	270554	8%
7.40	247201	267819	8%
7.50	244256	265294	9%
7.60	241310	262559	9%
7.70	238575	260035	9%
7.80	235630	257510	9%
7.90	232895	254985	9%
8.00	230160	252671	10%
8.10	227635	250147	10%
8.20	224900	247832	10%
8.30	222376	245308	10%
8.40	219851	242994	11%
8.50	217116	240679	11%
8.60	214802	238365	11%
8.70	212277	235840	11%
8.80	209816	233737	11%
8.90	207397	231422	12%
9.00	205082	229108	12%
9.10	202684	226794	12%
9.20	200286	224480	12%
9.30	197950	222376	12%
9.40	195552	220062	13%
9.50	193238	217747	13%
9.60	190902	215644	13%
9.70	188546	213329	13%
9.80	186106	211015	13%
9.90	183623	208659	14%

4.90	47189	85121	80%
5.00	45401	83060	83%
5.10	43697	80956	85%
5.20	42056	78915	88%
5.30	40499	77001	90%
5.40	38963	75065	93%
5.50	37511	73235	95%
5.60	36102	71510	98%
5.70	34798	69784	101%
5.80	33493	68080	103%
5.90	32294	66439	106%
6.00	31158	64861	108%
6.10	30106	63305	110%
6.20	29033	61811	113%
6.30	27981	60401	116%
6.40	26908	59013	119%
6.50	25940	57708	122%
6.60	24952	56446	126%
6.70	24026	55247	130%
6.80	23037	54006	134%
6.90	22153	52806	138%
7.00	21291	51670	143%
7.10	20481	50534	147%
7.20	19736	49440	151%
7.30	19008	48325	154%
7.40	18312	47273	158%
7.50	17609	46200	162%
7.60	16963	45190	166%
7.70	16343	44139	170%
7.80	15728	43171	174%
7.90	15108	42161	179%
8.00	14533	41235	184%
8.10	13978	40310	188%
8.20	13441	39363	193%
8.30	12941	38479	197%
8.40	12476	37533	201%
8.50	12019	36670	205%
8.60	11580	35828	209%
8.70	11171	35008	213%
8.80	10738	34208	219%
8.90	10347	33409	223%
9.00	9964	32694	228%
9.10	9583	31957	233%
9.20	9236	31200	238%
9.30	8887	30464	243%
9.40	8552	29727	248%
9.50	8224	29012	253%
9.60	7862	28276	260%
9.70	7488	27518	267%
9.80	7115	26803	277%
9.90	6743	26025	286%

MIL2C

Flow (cfs)	Existing	Run 5A	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1694222	26%
0.20	1175415	1336359	14%
0.30	1065805	1171628	10%
0.40	982493	1060967	8%
0.50	914329	972395	6%
0.60	854790	897709	5%
0.70	802615	832700	4%
0.80	756120	774634	2%
0.90	714885	724562	1%
1.00	678068	681013	0%
1.10	644827	642513	0%
1.20	614111	608851	-1%
1.30	586130	579187	-1%
1.40	560673	552679	-1%
1.50	537531	529116	-2%
1.60	515651	508498	-1%
1.70	495454	489774	-1%
1.80	476730	472943	-1%
1.90	459479	457585	0%
2.00	443700	443700	0%
2.10	428342	431077	1%
2.20	414667	419085	1%
2.30	401623	408145	2%
2.40	389000	397836	2%
2.50	377219	387948	3%
2.60	366068	378691	3%
2.70	355339	370065	4%
2.80	345240	361650	5%
2.90	335562	353866	5%
3.00	326306	346502	6%
3.10	317469	339349	7%
3.20	309264	332196	7%
3.30	301270	325674	8%
3.40	293696	319363	9%
3.50	286543	313472	9%
3.60	279390	307792	10%
3.70	272868	302322	11%
3.80	266346	297062	12%
3.90	260245	291803	12%
4.00	254565	286964	13%
4.10	248884	282335	13%
4.20	243625	277496	14%
4.30	238575	273078	14%
4.40	233526	268660	15%
4.50	228898	264663	16%
4.60	224480	260666	16%
4.70	220272	256879	17%
4.80	216275	253092	17%

MIL2D

Flow (cfs)	Existing	Run 5A	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	249305	17%
5.00	208533	245729	18%
5.10	204830	242362	18%
5.20	201232	238786	19%
5.30	197656	235420	19%
5.40	194248	232264	20%
5.50	190902	229108	20%
5.60	187578	225742	20%
5.70	184402	222586	21%
5.80	181393	219431	21%
5.90	178490	216275	21%
6.00	175755	213329	21%
6.10	172999	210279	22%
6.20	170285	207333	22%
6.30	167613	204409	22%
6.40	164983	201485	22%
6.50	162416	198518	22%
6.60	159955	195657	22%
6.70	157409	192838	23%
6.80	154885	189977	23%
6.90	152507	187116	23%
7.00	150151	184275	23%
7.10	147858	181456	23%
7.20	145544	178679	23%
7.30	143166	175923	23%
7.40	140831	173293	23%
7.50	138559	170600	23%
7.60	136245	167992	23%
7.70	133909	165404	24%
7.80	131637	162795	24%
7.90	129428	160186	24%
8.00	127303	157662	24%
8.10	125136	155200	24%
8.20	123012	152739	24%
8.30	120866	150256	24%
8.40	118741	147795	24%
8.50	116763	145417	25%
8.60	114786	143061	25%
8.70	112808	140789	25%
8.80	110830	138517	25%
8.90	108916	136245	25%
9.00	107064	133888	25%
9.10	105255	131658	25%
9.20	103425	129302	25%
9.30	101531	126988	25%
9.40	99722	124695	25%
9.50	97955	122401	25%
9.60	96103	120087	25%
9.70	94231	117689	25%
9.80	92295	115333	25%
9.90	90339	112955	25%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 5B	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1744715	18%
0.20	1309640	1627110	24%
0.30	1205711	1529702	27%
0.40	1127658	1446390	28%
0.50	1065805	1390428	30%
0.60	1013630	1349193	33%
0.70	967556	1313848	36%
0.80	926531	1281449	38%
0.90	889083	1241055	40%
1.00	854790	1196033	40%
1.10	823233	1147224	39%
1.20	793779	1098204	38%
1.30	766850	1049395	37%
1.40	741604	1000376	35%
1.50	718251	953881	33%
1.60	696581	909700	31%
1.70	675753	868044	28%
1.80	656398	828282	26%
1.90	638095	791465	24%
2.00	620633	757803	22%
2.10	604433	727087	20%
2.20	589075	698685	19%
2.30	574559	672177	17%
2.40	560673	647562	15%
2.50	547419	625051	14%
2.60	534796	604223	13%
2.70	522594	584868	12%
2.80	511023	566774	11%
2.90	500083	549944	10%
3.00	489774	533955	9%
3.10	479676	519017	8%
3.20	470208	504922	7%
3.30	461162	491667	7%
3.40	452115	479044	6%
3.50	443700	467473	5%
3.60	435495	456113	5%
3.70	427711	445383	4%
3.80	419926	435495	4%
3.90	412563	425817	3%
4.00	405200	416771	3%
4.10	398047	407935	2%
4.20	391104	399519	2%
4.30	384582	391525	2%
4.40	378060	383951	2%
4.50	371959	376798	1%
4.60	365858	370065	1%
4.70	359967	363333	1%
4.80	354076	357022	1%

MIL2B

Flow (cfs)	Existing	Run 5B	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1427035	35%
0.20	849741	1314900	55%
0.30	714043	1259148	76%
0.40	615373	1215599	98%
0.50	540897	1160689	115%
0.60	481569	1064333	121%
0.70	435074	839432	93%
0.80	396784	590338	49%
0.90	363754	424345	17%
1.00	335142	321256	-4%
1.10	310527	259824	-16%
1.20	288436	225742	-22%
1.30	269081	206618	-23%
1.40	251619	194563	-23%
1.50	236051	185643	-21%
1.60	221534	178111	-20%
1.70	208301	171358	-18%
1.80	196099	165172	-16%
1.90	185096	159555	-14%
2.00	174850	154380	-12%
2.10	165362	149394	-10%
2.20	156547	144597	-8%
2.30	148321	140074	-6%
2.40	140831	135782	-4%
2.50	133909	131827	-2%
2.60	127409	128019	0%
2.70	121328	124484	3%
2.80	115690	120971	5%
2.90	110262	117689	7%
3.00	105234	114470	9%
3.10	100374	111377	11%
3.20	95851	108327	13%
3.30	91496	105318	15%
3.40	87541	102520	17%
3.50	83796	99722	19%
3.60	80240	97050	21%
3.70	76853	94420	23%
3.80	73698	91896	25%
3.90	70710	89476	27%
4.00	67765	87183	29%
4.10	64946	84953	31%
4.20	62274	82828	33%
4.30	59875	80766	35%
4.40	57498	78747	37%
4.50	55205	76832	39%
4.60	52975	74981	42%
4.70	50913	73129	44%
4.80	48977	71341	46%

4.90	348606	350921	1%
5.00	343136	345030	1%
5.10	337877	339560	0%
5.20	332827	334300	0%
5.30	327778	329041	0%
5.40	322939	324202	0%
5.50	318311	319573	0%
5.60	313683	314734	0%
5.70	309054	310316	0%
5.80	304846	306109	0%
5.90	300428	301901	0%
6.00	296221	297904	1%
6.10	292223	294117	1%
6.20	288226	290330	1%
6.30	284439	286543	1%
6.40	280652	282966	1%
6.50	276865	279600	1%
6.60	273289	276234	1%
6.70	269712	272868	1%
6.80	266346	269502	1%
6.90	262980	266557	1%
7.00	259614	263401	1%
7.10	256458	260245	1%
7.20	253302	257089	1%
7.30	250147	254144	2%
7.40	247201	251198	2%
7.50	244256	248253	2%
7.60	241310	245518	2%
7.70	238575	242783	2%
7.80	235630	240048	2%
7.90	232895	237524	2%
8.00	230160	234999	2%
8.10	227635	232474	2%
8.20	224900	229950	2%
8.30	222376	227425	2%
8.40	219851	225111	2%
8.50	217116	222586	3%
8.60	214802	220272	3%
8.70	212277	217958	3%
8.80	209816	215644	3%
8.90	207397	213540	3%
9.00	205082	211226	3%
9.10	202684	209017	3%
9.20	200286	206786	3%
9.30	197950	204598	3%
9.40	195552	202453	4%
9.50	193238	200286	4%
9.60	190902	198077	4%
9.70	188546	195889	4%
9.80	186106	193722	4%
9.90	183623	191470	4%

4.90	47189	69595	47%
5.00	45401	67933	50%
5.10	43697	66271	52%
5.20	42056	64651	54%
5.30	40499	63094	56%
5.40	38963	61685	58%
5.50	37511	60233	61%
5.60	36102	58823	63%
5.70	34798	57414	65%
5.80	33493	56025	67%
5.90	32294	54742	70%
6.00	31158	53501	72%
6.10	30106	52280	74%
6.20	29033	51060	76%
6.30	27981	49903	78%
6.40	26908	48809	81%
6.50	25940	47757	84%
6.60	24952	46705	87%
6.70	24026	45695	90%
6.80	23037	44707	94%
6.90	22153	43739	97%
7.00	21291	42813	101%
7.10	20481	41908	105%
7.20	19736	41046	108%
7.30	19008	40204	112%
7.40	18312	39363	115%
7.50	17609	38500	119%
7.60	16963	37701	122%
7.70	16343	36880	126%
7.80	15728	36060	129%
7.90	15108	35302	134%
8.00	14533	34566	138%
8.10	13978	33851	142%
8.20	13441	33135	147%
8.30	12941	32441	151%
8.40	12476	31663	154%
8.50	12019	30969	158%
8.60	11580	30337	162%
8.70	11171	29664	166%
8.80	10738	28970	170%
8.90	10347	28360	174%
9.00	9964	27729	178%
9.10	9583	27118	183%
9.20	9236	26487	187%
9.30	8887	25877	191%
9.40	8552	25204	195%
9.50	8224	24615	199%
9.60	7862	23963	205%
9.70	7488	23332	212%
9.80	7115	22764	220%
9.90	6743	22132	228%

MIL2C

Flow (cfs)	Existing	Run 5B	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1633421	21%
0.20	1175415	1476685	26%
0.30	1065805	1315952	23%
0.40	982493	1189301	21%
0.50	914329	1086633	19%
0.60	854790	998482	17%
0.70	802615	921482	15%
0.80	756120	854580	13%
0.90	714885	794410	11%
1.00	678068	741183	9%
1.10	644827	695319	8%
1.20	614111	654505	7%
1.30	586130	618319	5%
1.40	560673	585919	5%
1.50	537531	556466	4%
1.60	515651	530378	3%
1.70	495454	506815	2%
1.80	476730	485356	2%
1.90	459479	465790	1%
2.00	443700	447908	1%
2.10	428342	431918	1%
2.20	414667	417191	1%
2.30	401623	403517	0%
2.40	389000	391104	1%
2.50	377219	379322	1%
2.60	366068	368382	1%
2.70	355339	358074	1%
2.80	345240	348606	1%
2.90	335562	339560	1%
3.00	326306	331144	1%
3.10	317469	323360	2%
3.20	309264	315786	2%
3.30	301270	308844	3%
3.40	293696	302322	3%
3.50	286543	296010	3%
3.60	279390	290120	4%
3.70	272868	284439	4%
3.80	266346	279390	5%
3.90	260245	274341	5%
4.00	254565	269502	6%
4.10	248884	264663	6%
4.20	243625	260455	7%
4.30	238575	256037	7%
4.40	233526	251830	8%
4.50	228898	247832	8%
4.60	224480	244045	9%
4.70	220272	240259	9%
4.80	216275	236472	9%

MIL2D

Flow (cfs)	Existing	Run 5B	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	233105	10%
5.00	208533	229739	10%
5.10	204830	226373	11%
5.20	201232	223217	11%
5.30	197656	220062	11%
5.40	194248	217116	12%
5.50	190902	213961	12%
5.60	187578	211015	12%
5.70	184402	208133	13%
5.80	181393	205356	13%
5.90	178490	202600	14%
6.00	175755	199865	14%
6.10	172999	197046	14%
6.20	170285	194290	14%
6.30	167613	191555	14%
6.40	164983	188862	14%
6.50	162416	186169	15%
6.60	159955	183518	15%
6.70	157409	180930	15%
6.80	154885	178321	15%
6.90	152507	175797	15%
7.00	150151	173272	15%
7.10	147858	170748	15%
7.20	145544	168244	16%
7.30	143166	165741	16%
7.40	140831	163300	16%
7.50	138559	160923	16%
7.60	136245	158608	16%
7.70	133909	156231	17%
7.80	131637	153875	17%
7.90	129428	151540	17%
8.00	127303	149267	17%
8.10	125136	147058	18%
8.20	123012	144786	18%
8.30	120866	142514	18%
8.40	118741	140284	18%
8.50	116763	138117	18%
8.60	114786	135929	18%
8.70	112808	133825	19%
8.80	110830	131721	19%
8.90	108916	129639	19%
9.00	107064	127514	19%
9.10	105255	125410	19%
9.20	103425	123285	19%
9.30	101531	121160	19%
9.40	99722	119098	19%
9.50	97955	116974	19%
9.60	96103	114764	19%
9.70	94231	112598	19%
9.80	92295	110410	20%
9.90	90339	108158	20%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 6A	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1687700	14%
0.20	1309640	1554317	19%
0.30	1205711	1453964	21%
0.40	1127658	1372124	22%
0.50	1065805	1305012	22%
0.60	1013630	1245473	23%
0.70	967556	1193298	23%
0.80	926531	1146382	24%
0.90	889083	1104726	24%
1.00	854790	1066647	25%
1.10	823233	1031092	25%
1.20	793779	997431	26%
1.30	766850	966294	26%
1.40	741604	937471	26%
1.50	718251	910332	27%
1.60	696581	884875	27%
1.70	675753	860471	27%
1.80	656398	837959	28%
1.90	638095	816290	28%
2.00	620633	795462	28%
2.10	604433	775896	28%
2.20	589075	757172	29%
2.30	574559	739289	29%
2.40	560673	722248	29%
2.50	547419	705838	29%
2.60	534796	690270	29%
2.70	522594	675333	29%
2.80	511023	660816	29%
2.90	500083	646931	29%
3.00	489774	633466	29%
3.10	479676	620633	29%
3.20	470208	607799	29%
3.30	461162	595597	29%
3.40	452115	583395	29%
3.50	443700	571824	29%
3.60	435495	560884	29%
3.70	427711	549944	29%
3.80	419926	539425	28%
3.90	412563	529537	28%
4.00	405200	519859	28%
4.10	398047	510392	28%
4.20	391104	501345	28%
4.30	384582	492509	28%
4.40	378060	484094	28%
4.50	371959	475678	28%
4.60	365858	467473	28%
4.70	359967	459479	28%
4.80	354076	451694	28%

MIL2B

Flow (cfs)	Existing	Run 6A	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1485101	40%
0.20	849741	1282080	51%
0.30	714043	1138809	59%
0.40	615373	1024360	66%
0.50	540897	930318	72%
0.60	481569	851845	77%
0.70	435074	783260	80%
0.80	396784	722669	82%
0.90	363754	669232	84%
1.00	335142	620843	85%
1.10	310527	577925	86%
1.20	288436	537531	86%
1.30	269081	500083	86%
1.40	251619	465790	85%
1.50	236051	435074	84%
1.60	221534	406462	83%
1.70	208301	380374	83%
1.80	196099	355759	81%
1.90	185096	333038	80%
2.00	174850	312210	79%
2.10	165362	292855	77%
2.20	156547	274972	76%
2.30	148321	257931	74%
2.40	140831	241731	72%
2.50	133909	226373	69%
2.60	127409	212488	67%
2.70	121328	199465	64%
2.80	115690	187557	62%
2.90	110262	176554	60%
3.00	105234	166309	58%
3.10	100374	156862	56%
3.20	95851	148678	55%
3.30	91496	140810	54%
3.40	87541	133404	52%
3.50	83796	126167	51%
3.60	80240	119561	49%
3.70	76853	113355	47%
3.80	73698	107675	46%
3.90	70710	102436	45%
4.00	67765	97387	44%
4.10	64946	92863	43%
4.20	62274	88572	42%
4.30	59875	84385	41%
4.40	57498	80451	40%
4.50	55205	76811	39%
4.60	52975	73340	38%
4.70	50913	69826	37%
4.80	48977	66544	36%

4.90	348606	444121	27%
5.00	343136	436757	27%
5.10	337877	429394	27%
5.20	332827	422241	27%
5.30	327778	415508	27%
5.40	322939	408986	27%
5.50	318311	402465	26%
5.60	313683	396153	26%
5.70	309054	390262	26%
5.80	304846	384161	26%
5.90	300428	378481	26%
6.00	296221	372800	26%
6.10	292223	367330	26%
6.20	288226	362071	26%
6.30	284439	357022	26%
6.40	280652	351972	25%
6.50	276865	347134	25%
6.60	273289	342295	25%
6.70	269712	337456	25%
6.80	266346	332827	25%
6.90	262980	328199	25%
7.00	259614	323781	25%
7.10	256458	319573	25%
7.20	253302	315366	25%
7.30	250147	311158	24%
7.40	247201	307161	24%
7.50	244256	303163	24%
7.60	241310	299166	24%
7.70	238575	295379	24%
7.80	235630	291592	24%
7.90	232895	288016	24%
8.00	230160	284439	24%
8.10	227635	280863	23%
8.20	224900	277286	23%
8.30	222376	273710	23%
8.40	219851	270343	23%
8.50	217116	266767	23%
8.60	214802	263611	23%
8.70	212277	260245	23%
8.80	209816	257089	23%
8.90	207397	253933	22%
9.00	205082	250778	22%
9.10	202684	247622	22%
9.20	200286	244466	22%
9.30	197950	241521	22%
9.40	195552	238365	22%
9.50	193238	235209	22%
9.60	190902	232054	22%
9.70	188546	229108	22%
9.80	186106	225952	21%
9.90	183623	222586	21%

4.90	47189	63494	35%
5.00	45401	60527	33%
5.10	43697	57729	32%
5.20	42056	55015	31%
5.30	40499	52280	29%
5.40	38963	49735	28%
5.50	37511	47484	27%
5.60	36102	45254	25%
5.70	34798	43171	24%
5.80	33493	41277	23%
5.90	32294	39489	22%
6.00	31158	37743	21%
6.10	30106	36018	20%
6.20	29033	34461	19%
6.30	27981	32925	18%
6.40	26908	31579	17%
6.50	25940	30211	16%
6.60	24952	28844	16%
6.70	24026	27455	14%
6.80	23037	26130	13%
6.90	22153	24867	12%
7.00	21291	23710	11%
7.10	20481	22469	10%
7.20	19736	21354	8%
7.30	19008	20468	8%
7.40	18312	19547	7%
7.50	17609	18659	6%
7.60	16963	17807	5%
7.70	16343	16995	4%
7.80	15728	16284	4%
7.90	15108	15594	3%
8.00	14533	14906	3%
8.10	13978	14302	2%
8.20	13441	13641	1%
8.30	12941	13037	1%
8.40	12476	12398	-1%
8.50	12019	11805	-2%
8.60	11580	11253	-3%
8.70	11171	10700	-4%
8.80	10738	10204	-5%
8.90	10347	9737	-6%
9.00	9964	9251	-7%
9.10	9583	8813	-8%
9.20	9236	8373	-9%
9.30	8887	7955	-10%
9.40	8552	7523	-12%
9.50	8224	7124	-13%
9.60	7862	6791	-14%
9.70	7488	6377	-15%
9.80	7115	6030	-15%
9.90	6743	5687	-16%

MIL2C

Flow (cfs)	Existing	Run 6A	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1533068	14%
0.20	1175415	1353611	15%
0.30	1065805	1228643	15%
0.40	982493	1133339	15%
0.50	914329	1056338	16%
0.60	854790	989015	16%
0.70	802615	930739	16%
0.80	756120	879405	16%
0.90	714885	833962	17%
1.00	678068	792517	17%
1.10	644827	755279	17%
1.20	614111	720986	17%
1.30	586130	689428	18%
1.40	560673	660816	18%
1.50	537531	633887	18%
1.60	515651	609062	18%
1.70	495454	586130	18%
1.80	476730	564460	18%
1.90	459479	544053	18%
2.00	443700	525329	18%
2.10	428342	507657	19%
2.20	414667	491036	18%
2.30	401623	475257	18%
2.40	389000	460320	18%
2.50	377219	446224	18%
2.60	366068	433181	18%
2.70	355339	420347	18%
2.80	345240	408145	18%
2.90	335562	396363	18%
3.00	326306	385213	18%
3.10	317469	374694	18%
3.20	309264	364806	18%
3.30	301270	355339	18%
3.40	293696	346502	18%
3.50	286543	337877	18%
3.60	279390	329672	18%
3.70	272868	321467	18%
3.80	266346	313683	18%
3.90	260245	306319	18%
4.00	254565	299166	18%
4.10	248884	292434	17%
4.20	243625	286122	17%
4.30	238575	280021	17%
4.40	233526	274130	17%
4.50	228898	268240	17%
4.60	224480	262770	17%
4.70	220272	257510	17%
4.80	216275	252250	17%

MIL2D

Flow (cfs)	Existing	Run 6A	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	247412	17%
5.00	208533	242573	16%
5.10	204830	238155	16%
5.20	201232	233737	16%
5.30	197656	229529	16%
5.40	194248	225321	16%
5.50	190902	221114	16%
5.60	187578	217116	16%
5.70	184402	213329	16%
5.80	181393	209500	15%
5.90	178490	205713	15%
6.00	175755	201927	15%
6.10	172999	198224	15%
6.20	170285	194563	14%
6.30	167613	191029	14%
6.40	164983	187494	14%
6.50	162416	184086	13%
6.60	159955	180594	13%
6.70	157409	177206	13%
6.80	154885	173924	12%
6.90	152507	170727	12%
7.00	150151	167508	12%
7.10	147858	164310	11%
7.20	145544	161154	11%
7.30	143166	158061	10%
7.40	140831	155053	10%
7.50	138559	152045	10%
7.60	136245	149183	9%
7.70	133909	146322	9%
7.80	131637	143503	9%
7.90	129428	140726	9%
8.00	127303	137928	8%
8.10	125136	135130	8%
8.20	123012	132479	8%
8.30	120866	129807	7%
8.40	118741	127093	7%
8.50	116763	124442	7%
8.60	114786	121854	6%
8.70	112808	119267	6%
8.80	110830	116679	5%
8.90	108916	114217	5%
9.00	107064	111798	4%
9.10	105255	109400	4%
9.20	103425	106980	3%
9.30	101531	104729	3%
9.40	99722	102457	3%
9.50	97955	100248	2%
9.60	96103	98081	2%
9.70	94231	95872	2%
9.80	92295	93600	1%
9.90	90339	91286	1%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

MIL2A

Flow (cfs)	Existing	Run 6B	Change (%)
0.00	2103840	2103840	0%
0.10	1474161	1660561	13%
0.20	1309640	1521497	16%
0.30	1205711	1417778	18%
0.40	1127658	1336359	19%
0.50	1065805	1268616	19%
0.60	1013630	1209077	19%
0.70	967556	1157112	20%
0.80	926531	1111669	20%
0.90	889083	1070434	20%
1.00	854790	1032565	21%
1.10	823233	996589	21%
1.20	793779	963979	21%
1.30	766850	933684	22%
1.40	741604	905072	22%
1.50	718251	878353	22%
1.60	696581	853528	23%
1.70	675753	830386	23%
1.80	656398	808295	23%
1.90	638095	787257	23%
2.00	620633	767270	24%
2.10	604433	748336	24%
2.20	589075	730243	24%
2.30	574559	712571	24%
2.40	560673	696161	24%
2.50	547419	680382	24%
2.60	534796	665234	24%
2.70	522594	650928	25%
2.80	511023	636832	25%
2.90	500083	623578	25%
3.00	489774	610534	25%
3.10	479676	598122	25%
3.20	470208	585919	25%
3.30	461162	574348	25%
3.40	452115	562988	25%
3.50	443700	552258	24%
3.60	435495	541739	24%
3.70	427711	531640	24%
3.80	419926	521752	24%
3.90	412563	512495	24%
4.00	405200	503239	24%
4.10	398047	494402	24%
4.20	391104	485777	24%
4.30	384582	477572	24%
4.40	378060	469577	24%
4.50	371959	461793	24%
4.60	365858	454009	24%
4.70	359967	446645	24%
4.80	354076	439282	24%

MIL2B

Flow (cfs)	Existing	Run 6B	Change (%)
0.00	2103840	2103840	0%
0.10	1059494	1432925	35%
0.20	849741	1227380	44%
0.30	714043	1081584	51%
0.40	615373	967135	57%
0.50	540897	876670	62%
0.60	481569	800301	66%
0.70	435074	734030	69%
0.80	396784	676174	70%
0.90	363754	624630	72%
1.00	335142	579398	73%
1.10	310527	537110	73%
1.20	288436	499452	73%
1.30	269081	464949	73%
1.40	251619	434233	73%
1.50	236051	405831	72%
1.60	221534	379743	71%
1.70	208301	355759	71%
1.80	196099	333879	70%
1.90	185096	313472	69%
2.00	174850	294958	69%
2.10	165362	277286	68%
2.20	156547	260455	66%
2.30	148321	245097	65%
2.40	140831	231002	64%
2.50	133909	217958	63%
2.60	127409	205882	62%
2.70	121328	194795	61%
2.80	115690	184423	59%
2.90	110262	174829	59%
3.00	105234	165993	58%
3.10	100374	158019	57%
3.20	95851	150656	57%
3.30	91496	143882	57%
3.40	87541	137465	57%
3.50	83796	131553	57%
3.60	80240	125957	57%
3.70	76853	120655	57%
3.80	73698	115543	57%
3.90	70710	110683	57%
4.00	67765	106160	57%
4.10	64946	101847	57%
4.20	62274	97702	57%
4.30	59875	93936	57%
4.40	57498	90234	57%
4.50	55205	86804	57%
4.60	52975	83543	58%
4.70	50913	80409	58%
4.80	48977	77442	58%

4.90	348606	432339	24%
5.00	343136	425607	24%
5.10	337877	418875	24%
5.20	332827	412353	24%
5.30	327778	405831	24%
5.40	322939	399730	24%
5.50	318311	393839	24%
5.60	313683	387948	24%
5.70	309054	382478	24%
5.80	304846	377008	24%
5.90	300428	371749	24%
6.00	296221	366699	24%
6.10	292223	361650	24%
6.20	288226	356811	24%
6.30	284439	351972	24%
6.40	280652	347344	24%
6.50	276865	342716	24%
6.60	273289	338297	24%
6.70	269712	333879	24%
6.80	266346	329672	24%
6.90	262980	325464	24%
7.00	259614	321256	24%
7.10	256458	317259	24%
7.20	253302	313262	24%
7.30	250147	309264	24%
7.40	247201	305478	24%
7.50	244256	301691	24%
7.60	241310	298114	24%
7.70	238575	294538	23%
7.80	235630	290961	23%
7.90	232895	287385	23%
8.00	230160	284018	23%
8.10	227635	280442	23%
8.20	224900	277286	23%
8.30	222376	273920	23%
8.40	219851	270764	23%
8.50	217116	267608	23%
8.60	214802	264453	23%
8.70	212277	261507	23%
8.80	209816	258562	23%
8.90	207397	255406	23%
9.00	205082	252671	23%
9.10	202684	249515	23%
9.20	200286	246570	23%
9.30	197950	243625	23%
9.40	195552	240679	23%
9.50	193238	237734	23%
9.60	190902	234789	23%
9.70	188546	231633	23%
9.80	186106	228687	23%
9.90	183623	225532	23%

4.90	47189	74560	58%
5.00	45401	71762	58%
5.10	43697	69153	58%
5.20	42056	66523	58%
5.30	40499	64041	58%
5.40	38963	61643	58%
5.50	37511	59412	58%
5.60	36102	57224	59%
5.70	34798	55163	59%
5.80	33493	53206	59%
5.90	32294	51313	59%
6.00	31158	49545	59%
6.10	30106	47736	59%
6.20	29033	46074	59%
6.30	27981	44391	59%
6.40	26908	42834	59%
6.50	25940	41361	59%
6.60	24952	39868	60%
6.70	24026	38458	60%
6.80	23037	37217	62%
6.90	22153	35955	62%
7.00	21291	34734	63%
7.10	20481	33556	64%
7.20	19736	32399	64%
7.30	19008	31263	64%
7.40	18312	30148	65%
7.50	17609	29054	65%
7.60	16963	28023	65%
7.70	16343	27055	66%
7.80	15728	26151	66%
7.90	15108	25309	68%
8.00	14533	24447	68%
8.10	13978	23584	69%
8.20	13441	22764	69%
8.30	12941	22006	70%
8.40	12476	21291	71%
8.50	12019	20576	71%
8.60	11580	19953	72%
8.70	11171	19332	73%
8.80	10738	18747	75%
8.90	10347	18131	75%
9.00	9964	17521	76%
9.10	9583	16871	76%
9.20	9236	16206	75%
9.30	8887	15642	76%
9.40	8552	15082	76%
9.50	8224	14500	76%
9.60	7862	13963	78%
9.70	7488	13401	79%
9.80	7115	12844	81%
9.90	6743	12310	83%

MIL2C

Flow (cfs)	Existing	Run 6B	Change (%)
0.00	2103840	2103840	0%
0.10	1346668	1511399	12%
0.20	1175415	1331941	13%
0.30	1065805	1207394	13%
0.40	982493	1114194	13%
0.50	914329	1037824	14%
0.60	854790	971133	14%
0.70	802615	913908	14%
0.80	756120	864468	14%
0.90	714885	819656	15%
1.00	678068	779473	15%
1.10	644827	742866	15%
1.20	614111	709415	16%
1.30	586130	678909	16%
1.40	560673	650718	16%
1.50	537531	625051	16%
1.60	515651	600857	17%
1.70	495454	578556	17%
1.80	476730	557728	17%
1.90	459479	537952	17%
2.00	443700	519648	17%
2.10	428342	502607	17%
2.20	414667	486618	17%
2.30	401623	471681	17%
2.40	389000	457164	18%
2.50	377219	443700	18%
2.60	366068	430656	18%
2.70	355339	418243	18%
2.80	345240	406462	18%
2.90	335562	395101	18%
3.00	326306	384372	18%
3.10	317469	374063	18%
3.20	309264	364385	18%
3.30	301270	355128	18%
3.40	293696	346502	18%
3.50	286543	338087	18%
3.60	279390	330092	18%
3.70	272868	322308	18%
3.80	266346	314734	18%
3.90	260245	307581	18%
4.00	254565	300639	18%
4.10	248884	294117	18%
4.20	243625	287805	18%
4.30	238575	281915	18%
4.40	233526	276234	18%
4.50	228898	270764	18%
4.60	224480	265294	18%
4.70	220272	260245	18%
4.80	216275	255196	18%

MIL2D

Flow (cfs)	Existing	Run 6B	Change (%)
0.00	2103840	2103840	0%
0.10	1228222	1247156	2%
0.20	1044346	1059915	1%
0.30	925269	940416	2%
0.40	832700	849110	2%
0.50	757593	772951	2%
0.60	694688	710256	2%
0.70	641882	657660	2%
0.80	596439	612849	3%
0.90	557307	574348	3%
1.00	522594	540897	4%
1.10	491878	511233	4%
1.20	464738	484514	4%
1.30	440334	460531	5%
1.40	418454	438861	5%
1.50	398467	419085	5%
1.60	379954	400571	5%
1.70	363123	383530	6%
1.80	347554	367962	6%
1.90	333038	353445	6%
2.00	319573	339560	6%
2.10	307161	326937	6%
2.20	295379	315155	7%
2.30	284439	304215	7%
2.40	274341	293696	7%
2.50	264663	284018	7%
2.60	255827	274762	7%
2.70	247412	266346	8%
2.80	239627	258141	8%
2.90	232264	250778	8%
3.00	225532	243835	8%
3.10	219431	237313	8%
3.20	213540	231002	8%
3.30	208007	225321	8%
3.40	202831	220272	9%
3.50	197803	215223	9%
3.60	192943	210384	9%
3.70	188252	205798	9%
3.80	183897	201211	9%
3.90	179731	196814	10%
4.00	175713	192396	9%
4.10	171842	188020	9%
4.20	167992	183749	9%
4.30	164247	179437	9%
4.40	160649	175208	9%
4.50	157115	171105	9%
4.60	153559	167150	9%
4.70	150046	163153	9%
4.80	146469	159324	9%

4.90	212277	250567	18%
5.00	208533	245939	18%
5.10	204830	241310	18%
5.20	201232	237103	18%
5.30	197656	232895	18%
5.40	194248	228687	18%
5.50	190902	224480	18%
5.60	187578	220482	18%
5.70	184402	216485	17%
5.80	181393	212488	17%
5.90	178490	208638	17%
6.00	175755	204851	17%
6.10	172999	201190	16%
6.20	170285	197572	16%
6.30	167613	193932	16%
6.40	164983	190398	15%
6.50	162416	186905	15%
6.60	159955	183434	15%
6.70	157409	180047	14%
6.80	154885	176702	14%
6.90	152507	173377	14%
7.00	150151	170159	13%
7.10	147858	166856	13%
7.20	145544	163721	12%
7.30	143166	160607	12%
7.40	140831	157515	12%
7.50	138559	154506	12%
7.60	136245	151561	11%
7.70	133909	148657	11%
7.80	131637	145796	11%
7.90	129428	142977	10%
8.00	127303	140158	10%
8.10	125136	137423	10%
8.20	123012	134709	10%
8.30	120866	131995	9%
8.40	118741	129365	9%
8.50	116763	126735	9%
8.60	114786	124042	8%
8.70	112808	121413	8%
8.80	110830	118825	7%
8.90	108916	116279	7%
9.00	107064	113755	6%
9.10	105255	111293	6%
9.20	103425	108832	5%
9.30	101531	106475	5%
9.40	99722	104161	4%
9.50	97955	101889	4%
9.60	96103	99575	4%
9.70	94231	97197	3%
9.80	92295	94862	3%
9.90	90339	92443	2%

4.90	142914	155558	9%
5.00	139295	151666	9%
5.10	135824	147816	9%
5.20	132416	144218	9%
5.30	129007	140726	9%
5.40	125599	137233	9%
5.50	122317	133825	9%
5.60	119225	130354	9%
5.70	116174	126925	9%
5.80	113187	123685	9%
5.90	110241	120508	9%
6.00	107338	117373	9%
6.10	104519	114175	9%
6.20	101784	111209	9%
6.30	99049	108158	9%
6.40	96377	105255	9%
6.50	93831	102373	9%
6.60	91370	99575	9%
6.70	88866	96882	9%
6.80	86405	94273	9%
6.90	84006	91791	9%
7.00	81692	89245	9%
7.10	79399	86741	9%
7.20	77106	84280	9%
7.30	74834	81902	9%
7.40	72646	79609	10%
7.50	70542	77316	10%
7.60	68501	75107	10%
7.70	66481	72961	10%
7.80	64525	70899	10%
7.90	62631	68838	10%
8.00	60801	66965	10%
8.10	58971	65114	10%
8.20	57203	63305	11%
8.30	55541	61558	11%
8.40	54090	59959	11%
8.50	52722	58403	11%
8.60	51397	57014	11%
8.70	50092	55752	11%
8.80	48893	54532	12%
8.90	47736	53416	12%
9.00	46642	52301	12%
9.10	45611	51250	12%
9.20	44622	50177	12%
9.30	43718	49209	13%
9.40	42834	48262	13%
9.50	42035	47421	13%
9.60	41298	46579	13%
9.70	40583	45843	13%
9.80	39889	45148	13%
9.90	39216	44496	13%

APPENDIX D: Erosive Flow Durations (15-minute time step; 60-year simulation period)

MIL2A 0.9% 1.7%

Frequency	Flow (cfs)	Existing	Future	Change (%)
0.5Q2	35.04	18076	35892	99%
	37.21	15207	31347	106%
	39.38	12779	27308	114%
	41.55	10761	23794	121%
	43.72	9145	20780	127%
	45.89	7700	18095	135%
	48.06	6553	15863	142%
	50.24	5525	13774	149%
	52.41	4738	12101	155%
	54.58	4098	10603	159%
	56.75	3522	9232	162%
	58.92	3131	8087	158%
	61.09	2781	7176	158%
	63.26	2506	6312	152%
	65.43	2255	5624	149%
	67.60	2014	5016	149%
	69.77	1804	4420	145%
Q2	70.08	1777	4344	144%
	71.94	1618	3890	140%
	74.11	1418	3425	142%
	76.28	1221	3051	150%
	78.45	1018	2695	165%
	80.62	884	2394	171%
	82.79	783	2085	166%
	84.97	697	1871	168%
	87.14	631	1641	160%
	89.31	570	1430	151%
	91.48	474	1267	167%
	93.65	398	1135	185%
	95.82	352	996	183%
	97.99	317	869	174%
	100.16	297	769	159%
	102.33	269	667	148%
	104.50	239	570	138%
	106.67	217	506	133%
	108.84	191	444	132%

	111.01	166	395	138%
Q5	112.52	152	371	144%
	113.18	146	360	147%
	115.35	132	323	145%
	117.52	115	294	156%
	119.70	105	264	151%
	121.87	96	233	143%
	124.04	87	208	139%
	126.21	81	192	137%
	128.38	71	175	146%
	130.55	63	164	160%
	132.72	58	147	153%
	134.89	54	131	143%
	137.06	50	125	150%
	139.23	47	119	153%
	141.40	46	114	148%
	143.57	44	110	150%
	145.74	43	106	147%
Q10	147.91	40	102	155%
	150.08	36	96	167%
	152.26	35	92	163%
	154.43	33	90	173%
	156.60	32	84	163%
	158.77	30	78	160%
	160.94	27	75	178%
	163.11	27	72	167%
	165.28	26	71	173%
	167.45	26	68	162%
	169.62	25	65	160%
	171.79	22	62	182%
	173.96	20	60	200%
	176.13	20	58	190%
	178.30	19	55	189%
	180.47	19	48	153%
	182.64	17	48	182%
	184.81	15	44	193%
	186.99	15	39	160%
	189.16	15	36	140%
	191.33	15	33	120%

	193.50	15	31	107%
	195.67	15	30	100%
	197.84	15	27	80%
	200.01	14	25	79%
Q25	202.18	14	23	64%
	204.35	13	20	54%
	206.52	12	18	50%
	208.69	11	17	55%
	210.86	10	17	70%
	213.03	10	16	60%
	215.20	10	14	40%
	217.37	9	13	44%
	219.54	9	13	44%
	221.72	8	13	63%
	223.89	8	12	50%
	226.06	8	12	50%
	228.23	8	12	50%
	230.40	8	12	50%
	232.57	7	12	71%
	234.74	7	10	43%
	236.91	6	9	50%
	239.08	6	9	50%
	241.25	6	9	50%
	243.42	6	9	50%
	245.59	6	8	33%
	247.76	6	8	33%
Q50	249.93	6	7	17%

MIL2B 0.6% 2.4%

Frequency	Flow (cfs)	Existing	Future	Change (%)
0.5Q2	8.51	11979	49609	314%
	9.32	8830	40015	353%
	10.13	6173	31999	418%
	10.94	4980	27813	458%
	11.75	4044	24026	494%
	12.56	3305	20546	522%
	13.37	2687	17458	550%
	14.17	2236	14813	562%
	14.98	1893	12497	560%
	15.79	1576	10580	571%
	16.60	1247	8861	611%
Q2	17.02	1141	8090	609%
	17.41	1042	7376	608%
	18.22	843	6107	624%
	19.03	654	5030	669%
	19.84	524	4098	682%
	20.65	428	3377	689%
	21.46	369	2819	664%
	22.27	320	2310	622%
	23.07	281	1900	576%
	23.88	248	1598	544%
	24.69	218	1260	478%
	25.50	192	1029	436%
	26.31	174	859	394%
	27.12	163	695	326%
	27.93	140	539	285%
	28.74	130	447	244%
	29.55	116	377	225%
	30.36	100	319	219%
Q5	31.11	93	292	212%
	31.17	93	290	212%
	31.97	77	261	239%
	32.78	71	237	234%
	33.59	66	216	227%
	34.40	64	198	209%
	35.21	56	185	230%
	36.02	51	176	245%

	36.83	45	162	260%
	37.64	41	153	273%
	38.45	37	141	281%
	39.26	36	137	281%
	40.07	35	127	263%
	40.88	30	122	307%
	41.68	27	115	326%
	42.49	26	105	304%
	43.30	25	94	276%
	44.11	25	85	240%
Q10	44.37	24	83	247%
	44.92	22	80	264%
	45.73	21	74	252%
	46.54	21	66	214%
	47.35	20	61	205%
	48.16	20	59	195%
	48.97	19	58	205%
	49.78	19	53	179%
	50.58	17	50	194%
	51.39	17	48	182%
	52.20	16	45	181%
	53.01	15	44	193%
	53.82	14	41	193%
	54.63	12	38	217%
	55.44	12	36	200%
	56.25	10	33	230%
	57.06	10	30	200%
	57.87	10	29	190%
	58.68	10	25	150%
	59.48	10	23	130%
	60.29	10	21	110%
	61.10	10	18	80%
	61.91	10	17	70%
	62.72	10	16	60%
	63.53	9	15	67%
	64.34	9	15	67%
	65.15	8	15	88%
	65.96	7	13	86%
Q25	66.77	7	12	71%

	67.58	6	12	100%
	68.38	6	12	100%
	69.19	6	12	100%
	70.00	5	10	100%
	70.81	5	10	100%
	71.62	5	10	100%
	72.43	5	10	100%
	73.24	5	9	80%
	74.05	5	9	80%
	74.86	5	8	60%
	75.67	4	8	100%
	76.48	4	7	75%
	77.28	4	7	75%
	78.09	4	7	75%
	78.90	4	5	25%
	79.71	4	5	25%
	80.52	4	3	-25%
	81.33	4	3	-25%
	82.14	4	2	-50%
	82.95	4	2	-50%
	83.76	4	2	-50%
	84.57	4	2	-50%
	85.38	4	2	-50%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C 1.9% 2.7%

Frequency	Flow (cfs)	Existing	Future	Change (%)
0.5Q2	15.58	38984	55941	43%
	16.48	33998	49693	46%
	17.39	29412	44265	50%
	18.29	25562	39447	54%
	19.19	22048	35050	59%
	20.09	18695	31011	66%
	20.99	16454	27939	70%
	21.89	14453	24973	73%
	22.79	12848	22343	74%
	23.69	11443	20016	75%
	24.60	10288	17942	74%
	25.50	9295	16164	74%
	26.40	8321	14582	75%
	27.30	7467	13145	76%
	28.20	6675	11796	77%
	29.10	6023	10563	75%
	30.00	5419	9459	75%
	30.90	4830	8577	78%
Q2	31.17	4683	8340	78%
	31.80	4325	7761	79%
	32.71	3842	7004	82%
	33.61	3421	6337	85%
	34.51	3124	5733	84%
	35.41	2872	5230	82%
	36.31	2682	4715	76%
	37.21	2489	4254	71%
	38.11	2272	3840	69%
	39.01	2085	3486	67%
	39.92	1922	3183	66%
	40.82	1781	2935	65%
	41.72	1686	2716	61%
	42.62	1571	2518	60%
	43.52	1446	2339	62%
	44.42	1350	2169	61%
	45.32	1238	2006	62%
	46.22	1121	1865	66%
	47.13	970	1723	78%

	48.03	848	1560	84%
	48.93	748	1405	88%
	49.83	695	1282	84%
Q5	50.25	660	1231	87%
	50.73	620	1174	89%
	51.63	573	1064	86%
	52.53	528	973	84%
	53.43	480	905	89%
	54.34	452	847	87%
	55.24	404	792	96%
	56.14	350	731	109%
	57.04	307	678	121%
	57.94	284	611	115%
	58.84	252	556	121%
	59.74	225	505	124%
	60.64	200	464	132%
	61.54	182	422	132%
	62.45	168	394	135%
	63.35	152	363	139%
	64.25	140	338	141%
Q10	65.15	115	317	176%
	66.05	101	293	190%
	66.95	90	269	199%
	67.85	82	256	212%
	68.75	67	244	264%
	69.66	59	230	290%
	70.56	50	215	330%
	71.46	43	200	365%
	72.36	39	188	382%
	73.26	36	173	381%
	74.16	32	150	369%
	75.06	29	137	372%
	75.96	28	126	350%
	76.87	25	118	372%
	77.77	24	111	363%
	78.67	24	105	338%
	79.57	22	102	364%
	80.47	22	95	332%
	81.37	21	91	333%

	82.27	20	86	330%
	83.17	19	81	326%
	84.08	19	78	311%
	84.98	17	72	324%
	85.88	17	70	312%
Q25	86.78	17	68	300%
	87.68	16	64	300%
	88.58	15	62	313%
	89.48	15	59	293%
	90.38	14	57	307%
	91.29	13	52	300%
	92.19	13	50	285%
	93.09	11	47	327%
	93.99	11	45	309%
	94.89	11	39	255%
	95.79	11	37	236%
	96.69	10	34	240%
	97.59	10	31	210%
	98.49	10	27	170%
	99.40	10	23	130%
	100.30	10	19	90%
	101.20	9	15	67%
	102.10	8	13	63%
	103.00	8	13	63%
	103.90	8	12	50%
Q50	104.80	8	12	50%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Future	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 1.5%

Frequency	Flow (cfs)	Existing	Run 1A	Change (%)
0.5Q2	35.04	18076	32588	80%
	37.21	15207	28170	85%
	39.38	12779	24278	90%
	41.55	10761	21011	95%
	43.72	9145	18209	99%
	45.89	7700	15867	106%
	48.06	6553	13717	109%
	50.24	5525	11914	116%
	52.41	4738	10422	120%
	54.58	4098	8986	119%
	56.75	3522	7801	121%
	58.92	3131	6894	120%
	61.09	2781	6101	119%
	63.26	2506	5434	117%
	65.43	2255	4790	112%
	67.60	2014	4210	109%
	69.77	1804	3692	105%
Q2	70.08	1777	3632	104%
	71.94	1618	3276	102%
	74.11	1418	2889	104%
	76.28	1221	2560	110%
	78.45	1018	2260	122%
	80.62	884	1989	125%
	82.79	783	1766	126%
	84.97	697	1515	117%
	87.14	631	1309	107%
	89.31	570	1178	107%
	91.48	474	1035	118%
	93.65	398	903	127%
	95.82	352	791	125%
	97.99	317	664	109%
	100.16	297	594	100%
	102.33	269	514	91%
	104.50	239	453	90%
	106.67	217	406	87%
	108.84	191	361	89%
	111.01	166	323	95%

Q5	112.52	152	297	95%
	113.18	146	286	96%
	115.35	132	258	95%
	117.52	115	233	103%
	119.70	105	202	92%
	121.87	96	183	91%
	124.04	87	160	84%
	126.21	81	146	80%
	128.38	71	133	87%
	130.55	63	122	94%
	132.72	58	114	97%
	134.89	54	107	98%
	137.06	50	101	102%
	139.23	47	93	98%
	141.40	46	91	98%
	143.57	44	87	98%
	145.74	43	83	93%
Q10	147.91	40	79	98%
	150.08	36	73	103%
	152.26	35	70	100%
	154.43	33	68	106%
	156.60	32	60	88%
	158.77	30	60	100%
	160.94	27	56	107%
	163.11	27	54	100%
	165.28	26	51	96%
	167.45	26	49	88%
	169.62	25	44	76%
	171.79	22	41	86%
	173.96	20	37	85%
	176.13	20	35	75%
	178.30	19	33	74%
	180.47	19	30	58%
	182.64	17	25	47%
	184.81	15	23	53%
	186.99	15	22	47%
	189.16	15	19	27%
	191.33	15	19	27%
	193.50	15	18	20%

	195.67	15	16	7%
	197.84	15	15	0%
	200.01	14	14	0%
Q25	202.18	14	13	-7%
	204.35	13	13	0%
	206.52	12	12	0%
	208.69	11	12	9%
	210.86	10	12	20%
	213.03	10	11	10%
	215.20	10	9	-10%
	217.37	9	9	0%
	219.54	9	9	0%
	221.72	8	9	13%
	223.89	8	8	0%
	226.06	8	7	-13%
	228.23	8	6	-25%
	230.40	8	6	-25%
	232.57	7	5	-29%
	234.74	7	5	-29%
	236.91	6	5	-17%
	239.08	6	5	-17%
	241.25	6	5	-17%
	243.42	6	5	-17%
	245.59	6	5	-17%
	247.76	6	4	-33%
Q50	249.93	6	4	-33%

MIL2B 0.6% 1.9%

Frequency	Flow (cfs)	Existing	Run 1A	Change (%)
0.5Q2	8.51	11979	39405	229%
	9.32	8830	31158	253%
	10.13	6173	24194	292%
	10.94	4980	20723	316%
	11.75	4044	17601	335%
	12.56	3305	14870	350%
	13.37	2687	12465	364%
	14.17	2236	10465	368%
	14.98	1893	8680	359%
	15.79	1576	7132	353%
	16.60	1247	5859	370%
Q2	17.02	1141	5289	364%
	17.41	1042	4761	357%
	18.22	843	3901	363%
	19.03	654	3187	387%
	19.84	524	2609	398%
	20.65	428	2138	400%
	21.46	369	1781	383%
	22.27	320	1446	352%
	23.07	281	1150	309%
	23.88	248	954	285%
	24.69	218	774	255%
	25.50	192	561	192%
	26.31	174	413	137%
	27.12	163	327	101%
	27.93	140	263	88%
	28.74	130	214	65%
	29.55	116	176	52%
	30.36	100	153	53%
Q5	31.11	93	141	51%
	31.17	93	140	51%
	31.97	77	121	57%
	32.78	71	111	56%
	33.59	66	104	58%
	34.40	64	92	44%
	35.21	56	85	52%
	36.02	51	79	55%

	36.83	45	72	60%
	37.64	41	67	63%
	38.45	37	60	62%
	39.26	36	58	61%
	40.07	35	51	46%
	40.88	30	49	63%
	41.68	27	43	59%
	42.49	26	39	50%
	43.30	25	35	40%
	44.11	25	34	36%
Q10	44.37	24	33	39%
	44.92	22	32	45%
	45.73	21	31	48%
	46.54	21	29	38%
	47.35	20	26	30%
	48.16	20	23	15%
	48.97	19	22	16%
	49.78	19	22	16%
	50.58	17	20	18%
	51.39	17	19	12%
	52.20	16	18	13%
	53.01	15	17	13%
	53.82	14	17	21%
	54.63	12	15	25%
	55.44	12	14	17%
	56.25	10	14	40%
	57.06	10	13	30%
	57.87	10	11	10%
	58.68	10	11	10%
	59.48	10	11	10%
	60.29	10	10	0%
	61.10	10	9	-10%
	61.91	10	9	-10%
	62.72	10	8	-20%
	63.53	9	8	-11%
	64.34	9	7	-22%
	65.15	8	7	-13%
	65.96	7	4	-43%
Q25	66.77	7	3	-57%

	67.58	6	2	-67%
	68.38	6	2	-67%
	69.19	6	0	-100%
	70.00	5	0	-100%
	70.81	5	0	-100%
	71.62	5	0	-100%
	72.43	5	0	-100%
	73.24	5	0	-100%
	74.05	5	0	-100%
	74.86	5	0	-100%
	75.67	4	0	-100%
	76.48	4	0	-100%
	77.28	4	0	-100%
	78.09	4	0	-100%
	78.90	4	0	-100%
	79.71	4	0	-100%
	80.52	4	0	-100%
	81.33	4	0	-100%
	82.14	4	0	-100%
	82.95	4	0	-100%
	83.76	4	0	-100%
	84.57	4	0	-100%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C 1.9% 2.5%

Frequency	Flow (cfs)	Existing	Run 1A	Change (%)
0.5Q2	15.58	38984	53416	37%
	16.48	33998	47357	39%
	17.39	29412	42098	43%
	18.29	25562	37301	46%
	19.19	22048	33009	50%
	20.09	18695	29075	56%
	20.99	16454	25919	58%
	21.89	14453	23058	60%
	22.79	12848	20510	60%
	23.69	11443	18293	60%
	24.60	10288	16536	61%
	25.50	9295	14870	60%
	26.40	8321	13311	60%
	27.30	7467	11922	60%
	28.20	6675	10744	61%
	29.10	6023	9612	60%
	30.00	5419	8636	59%
	30.90	4830	7791	61%
Q2	31.17	4683	7561	61%
	31.80	4325	6999	62%
	32.71	3842	6337	65%
	33.61	3421	5750	68%
	34.51	3124	5173	66%
	35.41	2872	4647	62%
	36.31	2682	4121	54%
	37.21	2489	3730	50%
	38.11	2272	3368	48%
	39.01	2085	3099	49%
	39.92	1922	2886	50%
	40.82	1781	2668	50%
	41.72	1686	2474	47%
	42.62	1571	2306	47%
	43.52	1446	2138	48%
	44.42	1350	1974	46%
	45.32	1238	1810	46%
	46.22	1121	1657	48%
	47.13	970	1507	55%

	48.03	848	1359	60%
	48.93	748	1248	67%
	49.83	695	1137	64%
Q5	50.25	660	1083	64%
	50.73	620	1021	65%
	51.63	573	930	62%
	52.53	528	879	66%
	53.43	480	820	71%
	54.34	452	761	68%
	55.24	404	710	76%
	56.14	350	662	89%
	57.04	307	603	96%
	57.94	284	543	91%
	58.84	252	489	94%
	59.74	225	447	99%
	60.64	200	405	103%
	61.54	182	362	99%
	62.45	168	341	103%
	63.35	152	319	110%
	64.25	140	297	112%
Q10	65.15	115	273	137%
	66.05	101	259	156%
	66.95	90	243	170%
	67.85	82	231	182%
	68.75	67	217	224%
	69.66	59	201	241%
	70.56	50	188	276%
	71.46	43	171	298%
	72.36	39	158	305%
	73.26	36	144	300%
	74.16	32	128	300%
	75.06	29	121	317%
	75.96	28	110	293%
	76.87	25	102	308%
	77.77	24	96	300%
	78.67	24	92	283%
	79.57	22	88	300%
	80.47	22	84	282%
	81.37	21	77	267%

	82.27	20	72	260%
	83.17	19	69	263%
	84.08	19	65	242%
	84.98	17	62	265%
	85.88	17	56	229%
Q25	86.78	17	53	212%
	87.68	16	50	213%
	88.58	15	44	193%
	89.48	15	41	173%
	90.38	14	37	164%
	91.29	13	35	169%
	92.19	13	32	146%
	93.09	11	28	155%
	93.99	11	22	100%
	94.89	11	20	82%
	95.79	11	16	45%
	96.69	10	14	40%
	97.59	10	13	30%
	98.49	10	11	10%
	99.40	10	11	10%
	100.30	10	10	0%
	101.20	9	9	0%
	102.10	8	8	0%
	103.00	8	6	-25%
	103.90	8	6	-25%
Q50	104.80	8	6	-25%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 1A	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 1.5%

Frequency	Flow (cfs)	Existing	Run 1B	Change (%)
0.5Q2	35.04	18076	32588	80%
	37.21	15207	28170	85%
	39.38	12779	24299	90%
	41.55	10761	21013	95%
	43.72	9145	18219	99%
	45.89	7700	15876	106%
	48.06	6553	13725	109%
	50.24	5525	11920	116%
	52.41	4738	10433	120%
	54.58	4098	8990	119%
	56.75	3522	7803	122%
	58.92	3131	6905	121%
	61.09	2781	6114	120%
	63.26	2506	5441	117%
	65.43	2255	4795	113%
	67.60	2014	4214	109%
	69.77	1804	3694	105%
Q2	70.08	1777	3634	104%
	71.94	1618	3278	103%
	74.11	1418	2893	104%
	76.28	1221	2573	111%
	78.45	1018	2264	122%
	80.62	884	1995	126%
	82.79	783	1771	126%
	84.97	697	1521	118%
	87.14	631	1313	108%
	89.31	570	1182	107%
	91.48	474	1041	120%
	93.65	398	904	127%
	95.82	352	797	126%
	97.99	317	669	111%
	100.16	297	596	101%
	102.33	269	517	92%
	104.50	239	456	91%
	106.67	217	409	88%
	108.84	191	366	92%
	111.01	166	324	95%

Q5	112.52	152	299	97%
	113.18	146	288	97%
	115.35	132	260	97%
	117.52	115	236	105%
	119.70	105	205	95%
	121.87	96	184	92%
	124.04	87	160	84%
	126.21	81	147	81%
	128.38	71	134	89%
	130.55	63	124	97%
	132.72	58	114	97%
	134.89	54	108	100%
	137.06	50	104	108%
	139.23	47	93	98%
	141.40	46	91	98%
	143.57	44	88	100%
	145.74	43	83	93%
Q10	147.91	40	79	98%
	150.08	36	73	103%
	152.26	35	71	103%
	154.43	33	69	109%
	156.60	32	61	91%
	158.77	30	60	100%
	160.94	27	56	107%
	163.11	27	54	100%
	165.28	26	51	96%
	167.45	26	49	88%
	169.62	25	44	76%
	171.79	22	41	86%
	173.96	20	38	90%
	176.13	20	35	75%
	178.30	19	33	74%
	180.47	19	30	58%
	182.64	17	25	47%
	184.81	15	23	53%
	186.99	15	22	47%
	189.16	15	20	33%
	191.33	15	19	27%
	193.50	15	18	20%

	195.67	15	16	7%
	197.84	15	15	0%
	200.01	14	14	0%
Q25	202.18	14	13	-7%
	204.35	13	13	0%
	206.52	12	12	0%
	208.69	11	12	9%
	210.86	10	12	20%
	213.03	10	11	10%
	215.20	10	9	-10%
	217.37	9	9	0%
	219.54	9	9	0%
	221.72	8	9	13%
	223.89	8	8	0%
	226.06	8	8	0%
	228.23	8	6	-25%
	230.40	8	6	-25%
	232.57	7	5	-29%
	234.74	7	5	-29%
	236.91	6	5	-17%
	239.08	6	5	-17%
	241.25	6	5	-17%
	243.42	6	5	-17%
	245.59	6	5	-17%
	247.76	6	4	-33%
Q50	249.93	6	4	-33%

MIL2B 0.6% 1.9%

Frequency	Flow (cfs)	Existing	Run 1B	Change (%)
0.5Q2	8.51	11979	39426	229%
	9.32	8830	31179	253%
	10.13	6173	24215	292%
	10.94	4980	20731	316%
	11.75	4044	17609	335%
	12.56	3305	14887	350%
	13.37	2687	12484	365%
	14.17	2236	10481	369%
	14.98	1893	8695	359%
	15.79	1576	7159	354%
	16.60	1247	5878	371%
Q2	17.02	1141	5306	365%
	17.41	1042	4776	358%
	18.22	843	3919	365%
	19.03	654	3194	388%
	19.84	524	2630	402%
	20.65	428	2156	404%
	21.46	369	1799	388%
	22.27	320	1461	357%
	23.07	281	1163	314%
	23.88	248	964	289%
	24.69	218	788	261%
	25.50	192	572	198%
	26.31	174	420	141%
	27.12	163	334	105%
	27.93	140	272	94%
	28.74	130	217	67%
	29.55	116	178	53%
	30.36	100	159	59%
Q5	31.11	93	142	52%
	31.17	93	141	52%
	31.97	77	125	62%
	32.78	71	112	58%
	33.59	66	105	59%
	34.40	64	92	44%
	35.21	56	86	54%
	36.02	51	79	55%

	36.83	45	74	64%
	37.64	41	68	66%
	38.45	37	60	62%
	39.26	36	58	61%
	40.07	35	52	49%
	40.88	30	49	63%
	41.68	27	46	70%
	42.49	26	40	54%
	43.30	25	36	44%
	44.11	25	34	36%
Q10	44.37	24	33	39%
	44.92	22	32	45%
	45.73	21	31	48%
	46.54	21	29	38%
	47.35	20	26	30%
	48.16	20	23	15%
	48.97	19	22	16%
	49.78	19	22	16%
	50.58	17	21	24%
	51.39	17	20	18%
	52.20	16	18	13%
	53.01	15	17	13%
	53.82	14	17	21%
	54.63	12	15	25%
	55.44	12	15	25%
	56.25	10	14	40%
	57.06	10	13	30%
	57.87	10	11	10%
	58.68	10	11	10%
	59.48	10	11	10%
	60.29	10	10	0%
	61.10	10	9	-10%
	61.91	10	9	-10%
	62.72	10	8	-20%
	63.53	9	8	-11%
	64.34	9	7	-22%
	65.15	8	7	-13%
	65.96	7	4	-43%
Q25	66.77	7	3	-57%

	67.58	6	2	-67%
	68.38	6	2	-67%
	69.19	6	0	-100%
	70.00	5	0	-100%
	70.81	5	0	-100%
	71.62	5	0	-100%
	72.43	5	0	-100%
	73.24	5	0	-100%
	74.05	5	0	-100%
	74.86	5	0	-100%
	75.67	4	0	-100%
	76.48	4	0	-100%
	77.28	4	0	-100%
	78.09	4	0	-100%
	78.90	4	0	-100%
	79.71	4	0	-100%
	80.52	4	0	-100%
	81.33	4	0	-100%
	82.14	4	0	-100%
	82.95	4	0	-100%
	83.76	4	0	-100%
	84.57	4	0	-100%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C 1.9% 2.5%

Frequency	Flow (cfs)	Existing	Run 1B	Change (%)
0.5Q2	15.58	38984	53416	37%
	16.48	33998	47378	39%
	17.39	29412	42098	43%
	18.29	25562	37322	46%
	19.19	22048	33009	50%
	20.09	18695	29075	56%
	20.99	16454	25919	58%
	21.89	14453	23079	60%
	22.79	12848	20521	60%
	23.69	11443	18297	60%
	24.60	10288	16540	61%
	25.50	9295	14874	60%
	26.40	8321	13311	60%
	27.30	7467	11927	60%
	28.20	6675	10753	61%
	29.10	6023	9619	60%
	30.00	5419	8645	60%
	30.90	4830	7799	61%
Q2	31.17	4683	7566	62%
	31.80	4325	6999	62%
	32.71	3842	6339	65%
	33.61	3421	5756	68%
	34.51	3124	5175	66%
	35.41	2872	4654	62%
	36.31	2682	4130	54%
	37.21	2489	3739	50%
	38.11	2272	3375	49%
	39.01	2085	3101	49%
	39.92	1922	2886	50%
	40.82	1781	2670	50%
	41.72	1686	2478	47%
	42.62	1571	2306	47%
	43.52	1446	2144	48%
	44.42	1350	1975	46%
	45.32	1238	1813	46%
	46.22	1121	1658	48%
	47.13	970	1509	56%

	48.03	848	1360	60%
	48.93	748	1250	67%
	49.83	695	1139	64%
Q5	50.25	660	1085	64%
	50.73	620	1023	65%
	51.63	573	931	62%
	52.53	528	881	67%
	53.43	480	822	71%
	54.34	452	761	68%
	55.24	404	711	76%
	56.14	350	662	89%
	57.04	307	604	97%
	57.94	284	544	92%
	58.84	252	491	95%
	59.74	225	447	99%
	60.64	200	408	104%
	61.54	182	365	101%
	62.45	168	342	104%
	63.35	152	320	111%
	64.25	140	298	113%
Q10	65.15	115	274	138%
	66.05	101	259	156%
	66.95	90	243	170%
	67.85	82	231	182%
	68.75	67	217	224%
	69.66	59	205	247%
	70.56	50	189	278%
	71.46	43	171	298%
	72.36	39	159	308%
	73.26	36	145	303%
	74.16	32	128	300%
	75.06	29	121	317%
	75.96	28	110	293%
	76.87	25	102	308%
	77.77	24	98	308%
	78.67	24	92	283%
	79.57	22	88	300%
	80.47	22	84	282%
	81.37	21	77	267%

	82.27	20	73	265%
	83.17	19	69	263%
	84.08	19	65	242%
	84.98	17	62	265%
	85.88	17	57	235%
Q25	86.78	17	53	212%
	87.68	16	51	219%
	88.58	15	45	200%
	89.48	15	41	173%
	90.38	14	37	164%
	91.29	13	35	169%
	92.19	13	32	146%
	93.09	11	28	155%
	93.99	11	23	109%
	94.89	11	20	82%
	95.79	11	16	45%
	96.69	10	14	40%
	97.59	10	13	30%
	98.49	10	11	10%
	99.40	10	11	10%
	100.30	10	10	0%
	101.20	9	9	0%
	102.10	8	8	0%
	103.00	8	6	-25%
	103.90	8	6	-25%
Q50	104.80	8	6	-25%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 1B	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 1.0%

Frequency	Flow (cfs)	Existing	Run 2A	Change (%)
0.5Q2	35.04	18076	21080	17%
	37.21	15207	17908	18%
	39.38	12779	15282	20%
	41.55	10761	13080	22%
	43.72	9145	11298	24%
	45.89	7700	9694	26%
	48.06	6553	8255	26%
	50.24	5525	7071	28%
	52.41	4738	6265	32%
	54.58	4098	5535	35%
	56.75	3522	4944	40%
	58.92	3131	4342	39%
	61.09	2781	3856	39%
	63.26	2506	3438	37%
	65.43	2255	3025	34%
	67.60	2014	2697	34%
	69.77	1804	2438	35%
Q2	70.08	1777	2403	35%
	71.94	1618	2194	36%
	74.11	1418	1894	34%
	76.28	1221	1669	37%
	78.45	1018	1455	43%
	80.62	884	1279	45%
	82.79	783	1142	46%
	84.97	697	1042	49%
	87.14	631	917	45%
	89.31	570	784	38%
	91.48	474	681	44%
	93.65	398	600	51%
	95.82	352	533	51%
	97.99	317	476	50%
	100.16	297	414	39%
	102.33	269	375	39%
	104.50	239	338	41%
	106.67	217	307	41%
	108.84	191	273	43%
	111.01	166	249	50%

Q5	112.52	152	232	52%
	113.18	146	224	53%
	115.35	132	202	53%
	117.52	115	173	50%
	119.70	105	157	50%
	121.87	96	140	46%
	124.04	87	130	49%
	126.21	81	121	49%
	128.38	71	111	56%
	130.55	63	101	60%
	132.72	58	90	55%
	134.89	54	82	52%
	137.06	50	73	46%
	139.23	47	68	45%
	141.40	46	62	35%
	143.57	44	51	16%
	145.74	43	44	2%
Q10	147.91	40	39	-3%
	150.08	36	36	0%
	152.26	35	33	-6%
	154.43	33	31	-6%
	156.60	32	29	-9%
	158.77	30	27	-10%
	160.94	27	24	-11%
	163.11	27	23	-15%
	165.28	26	22	-15%
	167.45	26	21	-19%
	169.62	25	21	-16%
	171.79	22	19	-14%
	173.96	20	14	-30%
	176.13	20	12	-40%
	178.30	19	6	-68%
	180.47	19	4	-79%
	182.64	17	3	-82%
	184.81	15	3	-80%
	186.99	15	3	-80%
	189.16	15	3	-80%
	191.33	15	3	-80%
	193.50	15	3	-80%

	195.67	15	2	-87%
	197.84	15	2	-87%
	200.01	14	2	-86%
Q25	202.18	14	2	-86%
	204.35	13	2	-85%
	206.52	12	2	-83%
	208.69	11	2	-82%
	210.86	10	2	-80%
	213.03	10	2	-80%
	215.20	10	2	-80%
	217.37	9	2	-78%
	219.54	9	1	-89%
	221.72	8	1	-88%
	223.89	8	1	-88%
	226.06	8	1	-88%
	228.23	8	1	-88%
	230.40	8	1	-88%
	232.57	7	0	-100%
	234.74	7	0	-100%
	236.91	6	0	-100%
	239.08	6	0	-100%
	241.25	6	0	-100%
	243.42	6	0	-100%
	245.59	6	0	-100%
	247.76	6	0	-100%
Q50	249.93	6	0	-100%

MIL2B 0.6% 1.2%

Frequency	Flow (cfs)	Existing	Run 2A	Change (%)
0.5Q2	8.51	11979	25162	110%
	9.32	8830	19277	118%
	10.13	6173	14748	139%
	10.94	4980	12623	153%
	11.75	4044	10652	163%
	12.56	3305	8861	168%
	13.37	2687	7277	171%
	14.17	2236	6101	173%
	14.98	1893	5066	168%
	15.79	1576	4246	169%
	16.60	1247	3534	183%
Q2	17.02	1141	3243	184%
	17.41	1042	2973	185%
	18.22	843	2508	198%
	19.03	654	2144	228%
	19.84	524	1781	240%
	20.65	428	1505	252%
	21.46	369	1266	243%
	22.27	320	1086	239%
	23.07	281	891	217%
	23.88	248	740	198%
	24.69	218	562	158%
	25.50	192	459	139%
	26.31	174	375	116%
	27.12	163	294	80%
	27.93	140	238	70%
	28.74	130	204	57%
	29.55	116	173	49%
	30.36	100	146	46%
Q5	31.11	93	125	34%
	31.17	93	124	33%
	31.97	77	98	27%
	32.78	71	82	15%
	33.59	66	69	5%
	34.40	64	60	-6%
	35.21	56	51	-9%
	36.02	51	43	-16%

	36.83	45	31	-31%
	37.64	41	30	-27%
	38.45	37	28	-24%
	39.26	36	27	-25%
	40.07	35	26	-26%
	40.88	30	24	-20%
	41.68	27	23	-15%
	42.49	26	22	-15%
	43.30	25	21	-16%
	44.11	25	20	-20%
Q10	44.37	24	19	-21%
	44.92	22	17	-23%
	45.73	21	16	-24%
	46.54	21	16	-24%
	47.35	20	15	-25%
	48.16	20	15	-25%
	48.97	19	14	-26%
	49.78	19	13	-32%
	50.58	17	12	-29%
	51.39	17	12	-29%
	52.20	16	3	-81%
	53.01	15	0	-100%
	53.82	14	0	-100%
	54.63	12	0	-100%
	55.44	12	0	-100%
	56.25	10	0	-100%
	57.06	10	0	-100%
	57.87	10	0	-100%
	58.68	10	0	-100%
	59.48	10	0	-100%
	60.29	10	0	-100%
	61.10	10	0	-100%
	61.91	10	0	-100%
	62.72	10	0	-100%
	63.53	9	0	-100%
	64.34	9	0	-100%
	65.15	8	0	-100%
	65.96	7	0	-100%
Q25	66.77	7	0	-100%

	67.58	6	0	-100%
	68.38	6	0	-100%
	69.19	6	0	-100%
	70.00	5	0	-100%
	70.81	5	0	-100%
	71.62	5	0	-100%
	72.43	5	0	-100%
	73.24	5	0	-100%
	74.05	5	0	-100%
	74.86	5	0	-100%
	75.67	4	0	-100%
	76.48	4	0	-100%
	77.28	4	0	-100%
	78.09	4	0	-100%
	78.90	4	0	-100%
	79.71	4	0	-100%
	80.52	4	0	-100%
	81.33	4	0	-100%
	82.14	4	0	-100%
	82.95	4	0	-100%
	83.76	4	0	-100%
	84.57	4	0	-100%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C		1.9%	1.8%	
Frequency	Flow (cfs)	Existing	Run 2A	Change (%)
0.5Q2	15.58	38984	37890	-3%
	16.48	33998	32862	-3%
	17.39	29412	28507	-3%
	18.29	25562	24447	-4%
	19.19	22048	21001	-5%
	20.09	18695	18318	-2%
	20.99	16454	16183	-2%
	21.89	14453	14361	-1%
	22.79	12848	12779	-1%
	23.69	11443	11470	0%
	24.60	10288	10290	0%
	25.50	9295	9181	-1%
	26.40	8321	8131	-2%
	27.30	7467	7309	-2%
	28.20	6675	6564	-2%
	29.10	6023	5935	-1%
	30.00	5419	5369	-1%
	30.90	4830	4833	0%
Q2	31.17	4683	4693	0%
	31.80	4325	4351	1%
	32.71	3842	3892	1%
	33.61	3421	3503	2%
	34.51	3124	3189	2%
	35.41	2872	2947	3%
	36.31	2682	2729	2%
	37.21	2489	2512	1%
	38.11	2272	2327	2%
	39.01	2085	2163	4%
	39.92	1922	1972	3%
	40.82	1781	1819	2%
	41.72	1686	1681	0%
	42.62	1571	1530	-3%
	43.52	1446	1367	-5%
	44.42	1350	1259	-7%
	45.32	1238	1157	-7%
	46.22	1121	1054	-6%
	47.13	970	970	0%

	48.03	848	909	7%
	48.93	748	848	13%
	49.83	695	797	15%
Q5	50.25	660	771	17%
	50.73	620	741	20%
	51.63	573	672	17%
	52.53	528	614	16%
	53.43	480	566	18%
	54.34	452	526	16%
	55.24	404	487	21%
	56.14	350	444	27%
	57.04	307	404	32%
	57.94	284	374	32%
	58.84	252	354	40%
	59.74	225	330	47%
	60.64	200	298	49%
	61.54	182	277	52%
	62.45	168	256	52%
	63.35	152	244	61%
	64.25	140	231	65%
Q10	65.15	115	214	86%
	66.05	101	204	102%
	66.95	90	185	106%
	67.85	82	178	117%
	68.75	67	167	149%
	69.66	59	157	166%
	70.56	50	145	190%
	71.46	43	134	212%
	72.36	39	127	226%
	73.26	36	116	222%
	74.16	32	107	234%
	75.06	29	99	241%
	75.96	28	87	211%
	76.87	25	78	212%
	77.77	24	67	179%
	78.67	24	56	133%
	79.57	22	44	100%
	80.47	22	36	64%
	81.37	21	25	19%

	82.27	20	23	15%
	83.17	19	19	0%
	84.08	19	14	-26%
	84.98	17	12	-29%
	85.88	17	10	-41%
Q25	86.78	17	9	-47%
	87.68	16	7	-56%
	88.58	15	4	-73%
	89.48	15	0	-100%
	90.38	14	0	-100%
	91.29	13	0	-100%
	92.19	13	0	-100%
	93.09	11	0	-100%
	93.99	11	0	-100%
	94.89	11	0	-100%
	95.79	11	0	-100%
	96.69	10	0	-100%
	97.59	10	0	-100%
	98.49	10	0	-100%
	99.40	10	0	-100%
	100.30	10	0	-100%
	101.20	9	0	-100%
	102.10	8	0	-100%
	103.00	8	0	-100%
	103.90	8	0	-100%
Q50	104.80	8	0	-100%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 2A	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 1.0%

Frequency	Flow (cfs)	Existing	Run 2B	Change (%)
0.5Q2	35.04	18076	20447	13%
	37.21	15207	17199	13%
	39.38	12779	14550	14%
	41.55	10761	12329	15%
	43.72	9145	10526	15%
	45.89	7700	8990	17%
	48.06	6553	7551	15%
	50.24	5525	6480	17%
	52.41	4738	5685	20%
	54.58	4098	5024	23%
	56.75	3522	4416	25%
	58.92	3131	3907	25%
	61.09	2781	3467	25%
	63.26	2506	3027	21%
	65.43	2255	2697	20%
	67.60	2014	2430	21%
	69.77	1804	2173	20%
Q2	70.08	1777	2134	20%
	71.94	1618	1902	18%
	74.11	1418	1654	17%
	76.28	1221	1460	20%
	78.45	1018	1272	25%
	80.62	884	1118	26%
	82.79	783	1004	28%
	84.97	697	886	27%
	87.14	631	762	21%
	89.31	570	650	14%
	91.48	474	578	22%
	93.65	398	516	30%
	95.82	352	460	31%
	97.99	317	404	27%
	100.16	297	366	23%
	102.33	269	326	21%
	104.50	239	292	22%
	106.67	217	262	21%
	108.84	191	239	25%
	111.01	166	220	33%

Q5	112.52	152	205	35%
	113.18	146	198	36%
	115.35	132	171	30%
	117.52	115	150	30%
	119.70	105	135	29%
	121.87	96	124	29%
	124.04	87	113	30%
	126.21	81	95	17%
	128.38	71	84	18%
	130.55	63	78	24%
	132.72	58	70	21%
	134.89	54	62	15%
	137.06	50	56	12%
	139.23	47	48	2%
	141.40	46	44	-4%
	143.57	44	41	-7%
	145.74	43	39	-9%
Q10	147.91	40	35	-13%
	150.08	36	31	-14%
	152.26	35	30	-14%
	154.43	33	28	-15%
	156.60	32	26	-19%
	158.77	30	24	-20%
	160.94	27	22	-19%
	163.11	27	21	-22%
	165.28	26	19	-27%
	167.45	26	16	-38%
	169.62	25	13	-48%
	171.79	22	9	-59%
	173.96	20	5	-75%
	176.13	20	4	-80%
	178.30	19	4	-79%
	180.47	19	3	-84%
	182.64	17	3	-82%
	184.81	15	3	-80%
	186.99	15	3	-80%
	189.16	15	3	-80%
	191.33	15	3	-80%
	193.50	15	3	-80%

	195.67	15	2	-87%
	197.84	15	2	-87%
	200.01	14	2	-86%
Q25	202.18	14	2	-86%
	204.35	13	2	-85%
	206.52	12	2	-83%
	208.69	11	2	-82%
	210.86	10	2	-80%
	213.03	10	2	-80%
	215.20	10	2	-80%
	217.37	9	2	-78%
	219.54	9	1	-89%
	221.72	8	1	-88%
	223.89	8	1	-88%
	226.06	8	1	-88%
	228.23	8	1	-88%
	230.40	8	1	-88%
	232.57	7	0	-100%
	234.74	7	0	-100%
	236.91	6	0	-100%
	239.08	6	0	-100%
	241.25	6	0	-100%
	243.42	6	0	-100%
	245.59	6	0	-100%
	247.76	6	0	-100%
Q50	249.93	6	0	-100%

MIL2B 0.6% 1.1%

Frequency	Flow (cfs)	Existing	Run 2B	Change (%)
0.5Q2	8.51	11979	23647	97%
	9.32	8830	17788	101%
	10.13	6173	13309	116%
	10.94	4980	11203	125%
	11.75	4044	9381	132%
	12.56	3305	7715	133%
	13.37	2687	6282	134%
	14.17	2236	5081	127%
	14.98	1893	4178	121%
	15.79	1576	3444	119%
	16.60	1247	2828	127%
Q2	17.02	1141	2591	127%
	17.41	1042	2371	128%
	18.22	843	1965	133%
	19.03	654	1653	153%
	19.84	524	1352	158%
	20.65	428	1148	168%
	21.46	369	942	155%
	22.27	320	732	129%
	23.07	281	570	103%
	23.88	248	463	87%
	24.69	218	387	78%
	25.50	192	314	64%
	26.31	174	263	51%
	27.12	163	209	28%
	27.93	140	180	29%
	28.74	130	151	16%
	29.55	116	108	-7%
	30.36	100	82	-18%
Q5	31.11	93	49	-47%
	31.17	93	47	-49%
	31.97	77	42	-45%
	32.78	71	38	-46%
	33.59	66	35	-47%
	34.40	64	34	-47%
	35.21	56	31	-45%
	36.02	51	31	-39%

	36.83	45	28	-38%
	37.64	41	27	-34%
	38.45	37	26	-30%
	39.26	36	24	-33%
	40.07	35	22	-37%
	40.88	30	22	-27%
	41.68	27	21	-22%
	42.49	26	20	-23%
	43.30	25	19	-24%
	44.11	25	17	-32%
Q10	44.37	24	17	-29%
	44.92	22	17	-23%
	45.73	21	14	-33%
	46.54	21	13	-38%
	47.35	20	12	-40%
	48.16	20	11	-45%
	48.97	19	5	-74%
	49.78	19	1	-95%
	50.58	17	0	-100%
	51.39	17	0	-100%
	52.20	16	0	-100%
	53.01	15	0	-100%
	53.82	14	0	-100%
	54.63	12	0	-100%
	55.44	12	0	-100%
	56.25	10	0	-100%
	57.06	10	0	-100%
	57.87	10	0	-100%
	58.68	10	0	-100%
	59.48	10	0	-100%
	60.29	10	0	-100%
	61.10	10	0	-100%
	61.91	10	0	-100%
	62.72	10	0	-100%
	63.53	9	0	-100%
	64.34	9	0	-100%
	65.15	8	0	-100%
	65.96	7	0	-100%
Q25	66.77	7	0	-100%

	67.58	6	0	-100%
	68.38	6	0	-100%
	69.19	6	0	-100%
	70.00	5	0	-100%
	70.81	5	0	-100%
	71.62	5	0	-100%
	72.43	5	0	-100%
	73.24	5	0	-100%
	74.05	5	0	-100%
	74.86	5	0	-100%
	75.67	4	0	-100%
	76.48	4	0	-100%
	77.28	4	0	-100%
	78.09	4	0	-100%
	78.90	4	0	-100%
	79.71	4	0	-100%
	80.52	4	0	-100%
	81.33	4	0	-100%
	82.14	4	0	-100%
	82.95	4	0	-100%
	83.76	4	0	-100%
	84.57	4	0	-100%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C		1.9%	1.8%	
Frequency	Flow (cfs)	Existing	Run 2B	Change (%)
0.5Q2	15.58	38984	38500	-1%
	16.48	33998	33325	-2%
	17.39	29412	28823	-2%
	18.29	25562	24657	-4%
	19.19	22048	21080	-4%
	20.09	18695	18219	-3%
	20.99	16454	16012	-3%
	21.89	14453	14028	-3%
	22.79	12848	12436	-3%
	23.69	11443	11144	-3%
	24.60	10288	9869	-4%
	25.50	9295	8744	-6%
	26.40	8321	7706	-7%
	27.30	7467	6888	-8%
	28.20	6675	6135	-8%
	29.10	6023	5468	-9%
	30.00	5419	4889	-10%
	30.90	4830	4374	-9%
Q2	31.17	4683	4231	-10%
	31.80	4325	3882	-10%
	32.71	3842	3478	-9%
	33.61	3421	3173	-7%
	34.51	3124	2908	-7%
	35.41	2872	2708	-6%
	36.31	2682	2489	-7%
	37.21	2489	2306	-7%
	38.11	2272	2146	-6%
	39.01	2085	1964	-6%
	39.92	1922	1794	-7%
	40.82	1781	1653	-7%
	41.72	1686	1506	-11%
	42.62	1571	1355	-14%
	43.52	1446	1237	-14%
	44.42	1350	1151	-15%
	45.32	1238	1047	-15%
	46.22	1121	935	-17%
	47.13	970	874	-10%

	48.03	848	822	-3%
	48.93	748	781	4%
	49.83	695	731	5%
Q5	50.25	660	705	7%
	50.73	620	676	9%
	51.63	573	607	6%
	52.53	528	560	6%
	53.43	480	511	6%
	54.34	452	463	2%
	55.24	404	417	3%
	56.14	350	392	12%
	57.04	307	364	19%
	57.94	284	340	20%
	58.84	252	315	25%
	59.74	225	288	28%
	60.64	200	271	36%
	61.54	182	253	39%
	62.45	168	238	42%
	63.35	152	223	47%
	64.25	140	210	50%
Q10	65.15	115	201	75%
	66.05	101	187	85%
	66.95	90	174	93%
	67.85	82	166	102%
	68.75	67	154	130%
	69.66	59	143	142%
	70.56	50	131	162%
	71.46	43	120	179%
	72.36	39	111	185%
	73.26	36	99	175%
	74.16	32	81	153%
	75.06	29	69	138%
	75.96	28	61	118%
	76.87	25	52	108%
	77.77	24	45	88%
	78.67	24	38	58%
	79.57	22	29	32%
	80.47	22	25	14%
	81.37	21	16	-24%

	82.27	20	14	-30%
	83.17	19	13	-32%
	84.08	19	11	-42%
	84.98	17	9	-47%
	85.88	17	8	-53%
Q25	86.78	17	6	-65%
	87.68	16	3	-81%
	88.58	15	0	-100%
	89.48	15	0	-100%
	90.38	14	0	-100%
	91.29	13	0	-100%
	92.19	13	0	-100%
	93.09	11	0	-100%
	93.99	11	0	-100%
	94.89	11	0	-100%
	95.79	11	0	-100%
	96.69	10	0	-100%
	97.59	10	0	-100%
	98.49	10	0	-100%
	99.40	10	0	-100%
	100.30	10	0	-100%
	101.20	9	0	-100%
	102.10	8	0	-100%
	103.00	8	0	-100%
	103.90	8	0	-100%
Q50	104.80	8	0	-100%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 2B	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 1.7%

Frequency	Flow (cfs)	Existing	Run 3A	Change (%)
0.5Q2	35.04	18076	34945	93%
	37.21	15207	30464	100%
	39.38	12779	26571	108%
	41.55	10761	23142	115%
	43.72	9145	20209	121%
	45.89	7700	17641	129%
	48.06	6553	15467	136%
	50.24	5525	13416	143%
	52.41	4738	11809	149%
	54.58	4098	10370	153%
	56.75	3522	9023	156%
	58.92	3131	7915	153%
	61.09	2781	7016	152%
	63.26	2506	6187	147%
	65.43	2255	5520	145%
	67.60	2014	4904	143%
	69.77	1804	4330	140%
Q2	70.08	1777	4257	140%
	71.94	1618	3821	136%
	74.11	1418	3362	137%
	76.28	1221	2990	145%
	78.45	1018	2651	160%
	80.62	884	2337	164%
	82.79	783	2051	162%
	84.97	697	1852	166%
	87.14	631	1614	156%
	89.31	570	1395	145%
	91.48	474	1247	163%
	93.65	398	1111	179%
	95.82	352	970	176%
	97.99	317	853	169%
	100.16	297	746	151%
	102.33	269	651	142%
	104.50	239	564	136%
	106.67	217	494	128%
	108.84	191	437	129%
	111.01	166	387	133%

Q5	112.52	152	364	139%
	113.18	146	354	142%
	115.35	132	319	142%
	117.52	115	290	152%
	119.70	105	256	144%
	121.87	96	228	138%
	124.04	87	204	134%
	126.21	81	192	137%
	128.38	71	173	144%
	130.55	63	157	149%
	132.72	58	142	145%
	134.89	54	130	141%
	137.06	50	123	146%
	139.23	47	117	149%
	141.40	46	113	146%
	143.57	44	109	148%
	145.74	43	106	147%
Q10	147.91	40	99	148%
	150.08	36	96	167%
	152.26	35	91	160%
	154.43	33	87	164%
	156.60	32	79	147%
	158.77	30	76	153%
	160.94	27	74	174%
	163.11	27	72	167%
	165.28	26	71	173%
	167.45	26	66	154%
	169.62	25	64	156%
	171.79	22	61	177%
	173.96	20	59	195%
	176.13	20	56	180%
	178.30	19	49	158%
	180.47	19	48	153%
	182.64	17	45	165%
	184.81	15	42	180%
	186.99	15	37	147%
	189.16	15	35	133%
	191.33	15	32	113%
	193.50	15	31	107%

	195.67	15	28	87%
	197.84	15	26	73%
	200.01	14	24	71%
Q25	202.18	14	21	50%
	204.35	13	19	46%
	206.52	12	18	50%
	208.69	11	17	55%
	210.86	10	17	70%
	213.03	10	16	60%
	215.20	10	14	40%
	217.37	9	13	44%
	219.54	9	13	44%
	221.72	8	13	63%
	223.89	8	12	50%
	226.06	8	12	50%
	228.23	8	12	50%
	230.40	8	12	50%
	232.57	7	12	71%
	234.74	7	10	43%
	236.91	6	9	50%
	239.08	6	9	50%
	241.25	6	9	50%
	243.42	6	9	50%
	245.59	6	8	33%
	247.76	6	7	17%
Q50	249.93	6	6	0%

MIL2B 0.6% 2.2%

Frequency	Flow (cfs)	Existing	Run 3A	Change (%)
0.5Q2	8.51	11979	46895	291%
	9.32	8830	37911	329%
	10.13	6173	30337	391%
	10.94	4980	26382	430%
	11.75	4044	22785	463%
	12.56	3305	19568	492%
	13.37	2687	16652	520%
	14.17	2236	14119	531%
	14.98	1893	11956	532%
	15.79	1576	10134	543%
	16.60	1247	8489	581%
Q2	17.02	1141	7753	580%
	17.41	1042	7071	579%
	18.22	843	5838	593%
	19.03	654	4782	631%
	19.84	524	3919	648%
	20.65	428	3250	659%
	21.46	369	2720	637%
	22.27	320	2222	594%
	23.07	281	1848	558%
	23.88	248	1557	528%
	24.69	218	1217	458%
	25.50	192	1006	424%
	26.31	174	838	382%
	27.12	163	680	317%
	27.93	140	511	265%
	28.74	130	413	218%
	29.55	116	344	197%
	30.36	100	301	201%
Q5	31.11	93	271	190%
	31.17	93	269	189%
	31.97	77	249	223%
	32.78	71	221	211%
	33.59	66	203	208%
	34.40	64	189	195%
	35.21	56	177	216%
	36.02	51	163	220%

	36.83	45	156	247%
	37.64	41	146	256%
	38.45	37	137	270%
	39.26	36	130	261%
	40.07	35	125	257%
	40.88	30	120	300%
	41.68	27	107	296%
	42.49	26	98	277%
	43.30	25	87	248%
	44.11	25	79	216%
Q10	44.37	24	77	222%
	44.92	22	74	236%
	45.73	21	68	224%
	46.54	21	60	186%
	47.35	20	59	195%
	48.16	20	58	190%
	48.97	19	57	200%
	49.78	19	52	174%
	50.58	17	48	182%
	51.39	17	46	171%
	52.20	16	44	175%
	53.01	15	41	173%
	53.82	14	40	186%
	54.63	12	36	200%
	55.44	12	33	175%
	56.25	10	30	200%
	57.06	10	28	180%
	57.87	10	26	160%
	58.68	10	23	130%
	59.48	10	21	110%
	60.29	10	18	80%
	61.10	10	17	70%
	61.91	10	17	70%
	62.72	10	16	60%
	63.53	9	15	67%
	64.34	9	15	67%
	65.15	8	15	88%
	65.96	7	12	71%
Q25	66.77	7	12	71%

	67.58	6	12	100%
	68.38	6	12	100%
	69.19	6	10	67%
	70.00	5	10	100%
	70.81	5	10	100%
	71.62	5	10	100%
	72.43	5	10	100%
	73.24	5	9	80%
	74.05	5	8	60%
	74.86	5	8	60%
	75.67	4	8	100%
	76.48	4	7	75%
	77.28	4	7	75%
	78.09	4	5	25%
	78.90	4	5	25%
	79.71	4	3	-25%
	80.52	4	3	-25%
	81.33	4	2	-50%
	82.14	4	2	-50%
	82.95	4	2	-50%
	83.76	4	2	-50%
	84.57	4	2	-50%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C 1.9% 2.6%

Frequency	Flow (cfs)	Existing	Run 3A	Change (%)
0.5Q2	15.58	38984	55036	41%
	16.48	33998	48893	44%
	17.39	29412	43549	48%
	18.29	25562	38795	52%
	19.19	22048	34440	56%
	20.09	18695	30506	63%
	20.99	16454	27392	66%
	21.89	14453	24489	69%
	22.79	12848	21922	71%
	23.69	11443	19656	72%
	24.60	10288	17641	71%
	25.50	9295	15892	71%
	26.40	8321	14340	72%
	27.30	7467	12941	73%
	28.20	6675	11580	73%
	29.10	6023	10385	72%
	30.00	5419	9312	72%
	30.90	4830	8447	75%
Q2	31.17	4683	8211	75%
	31.80	4325	7637	77%
	32.71	3842	6894	79%
	33.61	3421	6229	82%
	34.51	3124	5655	81%
	35.41	2872	5142	79%
	36.31	2682	4656	74%
	37.21	2489	4178	68%
	38.11	2272	3768	66%
	39.01	2085	3438	65%
	39.92	1922	3135	63%
	40.82	1781	2901	63%
	41.72	1686	2680	59%
	42.62	1571	2480	58%
	43.52	1446	2302	59%
	44.42	1350	2135	58%
	45.32	1238	1988	61%
	46.22	1121	1847	65%
	47.13	970	1688	74%

	48.03	848	1515	79%
	48.93	748	1385	85%
	49.83	695	1266	82%
Q5	50.25	660	1214	84%
	50.73	620	1155	86%
	51.63	573	1051	83%
	52.53	528	962	82%
	53.43	480	901	88%
	54.34	452	840	86%
	55.24	404	780	93%
	56.14	350	721	106%
	57.04	307	671	119%
	57.94	284	598	111%
	58.84	252	549	118%
	59.74	225	500	122%
	60.64	200	462	131%
	61.54	182	419	130%
	62.45	168	389	132%
	63.35	152	360	137%
	64.25	140	336	140%
Q10	65.15	115	313	172%
	66.05	101	289	186%
	66.95	90	267	197%
	67.85	82	254	210%
	68.75	67	241	260%
	69.66	59	226	283%
	70.56	50	215	330%
	71.46	43	198	360%
	72.36	39	187	379%
	73.26	36	171	375%
	74.16	32	148	363%
	75.06	29	135	366%
	75.96	28	125	346%
	76.87	25	117	368%
	77.77	24	111	363%
	78.67	24	105	338%
	79.57	22	100	355%
	80.47	22	95	332%
	81.37	21	91	333%

	82.27	20	84	320%
	83.17	19	80	321%
	84.08	19	76	300%
	84.98	17	70	312%
	85.88	17	69	306%
Q25	86.78	17	67	294%
	87.68	16	64	300%
	88.58	15	62	313%
	89.48	15	58	287%
	90.38	14	57	307%
	91.29	13	52	300%
	92.19	13	49	277%
	93.09	11	46	318%
	93.99	11	44	300%
	94.89	11	38	245%
	95.79	11	37	236%
	96.69	10	34	240%
	97.59	10	29	190%
	98.49	10	26	160%
	99.40	10	22	120%
	100.30	10	19	90%
	101.20	9	15	67%
	102.10	8	13	63%
	103.00	8	13	63%
	103.90	8	12	50%
Q50	104.80	8	12	50%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 3A	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 1.6%

Frequency	Flow (cfs)	Existing	Run 3B	Change (%)
0.5Q2	35.04	18076	34335	90%
	37.21	15207	29896	97%
	39.38	12779	26046	104%
	41.55	10761	22721	111%
	43.72	9145	19839	117%
	45.89	7700	17323	125%
	48.06	6553	15213	132%
	50.24	5525	13204	139%
	52.41	4738	11626	145%
	54.58	4098	10204	149%
	56.75	3522	8870	152%
	58.92	3131	7791	149%
	61.09	2781	6905	148%
	63.26	2506	6091	143%
	65.43	2255	5449	142%
	67.60	2014	4828	140%
	69.77	1804	4269	137%
Q2	70.08	1777	4197	136%
	71.94	1618	3764	133%
	74.11	1418	3322	134%
	76.28	1221	2947	141%
	78.45	1018	2626	158%
	80.62	884	2297	160%
	82.79	783	2030	159%
	84.97	697	1835	163%
	87.14	631	1589	152%
	89.31	570	1376	141%
	91.48	474	1233	160%
	93.65	398	1096	175%
	95.82	352	947	169%
	97.99	317	842	166%
	100.16	297	735	147%
	102.33	269	645	140%
	104.50	239	560	134%
	106.67	217	488	125%
	108.84	191	435	128%
	111.01	166	384	131%

Q5	112.52	152	361	137%
	113.18	146	351	140%
	115.35	132	317	140%
	117.52	115	288	150%
	119.70	105	253	141%
	121.87	96	225	134%
	124.04	87	202	132%
	126.21	81	187	131%
	128.38	71	171	141%
	130.55	63	152	141%
	132.72	58	137	136%
	134.89	54	129	139%
	137.06	50	123	146%
	139.23	47	117	149%
	141.40	46	113	146%
	143.57	44	109	148%
	145.74	43	105	144%
Q10	147.91	40	99	148%
	150.08	36	94	161%
	152.26	35	91	160%
	154.43	33	85	158%
	156.60	32	78	144%
	158.77	30	76	153%
	160.94	27	73	170%
	163.11	27	71	163%
	165.28	26	70	169%
	167.45	26	65	150%
	169.62	25	62	148%
	171.79	22	61	177%
	173.96	20	59	195%
	176.13	20	54	170%
	178.30	19	49	158%
	180.47	19	47	147%
	182.64	17	44	159%
	184.81	15	38	153%
	186.99	15	36	140%
	189.16	15	35	133%
	191.33	15	32	113%
	193.50	15	31	107%

	195.67	15	27	80%
	197.84	15	26	73%
	200.01	14	23	64%
Q25	202.18	14	21	50%
	204.35	13	18	38%
	206.52	12	18	50%
	208.69	11	17	55%
	210.86	10	17	70%
	213.03	10	15	50%
	215.20	10	14	40%
	217.37	9	13	44%
	219.54	9	13	44%
	221.72	8	13	63%
	223.89	8	12	50%
	226.06	8	12	50%
	228.23	8	12	50%
	230.40	8	12	50%
	232.57	7	11	57%
	234.74	7	9	29%
	236.91	6	9	50%
	239.08	6	9	50%
	241.25	6	9	50%
	243.42	6	8	33%
	245.59	6	8	33%
	247.76	6	7	17%
Q50	249.93	6	6	0%

MIL2B 0.6% 2.1%

Frequency	Flow (cfs)	Existing	Run 3B	Change (%)
0.5Q2	8.51	11979	45064	276%
	9.32	8830	36565	314%
	10.13	6173	29222	373%
	10.94	4980	25478	412%
	11.75	4044	22048	445%
	12.56	3305	18903	472%
	13.37	2687	16134	500%
	14.17	2236	13696	513%
	14.98	1893	11598	513%
	15.79	1576	9854	525%
	16.60	1247	8237	561%
Q2	17.02	1141	7522	559%
	17.41	1042	6859	558%
	18.22	843	5661	572%
	19.03	654	4633	608%
	19.84	524	3802	626%
	20.65	428	3173	641%
	21.46	369	2640	615%
	22.27	320	2161	575%
	23.07	281	1815	546%
	23.88	248	1517	512%
	24.69	218	1191	446%
	25.50	192	988	415%
	26.31	174	824	374%
	27.12	163	661	306%
	27.93	140	499	256%
	28.74	130	398	206%
	29.55	116	331	185%
	30.36	100	285	185%
Q5	31.11	93	263	181%
	31.17	93	261	181%
	31.97	77	233	203%
	32.78	71	212	199%
	33.59	66	197	198%
	34.40	64	187	192%
	35.21	56	171	205%
	36.02	51	157	208%

	36.83	45	153	240%
	37.64	41	138	237%
	38.45	37	135	265%
	39.26	36	127	253%
	40.07	35	123	251%
	40.88	30	113	277%
	41.68	27	101	274%
	42.49	26	91	250%
	43.30	25	83	232%
	44.11	25	77	208%
Q10	44.37	24	75	214%
	44.92	22	72	227%
	45.73	21	63	200%
	46.54	21	59	181%
	47.35	20	59	195%
	48.16	20	57	185%
	48.97	19	55	189%
	49.78	19	48	153%
	50.58	17	47	176%
	51.39	17	45	165%
	52.20	16	43	169%
	53.01	15	40	167%
	53.82	14	38	171%
	54.63	12	34	183%
	55.44	12	32	167%
	56.25	10	30	200%
	57.06	10	27	170%
	57.87	10	24	140%
	58.68	10	23	130%
	59.48	10	18	80%
	60.29	10	18	80%
	61.10	10	17	70%
	61.91	10	16	60%
	62.72	10	15	50%
	63.53	9	15	67%
	64.34	9	15	67%
	65.15	8	13	63%
	65.96	7	12	71%
Q25	66.77	7	12	71%

	67.58	6	12	100%
	68.38	6	12	100%
	69.19	6	10	67%
	70.00	5	10	100%
	70.81	5	10	100%
	71.62	5	10	100%
	72.43	5	9	80%
	73.24	5	9	80%
	74.05	5	8	60%
	74.86	5	8	60%
	75.67	4	7	75%
	76.48	4	7	75%
	77.28	4	7	75%
	78.09	4	5	25%
	78.90	4	5	25%
	79.71	4	3	-25%
	80.52	4	3	-25%
	81.33	4	2	-50%
	82.14	4	2	-50%
	82.95	4	2	-50%
	83.76	4	2	-50%
	84.57	4	0	-100%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C 1.9% 2.6%

Frequency	Flow (cfs)	Existing	Run 3B	Change (%)
0.5Q2	15.58	38984	54468	40%
	16.48	33998	48388	42%
	17.39	29412	43087	46%
	18.29	25562	38332	50%
	19.19	22048	34061	54%
	20.09	18695	30148	61%
	20.99	16454	27076	65%
	21.89	14453	24194	67%
	22.79	12848	21649	69%
	23.69	11443	19414	70%
	24.60	10288	17449	70%
	25.50	9295	15749	69%
	26.40	8321	14174	70%
	27.30	7467	12800	71%
	28.20	6675	11447	71%
	29.10	6023	10263	70%
	30.00	5419	9211	70%
	30.90	4830	8350	73%
Q2	31.17	4683	8119	73%
	31.80	4325	7555	75%
	32.71	3842	6827	78%
	33.61	3421	6164	80%
	34.51	3124	5600	79%
	35.41	2872	5089	77%
	36.31	2682	4605	72%
	37.21	2489	4134	66%
	38.11	2272	3732	64%
	39.01	2085	3408	63%
	39.92	1922	3107	62%
	40.82	1781	2880	62%
	41.72	1686	2657	58%
	42.62	1571	2461	57%
	43.52	1446	2285	58%
	44.42	1350	2114	57%
	45.32	1238	1970	59%
	46.22	1121	1834	64%

	47.13	970	1675	73%
	48.03	848	1502	77%
	48.93	748	1362	82%
	49.83	695	1254	80%
Q5	50.25	660	1203	82%
	50.73	620	1145	85%
	51.63	573	1035	81%
	52.53	528	959	82%
	53.43	480	890	85%
	54.34	452	833	84%
	55.24	404	772	91%
	56.14	350	711	103%
	57.04	307	666	117%
	57.94	284	595	110%
	58.84	252	547	117%
	59.74	225	493	119%
	60.64	200	459	130%
	61.54	182	415	128%
	62.45	168	387	130%
	63.35	152	356	134%
	64.25	140	331	136%
Q10	65.15	115	311	170%
	66.05	101	283	180%
	66.95	90	266	196%
	67.85	82	254	210%
	68.75	67	241	260%
	69.66	59	224	280%
	70.56	50	214	328%
	71.46	43	197	358%
	72.36	39	186	377%
	73.26	36	169	369%
	74.16	32	146	356%
	75.06	29	133	359%
	75.96	28	123	339%
	76.87	25	117	368%
	77.77	24	111	363%
	78.67	24	104	333%
	79.57	22	100	355%
	80.47	22	95	332%

	81.37	21	91	333%
	82.27	20	84	320%
	83.17	19	80	321%
	84.08	19	75	295%
	84.98	17	70	312%
	85.88	17	69	306%
Q25	86.78	17	66	288%
	87.68	16	64	300%
	88.58	15	61	307%
	89.48	15	57	280%
	90.38	14	54	286%
	91.29	13	52	300%
	92.19	13	48	269%
	93.09	11	46	318%
	93.99	11	41	273%
	94.89	11	37	236%
	95.79	11	37	236%
	96.69	10	32	220%
	97.59	10	29	190%
	98.49	10	25	150%
	99.40	10	20	100%
	100.30	10	15	50%
	101.20	9	15	67%
	102.10	8	13	63%
	103.00	8	12	50%
	103.90	8	12	50%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 3B	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A		0.9%	0.6%	
Frequency	Flow (cfs)	Existing	Run 4A	Change (%)
0.5Q2	35.04	18076	13063	-28%
	37.21	15207	10582	-30%
	39.38	12779	8624	-33%
	41.55	10761	6928	-36%
	43.72	9145	5611	-39%
	45.89	7700	4544	-41%
	48.06	6553	3783	-42%
	50.24	5525	3168	-43%
	52.41	4738	2670	-44%
	54.58	4098	2318	-43%
	56.75	3522	2046	-42%
	58.92	3131	1860	-41%
	61.09	2781	1666	-40%
	63.26	2506	1456	-42%
	65.43	2255	1283	-43%
	67.60	2014	1104	-45%
	69.77	1804	986	-45%
Q2	70.08	1777	970	-45%
	71.94	1618	871	-46%
	74.11	1418	760	-46%
	76.28	1221	643	-47%
	78.45	1018	558	-45%
	80.62	884	521	-41%
	82.79	783	481	-39%
	84.97	697	413	-41%
	87.14	631	354	-44%
	89.31	570	311	-45%
	91.48	474	283	-40%
	93.65	398	259	-35%
	95.82	352	231	-34%
	97.99	317	212	-33%
	100.16	297	196	-34%
	102.33	269	173	-36%
	104.50	239	153	-36%
	106.67	217	139	-36%
	108.84	191	131	-31%
	111.01	166	108	-35%

Q5	112.52	152	99	-35%
	113.18	146	95	-35%
	115.35	132	86	-35%
	117.52	115	79	-31%
	119.70	105	72	-31%
	121.87	96	68	-29%
	124.04	87	61	-30%
	126.21	81	57	-30%
	128.38	71	55	-23%
	130.55	63	53	-16%
	132.72	58	50	-14%
	134.89	54	47	-13%
	137.06	50	45	-10%
	139.23	47	43	-9%
	141.40	46	40	-13%
	143.57	44	37	-16%
	145.74	43	32	-26%
Q10	147.91	40	28	-30%
	150.08	36	22	-39%
	152.26	35	19	-46%
	154.43	33	18	-45%
	156.60	32	15	-53%
	158.77	30	10	-67%
	160.94	27	7	-74%
	163.11	27	3	-89%
	165.28	26	3	-88%
	167.45	26	2	-92%
	169.62	25	2	-92%
	171.79	22	2	-91%
	173.96	20	2	-90%
	176.13	20	2	-90%
	178.30	19	2	-89%
	180.47	19	2	-89%
	182.64	17	2	-88%
	184.81	15	2	-87%
	186.99	15	2	-87%
	189.16	15	1	-93%
	191.33	15	1	-93%
	193.50	15	1	-93%

	195.67	15	1	-93%
	197.84	15	1	-93%
	200.01	14	1	-93%
Q25	202.18	14	1	-93%
	204.35	13	1	-92%
	206.52	12	1	-92%
	208.69	11	0	-100%
	210.86	10	0	-100%
	213.03	10	0	-100%
	215.20	10	0	-100%
	217.37	9	0	-100%
	219.54	9	0	-100%
	221.72	8	0	-100%
	223.89	8	0	-100%
	226.06	8	0	-100%
	228.23	8	0	-100%
	230.40	8	0	-100%
	232.57	7	0	-100%
	234.74	7	0	-100%
	236.91	6	0	-100%
	239.08	6	0	-100%
	241.25	6	0	-100%
	243.42	6	0	-100%
	245.59	6	0	-100%
	247.76	6	0	-100%
Q50	249.93	6	0	-100%

MIL2B 0.6% 0.2%

Frequency	Flow (cfs)	Existing	Run 4A	Change (%)
0.5Q2	8.51	11979	3842	-68%
	9.32	8830	2544	-71%
	10.13	6173	1984	-68%
	10.94	4980	1701	-66%
	11.75	4044	1519	-62%
	12.56	3305	1370	-59%
	13.37	2687	1251	-53%
	14.17	2236	1122	-50%
	14.98	1893	1024	-46%
	15.79	1576	921	-42%
	16.60	1247	833	-33%
Q2	17.02	1141	783	-31%
	17.41	1042	736	-29%
	18.22	843	623	-26%
	19.03	654	457	-30%
	19.84	524	374	-29%
	20.65	428	283	-34%
	21.46	369	253	-31%
	22.27	320	223	-30%
	23.07	281	188	-33%
	23.88	248	152	-39%
	24.69	218	124	-43%
	25.50	192	109	-43%
	26.31	174	93	-47%
	27.12	163	88	-46%
	27.93	140	81	-42%
	28.74	130	76	-42%
	29.55	116	69	-41%
	30.36	100	64	-36%
Q5	31.11	93	57	-39%
	31.17	93	57	-39%
	31.97	77	44	-43%
	32.78	71	41	-42%
	33.59	66	39	-41%
	34.40	64	36	-44%
	35.21	56	32	-43%
	36.02	51	29	-43%

	36.83	45	24	-47%
	37.64	41	13	-68%
	38.45	37	12	-68%
	39.26	36	9	-75%
	40.07	35	7	-80%
	40.88	30	4	-87%
	41.68	27	0	-100%
	42.49	26	0	-100%
	43.30	25	0	-100%
	44.11	25	0	-100%
Q10	44.37	24	0	-100%
	44.92	22	0	-100%
	45.73	21	0	-100%
	46.54	21	0	-100%
	47.35	20	0	-100%
	48.16	20	0	-100%
	48.97	19	0	-100%
	49.78	19	0	-100%
	50.58	17	0	-100%
	51.39	17	0	-100%
	52.20	16	0	-100%
	53.01	15	0	-100%
	53.82	14	0	-100%
	54.63	12	0	-100%
	55.44	12	0	-100%
	56.25	10	0	-100%
	57.06	10	0	-100%
	57.87	10	0	-100%
	58.68	10	0	-100%
	59.48	10	0	-100%
	60.29	10	0	-100%
	61.10	10	0	-100%
	61.91	10	0	-100%
	62.72	10	0	-100%
	63.53	9	0	-100%
	64.34	9	0	-100%
	65.15	8	0	-100%
	65.96	7	0	-100%
Q25	66.77	7	0	-100%

	67.58	6	0	-100%
	68.38	6	0	-100%
	69.19	6	0	-100%
	70.00	5	0	-100%
	70.81	5	0	-100%
	71.62	5	0	-100%
	72.43	5	0	-100%
	73.24	5	0	-100%
	74.05	5	0	-100%
	74.86	5	0	-100%
	75.67	4	0	-100%
	76.48	4	0	-100%
	77.28	4	0	-100%
	78.09	4	0	-100%
	78.90	4	0	-100%
	79.71	4	0	-100%
	80.52	4	0	-100%
	81.33	4	0	-100%
	82.14	4	0	-100%
	82.95	4	0	-100%
	83.76	4	0	-100%
	84.57	4	0	-100%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C 1.9% 1.7%

Frequency	Flow (cfs)	Existing	Run 4A	Change (%)
0.5Q2	15.58	38984	35870	-8%
	16.48	33998	30716	-10%
	17.39	29412	26256	-11%
	18.29	25562	22090	-14%
	19.19	22048	18823	-15%
	20.09	18695	16248	-13%
	20.99	16454	14270	-13%
	21.89	14453	12406	-14%
	22.79	12848	11020	-14%
	23.69	11443	9806	-14%
	24.60	10288	8710	-15%
	25.50	9295	7696	-17%
	26.40	8321	6926	-17%
	27.30	7467	6253	-16%
	28.20	6675	5525	-17%
	29.10	6023	4822	-20%
	30.00	5419	4117	-24%
	30.90	4830	3627	-25%
Q2	31.17	4683	3506	-25%
	31.80	4325	3210	-26%
	32.71	3842	2914	-24%
	33.61	3421	2642	-23%
	34.51	3124	2379	-24%
	35.41	2872	2148	-25%
	36.31	2682	1980	-26%
	37.21	2489	1831	-26%
	38.11	2272	1680	-26%
	39.01	2085	1567	-25%
	39.92	1922	1468	-24%
	40.82	1781	1367	-23%
	41.72	1686	1277	-24%
	42.62	1571	1145	-27%
	43.52	1446	1037	-28%
	44.42	1350	946	-30%
	45.32	1238	838	-32%
	46.22	1121	757	-32%
	47.13	970	707	-27%

	48.03	848	659	-22%
	48.93	748	599	-20%
	49.83	695	551	-21%
Q5	50.25	660	532	-19%
	50.73	620	511	-18%
	51.63	573	439	-23%
	52.53	528	394	-25%
	53.43	480	362	-25%
	54.34	452	331	-27%
	55.24	404	302	-25%
	56.14	350	280	-20%
	57.04	307	264	-14%
	57.94	284	249	-12%
	58.84	252	234	-7%
	59.74	225	215	-4%
	60.64	200	205	3%
	61.54	182	193	6%
	62.45	168	184	10%
	63.35	152	173	14%
	64.25	140	162	16%
Q10	65.15	115	149	30%
	66.05	101	137	36%
	66.95	90	119	32%
	67.85	82	100	22%
	68.75	67	88	31%
	69.66	59	81	37%
	70.56	50	74	48%
	71.46	43	67	56%
	72.36	39	63	62%
	73.26	36	55	53%
	74.16	32	50	56%
	75.06	29	48	66%
	75.96	28	46	64%
	76.87	25	42	68%
	77.77	24	41	71%
	78.67	24	39	63%
	79.57	22	36	64%
	80.47	22	33	50%
	81.37	21	30	43%

	82.27	20	27	35%
	83.17	19	24	26%
	84.08	19	21	11%
	84.98	17	16	-6%
	85.88	17	10	-41%
Q25	86.78	17	7	-59%
	87.68	16	5	-69%
	88.58	15	1	-93%
	89.48	15	0	-100%
	90.38	14	0	-100%
	91.29	13	0	-100%
	92.19	13	0	-100%
	93.09	11	0	-100%
	93.99	11	0	-100%
	94.89	11	0	-100%
	95.79	11	0	-100%
	96.69	10	0	-100%
	97.59	10	0	-100%
	98.49	10	0	-100%
	99.40	10	0	-100%
	100.30	10	0	-100%
	101.20	9	0	-100%
	102.10	8	0	-100%
	103.00	8	0	-100%
	103.90	8	0	-100%
Q50	104.80	8	0	-100%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 4A	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 1.0%

Frequency	Flow (cfs)	Existing	Run 4B	Change (%)
0.5Q2	35.04	18076	20313	12%
	37.21	15207	17214	13%
	39.38	12779	14702	15%
	41.55	10761	12541	17%
	43.72	9145	10727	17%
	45.89	7700	9137	19%
	48.06	6553	7814	19%
	50.24	5525	6768	22%
	52.41	4738	5988	26%
	54.58	4098	5272	29%
	56.75	3522	4622	31%
	58.92	3131	4048	29%
	61.09	2781	3612	30%
	63.26	2506	3200	28%
	65.43	2255	2840	26%
	67.60	2014	2552	27%
	69.77	1804	2287	27%
Q2	70.08	1777	2243	26%
	71.94	1618	1982	22%
	74.11	1418	1723	22%
	76.28	1221	1522	25%
	78.45	1018	1298	28%
	80.62	884	1163	32%
	82.79	783	1053	34%
	84.97	697	930	33%
	87.14	631	797	26%
	89.31	570	694	22%
	91.48	474	615	30%
	93.65	398	545	37%
	95.82	352	481	37%
	97.99	317	417	32%
	100.16	297	380	28%
	102.33	269	336	25%
	104.50	239	295	23%
	106.67	217	266	23%
	108.84	191	244	28%
	111.01	166	220	33%

Q5	112.52	152	205	35%
	113.18	146	199	36%
	115.35	132	166	26%
	117.52	115	149	30%
	119.70	105	129	23%
	121.87	96	112	17%
	124.04	87	98	13%
	126.21	81	85	5%
	128.38	71	77	8%
	130.55	63	72	14%
	132.72	58	64	10%
	134.89	54	60	11%
	137.06	50	54	8%
	139.23	47	42	-11%
	141.40	46	39	-15%
	143.57	44	38	-14%
	145.74	43	36	-16%
Q10	147.91	40	32	-20%
	150.08	36	29	-19%
	152.26	35	27	-23%
	154.43	33	25	-24%
	156.60	32	24	-25%
	158.77	30	20	-33%
	160.94	27	17	-37%
	163.11	27	14	-48%
	165.28	26	13	-50%
	167.45	26	9	-65%
	169.62	25	7	-72%
	171.79	22	3	-86%
	173.96	20	3	-85%
	176.13	20	3	-85%
	178.30	19	3	-84%
	180.47	19	3	-84%
	182.64	17	3	-82%
	184.81	15	3	-80%
	186.99	15	3	-80%
	189.16	15	2	-87%
	191.33	15	2	-87%
	193.50	15	2	-87%

	195.67	15	2	-87%
	197.84	15	2	-87%
	200.01	14	2	-86%
Q25	202.18	14	2	-86%
	204.35	13	2	-85%
	206.52	12	2	-83%
	208.69	11	2	-82%
	210.86	10	2	-80%
	213.03	10	2	-80%
	215.20	10	1	-90%
	217.37	9	1	-89%
	219.54	9	1	-89%
	221.72	8	1	-88%
	223.89	8	1	-88%
	226.06	8	1	-88%
	228.23	8	0	-100%
	230.40	8	0	-100%
	232.57	7	0	-100%
	234.74	7	0	-100%
	236.91	6	0	-100%
	239.08	6	0	-100%
	241.25	6	0	-100%
	243.42	6	0	-100%
	245.59	6	0	-100%
	247.76	6	0	-100%
Q50	249.93	6	0	-100%

MIL2B 0.6% 1.1%

Frequency	Flow (cfs)	Existing	Run 4B	Change (%)
0.5Q2	8.51	11979	22553	88%
	9.32	8830	17435	97%
	10.13	6173	13231	114%
	10.94	4980	11117	123%
	11.75	4044	9141	126%
	12.56	3305	7429	125%
	13.37	2687	6238	132%
	14.17	2236	5135	130%
	14.98	1893	4195	122%
	15.79	1576	3467	120%
	16.60	1247	2908	133%
Q2	17.02	1141	2667	134%
	17.41	1042	2443	134%
	18.22	843	1983	135%
	19.03	654	1602	145%
	19.84	524	1356	159%
	20.65	428	1145	168%
	21.46	369	926	151%
	22.27	320	678	112%
	23.07	281	518	84%
	23.88	248	441	78%
	24.69	218	339	56%
	25.50	192	280	46%
	26.31	174	231	33%
	27.12	163	159	-2%
	27.93	140	115	-18%
	28.74	130	74	-43%
	29.55	116	56	-52%
	30.36	100	47	-53%
Q5	31.11	93	38	-60%
	31.17	93	37	-60%
	31.97	77	35	-55%
	32.78	71	33	-54%
	33.59	66	33	-50%
	34.40	64	32	-50%
	35.21	56	29	-48%
	36.02	51	28	-45%

	36.83	45	27	-40%
	37.64	41	26	-37%
	38.45	37	24	-35%
	39.26	36	22	-39%
	40.07	35	22	-37%
	40.88	30	20	-33%
	41.68	27	18	-33%
	42.49	26	17	-35%
	43.30	25	16	-36%
	44.11	25	15	-40%
Q10	44.37	24	15	-38%
	44.92	22	15	-32%
	45.73	21	14	-33%
	46.54	21	14	-33%
	47.35	20	13	-35%
	48.16	20	12	-40%
	48.97	19	12	-37%
	49.78	19	6	-68%
	50.58	17	4	-76%
	51.39	17	0	-100%
	52.20	16	0	-100%
	53.01	15	0	-100%
	53.82	14	0	-100%
	54.63	12	0	-100%
	55.44	12	0	-100%
	56.25	10	0	-100%
	57.06	10	0	-100%
	57.87	10	0	-100%
	58.68	10	0	-100%
	59.48	10	0	-100%
	60.29	10	0	-100%
	61.10	10	0	-100%
	61.91	10	0	-100%
	62.72	10	0	-100%
	63.53	9	0	-100%
	64.34	9	0	-100%
	65.15	8	0	-100%
	65.96	7	0	-100%
Q25	66.77	7	0	-100%

	67.58	6	0	-100%
	68.38	6	0	-100%
	69.19	6	0	-100%
	70.00	5	0	-100%
	70.81	5	0	-100%
	71.62	5	0	-100%
	72.43	5	0	-100%
	73.24	5	0	-100%
	74.05	5	0	-100%
	74.86	5	0	-100%
	75.67	4	0	-100%
	76.48	4	0	-100%
	77.28	4	0	-100%
	78.09	4	0	-100%
	78.90	4	0	-100%
	79.71	4	0	-100%
	80.52	4	0	-100%
	81.33	4	0	-100%
	82.14	4	0	-100%
	82.95	4	0	-100%
	83.76	4	0	-100%
	84.57	4	0	-100%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C		1.9%	1.8%	
Frequency	Flow (cfs)	Existing	Run 4B	Change (%)
0.5Q2	15.58	38984	37385	-4%
	16.48	33998	32399	-5%
	17.39	29412	28002	-5%
	18.29	25562	24005	-6%
	19.19	22048	20733	-6%
	20.09	18695	18030	-4%
	20.99	16454	15905	-3%
	21.89	14453	14108	-2%
	22.79	12848	12564	-2%
	23.69	11443	11323	-1%
	24.60	10288	10126	-2%
	25.50	9295	9021	-3%
	26.40	8321	8018	-4%
	27.30	7467	7185	-4%
	28.20	6675	6461	-3%
	29.10	6023	5838	-3%
	30.00	5419	5293	-2%
	30.90	4830	4742	-2%
Q2	31.17	4683	4609	-2%
	31.80	4325	4286	-1%
	32.71	3842	3844	0%
	33.61	3421	3459	1%
	34.51	3124	3143	1%
	35.41	2872	2903	1%
	36.31	2682	2682	0%
	37.21	2489	2472	-1%
	38.11	2272	2310	2%
	39.01	2085	2129	2%
	39.92	1922	1941	1%
	40.82	1781	1788	0%
	41.72	1686	1667	-1%
	42.62	1571	1499	-5%
	43.52	1446	1338	-7%
	44.42	1350	1244	-8%
	45.32	1238	1147	-7%
	46.22	1121	1038	-7%
	47.13	970	968	0%

	48.03	848	917	8%
	48.93	748	850	14%
	49.83	695	798	15%
Q5	50.25	660	773	17%
	50.73	620	744	20%
	51.63	573	670	17%
	52.53	528	610	16%
	53.43	480	566	18%
	54.34	452	532	18%
	55.24	404	483	20%
	56.14	350	437	25%
	57.04	307	404	32%
	57.94	284	382	35%
	58.84	252	355	41%
	59.74	225	333	48%
	60.64	200	298	49%
	61.54	182	275	51%
	62.45	168	265	58%
	63.35	152	247	63%
	64.25	140	229	64%
Q10	65.15	115	218	90%
	66.05	101	206	104%
	66.95	90	192	113%
	67.85	82	181	121%
	68.75	67	172	157%
	69.66	59	158	168%
	70.56	50	147	194%
	71.46	43	133	209%
	72.36	39	121	210%
	73.26	36	109	203%
	74.16	32	95	197%
	75.06	29	70	141%
	75.96	28	61	118%
	76.87	25	51	104%
	77.77	24	38	58%
	78.67	24	33	38%
	79.57	22	25	14%
	80.47	22	14	-36%
	81.37	21	11	-48%

	82.27	20	9	-55%
	83.17	19	7	-63%
	84.08	19	5	-74%
	84.98	17	3	-82%
	85.88	17	0	-100%
Q25	86.78	17	0	-100%
	87.68	16	0	-100%
	88.58	15	0	-100%
	89.48	15	0	-100%
	90.38	14	0	-100%
	91.29	13	0	-100%
	92.19	13	0	-100%
	93.09	11	0	-100%
	93.99	11	0	-100%
	94.89	11	0	-100%
	95.79	11	0	-100%
	96.69	10	0	-100%
	97.59	10	0	-100%
	98.49	10	0	-100%
	99.40	10	0	-100%
	100.30	10	0	-100%
	101.20	9	0	-100%
	102.10	8	0	-100%
	103.00	8	0	-100%
	103.90	8	0	-100%
Q50	104.80	8	0	-100%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 4B	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 1.0%

Frequency	Flow (cfs)	Existing	Run 4C	Change (%)
0.5Q2	35.04	18076	20361	13%
	37.21	15207	17270	14%
	39.38	12779	14712	15%
	41.55	10761	12577	17%
	43.72	9145	10805	18%
	45.89	7700	9196	19%
	48.06	6553	7828	19%
	50.24	5525	6789	23%
	52.41	4738	5985	26%
	54.58	4098	5304	29%
	56.75	3522	4660	32%
	58.92	3131	4084	30%
	61.09	2781	3648	31%
	63.26	2506	3225	29%
	65.43	2255	2851	26%
	67.60	2014	2562	27%
	69.77	1804	2310	28%
Q2	70.08	1777	2270	28%
	71.94	1618	2028	25%
	74.11	1418	1743	23%
	76.28	1221	1542	26%
	78.45	1018	1326	30%
	80.62	884	1164	32%
	82.79	783	1059	35%
	84.97	697	946	36%
	87.14	631	796	26%
	89.31	570	703	23%
	91.48	474	609	28%
	93.65	398	540	36%
	95.82	352	483	37%
	97.99	317	419	32%
	100.16	297	379	28%
	102.33	269	339	26%
	104.50	239	305	28%
	106.67	217	271	25%
	108.84	191	246	29%
	111.01	166	223	34%

Q5	112.52	152	208	37%
	113.18	146	201	38%
	115.35	132	171	30%
	117.52	115	151	31%
	119.70	105	137	30%
	121.87	96	126	31%
	124.04	87	115	32%
	126.21	81	100	23%
	128.38	71	89	25%
	130.55	63	79	25%
	132.72	58	75	29%
	134.89	54	68	26%
	137.06	50	60	20%
	139.23	47	54	15%
	141.40	46	44	-4%
	143.57	44	39	-11%
	145.74	43	38	-12%
Q10	147.91	40	37	-8%
	150.08	36	32	-11%
	152.26	35	30	-14%
	154.43	33	30	-9%
	156.60	32	26	-19%
	158.77	30	23	-23%
	160.94	27	23	-15%
	163.11	27	22	-19%
	165.28	26	21	-19%
	167.45	26	19	-27%
	169.62	25	16	-36%
	171.79	22	15	-32%
	173.96	20	10	-50%
	176.13	20	6	-70%
	178.30	19	3	-84%
	180.47	19	3	-84%
	182.64	17	3	-82%
	184.81	15	3	-80%
	186.99	15	3	-80%
	189.16	15	3	-80%
	191.33	15	3	-80%
	193.50	15	2	-87%

	195.67	15	2	-87%
	197.84	15	2	-87%
	200.01	14	2	-86%
Q25	202.18	14	2	-86%
	204.35	13	2	-85%
	206.52	12	2	-83%
	208.69	11	2	-82%
	210.86	10	2	-80%
	213.03	10	2	-80%
	215.20	10	2	-80%
	217.37	9	1	-89%
	219.54	9	1	-89%
	221.72	8	1	-88%
	223.89	8	1	-88%
	226.06	8	1	-88%
	228.23	8	1	-88%
	230.40	8	0	-100%
	232.57	7	0	-100%
	234.74	7	0	-100%
	236.91	6	0	-100%
	239.08	6	0	-100%
	241.25	6	0	-100%
	243.42	6	0	-100%
	245.59	6	0	-100%
	247.76	6	0	-100%
Q50	249.93	6	0	-100%

MIL2B 0.6% 1.1%

Frequency	Flow (cfs)	Existing	Run 4C	Change (%)
0.5Q2	8.51	11979	22553	88%
	9.32	8830	17435	97%
	10.13	6173	13231	114%
	10.94	4980	11117	123%
	11.75	4044	9141	126%
	12.56	3305	7429	125%
	13.37	2687	6238	132%
	14.17	2236	5135	130%
	14.98	1893	4195	122%
	15.79	1576	3467	120%
	16.60	1247	2908	133%
Q2	17.02	1141	2667	134%
	17.41	1042	2443	134%
	18.22	843	1983	135%
	19.03	654	1602	145%
	19.84	524	1356	159%
	20.65	428	1145	168%
	21.46	369	926	151%
	22.27	320	678	112%
	23.07	281	518	84%
	23.88	248	441	78%
	24.69	218	339	56%
	25.50	192	280	46%
	26.31	174	231	33%
	27.12	163	159	-2%
	27.93	140	115	-18%
	28.74	130	74	-43%
	29.55	116	56	-52%
	30.36	100	47	-53%
Q5	31.11	93	38	-60%
	31.17	93	37	-60%
	31.97	77	35	-55%
	32.78	71	33	-54%
	33.59	66	33	-50%
	34.40	64	32	-50%
	35.21	56	29	-48%
	36.02	51	28	-45%

	36.83	45	27	-40%
	37.64	41	26	-37%
	38.45	37	24	-35%
	39.26	36	22	-39%
	40.07	35	22	-37%
	40.88	30	20	-33%
	41.68	27	18	-33%
	42.49	26	17	-35%
	43.30	25	16	-36%
	44.11	25	15	-40%
Q10	44.37	24	15	-38%
	44.92	22	15	-32%
	45.73	21	14	-33%
	46.54	21	14	-33%
	47.35	20	13	-35%
	48.16	20	12	-40%
	48.97	19	12	-37%
	49.78	19	6	-68%
	50.58	17	4	-76%
	51.39	17	0	-100%
	52.20	16	0	-100%
	53.01	15	0	-100%
	53.82	14	0	-100%
	54.63	12	0	-100%
	55.44	12	0	-100%
	56.25	10	0	-100%
	57.06	10	0	-100%
	57.87	10	0	-100%
	58.68	10	0	-100%
	59.48	10	0	-100%
	60.29	10	0	-100%
	61.10	10	0	-100%
	61.91	10	0	-100%
	62.72	10	0	-100%
	63.53	9	0	-100%
	64.34	9	0	-100%
	65.15	8	0	-100%
	65.96	7	0	-100%
Q25	66.77	7	0	-100%

	67.58	6	0	-100%
	68.38	6	0	-100%
	69.19	6	0	-100%
	70.00	5	0	-100%
	70.81	5	0	-100%
	71.62	5	0	-100%
	72.43	5	0	-100%
	73.24	5	0	-100%
	74.05	5	0	-100%
	74.86	5	0	-100%
	75.67	4	0	-100%
	76.48	4	0	-100%
	77.28	4	0	-100%
	78.09	4	0	-100%
	78.90	4	0	-100%
	79.71	4	0	-100%
	80.52	4	0	-100%
	81.33	4	0	-100%
	82.14	4	0	-100%
	82.95	4	0	-100%
	83.76	4	0	-100%
	84.57	4	0	-100%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C		1.9%	1.8%	
Frequency	Flow (cfs)	Existing	Run 4C	Change (%)
0.5Q2	15.58	38984	37385	-4%
	16.48	33998	32462	-5%
	17.39	29412	28065	-5%
	18.29	25562	24068	-6%
	19.19	22048	20735	-6%
	20.09	18695	18040	-4%
	20.99	16454	15960	-3%
	21.89	14453	14165	-2%
	22.79	12848	12589	-2%
	23.69	11443	11342	-1%
	24.60	10288	10162	-1%
	25.50	9295	9059	-3%
	26.40	8321	8039	-3%
	27.30	7467	7193	-4%
	28.20	6675	6503	-3%
	29.10	6023	5851	-3%
	30.00	5419	5297	-2%
	30.90	4830	4746	-2%
Q2	31.17	4683	4610	-2%
	31.80	4325	4277	-1%
	32.71	3842	3806	-1%
	33.61	3421	3442	1%
	34.51	3124	3156	1%
	35.41	2872	2908	1%
	36.31	2682	2684	0%
	37.21	2489	2472	-1%
	38.11	2272	2297	1%
	39.01	2085	2129	2%
	39.92	1922	1943	1%
	40.82	1781	1792	1%
	41.72	1686	1656	-2%
	42.62	1571	1505	-4%
	43.52	1446	1345	-7%
	44.42	1350	1242	-8%
	45.32	1238	1137	-8%
	46.22	1121	1041	-7%
	47.13	970	951	-2%

	48.03	848	874	3%
	48.93	748	829	11%
	49.83	695	779	12%
Q5	50.25	660	748	13%
	50.73	620	713	15%
	51.63	573	645	13%
	52.53	528	599	13%
	53.43	480	557	16%
	54.34	452	508	12%
	55.24	404	472	17%
	56.14	350	438	25%
	57.04	307	402	31%
	57.94	284	372	31%
	58.84	252	347	38%
	59.74	225	321	43%
	60.64	200	290	45%
	61.54	182	274	51%
	62.45	168	260	55%
	63.35	152	242	59%
	64.25	140	229	64%
Q10	65.15	115	218	90%
	66.05	101	201	99%
	66.95	90	190	111%
	67.85	82	177	116%
	68.75	67	168	151%
	69.66	59	158	168%
	70.56	50	145	190%
	71.46	43	135	214%
	72.36	39	128	228%
	73.26	36	120	233%
	74.16	32	114	256%
	75.06	29	104	259%
	75.96	28	94	236%
	76.87	25	81	224%
	77.77	24	67	179%
	78.67	24	59	146%
	79.57	22	49	123%
	80.47	22	39	77%
	81.37	21	34	62%

	82.27	20	24	20%
	83.17	19	21	11%
	84.08	19	19	0%
	84.98	17	15	-12%
	85.88	17	12	-29%
Q25	86.78	17	8	-53%
	87.68	16	6	-63%
	88.58	15	3	-80%
	89.48	15	0	-100%
	90.38	14	0	-100%
	91.29	13	0	-100%
	92.19	13	0	-100%
	93.09	11	0	-100%
	93.99	11	0	-100%
	94.89	11	0	-100%
	95.79	11	0	-100%
	96.69	10	0	-100%
	97.59	10	0	-100%
	98.49	10	0	-100%
	99.40	10	0	-100%
	100.30	10	0	-100%
	101.20	9	0	-100%
	102.10	8	0	-100%
	103.00	8	0	-100%
	103.90	8	0	-100%
Q50	104.80	8	0	-100%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 4C	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 1.5%

Frequency	Flow (cfs)	Existing	Run 5A	Change (%)
0.5Q2	35.04	18076	32567	80%
	37.21	15207	28717	89%
	39.38	12779	25309	98%
	41.55	10761	22343	108%
	43.72	9145	19713	116%
	45.89	7700	17405	126%
	48.06	6553	15415	135%
	50.24	5525	13582	146%
	52.41	4738	12076	155%
	54.58	4098	10688	161%
	56.75	3522	9373	166%
	58.92	3131	8249	163%
	61.09	2781	7290	162%
	63.26	2506	6480	159%
	65.43	2255	5731	154%
	67.60	2014	5148	156%
	69.77	1804	4584	154%
Q2	70.08	1777	4510	154%
	71.94	1618	4067	151%
	74.11	1418	3602	154%
	76.28	1221	3187	161%
	78.45	1018	2846	180%
	80.62	884	2531	186%
	82.79	783	2213	183%
	84.97	697	1973	183%
	87.14	631	1745	177%
	89.31	570	1548	172%
	91.48	474	1372	189%
	93.65	398	1221	207%
	95.82	352	1069	204%
	97.99	317	922	191%
	100.16	297	823	177%
	102.33	269	729	171%
	104.50	239	639	167%
	106.67	217	570	163%
	108.84	191	503	163%
	111.01	166	430	159%

Q5	112.52	152	401	163%
	113.18	146	388	166%
	115.35	132	352	167%
	117.52	115	323	181%
	119.70	105	297	183%
	121.87	96	272	183%
	124.04	87	244	180%
	126.21	81	218	169%
	128.38	71	203	186%
	130.55	63	181	187%
	132.72	58	168	190%
	134.89	54	158	193%
	137.06	50	142	184%
	139.23	47	130	177%
	141.40	46	120	161%
	143.57	44	117	166%
	145.74	43	109	153%
Q10	147.91	40	107	168%
	150.08	36	104	189%
	152.26	35	98	180%
	154.43	33	95	188%
	156.60	32	93	191%
	158.77	30	88	193%
	160.94	27	84	211%
	163.11	27	79	193%
	165.28	26	74	185%
	167.45	26	73	181%
	169.62	25	69	176%
	171.79	22	66	200%
	173.96	20	65	225%
	176.13	20	63	215%
	178.30	19	60	216%
	180.47	19	59	211%
	182.64	17	55	224%
	184.81	15	52	247%
	186.99	15	49	227%
	189.16	15	46	207%
	191.33	15	42	180%
	193.50	15	37	147%

	195.67	15	34	127%
	197.84	15	33	120%
	200.01	14	31	121%
Q25	202.18	14	28	100%
	204.35	13	26	100%
	206.52	12	26	117%
	208.69	11	24	118%
	210.86	10	23	130%
	213.03	10	19	90%
	215.20	10	17	70%
	217.37	9	16	78%
	219.54	9	16	78%
	221.72	8	16	100%
	223.89	8	13	63%
	226.06	8	13	63%
	228.23	8	13	63%
	230.40	8	12	50%
	232.57	7	12	71%
	234.74	7	12	71%
	236.91	6	12	100%
	239.08	6	12	100%
	241.25	6	12	100%
	243.42	6	11	83%
	245.59	6	11	83%
	247.76	6	9	50%
Q50	249.93	6	9	50%

MIL2B 0.6% 1.7%

Frequency	Flow (cfs)	Existing	Run 5A	Change (%)
0.5Q2	8.51	11979	36565	205%
	9.32	8830	30316	243%
	10.13	6173	24952	304%
	10.94	4980	22406	350%
	11.75	4044	20071	396%
	12.56	3305	17914	442%
	13.37	2687	16061	498%
	14.17	2236	14258	538%
	14.98	1893	12482	559%
	15.79	1576	10706	579%
	16.60	1247	9044	625%
Q2	17.02	1141	8289	627%
	17.41	1042	7589	628%
	18.22	843	6333	651%
	19.03	654	5304	711%
	19.84	524	4376	735%
	20.65	428	3667	757%
	21.46	369	3097	739%
	22.27	320	2638	724%
	23.07	281	2186	678%
	23.88	248	1800	626%
	24.69	218	1506	591%
	25.50	192	1229	540%
	26.31	174	971	458%
	27.12	163	823	405%
	27.93	140	649	364%
	28.74	130	520	300%
	29.55	116	427	268%
	30.36	100	371	271%
Q5	31.11	93	312	234%
	31.17	93	308	231%
	31.97	77	261	239%
	32.78	71	231	225%
	33.59	66	204	209%
	34.40	64	187	192%
	35.21	56	172	207%
	36.02	51	162	218%

	36.83	45	155	244%
	37.64	41	148	261%
	38.45	37	137	270%
	39.26	36	131	264%
	40.07	35	121	246%
	40.88	30	116	287%
	41.68	27	113	319%
	42.49	26	109	319%
	43.30	25	103	312%
	44.11	25	101	304%
Q10	44.37	24	99	312%
	44.92	22	95	332%
	45.73	21	92	338%
	46.54	21	88	319%
	47.35	20	78	290%
	48.16	20	75	275%
	48.97	19	69	263%
	49.78	19	62	226%
	50.58	17	59	247%
	51.39	17	56	229%
	52.20	16	53	231%
	53.01	15	50	233%
	53.82	14	47	236%
	54.63	12	45	275%
	55.44	12	43	258%
	56.25	10	41	310%
	57.06	10	38	280%
	57.87	10	35	250%
	58.68	10	33	230%
	59.48	10	31	210%
	60.29	10	29	190%
	61.10	10	27	170%
	61.91	10	24	140%
	62.72	10	22	120%
	63.53	9	19	111%
	64.34	9	17	89%
	65.15	8	15	88%
	65.96	7	15	114%
Q25	66.77	7	15	114%

	67.58	6	14	133%
	68.38	6	14	133%
	69.19	6	14	133%
	70.00	5	14	180%
	70.81	5	13	160%
	71.62	5	12	140%
	72.43	5	12	140%
	73.24	5	11	120%
	74.05	5	10	100%
	74.86	5	10	100%
	75.67	4	10	150%
	76.48	4	10	150%
	77.28	4	9	125%
	78.09	4	8	100%
	78.90	4	8	100%
	79.71	4	8	100%
	80.52	4	8	100%
	81.33	4	7	75%
	82.14	4	6	50%
	82.95	4	5	25%
	83.76	4	5	25%
	84.57	4	4	0%
	85.38	4	4	0%
	86.18	4	4	0%
	86.99	4	4	0%
	87.80	4	3	-25%
Q50	88.61	4	2	-50%

MIL2C 1.9% 2.6%

Frequency	Flow (cfs)	Existing	Run 5A	Change (%)
0.5Q2	15.58	38984	54489	40%
	16.48	33998	48767	43%
	17.39	29412	43549	48%
	18.29	25562	38921	52%
	19.19	22048	34692	57%
	20.09	18695	30779	65%
	20.99	16454	27750	69%
	21.89	14453	24973	73%
	22.79	12848	22427	75%
	23.69	11443	20235	77%
	24.60	10288	18234	77%
	25.50	9295	16423	77%
	26.40	8321	14872	79%
	27.30	7467	13435	80%
	28.20	6675	12097	81%
	29.10	6023	10824	80%
	30.00	5419	9722	79%
	30.90	4830	8748	81%
Q2	31.17	4683	8496	81%
	31.80	4325	7883	82%
	32.71	3842	7117	85%
	33.61	3421	6455	89%
	34.51	3124	5866	88%
	35.41	2872	5314	85%
	36.31	2682	4875	82%
	37.21	2489	4380	76%
	38.11	2272	3985	75%
	39.01	2085	3635	74%
	39.92	1922	3318	73%
	40.82	1781	3042	71%
	41.72	1686	2804	66%
	42.62	1571	2579	64%
	43.52	1446	2407	66%
	44.42	1350	2224	65%
	45.32	1238	2079	68%
	46.22	1121	1934	73%
	47.13	970	1787	84%

	48.03	848	1627	92%
	48.93	748	1465	96%
	49.83	695	1333	92%
Q5	50.25	660	1288	95%
	50.73	620	1236	99%
	51.63	573	1131	97%
	52.53	528	1034	96%
	53.43	480	945	97%
	54.34	452	871	93%
	55.24	404	812	101%
	56.14	350	754	115%
	57.04	307	697	127%
	57.94	284	634	123%
	58.84	252	574	128%
	59.74	225	520	131%
	60.64	200	477	139%
	61.54	182	441	142%
	62.45	168	409	143%
	63.35	152	384	153%
	64.25	140	358	156%
Q10	65.15	115	328	185%
	66.05	101	302	199%
	66.95	90	283	214%
	67.85	82	265	223%
	68.75	67	249	272%
	69.66	59	238	303%
	70.56	50	223	346%
	71.46	43	213	395%
	72.36	39	195	400%
	73.26	36	182	406%
	74.16	32	158	394%
	75.06	29	146	403%
	75.96	28	137	389%
	76.87	25	126	404%
	77.77	24	118	392%
	78.67	24	108	350%
	79.57	22	106	382%
	80.47	22	99	350%
	81.37	21	95	352%

	82.27	20	90	350%
	83.17	19	87	358%
	84.08	19	83	337%
	84.98	17	79	365%
	85.88	17	74	335%
Q25	86.78	17	70	312%
	87.68	16	67	319%
	88.58	15	64	327%
	89.48	15	60	300%
	90.38	14	60	329%
	91.29	13	60	362%
	92.19	13	55	323%
	93.09	11	53	382%
	93.99	11	49	345%
	94.89	11	45	309%
	95.79	11	41	273%
	96.69	10	40	300%
	97.59	10	37	270%
	98.49	10	34	240%
	99.40	10	31	210%
	100.30	10	30	200%
	101.20	9	25	178%
	102.10	8	23	188%
	103.00	8	18	125%
	103.90	8	14	75%
Q50	104.80	8	14	75%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 5A	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 1.4%

Frequency	Flow (cfs)	Existing	Run 5B	Change (%)
0.5Q2	35.04	18076	30106	67%
	37.21	15207	26508	74%
	39.38	12779	23416	83%
	41.55	10761	20677	92%
	43.72	9145	18320	100%
	45.89	7700	16115	109%
	48.06	6553	14367	119%
	50.24	5525	12728	130%
	52.41	4738	11359	140%
	54.58	4098	10105	147%
	56.75	3522	8868	152%
	58.92	3131	7837	150%
	61.09	2781	6911	149%
	63.26	2506	6208	148%
	65.43	2255	5516	145%
	67.60	2014	4967	147%
	69.77	1804	4454	147%
Q2	70.08	1777	4385	147%
	71.94	1618	3970	145%
	74.11	1418	3545	150%
	76.28	1221	3143	157%
	78.45	1018	2785	174%
	80.62	884	2476	180%
	82.79	783	2188	179%
	84.97	697	1953	180%
	87.14	631	1755	178%
	89.31	570	1533	169%
	91.48	474	1368	189%
	93.65	398	1207	203%
	95.82	352	1045	197%
	97.99	317	921	191%
	100.16	297	828	179%
	102.33	269	737	174%
	104.50	239	645	170%
	106.67	217	573	164%
	108.84	191	510	167%
	111.01	166	453	173%

Q5	112.52	152	413	171%
	113.18	146	395	171%
	115.35	132	355	169%
	117.52	115	326	183%
	119.70	105	295	181%
	121.87	96	269	180%
	124.04	87	248	185%
	126.21	81	217	168%
	128.38	71	200	182%
	130.55	63	179	184%
	132.72	58	163	181%
	134.89	54	154	185%
	137.06	50	144	188%
	139.23	47	129	174%
	141.40	46	121	163%
	143.57	44	117	166%
	145.74	43	109	153%
Q10	147.91	40	107	168%
	150.08	36	105	192%
	152.26	35	99	183%
	154.43	33	95	188%
	156.60	32	93	191%
	158.77	30	88	193%
	160.94	27	86	219%
	163.11	27	82	204%
	165.28	26	74	185%
	167.45	26	73	181%
	169.62	25	69	176%
	171.79	22	66	200%
	173.96	20	65	225%
	176.13	20	64	220%
	178.30	19	60	216%
	180.47	19	59	211%
	182.64	17	57	235%
	184.81	15	53	253%
	186.99	15	50	233%
	189.16	15	46	207%
	191.33	15	42	180%
	193.50	15	37	147%

	195.67	15	34	127%
	197.84	15	33	120%
	200.01	14	33	136%
Q25	202.18	14	29	107%
	204.35	13	27	108%
	206.52	12	26	117%
	208.69	11	26	136%
	210.86	10	23	130%
	213.03	10	20	100%
	215.20	10	17	70%
	217.37	9	17	89%
	219.54	9	16	78%
	221.72	8	16	100%
	223.89	8	14	75%
	226.06	8	13	63%
	228.23	8	13	63%
	230.40	8	13	63%
	232.57	7	12	71%
	234.74	7	12	71%
	236.91	6	12	100%
	239.08	6	12	100%
	241.25	6	12	100%
	243.42	6	11	83%
	245.59	6	11	83%
	247.76	6	9	50%
Q50	249.93	6	9	50%

MIL2B 0.6% 1.5%

Frequency	Flow (cfs)	Existing	Run 5B	Change (%)
0.5Q2	8.51	11979	30905	158%
	9.32	8830	25730	191%
	10.13	6173	21249	244%
	10.94	4980	19105	284%
	11.75	4044	17134	324%
	12.56	3305	15329	364%
	13.37	2687	13753	412%
	14.17	2236	12274	449%
	14.98	1893	10875	474%
	15.79	1576	9532	505%
	16.60	1247	8255	562%
Q2	17.02	1141	7608	567%
	17.41	1042	7008	573%
	18.22	843	5819	590%
	19.03	654	4900	649%
	19.84	524	4063	675%
	20.65	428	3404	695%
	21.46	369	2922	692%
	22.27	320	2504	683%
	23.07	281	2096	646%
	23.88	248	1727	596%
	24.69	218	1443	562%
	25.50	192	1191	520%
	26.31	174	933	436%
	27.12	163	797	389%
	27.93	140	651	365%
	28.74	130	517	298%
	29.55	116	423	265%
	30.36	100	360	260%
Q5	31.11	93	306	227%
	31.17	93	302	225%
	31.97	77	256	232%
	32.78	71	219	208%
	33.59	66	196	197%
	34.40	64	181	183%
	35.21	56	167	198%
	36.02	51	157	208%

	36.83	45	147	227%
	37.64	41	145	254%
	38.45	37	132	257%
	39.26	36	126	250%
	40.07	35	116	231%
	40.88	30	111	270%
	41.68	27	107	296%
	42.49	26	101	288%
	43.30	25	98	292%
	44.11	25	96	284%
Q10	44.37	24	93	287%
	44.92	22	87	295%
	45.73	21	84	300%
	46.54	21	79	276%
	47.35	20	72	260%
	48.16	20	69	245%
	48.97	19	64	237%
	49.78	19	61	221%
	50.58	17	59	247%
	51.39	17	56	229%
	52.20	16	53	231%
	53.01	15	51	240%
	53.82	14	47	236%
	54.63	12	45	275%
	55.44	12	43	258%
	56.25	10	41	310%
	57.06	10	38	280%
	57.87	10	35	250%
	58.68	10	32	220%
	59.48	10	31	210%
	60.29	10	29	190%
	61.10	10	26	160%
	61.91	10	24	140%
	62.72	10	22	120%
	63.53	9	18	100%
	64.34	9	17	89%
	65.15	8	16	100%
	65.96	7	15	114%
Q25	66.77	7	15	114%

	67.58	6	14	133%
	68.38	6	14	133%
	69.19	6	14	133%
	70.00	5	14	180%
	70.81	5	13	160%
	71.62	5	12	140%
	72.43	5	12	140%
	73.24	5	11	120%
	74.05	5	10	100%
	74.86	5	10	100%
	75.67	4	10	150%
	76.48	4	10	150%
	77.28	4	9	125%
	78.09	4	8	100%
	78.90	4	8	100%
	79.71	4	8	100%
	80.52	4	8	100%
	81.33	4	7	75%
	82.14	4	6	50%
	82.95	4	5	25%
	83.76	4	5	25%
	84.57	4	4	0%
	85.38	4	4	0%
	86.18	4	4	0%
	86.99	4	4	0%
	87.80	4	3	-25%
Q50	88.61	4	2	-50%

MIL2C		1.9%	2.5%	
Frequency	Flow (cfs)	Existing	Run 5B	Change (%)
0.5Q2	15.58	38984	52869	36%
	16.48	33998	47421	39%
	17.39	29412	42413	44%
	18.29	25562	37995	49%
	19.19	22048	33935	54%
	20.09	18695	30169	61%
	20.99	16454	27245	66%
	21.89	14453	24552	70%
	22.79	12848	22069	72%
	23.69	11443	19936	74%
	24.60	10288	17954	75%
	25.50	9295	16229	75%
	26.40	8321	14683	76%
	27.30	7467	13317	78%
	28.20	6675	11988	80%
	29.10	6023	10717	78%
	30.00	5419	9625	78%
	30.90	4830	8676	80%
Q2	31.17	4683	8433	80%
	31.80	4325	7841	81%
	32.71	3842	7098	85%
	33.61	3421	6471	89%
	34.51	3124	5882	88%
	35.41	2872	5342	86%
	36.31	2682	4902	83%
	37.21	2489	4401	77%
	38.11	2272	4008	76%
	39.01	2085	3663	76%
	39.92	1922	3351	74%
	40.82	1781	3067	72%
	41.72	1686	2821	67%
	42.62	1571	2596	65%
	43.52	1446	2424	68%
	44.42	1350	2236	66%
	45.32	1238	2089	69%
	46.22	1121	1949	74%
	47.13	970	1809	86%

	48.03	848	1638	93%
	48.93	748	1474	97%
	49.83	695	1340	93%
Q5	50.25	660	1295	96%
	50.73	620	1245	101%
	51.63	573	1147	100%
	52.53	528	1041	97%
	53.43	480	961	100%
	54.34	452	878	94%
	55.24	404	820	103%
	56.14	350	760	117%
	57.04	307	705	130%
	57.94	284	637	124%
	58.84	252	583	131%
	59.74	225	530	136%
	60.64	200	483	142%
	61.54	182	444	144%
	62.45	168	413	146%
	63.35	152	387	155%
	64.25	140	364	160%
Q10	65.15	115	335	191%
	66.05	101	305	202%
	66.95	90	284	216%
	67.85	82	269	228%
	68.75	67	252	276%
	69.66	59	241	308%
	70.56	50	227	354%
	71.46	43	213	395%
	72.36	39	197	405%
	73.26	36	184	411%
	74.16	32	159	397%
	75.06	29	151	421%
	75.96	28	138	393%
	76.87	25	128	412%
	77.77	24	119	396%
	78.67	24	110	358%
	79.57	22	106	382%
	80.47	22	100	355%
	81.37	21	95	352%

	82.27	20	92	360%
	83.17	19	87	358%
	84.08	19	84	342%
	84.98	17	81	376%
	85.88	17	76	347%
Q25	86.78	17	72	324%
	87.68	16	68	325%
	88.58	15	66	340%
	89.48	15	62	313%
	90.38	14	60	329%
	91.29	13	60	362%
	92.19	13	55	323%
	93.09	11	54	391%
	93.99	11	51	364%
	94.89	11	47	327%
	95.79	11	43	291%
	96.69	10	40	300%
	97.59	10	38	280%
	98.49	10	35	250%
	99.40	10	32	220%
	100.30	10	30	200%
	101.20	9	26	189%
	102.10	8	24	200%
	103.00	8	19	138%
	103.90	8	14	75%
Q50	104.80	8	14	75%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 5B	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 0.8%

Frequency	Flow (cfs)	Existing	Run 6A	Change (%)
0.5Q2	35.04	18076	16816	-7%
	37.21	15207	13820	-9%
	39.38	12779	11512	-10%
	41.55	10761	9661	-10%
	43.72	9145	8093	-12%
	45.89	7700	6739	-12%
	48.06	6553	5640	-14%
	50.24	5525	4649	-16%
	52.41	4738	3915	-17%
	54.58	4098	3316	-19%
	56.75	3522	2880	-18%
	58.92	3131	2495	-20%
	61.09	2781	2199	-21%
	63.26	2506	1942	-23%
	65.43	2255	1749	-22%
	67.60	2014	1521	-24%
	69.77	1804	1354	-25%
Q2	70.08	1777	1327	-25%
	71.94	1618	1168	-28%
	74.11	1418	1015	-28%
	76.28	1221	876	-28%
	78.45	1018	746	-27%
	80.62	884	681	-23%
	82.79	783	617	-21%
	84.97	697	510	-27%
	87.14	631	406	-36%
	89.31	570	358	-37%
	91.48	474	333	-30%
	93.65	398	307	-23%
	95.82	352	280	-20%
	97.99	317	260	-18%
	100.16	297	242	-19%
	102.33	269	222	-17%
	104.50	239	204	-15%
	106.67	217	187	-14%
	108.84	191	163	-15%
	111.01	166	138	-17%

Q5	112.52	152	129	-15%
	113.18	146	125	-14%
	115.35	132	118	-11%
	117.52	115	107	-7%
	119.70	105	97	-8%
	121.87	96	86	-10%
	124.04	87	75	-14%
	126.21	81	69	-15%
	128.38	71	62	-13%
	130.55	63	55	-13%
	132.72	58	52	-10%
	134.89	54	49	-9%
	137.06	50	47	-6%
	139.23	47	45	-4%
	141.40	46	44	-4%
	143.57	44	43	-2%
	145.74	43	39	-9%
Q10	147.91	40	36	-10%
	150.08	36	35	-3%
	152.26	35	33	-6%
	154.43	33	31	-6%
	156.60	32	31	-3%
	158.77	30	29	-3%
	160.94	27	24	-11%
	163.11	27	22	-19%
	165.28	26	18	-31%
	167.45	26	17	-35%
	169.62	25	17	-32%
	171.79	22	15	-32%
	173.96	20	12	-40%
	176.13	20	10	-50%
	178.30	19	4	-79%
	180.47	19	2	-89%
	182.64	17	2	-88%
	184.81	15	2	-87%
	186.99	15	2	-87%
	189.16	15	2	-87%
	191.33	15	2	-87%
	193.50	15	1	-93%

	195.67	15	1	-93%
	197.84	15	1	-93%
	200.01	14	1	-93%
Q25	202.18	14	1	-93%
	204.35	13	1	-92%
	206.52	12	1	-92%
	208.69	11	1	-91%
	210.86	10	0	-100%
	213.03	10	0	-100%
	215.20	10	0	-100%
	217.37	9	0	-100%
	219.54	9	0	-100%
	221.72	8	0	-100%
	223.89	8	0	-100%
	226.06	8	0	-100%
	228.23	8	0	-100%
	230.40	8	0	-100%
	232.57	7	0	-100%
	234.74	7	0	-100%
	236.91	6	0	-100%
	239.08	6	0	-100%
	241.25	6	0	-100%
	243.42	6	0	-100%
	245.59	6	0	-100%
	247.76	6	0	-100%
Q50	249.93	6	0	-100%

MIL2B		0.6%	0.6%	
Frequency	Flow (cfs)	Existing	Run 6A	Change (%)
0.5Q2	8.51	11979	11746	-2%
	9.32	8830	7860	-11%
	10.13	6173	4948	-20%
	10.94	4980	3391	-32%
	11.75	4044	2348	-42%
	12.56	3305	1798	-46%
	13.37	2687	1553	-42%
	14.17	2236	1400	-37%
	14.98	1893	1295	-32%
	15.79	1576	1154	-27%
	16.60	1247	1047	-16%
Q2	17.02	1141	998	-13%
	17.41	1042	952	-9%
	18.22	843	807	-4%
	19.03	654	681	4%
	19.84	524	597	14%
	20.65	428	525	23%
	21.46	369	453	23%
	22.27	320	389	22%
	23.07	281	334	19%
	23.88	248	289	17%
	24.69	218	244	12%
	25.50	192	198	3%
	26.31	174	169	-3%
	27.12	163	148	-9%
	27.93	140	128	-9%
	28.74	130	113	-13%
	29.55	116	99	-15%
	30.36	100	85	-15%
Q5	31.11	93	80	-14%
	31.17	93	80	-14%
	31.97	77	72	-6%
	32.78	71	65	-8%
	33.59	66	59	-11%
	34.40	64	46	-28%
	35.21	56	45	-20%
	36.02	51	43	-16%

	36.83	45	40	-11%
	37.64	41	39	-5%
	38.45	37	36	-3%
	39.26	36	35	-3%
	40.07	35	32	-9%
	40.88	30	29	-3%
	41.68	27	25	-7%
	42.49	26	21	-19%
	43.30	25	20	-20%
	44.11	25	18	-28%
Q10	44.37	24	18	-25%
	44.92	22	18	-18%
	45.73	21	17	-19%
	46.54	21	16	-24%
	47.35	20	15	-25%
	48.16	20	14	-30%
	48.97	19	12	-37%
	49.78	19	12	-37%
	50.58	17	6	-65%
	51.39	17	0	-100%
	52.20	16	0	-100%
	53.01	15	0	-100%
	53.82	14	0	-100%
	54.63	12	0	-100%
	55.44	12	0	-100%
	56.25	10	0	-100%
	57.06	10	0	-100%
	57.87	10	0	-100%
	58.68	10	0	-100%
	59.48	10	0	-100%
	60.29	10	0	-100%
	61.10	10	0	-100%
	61.91	10	0	-100%
	62.72	10	0	-100%
	63.53	9	0	-100%
	64.34	9	0	-100%
	65.15	8	0	-100%
	65.96	7	0	-100%
Q25	66.77	7	0	-100%

	67.58	6	0	-100%
	68.38	6	0	-100%
	69.19	6	0	-100%
	70.00	5	0	-100%
	70.81	5	0	-100%
	71.62	5	0	-100%
	72.43	5	0	-100%
	73.24	5	0	-100%
	74.05	5	0	-100%
	74.86	5	0	-100%
	75.67	4	0	-100%
	76.48	4	0	-100%
	77.28	4	0	-100%
	78.09	4	0	-100%
	78.90	4	0	-100%
	79.71	4	0	-100%
	80.52	4	0	-100%
	81.33	4	0	-100%
	82.14	4	0	-100%
	82.95	4	0	-100%
	83.76	4	0	-100%
	84.57	4	0	-100%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C 1.9% 1.7%

Frequency	Flow (cfs)	Existing	Run 6A	Change (%)
0.5Q2	15.58	38984	36544	-6%
	16.48	33998	31747	-7%
	17.39	29412	27581	-6%
	18.29	25562	23815	-7%
	19.19	22048	20315	-8%
	20.09	18695	17470	-7%
	20.99	16454	15470	-6%
	21.89	14453	13597	-6%
	22.79	12848	12219	-5%
	23.69	11443	11039	-4%
	24.60	10288	9888	-4%
	25.50	9295	8960	-4%
	26.40	8321	8119	-2%
	27.30	7467	7271	-3%
	28.20	6675	6682	0%
	29.10	6023	6004	0%
	30.00	5419	5413	0%
	30.90	4830	4807	0%
Q2	31.17	4683	4640	-1%
	31.80	4325	4233	-2%
	32.71	3842	3736	-3%
	33.61	3421	3316	-3%
	34.51	3124	2998	-4%
	35.41	2872	2777	-3%
	36.31	2682	2539	-5%
	37.21	2489	2337	-6%
	38.11	2272	2152	-5%
	39.01	2085	1925	-8%
	39.92	1922	1762	-8%
	40.82	1781	1610	-10%
	41.72	1686	1490	-12%
	42.62	1571	1382	-12%
	43.52	1446	1257	-13%
	44.42	1350	1123	-17%
	45.32	1238	999	-19%
	46.22	1121	900	-20%

	47.13	970	845	-13%
	48.03	848	781	-8%
	48.93	748	702	-6%
	49.83	695	642	-8%
Q5	50.25	660	616	-7%
	50.73	620	586	-5%
	51.63	573	509	-11%
	52.53	528	453	-14%
	53.43	480	419	-13%
	54.34	452	388	-14%
	55.24	404	357	-12%
	56.14	350	325	-7%
	57.04	307	298	-3%
	57.94	284	278	-2%
	58.84	252	259	3%
	59.74	225	241	7%
	60.64	200	225	13%
	61.54	182	207	14%
	62.45	168	195	16%
	63.35	152	184	21%
	64.25	140	176	26%
Q10	65.15	115	167	45%
	66.05	101	156	54%
	66.95	90	142	58%
	67.85	82	120	46%
	68.75	67	110	64%
	69.66	59	104	76%
	70.56	50	97	94%
	71.46	43	86	100%
	72.36	39	75	92%
	73.26	36	69	92%
	74.16	32	64	100%
	75.06	29	55	90%
	75.96	28	52	86%
	76.87	25	47	88%
	77.77	24	41	71%
	78.67	24	39	63%
	79.57	22	37	68%
	80.47	22	34	55%

	81.37	21	31	48%
	82.27	20	30	50%
	83.17	19	28	47%
	84.08	19	25	32%
	84.98	17	22	29%
	85.88	17	20	18%
Q25	86.78	17	13	-24%
	87.68	16	10	-38%
	88.58	15	9	-40%
	89.48	15	6	-60%
	90.38	14	0	-100%
	91.29	13	0	-100%
	92.19	13	0	-100%
	93.09	11	0	-100%
	93.99	11	0	-100%
	94.89	11	0	-100%
	95.79	11	0	-100%
	96.69	10	0	-100%
	97.59	10	0	-100%
	98.49	10	0	-100%
	99.40	10	0	-100%
	100.30	10	0	-100%
	101.20	9	0	-100%
	102.10	8	0	-100%
	103.00	8	0	-100%
	103.90	8	0	-100%
Q50	104.80	8	0	-100%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 6A	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

MIL2A 0.9% 0.9%

Frequency	Flow (cfs)	Existing	Run 6B	Change (%)
0.5Q2	35.04	18076	19869	10%
	37.21	15207	16755	10%
	39.38	12779	14161	11%
	41.55	10761	11979	11%
	43.72	9145	10082	10%
	45.89	7700	8645	12%
	48.06	6553	7410	13%
	50.24	5525	6408	16%
	52.41	4738	5531	17%
	54.58	4098	4811	17%
	56.75	3522	4193	19%
	58.92	3131	3650	17%
	61.09	2781	3215	16%
	63.26	2506	2884	15%
	65.43	2255	2535	12%
	67.60	2014	2238	11%
	69.77	1804	1959	9%
Q2	70.08	1777	1925	8%
	71.94	1618	1722	6%
	74.11	1418	1465	3%
	76.28	1221	1277	5%
	78.45	1018	1087	7%
	80.62	884	976	10%
	82.79	783	870	11%
	84.97	697	765	10%
	87.14	631	655	4%
	89.31	570	544	-5%
	91.48	474	459	-3%
	93.65	398	405	2%
	95.82	352	354	1%
	97.99	317	310	-2%
	100.16	297	281	-5%
	102.33	269	260	-3%
	104.50	239	240	0%
	106.67	217	226	4%
	108.84	191	207	8%
	111.01	166	186	12%

Q5	112.52	152	174	15%
	113.18	146	169	16%
	115.35	132	153	16%
	117.52	115	138	20%
	119.70	105	126	20%
	121.87	96	111	16%
	124.04	87	101	16%
	126.21	81	94	16%
	128.38	71	87	23%
	130.55	63	83	32%
	132.72	58	77	33%
	134.89	54	70	30%
	137.06	50	65	30%
	139.23	47	56	19%
	141.40	46	51	11%
	143.57	44	43	-2%
	145.74	43	37	-14%
Q10	147.91	40	34	-15%
	150.08	36	33	-8%
	152.26	35	30	-14%
	154.43	33	28	-15%
	156.60	32	27	-16%
	158.77	30	24	-20%
	160.94	27	23	-15%
	163.11	27	22	-19%
	165.28	26	22	-15%
	167.45	26	19	-27%
	169.62	25	19	-24%
	171.79	22	18	-18%
	173.96	20	17	-15%
	176.13	20	17	-15%
	178.30	19	16	-16%
	180.47	19	16	-16%
	182.64	17	11	-35%
	184.81	15	9	-40%
	186.99	15	7	-53%
	189.16	15	6	-60%
	191.33	15	5	-67%
	193.50	15	5	-67%

	195.67	15	5	-67%
	197.84	15	3	-80%
	200.01	14	2	-86%
Q25	202.18	14	2	-86%
	204.35	13	2	-85%
	206.52	12	1	-92%
	208.69	11	1	-91%
	210.86	10	1	-90%
	213.03	10	1	-90%
	215.20	10	1	-90%
	217.37	9	1	-89%
	219.54	9	0	-100%
	221.72	8	0	-100%
	223.89	8	0	-100%
	226.06	8	0	-100%
	228.23	8	0	-100%
	230.40	8	0	-100%
	232.57	7	0	-100%
	234.74	7	0	-100%
	236.91	6	0	-100%
	239.08	6	0	-100%
	241.25	6	0	-100%
	243.42	6	0	-100%
	245.59	6	0	-100%
	247.76	6	0	-100%
Q50	249.93	6	0	-100%

MIL2B 0.6% 1.0%

Frequency	Flow (cfs)	Existing	Run 6B	Change (%)
0.5Q2	8.51	11979	20504	71%
	9.32	8830	15547	76%
	10.13	6173	11357	84%
	10.94	4980	9288	87%
	11.75	4044	7445	84%
	12.56	3305	5952	80%
	13.37	2687	4746	77%
	14.17	2236	3751	68%
	14.98	1893	3042	61%
	15.79	1576	2390	52%
	16.60	1247	1886	51%
Q2	17.02	1141	1682	47%
	17.41	1042	1493	43%
	18.22	843	1153	37%
	19.03	654	877	34%
	19.84	524	644	23%
	20.65	428	492	15%
	21.46	369	425	15%
	22.27	320	381	19%
	23.07	281	343	22%
	23.88	248	304	23%
	24.69	218	270	24%
	25.50	192	226	18%
	26.31	174	195	12%
	27.12	163	171	5%
	27.93	140	155	11%
	28.74	130	142	9%
	29.55	116	126	9%
	30.36	100	117	17%
Q5	31.11	93	108	15%
	31.17	93	107	15%
	31.97	77	96	25%
	32.78	71	82	15%
	33.59	66	75	14%
	34.40	64	61	-5%
	35.21	56	52	-7%
	36.02	51	49	-4%

	36.83	45	43	-4%
	37.64	41	36	-12%
	38.45	37	34	-8%
	39.26	36	34	-6%
	40.07	35	32	-9%
	40.88	30	29	-3%
	41.68	27	29	7%
	42.49	26	25	-4%
	43.30	25	22	-12%
	44.11	25	19	-24%
Q10	44.37	24	19	-22%
	44.92	22	18	-18%
	45.73	21	18	-14%
	46.54	21	17	-19%
	47.35	20	16	-20%
	48.16	20	16	-20%
	48.97	19	15	-21%
	49.78	19	15	-21%
	50.58	17	14	-18%
	51.39	17	14	-18%
	52.20	16	12	-25%
	53.01	15	7	-53%
	53.82	14	6	-57%
	54.63	12	5	-58%
	55.44	12	5	-58%
	56.25	10	4	-60%
	57.06	10	4	-60%
	57.87	10	4	-60%
	58.68	10	2	-80%
	59.48	10	2	-80%
	60.29	10	1	-90%
	61.10	10	0	-100%
	61.91	10	0	-100%
	62.72	10	0	-100%
	63.53	9	0	-100%
	64.34	9	0	-100%
	65.15	8	0	-100%
	65.96	7	0	-100%
Q25	66.77	7	0	-100%

	67.58	6	0	-100%
	68.38	6	0	-100%
	69.19	6	0	-100%
	70.00	5	0	-100%
	70.81	5	0	-100%
	71.62	5	0	-100%
	72.43	5	0	-100%
	73.24	5	0	-100%
	74.05	5	0	-100%
	74.86	5	0	-100%
	75.67	4	0	-100%
	76.48	4	0	-100%
	77.28	4	0	-100%
	78.09	4	0	-100%
	78.90	4	0	-100%
	79.71	4	0	-100%
	80.52	4	0	-100%
	81.33	4	0	-100%
	82.14	4	0	-100%
	82.95	4	0	-100%
	83.76	4	0	-100%
	84.57	4	0	-100%
	85.38	4	0	-100%
	86.18	4	0	-100%
	86.99	4	0	-100%
	87.80	4	0	-100%
Q50	88.61	4	0	-100%

MIL2C		1.9%	1.8%	
Frequency	Flow (cfs)	Existing	Run 6B	Change (%)
0.5Q2	15.58	38984	37385	-4%
	16.48	33998	32357	-5%
	17.39	29412	27981	-5%
	18.29	25562	24068	-6%
	19.19	22048	20735	-6%
	20.09	18695	17956	-4%
	20.99	16454	15783	-4%
	21.89	14453	14033	-3%
	22.79	12848	12530	-2%
	23.69	11443	11207	-2%
	24.60	10288	10025	-3%
	25.50	9295	8918	-4%
	26.40	8321	7982	-4%
	27.30	7467	7145	-4%
	28.20	6675	6513	-2%
	29.10	6023	5882	-2%
	30.00	5419	5323	-2%
	30.90	4830	4765	-1%
Q2	31.17	4683	4643	-1%
	31.80	4325	4347	1%
	32.71	3842	3934	2%
	33.61	3421	3534	3%
	34.51	3124	3202	2%
	35.41	2872	2954	3%
	36.31	2682	2718	1%
	37.21	2489	2523	1%
	38.11	2272	2327	2%
	39.01	2085	2125	2%
	39.92	1922	1966	2%
	40.82	1781	1815	2%
	41.72	1686	1666	-1%
	42.62	1571	1511	-4%
	43.52	1446	1363	-6%
	44.42	1350	1261	-7%
	45.32	1238	1147	-7%
	46.22	1121	1045	-7%
	47.13	970	1002	3%

	48.03	848	950	12%
	48.93	748	870	16%
	49.83	695	813	17%
Q5	50.25	660	783	19%
	50.73	620	749	21%
	51.63	573	670	17%
	52.53	528	595	13%
	53.43	480	552	15%
	54.34	452	490	8%
	55.24	404	451	12%
	56.14	350	420	20%
	57.04	307	395	29%
	57.94	284	349	23%
	58.84	252	318	26%
	59.74	225	288	28%
	60.64	200	272	36%
	61.54	182	257	41%
	62.45	168	243	45%
	63.35	152	223	47%
	64.25	140	202	44%
Q10	65.15	115	188	63%
	66.05	101	174	72%
	66.95	90	164	82%
	67.85	82	154	88%
	68.75	67	142	112%
	69.66	59	132	124%
	70.56	50	118	136%
	71.46	43	109	153%
	72.36	39	101	159%
	73.26	36	91	153%
	74.16	32	83	159%
	75.06	29	77	166%
	75.96	28	68	143%
	76.87	25	59	136%
	77.77	24	53	121%
	78.67	24	44	83%
	79.57	22	35	59%
	80.47	22	27	23%
	81.37	21	21	0%

	82.27	20	18	-10%
	83.17	19	17	-11%
	84.08	19	17	-11%
	84.98	17	15	-12%
	85.88	17	15	-12%
Q25	86.78	17	14	-18%
	87.68	16	12	-25%
	88.58	15	12	-20%
	89.48	15	11	-27%
	90.38	14	0	-100%
	91.29	13	0	-100%
	92.19	13	0	-100%
	93.09	11	0	-100%
	93.99	11	0	-100%
	94.89	11	0	-100%
	95.79	11	0	-100%
	96.69	10	0	-100%
	97.59	10	0	-100%
	98.49	10	0	-100%
	99.40	10	0	-100%
	100.30	10	0	-100%
	101.20	9	0	-100%
	102.10	8	0	-100%
	103.00	8	0	-100%
	103.90	8	0	-100%
Q50	104.80	8	0	-100%

MIL2D 2.1% 2.4%

Frequency	Flow (cfs)	Existing	Run 6B	Change (%)
0.5Q2	9.19	44707	50303	13%
	9.57	41509	46831	13%
	9.95	38879	44139	14%
	10.33	34819	39973	15%
	10.71	31116	36207	16%
	11.10	28107	33072	18%
	11.48	25499	30253	19%
	11.86	23290	27708	19%
	12.24	21312	25393	19%
	12.62	19208	23058	20%
	13.00	17496	21022	20%
	13.38	15937	19090	20%
	13.76	14622	17451	19%
	14.14	13511	16073	19%
	14.53	12455	14929	20%
	14.91	11628	13894	19%
	15.29	10824	12894	19%
	15.67	10168	12021	18%
	16.05	9480	11178	18%
	16.43	8880	10469	18%
	16.81	8266	9833	19%
	17.19	7704	9257	20%
	17.57	7168	8664	21%
	17.96	6701	8060	20%
	18.34	6280	7557	20%
Q2	18.38	6235	7505	20%
	18.72	5887	7111	21%
	19.10	5518	6758	22%
	19.48	5224	6387	22%
	19.86	4965	6049	22%
	20.24	4567	5630	23%
	20.62	4151	5247	26%
	21.00	3812	4837	27%
	21.39	3553	4479	26%
	21.77	3305	4077	23%
	22.15	3095	3818	23%
	22.53	2926	3606	23%

	22.91	2790	3354	20%
	23.29	2655	3147	19%
	23.67	2523	2983	18%
	24.05	2379	2832	19%
	24.43	2241	2695	20%
	24.82	2114	2544	20%
	25.20	1997	2407	21%
	25.58	1899	2272	20%
	25.96	1822	2140	17%
	26.34	1738	2022	16%
	26.72	1650	1895	15%
	27.10	1580	1830	16%
Q5	27.20	1564	1809	16%
	27.48	1518	1749	15%
	27.86	1428	1650	16%
	28.25	1377	1593	16%
	28.63	1321	1537	16%
	29.01	1255	1461	16%
	29.39	1178	1403	19%
	29.77	1091	1331	22%
	30.15	973	1250	28%
	30.53	866	1160	34%
	30.91	790	1073	36%
	31.29	719	987	37%
	31.68	675	892	32%
	32.06	643	818	27%
	32.44	607	773	27%
	32.82	587	719	22%
	33.20	569	685	20%
Q10	33.24	567	681	20%
	33.58	548	648	18%
	33.96	526	610	16%
	34.34	508	581	14%
	34.72	479	554	16%
	35.11	453	510	13%
	35.49	408	481	18%
	35.87	370	437	18%
	36.25	344	421	22%
	36.63	330	402	22%

	37.01	307	378	23%
	37.39	287	363	26%
	37.77	269	344	28%
	38.15	246	332	35%
	38.53	224	317	42%
	38.92	199	302	52%
	39.30	165	287	74%
	39.68	135	272	101%
	40.06	124	256	106%
	40.44	109	234	115%
	40.82	94	213	127%
Q25	41.03	91	205	124%
	41.20	89	198	122%
	41.58	85	184	116%
	41.96	78	168	115%
	42.35	73	143	96%
	42.73	65	131	102%
	43.11	61	122	100%
	43.49	58	116	100%
	43.87	55	106	93%
	44.25	53	95	79%
	44.63	49	83	69%
	45.01	45	68	51%
	45.39	39	52	33%
	45.78	34	50	47%
	46.16	28	47	68%
	46.54	25	43	72%
Q50	46.92	22	39	77%

Exhibit D

Appendix J

Whipple Creek Watershed-Scale Stormwater Plan Report

Whipple Creek Watershed Existing and Future Land Cover Data

Prepared by

Clark County Department of Public Works

Clean Water Division

January 2017

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Introduction

Clark County is conducting a watershed level study of Whipple Creek watershed as mandated under NPDES permit requirements. The project includes development of HSPF model to represent the hydrologic and stream flow conditions of the watershed under both existing and future land use conditions. An existing HSPF model developed by Otak (2006) was used as a starting point and was updated to represent the current and future land cover conditions. The entire watershed is divided into 27 sub-basins based on the topography and or hydrologic control points. The sub-basin boundaries are shown in Figure 1. The existing land cover is based on the current development conditions throughout the watershed while the future land covers are based on the future buildout conditions as defined in the County's comprehensive growth management plan. The general procedures used to calculate the land cover types under both conditions are presented in the subsequent paragraphs.

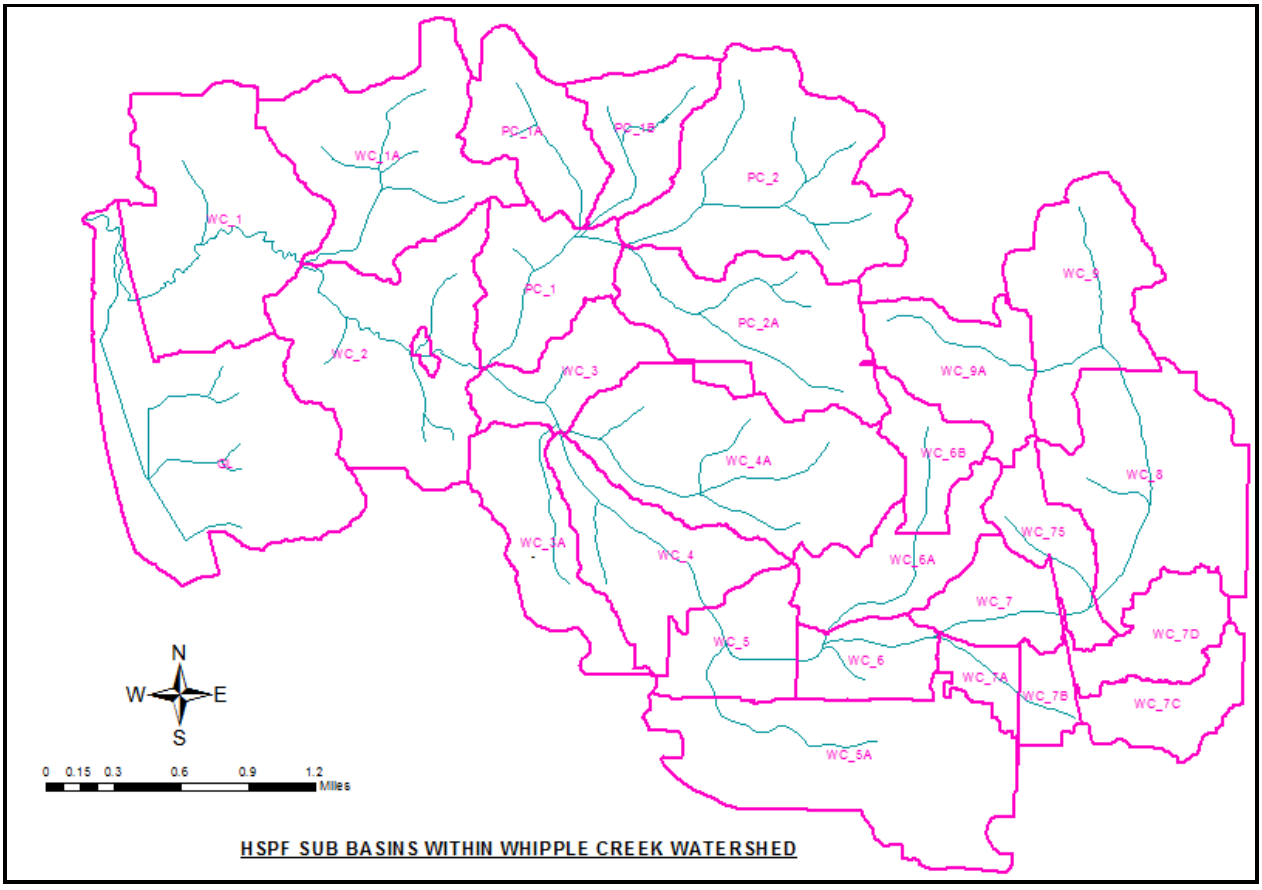


Figure-1. Whipple Creek Watershed HSPF Sub-basins.

Existing Land Cover

The original HSPF model developed in 2006 had used land covers as reflected in the County's aerial imagery 2002. While some areas have seen significant development since 2002, the land use conditions from that year provided a good "base" condition from which future development impacts were measured. The most recent available aerial imagery (2014) in County's GIS section was used to update land cover for the calibrated existing condition. ArcGIS tool was used to measure and update the land cover types within the identified areas of change.

The entire impervious area within each sub-basin was further broken down into four different categories as listed below.

- Residential Roof
- Residential Pavement
- Non-Residential Roof
- Non-Residential Pavement

The main objective of this break down is to effectively estimate the impact of certain BMPs such as street sweeping and downspout disconnection that only apply to certain types of impervious surface.

A 'roof to pavement' ratio was established for various land use types and was applied throughout the watershed in order to break down the total impervious area into roof and pavement. Three representative areas were used to represent one each of high density residential, low density residential, and non-residential land use types. The land cover type GIS layer created by Clark County in 2002 using LiDAR, Orthophoto, and Infra-Red data differentiated roofs and pavement for the calculation. Table 1 below shows the ratios calculated for representative areas.

Table 1: Roof/Pavement Ratio for Various Land Use Types

Land Use Type	Impervious Area Type		Roof to Pavement Ratio
	Roof (acres)	Pavement (acres)	
High density residential (Figure-2)	60.40	462.84	0.13
Low density residential (Figure-3)	15.23	32.99	0.46
Non-residential (Figure-4)	17.90	314.45	0.06

A fully developed residential area located to the east of interstate I-5 was picked to represent a high density residential site. An area located along NW 149th corridor on the west side and just outside of urban growth boundary was chosen to represent a low density residential site. An area along NE 139th street on the west side of interstate I-5 was selected to represent a non-residential site. The representative areas for each land use type are shown in Figures 2 through 4.

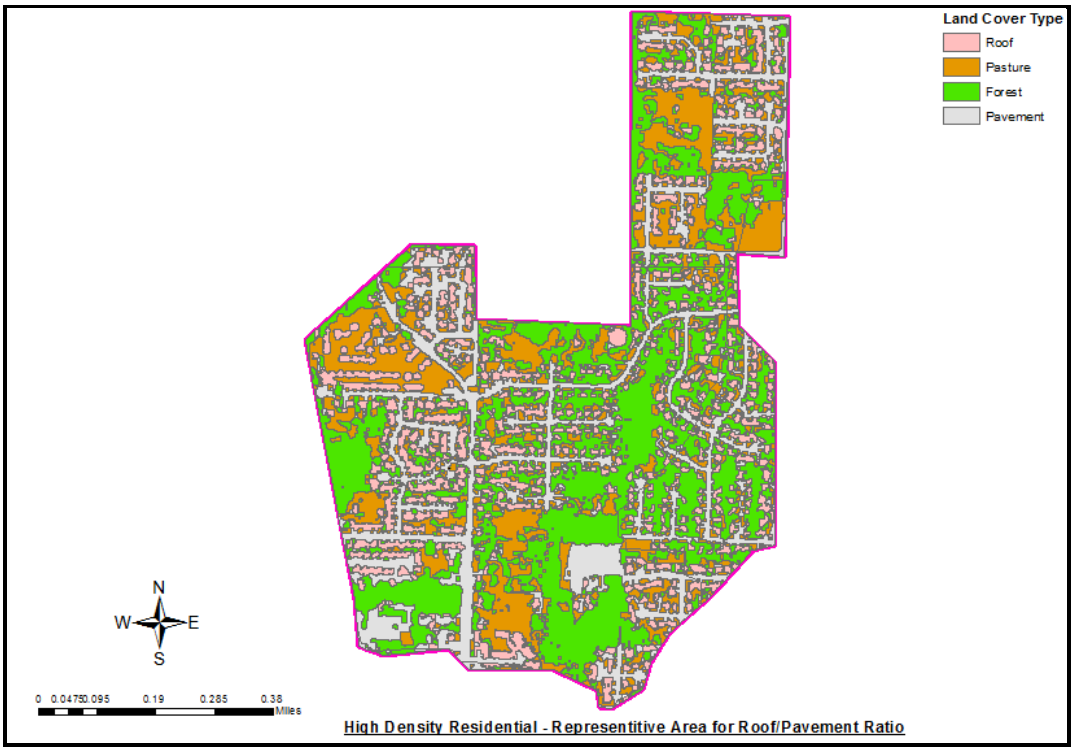


Figure-2. High Density Residential Land Use- Representative Area

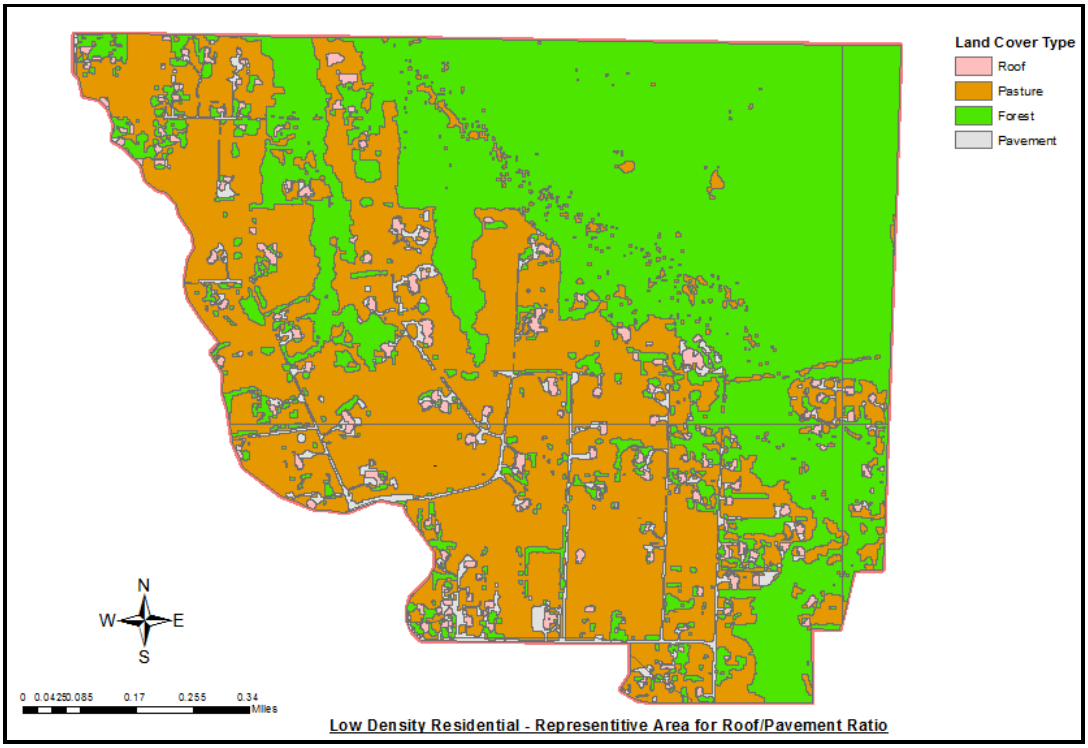


Figure-3. Low Density Residential Land Use- Representative Area

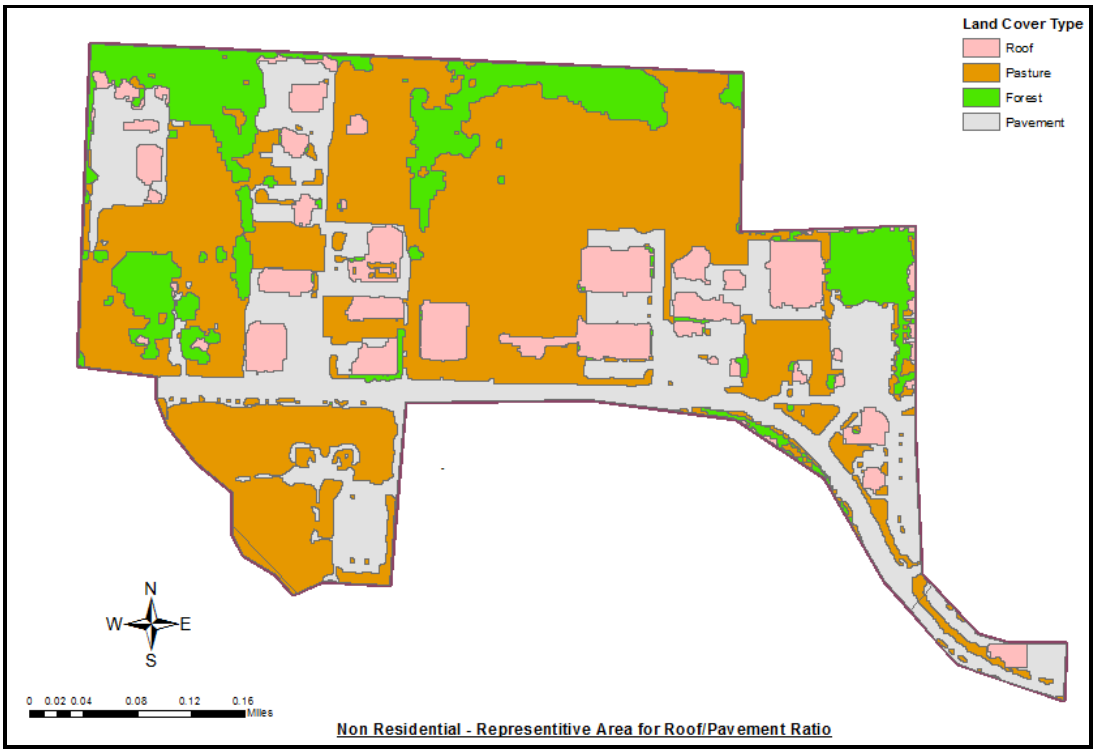


Figure-4. Non Residential Land Use- Representative Area

Future Land Cover

The future conditions land use assumptions were based on the County's comprehensive growth management plan for the area outside of urban growth boundary. The future land use assumptions were based on Predictive Land Use Model for Sewers (PLUMS) developed by Clark Regional Wastewater District (CRWWD) for the area inside the urban growth boundary. A list of HSPF sub-basins with a breakdown based on their location inside or outside of UGA boundaries is presented in Table 2.

Table 2: HSPF Sub-basins

Within UGA Boundary	Outside of UGA Boundary
WC_9	GL
WC_9A	WC_1
WC_8	WC_1A
WC_75	WC_2
WC_7D	WC_3
WC_7C	WC_3A
WC_7B	WC_4
WC_7A	PC_1
WC_7	PC_1A
WC_6B	PC_1B
WC_6A	PC_2
WC_6	PC_2A
WC_5A	
WC_5	
WC_4A	

GIS information for zoning from Clark County's comprehensive plan (2016) was applied for the sub-basins located outside of UGA, intending to represent full buildout of the basins. In general, it is assumed that the parcels will be developed to the maximum extent allowed by the proposed zoning. Exception was the 100-foot priority habitat buffer located on both sides of Whipple Creek, Packard Creek, and major tributaries. These areas will be modeled as forest, consistent with the County's Critical Areas Ordinance. All the areas encompassed between the buffers on either side of the stream will be modeled as forest. As the future land cover calculation was solely based on the book values from the comprehensive plan, the resulting impervious areas for some of the sub-basins were less than in the existing condition. In such instances, the impervious area from the existing condition was matched for the future condition. That means it was assumed that the already developed area will continue to hold in the future condition.

For the sub-basins located inside the UGA, PLUMS model was used to identify the future land use types. PLUMS model was created by CRWWD as a planning tool to represent how areas inside the urban growth boundary are expected to develop and it more accurately represents the lot by lot potential to develop in the area. Roof to Pavement ratio from Table 1 above was used to break down the total

impervious areas within each sub-basin into roofs and pavements. Break down of land cover types for various land use/zoning categories for future conditions are shown in Table 3.

Table 3: Future Land Use and HSPF Land Cover Percentages					
Description	EIA %	Forest %	Pasture %	Lawn %	Wetlands
Urban Low Density Res	23			77	
Urban Medium Density Res	23			77	
Community Commercial	85			15	
General Commercial	85			15	
Light Industrial	85			15	
Mixed Use	48			52	
Public Facility	23			77	
Parks/Open Space	0	25	25	50	
Urban Reserve	23			77	
Rural 5	6		75	19	
Agriculture			100		
Agri-Wildlife		50	50		
Water					100
Employment Center	85			15	
Rural 10	4		77	19	
Rural 20	4		77	19	
Forest		100			

The resulting land cover types within each sub-basin for both existing and future land use conditions are shown in Appendix A. Sub-basins located within the Urban Growth Boundary generally show an increase in impervious area along with a decrease in forested or pasture areas. In more rural areas, the existing land use is largely unchanged in the future land use scenario. Table 4 shows the change in impervious area for several key sub-basins.

Table 4: Land Use Change in Key Sub-basins					
Sub-basin	Location	Total Sub-basin Area (acres)	Exiting Impervious Percentage	Future Impervious Percentage	Change
WC_8	Major sub-basin east of I-5	459.83	15%	26%	11%
WC_5A	Southern sub-basin south of 149th	561.43	27%	28%	1%
WC_4A	Central Sub-basin near Whipple Creek Park	522.31	3%	9%	6%
PC_2	Northern sub-basin of Packard Creek	518.05	4%	5%	1%
WC_2	Main stem sub-basin downstream of 41st	496.78	5%	5%	0%

Appendix A

(Table Summary of Existing and Future Land Cover Data)

Whipple Creek Watershed Existing Land Cover in acres

Sub-basins	Impervious Land (IMPLND 100)				Pervious Land (PERLND)									Water (500)
	Residential		Non-residential		SG3			SG4			SG5			
	Roof	Pavement	Roof	Pavement	Forest (200)	Pasture (210)	Lawn (220)	Forest (260)	Pasture (270)	Lawn (280)	Forest (300)	Pasture (310)	Lawn (320)	
GL	6.78	14.73	-	-	140.74	271.28	32.27	-	-	-	-	-	-	184.85
WC_1	9.02	19.60	-	-	146.62	234.87	95.33	-	-	-	-	-	-	1.78
WC_1A	6.84	14.87	-	-	-	-	-	145.38	190.22	82.40	-	-	-	-
WC_2	7.40	16.10	-	-	127.58	253.21	92.49	-	-	-	-	-	-	-
WC_3	1.61	3.50	-	-	63.38	82.42	17.81	-	-	-	-	-	-	0.44
WC_3A	3.45	7.51	-	-	43.70	140.85	35.14	-	-	-	-	-	-	-
WC_4	2.79	6.05	-	-	167.20	77.35	29.33	-	-	-	-	-	-	-
WC_4A	1.85	14.19	-	-	221.70	-	-	37.19	168.15	79.22	-	-	-	-
WC_5	6.23	13.54	-	-	77.47	35.97	44.48	-	-	-	-	-	-	-
WC_5A	8.30	63.90	2.37	41.70	83.06	60.81	293.01	-	-	-	-	-	5.76	2.53
WC_6	4.27	32.81	-	-	49.31	6.91	42.24	-	-	-	-	-	-	-
WC_6A	1.51	11.58	1.56	18.10	35.80	80.82	52.69	-	-	-	-	-	-	0.50
WC_6B	0.13	1.02	2.02	35.35	-	-	-	19.15	21.28	40.51	-	-	-	-
WC_7	0.35	2.69	1.38	5.71	52.61	50.90	25.97	-	-	-	-	-	-	0.22
WC_7A	0.90	6.94	-	-	24.42	14.93	16.91	-	-	-	-	-	-	-
WC_7B	0.20	1.52	0.84	14.67	12.17	18.93	18.53	-	-	-	-	-	-	-
WC_7C	3.44	26.49	-	-	-	-	-	28.13	9.19	74.21	-	-	-	-
WC_7D	4.13	31.73	-	-	-	-	-	23.44	3.09	90.50	-	-	-	1.30
WC_75	2.97	22.87	0.35	6.07	-	-	-	14.31	35.22	57.27	-	-	-	-
WC_8	7.74	59.56	-	-	-	-	-	179.85	68.29	144.39	-	-	-	-
WC_9	2.27	17.43	0.84	14.66	-	-	-	99.05	107.10	77.69	-	-	-	-
WC_9A	1.27	9.90	2.4	42.30	-	-	-	44.34	47.41	76.89	-	-	-	-
PC_1	2.81	6.12	-	-	-	-	-	109.20	84.36	17.27	-	-	-	-
PC_1A	2.16	4.71	-	-	-	-	-	74.26	92.84	35.88	-	-	-	-
PC_1B	2.20	4.78	-	-	-	-	-	63.73	79.12	27.53	-	-	-	-
PC_2	6.70	14.58	-	-	-	-	-	196.59	212.73	87.46	-	-	-	-
PC_2A	4.72	10.26	-	-	-	-	-	116.76	191.94	68.60	-	-	-	-

Whipple Creek Watershed Future (Build-out) Land Cover in acres

Sub-basins	Impervious Land (IMPLND 100)				Pervious Land (PERLND)									Water (500)
	Residential		Non-residential		SG3			SG4			SG5			
	Roof	Pavement	Roof	Pavement	Forest (200)	Pasture (210)	Lawn (220)	Forest (260)	Pasture (270)	Lawn (280)	Forest (300)	Pasture (310)	Lawn (320)	
GL	6.78	14.73	-	-	35.60	359.11	49.58	-	-	-	-	-	-	184.85
WC_1	9.02	19.60	-	-	135.20	248.07	95.33	-	-	-	-	-	-	-
WC_1A	6.84	14.87	-	-	-	-	-	137.30	198.30	82.40	-	-	-	-
WC_2	7.40	16.10	-	-	109.10	271.69	92.49	-	-	-	-	-	-	-
WC_3	1.61	3.50	-	-	63.38	82.86	17.81	-	-	-	-	-	-	-
WC_3A	3.45	7.51	-	-	41.40	143.15	35.14	-	-	-	-	-	-	-
WC_4	2.86	6.23	-	-	167.20	77.10	29.33	-	-	-	-	-	-	-
WC_4A	3.39	23.01	1.07	18.80	221.70	-	-	10.28	87.47	156.58	-	-	-	-
WC_5	6.23	13.54	-	-	60.90	32.09	64.93	-	-	-	-	-	-	-
WC_5A	12.46	95.84	2.68	47.05	66.20	8.06	323.39	-	-	-	-	-	5.76	-
WC_6	4.27	32.81	-	-	36.00	6.73	55.73	-	-	-	-	-	-	-
WC_6A	2.55	19.60	3.46	60.66	31.86	1.77	82.66	-	-	-	-	-	-	-
WC_6B	0.13	1.02	2.02	35.35	-	-	-	19.15	1.59	60.20	-	-	-	-
WC_7	0.55	4.26	3.52	62.32	41.20	-	27.98	-	-	-	-	-	-	-
WC_7A	1.45	11.13	0.43	7.58	14.83	-	28.68	-	-	-	-	-	-	-
WC_7B	0.48	3.66	1.93	34.09	6.50	-	20.20	-	-	-	-	-	-	-
WC_7C	3.82	29.36	-	-	-	-	-	8.07	1.67	98.54	-	-	-	-
WC_7D	4.13	31.73	-	-	-	-	-	15.13	3.30	99.90	-	-	-	-
WC_75	2.97	22.87	1.06	37.74	-	-	-	14.31	1.70	58.41	-	-	-	-
WC_8	13.22	101.68	0.19	3.37	-	-	-	138.85	15.17	187.35	-	-	-	-
WC_9	3.22	24.73	25.18	142.72	-	-	-	28.63	-	94.56	-	-	-	-
WC_9A	2.20	16.93	5.82	102.14	-	-	-	15.32	-	82.10	-	-	-	-
PC_1	2.81	6.12	-	-	-	-	-	109.20	84.33	17.30	-	-	-	-
PC_1A	2.92	6.34	-	-	-	-	-	55.50	109.21	35.88	-	-	-	-
PC_1B	2.79	6.08	-	-	-	-	-	29.50	110.90	28.09	-	-	-	-
PC_2	7.63	16.58	-	-	-	-	-	114.50	291.89	87.46	-	-	-	-
PC_2A	5.26	25.14	0.19	3.36	-	-	-	96.70	147.64	113.99	-	-	-	-

Exhibit E

Lower Columbia Urban Streams (LCUS) Monitoring Annual Status Report (2022-2023)

Receiving Waters

Prepared for Ecology on behalf of the Stormwater Workgroup by Clark County Public Works, Clean Water Division

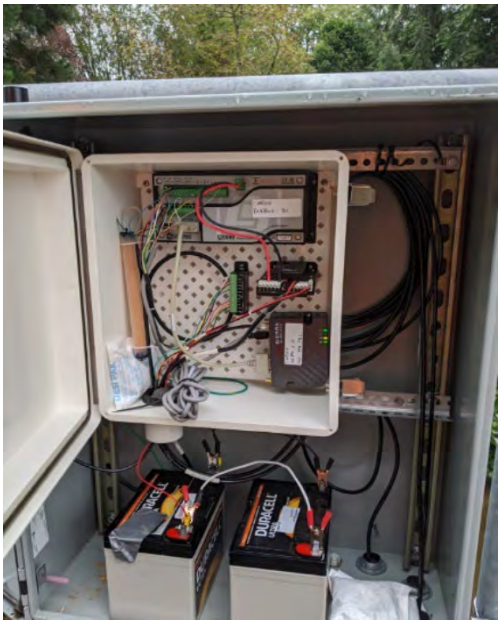
SAM Stormwater Action Monitoring

SAM funds Clark County to conduct annual stream health monitoring and track changes over time in the Lower Columbia region. This status and trends monitoring will help evaluate regional progress towards reducing stormwater impacts on environmental health.

Stream health conditions in this LCUS study are measured by multiple indicators and LCUS findings are summarized below:

- **Land Cover: All but one subwatershed exceeded TIA values for supporting conditions that are healthy for macroinvertebrates and salmonids (TIA > 15%).**
- **Flow Metrics (based on stage): TQmean values for all WY2023 sites fell into "Supporting Salmonid Use".**
- **Total Impervious Area (TIA) and Daily Traffic Intensity (ADT): Subwatershed Benthic Index of Biotic Integrity (BIBI) scores generally declines with increasing TIA and ADT traffic values > 20,000 daily trip miles per square mile.**
- **BIBI: Taxa analysis showed moderate changes in composition due to replacement of some sensitive taxa by more tolerant taxa. LCUS sites**

  with a "Fair" BIBI score showed more taxa diversity than sites with a "Poor to Very Poor" BIBI score.
- **Stream Temperature: No sites met state stream temperature criteria beneficial for salmonid use. Five of the eight LCUS sites exceeded their Washinton State aquatic life temperature criteria over 75% of the monitoring timeframe.**
- **Sediment: Metals (arsenic, cadmium, chromium, copper, lead and zinc) met freshwater sediment cleanup objectives.**
- **Habitat: Substrate embeddedness for all sites fell into the "Marginal to Poor" stream condition category. Three sites had "Poor or Very Poor" BIBI scores with human disturbance index percentages > than 40. Most sites with greater than 80% riparian cover had "Fair" BIBI scores**





Campen Creek (CMP010) trend site.

Why stream monitoring for stormwater management?

Stormwater management actions, implemented in Lower Columbia region under municipal stormwater permits, are intended to help reduce stormwater impacts to receiving waters. SAM's Lower Columbia Urban Streams (LCUS) monitoring provides a regional status assessment of selected streams in the permit coverage areas. Continued monitoring will eventually allow assessment of stream health trends. These assessments assist in evaluating whether collective stormwater and environmental management efforts are meeting state and regional goals to protect water quality and biota in streams. Current status of stream health in Clark County can be found in the 2023 Stream Health Report.

Stormwater runoff from urban and urbanizing areas is a major contributor to habitat and water quality degradation in small streams. Local jurisdictions throughout the Lower Columbia River region are increasing their stormwater management efforts to reduce flow volumes and pollutants. Water year 2023 is the third year of a long-term regional evaluation of stream health that focuses on areas covered by municipal stormwater permits in the southwest Washington region, which include Clark and Cowlitz Counties; the Cities of Camas, Longview, Vancouver, Battle Ground, Kelso, and Washougal, and the Washington State Department of Transportation (WSDOT). This ongoing study is funded by the regional permittees. Clark County is performing the study under an Interagency Agreement (IAA) with Ecology. This study will provide a better understanding of influential stressors contributing to impaired waters and overall stream health. Identifying stressors that impact hydrology and biological health may suggest solutions to decrease the impacts of stormwater runoff on streams. Over time, LCUS results may detect changes in stream quality that indicate the effectiveness of stormwater management strategies. LCUS monitoring sites and associated drainage areas can be found in Appendix A.

Monitoring receiving water health indicators in urban/urbanizing areas

The LCUS study follows protocols developed for the on-going statewide stream health monitoring program Status and Trends Monitoring for Watershed Health and Salmon Recovery (WHSR) for physical habitat and biological measurements (https://apps.ecology.wa.gov/publications/documents/0603203.pdf).To better capture the stormwater related hydrologic, water and sediment chemistry changes, this study also monitors water level and temperature continuously for one full water year at each targeted sampling site (Appendix B).

LCUS streams health status in 2022-2023

Impervious surfaces and land use

Total Impervious Area, or TIA, is a measure of the amount of hard surface and serves as an indicator of the potential impacts of urbanization and development on stream health. Impervious cover results in multiple stressors to a subwatershed, such as increased pollutant loads from stormwater runoff, altered stream flow, decreased bank stability, and increased water temperatures. The significance of this metric in reducing salmon recovery potential is based on the multiple impacts to the subwatershed as well as the nearly irreversible nature of imperviousness due to urbanization.

In terms of the subwatershed condition for TIA, most water year 2023 LCUS sites have a medium or high degree of impervious surface (Figure 1). TIA for each LCUS subwatershed ranged from 14 to 97 percent when all developed land cover categories were added together within each monitoring site's drainage area. This means that the subwatersheds of the LCUS study may have too much impervious area for supporting watershed conditions that are healthy for macroinvertebrates and salmon. Watersheds with greater than 15% TIA may be at risk for more adverse conditions effecting healthy biota in streams (EPA, 2018).

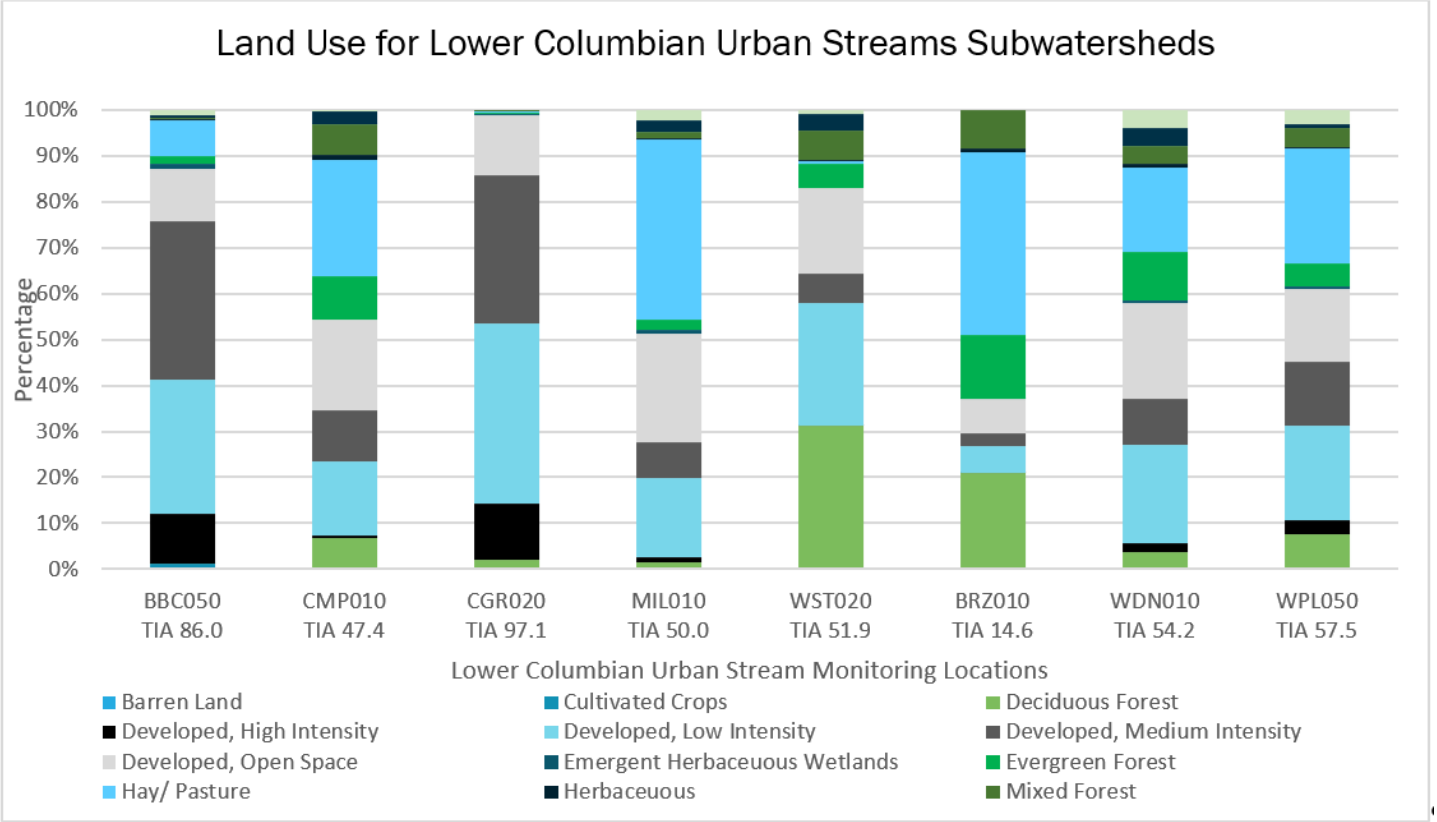


Figure 1. Land use for LCUS subwatersheds monitored for water year 2023, including Total Impervious Area (TIA %). Land cover data are derived from the 2016 National Land Cover Database (NLCD).

Hydrologic metrics

Flashiness, or frequency of high flows, of a stream is an important characteristic of the stream hydrologic regime that indicates likely presence of erosive flows and reflects how quickly and often flow in a waterbody increases and decreases during rainfall events. Urbanization is the primary cause of increased flashiness and hydrologic alterations. Increased stream flashiness in urban areas is typically a result of increased hardscape, soil compaction, and the increased hydraulic efficiency of traditional stormwater and flood management practices that are designed to quickly drain urban areas. Natural conditions may also contribute to stream flashiness. For example, regions with little attenuation of runoff, such as an area with clay soils or rock layers, typically have higher flashiness compared to areas with more permeable soils. (Schoonover et al., 2006). This LCUS study uses alternative interpretations of TQMean, Richard-Baker Index (RBI) and Flow Reversals based on continuous stage for analyses of flashiness of streams as defined in Figure 2. Booth and Konrad 2017, found that hydrologic metrics based on stage provide useful metrics of status and trends monitoring of urbanizing subwatersheds.

TQMean: The TQmean is the percent of days that stream stage is greater than the mean annual stage. Flashier streams have lower TQmean values.

RBI: Is a dimensionless index of stage oscillations relative to total stage, based on daily average stage measured per water year.

Flow reversals: The number of times that the stage differences rate changed from an increase to a decrease or vice versa during the year. Stage changes of less than 2% are not considered.

Figure 2. LCUS hydrology metric definitions derived from Booth and Konrad, 2017.

TQmean tends to decrease with increased urbanization and a value of less than about 0.27 is associated with non-supporting streams for salmon, while a TQmean of greater than 0.37 is associated with fully supporting streams (Clark County, 2022). All LCUS sites had a TQmean of 0.37 or greater. RBI and flow reversal values tend to increase with urbanization. RBI values greater than 0.25 and flow reversal values greater than 65 are typically associated with subwatershed that have a TIA greater than 20% (Booth and Konrad, 2017). Cougar Creek (TIA greater than 97%) and Whipple Creek (TIA of 57%) were the only sites to have an RBI value greater than 0.25.

It appears that despite having all LCUS sites having too much TIA to support healthy biota in streams, much of the site hydrology may not be in the poor health category. Further analysis will be conducted in future monitoring years to identify regulating factors supporting site hydrology.

Location Type	Location Name	Location ID	Flow Metric Results (using stage as a surrogate for flow)		
			TQ mean	RBI	Reversals
Trend	Burnt Bridge Creek	BBC050	0.41	0.13	39
Trend	Cougar Creek	CGR020	0.37	0.30	38
Trend	Campen Creek	CMP010	NA	NA	NA
Trend	Mill Creek	MIL010	0.46	0.16	29
Trend	Westover Creek	WST020	0.44	0.12	49
Status	Brezee Creek	BRZ010	NA	NA	NA
Status	Whipple Creek	WPL050	0.38	0.33	46
Status	Woodin Creek	WDN010	0.48	0.16	41

Table 1. Hydrology metrics of flashiness calculated by analyzing 15-minute continuous stage data.

BIBI

Benthic macroinvertebrate communities provide a strong indicator of stream habitat quality and can be significantly influenced by changes to habitat associated with urban stream hydrology, water quality, embeddedness and stream temperature.

BIBI scores can also be a strong indicator of water quality problems that harm salmonids. Two common problems are high water temperature due to the lack of shade and toxic effects of urban stormwater runoff. Low BIBI scores can indicate factors other than hydrology that prevent a stream from supporting salmon and other sensitive aquatic life.

Clark County has used the BIBI score as a tool to quantify stream health for many years. Clark County stores all BIBI data in the Puget Sound Database (https://pugetsoundstreambenthos.org/) and has the original taxonomic counts converted to the 100-point system (Table 2). Streams having "Poor" BIBI scores (40 or less) are considered non-supporting for salmon habitat (Ecology, 1999). Three LCUS sites had a BIBI score of less than 40 (Table 3).

Table 2. BIBI Biological Condition Categories

Biological Condition	0 to 100 BIBI
Excellent	80 to 100
Good	60 to 80
Fair	40 to 60
Poor	20 to 40
Very Poor	0 to 20

Table 3. LCUS BIBI Scores.

	BBC050	CMP010	CGR020	MIL010	WST020	BRZ010	WPL050	WDN010
BIBI Score	28	53	9	57	35	56	40	43
BIBI Category	Poor	Fair	Very Poor	Fair	Poor	Fair	Fair	Fair

Taxa composition at all 2023 LCUS sites ranged from four to six on the EPA's Biological Condition Gradient (BCG). The BCG framework represents ecological conditions in terms of measurable ecological characteristics, or attributes, of an aquatic community in response to anthropogenic stressors (EPA, 2021).

A BCG range from four to six indicates that chemistry, habitat, and / or flow regime was altered from natural conditions. At the four to six BCG level, there are moderate to extreme changes in structure due to replacement of some sensitive ubiquitous taxa by more tolerant taxa (EPA, 2021). Compared to healthier streams, water year 2023 BIBI samples showed many more tolerant taxa, many taxa that are both lotic and lentic, and loss of sensitive taxa.

Traffic Intensity and BIBI

Traffic intensity, as measured by vehicle trips per square mile (ADT), typically increases with urbanization and provides a robust urbanization metric. Traffic intensity is associated with both the level of urbanization and the presence of high traffic freeways and highways in rural areas. Low density urban residential areas tend to have much lower traffic and associated pollution than commercial, industrial and multifamily areas along arterial roadways.

Considering that much of the stormwater pollution in the MS4 comes from roads, traffic intensity is strongly associated with stormwater influence on streams in both urban and rural areas.

There is detailed estimated traffic count data for every road in Clark County, including cities, based on computer modeling by a regional transportation planning agency. The transportation model provides a detailed and uniform surrogate for potential stormwater impacts across Clark County. Figure 3 shows a general decreasing BIBI scores with increasing traffic intensity. It appears that BIBI scores in basins with an ADT value of 20,000 or greater typically fall into the "Poor" category. Considering that BIBI scores depend on a number of factors, including substrate and water quality, BIBI scores can be low in areas of low urbanization (e.g. land under intensive agricultural use). However, BIBI scores are rarely better than poor in areas of intense urbanization.

All LCUS sites with an ADT greater than 20,000 had a "Poor" or "Very Poor" BIBI score (excludes Westover Creek with no ADT data). Sites with ADT less than 20,000 had "Fair" BIBI scores.

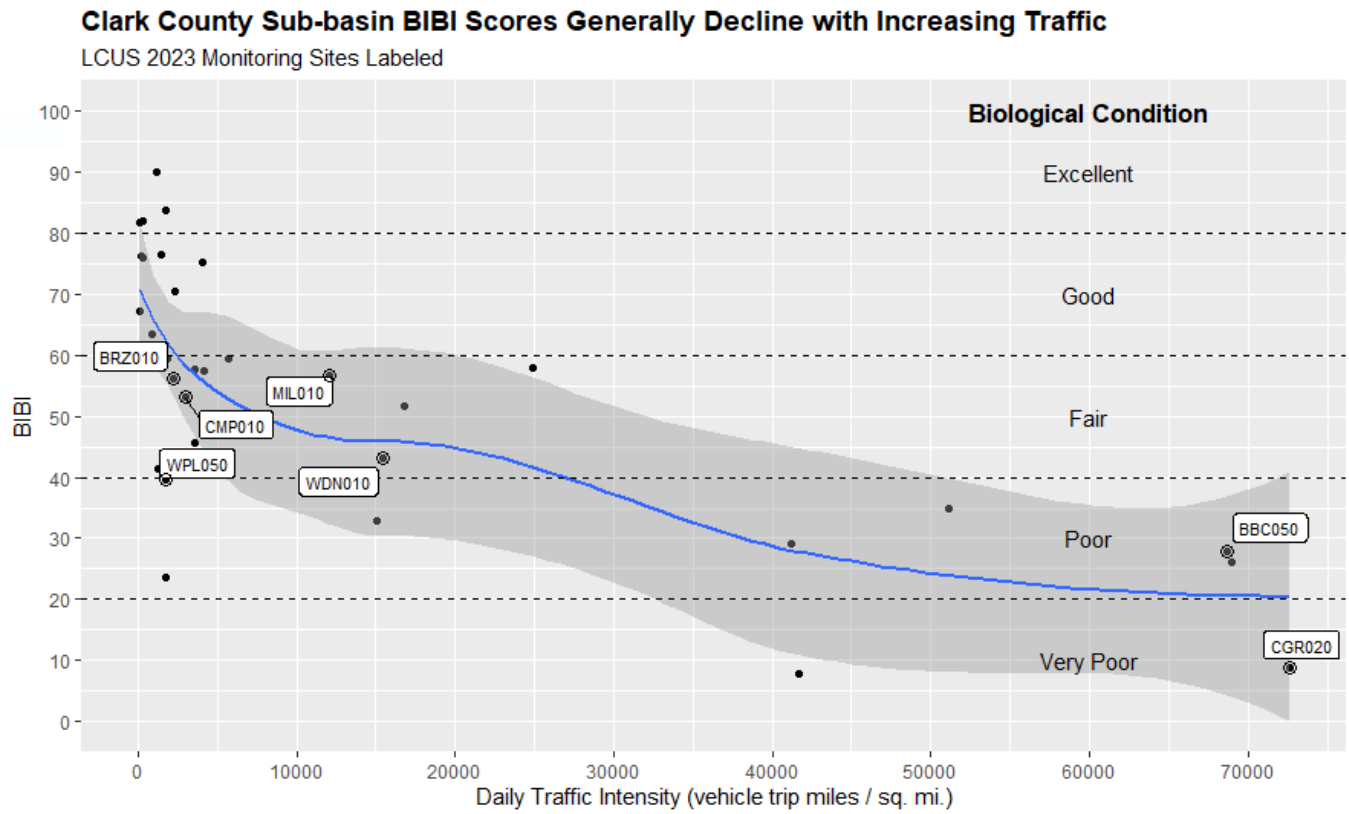


Figure 3. Comparison of available Clark County BIBI scores to sub-basin traffic intensity (Clark County, 2024).

Stream Temperature

Water temperatures have a large impact on the productivity and diversity of freshwater ecosystems. Anadromous species like salmon and steelhead require cool fresh waters throughout their life cycles (Figure 4).

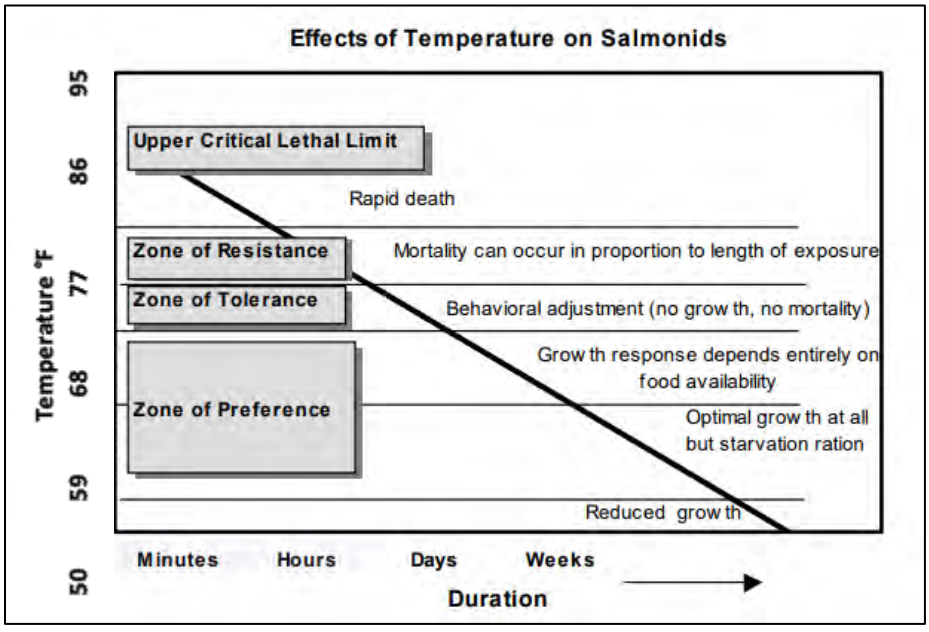


Figure 4. General biological effects of temperature on salmonids of the Pacific Northwest in relation to duration and magnitude of temperature (Sullivan et al. 2000).

Washington state aquatic life temperature criteria in freshwater to protect salmonids is based on the 7-day average of the daily maximum temperature (7-DADmax) measured from June 15 - September 15, equaling a 93 day total monitoring period (Table 4).

No LCUS site met Washington State aquatic life temperature criteria for fresh water (Table 5). Five out of the eight LCUS sites exceeded their Washington State aquatic life temperature criteria over 75 percent of the designated 93-day criteria period, suggesting that these streams are not supportive of salmonids.

Table 4. Washington State aquatic life temperature criteria in fresh water.

Category	Highest 7-DADMax
Char Spawning and Rearing	53.6°F
Core Summer Salmonid Habitat	60.8°F
Salmonid Rearing, and Migration Only	63.5°F
Salmonid Spawning, Rearing, and Migration	63.5°F
Nonanadromous Interior Redband Trout	64.4°F
Indigenous Warm Water Species	68.0°F

Table 5. Stream temperature (7-DADMax) of LCUS WY2023 sites.

Location Type	Stream Name	Location ID	Max 7-DADMax	Max Date	Max 7-DADDaily Difference	Max Date	Days >60.8	Days >63.5	Days >71.6	Days >73.4	Highest 7-DADMax Aquatic Life
Trend	Burnt Bridge Creek	BBC050	77.1	15-Aug-23	11.7	2-Jul-23	90	90	60	40	63.5
	Cougar Creek	CGR020	62.7	15-Aug-23	4.3	2-Jul-23	1	1	0	0	60.8
	Campen Creek	CMP010*	73.7	17-Jul-23	9.9	24-Jun-23	84	84	23	13	63.5
	Mill Creek	MIL010	66.2	15-Aug-23	4	2-Jul-23	26	26	0	0	60.8
	Westover Creek	WST020	65.6	16-Aug-23	2.2	16-Aug-23	9	9	0	0	63.5
Status	Brezee Creek	BRZ010*	71.8	15-Aug-23	10.2	2-Jul-23	84	84	6	0	63.5
	Whipple Creek	WPL050*	69	15-Aug-23	6.1	24-Jun-23	71	71	0	0	63.5
	Woodin Creek	WDN010	76.1	15-Aug-23	11.3	2-Jul-23	90	90	51	29	63.5

* Site locations were influenced by beaver activity.

Stream sediment and Habitat Conditions

Streambed sediment samples were collected once during the summer of 2023 from the stream substrate at all LCUS sites. Sieved sediment samples were analyzed for metals and organic contaminants, including PAHs and total organic carbon. Metals were detected at every site and were below freshwater sediment cleanup objectives. PAHs were detected at three of the eight LCUS monitoring locations. BBC050 had the highest PAHs values. LCUS sediment data can be found in Ecology's Environmental Information Management (EIM) database at https://ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database.

Excessive fine-grained sediment in streams, as measured by embeddedness or the amount of fine sediment in gravel beds, has adverse effects on the biota that inhabit streams (Figure 5). Embeddedness for LCUS sites ranged from 57 to over 90 percent falling into the marginal to poor stream condition category (Table 6).

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
2.a Embeddedness (high gradient)	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

2a. Embeddedness--High Gradient

Figure 5. Stream habitat embeddedness condition category scores (Environmental Protection Agency, 1998).

Table 6. Percent embeddedness for WY2023 LCUS sites based on 121 in stream substrate measurements per stream.

Habitat Parameter	BBC050	CGR020	CMP010	MIL010	WST020	BRZ010	WPL050	WDN010
Embeddedness	68	59	79	56	90	80	67	57
Condition Category	Marginal	Marginal	Poor	Marginal	Poor	Poor	Marginal	Marginal

Human disturbance activities, such as vegetation removal, road building, construction near streambanks, litter and more are physical habitat stressors to streams and can negatively affect fish, macroinvertebrates, as well as human uses of the waterbody. Measuring the extent and intensity of human disturbance of streams using Watershed Health Monitoring Protocols gives an indication of the impact of human activities on the natural environment. Three LCUS sites (BBC050, CGR020 and WST020), had either a “Poor” or “Very Poor” BIBI score while also having a human disturbance percentage greater than 40.

Riparian vegetation and cover are extremely important for healthy streams because of the many functions it serves including bank stabilization, fish habitat, food chain support, thermal cover and flood control. Most water year 2023 LCUS sites with greater than 80 percent riparian vegetation cover had “Fair” BIBI scores. However, both Westover Creek and Cougar Creek with over 90 percent riparian vegetation cover had “Poor” and “Very Poor” BIBI scores, respectively. These results are likely due to these two sites’ riparian vegetation cover being dominated by blackberry.

Stream health changes over time: Are they improving?

Over time, the Southwest Washington Permittees and Ecology will use this study to track stream conditions as they may relate to stormwater management impacts on streams and evaluate overall and long-term effectiveness of municipal stormwater permits, land use changes and environmental regulations.

What in this year’s findings are important for stormwater management?

As we continue to track regional conditions and identify key stressors impairing stream health, local officials and stormwater managers will be able to compare stream conditions and help prioritize and focus stormwater management practices. State and local agencies can use this information to develop regional protections, restoration strategies and evaluate the effectiveness of those programs.

Stormwater managers should review Table 7, determine what combinations of the key stressors are present in their jurisdictions, and then consider adjusting their management programs to address these stressors. Continued monitoring of trend and status site conditions will help establish reasonable expectations for good and poor biological conditions and help identify important stressors.

Table 7. List of important stressors identified in the LCUS study that effect overall stream health.

LCUS Summary Findings for WY2023
Imperviousness in all but one LCUS subwatershed was greater than 15%, indicating subwatershed conditions are not healthy for supporting macroinvertebrates and salmon (TIA > 15%).
Most flow metrics interpreted using stage are supportive of salmonid use.
Benthic invertebrate taxa analysis showed moderate changes in composition due to replacement of some sensitive taxa by more tolerant taxa.
BIBI scores generally declines with increasing TIA and ADT traffic values > 20,000 daily trip miles per square mile.
LCUS sites failed to meet state stream temperature criteria beneficial for salmonid use.
Sediment metals met freshwater sediment cleanup standards.
Substrate embeddedness for all sites fell into the “Marginal to Poor” stream condition category.
Streams with human disturbance percentages greater than 40 have "Poor to Very Poor" BIBI scores.
Most LCUS sites with greater than 80 percent riparian cover have "Fair" BIBI scores.

Next step

The LCUS study design includes trend sites that will be monitored yearly and status sites that will be sampled at five-year intervals.

Reporting will include annual assessment of stressors that effect overall stream health. Over time, this study will provide enough data to categorize LCUS streams in good, fair, or poor condition. Trend analyses and risk assessments will be conducted every five years to identify the key stressors causing poor stream conditions in the region.

The long-term goals of the study are: to evaluate the status and trends of water quality and hydrology in surface waters draining subwatersheds primarily within urban and urbanizing areas under the jurisdiction of NPDES municipal stormwater permittees; and to evaluate the status and trends of in-stream biological health, sediment quality and in-stream/riparian habitat conditions that are primarily within urban and urbanizing areas under the jurisdiction of NPDES municipal stormwater permittees.

Data are available on EIM database with Study ID SAM_LCU.
Additional results are published in the Appendix.
For more information: SAM status & trends webpage

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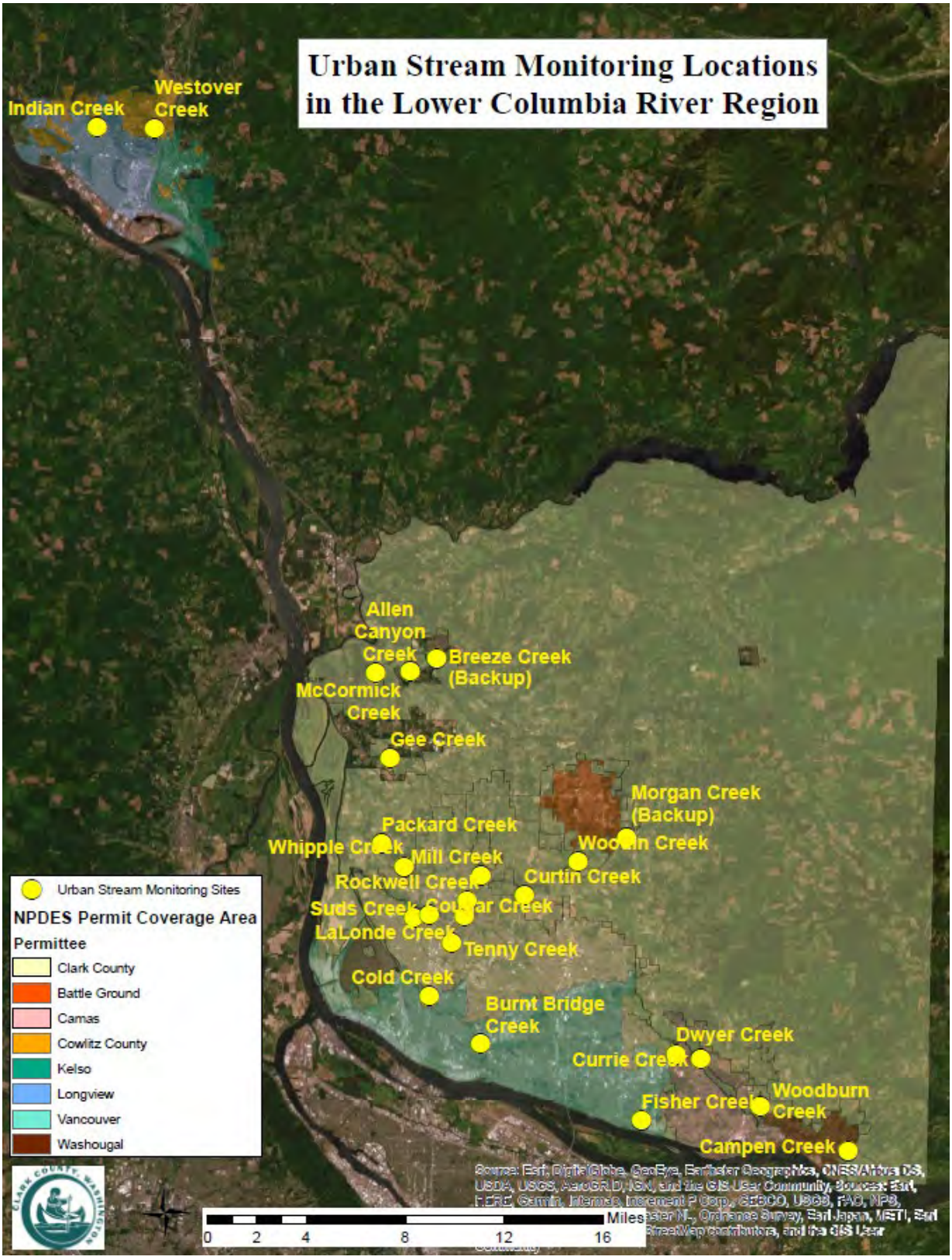
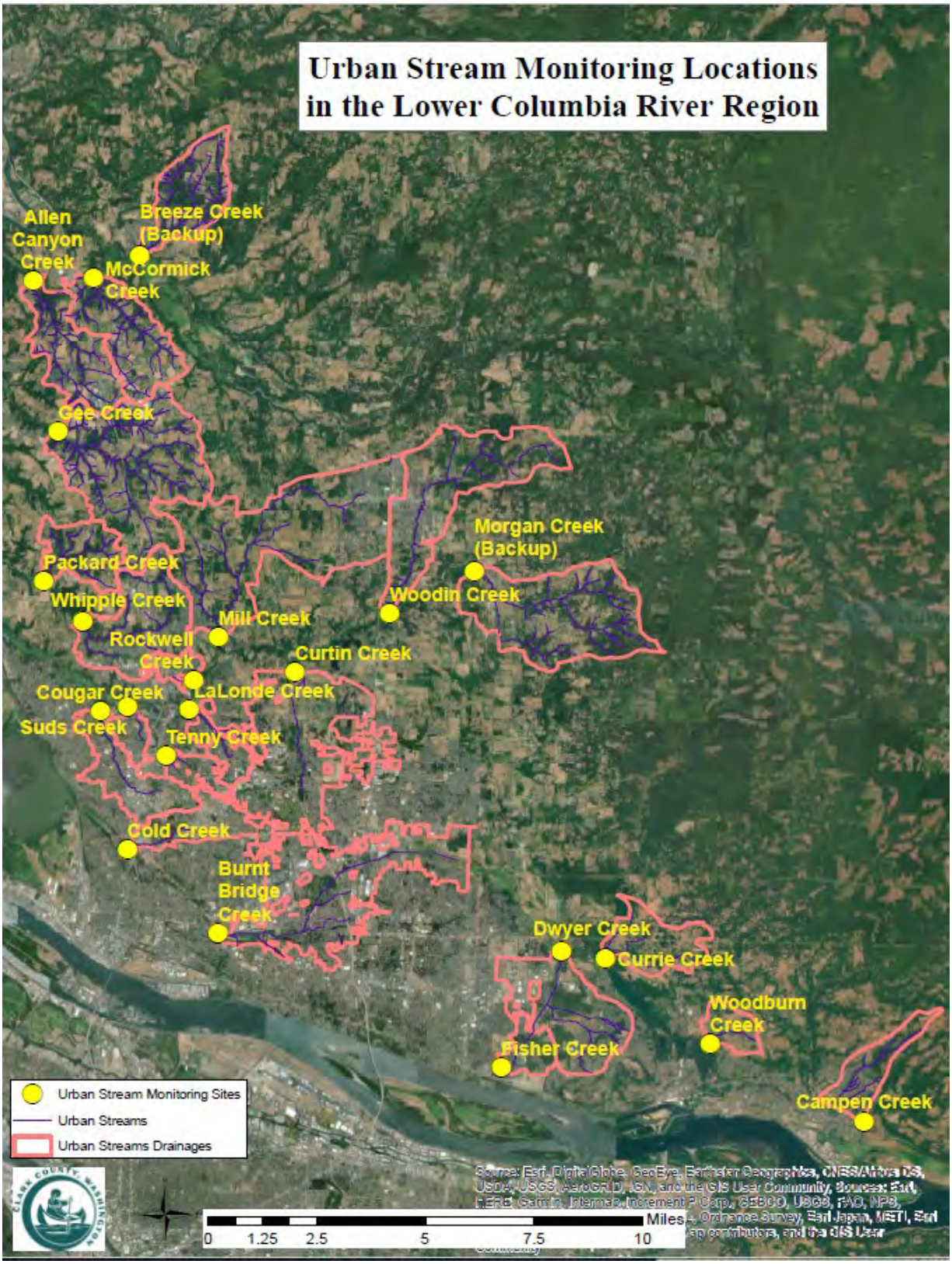
Appendix A. LCUS permittee areas, monitoring sites and associated drainage areas.



Map of urban stream monitoring locations and study boundaries in the Lower Columbia River Basin.



Map of urban stream monitoring locations and associated drainage catchments in Clark County.



Map of urban stream monitoring locations and associated drainage catchments in Cowlitz County.

Appendix B. Continuous time series data (stage and temperature) for LCUS sites for water year 2023.

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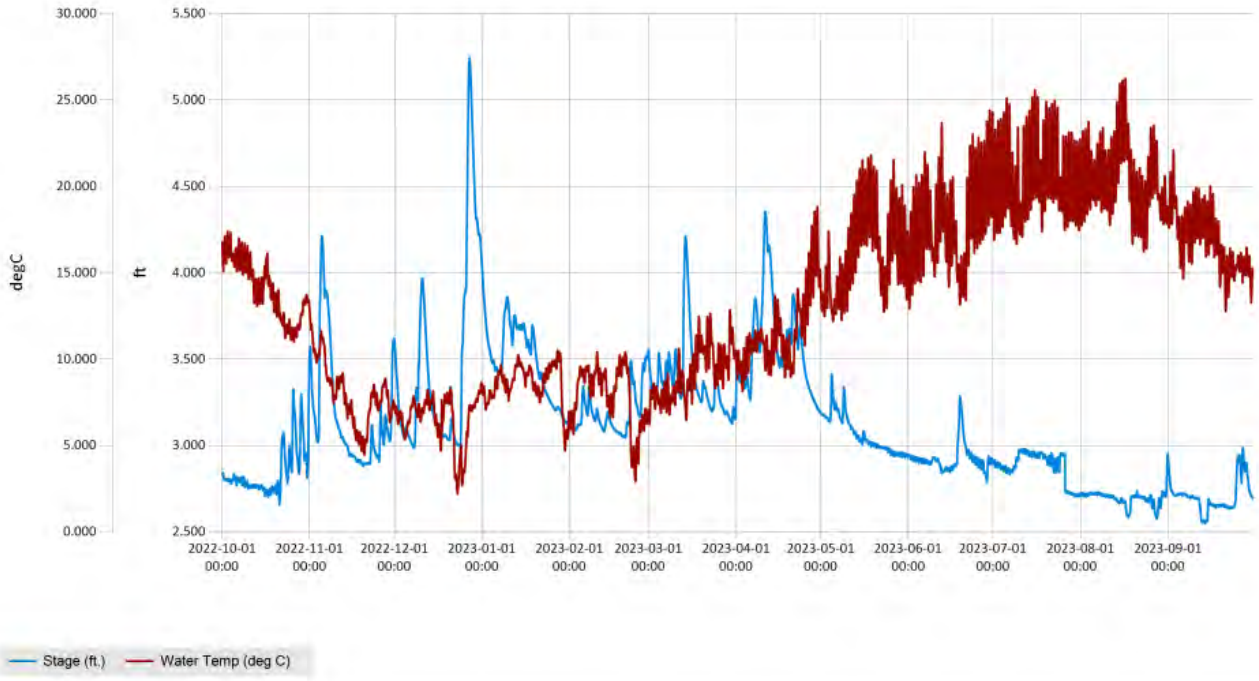
Time Series Data Report
15-minute Stage (ft.) and Water Temp (deg C) at Burnt Bridge Creek (BBC050) WY2023

Jul 11, 2024 | 1 of 1

Period Selected: 2022-10-01 00:00 - 2023-09-30 23:59 UTC Offset: -08:00



https://clark.wa.gov/public-works/stream-flow-and-precipitation-data

CLARK COUNTY WASHINGTON
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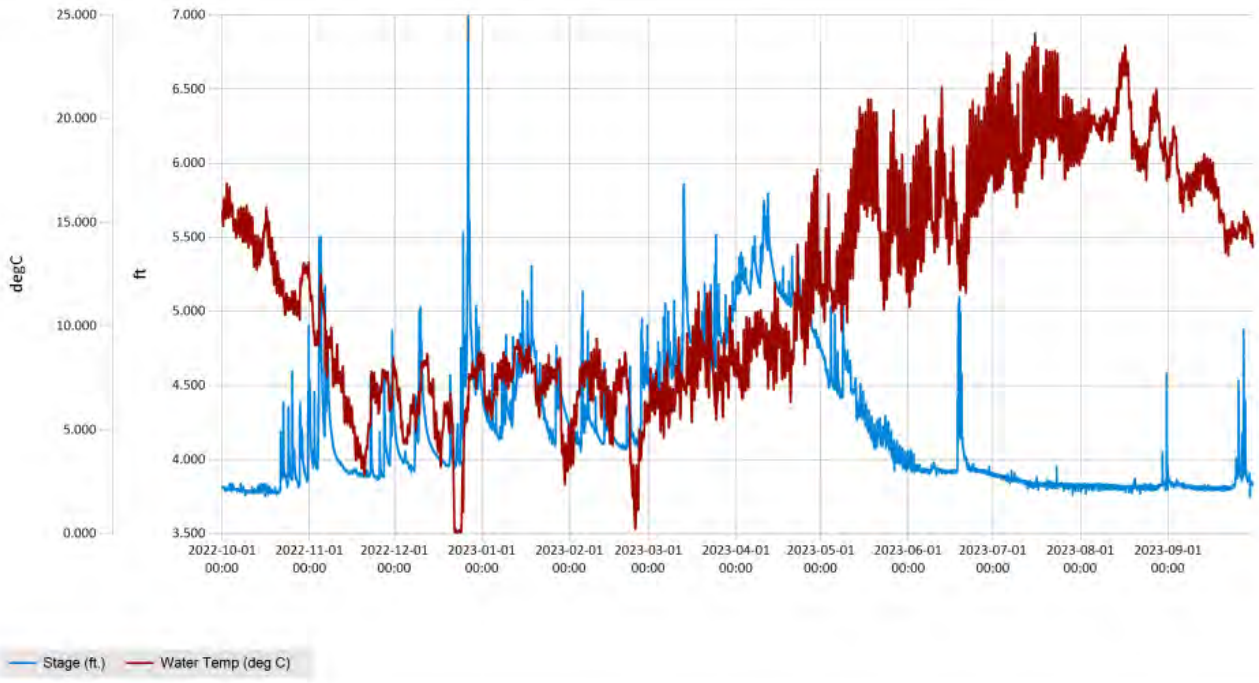
Time Series Data Report
15-minute Stage (ft.) and Water Temp (deg C) at Campen Creek (CMP010) WY2023

Jul 11, 2024 | 1 of 1

Period Selected: 2022-10-01 00:00 - 2023-09-30 23:59 UTC Offset: -08:00



https://clark.wa.gov/public-works/stream-flow-and-precipitation-data

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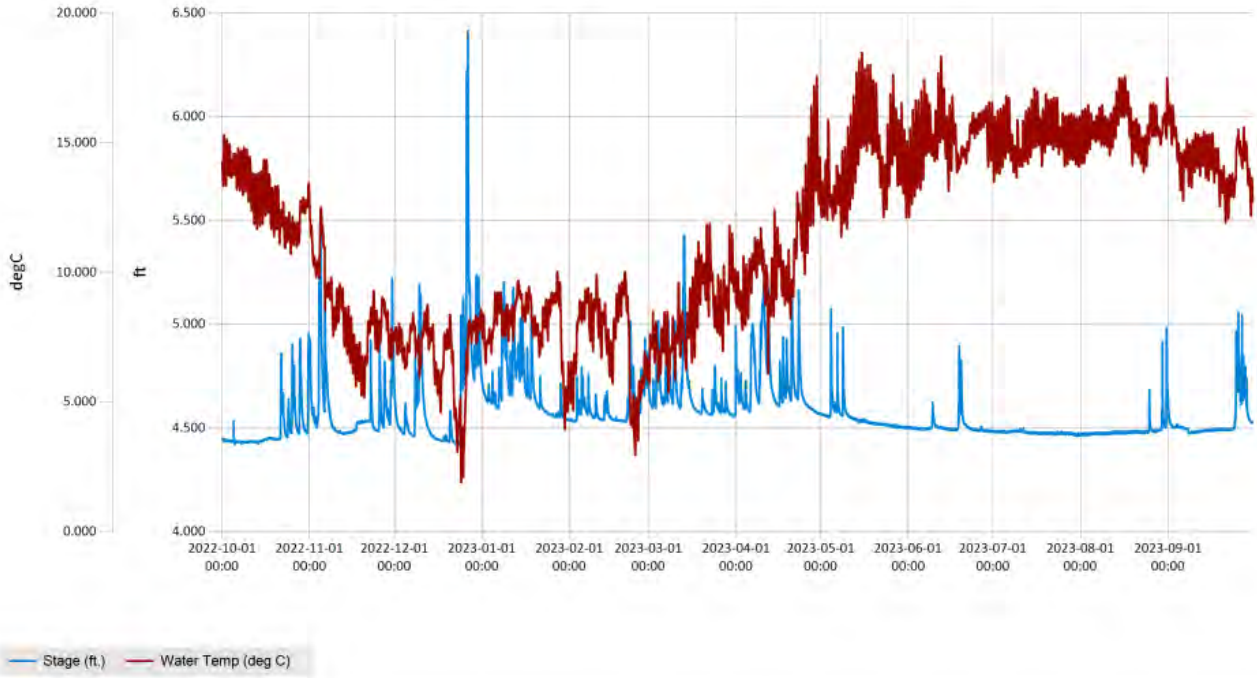
Time Series Data Report
15-minute Stage (ft.) and Water Temp (deg C) at Cougar Creek (CGR020) WY2023

Jul 11, 2024 | 1 of 1

Period Selected: 2022-10-01 00:00 - 2023-09-30 23:59 UTC Offset: -08:00



https://clark.wa.gov/public-works/stream-flow-and-precipitation-data

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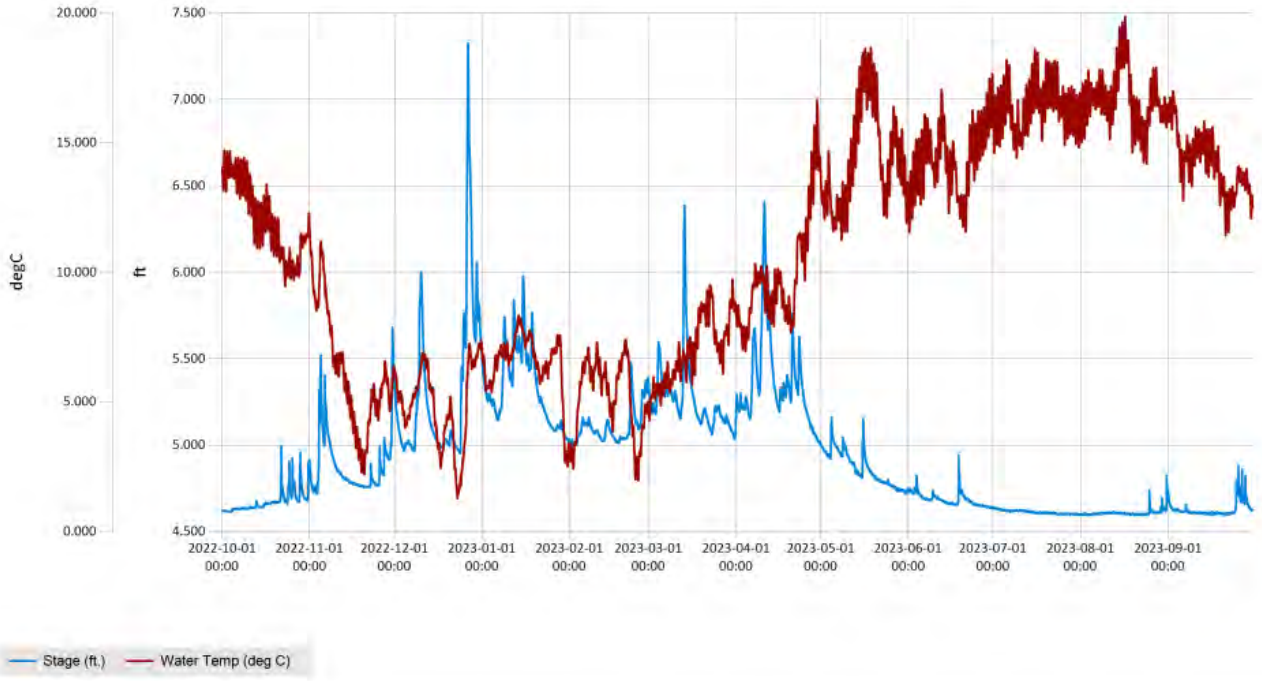
Time Series Data Report
15-minute Stage (ft.) and Water Temp (deg C) at Mill Creek (MIL010) WY2023

Jul 11, 2024 | 1 of 1

Period Selected: 2022-10-01 00:00 - 2023-09-30 23:59 UTC Offset: -08:00



https://clark.wa.gov/public-works/stream-flow-and-precipitation-data

CLARK COUNTY WASHINGTON
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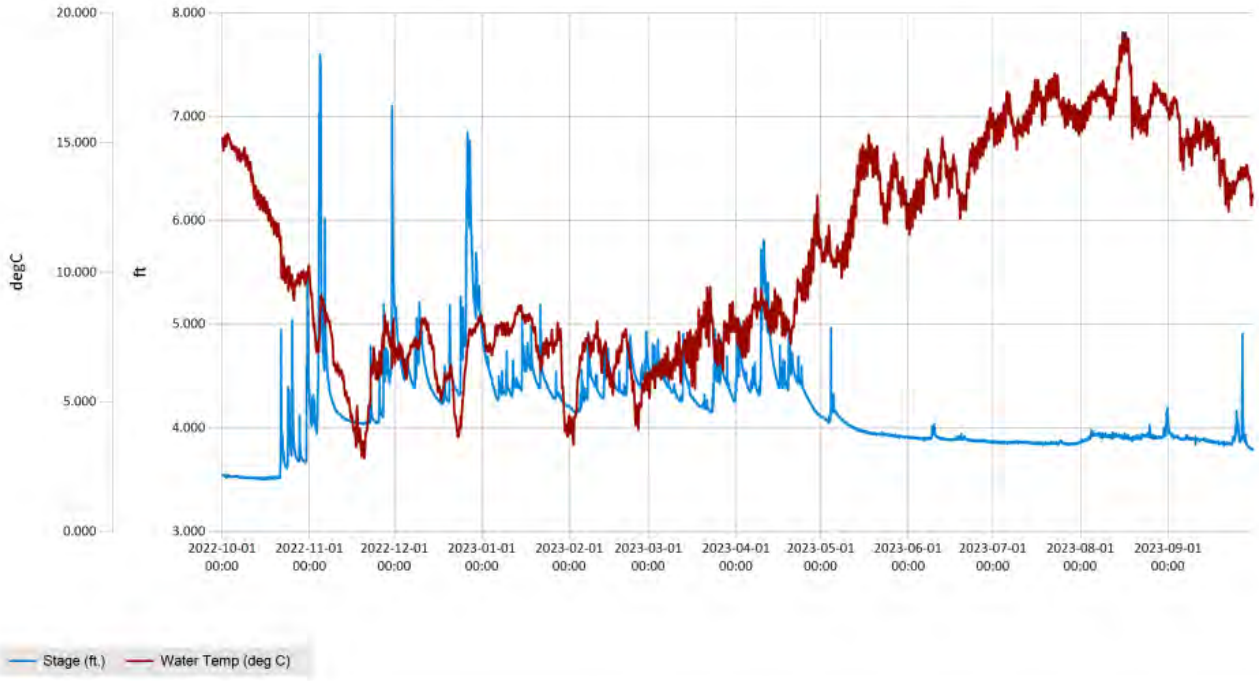
CLEAN WATER

Time Series Data Report
15-minute Stage (ft.) and Water Temp (deg C) at Westover Creek (WST020) WY2023

Jul 11, 2024 | 1 of 1

Period Selected: 2022-10-01 00:00 - 2023-09-30 23:59 UTC Offset: -08:00



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CLARK COUNTY WASHINGTON
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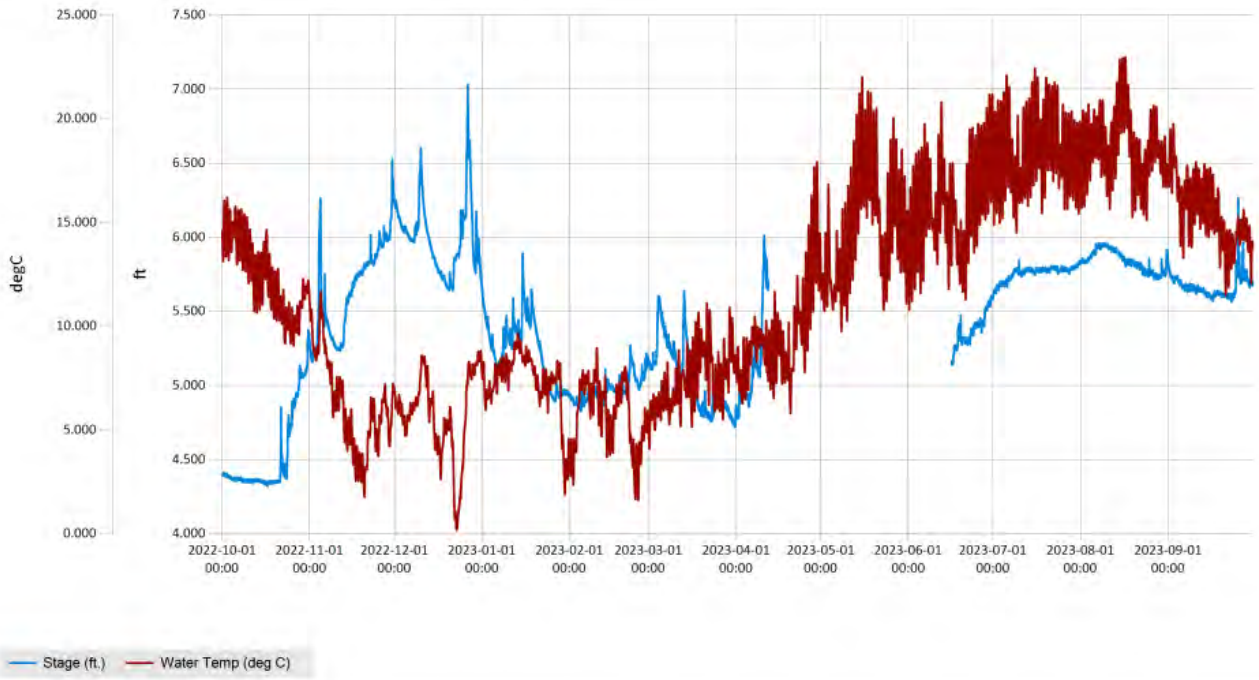
CLEAN WATER

Time Series Data Report
15-minute Stage (ft.) and Water Temp (deg C) at Brezee Creek (BRZ010) WY2023

Jul 11, 2024 | 1 of 1

Period Selected: 2022-10-01 00:00 - 2023-09-30 23:59 UTC Offset: -08:00



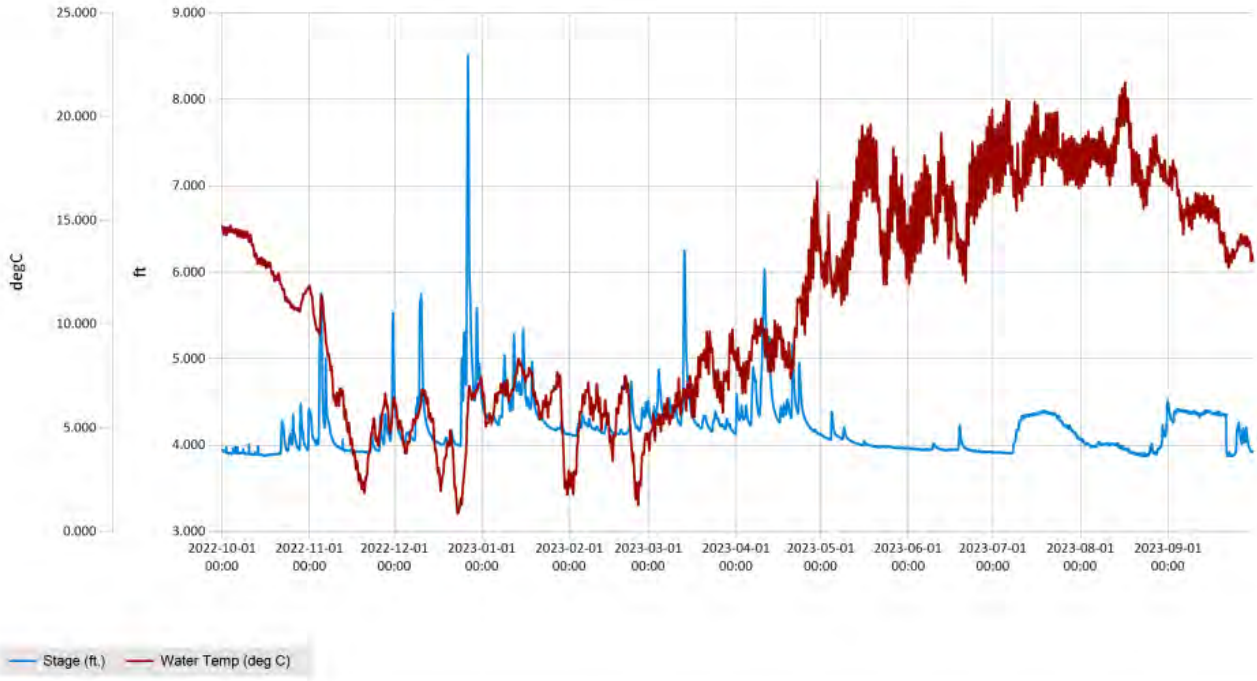
https://clark.wa.gov/public-works/stream-flow-and-precipitation-data

CLARK COUNTY WASHINGTON
PUBLIC WORKS
CLEAN WATER

Time Series Data Report
15-minute Stage (ft.) and Water Temp (deg C) at Whipple Creek (WPL050) WY2023

Jul 11, 2024 | 1 of 1

Period Selected: 2022-10-01 00:00 - 2023-09-30 23:59 UTC Offset: -08:00



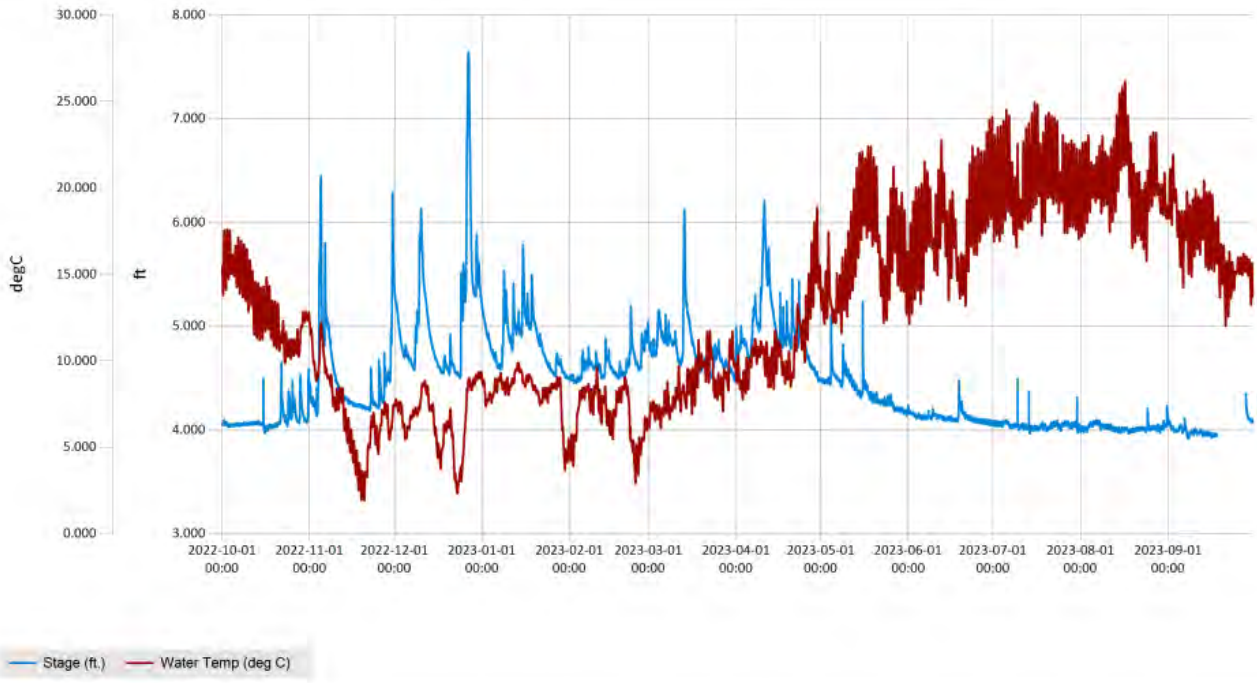
https://clark.wa.gov/public-works/stream-flow-and-precipitation-data

CLARK COUNTY WASHINGTON
PUBLIC WORKS
CLEAN WATER

Time Series Data Report
15-minute Stage (ft.) and Water Temp (deg C) at Woodin Creek (WDN010) WY2023

Jul 11, 2024 | 1 of 1

Period Selected: 2022-10-01 00:00 - 2023-09-30 23:59 UTC Offset: -08:00



https://clark.wa.gov/public-works/stream-flow-and-precipitation-data

Exhibit F

Lower Columbia Urban Streams (LCUS) Annual Status Report – 2023-2024

Stormwater Action Monitoring

Receiving Waters

Prepared for Ecology on behalf of the Stormwater Workgroup by
Clark County Public Works, Clean Water Division

SAM funds Clark County to conduct annual stream health monitoring and track changes over time in the Lower Columbia region. This status and trends monitoring will help evaluate regional progress toward reducing stormwater impacts on environmental health.

Summary Findings for 2023-2024

Stream health conditions in this LCUS study are measured by multiple indicators and LCUS findings are summarized below:

- Land Cover: All but three subwatersheds exceeded TIA values for Supporting conditions that are healthy for macroinvertebrates and salmonids (TIA > 15%).
- Flow Metrics (based on stage): TQmean values for five out of the eight LCUS WY2024 sites fell into "Supporting Salmonid Use."
- Total Impervious Area (TIA) and Daily Traffic Intensity (ADT): Subwatershed Benthic Index of Biotic Integrity (B-IBI) scores generally decline with increasing TIA and ADT traffic values > 20,000 daily trip miles per square mile.
- B-IBI: Taxa analysis showed moderate changes in composition due to replacement of some sensitive taxa by more tolerant taxa. All but one LCUS site fell into a "Poor" to "Very Poor" B-IBI category.
- Stream Temperature: No sites met state stream temperature criteria beneficial for salmonid use. Three of the eight LCUS sites exceeded their Washinton State aquatic life temperature criteria over 75% of the monitoring timeframe.
- Sediment: Metals (arsenic, cadmium, chromium, copper, lead and zinc) met freshwater sediment cleanup objectives.
- Habitat: Substrate embeddedness for all sites fell into the "Marginal to Poor" stream condition category. Three sites had "Poor or Very Poor" B-IBI scores with human disturbance index percentages > than 40. All sites had a 75% or greater riparian cover. The mostly "Poor" or Very Poor" B-IBI scores suggest other influences



McCormick Creek (MAC050) site

Why stream monitoring for stormwater management?

Stormwater management actions, implemented in the Lower Columbia region under municipal stormwater permits, are intended to help reduce stormwater impacts to receiving waters. SAM's Lower Columbia Urban Streams (LCUS) monitoring provides a regional status assessment of selected streams in the permit coverage areas. Continued monitoring will eventually allow assessment of stream health trends. These assessments assist in evaluating whether collective stormwater and environmental management efforts are meeting state and regional goals to protect water quality and biota in streams. Current status of stream health in Clark County can be found in the 2024 Stream Health Report.[1]

Stormwater runoff from urban and urbanizing areas is a major contributor to habitat and water quality degradation in small streams. Local jurisdictions throughout the Lower Columbia River region are increasing their stormwater management efforts to reduce flow volumes and pollutants. Water year 2024 is the fourth year of a long-term regional evaluation of stream health that focuses on areas covered by municipal stormwater permits in the southwest Washington region, which include Clark and Cowlitz Counties; the Cities of Camas, Longview, Vancouver, Battle Ground, Kelso, and Washougal, and the Washington State Department of Transportation (WSDOT). This ongoing study is funded by the regional permittees. Clark County is performing the study under an Interagency Agreement (IAA) with Ecology. This study will provide a better understanding of influential stressors contributing to impaired waters and overall stream health. Identifying stressors that impact hydrology and biological health may suggest solutions to decrease the impacts of stormwater runoff on streams. Over time, LCUS results may detect changes in stream quality that indicate the effectiveness of stormwater management strategies. LCUS monitoring sites and associated drainage areas can be found in Appendix A.

Monitoring receiving water health indicators in urban/urbanizing areas

The LCUS study follows protocols developed for the on-going statewide stream health monitoring program Status and Trends Monitoring for Watershed Health and Salmon Recovery[2] (WHSR) for physical habitat and biological measurements.

To better capture the stormwater related hydrologic, water and sediment chemistry changes, this study also monitors water level and temperature continuously for one full water year at each targeted sampling site (Appendix B).

LCUS streams health status in 2023-2024

Impervious surfaces and land use

Total Impervious Area, or TIA, is a measure of the amount of hard surface and serves as an indicator of the potential impacts of urbanization and development on stream health. Impervious cover results in multiple stressors to a subwatershed, such as increased pollutant loads from stormwater runoff, altered stream flow, decreased bank stability, and increased water temperatures. The significance of this metric in reducing salmon recovery potential is based on the multiple impacts to the subwatershed as well as the nearly irreversible nature of imperviousness due to urbanization.

TIA data values were calculated using the National Land Cover Database (NLCD) 2023 Fractional Impervious Surface dataset. Analysis of the 2023 Fractional Impervious Surface dataset were found to be more accurate than the 2016 NCLD Imperviousness dataset which overestimated TIA values for LCUS site subwatersheds in previous LCUS annual reports.

In terms of the subwatershed condition for TIA, most water year 2024 LCUS sites range from low to a high degree of impervious surface (Figure 1). TIA for each LCUS subwatershed ranged from 7 to 50 percent when all developed land cover categories were added together within each monitoring site's drainage area. This means that the multiple

[1] https://gis.clark.wa.gov/portal/apps/storymaps/collections/bd031a62574642db8f98c2f9beed7776
[2] https://apps.ecology.wa.gov/publications/documents/0603203.pdf

subwatersheds of the LCUS study may have too much impervious area for supporting watershed conditions that are healthy for macroinvertebrates and salmon. Watersheds with greater than 15% TIA may be at risk for more adverse conditions affecting healthy biota in streams (EPA, 2018).

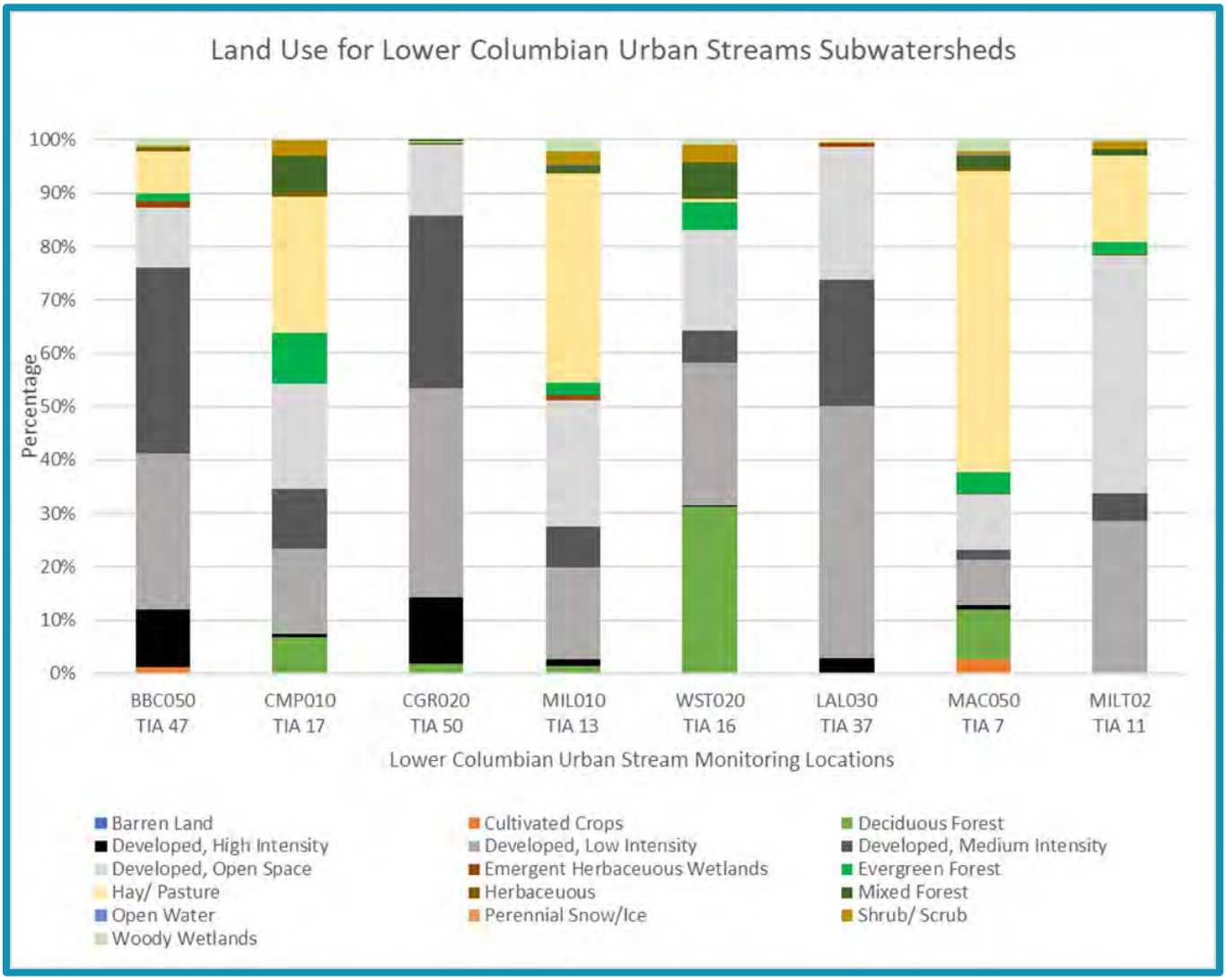


Figure 1. Land use for LCUS subwatersheds monitored for water year 2024, including Total Impervious Area (TIA %). Land cover is derived from the National Land Cover Database (NLCD) 2023 Fractional Impervious Surface dataset.

Hydrologic metrics

Flashiness, or frequency of high flows, of a stream is an important characteristic of the stream hydrologic regime that indicates likely presence of erosive flows and reflects how quickly and often flow in a waterbody increases and decreases during rainfall events. Urbanization is the primary cause of increased flashiness and hydrologic alterations. Increased stream flashiness in urban areas is typically a result of increased hardscape, soil compaction, and the increased hydraulic efficiency of traditional stormwater and flood management practices that are designed to quickly drain urban areas. Natural conditions may also contribute to stream flashiness.

TQMean: The percent of days that stream stage is greater than the mean annual stage. Flashier streams have lower TQmean values.

RBI: An index of stage oscillations relative to total stage, based on daily average stage measured per water year.

Flow reversals: The number of times that the stage differences rate changed from an increase to a decrease or vice versa during the year. Stage changes of less than 2% are not considered.

For example, regions with little attenuation of runoff, such as areas with clay soils or rock layers, typically have higher flashiness compared to areas with more permeable soils. (Schoonover et al., 2006). This LCUS study uses alternative interpretations of TQmean, Richard-Baker Index (RBI) and Flow Reversals based on continuous stage for analyses of flashiness of streams as defined in the sidebar. Booth and Konrad (2017) found that hydrologic metrics based on stage provide useful metrics of status and trends monitoring of urbanizing subwatersheds.

TQmean tends to decrease with increased urbanization and a value of less than about 0.27 is associated with non-supporting streams for salmon, while a TQmean of greater than 0.37 is associated with fully supporting streams (Clark County, 2022). All LCUS sites had a TQmean of 0.37 or greater with the exception of Cougar Creek, Westover Creek and Mill Creek Trib 2. RBI and flow reversal values tend to increase with urbanization. RBI values greater than 0.25 and flow reversal values greater than 65 are typically associated with subwatershed that have a TIA greater than 20% (Booth and Konrad, 2017). Cougar Creek (TIA of 50%), LaLonde Creek (TIA of 37%) and interestingly Mill Creek Trib 2 (TIA of 13%) were the only sites to have an RBI value greater than 0.25.

It appears that despite having most LCUS sites having too much TIA to support healthy biota in streams, much of the site hydrology may not be in the poor health category. Further analysis will be conducted in future monitoring years to identify regulating factors supporting site hydrology.

Table 1. Hydrology metrics of flashiness calculated by analyzing 15-minute continuous stage data.

Location Type	Location Name	Location ID	TQ mean	RBI	Reversals
Trend	Burnt Bridge Creek	BBC050	0.41	0.15	40
	Cougar Creek	CGR020	0.33	0.44	49
	Campen Creek	CMP010	0.42	0.23	44
	Mill Creek	MIL010	0.39	0.19	34
	Westover Creek	WST020	0.36	0.20	56
Status	LaLonde Creek	LAL030	0.38	0.26	29
	McCormick Creek	MAC050	0.43	0.16	28
	Mill Creek Trib 2	MILT02	0.34	0.29	28

B-IBI

Benthic macroinvertebrate communities provide a strong indicator of stream habitat quality and can be significantly influenced by changes to habitat associated with urban stream hydrology, water quality, embeddedness and stream temperature.

B-IBI scores can also be a strong indicator of water quality problems that harm salmonids. Two common problems are high water temperature due to the lack of shade and toxic effects of urban stormwater runoff. Low B-IBI scores can indicate factors other than hydrology that prevent a stream from supporting salmon and other sensitive aquatic life.

Clark County has used the B-IBI score as a tool to quantify stream health for many years.

Clark County stores all B-IBI data in the Puget Sound Database[3] and has the original taxonomic counts converted to the 100-point system (Table 2). Streams having "Poor" B-IBI scores (40 or less) are considered non-supporting for salmon habitat (Ecology, 1999). Three LCUS sites had a B-IBI score of less than 40 (Table 3).

Table 2. B-IBI Biological Condition Categories

Biological Condition	0 to 100 B-IBI
Excellent	80 to 100
Good	60 to 80
Fair	40 to 80
Poor	20 to 40
Very Poor	0 to 20

[3] https://pugetsoundstreambenthos.org/

Table 3. LCUS B-IBI Scores

Location ID	BBC050	CMP010	CGR020	MIL010	WST020	LAL030	MAC050	MILT02
B-IBI Score	8	28	18	54	17	16	29	26
B-IBI Category	Very Poor	Poor	Very Poor	Fair	Very Poor	Very Poor	Poor	Poor

Taxa composition at all 2023 LCUS sites ranged from four to six on the EPA's Biological Condition Gradient (BCG). The BCG framework represents ecological conditions in terms of measurable ecological characteristics, or attributes, of an aquatic community in response to anthropogenic stressors (EPA, 2021).

A BCG range from four to six indicates that chemistry, habitat, and/or flow regime was altered from natural conditions. At the four to six BCG level, there are moderate to extreme changes in structure due to replacement of some sensitive ubiquitous taxa by more tolerant taxa (EPA, 2021). Compared to healthier streams, water year 2023 B-IBI samples showed many more tolerant taxa, many taxa that are both lotic and lentic, and loss of sensitive taxa.

Traffic Intensity and B-IBI

Traffic intensity, as measured by vehicle trips per square mile (ADT), typically increases with urbanization and provides a robust urbanization metric. Traffic intensity is associated with both the level of urbanization and the presence of high traffic freeways and highways in rural areas. Low density urban residential areas tend to have much lower traffic and associated pollution than commercial, industrial and multifamily areas along arterial roadways.

Considering that much of the stormwater pollution in the MS4 comes from roads, traffic intensity is strongly associated with stormwater influence on streams in both urban and rural areas.

There is detailed estimated traffic count data for every road in Clark County, including cities, based on computer modeling by a regional transportation planning agency. The transportation model provides a detailed and uniform surrogate for potential stormwater impacts across Clark County. Figure 2 shows a general decreasing BIBI scores with increasing traffic intensity. It appears that BIBI scores in basins with an ADT value of 20,000 or greater typically fall into the "Poor" category.

Considering that BIBI scores depend on several factors, including substrate and water quality, BIBI scores can be low in areas of low urbanization (e.g. land under intensive agricultural use). However, BIBI scores are rarely better than poor in areas of intense urbanization.

All LCUS sites with an ADT greater than 20,000 had a "Poor" or "Very Poor" BIBI score (excludes Westover Creek with no ADT data). Most sites with ADT less than 20,000 had "Fair" BIBI scores.

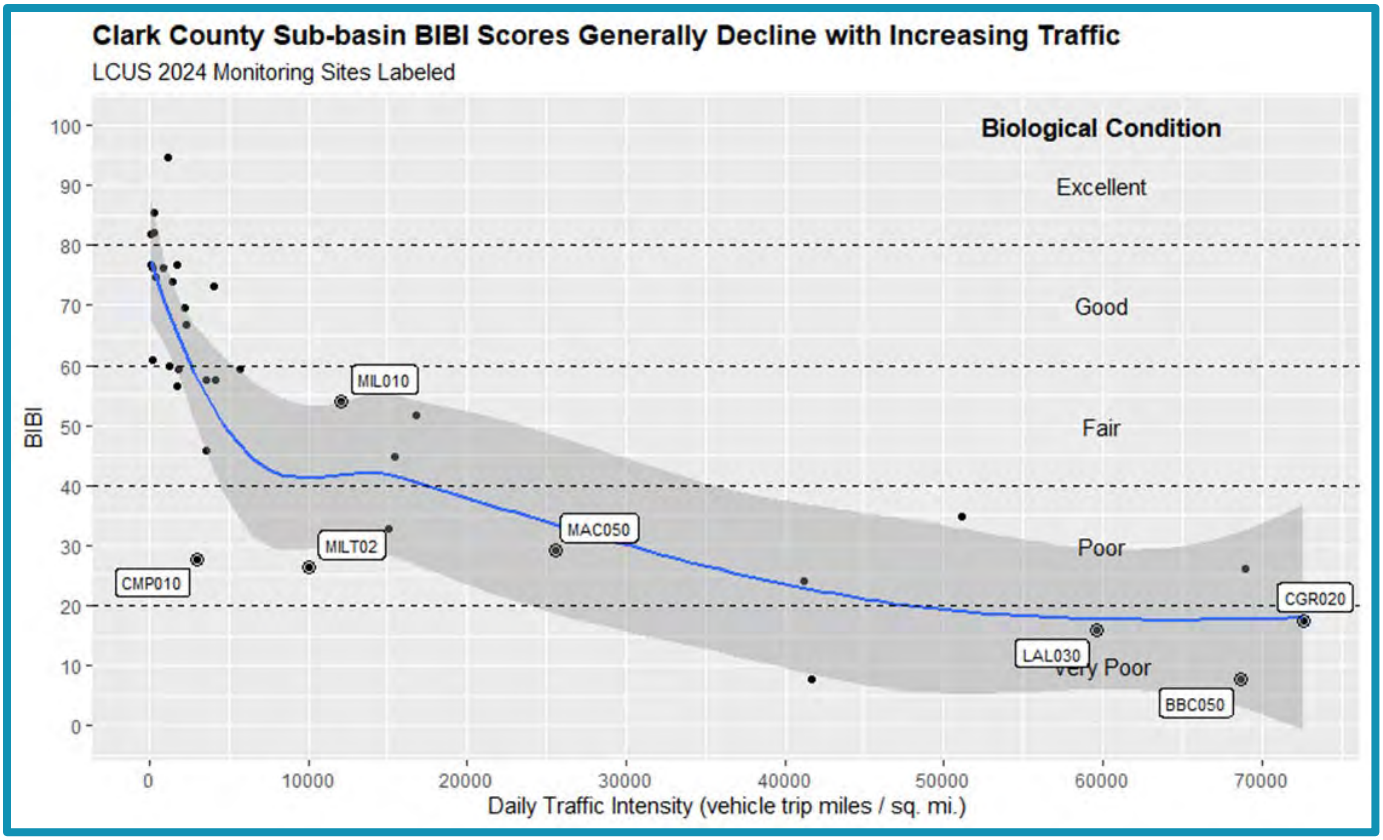


Figure 2. Comparison of available Clark County B-IBI scores to sub-basin traffic intensity (Clark County, 2024)

Stream Temperature

Water temperatures have a large impact on the productivity and diversity of freshwater ecosystems. Anadromous species like salmon and steelhead require cool fresh water throughout their life cycles (Figure 3).

Washington state aquatic life temperature criteria in freshwater to protect salmonids is based on the 7-day average of the daily maximum temperature (7-DADmax) measured from June 15 - September 15, equaling a 93-day total monitoring period (Table 4).

No LCUS site met Washington State aquatic life temperature criteria for fresh water (Table 5). Five out of the eight LCUS sites exceeded their Washington State aquatic life temperature criteria over 70 percent of the designated 93-day criteria period, suggesting that these streams are not supportive of salmonids.

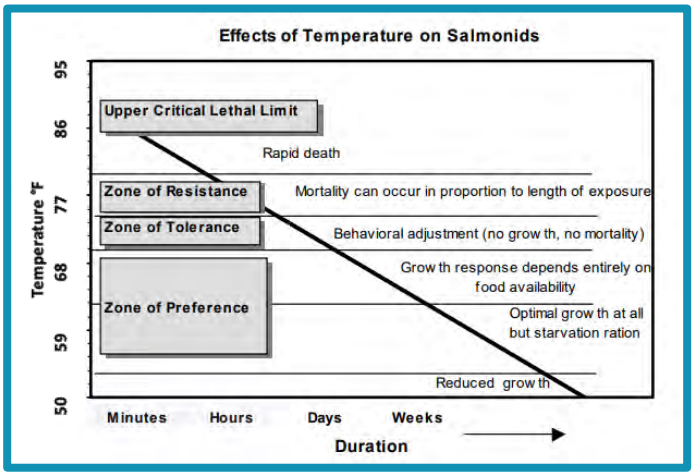


Figure 3. General biological effects of temperature on salmonids of the Pacific Northwest in relation to duration and magnitude of temperature (Sullivan, et al., 2000)

Table 4. Washington State aquatic life temperature criteria in fresh water

Category	Highest 7-DAD Max
Char Spawning and Rearing	53.6°F
Core Summer Salmonid Habitat	60.8°F
Salmonid Rearing and Migration Only	63.5°F
Salmonid Spawning, Rearing, and Migration	63.5°F
Nonanadromous Interior Redband Trout	64.4°F
Indigenous Warm Water Species	68.0°F

Table 5. Stream temperature (7-DADMax) of LCUS WY2024 sites

Location Type	Location Name	Location ID	Max 7-DAD Max (°F)	Max Date	Max 7-DAD Daily Difference (°F)	Max Date	Days above 60.8°F	Days above 63.5°F	Days above 71.6°F	Days above 73.4°F	Highest 7-DADMax Aquatic Life (°F)
Trend	Burnt Bridge Creek	BBC050	74.8	July 17	8.3	July 17	92	88	30	19	63.5
	Cougar Creek	CGR020	63.1	July 8	4.4	July 7	48	4	0	0	60.8
	Campen Creek	CMP010	73.9	July 8	10.4	June 21	91	82	18	5	63.5
	Mill Creek	MIL010	66.6	July 8	5.4	July 7	67	31	0	0	60.8
	Westover Creek	WST020	68.2	July 8	6.2	July 6	82	46	0	0	63.5
Status	LaLonde Creek	LAL030	61.3	July 8	4.4	July 7	14	1	0	0	63.5
	McCormick Creek	MAC050	71.5	July 7	7.0	June 19	89	77	5	0	63.5
	Mill Creek Trib 2	MILT02	66.5	July 10	5.9	July 7	67	32	0	0	63.5

Stream Sediment and Habitat Conditions

Streambed sediment samples were collected once during the summer of 2023 from the stream substrate at all LCUS sites. Sieved sediment samples were analyzed for metals and organic contaminants, including PAHs and total organic carbon. Metals were detected at every site and were below freshwater sediment cleanup objectives. PAHs were detected at three of the eight LCUS monitoring locations (BBC050, CGR020 and WST020). BBC050 had the highest PAHs values. LCUS sediment data can be found in Ecology's Environmental Information Management (EIM) database.[4]

Excessive fine-grained sediment in streams, as measured by embeddedness or the amount of fine sediment in gravel beds, has adverse effects on the biota that inhabit streams (Table 6). Embeddedness for LCUS sites ranged from 57 to over 90 percent, falling into the marginal to poor stream condition category (Table 7).

[4] https://ecology.wa.gov/research-data/data-resources/environmental-information-management-database

Table 6. Stream habitat embeddedness condition categories from Environmental Protection Agency (1998)

Embeddedness Condition Category	Optimal	Suboptimal	Marginal	Poor
Description	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.

Table 7. Percent embeddedness for WY2024 LCUS sites based on 121 in stream substrate measurements per stream

Location ID	BBC050	CMP010	CGR020	MIL010	WST020	LAL030	MAC050	MILT02
Embeddedness (%)	68	79	59	56	90	87	39	90
Condition Category	Marginal	Marginal	Poor	Marginal	Poor	Poor	Suboptimal	Poor

Human disturbance activities, such as vegetation removal, road building, construction near streambanks, litter and more are physical habitat stressors to streams and can negatively affect fish, macroinvertebrates, as well as human uses of the waterbody. Measuring the extent and intensity of human disturbance of streams using Watershed Health Monitoring Protocols gives an indication of the impact of human activities on the natural environment. Four LCUS sites (BBC050, CGR020, WST020 and MAC050), had either a “Poor” or “Very Poor” BIBI score while also having a human disturbance percentage greater than 35.

Riparian vegetation and cover are extremely important for healthy streams because of the many functions it serves including bank stabilization, fish habitat, food chain support, thermal cover and flood control. Only LCUS site MIL010 with greater than 80 percent riparian vegetation cover had “Fair” BIBI scores. All other water year 2024 LCUS sites had high percentages of riparian cover but had either had “Poor” and “Very Poor” BIBI scores. These results are likely due to other additional urban stressors affecting overall stream health.

Stream health changes over time: Are they improving?

Over time, the Southwest Washington Permittees and Ecology will use this study to track stream conditions as they may relate to stormwater management impacts on streams and evaluate overall and long-term effectiveness of municipal stormwater permits, land use changes and environmental regulations.

What in this year’s findings are important for stormwater management?

As we continue to track regional conditions and identify key stressors impairing stream health, local officials and stormwater managers will be able to compare stream conditions and help prioritize and focus stormwater management practices. State and local agencies can use this information to develop regional protections, restoration strategies and evaluate the effectiveness of those programs.

Stormwater managers should review Table 8, determine what combinations of the key stressors are present in their jurisdictions, and then consider adjusting their management programs to address these stressors. Continued monitoring of trend and status site conditions will help establish reasonable expectations for good and poor biological conditions and help identify important stressors.

Table 8. List of important stressors identified in the LCUS study that affect overall stream health

LCUS Summary Findings for WY2024
Imperviousness in all but three WY2024 LCUS subwatershed was greater than 15%, indicating subwatershed conditions are not healthy for supporting macroinvertebrates and salmon (TIA > 15%).
Most flow metrics interpreted using stage are supportive of salmonid use at five out of the eight WY2024 LCUS sites.
Benthic invertebrate taxa analysis showed moderate changes in composition due to replacement of some sensitive taxa by more tolerant taxa. All but one WY2024 LCUS sites fell into the "Poor" or "Very Poor" BIBI category.
B-IBI scores generally decline with increasing TIA and ADT traffic values > 20,000 daily trip miles per square mile.
LCUS sites failed to meet state stream temperature criteria beneficial for salmonid use.
Sediment metals met freshwater sediment cleanup standards.
Substrate embeddedness for all sites fell into the "Marginal to Poor" stream condition category.
Streams with human disturbance percentages greater than 35 have "Poor to Very Poor" B-IBI scores.
All LCUS sites had a 75 percent or greater riparian cover. All but one LCUS site fell into the "Poor" or "Very Poor" BIBI category suggesting other urban influences other than riparian cover may be affecting stream health.

Next step

The LCUS study design includes trend sites that will be monitored yearly and status sites that will be sampled at five-year intervals.

Reporting will include an annual assessment of stressors that affect overall stream health. Over time, this study will provide enough data to categorize LCUS streams in good, fair, or poor condition. Trend analyses and risk assessments will be conducted every five years to identify the key stressors causing poor stream conditions in the region.

The long-term goals of the study are: to evaluate the status and trends of water quality and hydrology in surface waters draining subwatersheds primarily within urban and urbanizing areas under the jurisdiction of NPDES municipal stormwater permittees; and to evaluate the status and trends of in-stream biological health, sediment quality and in-stream/riparian habitat conditions that are primarily within urban and urbanizing areas under the jurisdiction of NPDES municipal stormwater permittees.

Data are available in the EIM database with Study ID SAM_LCU.

Additional results are published in the Appendix.

For more information, including past status reports, visit the SAM status & trends webpage.

To request an ADA accommodation, contact Ecology by phone at 360-407-6600 or email at chelsea.morris@ecy.wa.gov, or visit https://ecology.wa.gov/accessibility. For Relay Service or TTY call 711 or 877-833-6341.

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Appendix A. LCUS permittee areas, monitoring sites, and associated drainage areas

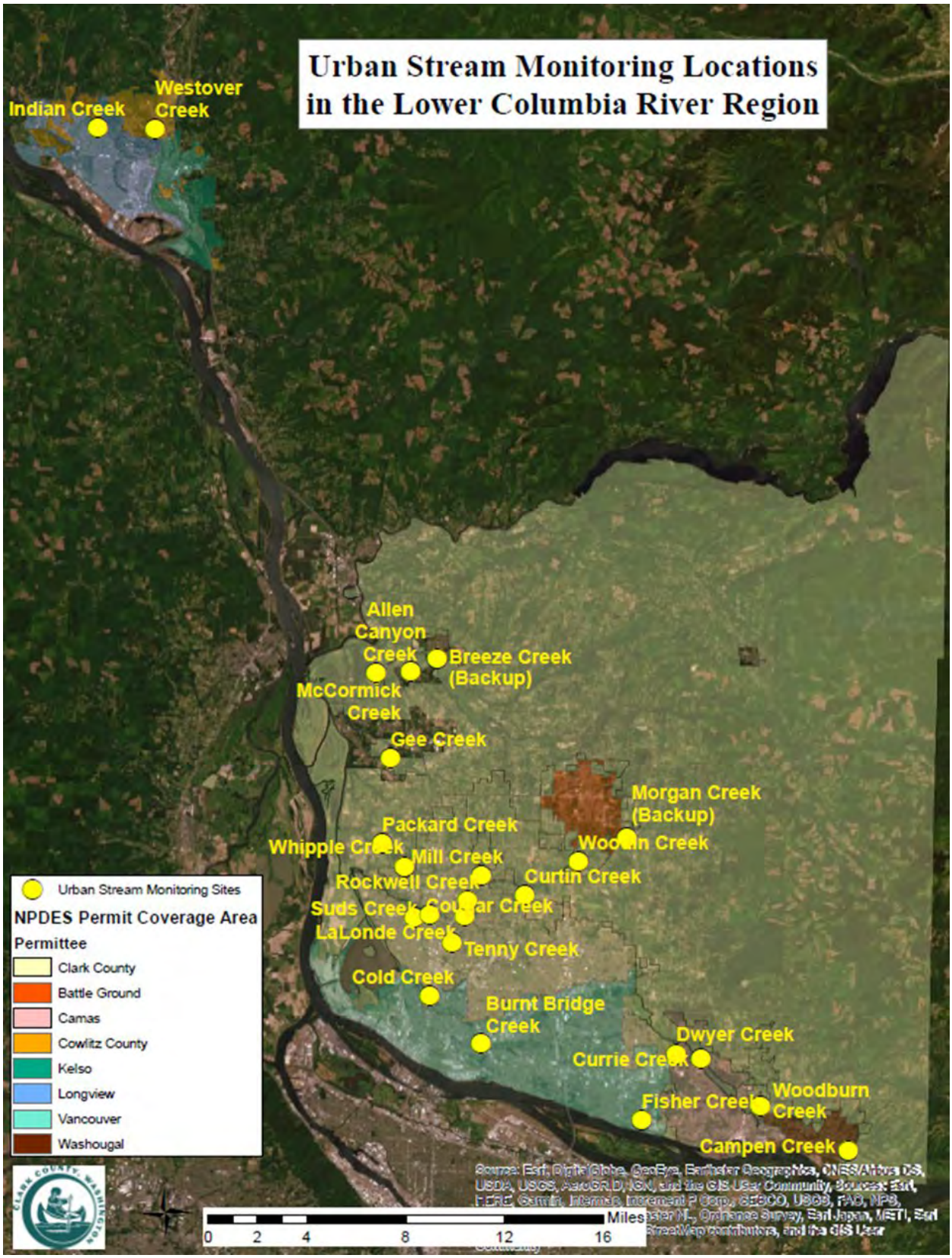

Figure A 1. Map of urban stream monitoring locations and study boundaries in the Lower Columbia River Basin

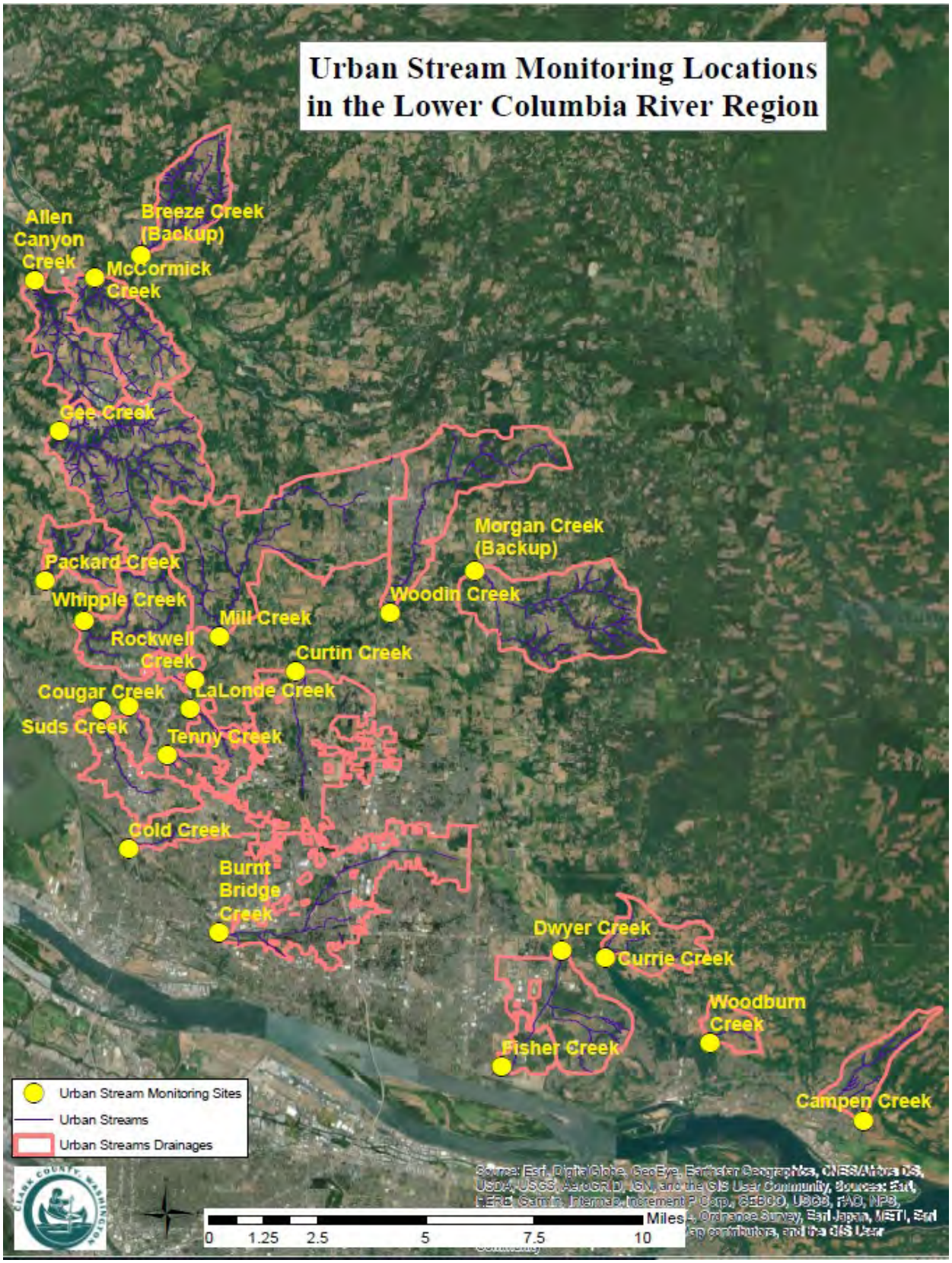

Figure A 2. Map of urban stream monitoring locations and associated drainage catchments in Clark County



Figure A 3. Map of urban stream monitoring locations and associated drainage catchments in Cowlitz County

Appendix B. Continuous time series data (stage and temperature) for LCUS sites for water year 2024

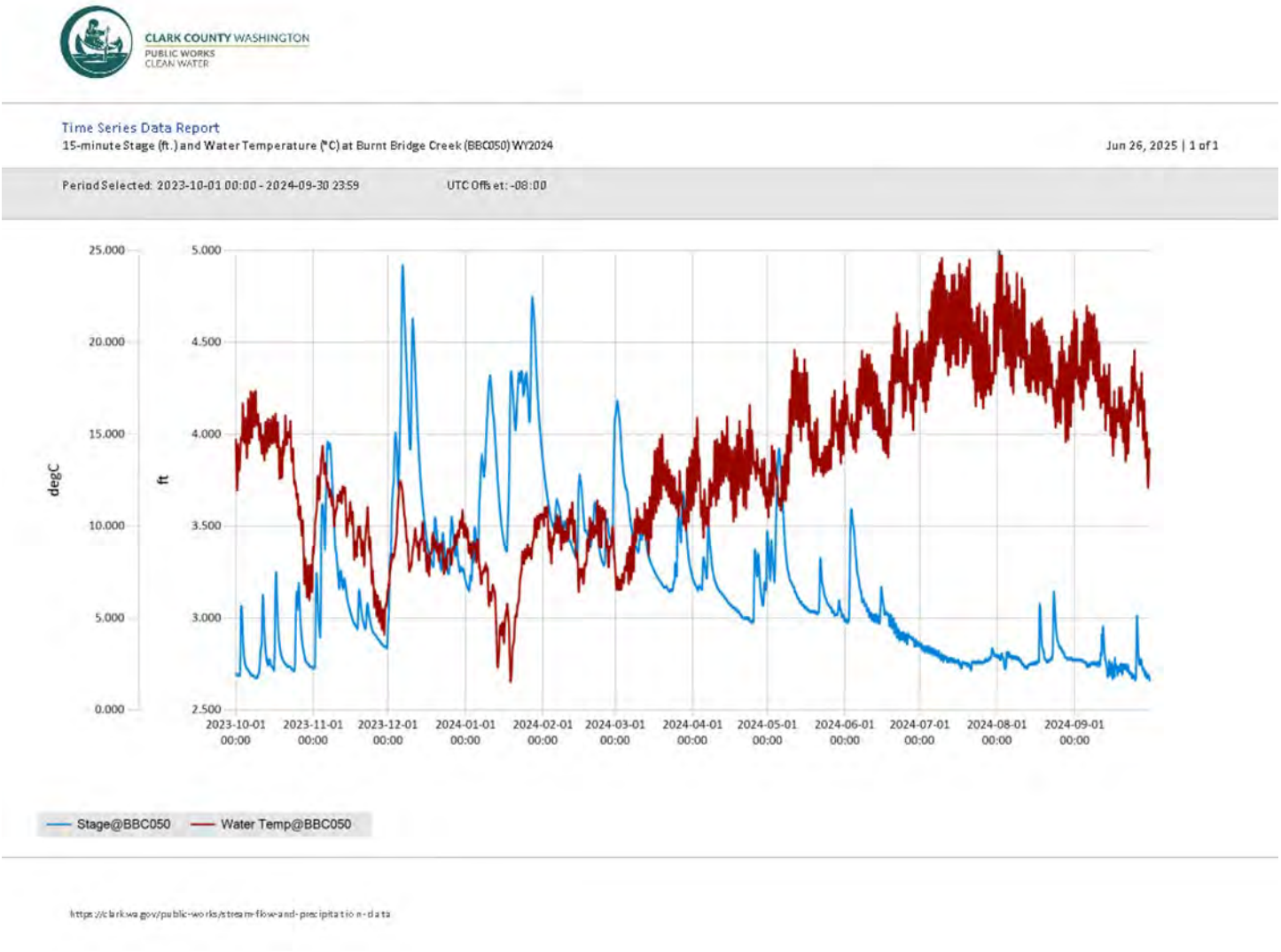

Figure B 1. 15-minute stage and temperature at Burnt Bridge Creek

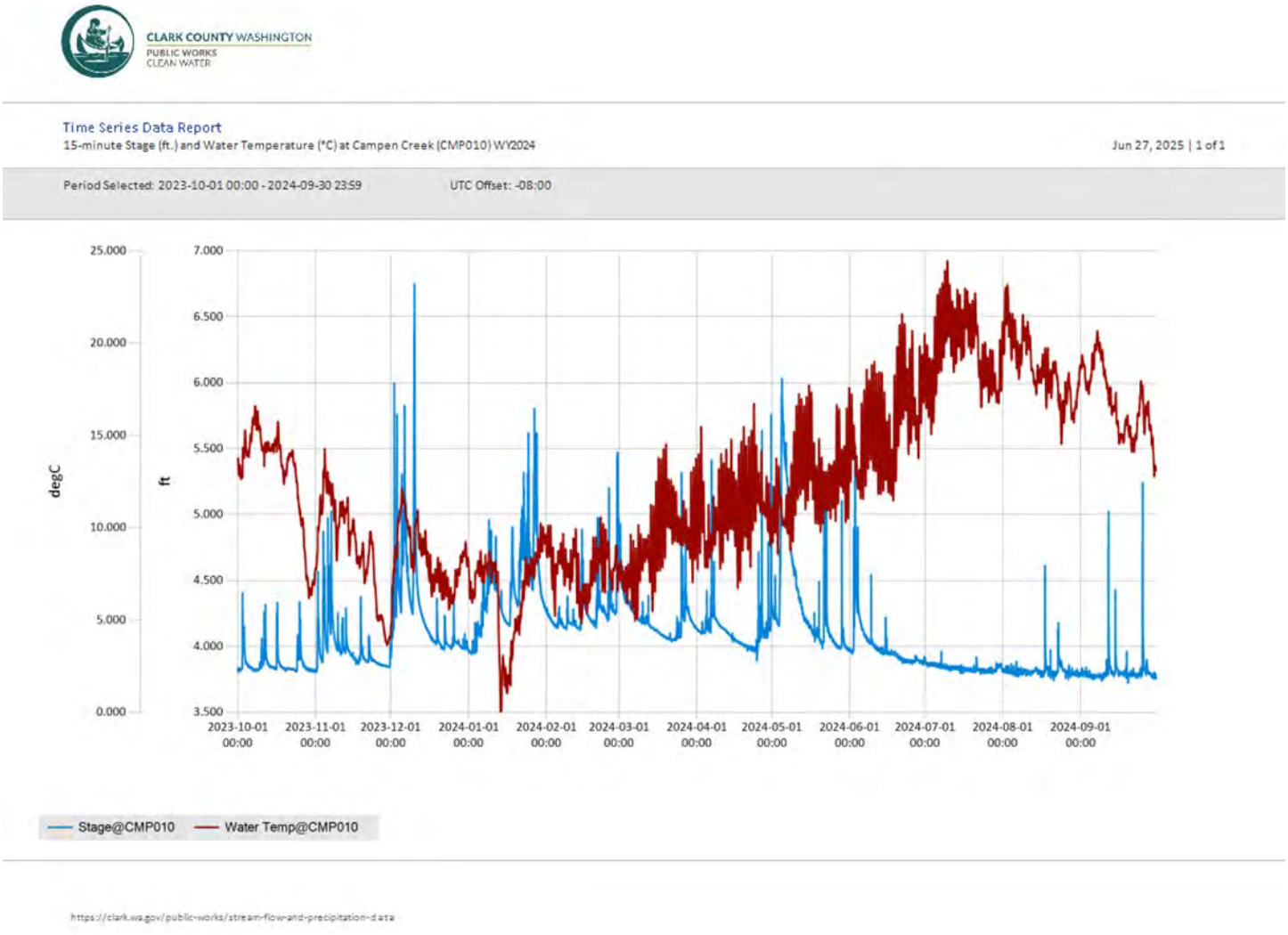

Figure B 2. 15-minute stage and temperature at Campen Creek

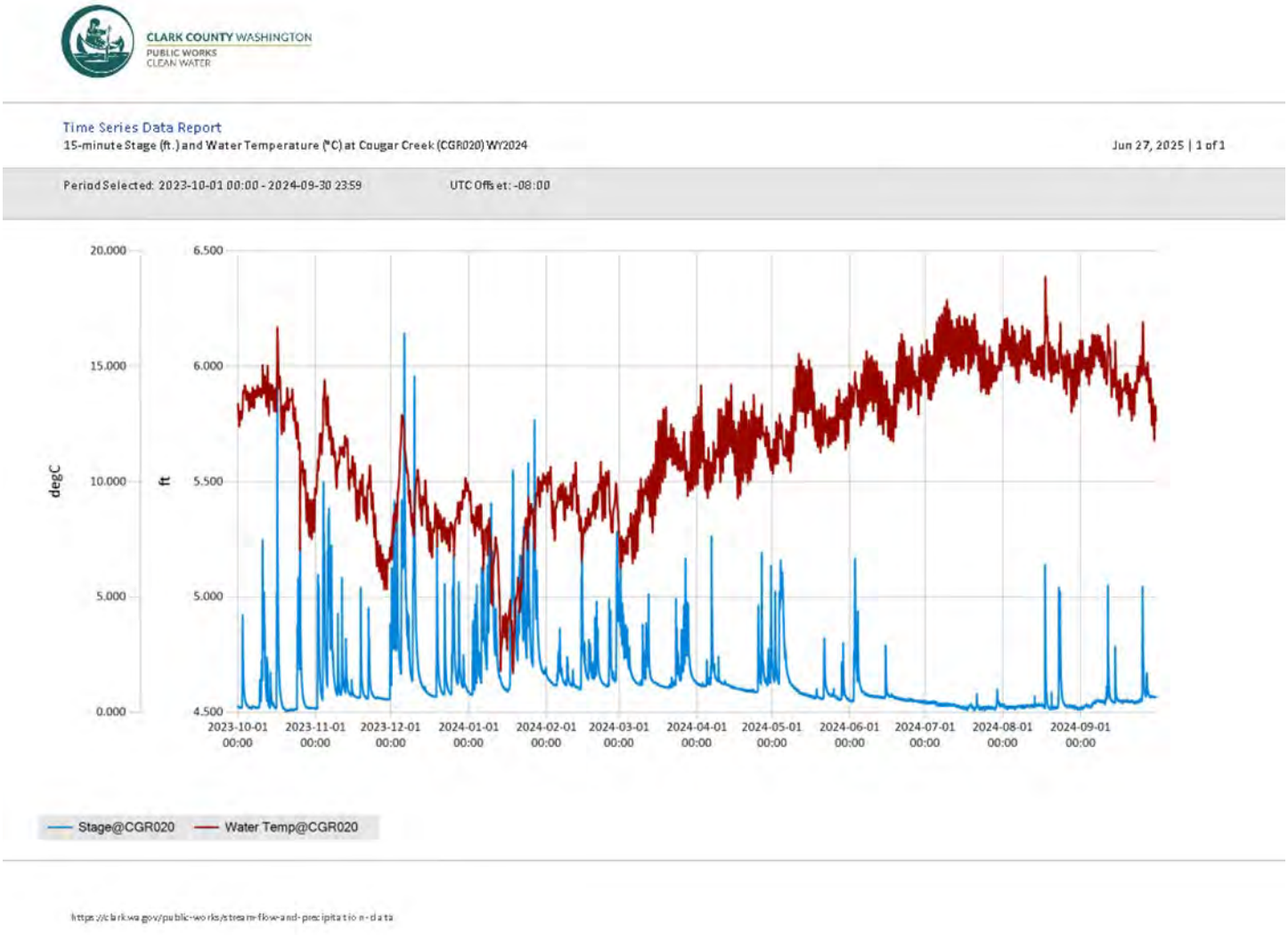

Figure B 3. 15-minute stage and temperature at Cougar Creek

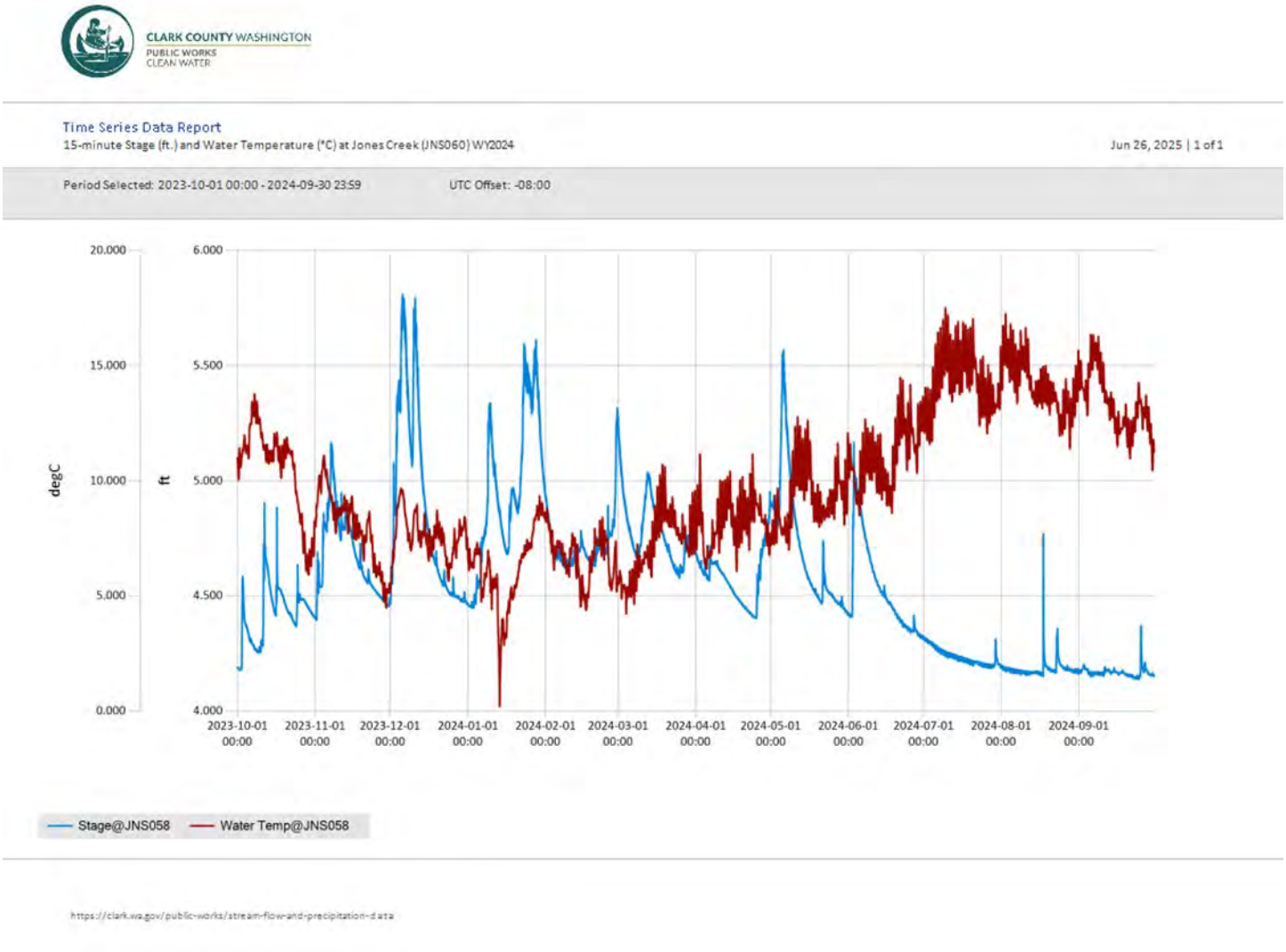

Figure B 4. 15-minute stage and temperature at Jones Creek

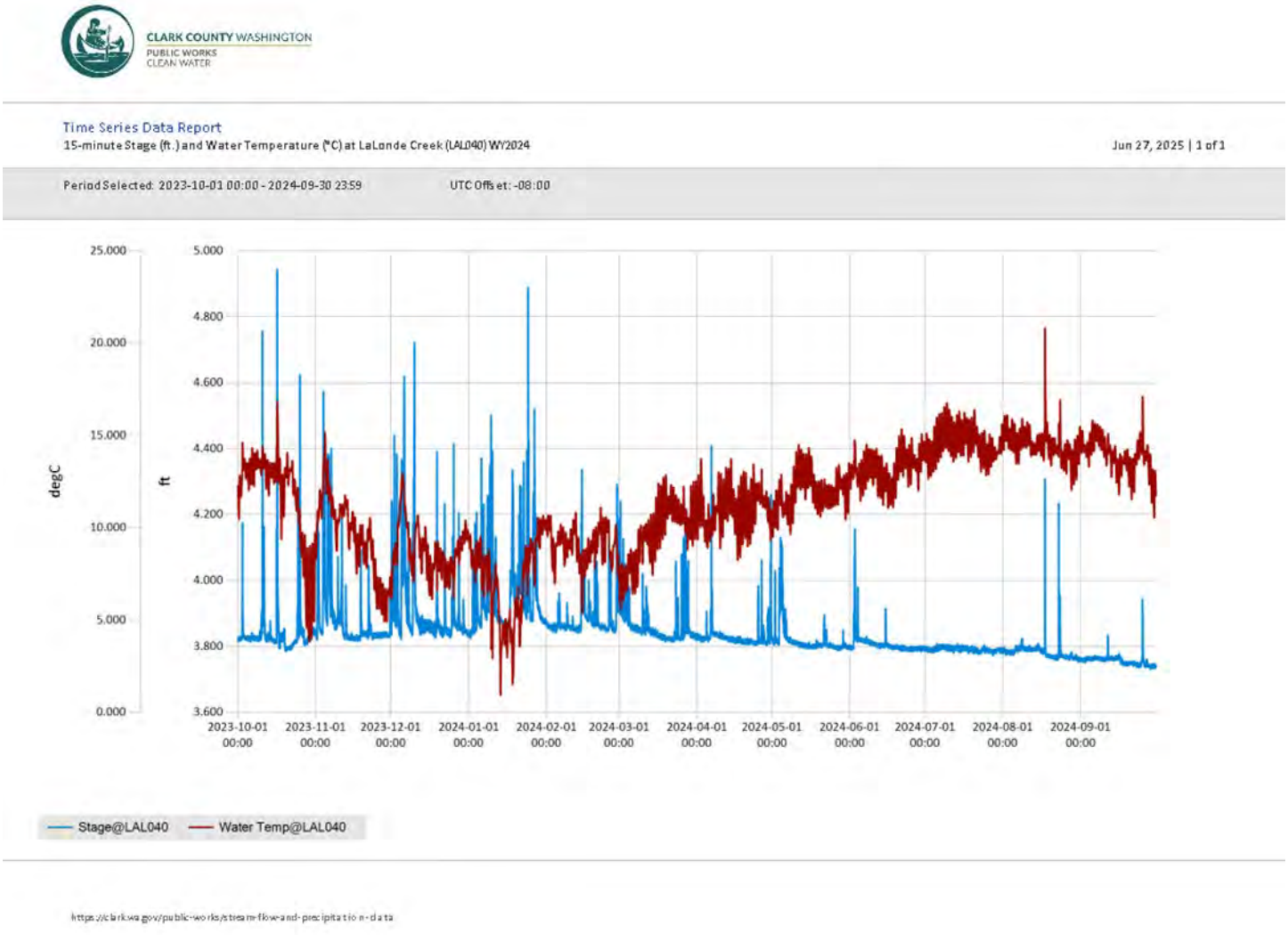

Figure B 5. 15-minute stage and temperature at LaLonde Creek

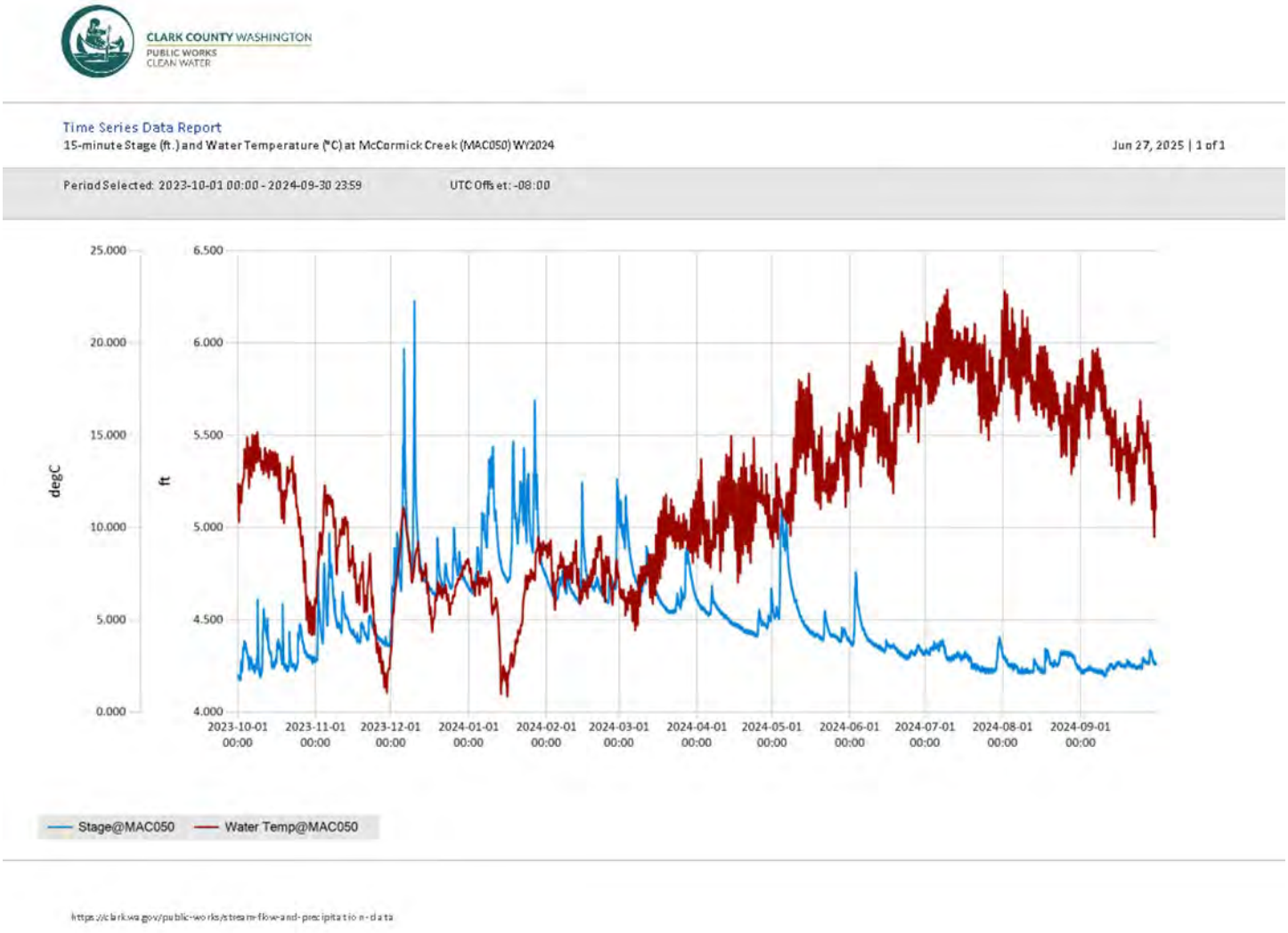

Figure B 6. 15-minute stage and temperature at McCormick Creek

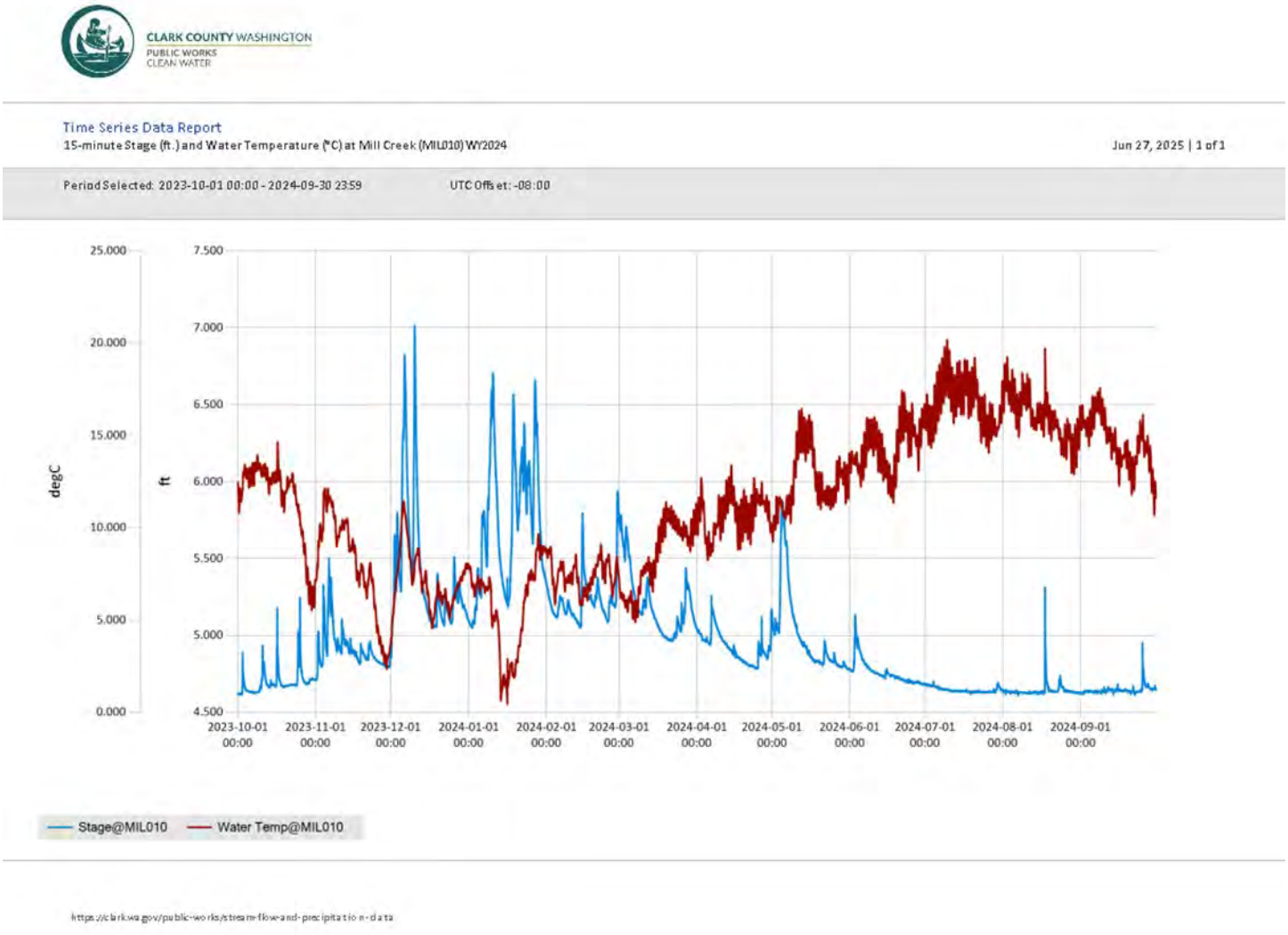

Figure B 7. 15-minute stage and temperature at Mill Creek

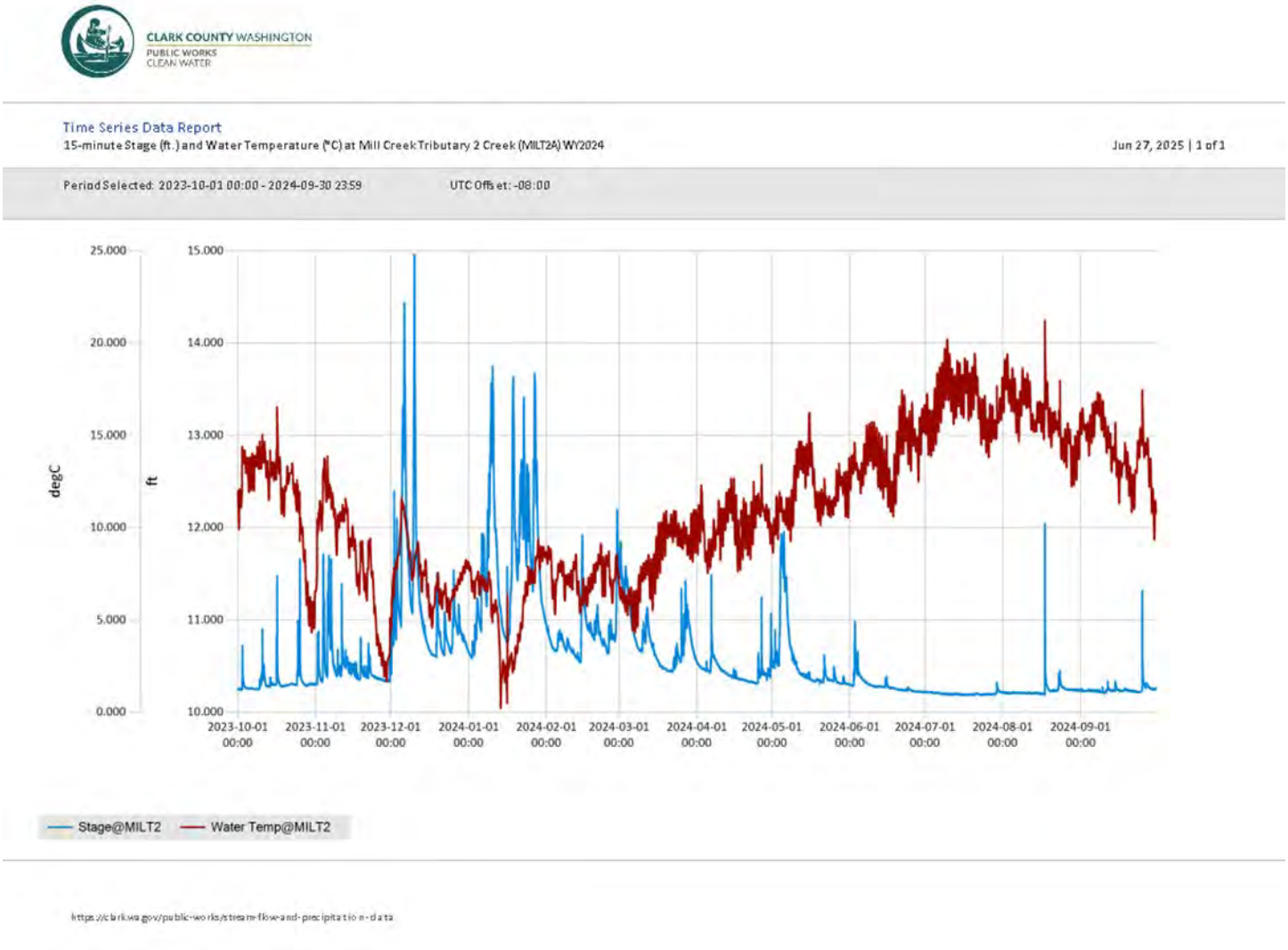

Figure B 8. 15-minute stage and temperature at Mill Creek Tributary

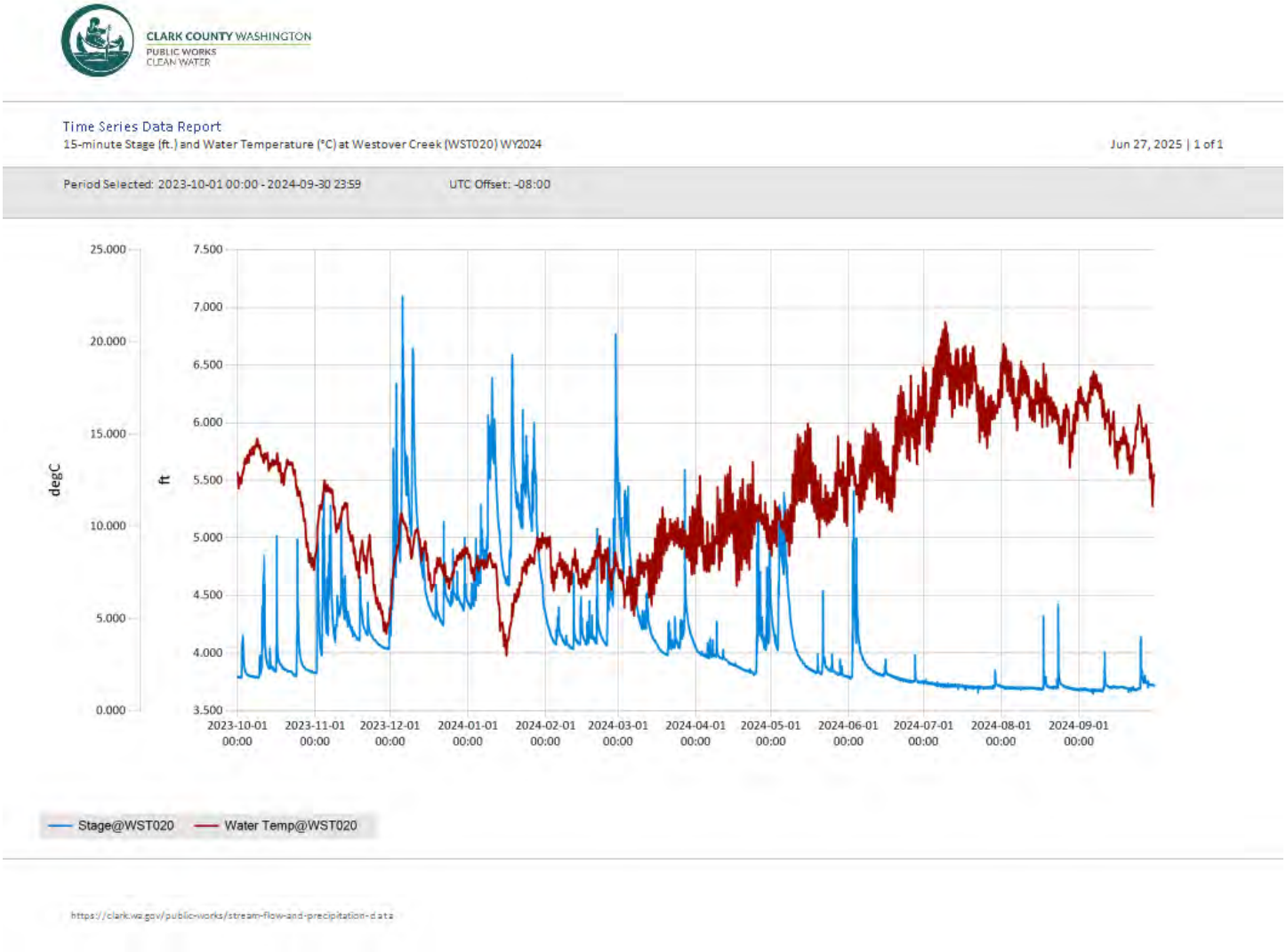

Figure B 9. 15-minute stage and temperature at Westover Creek

Exhibit G

10. Stormwater Technical Information Report and Stormwater Plan – Separately Bound

North Haven PUD
(PAC-2019-00183)

Preliminary Stormwater Report
Technical Information Report

Date: February 2020

Submitted to:
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Vancouver, WA 98660

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AKS Job Number: 4373

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Certificate of the Engineer

North Haven PUD
Clark County, Washington
Preliminary Technical Information Report

This Technical Information Report (TIR) and the data contained herein were prepared by the undersigned, whose seal, as a Professional Engineer licensed to practice as such, is affixed below. All information required by Clark County Code (CCC) Chapter 40.386 is included in the proposed stormwater plan and the proposed facilities are feasible.



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References

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Preliminary Stormwater Report
NORTH HAVEN SUBDIVISION PLANNED UNIT DEVELOPMENT
CLARK COUNTY, WASHINGTON

Section A: Project Overview

Site Information

The North Haven Planned Unit Development (PUD) site is located on three parcels of land totaling approximately 38 acres at the corner of NW 179th Street and NW 11th Ave. The project is located in the northeast quarter of Section 15, Township 3 North, Range 1 East of the Willamette Meridian in Ridgefield, Washington, Property Serial Numbers: 182164-000, 182168-000 and 182170-000. All parcels are zoned Residential (R-12) with an Urban Holding 10 (UH-10) overlay. The site is surrounded by properties zoned Single-Family Residential (R1-10) to the north, Single-Family Residential (R1-20) to the south, Rural-10 (R-10) to the west, and Public Facilities to the east. See the Vicinity Map in Appendix A for the project location.

The existing site contains one residential structure located on parcel 182170-000. On parcel 182168-000, there is a mobile home, carport, a barn and three outbuildings. Parcel 182164-000 does not contain any structures. All three parcels contain portions of agriculture fields and pasturelands as well as some trees. According to Clark County Geographic Information System (GIS), there is an existing septic system and well on site. All existing septic systems and wells on-site will be decommissioned, and all structures are proposed to be removed with the development of this site.

Wetlands and Floodplains

According to Clark County GIS, there are wetlands, a stream, and steep slopes present on site. The site is located within a Category II Critical Aquifer Recharge Area (CARA 2). The archaeological predictive is high to moderate-high across the site. There are no mapping indicators for historic sites within the project. The existing site vegetation consists of evergreen and deciduous trees, grass, shrubs and pasture grass. Much of the existing vegetation will be removed during development with the exception to the vegetation within the critical areas. Protected vegetation within the critical areas will not be disturbed.

The locations of the wetlands and stream shown on the plans are based on mapped information provided by Ecological Land Services (ELS). There are three wetlands and a seasonal stream that includes a floodplain on-site. Wetland A is a category III wetland and the largest on-site along the NW 11th Avenue frontage. Wetland B is a category IV wetland near the northwest corner of the site near the intersection of NW 179th Street and NW 11th Avenue. Wetland C is an isolated wetland to the southeast of Wetland A. All site flow is currently within the Whipple Creek watershed. The project flows into two separate sub-basins of the Whipple Creek watershed; the Whipple Creek (Lower) and the Whipple Creek (Upper) sub-basins.

Packard Creek is a type Ns stream per the Washington Department of Natural Resources water typing standards and is located above and below Wetland A in a slight valley in the middle of the project site. There is an associated floodway and floodway fringe for Packard Creek that extends into the site as determined by Federal Emergency Management Agency (FEMA) flood mapping. No development lies

within the floodway. Some grading and a stormwater treatment swale are proposed within the limits of the floodway fringe.

Site Topography and Hydrology

The existing topography for the North Haven PUD site consists of varying slopes that generally direct drainage east to west towards the middle of the site. There is a slight ridge running east to west on parcel no. 182164-000 splitting the site drainage into two separate threshold discharge areas (TDAs). The natural drainage system's two outfalls are defined as Points of Compliance (POCs) to which post-developed discharge will be routed. The off-site neighboring properties' runoff from the east and northeast will be accounted for and are included in the hydraulic modeling for Basin 1.3.

Detention and Treatment in Post-Development Basins

Three detention ponds are being proposed for water quantity mitigation of project runoff. TDA #1 includes parcel nos. 182168-000, 182170-000, and a majority of parcel no. 182164-000 that flows through the middle of the site to a low point along NW 11th Avenue and totals approximately 39.9 acres. The POC for TDA #1 consists of four separate basins (Basin 0.1, Basin 1.1, Basin 1.2 & Basin 1.3), two detention ponds, a combination of mechanical filtration catch basins and a biofiltration swale for site stormwater treatment. Basins 1.1 and 1.2 will require mechanical filter catch basins and will include the use of stormwater service laterals to reduce the treatment area required for each catch basin. Basin 0.1 is the contributing off site areas that flow through Basin 1.3 and into Pond 1.3. Off site basin areas are summarized within Basin 0.1 for modeling purposes, see the Basin Maps, Appendix D, and the WWHM model, Appendix F, for more information.

TDA #2 includes the southern portion of parcel no. 182164-000 that flows south into the Whipple Creek (Upper) sub-watershed basin. The contributing area for TDA #2 is approximately 3.7 acres and includes only one basin (Basin 2.1), which is detained in a single pond after mechanical filtration and discharged to POC #2 along the southern boundary of the site. Stormwater service laterals will be used to reduce the treatment flow rates required for each mechanical treatment catch basins.

The stormwater system for the site is designed using a combination of the 2012 Western Washington Hydrology Model, Version 4.2.12 (WWHM) and Clark County Map Data, as well as HydroCAD version 10.00-20. HydroCAD was used to model the water quality biofiltration swale for Basin 1.3.

There are no surface waters, adjacent (within ¼ mile) critical areas, or adjacent developments that will be negatively affected by the project. The majority of stormwater from the neighboring parcels will remain off site, and on-site mitigated stormwater runoff will either be detained on-site at or below pre-developed release rates or sheet flow utilizing full dispersion. Runoff from neighboring parcels that flows toward the development will be included in the hydraulic model.

Development Overview

As shown on the preliminary land use plans included with this submittal, the applicant proposes to subdivide three parcels into 329 attached and detached single-family lots. Development will also include associated infrastructure and amenities required by Clark County for a PUD. Proposed site improvements will include sidewalks, sewer, water, public streets, open spaces, and trails. Lots will range from approximately 2,000 square feet to 4,700 square feet in area.

The site will be served by two entrances along NW 11th Avenue. NW 179th Street is classified as an Urban Principal Arterial (Pr-4cb) and NW 11th Avenue is classified as an Urban Minor Arterial (M-2cb), each will require half-street improvements and right-of-way dedication along the frontage of the development.

The development is proposed to be completed in 6 phases: Phase 1, Phase 2A, Phase 2B, Phase 3, Phase 4, and Phase 5. See the development plans, Appendix C, for more information.

Determination of Applicable Minimum Requirements

Proposed land disturbances will consist of grading and excavation of unsuitable soils for the construction of sidewalks, utilities, streets and 329 residential lots. Due to the amount of proposed hard surfaces (greater than 5,000 square feet), the project is required to meet Minimum Requirements (MRs) #1-9 per Figure 1.2 of the Clark County Stormwater Manual (CCSM; see Appendix B).

The tables in this section provide information pertaining to each stormwater basin within the project area. See the Stormwater Basin Plans in Appendix D for basin locations.

Table A.1: Proposed Hard Surface and Landscaping

Basin	Threshold Discharge Area (TDA)	Existing Hard Surfaces (acres)	New Hard Surfaces (acres)	Replaced Hard Surfaces (acres)	Native Vegetation Replaced with Landscaping (acres)	Total Land Disturbed (acres)
Basin 0.1[1]	1	0.00	0.00	0.00	0.00	0.00
Basin 1.1	1	0.40	1.23	0.40	0.09	1.32
Basin 1.2	1	0.00	2.98	0.00	0.84	3.82
Basin 1.3	1	0.31	18.88	0.31	6.56	25.44
Basin 2.1	2	0.00	2.61	0.00	1.04	3.65

Note: Areas listed are in acres. Assumes 500-square-foot driveways, and 1,600- square-foot roof area per lot. See the Post-Developed Basin Plan in Appendix D. Areas in the table include all areas within the basins.

[1]Basin 0.1 is the offsite area that will be collected and passed through Basin 1.3 stormwater detention and treatment. Existing conditions are assumed for pre- & post developed scenarios.

Tables A.2 and A.3 show the mitigated site basins differentiated between pollution- and non-pollution-generating surfaces. Based on the design, it is important to note that most, if not all, non-pollution-generating areas will directly mix or can mix with stormwater runoff from pollution-generating areas and are therefore considered to be pollution-generating.

Table A.2: Pollution Generating Surfaces

Basin	Hard Surfaces (acres)	Pervious (acres)	Total (acres)
Basin 0.1[1]	0.00	9.04	9.04
Basin 1.1	1.23	0.09	1.32
Basin 1.2	1.44	0.45	1.89
Basin 1.3	18.88	6.56	25.44
Basin 2.1	1.57	0.62	2.19

Note: Areas listed are in acres. Assumes 500-square-foot driveways, and 1,600- square-foot roof area per lot. See the Post-Developed Basin Plan in Appendix D. Areas in the table include all areas within the basins.

[1]Basin 0.1 is the offsite area that will be collected and passed through Basin 1.3 stormwater detention and treatment.

Table A.3: Non-Pollution-Generating Surfaces

Basin	Hard Surfaces (acres)	Pervious (acres)	Total (acres)
Basin 0.1[1]	0.00	0.00	0.00
Basin 1.1	0.00	0.26	0.26
Basin 1.2	1.54	0.39	1.93
Basin 1.3	0.00	0.00	0.00
Basin 2.1	1.17	0.29	1.46

Note: Areas listed are in acres. Assumes 500-square-foot driveways, and 1,600- square-foot roof area per lot. See the Post-Developed Basin Plan in Appendix D. Areas in the table include all areas within the basins. Roof areas will connect to the storm main through a service lateral to avoid mixing with pollution generating surfaces.

[1]Basin 0.1 is the offsite area that will be collected and passed through Basin 1.3 stormwater detention and treatment.

Each developed basin's effective hard surfaces and their applicability to meeting MRs #6-8 are summarized in Table A.4 below. An analysis of the basins using WWHM modeling software is included in Appendix F.

Table A.4: Effective Hard Surfaces

Basin	TDA	Hard Surfaces Area (acres)	MR#6 Required (Y/N)	MR#7 Required (Y/N)	MR#8 Required (Y/N)
Basin 0.1[1]	1	0.00	N	N	N
Basin 1.1	1	1.23	Y	Y	N
Basin 1.2	1	2.98	Y	Y	N
Basin 1.3	1	18.88	Y	Y	N
Basin 2.1	2	2.61	Y	Y	N

Note: Areas listed are in acres. Assumes 500-square-foot driveways, and 1,600- square-foot roof area per lot. See the Post-Developed Basin Plan in Appendix D. Areas in the table include all areas within the basins.

[1]Basin 0.1 is the offsite area that will collected and passed through Basin 1.3 stormwater detention and treatment.

Section B: Minimum Requirements

MR #1: Preparation of Stormwater Site Plans

Stormwater Engineering Plans have been submitted for review.

MR #2: Construction Stormwater Pollution Prevention Plan (SWPPP)

MR #2 is not applicable per 1.8.1.5 of the 2015 CCSM for the Preliminary TIR. A Stormwater Pollution Prevention Plan (SWPPP) will be provided during final engineering.

MR #3: Source Control of Pollution

In conformance with the requirements of CCC Chapter 13.26A, there will be no prohibited discharges planned from the site. Best management practices (BMPs) will be designed and indicated on the SWPPP and Erosion Control Plans, including details on preventing sediment-laden runoff from leaving the site and impacting any neighboring properties and County systems such as state waters. In addition, BMPs will be implemented as necessary to prevent pollutants from mixing with stormwater during construction. None of the development activities listed in Appendix 3-A of Book 3 of the 2015 CCSM are applicable to the project.

MR #4: Preservation of Natural Drainage Systems and Outfalls

Basins 0.1, 1.1, 1.2, and 1.3 surfaces currently sheet flow to the Type Ns Packard Creek drainage corridor. After development, most runoff will be collected via catch basins and stormwater laterals for roof runoff and conveyed to stormwater ponds where it will be detained to equal to, or below the pre-developed discharge rates. Discharge will occur at the natural drainage systems outfall at POC 1 and be equipped with energy dissipaters. Basin 1.3 will use weep holes in the curb for lot drainage to discharge into the street and convey to catch basins.

Basin 2.1 surface currently sheet flows in a southernly direction onto the neighboring property's pasture. After development, all runoff will be collected via catch basins and stormwater laterals for roof runoff and conveyed to a stormwater pond where it will be detained to equal to or below the pre-developed discharge rates. Discharge will occur at the natural drainage systems outfall to POC 2. The outfall will be equipped with an energy dissipater and a flow spreader.

The stormwater facilities will detain runoff at equal or below the pre-developed discharge rates from the TDA, as required per MR #7.

MR #5: On-Site Stormwater Management BMPs

General

The project proposes to use three detention ponds, flow control manholes, sedimentation manholes, mechanical water quality catch basin filters, basic biofiltration swale or wet biofiltration swale (BMP T9.10 and BMP T9.20), and/or biofiltration systems (proprietary BMP – StormFilter, PerkFilter, Filtera, or an approved equal). All roof runoff is proposed to either flow through weep holes into the right-of-way and mix with pollution-generating asphalt roadway surfaces or connect via a stormwater service lateral to the stormwater main line and bypass treatment. All crawl spaces, foundation drains, and incidental landscape runoff that is collected with grated drain basins will be collected and conveyed in the same manner. All driveways will flow into the right-of-way and mix roadway surfaces.

Per the Soil Survey of Clark County, Washington (U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS)), on-site soils consist of the following:

- HoB (Hillsboro silt loam, 3-8 % slopes), 23% of site
- SlB (Sara silt loam, 0-8% slopes), 5% of site
- SlD (Sara silt loam, 8-20% slopes), 72% of site

A County GIS soils map is included in Appendix A.

A preliminary geotechnical investigation dated January 2019, by Earth Engineering, Inc. (EEI) was completed for the site and includes infiltration testing. Of the 12 test pits dug at the site, testing was performed in three test pits, with the results of all three being 0.0 inches/hour. Groundwater was identified in only two of the test pits. These test pits were located along the central drainage channel of the site, and groundwater was met at approximately three feet below existing grade. Groundwater was not encountered in the remaining test pits for the site. The field investigation indicated approximately 8-18 inches of topsoil for the site.

See the Soils Map and Geotechnical Report in Appendix G for additional information.

All stormwater quality and quantity facilities for the site have been designed in conformance with the 2015 CCSM and are detailed on the Development Plans included in Appendix C. See Appendix E for additional design criteria for the proposed BMPs.

LID

From Figure 2.1: Flow Chart for Determining Low-Impact Development (LID) Minimum Requirement #5 Requirements of the CCSM, the project is required to meet the LID Performance Standard through use of any BMP(s) in the CCSM except for Rain Gardens, the LID Performance Standard is not being met. Mandatory List #2 (Table 2.2) was therefore used to evaluate LID BMPs to be considered for projects subject to MR#1-9.

Infiltration is not recommended for this site due to the very low permeability of the on-site infiltration testing performed during the preliminary geotechnical investigation, making most LID BMPs infeasible for this project. Due to site layout and unknown slopes at the rear of lots adjacent to on-site open spaces, dispersion of lot stormwater may be utilized during final engineering analysis once final site grading is determined. In lieu of the LID Performance Standard, the LID Feasibility Checklist is used for this project, see Appendix I. Due to the site being new development within an urban growth area (UGA), List #2 is used

for roofs and other hard surfaces. In following the checklists guidelines, all LID BMPs were determined to be infeasible for this project as a whole.

MR #6: Runoff Treatment Analysis and Design

The proposed stormwater facilities will provide basic runoff treatment for all the on-site pollution-generating impervious surfaces, which are totaled in Table A.2, above. The project proposed the use of a water quality treatment biofiltration swale (BMP T9.10), and a combination of mechanical water quality catch basin filters, and/or biofiltration systems (Proprietary BMP – StormFilter, Perkfilter, Filtera, or an approved equal) for water quality prior to discharging to site detention facilities. All roof runoff is proposed to either flow through weep holes into the right-of-way and mix with pollution-generating asphalt roadway surfaces or connect via a stormwater service lateral to the stormwater main line and bypass treatment. All crawl spaces, foundation drains, and incidental landscape runoff that is collected with grated drain basins will be collected and conveyed in the same manner. All driveways will flow into the right-of-way and mix roadway surfaces. Basin 1.3 will utilize a post-detention water quality biofiltration swale which is designed to pass the full 2-year flow rate for water quality treatment, see Appendix F for HydroCAD output for swale sizing.

All stormwater quality facilities for the site have been designed in conformance with the 2015 CCSM. The approximate location and size of the proposed runoff treatment facilities are shown on the Preliminary Development Plans in Appendix C.

MR #7: Flow Control

The proposed stormwater facilities in each basin will provide flow control for the increased runoff generated by the new developments impervious and pervious surfaces, the surfaces are totaled in Table A.1 above.

The project proposes to use three detention ponds, each equipped with a flow control manhole, to meet site flow control requirements. All roof, driveway and incidental landscape runoff is proposed to flow through site detention ponds. Location of site detention ponds are summarized in the Development Plans in Appendix C, while the site detention ponds were sized using WWHM (see Appendix F for WWHM model output). Infiltration BMPs were not selected based on infiltration testing done by Earth Engineering Inc., which indicated very low infiltration rates for on-site soils (Appendix G).

Each detention pond will be equipped with an emergency overflow spillway sized to pass the 100-year flow to prevent breaching of the pond embankment due to high inflows or blockage of the control manholes. The overflows will be located at or near the control manholes in a location nearest the points of discharge to the natural drainage flow paths. All stormwater quantity facilities for the site have been designed to conform with the CCSM.

MR #8: Wetlands Protection

The site contains three total on-site wetlands associated with the natural drainage ways on site. Wetland A is a category III, Wetlands B and C are a category IV. Any discharge to a wetland shall maintain the hydrologic conditions, hydrophytic vegetation, and substrate characteristics necessary to support existing and designated uses. All criteria from Appendix 1-H, Wetland Guidelines of the CCSM, have been met and a completed checklist is provided in Appendix H of this report.

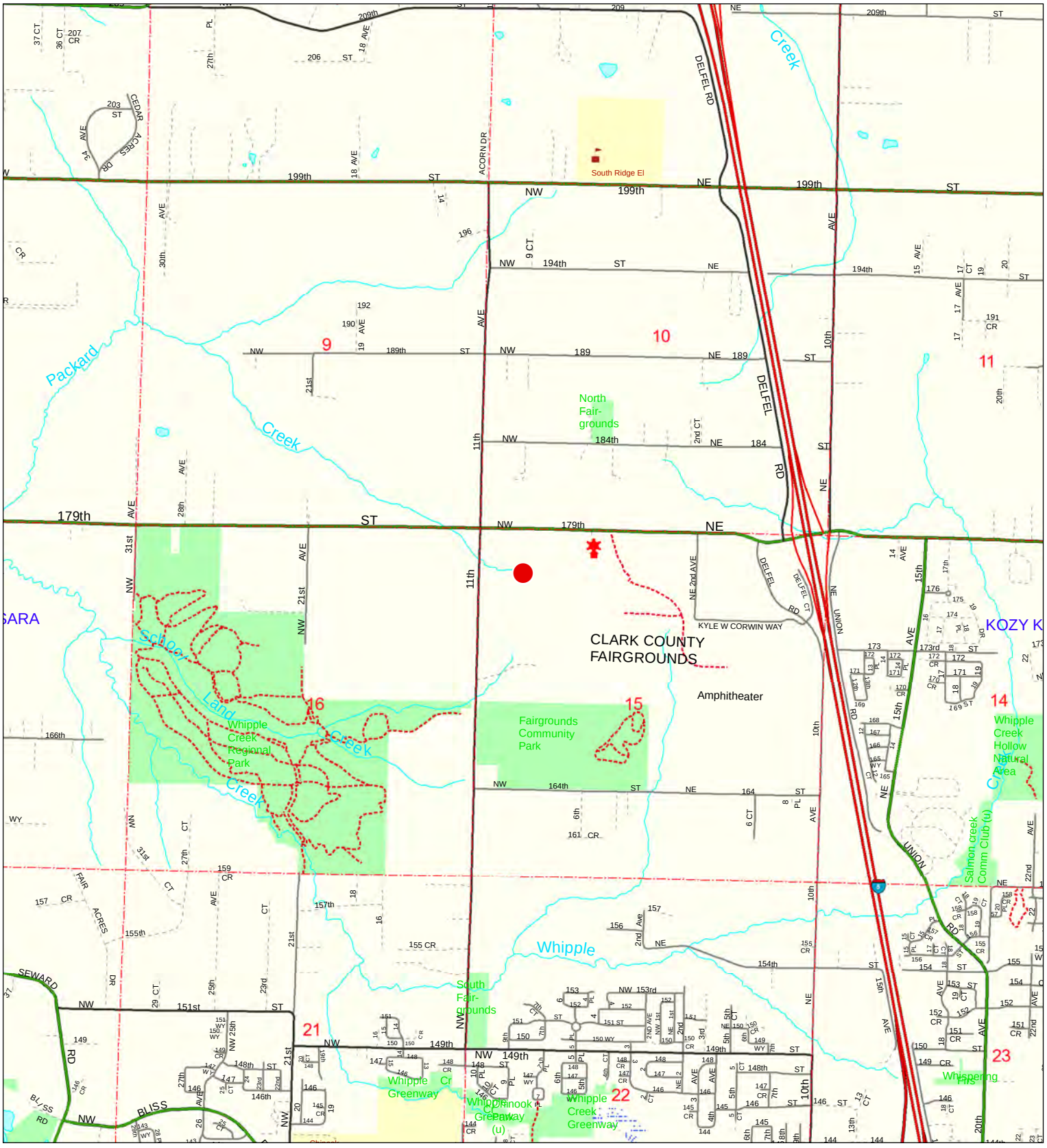
Stormwater treatment and flow control facilities are not proposed to be built within native vegetative buffers, except for necessary grading, conveyance, dispersion, and discharge systems as allowed within

Category III Wetlands per the Unified Development Code (UDC) 40.450, Wetland Protection. See separate Critical Areas Report prepared for BTMC, LLC. By Ecological Land Services dated February 2020 for complete impact and mitigation activities.

MR #9: Operation and Maintenance

All stormwater facilities located within the right-of-way or open-space tracts of land (detention ponds, mechanical filter catch-basins, biofiltration swales, manholes, catch basins, conveyance piping, conveyance ditching, culverts, and water quantity control structures, unless otherwise specified on the plans), will be owned and maintained by the County consistent with County policy. All other stormwater facilities located on private property (area drains, conveyance piping, and associated structures) are proposed to be maintained by the lot owners or the Homeowner's Association.

Appendix A:
Map Submittals

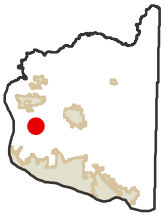


General Location

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

Location of Subject Property(s)

Printed on: August 19, 2019



CLARK COUNTY, WASHINGTON
Geographic Information System

0 1,000 2,000 Feet

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



Elevation Contours

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

Printed on: August 19, 2019

CLARK COUNTY, WASHINGTON
Geographic Information System

N

0 200 400 Feet

Subject Property(s)
Public Road
Transportation or Major Utility Easement
10' Elevation Contours
2' Elevation Contours

31109	31110	31111
31116	31115	31114
31121	31122	31123

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.

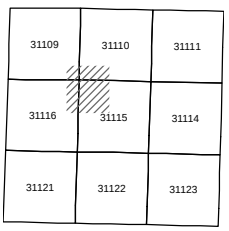


2016 Aerial Photography

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

Subject Property(s)

Printed on: August 19, 2019



CLARK COUNTY, WASHINGTON
Geographic Information System

N

0 200 400 Feet

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2016 Aerial Photography with Elevation Contours

Printed on: August 19, 2019

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

CLARK COUNTY, WASHINGTON
Geographic Information System

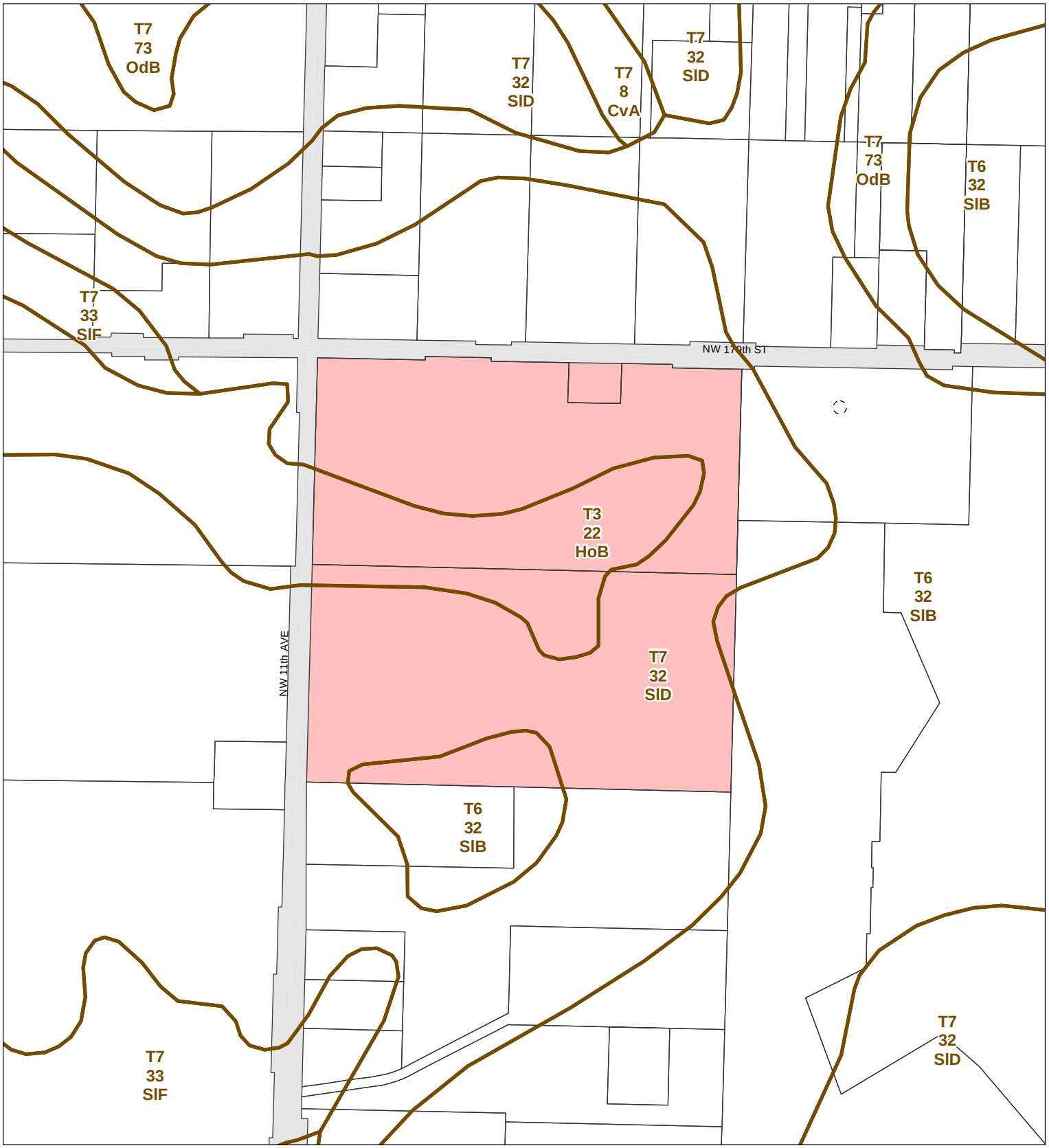
N

0 100 200 Feet

Subject Property(s)
2' Elevation Contours

31109	31110	31111
31116	31115	31114
31121	31122	31123

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



Soil Types

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

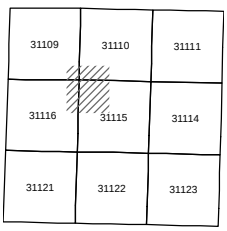
Printed on: August 19, 2019

CLARK COUNTY, WASHINGTON
Geographic Information System

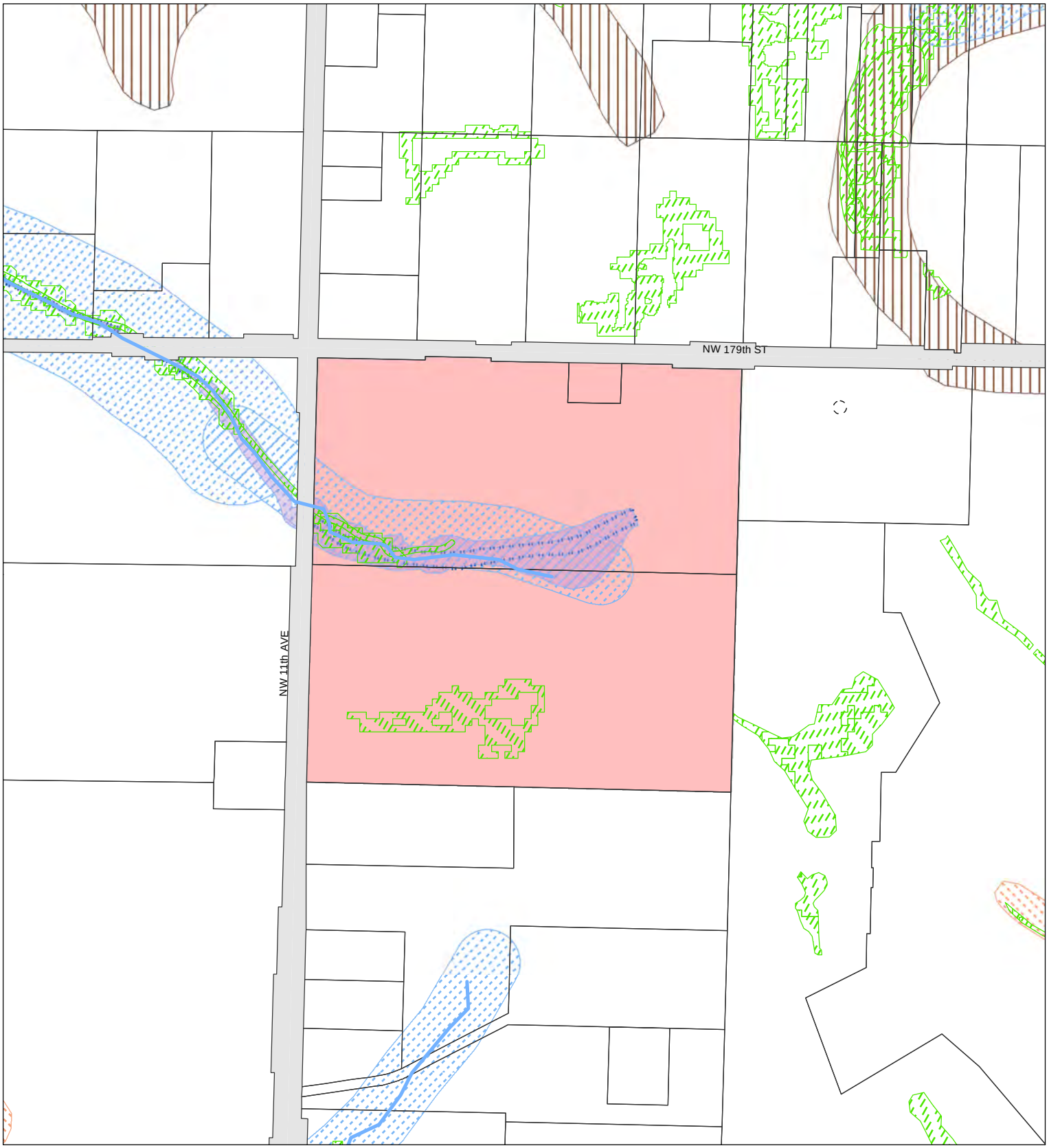
N

0 200 400 Feet

Subject Property(s)
Public Road
Transportation or Major Utility Easement
Soil Type Boundary



Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



Environmental Constraints I

Printed on: August 19, 2019

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

CLARK COUNTY, WASHINGTON
Geographic Information System

N

0 200 400 Feet

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.

- Subject Property(s)
- Public Road
- Transportation or Major Utility Easement
- Hydric Soils
- Wetland Inventory
- CARA Category 1
- Riparian Habitat or Species Area
- Non-Riparian Habitat or Species Area
- 100 year Floodplains
- Floodway
- Shorelines
- Stream

31109	31110	31111
31116	31115	31114
31121	31122	31123

Appendix B:
New Development Flow Chart

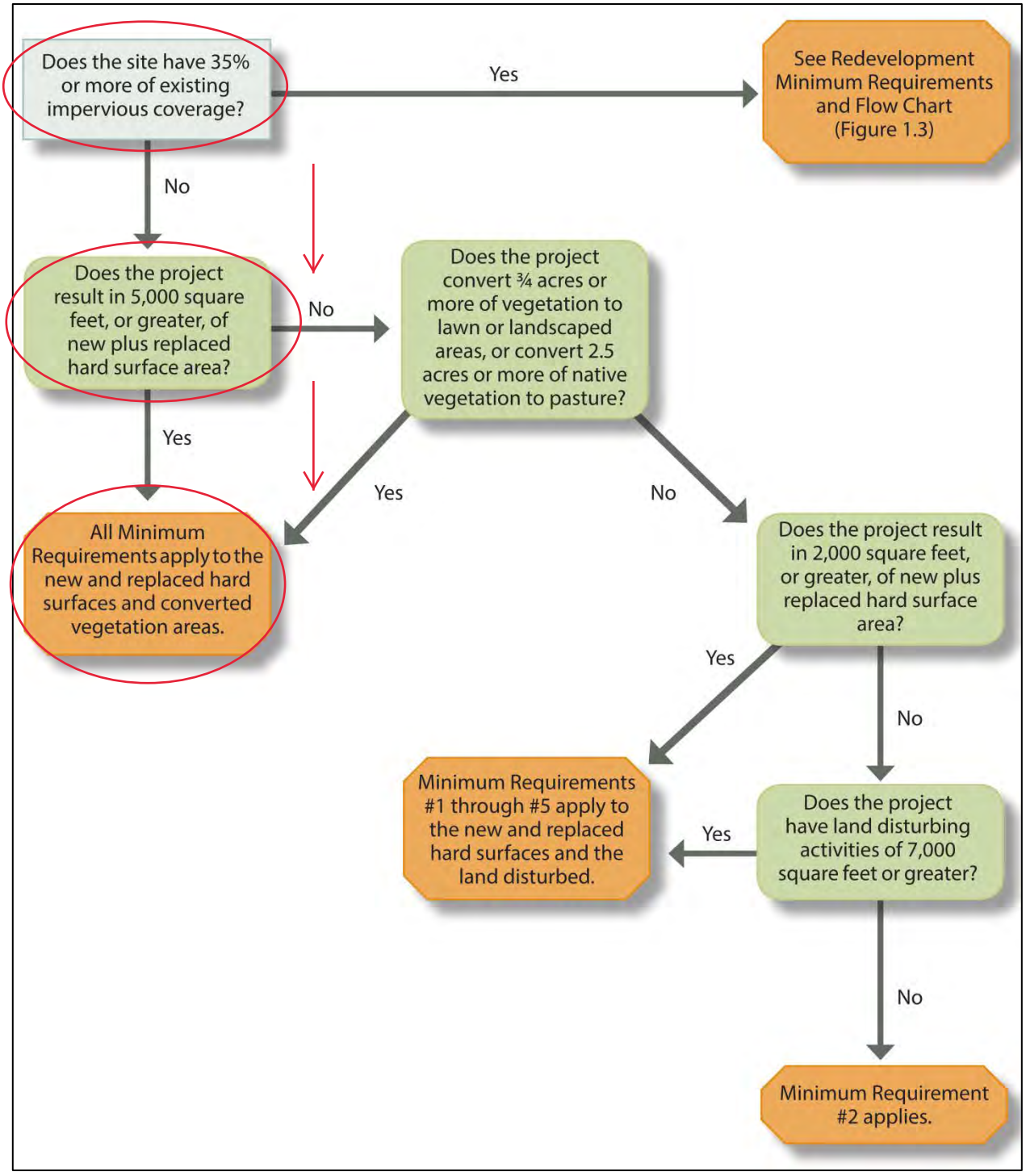


Figure 1.2: New Development Flow Chart

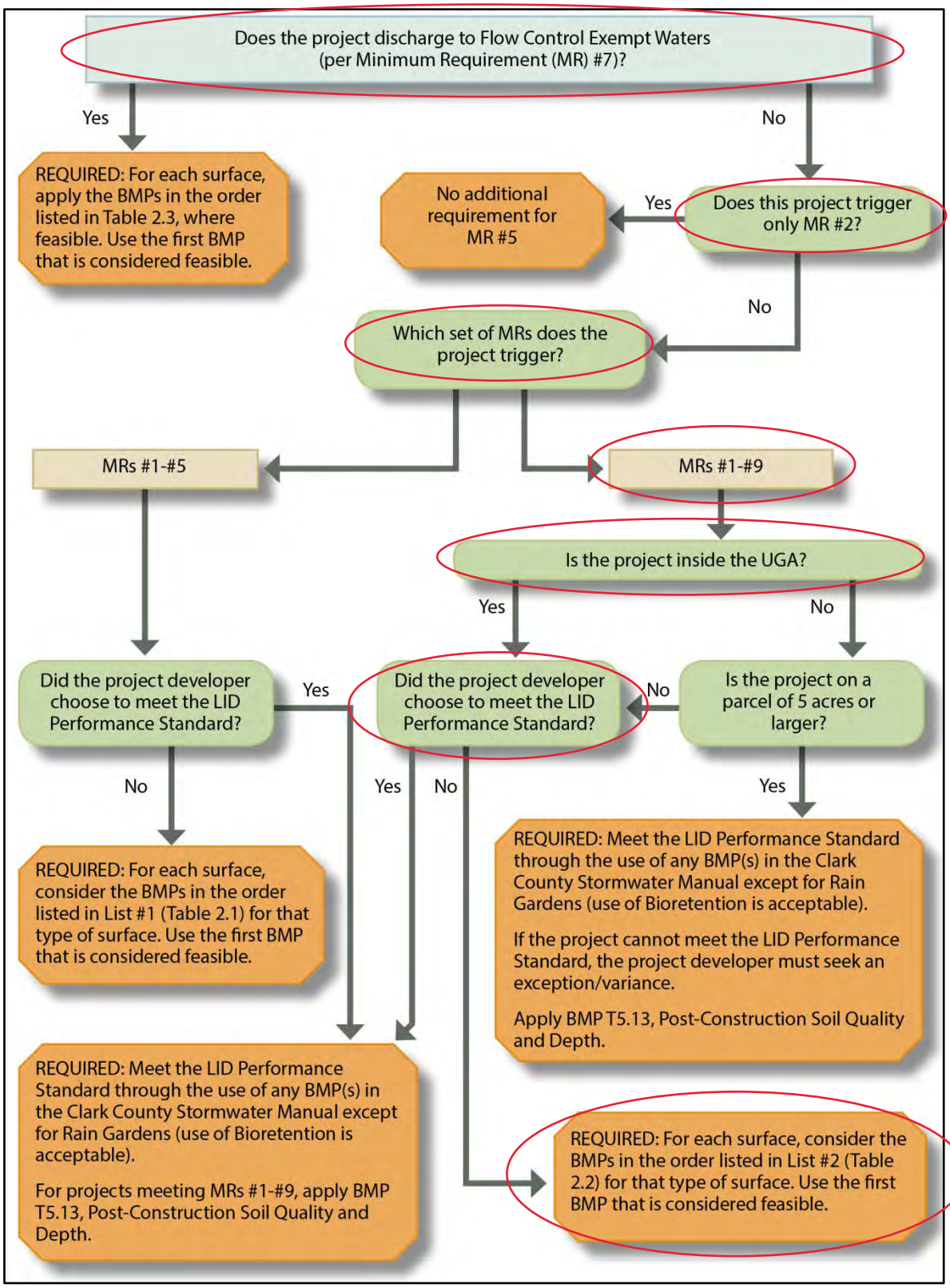


Figure 2.1: Flow Chart for Determining LID Minimum Requirement #5 Requirements

Appendix C:
Development Plans



PHASE 1		
LOT #	AREA	DESTINATION
1–16, 226–249, 257–266, 294–329, TRACTS C, D, E, F, K, R	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN PRIOR TO POND 1.3
17–30, TRACT G	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	FILTER CATCH BASIN PRIOR TO POND 2.1
TRACT A	PUMP STATION	FILTER CATCH BASIN TO DIRECT DISCHARGE

PHASE 2A		
LOT # / TRACT	AREA	DESTINATION
135, 136, 183–200, TRACT P, TRACT Q	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	FILTER CATCH BASIN PRIOR TO POND 1.2
70–76, 165–182, 201–214	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN PRIOR TO POND 1.3

PHASE 2B		
LOT # / TRACT	AREA	DESTINATION
TRACT N	LANDSCAPE, CRITICAL AREA	DIRECT DISCHARGE

PHASE 3		
LOT # / TRACT	AREA	DESTINATION
31–48, TRACT H	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	FILTER CATCH BASIN PRIOR TO POND 2.1
49–69, 215–225, 250–254, 267–272, 275–293	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN PRIOR TO POND 1.3

PHASE 4		
LOT # / TRACT	AREA	DESTINATION
77–118, 143–164, TRACT L, TRACT M, TRACT T	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN PRIOR TO POND 1.3
119–134, 137–142	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	FILTER CATCH BASIN PRIOR TO POND 1.2
NW 179TH STREET	LANDSCAPE, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN PRIOR TO POND 1.3

PHASE 5		
LOT # / TRACT	AREA	DESTINATION
255–256, 273–274, TRACT J	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN AND DITCH INLET PRIOR TO POND 1.3

GENERAL NOTES:

1. UTILITIES SHOWN ARE BASED ON UNDERGROUND UTILITY LOCATE MARKINGS AS PROVIDED BY OTHERS PER UTILITY LOCATE TICKET NUMBER 18511980. THIS SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND LOCATES REPRESENT THE ONLY UTILITIES IN THE AREA. CONTRACTORS ARE RESPONSIBLE FOR VERIFYING ALL EXISTING CONDITIONS PRIOR TO BEGINNING CONSTRUCTION.
2. FIELD WORK WAS CONDUCTED DECEMBER, 2018 – JANUARY, 2019.
3. VERTICAL DATUM: ELEVATIONS ARE BASED ON NGVD29(47) CLARK COUNTY DATUM AND BENCHMARK "SARA 3" LOCATED THE CENTERLINE–CENTERLINE INTERSECTION OF NW 179TH STREET AND NW 11TH AVENUE WITH ELEVATION = 278.613 FEET.
4. THIS MAP DOES NOT CONSTITUTE A PROPERTY BOUNDARY SURVEY TO BE RECORDED WITH THE COUNTY. BOUNDARIES MAY BE PRELIMINARY AND SHOULD BE CONFIRMED WITH THE STAMPING SURVEYOR PRIOR TO RELYING ON FOR DETAILED DESIGN OR CONSTRUCTION.
5. CONTOUR INTERVAL IS 2 FOOT.
6. TREES ARE NOT SHOWN.
7. WETLAND BOUNDARIES WERE FLAGGED BY ENVIRONMENTAL LAND SERVICES AND PROFESSIONALLY SURVEYED BY AKS ENGINEERING & FORESTRY ON 01/14/2020.
8. OFF–SITE AREAS CONTRIBUTING TO RUNOFF INCLUDE NW 11TH AVENUE, NW 179TH STREET, PARCEL NO. 116610–000, PARCEL NO. 116600–000, PARCEL NO. 116590–000, PARCEL NO. 116570–000, PARCEL NO. 182217–000, AND PARCEL NO. 182144–000.

LEGEND

- EXISTING GROUND CONTOUR (2 FT)
- EXISTING GROUND CONTOUR (10 FT) —350—
- FINISHED GRADE CONTOUR (2 FT)
- FINISHED GRADE CONTOUR (10 FT) —350—
- WETLAND BOUNDARY —WL—WL—WL—WL—
- PHASE BOUNDARY
- TDA BOUNDARY
- STORM FACILITY ACCESS

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9600 NE 126TH AVE, STE 2520
VANCOUVER, WA 98682
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WWW.AKS-ENG.COM

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FORESTRY • PLANNING • LANDSCAPE ARCHITECTURE

PRELIMINARY STORMWATER PLAN
NORTH HAVEN PUD
BTMC, LLC
CLARK COUNTY, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	4373
DATE:	2/12/2020
DESIGNED BY:	CJS
DRAWN BY:	CJS
CHECKED BY:	JMM

P5.0

AKS DRAWING FILE: 4373 P5.0 STORMLDWG | LAYOUT: P5.0

Appendix D:
Stormwater Basin Plans



NOTE:

1. TDA #1 CONSISTS OF BASIN 0.1 AND BASIN 1.0
2. TDA #2 CONSISTS OF BASIN 2.0

N

SCALE: 1"=100 FEET

100 0 20 50 100

ORIGINAL PAGE SIZE: 24" x 36"

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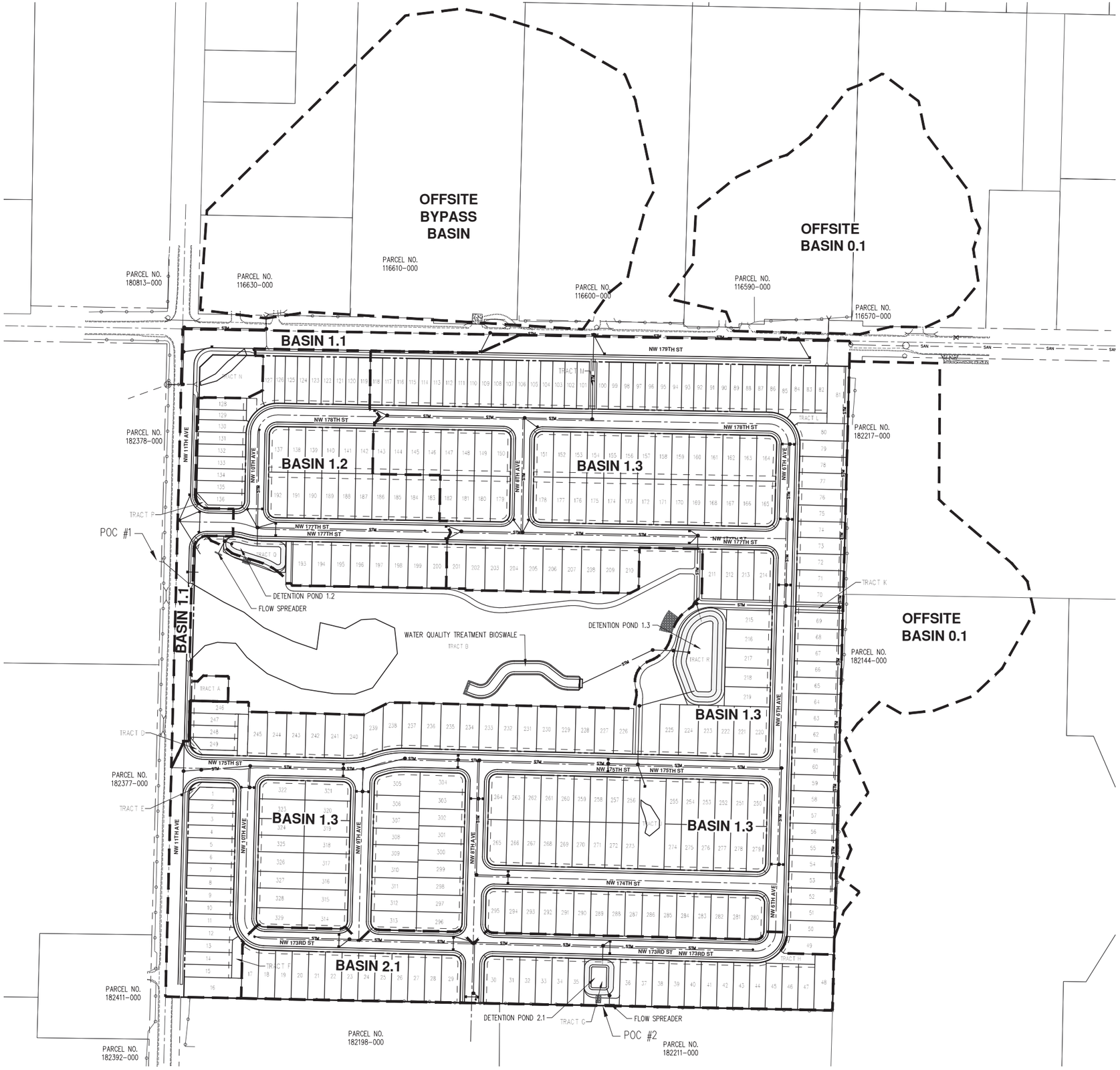
PRE-DEVELOPED BASIN PLAN
NORTH HAVEN PUD
BTMC, LLC
CLARK COUNTY, WASHINGTON

PRELIMINARY
NOT FOR
CONSTRUCTION

JOB NUMBER:	4373
DATE:	2/5/2020
DESIGNED BY:	CJS
DRAWN BY:	CJS
CHECKED BY:	JMM

ST-1

AKS DRAWING FILE: 4373 PRE-DEVELOPED.DWG | LAYOUT: PRE-DEV



NOTE:

1. TDA #1 CONSISTS OF BASIN 0.1, BASIN 1.1, BASIN 1.2 AND BASIN 1.3
2. TDA #2 CONSISTS OF BASIN 2.1

N

SCALE: 1"=100 FEET

100 0 20 50 100

ORIGINAL PAGE SIZE: 22" x 34"

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POST-DEVELOPED BASIN PLAN
NORTH HAVEN PUD
BTMC, LLC
CLARK COUNTY, WASHINGTON

PRELIMINARY
NOT FOR CONSTRUCTION

JOB NUMBER:	4373
DATE:	2/5/2020
DESIGNED BY:	CJS
DRAWN BY:	CJS
CHECKED BY:	JMM

ST-2

AKS DRAWING FILE: 4373 POST-DEVELOPED.DWG | LAYOUT: POST-DEV

Appendix E:
BMP Details

BMP T5.13: Post-Construction Soil Quality and Depth

Purpose and Description

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal topsoil and sod. Not only are these important stormwater functions lost, but such landscapes themselves become pollution generating pervious surfaces due to increased use of pesticides, fertilizers and other landscaping and household/industrial chemicals, the concentration of pet wastes, and pollutants that accompany roadside litter. Establishing soil quality and depth regains greater stormwater functions in the post development landscape, provides increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals, thus reducing pollution through prevention.

Cross Reference Guide

Soils Assessment	NA
Meets Minimum Requirements	#5
Related BMPs	None
Selection Criteria	Book 1, Sections 2.2 and 2.5.2
Maintenance	Book 4

Applications, Limitations and Setbacks

Establishing a minimum soil quality and depth is not the same as preservation of naturally occurring soil and vegetation. However, establishing a minimum soil quality and depth will provide improved onsite management of stormwater flow and water quality. Soil organic matter can be attained through addition of numerous materials such as compost, composted woody material, biosolids, and forest product residuals. It is important that the materials used to meet the soil quality and depth BMP be appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay fines. This BMP can be considered infeasible on slopes greater than 33 percent.

Soil and vegetation provide significant benefits, including:

- Water infiltration.
- Absorption of nutrients, sediments and pollutants.

BMP T9.10: Basic Biofiltration Swale

Purpose and Description

Biofiltration swales are typically shaped as a trapezoid or a parabola as shown below.

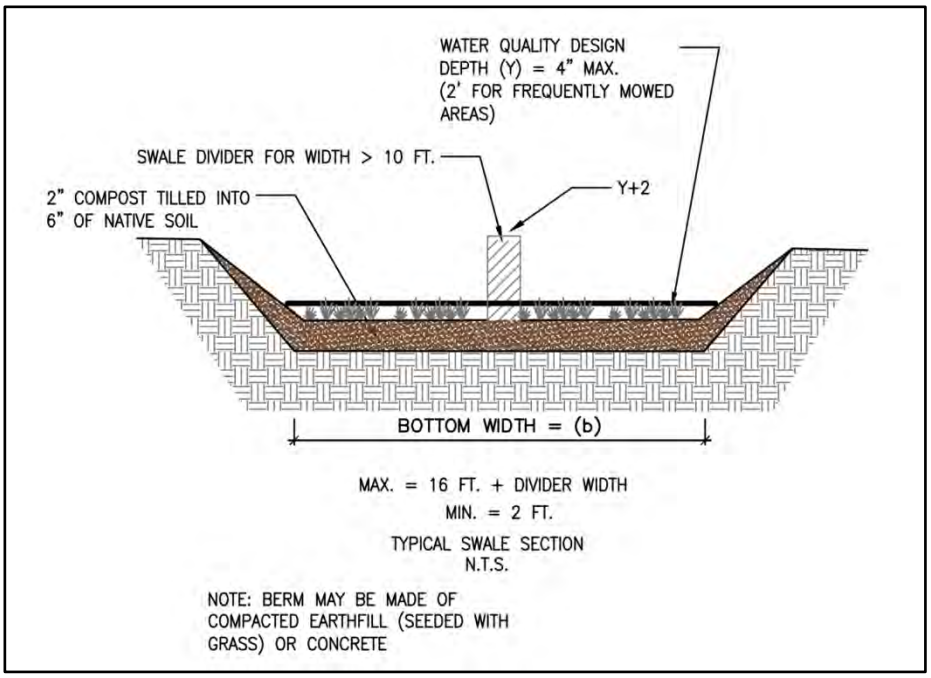


Figure 4.17: Typical Swale Section

(Source: redrawn from Stormwater Management Manual for Western Washington, 2014)

Cross Reference Guide

Soils Assessment	None
Minimum Requirements/ Treatment Type	MR #6 Meets Basic; Meets Enhanced and Phosphorus as part of a treatment train
Related BMPs	BMP T8.10 (Enhanced or Phosphorus), BMP T8.20 (Enhanced or Phosphorus), or BMP T8.40 (Enhanced) for a treatment train.
Selection/Infeasibility Criteria	Book 1, Section 3.2 and Section 3.4.4
Maintenance	Book 4

Application, Limitations and Setbacks

Data suggest that the performance of biofiltration swales is highly variable from storm to storm. Ecology recommends considering other treatment methods that perform more consistently, such as sand filters and wet ponds, before using a biofiltration swale. Biofiltration swales downstream of devices of equal or greater effectiveness can convey runoff; but do not consider them to offer a treatment benefit. (Horner, 2000).

Setbacks

See Section 3.1.4.

Design Criteria

- Table 4.5 specifies design criteria. Use a 9 minute hydraulic residence time at a multiple of the peak 15 minute Water Quality Design Flow Rate (Q) representing 91% runoff volume as determined by an approved continuous flow model.
- Check the hydraulic capacity/stability for inflows greater than design flows. Bypass high flows, or control release rates into the biofilter, if necessary.
- Install a Clark County Flow Spreader with Sediment Trap at the swale inlet (see Figure 3.3). Avoid the use of rock (e.g. quarry spalls) for energy dissipation within the swale because they make mowing and vegetation management difficult.
- Install concrete level spreaders at the head and every 50 feet in swales of ≥4 feet width. Include sediment cleanouts (weir, settling basin, or equivalent) at the head of the biofilter as needed.
- The use of riprap energy dissipaters due to increased downslopes must be approved by the Responsible Official.
- See Section 3.1.4 for information on allowable side slopes.

Guidance for Bypassing Off-line Facilities

Swales designed in an off-line mode should not engage a bypass until the flow rate exceeds a value determined by multiplying Q, the off-line water quality design flow rate predicted by an approved continuous flow model, by the ratio determined in Figure 4.3, Ratio of SBUH Peak/WQ Flow for Off-Line. This modified design flow rate is an estimate of the design flow rate determined by using SBUH procedures. The only advantage of designing a swale to be off-line is that the stability check, which may make the swale larger, is not necessary.

Sizing Procedure for Biofiltration Swales

This guide provides biofilter swale design procedures in full detail, along with examples.

Preliminary Steps (P)

- **P-1** Determine the Water Quality design flow rate (Q) in 15-minute time-steps using the WWHM. Use the correct flow rate, off-line or on-line, for the design situation.
- **P-2** Establish the longitudinal slope of the proposed biofilter.
- **P-3** Select a vegetation cover suitable for the site. Refer to Table 4.7 and Table 4.8 to select vegetation for western Washington.

Design Calculations for Biofiltration Swale

The procedure recommended here is an adaptation from the design procedure originated by Chow (Chow, 1959) for biofiltration applications in the Puget Sound region.

This procedure reverses Chow's order, designing first for capacity and then for stability. The capacity analysis emphasizes the promotion of biofiltration, rather than transporting flow with the greatest possible hydraulic efficiency. Therefore, it is based on criteria that promote sedimentation, filtration, and other pollutant removal mechanisms. Because these criteria include a lower maximum velocity than permitted for stability, the biofilter dimensions usually do not have to be modified after a stability check.

Design Steps (D)

- **D-1**. Select the type of vegetation, and design depth of flow, based on frequency of mowing and type of vegetation. Table 4.7 and Table 4.8 list suitable vegetation types.
- **D-2**. Select a value of Manning's n (Table 4.5 with footnote #3).

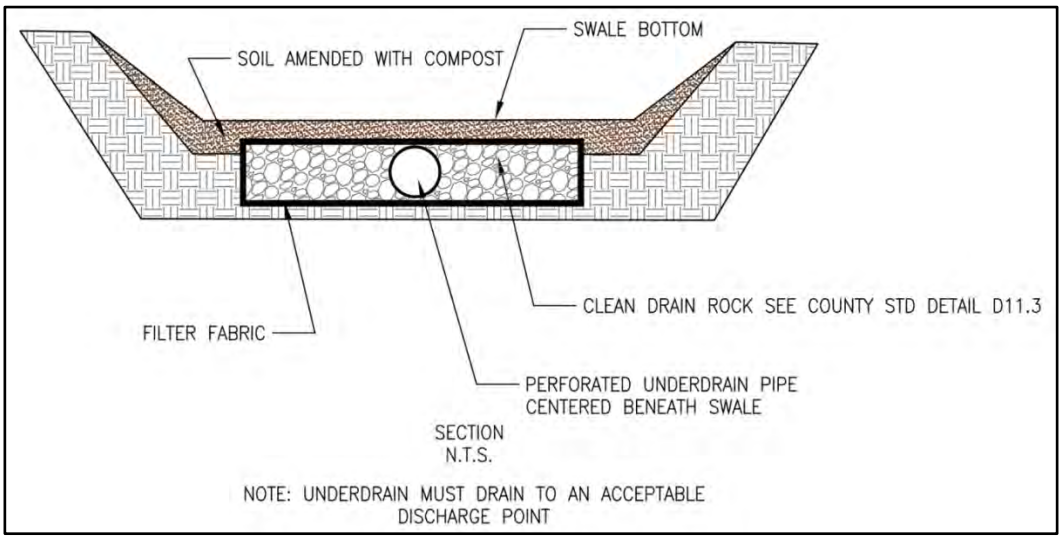


Figure 4.18: Biofiltration Swale Underdrain Detail

(Source: redrawn from WA State Dept. of Ecology)

Table 4.5: Biofiltration Swale Sizing Criteria

Design parameter	
Longitudinal Slope	0.015 - 0.025[1]
Maximum velocity	1 ft / sec (@ K multiplied by the WQ design flow rate ; for stability, 3 ft/sec max.
Maximum water depth[2]	2"- if mowed frequently; 4" if mowed infrequently
Manning coefficient (22)	(0.2 – 0.3)[3](0.24 if mowed infrequently)
Bed width (bottom)	(2 - 10 ft)[4]
Freeboard height	0.5 ft
Minimum hydraulic residence time at Water Quality Design Flow Rate	9 minutes (18 minutes for continuous inflow)
Minimum length	100 ft
Maximum sideslope	3 H : 1 V 4H:1V preferred
Max. tributary drainage flow path	---
Max. longitudinal slope of contributing area	---
Max. lateral slope of contributing area	---

1. For swales, if the slope is less than 1.5% install an underdrain using a perforated pipe, or equivalent. Amend the soil if necessary to allow effective percolation of water to the underdrain. Install the low-flow drain 6" deep in the soil. Slopes greater than 2.5% need check dams (riprap) at vertical drops of 12-15 inches. Underdrains can be made of 6 inch Schedule 40 PVC perforated pipe with 6" of drain gravel on the pipe. The gravel and pipe must be enclosed by geotextile fabric. (See Figure 4.18, underdrain detail, and Figure 4.19, low-flow drain detail.)
2. Below the design water depth install an erosion control blanket, at least 4" of topsoil, and the selected biofiltration mix. Above the water line use a straw mulch or sod.
3. This range of Manning's n can be used in the equation; b = Qn/1.49y(1.67) s(0.5) – Zy with wider bottom width b, and lower depth, y, at the same flow. This provides the designer with the option of varying the bottom width of the swale depending on space limitations. Designing at the higher n within this range at the same flow decreases the hydraulic design depth, thus placing the pollutants in closer contact with the vegetation and the soil.
4. For swale widths up to 16 feet the cross-section can be divided with a berm (concrete, plastic, compacted earth fill) using a flow spreader at the inlet (Figure 4.20, dividing berm).

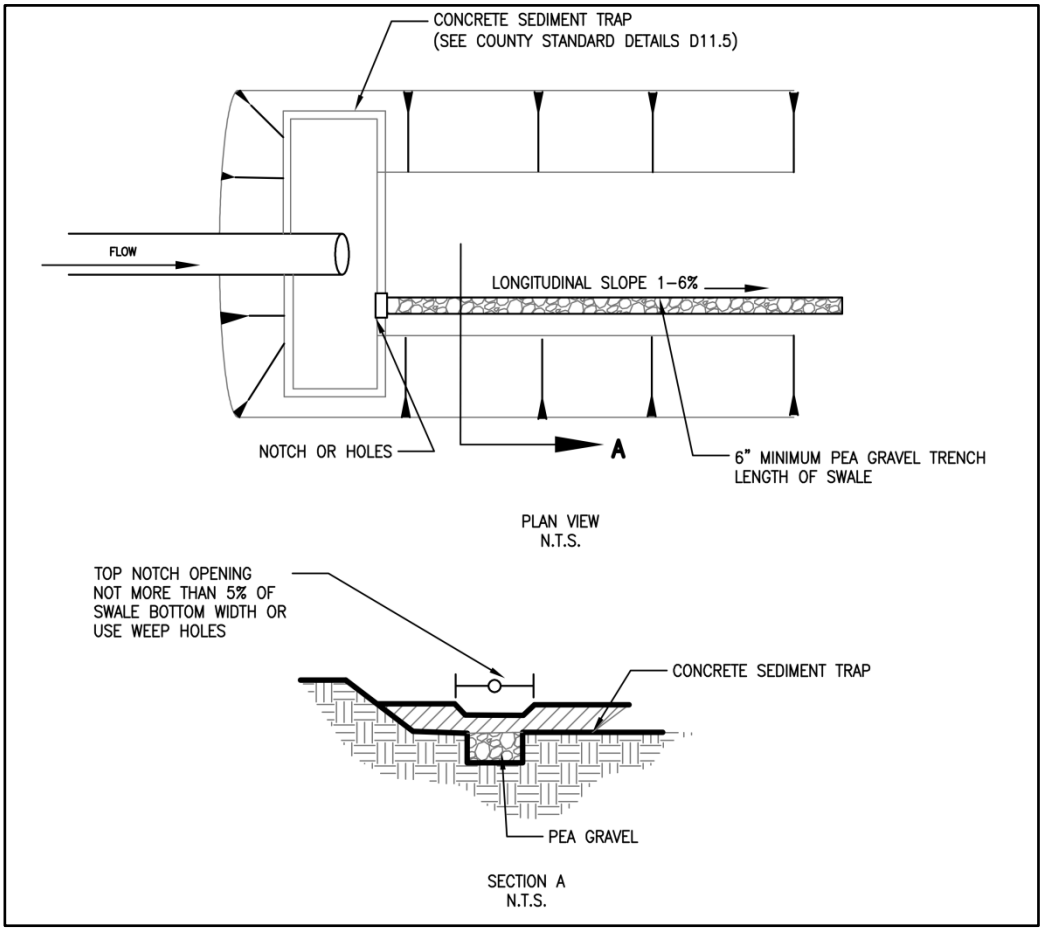


Figure 4.19: Biofiltration Swale Low-Flow Drain Detail

(Source: modified from WA State Dept. of Ecology)

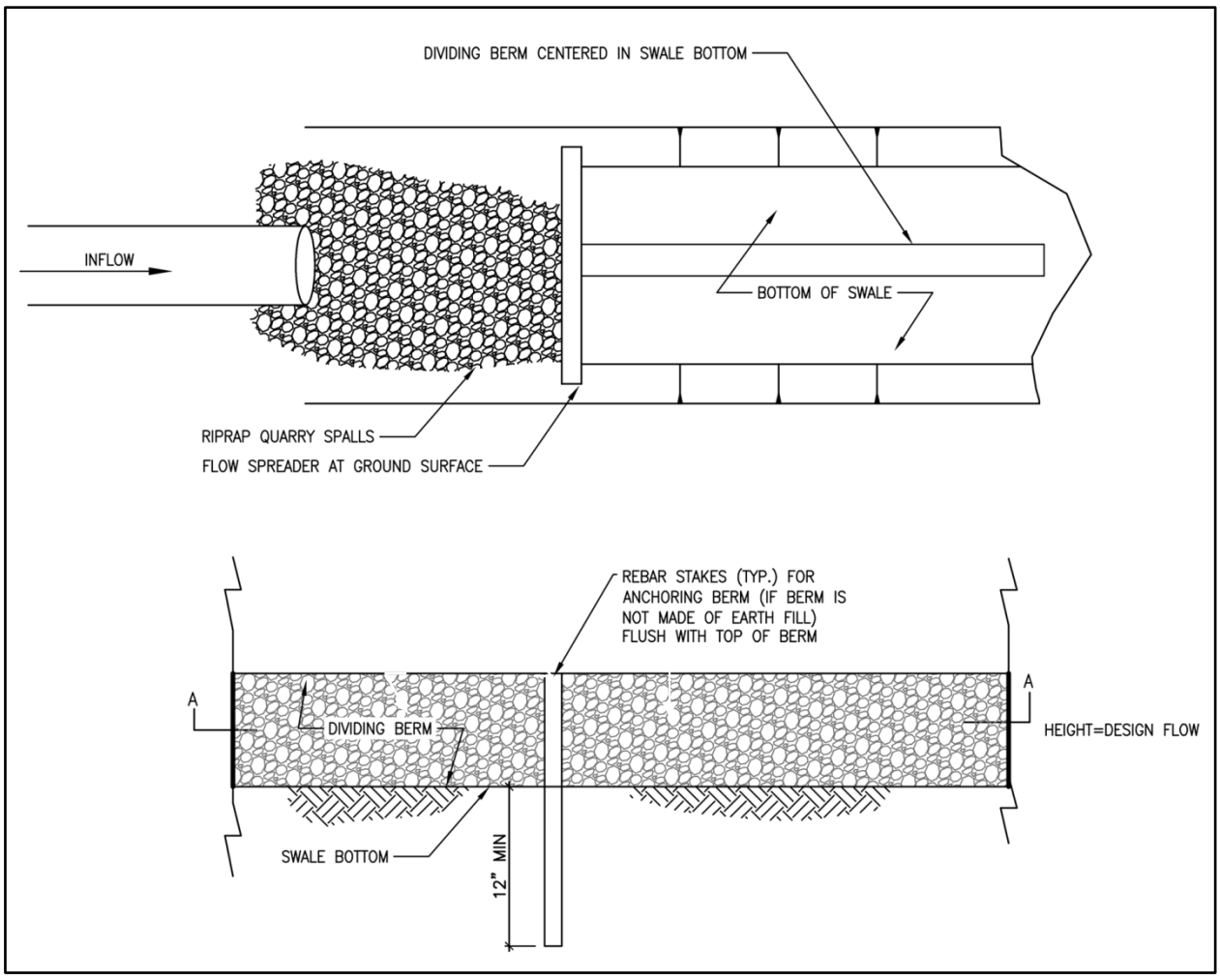


Figure 4.20: Swale Dividing Berm

(Source: redrawn from WA State Dept. of Ecology)

- **D-3**. Select swale shape-typically trapezoidal or parabolic.
- **D-4**. Use Manning's equation and first approximations relating hydraulic radius and dimensions for the selected swale shape to obtain a working value of a biofilter width dimension:

$$Q = \frac{1.49AR^{0.67}s^{0.5}}{n} \qquad \textbf{Equation 4-1}$$

$$A_{rectangle} = Ty \qquad \textbf{Equation 4-2}$$

$$R_{rectangle} = \frac{Ty}{T + 2y} \qquad \textbf{Equation 4-3}$$

Where:

- Q = Water Quality Design flow rate in 15-minute time steps based on WWHM, (ft^3/s, cfs)
- n = Manning's n (dimensionless)
- s = Longitudinal slope as a ratio of vertical rise/horizontal run (dimensionless)
- A = Cross-sectional area (ft^2)
- R = Hydraulic radius (ft)
- T = top width of trapezoid or width of a rectangle (ft)
- y = depth of flow (ft)
- b = bottom width of trapezoid (ft)

If Equations 4-2 and 4-3 are substituted into Equation 4-1 and solved for T, complex equations result that are difficult to solve manually. However, approximate solutions can be found by recognizing that T>>y and $Z^2>>1$, and that certain terms are nearly negligible. The approximation solutions for rectangular and trapezoidal shapes are:

$$R_{rectangle} \approx y, \qquad R_{trapezoid} \approx y, \qquad R_{parabolic} \approx 0.67y, \qquad R_v \approx 0.5y$$

Substitute $R_{trapezoid}$ and $A_{trapezoid}$ = by+Zy2 into Equation 4-1, and solve for the bottom width b (trapezoidal swale):

$$b \approx \frac{2.5Qn}{1.49y^{1.67}s^{0.5}} - Zy$$

Equation 4-4

For a trapezoid, select a side slope Z of at least 3. Compute b and then top width T, where T = b + 2yZ. (Note: Adjustment factor of 2.5 accounts for the differential between Water Quality design flow rate and the SBUH design flow. This equation is used to estimate an initial cross-sectional area. It does not affect the overall biofiltration swale size.)

If b for a swale is greater than 10 ft, either investigate how Q can be reduced, divide the flow by installing a low berm, or arbitrarily set b = 10 ft and continue with the analysis. For other swale shapes refer to Figure 4.21.

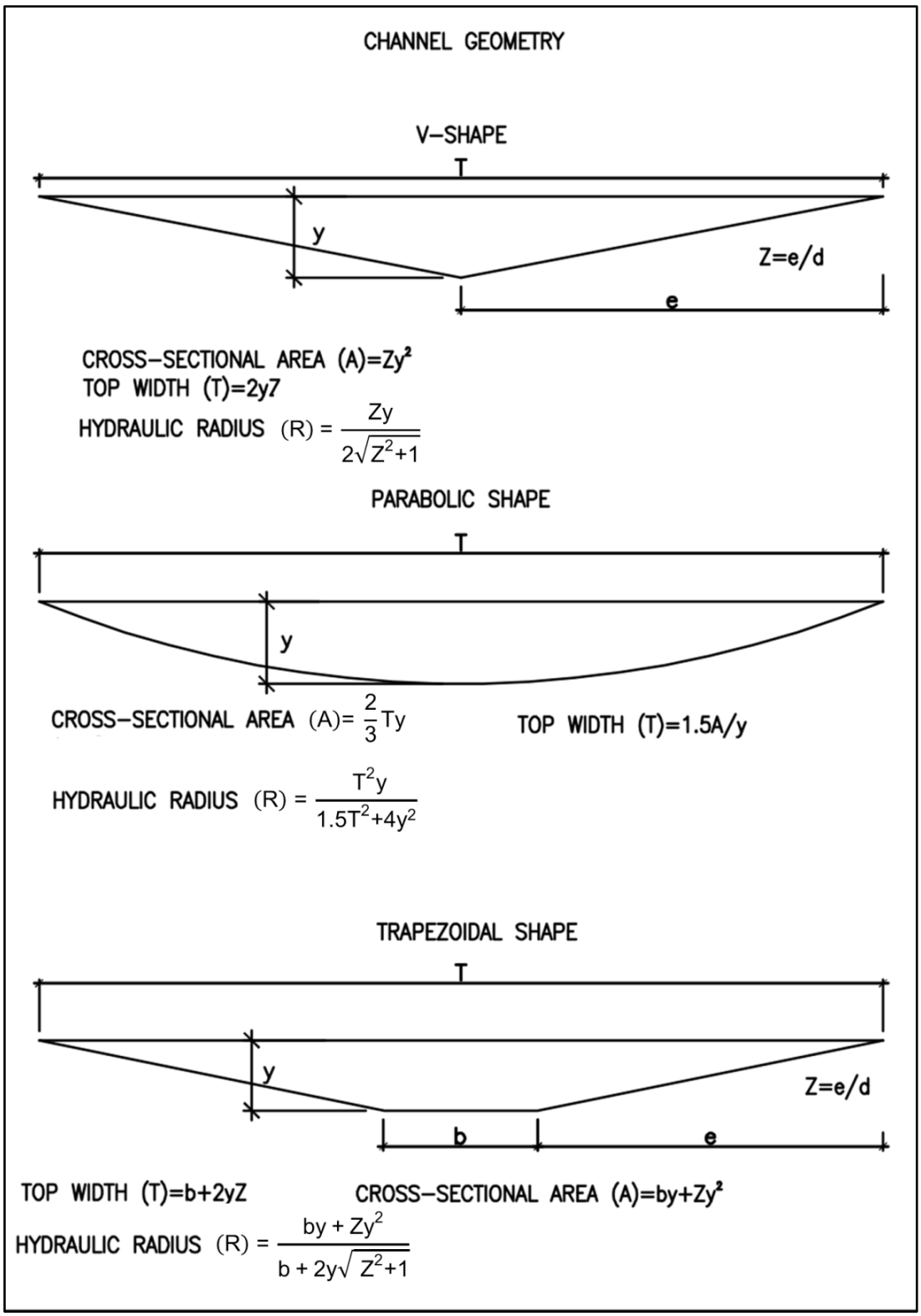


Figure 4.21: Geometric Formulas for Common Swale Shapes

(Source: redrawn from Livingston, et al, 1984)

- **D-5.** Compute A:

$$A_{rectangle} = Ty \quad \text{or} \quad A_{trapazoid} = by + Zy^2$$

$$A_{filter\ strip} = Ty$$

- **D-6.** Compute the flow velocity at design flow rate:

$$V = K\frac{Q}{A}$$

K = A ratio of the peak 10-minute flow predicted by SBUH to the water quality design flow rate estimated using the WWHM. The value of K is determined from Figure 4.2 for on-line facilities, or Figure 4.3 for off-line facilities.

If V >1.0 ft/sec (or V>0.5 ft/sec for a filter strip), repeat steps D-1 to D-6 until the condition is met. A velocity greater than 1.0 ft/sec was found to flatten grasses, thus reducing filtration. A velocity lower than this maximum value will allow a 9-minute hydraulic residence time criterion in a shorter biofilter. If the value of V suggests that a longer biofilter will be needed than space permits, investigate how Q can be reduced (e.g., use of low impact development BMPs), or increase y and/or T (up to the allowable maximum values) and repeat the analysis.

- **D-7.** Compute the swale length (L, ft)

$$L = Vt\ (60\ sec/min)$$

Where: t = hydraulic residence time (min)

Use t = 9 minutes for this calculation (use t = 18 minutes for a continuous inflow biofiltration swale). If a biofilter length is greater than the space permits, follow the advice in step D-6.

If a length less than 100 feet results from this analysis, increase it to 100 feet, the minimum allowed. In this case, it may be possible to save some space in width and still meet all criteria. This possibility can be checked by computing V in the 100 ft biofilter for t = 9 minutes, recalculating A (if V < 1.0 ft/sec) and recalculating T.

- **D-8**. If there is still not sufficient space for the biofilter, the project proponent should consider the following solutions (listed in order of preference):

    1. Divide the site drainage to flow to multiple biofilters.

    2. Use infiltration to provide lower discharge rates to the biofilter (only if the Site Suitability Criteria in Section 3.1.5.3 are met).

    3. Increase vegetation height and design depth of flow (note: the design must ensure that vegetation remains standing during design flow).

    4. Reduce the developed surface area to gain space for biofiltration.

5. Increase the longitudinal slope.

6. Increase the side slopes.

7. Nest the biofilter within or around another BMP.

Check for Stability (Minimizing Erosion)

The stability check must be performed for the combination of highest expected flow and least vegetation coverage and height. A check is not required for biofiltration swales that are located "off-line" from the primary conveyance/detention system. Maintain the same units as in the biofiltration capacity analysis.

- **SC-1**. Perform the stability check for the 100-year, return frequency flow using 15-minute time steps using an approved continuous flow model. Until WWHM peak flow rates in 15-minute time steps are available, use the WWHM 100-yr. hourly peak flows times with an adjustment factor of 1.6 to approximate peak flows in 15-minute time steps.
- **SC-2**. Estimate the vegetation coverage ("good" or "fair") and height on the first occasion that the biofilter will receive flow, or whenever the coverage and height will be least. Avoid flow introduction during the vegetation establishment period by timing planting or bypassing.
- **SC-3.** Estimate the degree of retardance from Table 4.6. When uncertain, be conservative by selecting a relatively low degree.

The maximum permissible velocity for erosion prevention (Vmax) is 3 feet per second.

- **SC-4.** Select a trial Manning's n for the high flow condition. The minimum value for poor vegetation cover and low height (possibly, knocked from the vertical by high flow) is 0.033. A good initial choice under these conditions is 0.04.
- **SC-5**. Refer to Figure 4.22, The Relationship of Manning's n with VR, to obtain a first approximation for VR of 3 feet/second
- **SC-6**. Compute hydraulic radius, R, from VR in Figure 4.22 and Vmax.
- **SC-7**. Use Manning's equation to solve for the actual VR.
- **SC-8.** Compare the actual VR from step SC-7 and first approximation from step SC-5. If they do not agree within 5 percent, repeat steps SC-4 to SC-8 until acceptable agreement is reached. If $n<0.033$ is needed to get agreement, set $n = 0.033$, repeat step SC-7, and then proceed to step SC-9.
- **SC-9.** Compute the actual V for the final design conditions: Check to be sure $V < V_{max}$ of 3 feet/second.
- **SC-10**. Compute the required swale cross-sectional area, A, for stability:
- **SC-11**. Compare the A, computed in step SC-10 of the stability analysis, with the A from the biofiltration capacity analysis (step D-5).

If less area is required for stability than is provided for capacity, the capacity design is acceptable. If not, use A from step SC-10 of the stability analysis and recalculate channel dimensions.

- **SC-12**. Calculate the depth of flow at the stability check design flow rate condition for the final dimensions and use A from step SC-10.
- **SC-13.** Compare the depth from step SC-12 to the depth used in the biofiltration capacity design (Step D-1). Use the larger of the two and add 0.5 ft. of freeboard to obtain the total depth (y_t) of the swale. Calculate the top width for the full depth using the appropriate equation.
- **SC-14.** Recalculate the hydraulic radius: (use b from Step D-4 calculated previously for biofiltration capacity, or Step SC-11, as appropriate, and y_t = total depth from Step SC-13)
- **SC-15.** Make a final check for capacity based on the stability check design storm (this check will ensure that capacity is adequate if the largest expected event coincides with the greatest retardance). Use Equation 1, a Manning's n selected in step D-2, and the calculated channel dimensions, including freeboard, to compute the flow capacity of the channel under these conditions. Use R from step SC-14, above, and $A = b(y_t) + Z(y_t)^2$ using b from Step D-4, D-15, or SC-11 as appropriate.

If the flow capacity is less than the stability check design storm flow rate, increase the channel cross-sectional area as needed for this conveyance. Specify the new channel dimensions.

Table 4.6: Guide for Selecting Degree of Retardance

Coverage	Average Grass Height (inches)	Degree of Retardance
Good	<2	E. Very Low
	2-6	D. Low
	6-10	C. Moderate
	11-24	B. High
	>30	A. Very High
Fair	<2	E. Very Low
	2-6	D. Low
	6-10	D. Low
	11-24	C. Moderate
	>30	B. High

See Chow (1959). In addition, Chow recommended selection of retardance C for a grass-legume mixture 6-8 inches high and D for a mixture 4-5 inches high. No retardance recommendations have appeared for emergent wetland species. Therefore, judgment must be used. Since these species generally grow less densely than grasses, using a "fair" coverage would be a reasonable approach.

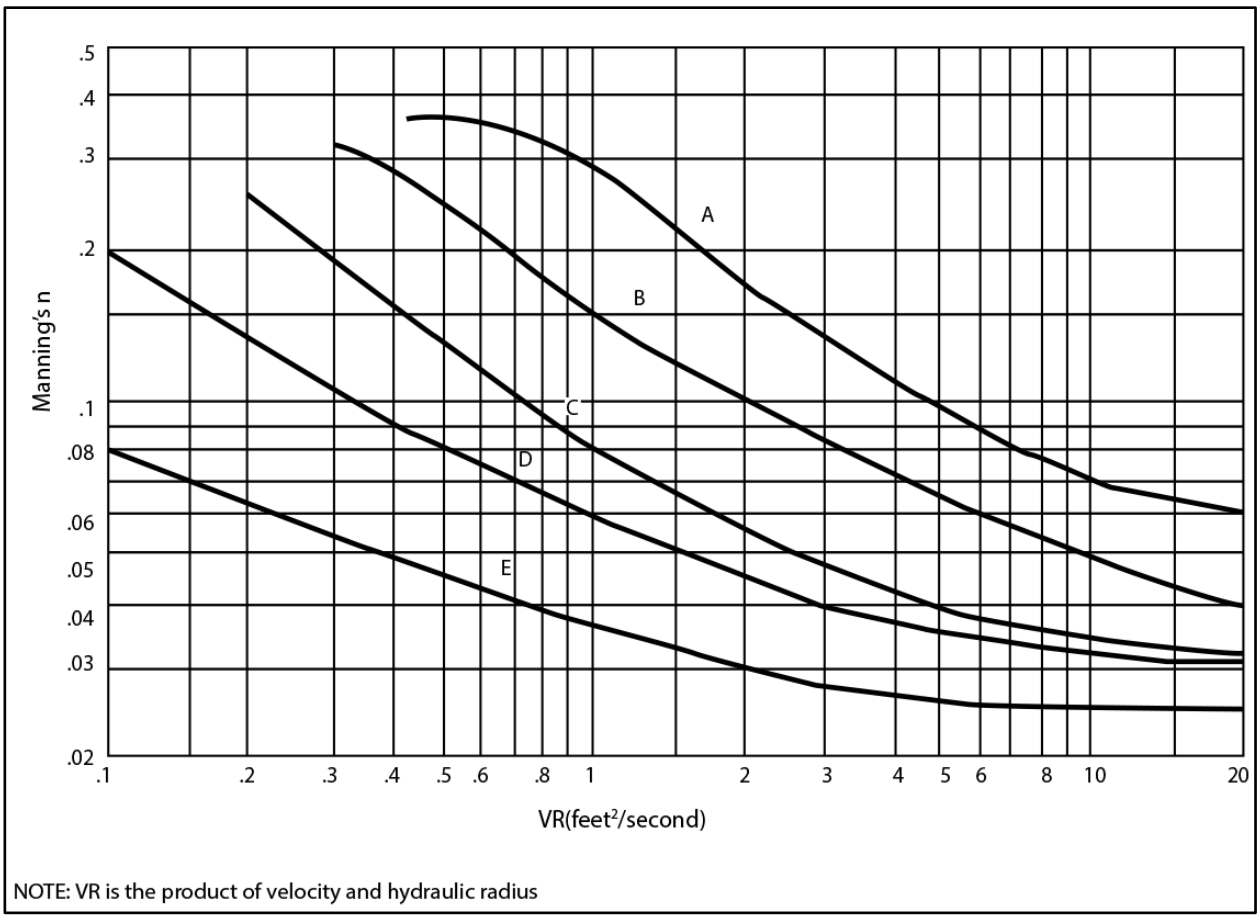


Figure 4.22: Relationship of Manning's n with VR

(Source: redrawn from Livingston, et al, 1984)

Completion Step (CO)

- **CO.** Review all of the criteria and guidelines for biofilter planning, design, installation, and operation above and specify all of the appropriate features for the application.

Soil Criteria

- The following top soil mix at least 8-inch deep:
    - Sandy loam 60-90 %
    - Clay 0-10 %
    - Composted organic matter, (excluding animal waste, toxics) 10-30 %

Use compost amended soil where practicable. Composted material shall meet the specifications for compost used in the Bioretention Soil Media (BMP ~~T7.30~~ 5.14B). This excludes use of biosolids and manures.

- Till to at least 8-inch depth

- For longitudinal slopes of < 2 percent use more sand to obtain more infiltration
- If groundwater contamination is a concern, seal the bed with clay or a geomembrane liner

Vegetation Criteria

See Table 4.7 and Table 4.8 for recommended grasses and groundcovers.

- Grass must be fine, turf-forming, water-resistant grasses where vegetative growth and moisture will be adequate for growth.
- Irrigate if moisture is insufficient during dry weather season.
- Use sod with low clay content and where needed to initiate adequate vegetative growth. Preferably sod should be laid to a minimum of one-foot vertical depth above the swale bottom.
- Consider sun/shade conditions for adequate vegetative growth Shade tolerant vegetation must be used when prolonged shading of any portion will occur.
- Stabilize soil areas upslope of the biofilter to prevent erosion
- Fertilizing a biofilter should be avoided if at all possible in any application where nutrient control is an objective. Test the soil for nitrogen, phosphorous, and potassium and consult with a landscape professional about the need for fertilizer in relation to soil nutrition and vegetation requirements. If use of a fertilizer cannot be avoided, use a slow-release fertilizer formulation in the least amount needed.

Table 4.7: Grass Seed Mixes Suitable for Biofiltration Swale Treatment Areas

Bioswale Dry Soil Conditions

Botanical Name	Common Name	% By Weight
Elymus glaucus	blue wildrye	50.00%
Agrostis exerata	spike bentgrass	10.00%
Bromus carinatus	California brome	10.00%
Festuca idahoensis	Idaho fescue	30.00%

Bioswale Wet or Dry Soil Conditions

Botanical Name	Common Name	%By Weight
Elymus glaucus	blue wildrye	60.00%
Hordeum brachyantherum	meadow barley	30.00%
Bromus carinatus	California brome	10.00%

Bioswale Wet Soil Conditions

Botanical Name	Common Name	% By Weight
Agrostis exerata	spike bentgrass	0.50%
Deschampsia cespitosa	tufted hairgrass	2.50%
Glyceria occidentalis	western mannagrass	25.00%
Juncus effusus	soft rush	8.00%
Beckmannia syzigachne	slough grass	4.00%
Alopecurus geniculatus	water foxtail	15.00%
Hordeum brachyantherum	meadow barley	45.00%

Selected plants shall not include any plants from the State of Washington Noxious Weed List. Refer to www.clark.wa.gov/environmental-services/vegetation-management for a current list of noxious weeds.

Table 4.8: Groundcovers and Grasses Suitable for Upper Side Slopes of a Swale

Groundcovers

Botanical Name	Common Name
Arctostaphylos uva-ursi	kinnikinnick
Fragaria chiloensis	strawberry
Lupinus latifolius	broadleaf lupine

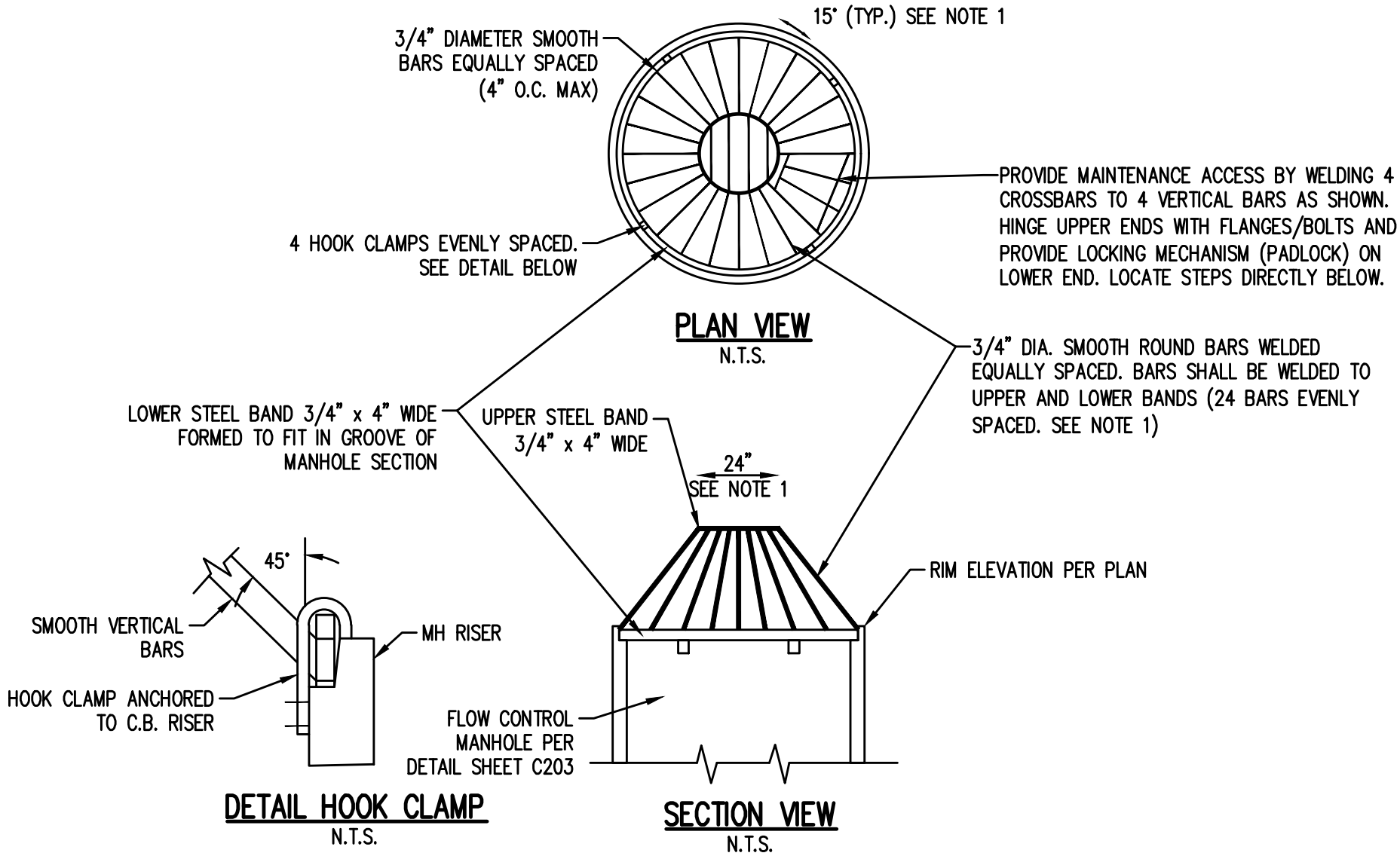
Grasses (drought-tolerant, minimum mowing

Botanical Name	Common Name
Festuca spp. (e.g., Many Mustang, Silverado)	dwarf tall fescues
Festuca ovina duriuscula (e.g., Reliant, Aurora)	hard fescue
Festuca amethystine	tufted fescue
Buchloe dactyloides	buffalo grass
Festuca rubra	red fescue
Festuca arundinacea	tall fescue grass
Helictotrichon sempervirens	blue oatgrass

Selected plants shall not include any plants from the State of Washington Noxious Weed List. Refer to www.clark.wa.gov/environmental-services/vegetation-management for a current list of noxious weeds.

Construction Criteria

The biofiltration swale should not be put into operation until areas of exposed soil in the contributing drainage catchment have been stabilized. Deposition of eroded soils can impede the growth of grass in the swale and reduce swale treatment effectiveness. The cost to restore a swale damaged by sediment deposition will be borne by the project or swale owner. Thus, effective erosion and sediment control measures should remain in place until the swale vegetation is established (see Book 1, Section 6.5 for selection of erosion and sediment control BMPs). Avoid compaction during construction. Grade biofilters to attain uniform longitudinal and lateral slopes.



NOTES:

1. DIMENSIONS ARE FOR ILLUSTRATION ON **54" DIAMETER MH**. FOR DIFFERENT DIAMETER MH'S, ADJUST TO MAINTAIN 45° ANGLE ON "VERTICAL" BARS AND 7" O.C. MAXIMUM SPACING OF BARS AROUND LOWER STEEL BAND.

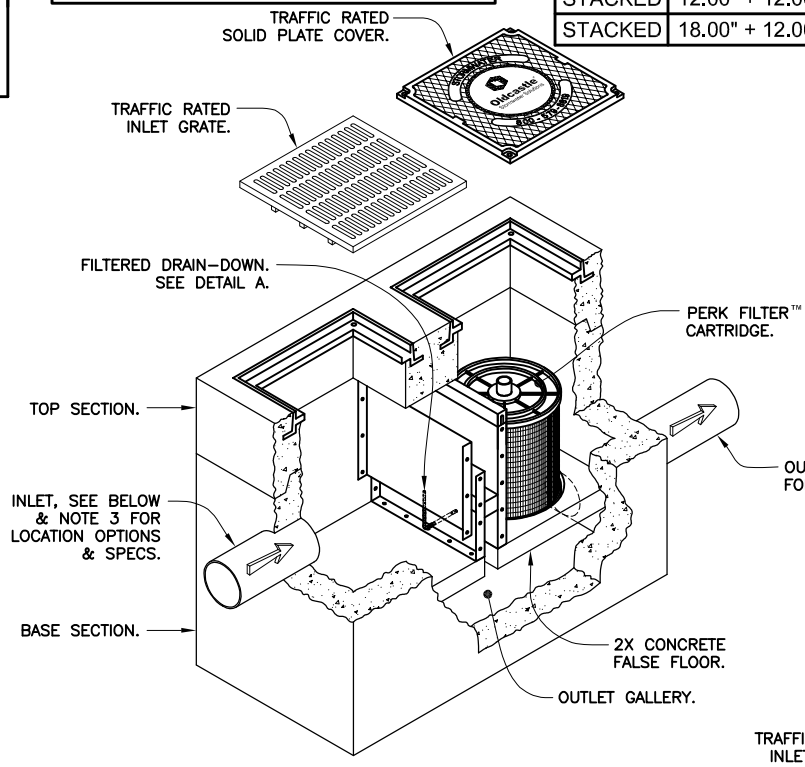
2. METAL PARTS MUST BE CORROSION RESISTANT; STEEL BARS MUST BE GALVANIZED.

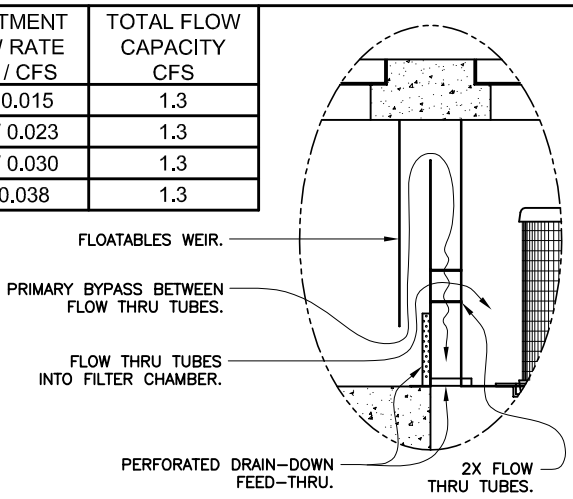
BIRDCAGE OVERFLOW STRUCTURE

PF-CCB-WA-0001

Washington GULD*

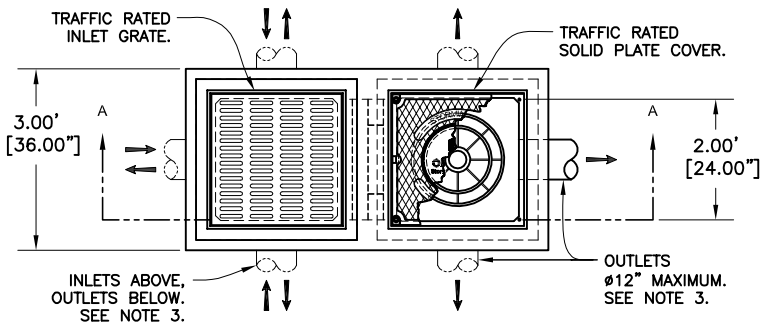
	CARTRIDGE SIZE	TREATMENT FLOW RATE GPM / CFS	TOTAL FLOW CAPACITY CFS
	12.00"	6.8 / 0.015	1.3
	18.00"	10.2 / 0.023	1.3
STACKED	12.00" + 12.00"	13.6 / 0.030	1.3
STACKED	18.00" + 12.00"	17 / 0.038	1.3





DETAIL A
INLET / BYPASS ASSEMBLY & DRAIN–DOWN SCALE: 2X

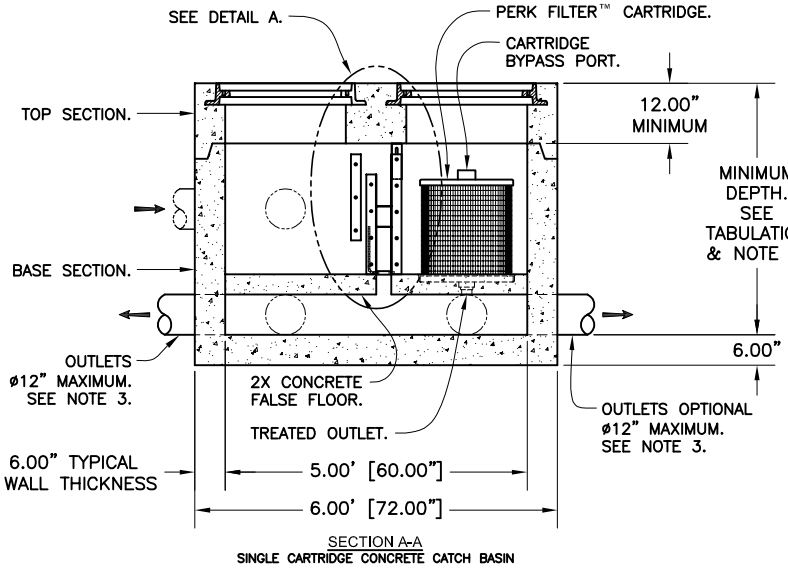
	MINIMUM DEPTHS (SEE NOTE 6)				
	CARTRIDGE SIZE	Ø 6.0" OUTLET PIPE (IN INCHES)	Ø 8.0" OUTLET PIPE (IN INCHES)	Ø 10.0" OUTLET PIPE (IN INCHES)	Ø 12.0" OUTLET PIPE (IN INCHES)
	12.00"	39	41	43	45
	18.00"	46	48	50	52
STACKED	12.00" + 12.00"	56	58	60	62
STACKED	18.00" + 12.00"	63	65	67	69



Notes:

1. Precast concrete structure shall be manufactured in accordance with ASTM Designation C857 and C858.
2. Perk Filter™ Catch basin shall be supplied with traffic rated (H20) bicycle-proof grates and solid plate cover.
3. Inlet pipe(s) may enter device on three sides of the inlet chamber. Outlet pipe(s) may exit on all four sides. All pipe is Ø 12" maximum.
4. Inlet chamber shall be supplied with a drain-down device designed to remove standing water between storm events.
5. Perk Filter™ cartridge shall be maintained in accordance with manufacturer recommendations.
6. For depths less than the specified minimum contact Oldcastle® Stormwater Solutions for engineering assistance.

*** Treatment Flow Rates shown conform to Washington State GULD Specifications.**



SECTION A-A
SINGLE CARTRIDGE CONCRETE CATCH BASIN

Media Filtration

Perk Filter™

Concrete Catch Basin

Washington State GULD

Single Cartridge

Oldcastle® Stormwater Solutions

7921 Southpark Plaza, Suite 200 | Littleton, CO | 80120 | Ph: 800.579.8819 | oldcastlestormwater.com

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DRAWING NO.	REV	ECO	DATE	
PF-CCB-WA-0001	E	ECO–0144 ZHD 8/26/16	JPR 3/2/11	SHEET 1 OF 1

Appendix F:
WWHM And HydroCad Analysis

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	4373 Prelim WWHM Flow Control
Site Name:	North Haven PUD-Quantity
Site Address:	179th St & 11th Ave
City:	Vancouver
Report Date:	1/30/2020
Gage:	Salmon Creek Treatment Plant
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.060
Version Date:	2018/10/10
Version:	4.2.16

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

DRAFT

Landuse Basin Data
Predeveloped Land Use

Pre Dev1.0

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Flat	30.846
Pervious Total	30.846
Impervious Land Use	acre
Impervious Total	0
Basin Total	30.846

Element Flows To:

Surface	Interflow	Groundwater

DRAFT

Offsite Basin0.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Field, Flat	9.041
Pervious Total	9.041

Impervious Land Use	acre
Impervious Total	0
Basin Total	9.041

Element Flows To:

Surface	Interflow	Groundwater

DRAFT

Pre Dev2.0

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Flat	3.651
Pervious Total	3.651
Impervious Land Use	acre
Impervious Total	0
Basin Total	3.651

Element Flows To:

Surface	Interflow	Groundwater

DRAFT

Mitigated Land Use

Dev Basin1.3

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	6.563
Pervious Total	6.563

Impervious Land Use	acre
ROADS FLAT	4.569
ROOF TOPS FLAT	9.366
DRIVEWAYS FLAT	2.927
SIDEWALKS FLAT	1.471
POND	0.547
Impervious Total	18.88
Basin Total	25.443

Element Flows To:

Surface	Interflow	Groundwater
Pond1.3	Pond1.3	

DRAFT

Dev Basin1.2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.839
Pervious Total	0.839

Impervious Land Use	acre
ROADS FLAT	0.591
ROOF TOPS FLAT	1.543
DRIVEWAYS FLAT	0.482
SIDEWALKS FLAT	0.21
POND	0.158
Impervious Total	2.984
Basin Total	3.823

Element Flows To:

Surface	Interflow	Groundwater
Pond1.2	Pond1.2	

DRAFT

Dev Basin1.1

Bypass:	Yes
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.353
Pervious Total	0.353

Impervious Land Use	acre
ROADS FLAT	1.227
Impervious Total	1.227
Basin Total	1.58

Element Flows To:

Surface	Interflow	Groundwater

DRAFT

Offsite Basin0.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Field, Flat	9.041
Pervious Total	9.041

Impervious Land Use	acre
Impervious Total	0
Basin Total	9.041

Element Flows To:

Surface	Interflow	Groundwater
Pond1.3	Pond1.3	

DRAFT

Dev Basin2.1

Bypass: No

GroundWater: No

Pervious Land Use	acre
SG4, Lawn, Flat	0.91
Pervious Total	0.91

Impervious Land Use	acre
ROADS FLAT	0.802
ROOF TOPS FLAT	1.175
DRIVEWAYS FLAT	0.367
SIDEWALKS FLAT	0.248
POND	0.149
Impervious Total	2.741
Basin Total	3.651

Element Flows To:

Surface	Interflow	Groundwater
Pond2.1	Pond2.1	

DRAFT

Mitigated Routing

Pond1.3

Bottom Length: 75.00 ft.
Bottom Width: 75.00 ft.
Depth: 13 ft.
Volume at riser head: 2.7994 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 12 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 1.100 ft.
Notch Height: 1.600 ft.
Orifice 1 Diameter: 4.2 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

DRAFT

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.129	0.000	0.000	0.000
0.1444	0.131	0.018	0.181	0.000
0.2889	0.133	0.037	0.257	0.000
0.4333	0.135	0.057	0.315	0.000
0.5778	0.137	0.076	0.363	0.000
0.7222	0.139	0.096	0.406	0.000
0.8667	0.141	0.117	0.445	0.000
1.0111	0.143	0.137	0.481	0.000
1.1556	0.145	0.158	0.514	0.000
1.3000	0.147	0.179	0.545	0.000
1.4444	0.149	0.201	0.575	0.000
1.5889	0.151	0.223	0.603	0.000
1.7333	0.154	0.245	0.630	0.000
1.8778	0.156	0.267	0.656	0.000
2.0222	0.158	0.290	0.680	0.000
2.1667	0.160	0.313	0.704	0.000
2.3111	0.162	0.336	0.727	0.000
2.4556	0.165	0.360	0.750	0.000
2.6000	0.167	0.384	0.771	0.000
2.7444	0.169	0.408	0.793	0.000
2.8889	0.172	0.433	0.813	0.000
3.0333	0.174	0.458	0.833	0.000
3.1778	0.176	0.483	0.853	0.000
3.3222	0.178	0.509	0.872	0.000
3.4667	0.181	0.535	0.891	0.000
3.6111	0.183	0.561	0.909	0.000
3.7556	0.186	0.588	0.927	0.000
3.9000	0.188	0.615	0.945	0.000
4.0444	0.190	0.643	0.962	0.000
4.1889	0.193	0.670	0.979	0.000
4.3333	0.195	0.698	0.996	0.000
4.4778	0.198	0.727	1.013	0.000

4.6222	0.200	0.756	1.029	0.000
4.7667	0.203	0.785	1.045	0.000
4.9111	0.205	0.814	1.060	0.000
5.0556	0.208	0.844	1.076	0.000
5.2000	0.210	0.874	1.091	0.000
5.3444	0.213	0.905	1.106	0.000
5.4889	0.215	0.936	1.121	0.000
5.6333	0.218	0.967	1.136	0.000
5.7778	0.221	0.999	1.150	0.000
5.9222	0.223	1.031	1.164	0.000
6.0667	0.226	1.064	1.179	0.000
6.2111	0.228	1.097	1.193	0.000
6.3556	0.231	1.130	1.206	0.000
6.5000	0.234	1.164	1.220	0.000
6.6444	0.236	1.198	1.233	0.000
6.7889	0.239	1.232	1.247	0.000
6.9333	0.242	1.267	1.260	0.000
7.0778	0.245	1.302	1.273	0.000
7.2222	0.247	1.338	1.286	0.000
7.3667	0.250	1.374	1.299	0.000
7.5111	0.253	1.410	1.311	0.000
7.6556	0.256	1.447	1.324	0.000
7.8000	0.258	1.484	1.336	0.000
7.9444	0.261	1.522	1.349	0.000
8.0889	0.264	1.560	1.361	0.000
8.2333	0.267	1.598	1.373	0.000
8.3778	0.270	1.637	1.385	0.000
8.5222	0.273	1.676	1.397	0.000
8.6667	0.276	1.716	1.409	0.000
8.8111	0.279	1.756	1.420	0.000
8.9556	0.281	1.796	1.432	0.000
9.1000	0.284	1.837	1.444	0.000
9.2444	0.287	1.879	1.455	0.000
9.3889	0.290	1.920	1.466	0.000
9.5333	0.293	1.963	1.478	0.000
9.6778	0.296	2.005	1.489	0.000
9.8222	0.299	2.048	1.500	0.000
9.9667	0.302	2.092	1.511	0.000
10.111	0.306	2.136	1.522	0.000
10.256	0.309	2.180	1.533	0.000
10.400	0.312	2.225	1.543	0.000
10.544	0.315	2.270	1.755	0.000
10.689	0.318	2.316	2.133	0.000
10.833	0.321	2.362	2.620	0.000
10.978	0.324	2.409	3.194	0.000
11.122	0.327	2.456	3.844	0.000
11.267	0.330	2.504	4.562	0.000
11.411	0.334	2.552	5.341	0.000
11.556	0.337	2.600	6.177	0.000
11.700	0.340	2.649	7.066	0.000
11.844	0.343	2.699	8.006	0.000
11.989	0.347	2.749	8.993	0.000
12.133	0.350	2.799	9.852	0.000
12.278	0.353	2.850	11.34	0.000
12.422	0.356	2.901	12.97	0.000
12.567	0.360	2.953	14.28	0.000
12.711	0.363	3.005	15.05	0.000
12.856	0.366	3.058	15.68	0.000

DRAFT

13.000	0.370	3.111	16.22	0.000
13.144	0.373	3.165	16.73	0.000

DRAFT

Pond1.2

Bottom Length: 45.00 ft.
Bottom Width: 45.00 ft.
Depth: 5 ft.
Volume at riser head: 0.2647 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 12 in.
Notch Type: Rectangular
Notch Width: 0.600 ft.
Notch Height: 0.750 ft.
Orifice 1 Diameter: 2.5 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Pond Hydraulic Table

DRAFT

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.046	0.000	0.000	0.000
0.0556	0.046	0.002	0.040	0.000
0.1111	0.047	0.005	0.056	0.000
0.1667	0.047	0.007	0.069	0.000
0.2222	0.048	0.010	0.080	0.000
0.2778	0.048	0.013	0.089	0.000
0.3333	0.049	0.016	0.097	0.000
0.3889	0.049	0.018	0.105	0.000
0.4444	0.050	0.021	0.113	0.000
0.5000	0.050	0.024	0.119	0.000
0.5556	0.051	0.027	0.126	0.000
0.6111	0.051	0.030	0.132	0.000
0.6667	0.052	0.032	0.138	0.000
0.7222	0.052	0.035	0.144	0.000
0.7778	0.053	0.038	0.149	0.000
0.8333	0.053	0.041	0.154	0.000
0.8889	0.054	0.044	0.159	0.000
0.9444	0.054	0.047	0.164	0.000
1.0000	0.055	0.050	0.169	0.000
1.0556	0.055	0.053	0.174	0.000
1.1111	0.056	0.056	0.178	0.000
1.1667	0.056	0.060	0.183	0.000
1.2222	0.057	0.063	0.187	0.000
1.2778	0.057	0.066	0.191	0.000
1.3333	0.058	0.069	0.195	0.000
1.3889	0.058	0.072	0.199	0.000
1.4444	0.059	0.076	0.203	0.000
1.5000	0.059	0.079	0.207	0.000
1.5556	0.060	0.082	0.211	0.000
1.6111	0.060	0.086	0.215	0.000
1.6667	0.061	0.089	0.219	0.000
1.7222	0.061	0.092	0.222	0.000
1.7778	0.062	0.096	0.226	0.000
1.8333	0.062	0.099	0.229	0.000

1.8889	0.063	0.103	0.233	0.000
1.9444	0.063	0.106	0.236	0.000
2.0000	0.064	0.110	0.239	0.000
2.0556	0.065	0.114	0.243	0.000
2.1111	0.065	0.117	0.246	0.000
2.1667	0.066	0.121	0.249	0.000
2.2222	0.066	0.125	0.252	0.000
2.2778	0.067	0.128	0.256	0.000
2.3333	0.067	0.132	0.259	0.000
2.3889	0.068	0.136	0.262	0.000
2.4444	0.068	0.140	0.265	0.000
2.5000	0.069	0.144	0.268	0.000
2.5556	0.070	0.147	0.271	0.000
2.6111	0.070	0.151	0.274	0.000
2.6667	0.071	0.155	0.277	0.000
2.7222	0.071	0.159	0.279	0.000
2.7778	0.072	0.163	0.282	0.000
2.8333	0.072	0.167	0.285	0.000
2.8889	0.073	0.171	0.288	0.000
2.9444	0.074	0.175	0.291	0.000
3.0000	0.074	0.180	0.293	0.000
3.0556	0.075	0.184	0.296	0.000
3.1111	0.075	0.188	0.299	0.000
3.1667	0.076	0.192	0.301	0.000
3.2222	0.076	0.196	0.304	0.000
3.2778	0.077	0.201	0.316	0.000
3.3333	0.078	0.205	0.357	0.000
3.3889	0.078	0.209	0.415	0.000
3.4444	0.079	0.214	0.486	0.000
3.5000	0.079	0.218	0.567	0.000
3.5556	0.080	0.223	0.657	0.000
3.6111	0.081	0.227	0.755	0.000
3.6667	0.081	0.232	0.862	0.000
3.7222	0.082	0.236	0.975	0.000
3.7778	0.083	0.241	1.095	0.000
3.8333	0.083	0.245	1.222	0.000
3.8889	0.084	0.250	1.354	0.000
3.9444	0.084	0.255	1.493	0.000
4.0000	0.085	0.259	1.636	0.000
4.0556	0.086	0.264	1.778	0.000
4.1111	0.086	0.269	2.031	0.000
4.1667	0.087	0.274	2.347	0.000
4.2222	0.087	0.279	2.692	0.000
4.2778	0.088	0.284	3.032	0.000
4.3333	0.089	0.289	3.334	0.000
4.3889	0.089	0.294	3.574	0.000
4.4444	0.090	0.299	3.743	0.000
4.5000	0.091	0.304	3.860	0.000
4.5556	0.091	0.309	4.007	0.000
4.6111	0.092	0.314	4.124	0.000
4.6667	0.093	0.319	4.235	0.000
4.7222	0.093	0.324	4.343	0.000
4.7778	0.094	0.329	4.446	0.000
4.8333	0.095	0.335	4.545	0.000
4.8889	0.095	0.340	4.642	0.000
4.9444	0.096	0.345	4.735	0.000
5.0000	0.097	0.351	4.826	0.000
5.0556	0.097	0.356	4.915	0.000

DRAFT

Pond2.1

Bottom Length: 32.00 ft.
Bottom Width: 32.00 ft.
Depth: 8 ft.
Volume at riser head: 0.3524 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 7 ft.
Riser Diameter: 15 in.
Notch Type: Rectangular
Notch Width: 0.250 ft.
Notch Height: 0.800 ft.
Orifice 1 Diameter: 1.8 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Pond Hydraulic Table

DRAFT

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.023	0.000	0.000	0.000
0.0889	0.024	0.002	0.026	0.000
0.1778	0.024	0.004	0.037	0.000
0.2667	0.025	0.006	0.045	0.000
0.3556	0.025	0.008	0.052	0.000
0.4444	0.026	0.011	0.058	0.000
0.5333	0.026	0.013	0.064	0.000
0.6222	0.027	0.015	0.069	0.000
0.7111	0.027	0.018	0.074	0.000
0.8000	0.028	0.020	0.078	0.000
0.8889	0.029	0.023	0.082	0.000
0.9778	0.029	0.025	0.086	0.000
1.0667	0.030	0.028	0.090	0.000
1.1556	0.030	0.031	0.094	0.000
1.2444	0.031	0.034	0.098	0.000
1.3333	0.032	0.036	0.101	0.000
1.4222	0.032	0.039	0.104	0.000
1.5111	0.033	0.042	0.108	0.000
1.6000	0.033	0.045	0.111	0.000
1.6889	0.034	0.048	0.114	0.000
1.7778	0.035	0.051	0.117	0.000
1.8667	0.035	0.054	0.120	0.000
1.9556	0.036	0.058	0.123	0.000
2.0444	0.037	0.061	0.125	0.000
2.1333	0.037	0.064	0.128	0.000
2.2222	0.038	0.068	0.131	0.000
2.3111	0.039	0.071	0.133	0.000
2.4000	0.039	0.075	0.136	0.000
2.4889	0.040	0.078	0.138	0.000
2.5778	0.041	0.082	0.141	0.000
2.6667	0.041	0.085	0.143	0.000
2.7556	0.042	0.089	0.146	0.000
2.8444	0.043	0.093	0.148	0.000
2.9333	0.043	0.097	0.150	0.000

3.0222	0.044	0.101	0.152	0.000
3.1111	0.045	0.105	0.155	0.000
3.2000	0.046	0.109	0.157	0.000
3.2889	0.046	0.113	0.159	0.000
3.3778	0.047	0.117	0.161	0.000
3.4667	0.048	0.121	0.163	0.000
3.5556	0.049	0.126	0.165	0.000
3.6444	0.049	0.130	0.167	0.000
3.7333	0.050	0.135	0.169	0.000
3.8222	0.051	0.139	0.171	0.000
3.9111	0.052	0.144	0.173	0.000
4.0000	0.052	0.148	0.175	0.000
4.0889	0.053	0.153	0.177	0.000
4.1778	0.054	0.158	0.179	0.000
4.2667	0.055	0.163	0.181	0.000
4.3556	0.056	0.168	0.183	0.000
4.4444	0.056	0.173	0.185	0.000
4.5333	0.057	0.178	0.187	0.000
4.6222	0.058	0.183	0.189	0.000
4.7111	0.059	0.188	0.190	0.000
4.8000	0.060	0.194	0.192	0.000
4.8889	0.061	0.199	0.194	0.000
4.9778	0.061	0.204	0.196	0.000
5.0667	0.062	0.210	0.197	0.000
5.1556	0.063	0.216	0.199	0.000
5.2444	0.064	0.221	0.201	0.000
5.3333	0.065	0.227	0.203	0.000
5.4222	0.066	0.233	0.204	0.000
5.5111	0.067	0.239	0.206	0.000
5.6000	0.067	0.245	0.208	0.000
5.6889	0.068	0.251	0.209	0.000
5.7778	0.069	0.257	0.211	0.000
5.8667	0.070	0.263	0.213	0.000
5.9556	0.071	0.270	0.214	0.000
6.0444	0.072	0.276	0.216	0.000
6.1333	0.073	0.283	0.217	0.000
6.2222	0.074	0.289	0.222	0.000
6.3111	0.075	0.296	0.251	0.000
6.4000	0.076	0.302	0.293	0.000
6.4889	0.077	0.309	0.345	0.000
6.5778	0.078	0.316	0.404	0.000
6.6667	0.079	0.323	0.467	0.000
6.7556	0.080	0.330	0.534	0.000
6.8444	0.080	0.337	0.605	0.000
6.9333	0.081	0.345	0.677	0.000
7.0222	0.082	0.352	0.777	0.000
7.1111	0.083	0.359	1.223	0.000
7.2000	0.084	0.367	1.895	0.000
7.2889	0.085	0.374	2.661	0.000
7.3778	0.086	0.382	3.397	0.000
7.4667	0.087	0.390	3.992	0.000
7.5556	0.088	0.398	4.390	0.000
7.6444	0.089	0.406	4.694	0.000
7.7333	0.090	0.414	4.959	0.000
7.8222	0.092	0.422	5.208	0.000
7.9111	0.093	0.430	5.445	0.000
8.0000	0.094	0.438	5.670	0.000
8.0889	0.095	0.447	5.885	0.000

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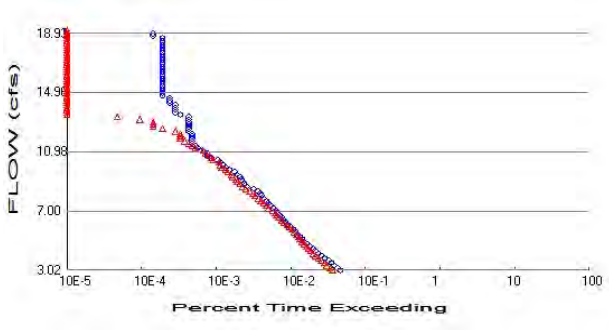
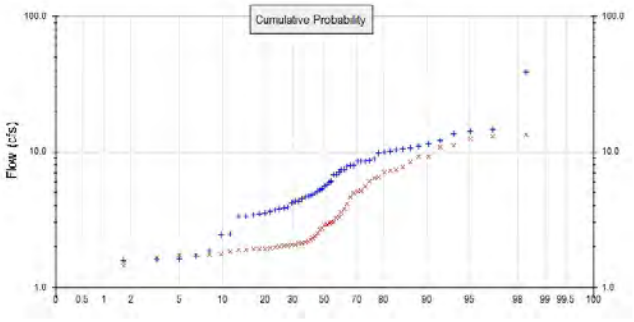
Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 39.887
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 16.796
Total Impervious Area: 23.091

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	6.049988
5 year	10.923118
10 year	13.846482
25 year	16.991471
50 year	18.934885
100 year	20.571764

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Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	3.201077
5 year	5.703758
10 year	7.9626
25 year	11.649478
50 year	15.103013
100 year	19.25644

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	4.754	6.010
1950	5.086	3.797
1951	9.744	5.530
1952	5.720	4.116
1953	4.760	2.016
1954	6.750	2.299
1955	3.496	1.898
1956	13.486	11.194
1957	7.378	2.119
1958	4.618	3.291

1959	3.351	1.745
1960	3.763	1.960
1961	7.960	6.421
1962	4.925	1.908
1963	5.255	2.033
1964	10.916	2.957
1965	6.004	7.420
1966	5.921	2.639
1967	5.348	2.044
1968	7.771	2.905
1969	6.731	5.069
1970	38.980	13.336
1971	3.730	1.886
1972	8.615	2.998
1973	4.331	2.356
1974	14.600	12.991
1975	7.083	2.998
1976	10.043	3.232
1977	0.057	1.654
1978	8.867	9.285
1979	4.305	2.524
1980	4.509	2.006
1981	11.481	8.426
1982	9.960	9.246
1983	14.124	4.960
1984	3.504	2.048
1985	2.450	2.747
1986	3.633	2.245
1987	8.545	7.719
1988	1.873	1.950
1989	2.481	1.750
1990	1.574	1.743
1991	4.201	1.904
1992	4.825	1.725
1993	8.498	3.569
1994	7.868	6.453
1995	3.893	7.231
1996	12.195	10.778
1997	10.634	12.512
1998	8.490	2.188
1999	5.586	7.083
2000	3.435	1.450
2001	1.604	1.404
2002	10.453	2.155
2003	10.367	4.590
2004	1.709	1.831
2005	1.605	1.917
2006	7.415	2.117
2007	3.825	5.178
2008	3.355	2.874

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	38.9797	13.3362
2	14.6001	12.9909
3	14.1241	12.5115
4	13.4856	11.1940

5	12.1949	10.7775
6	11.4813	9.2851
7	10.9155	9.2457
8	10.6339	8.4255
9	10.4526	7.7185
10	10.3671	7.4202
11	10.0426	7.2309
12	9.9598	7.0828
13	9.7441	6.4534
14	8.8672	6.4213
15	8.6149	6.0095
16	8.5450	5.5298
17	8.4982	5.1776
18	8.4905	5.0693
19	7.9597	4.9605
20	7.8681	4.5901
21	7.7706	4.1158
22	7.4148	3.7973
23	7.3776	3.5686
24	7.0827	3.2908
25	6.7496	3.2320
26	6.7309	2.9983
27	6.0036	2.9981
28	5.9214	2.9568
29	5.7199	2.9050
30	5.5863	2.8736
31	5.3479	2.7469
32	5.2550	2.6387
33	5.0862	2.5241
34	4.9249	2.3561
35	4.8248	2.2993
36	4.7597	2.2445
37	4.7543	2.1877
38	4.6184	2.1548
39	4.5091	2.1188
40	4.3312	2.1168
41	4.3051	2.0480
42	4.2006	2.0439
43	3.8928	2.0325
44	3.8249	2.0157
45	3.7627	2.0064
46	3.7298	1.9597
47	3.6335	1.9497
48	3.5044	1.9169
49	3.4964	1.9078
50	3.4355	1.9041
51	3.3548	1.8975
52	3.3507	1.8857
53	2.4815	1.8315
54	2.4500	1.7495
55	1.8733	1.7454
56	1.7090	1.7433
57	1.6055	1.7250
58	1.6041	1.6543
59	1.5745	1.4504
60	0.0566	1.4039

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Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
3.0250	978	762	77	Pass
3.1857	889	705	79	Pass
3.3464	805	643	79	Pass
3.5071	735	590	80	Pass
3.6678	673	539	80	Pass
3.8285	602	494	82	Pass
3.9892	541	455	84	Pass
4.1499	492	416	84	Pass
4.3106	450	388	86	Pass
4.4713	418	360	86	Pass
4.6321	378	341	90	Pass
4.7928	354	322	90	Pass
4.9535	320	302	94	Pass
5.1142	300	281	93	Pass
5.2749	279	271	97	Pass
5.4356	258	250	96	Pass
5.5963	243	232	95	Pass
5.7570	228	217	95	Pass
5.9177	211	200	94	Pass
6.0784	192	187	97	Pass
6.2391	179	170	94	Pass
6.3998	171	159	92	Pass
6.5605	159	144	90	Pass
6.7212	149	136	91	Pass
6.8819	139	129	92	Pass
7.0426	134	120	89	Pass
7.2033	122	105	86	Pass
7.3641	112	99	88	Pass
7.5248	104	91	87	Pass
7.6855	99	84	84	Pass
7.8462	91	78	85	Pass
8.0069	86	70	81	Pass
8.1676	82	66	80	Pass
8.3283	76	59	77	Pass
8.4890	67	52	77	Pass
8.6497	54	47	87	Pass
8.8104	50	44	88	Pass
8.9711	47	40	85	Pass
9.1318	46	39	84	Pass
9.2925	44	35	79	Pass
9.4532	40	34	85	Pass
9.6139	37	30	81	Pass
9.7746	32	28	87	Pass
9.9354	28	25	89	Pass
10.0961	26	24	92	Pass
10.2568	24	23	95	Pass
10.4175	22	19	86	Pass
10.5782	18	18	100	Pass
10.7389	16	17	106	Pass
10.8996	16	15	93	Pass
11.0603	13	14	107	Pass
11.2210	12	11	91	Pass
11.3817	11	10	90	Pass

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11.5424	10	9	90	Pass
11.7031	10	8	80	Pass
11.8638	10	7	70	Pass
12.0245	10	7	70	Pass
12.1852	10	7	70	Pass
12.3459	9	6	66	Pass
12.5066	9	4	44	Pass
12.6674	9	3	33	Pass
12.8281	9	3	33	Pass
12.9888	9	3	33	Pass
13.1495	9	2	22	Pass
13.3102	9	1	11	Pass
13.4709	7	0	0	Pass
13.6316	6	0	0	Pass
13.7923	6	0	0	Pass
13.9530	6	0	0	Pass
14.1137	6	0	0	Pass
14.2744	5	0	0	Pass
14.4351	5	0	0	Pass
14.5958	5	0	0	Pass
14.7565	4	0	0	Pass
14.9172	4	0	0	Pass
15.0779	4	0	0	Pass
15.2386	4	0	0	Pass
15.3994	4	0	0	Pass
15.5601	4	0	0	Pass
15.7208	4	0	0	Pass
15.8815	4	0	0	Pass
16.0422	4	0	0	Pass
16.2029	4	0	0	Pass
16.3636	4	0	0	Pass
16.5243	4	0	0	Pass
16.6850	4	0	0	Pass
16.8457	4	0	0	Pass
17.0064	4	0	0	Pass
17.1671	4	0	0	Pass
17.3278	4	0	0	Pass
17.4885	4	0	0	Pass
17.6492	4	0	0	Pass
17.8099	4	0	0	Pass
17.9706	4	0	0	Pass
18.1314	4	0	0	Pass
18.2921	4	0	0	Pass
18.4528	4	0	0	Pass
18.6135	4	0	0	Pass
18.7742	3	0	0	Pass
18.9349	3	0	0	Pass

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Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

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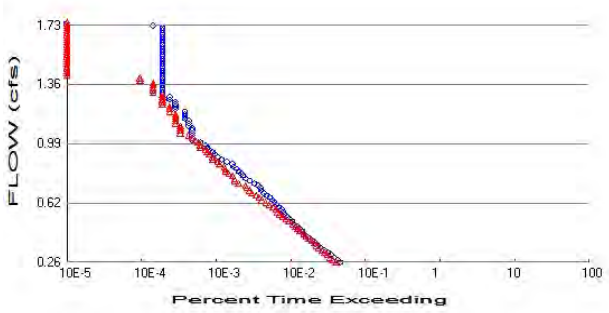
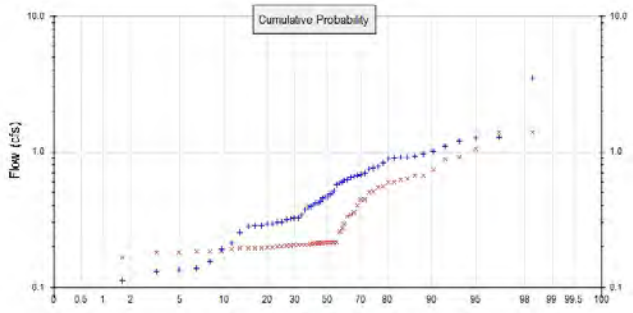
POC 2





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 3.651
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.91
Total Impervious Area: 2.741

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.510163
5 year	0.958832
10 year	1.235196
25 year	1.536985
50 year	1.725434
100 year	1.885189

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Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.287643
5 year	0.489946
10 year	0.670281
25 year	0.96233
50 year	1.234461
100 year	1.56071

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1949	0.409	0.511
1950	0.432	0.292
1951	0.823	0.440
1952	0.497	0.398
1953	0.415	0.205
1954	0.568	0.209
1955	0.295	0.197
1956	1.203	0.917
1957	0.615	0.205
1958	0.374	0.357
1959	0.280	0.180

1960	0.326	0.207
1961	0.682	0.597
1962	0.395	0.194
1963	0.459	0.213
1964	0.969	0.210
1965	0.520	0.597
1966	0.487	0.215
1967	0.464	0.204
1968	0.651	0.215
1969	0.595	0.627
1970	3.495	0.664
1971	0.300	0.193
1972	0.753	0.211
1973	0.324	0.215
1974	1.288	1.399
1975	0.591	0.214
1976	0.901	0.215
1977	0.003	0.182
1978	0.783	0.742
1979	0.254	0.215
1980	0.391	0.204
1981	1.008	0.668
1982	0.883	0.623
1983	1.260	0.259
1984	0.286	0.207
1985	0.192	0.334
1986	0.302	0.192
1987	0.759	0.442
1988	0.155	0.212
1989	0.211	0.182
1990	0.131	0.186
1991	0.344	0.199
1992	0.420	0.183
1993	0.697	0.272
1994	0.658	0.505
1995	0.318	0.891
1996	1.097	1.054
1997	0.908	1.403
1998	0.671	0.199
1999	0.457	0.558
2000	0.293	0.167
2001	0.134	0.154
2002	0.931	0.196
2003	0.916	0.342
2004	0.139	0.195
2005	0.112	0.204
2006	0.622	0.197
2007	0.316	0.547
2008	0.287	0.212

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	3.4952	1.4031
2	1.2877	1.3990
3	1.2603	1.0542
4	1.2026	0.9169
5	1.0970	0.8912

6	1.0082	0.7420
7	0.9687	0.6681
8	0.9312	0.6636
9	0.9164	0.6268
10	0.9078	0.6233
11	0.9009	0.5973
12	0.8832	0.5967
13	0.8234	0.5581
14	0.7829	0.5465
15	0.7595	0.5111
16	0.7526	0.5050
17	0.6970	0.4417
18	0.6817	0.4404
19	0.6715	0.3978
20	0.6580	0.3572
21	0.6509	0.3415
22	0.6225	0.3336
23	0.6150	0.2919
24	0.5952	0.2723
25	0.5906	0.2591
26	0.5684	0.2154
27	0.5197	0.2151
28	0.4971	0.2149
29	0.4868	0.2147
30	0.4639	0.2147
31	0.4586	0.2136
32	0.4575	0.2127
33	0.4315	0.2123
34	0.4196	0.2118
35	0.4154	0.2113
36	0.4086	0.2096
37	0.3950	0.2094
38	0.3912	0.2070
39	0.3736	0.2068
40	0.3437	0.2054
41	0.3255	0.2050
42	0.3238	0.2043
43	0.3176	0.2039
44	0.3164	0.2039
45	0.3024	0.1989
46	0.3000	0.1986
47	0.2952	0.1973
48	0.2935	0.1965
49	0.2868	0.1956
50	0.2860	0.1954
51	0.2800	0.1944
52	0.2542	0.1931
53	0.2109	0.1925
54	0.1919	0.1863
55	0.1551	0.1825
56	0.1387	0.1824
57	0.1343	0.1820
58	0.1314	0.1803
59	0.1120	0.1668
60	0.0032	0.1541

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Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.2551	973	847	87	Pass
0.2699	892	773	86	Pass
0.2848	805	697	86	Pass
0.2996	726	651	89	Pass
0.3145	665	601	90	Pass
0.3293	590	551	93	Pass
0.3442	536	498	92	Pass
0.3590	485	465	95	Pass
0.3739	444	433	97	Pass
0.3887	411	399	97	Pass
0.4036	380	369	97	Pass
0.4185	341	338	99	Pass
0.4333	318	316	99	Pass
0.4482	299	281	93	Pass
0.4630	276	262	94	Pass
0.4779	255	244	95	Pass
0.4927	232	223	96	Pass
0.5076	220	197	89	Pass
0.5224	204	181	88	Pass
0.5373	190	164	86	Pass
0.5521	177	151	85	Pass
0.5670	167	140	83	Pass
0.5818	157	133	84	Pass
0.5967	146	122	83	Pass
0.6115	135	108	80	Pass
0.6264	127	97	76	Pass
0.6412	119	87	73	Pass
0.6561	111	79	71	Pass
0.6709	100	72	72	Pass
0.6858	92	63	68	Pass
0.7006	86	59	68	Pass
0.7155	82	54	65	Pass
0.7303	77	52	67	Pass
0.7452	68	42	61	Pass
0.7601	59	38	64	Pass
0.7749	53	37	69	Pass
0.7898	48	35	72	Pass
0.8046	46	31	67	Pass
0.8195	42	28	66	Pass
0.8343	40	28	70	Pass
0.8492	36	27	75	Pass
0.8640	35	23	65	Pass
0.8789	29	22	75	Pass
0.8937	25	19	76	Pass
0.9086	22	19	86	Pass
0.9234	20	17	85	Pass
0.9383	19	16	84	Pass
0.9531	17	15	88	Pass
0.9680	16	13	81	Pass
0.9828	15	13	86	Pass
0.9977	13	12	92	Pass
1.0125	10	11	110	Pass
1.0274	10	10	100	Pass

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1.0422	10	9	90	Pass
1.0571	10	7	70	Pass
1.0719	10	7	70	Pass
1.0868	10	7	70	Pass
1.1016	9	7	77	Pass
1.1165	9	6	66	Pass
1.1314	9	6	66	Pass
1.1462	8	6	75	Pass
1.1611	8	6	75	Pass
1.1759	8	6	75	Pass
1.1908	8	5	62	Pass
1.2056	6	5	83	Pass
1.2205	6	5	83	Pass
1.2353	6	4	66	Pass
1.2502	6	4	66	Pass
1.2650	5	4	80	Pass
1.2799	5	4	80	Pass
1.2947	4	4	100	Pass
1.3096	4	3	75	Pass
1.3244	4	3	75	Pass
1.3393	4	3	75	Pass
1.3541	4	3	75	Pass
1.3690	4	3	75	Pass
1.3838	4	2	50	Pass
1.3987	4	2	50	Pass
1.4135	4	0	0	Pass
1.4284	4	0	0	Pass
1.4432	4	0	0	Pass
1.4581	4	0	0	Pass
1.4729	4	0	0	Pass
1.4878	4	0	0	Pass
1.5027	4	0	0	Pass
1.5175	4	0	0	Pass
1.5324	4	0	0	Pass
1.5472	4	0	0	Pass
1.5621	4	0	0	Pass
1.5769	4	0	0	Pass
1.5918	4	0	0	Pass
1.6066	4	0	0	Pass
1.6215	4	0	0	Pass
1.6363	4	0	0	Pass
1.6512	4	0	0	Pass
1.6660	4	0	0	Pass
1.6809	4	0	0	Pass
1.6957	4	0	0	Pass
1.7106	4	0	0	Pass
1.7254	3	0	0	Pass

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Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

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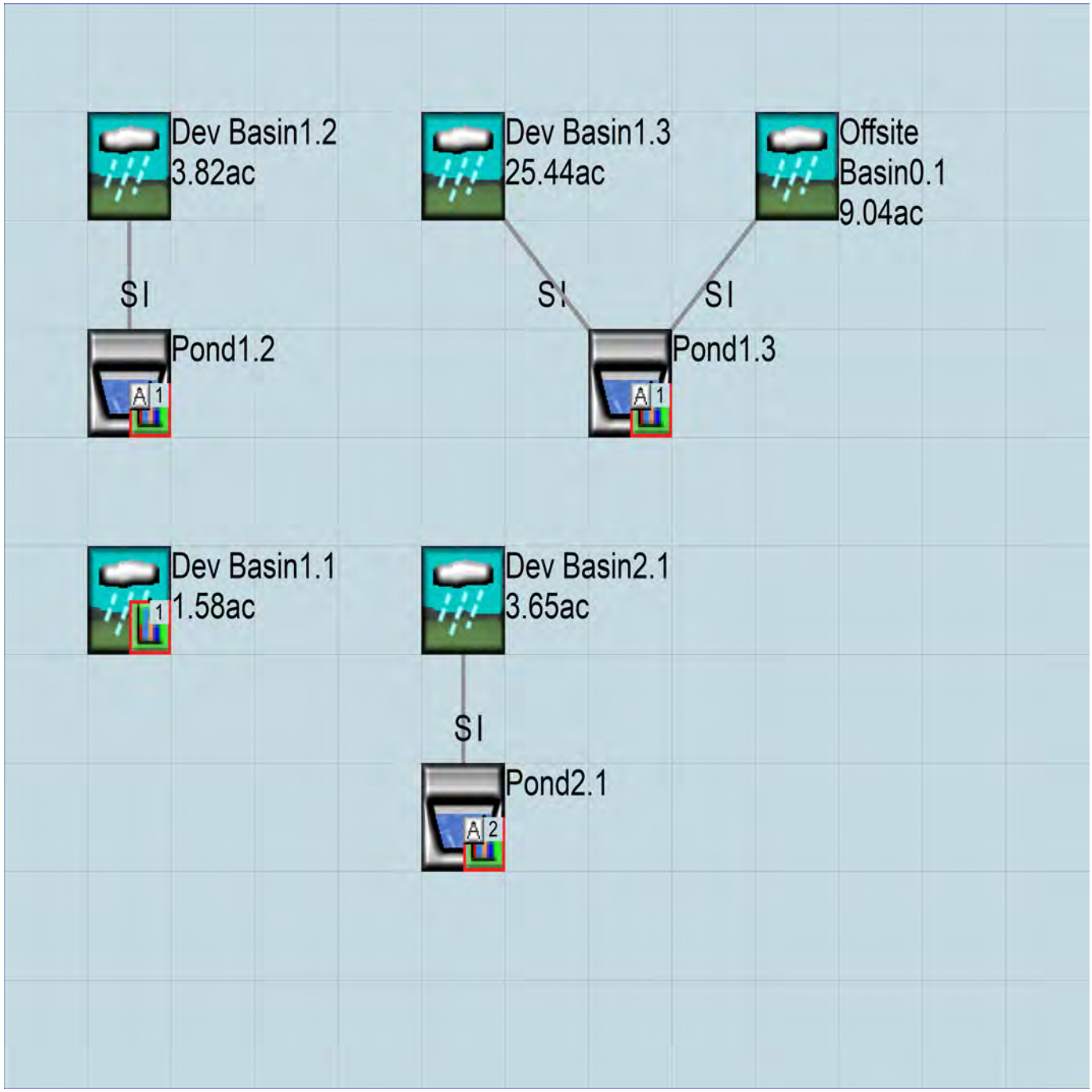
Appendix
Predeveloped Schematic



Mitigated Schematic



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WWHM2012

PROJECT REPORT

Water Quality
Calculations ONLY

General Model Information

Project Name:	4373 Prelim WWHM WQ
Site Name:	North Haven PUD-WQ
Site Address:	179th St & 11th Ave
City:	Vancouver
Report Date:	2/6/2020
Gage:	Salmon Creek Treatment Plant
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.060
Version Date:	2018/10/10
Version:	4.2.16

POC Thresholds

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Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year
Low Flow Threshold for POC3:	50 Percent of the 2 Year
High Flow Threshold for POC3:	50 Year
Low Flow Threshold for POC4:	50 Percent of the 2 Year
High Flow Threshold for POC4:	50 Year

Landuse Basin Data
Predeveloped Land Use

Pre Dev1.3

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Flat	25.443
Pervious Total	25.443
Impervious Land Use	acre
Impervious Total	0
Basin Total	25.443

Element Flows To:

Surface	Interflow	Groundwater

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Offsite Basin0.1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Field, Flat	9.041
Pervious Total	9.041
Impervious Land Use	acre
Impervious Total	0
Basin Total	9.041

Element Flows To:

Surface	Interflow	Groundwater

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Pre Dev2.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Forest, Flat	2.186
Pervious Total	2.186

Impervious Land Use	acre
Impervious Total	0
Basin Total	2.186

Element Flows To:

Surface	Interflow	Groundwater

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Pre Dev1.2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Flat	1.89
Pervious Total	1.89
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.89

Element Flows To:

Surface	Interflow	Groundwater

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Pre Dev1.1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Flat	1.32
Pervious Total	1.32
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.32

Element Flows To:

Surface	Interflow	Groundwater

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Mitigated Land Use

Dev Basin1.3

Bypass: No

GroundWater: No

Pervious Land Use	acre
SG4, Lawn, Flat	6.563
Pervious Total	6.563

Impervious Land Use	acre
ROADS FLAT	4.569
ROOF TOPS FLAT	9.366
DRIVEWAYS FLAT	2.927
SIDEWALKS FLAT	1.471
POND	0.547
Impervious Total	18.88
Basin Total	25.443

Element Flows To:

Surface	Interflow	Groundwater
Pond1.3	Pond1.3	

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Dev Basin1.2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.45
Pervious Total	0.45

Impervious Land Use	acre
ROADS FLAT	0.59
DRIVEWAYS FLAT	0.482
SIDEWALKS FLAT	0.21
POND	0.158
Impervious Total	1.44
Basin Total	1.89

Element Flows To:

Surface	Interflow	Groundwater

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Dev Basin1.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.09
Pervious Total	0.09

Impervious Land Use	acre
ROADS FLAT	1.23
Impervious Total	1.23
Basin Total	1.32

Element Flows To:

Surface	Interflow	Groundwater

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Offsite Basin0.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Field, Flat	9.041
Pervious Total	9.041

Impervious Land Use	acre
Impervious Total	0
Basin Total	9.041

Element Flows To:

Surface	Interflow	Groundwater
Pond1.3	Pond1.3	

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Dev Basin2.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.62
Pervious Total	0.62

Impervious Land Use	acre
ROADS FLAT	0.802
DRIVEWAYS FLAT	0.367
SIDEWALKS FLAT	0.248
POND	0.149
Impervious Total	1.566
Basin Total	2.186

Element Flows To:

Surface	Interflow	Groundwater

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Mitigated Routing

Pond1.3

Bottom Length: 75.00 ft.
Bottom Width: 75.00 ft.
Depth: 13 ft.
Volume at riser head: 2.7994 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 12 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 1.100 ft.
Notch Height: 1.600 ft.
Orifice 1 Diameter: 4.2 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

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Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.129	0.000	0.000	0.000
0.1444	0.131	0.018	0.181	0.000
0.2889	0.133	0.037	0.257	0.000
0.4333	0.135	0.057	0.315	0.000
0.5778	0.137	0.076	0.363	0.000
0.7222	0.139	0.096	0.406	0.000
0.8667	0.141	0.117	0.445	0.000
1.0111	0.143	0.137	0.481	0.000
1.1556	0.145	0.158	0.514	0.000
1.3000	0.147	0.179	0.545	0.000
1.4444	0.149	0.201	0.575	0.000
1.5889	0.151	0.223	0.603	0.000
1.7333	0.154	0.245	0.630	0.000
1.8778	0.156	0.267	0.656	0.000
2.0222	0.158	0.290	0.680	0.000
2.1667	0.160	0.313	0.704	0.000
2.3111	0.162	0.336	0.727	0.000
2.4556	0.165	0.360	0.750	0.000
2.6000	0.167	0.384	0.771	0.000
2.7444	0.169	0.408	0.793	0.000
2.8889	0.172	0.433	0.813	0.000
3.0333	0.174	0.458	0.833	0.000
3.1778	0.176	0.483	0.853	0.000
3.3222	0.178	0.509	0.872	0.000
3.4667	0.181	0.535	0.891	0.000
3.6111	0.183	0.561	0.909	0.000
3.7556	0.186	0.588	0.927	0.000
3.9000	0.188	0.615	0.945	0.000
4.0444	0.190	0.643	0.962	0.000
4.1889	0.193	0.670	0.979	0.000
4.3333	0.195	0.698	0.996	0.000
4.4778	0.198	0.727	1.013	0.000

4.6222	0.200	0.756	1.029	0.000
4.7667	0.203	0.785	1.045	0.000
4.9111	0.205	0.814	1.060	0.000
5.0556	0.208	0.844	1.076	0.000
5.2000	0.210	0.874	1.091	0.000
5.3444	0.213	0.905	1.106	0.000
5.4889	0.215	0.936	1.121	0.000
5.6333	0.218	0.967	1.136	0.000
5.7778	0.221	0.999	1.150	0.000
5.9222	0.223	1.031	1.164	0.000
6.0667	0.226	1.064	1.179	0.000
6.2111	0.228	1.097	1.193	0.000
6.3556	0.231	1.130	1.206	0.000
6.5000	0.234	1.164	1.220	0.000
6.6444	0.236	1.198	1.233	0.000
6.7889	0.239	1.232	1.247	0.000
6.9333	0.242	1.267	1.260	0.000
7.0778	0.245	1.302	1.273	0.000
7.2222	0.247	1.338	1.286	0.000
7.3667	0.250	1.374	1.299	0.000
7.5111	0.253	1.410	1.311	0.000
7.6556	0.256	1.447	1.324	0.000
7.8000	0.258	1.484	1.336	0.000
7.9444	0.261	1.522	1.349	0.000
8.0889	0.264	1.560	1.361	0.000
8.2333	0.267	1.598	1.373	0.000
8.3778	0.270	1.637	1.385	0.000
8.5222	0.273	1.676	1.397	0.000
8.6667	0.276	1.716	1.409	0.000
8.8111	0.279	1.756	1.420	0.000
8.9556	0.281	1.796	1.432	0.000
9.1000	0.284	1.837	1.444	0.000
9.2444	0.287	1.879	1.455	0.000
9.3889	0.290	1.920	1.466	0.000
9.5333	0.293	1.963	1.478	0.000
9.6778	0.296	2.005	1.489	0.000
9.8222	0.299	2.048	1.500	0.000
9.9667	0.302	2.092	1.511	0.000
10.111	0.306	2.136	1.522	0.000
10.256	0.309	2.180	1.533	0.000
10.400	0.312	2.225	1.543	0.000
10.544	0.315	2.270	1.755	0.000
10.689	0.318	2.316	2.133	0.000
10.833	0.321	2.362	2.620	0.000
10.978	0.324	2.409	3.194	0.000
11.122	0.327	2.456	3.844	0.000
11.267	0.330	2.504	4.562	0.000
11.411	0.334	2.552	5.341	0.000
11.556	0.337	2.600	6.177	0.000
11.700	0.340	2.649	7.066	0.000
11.844	0.343	2.699	8.006	0.000
11.989	0.347	2.749	8.993	0.000
12.133	0.350	2.799	9.852	0.000
12.278	0.353	2.850	11.34	0.000
12.422	0.356	2.901	12.97	0.000
12.567	0.360	2.953	14.28	0.000
12.711	0.363	3.005	15.05	0.000
12.856	0.366	3.058	15.68	0.000

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13.000	0.370	3.111	16.22	0.000
13.144	0.373	3.165	16.73	0.000

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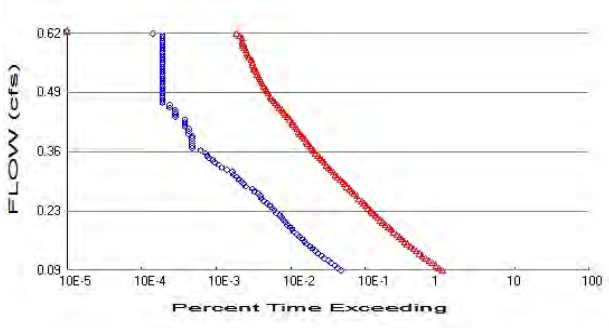
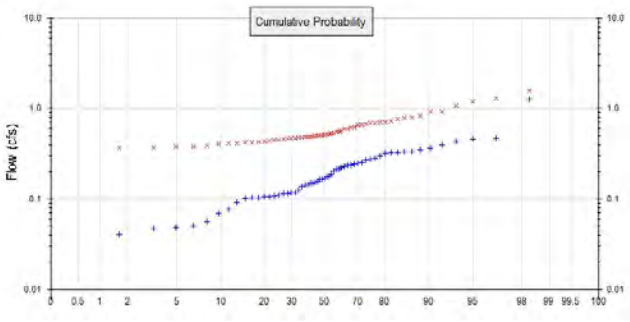
Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 1.32
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.09
Total Impervious Area: 1.23

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.184447
5 year	0.346661
10 year	0.446579
25 year	0.555689
50 year	0.623822
100 year	0.68158

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.541564
5 year	0.728563
10 year	0.867505
25 year	1.061083
50 year	1.218947
100 year	1.389013

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.148	0.929
1950	0.156	0.486
1951	0.298	0.568
1952	0.180	0.616
1953	0.150	0.487
1954	0.206	0.692
1955	0.107	0.419
1956	0.435	0.593
1957	0.222	0.450
1958	0.135	0.620

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1959	0.101	0.380
1960	0.118	0.504
1961	0.246	0.466
1962	0.143	0.489
1963	0.166	0.422
1964	0.350	0.511
1965	0.188	0.428
1966	0.176	0.406
1967	0.168	0.527
1968	0.235	1.073
1969	0.215	0.784
1970	1.264	1.583
1971	0.108	0.761
1972	0.272	0.589
1973	0.117	0.662
1974	0.466	0.676
1975	0.214	0.452
1976	0.326	0.479
1977	0.001	0.295
1978	0.283	0.465
1979	0.092	0.665
1980	0.141	0.373
1981	0.365	0.560
1982	0.319	0.718
1983	0.456	0.694
1984	0.103	0.439
1985	0.069	0.477
1986	0.109	0.826
1987	0.275	0.416
1988	0.056	0.500
1989	0.076	0.458
1990	0.048	0.380
1991	0.124	0.493
1992	0.152	0.411
1993	0.252	0.704
1994	0.238	0.465
1995	0.115	0.702
1996	0.397	1.296
1997	0.328	0.923
1998	0.243	0.800
1999	0.165	0.427
2000	0.106	0.367
2001	0.049	0.387
2002	0.337	0.561
2003	0.331	0.537
2004	0.050	0.531
2005	0.040	0.500
2006	0.225	0.519
2007	0.114	0.509
2008	0.104	1.195

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	1.2637	1.5828
2	0.4656	1.2960
3	0.4556	1.1953
4	0.4348	1.0726

5	0.3966	0.9295
6	0.3645	0.9228
7	0.3502	0.8257
8	0.3367	0.7997
9	0.3313	0.7836
10	0.3282	0.7615
11	0.3257	0.7178
12	0.3193	0.7044
13	0.2977	0.7020
14	0.2830	0.6939
15	0.2746	0.6918
16	0.2721	0.6763
17	0.2520	0.6648
18	0.2465	0.6616
19	0.2428	0.6200
20	0.2379	0.6163
21	0.2353	0.5932
22	0.2251	0.5888
23	0.2224	0.5682
24	0.2152	0.5609
25	0.2135	0.5600
26	0.2055	0.5372
27	0.1879	0.5311
28	0.1797	0.5268
29	0.1760	0.5193
30	0.1677	0.5112
31	0.1658	0.5088
32	0.1654	0.5035
33	0.1560	0.5004
34	0.1517	0.5002
35	0.1502	0.4930
36	0.1477	0.4890
37	0.1428	0.4870
38	0.1415	0.4860
39	0.1351	0.4788
40	0.1243	0.4772
41	0.1177	0.4663
42	0.1171	0.4653
43	0.1148	0.4648
44	0.1144	0.4582
45	0.1093	0.4522
46	0.1085	0.4503
47	0.1067	0.4391
48	0.1061	0.4278
49	0.1037	0.4269
50	0.1034	0.4221
51	0.1012	0.4188
52	0.0919	0.4163
53	0.0763	0.4110
54	0.0694	0.4055
55	0.0561	0.3867
56	0.0502	0.3802
57	0.0486	0.3796
58	0.0475	0.3730
59	0.0405	0.3672
60	0.0012	0.2953

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Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0922	979	22511	2299	Fail
0.0976	896	20407	2277	Fail
0.1030	822	18516	2252	Fail
0.1083	728	16488	2264	Fail
0.1137	672	14996	2231	Fail
0.1191	590	13431	2276	Fail
0.1244	542	12255	2261	Fail
0.1298	490	11241	2294	Fail
0.1352	444	10092	2272	Fail
0.1406	412	9261	2247	Fail
0.1459	381	8468	2222	Fail
0.1513	341	7666	2248	Fail
0.1567	322	7023	2181	Fail
0.1620	299	6450	2157	Fail
0.1674	277	5996	2164	Fail
0.1728	256	5523	2157	Fail
0.1781	230	5016	2180	Fail
0.1835	220	4660	2118	Fail
0.1889	205	4300	2097	Fail
0.1942	190	3917	2061	Fail
0.1996	180	3604	2002	Fail
0.2050	168	3347	1992	Fail
0.2104	157	3080	1961	Fail
0.2157	150	2870	1913	Fail
0.2211	135	2663	1972	Fail
0.2265	127	2493	1962	Fail
0.2318	120	2314	1928	Fail
0.2372	111	2150	1936	Fail
0.2426	101	2009	1989	Fail
0.2479	92	1861	2022	Fail
0.2533	86	1704	1981	Fail
0.2587	83	1610	1939	Fail
0.2641	77	1482	1924	Fail
0.2694	68	1394	2050	Fail
0.2748	64	1290	2015	Fail
0.2802	53	1188	2241	Fail
0.2855	49	1115	2275	Fail
0.2909	46	1053	2289	Fail
0.2963	42	965	2297	Fail
0.3016	40	891	2227	Fail
0.3070	36	824	2288	Fail
0.3124	35	778	2222	Fail
0.3178	29	720	2482	Fail
0.3231	25	671	2684	Fail
0.3285	23	626	2721	Fail
0.3339	20	591	2955	Fail
0.3392	19	554	2915	Fail
0.3446	17	518	3047	Fail
0.3500	16	487	3043	Fail
0.3553	15	447	2980	Fail
0.3607	13	427	3284	Fail
0.3661	10	399	3990	Fail
0.3714	10	379	3790	Fail
0.3768	10	357	3570	Fail

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0.3822	10	338	3380	Fail
0.3876	10	321	3209	Fail
0.3929	10	302	3020	Fail
0.3983	9	281	3122	Fail
0.4037	9	266	2955	Fail
0.4090	9	255	2833	Fail
0.4144	8	242	3025	Fail
0.4198	8	224	2800	Fail
0.4251	8	220	2750	Fail
0.4305	8	205	2562	Fail
0.4359	6	190	3166	Fail
0.4413	6	178	2966	Fail
0.4466	6	170	2833	Fail
0.4520	6	160	2666	Fail
0.4574	5	147	2940	Fail
0.4627	5	140	2800	Fail
0.4681	4	130	3250	Fail
0.4735	4	124	3100	Fail
0.4788	4	115	2875	Fail
0.4842	4	112	2800	Fail
0.4896	4	104	2600	Fail
0.4949	4	101	2525	Fail
0.5003	4	97	2425	Fail
0.5057	4	91	2275	Fail
0.5111	4	88	2200	Fail
0.5164	4	85	2125	Fail
0.5218	4	82	2050	Fail
0.5272	4	79	1975	Fail
0.5325	4	75	1875	Fail
0.5379	4	73	1825	Fail
0.5433	4	68	1700	Fail
0.5486	4	67	1675	Fail
0.5540	4	66	1650	Fail
0.5594	4	65	1625	Fail
0.5648	4	62	1550	Fail
0.5701	4	58	1450	Fail
0.5755	4	56	1400	Fail
0.5809	4	55	1375	Fail
0.5862	4	53	1325	Fail
0.5916	4	50	1250	Fail
0.5970	4	48	1200	Fail
0.6023	4	48	1200	Fail
0.6077	4	47	1175	Fail
0.6131	4	47	1175	Fail
0.6185	4	43	1075	Fail
0.6238	3	39	1300	Fail

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The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.15 acre-feet
On-line facility target flow:	0.2133 cfs.
Adjusted for 15 min:	0.2133 cfs.
Off-line facility target flow:	0.1195 cfs.
Adjusted for 15 min:	0.1195 cfs.

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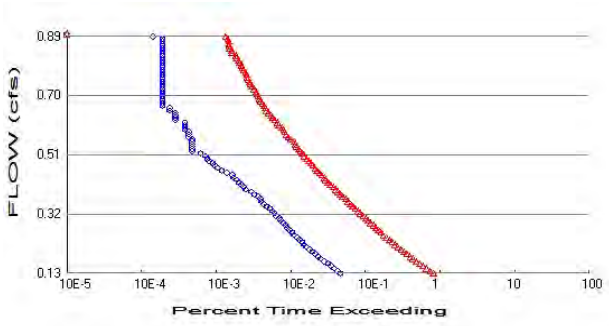
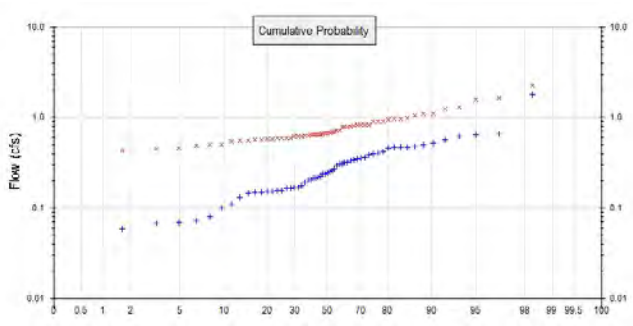
POC 2





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 1.89
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.45
Total Impervious Area: 1.44

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.264094
5 year	0.496355
10 year	0.639419
25 year	0.795645
50 year	0.893199
100 year	0.975898

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Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.70382
5 year	0.954672
10 year	1.142253
25 year	1.404972
50 year	1.620222
100 year	1.852978

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1949	0.212	1.088
1950	0.223	0.569
1951	0.426	0.791
1952	0.257	0.835
1953	0.215	0.641
1954	0.294	0.837
1955	0.153	0.491
1956	0.623	0.834
1957	0.318	0.629
1958	0.193	0.834
1959	0.145	0.504

1960	0.169	0.617
1961	0.353	0.652
1962	0.205	0.670
1963	0.237	0.570
1964	0.501	0.716
1965	0.269	0.593
1966	0.252	0.562
1967	0.240	0.687
1968	0.337	1.306
1969	0.308	0.992
1970	1.809	2.241
1971	0.155	0.902
1972	0.390	0.690
1973	0.168	0.775
1974	0.667	0.951
1975	0.306	0.628
1976	0.466	0.668
1977	0.002	0.346
1978	0.405	0.647
1979	0.132	0.907
1980	0.203	0.499
1981	0.522	0.783
1982	0.457	0.916
1983	0.652	0.974
1984	0.148	0.579
1985	0.099	0.598
1986	0.157	1.058
1987	0.393	0.547
1988	0.080	0.588
1989	0.109	0.613
1990	0.068	0.450
1991	0.178	0.661
1992	0.217	0.560
1993	0.361	0.977
1994	0.341	0.649
1995	0.164	0.822
1996	0.568	1.663
1997	0.470	1.236
1998	0.348	1.097
1999	0.237	0.576
2000	0.152	0.430
2001	0.070	0.455
2002	0.482	0.780
2003	0.474	0.722
2004	0.072	0.622
2005	0.058	0.594
2006	0.322	0.641
2007	0.164	0.680
2008	0.148	1.566

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	1.8094	2.2415
2	0.6666	1.6630
3	0.6524	1.5661
4	0.6225	1.3063
5	0.5679	1.2360

6	0.5219	1.0966
7	0.5015	1.0883
8	0.4821	1.0583
9	0.4744	0.9916
10	0.4700	0.9765
11	0.4664	0.9744
12	0.4572	0.9509
13	0.4262	0.9162
14	0.4053	0.9069
15	0.3931	0.9017
16	0.3896	0.8375
17	0.3608	0.8347
18	0.3529	0.8344
19	0.3476	0.8342
20	0.3406	0.8220
21	0.3370	0.7909
22	0.3222	0.7834
23	0.3184	0.7796
24	0.3081	0.7748
25	0.3058	0.7216
26	0.2943	0.7162
27	0.2690	0.6898
28	0.2573	0.6868
29	0.2520	0.6805
30	0.2402	0.6700
31	0.2374	0.6679
32	0.2368	0.6609
33	0.2234	0.6516
34	0.2172	0.6490
35	0.2150	0.6469
36	0.2115	0.6414
37	0.2045	0.6407
38	0.2025	0.6291
39	0.1934	0.6279
40	0.1779	0.6219
41	0.1685	0.6169
42	0.1676	0.6134
43	0.1644	0.5982
44	0.1638	0.5939
45	0.1566	0.5933
46	0.1553	0.5878
47	0.1528	0.5786
48	0.1519	0.5757
49	0.1485	0.5696
50	0.1480	0.5690
51	0.1450	0.5617
52	0.1316	0.5595
53	0.1092	0.5470
54	0.0993	0.5040
55	0.0803	0.4991
56	0.0718	0.4906
57	0.0695	0.4553
58	0.0680	0.4496
59	0.0580	0.4300
60	0.0017	0.3459

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Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1320	973	17153	1762	Fail
0.1397	895	15539	1736	Fail
0.1474	805	13869	1722	Fail
0.1551	724	12396	1712	Fail
0.1628	669	11226	1678	Fail
0.1705	593	10094	1702	Fail
0.1782	536	9097	1697	Fail
0.1859	490	8331	1700	Fail
0.1936	445	7563	1699	Fail
0.2012	411	6869	1671	Fail
0.2089	380	6322	1663	Fail
0.2166	341	5733	1681	Fail
0.2243	320	5236	1636	Fail
0.2320	300	4809	1603	Fail
0.2397	277	4401	1588	Fail
0.2474	255	3989	1564	Fail
0.2551	230	3650	1586	Fail
0.2627	220	3408	1549	Fail
0.2704	204	3141	1539	Fail
0.2781	190	2893	1522	Fail
0.2858	180	2695	1497	Fail
0.2935	167	2480	1485	Fail
0.3012	155	2293	1479	Fail
0.3089	149	2133	1431	Fail
0.3166	135	1972	1460	Fail
0.3243	127	1799	1416	Fail
0.3319	120	1683	1402	Fail
0.3396	111	1538	1385	Fail
0.3473	100	1429	1429	Fail
0.3550	92	1320	1434	Fail
0.3627	86	1222	1420	Fail
0.3704	82	1140	1390	Fail
0.3781	77	1048	1361	Fail
0.3858	68	976	1435	Fail
0.3935	62	911	1469	Fail
0.4011	53	841	1586	Fail
0.4088	49	780	1591	Fail
0.4165	46	713	1550	Fail
0.4242	42	665	1583	Fail
0.4319	40	624	1560	Fail
0.4396	36	590	1638	Fail
0.4473	35	545	1557	Fail
0.4550	29	509	1755	Fail
0.4626	25	472	1887	Fail
0.4703	22	446	2027	Fail
0.4780	20	415	2075	Fail
0.4857	19	392	2063	Fail
0.4934	17	364	2141	Fail
0.5011	16	341	2131	Fail
0.5088	15	322	2146	Fail
0.5165	13	300	2307	Fail
0.5242	10	283	2830	Fail
0.5318	10	269	2690	Fail
0.5395	10	254	2540	Fail

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0.5472	10	242	2420	Fail
0.5549	10	233	2330	Fail
0.5626	10	207	2070	Fail
0.5703	9	194	2155	Fail
0.5780	9	182	2022	Fail
0.5857	9	176	1955	Fail
0.5934	8	170	2125	Fail
0.6010	8	159	1987	Fail
0.6087	8	146	1825	Fail
0.6164	8	140	1750	Fail
0.6241	6	128	2133	Fail
0.6318	6	119	1983	Fail
0.6395	6	114	1900	Fail
0.6472	6	105	1750	Fail
0.6549	5	99	1979	Fail
0.6625	5	96	1920	Fail
0.6702	4	92	2300	Fail
0.6779	4	88	2200	Fail
0.6856	4	84	2100	Fail
0.6933	4	79	1975	Fail
0.7010	4	76	1900	Fail
0.7087	4	74	1850	Fail
0.7164	4	72	1800	Fail
0.7241	4	67	1675	Fail
0.7317	4	63	1575	Fail
0.7394	4	60	1500	Fail
0.7471	4	59	1475	Fail
0.7548	4	56	1400	Fail
0.7625	4	54	1350	Fail
0.7702	4	54	1350	Fail
0.7779	4	52	1300	Fail
0.7856	4	49	1225	Fail
0.7932	4	47	1175	Fail
0.8009	4	46	1150	Fail
0.8086	4	43	1075	Fail
0.8163	4	42	1050	Fail
0.8240	4	39	975	Fail
0.8317	4	39	975	Fail
0.8394	4	34	850	Fail
0.8471	4	34	850	Fail
0.8548	4	32	800	Fail
0.8624	4	31	775	Fail
0.8701	4	31	775	Fail
0.8778	4	31	775	Fail
0.8855	4	30	750	Fail
0.8932	3	28	933	Fail

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The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0.1094 acre-feet
On-line facility target flow:	0.0764 cfs.
Adjusted for 15 min:	0.0764 cfs.
Off-line facility target flow:	0.0399 cfs.
Adjusted for 15 min:	0.0399 cfs.

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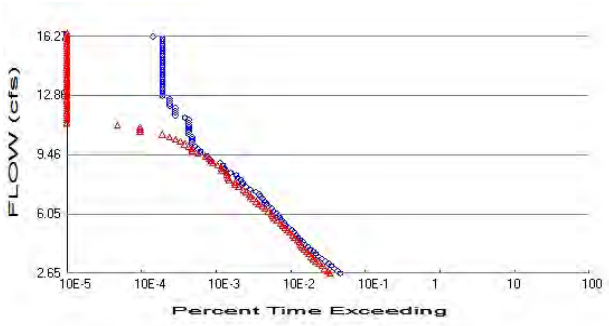
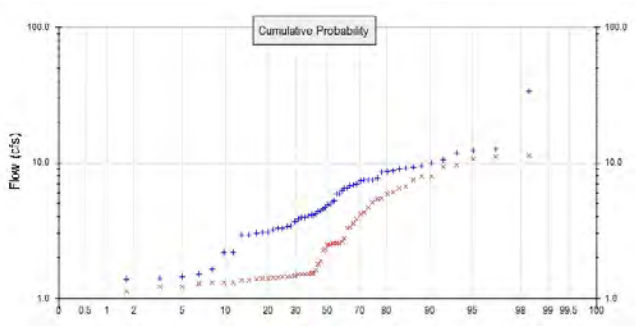
POC 3





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #3
Total Pervious Area: 34.484
Total Impervious Area: 0

Mitigated Landuse Totals for POC #3
Total Pervious Area: 15.604
Total Impervious Area: 18.88

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #3

Return Period	**Flow(cfs)**
2 year	5.294839
5 year	9.469017
10 year	11.957379
25 year	14.624914
50 year	16.2692
100 year	17.652006

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Flow Frequency Return Periods for Mitigated. POC #3

Return Period	**Flow(cfs)**	
2 year	2.522769	POC #3 WQ Flow Rate = Full 2-yr
5 year	4.736759	
10 year	6.769106	
25 year	10.120764	
50 year	13.282045	
100 year	17.099624	

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #3

Year	**Predeveloped**	**Mitigated**
1949	4.150	5.101
1950	4.448	3.275
1951	8.526	4.653
1952	4.984	3.315
1953	4.145	1.609
1954	5.908	1.903
1955	3.059	1.424
1956	11.706	9.600
1957	6.467	1.501
1958	4.066	2.531
1959	2.936	1.309

1960	3.281	1.405
1961	6.951	5.417
1962	4.340	1.359
1963	4.576	1.511
1964	9.482	2.542
1965	5.235	6.488
1966	5.201	2.234
1967	4.661	1.446
1968	6.807	2.488
1969	5.850	3.566
1970	33.807	11.264
1971	3.286	1.394
1972	7.501	2.557
1973	3.852	1.790
1974	12.694	11.163
1975	6.209	2.562
1976	8.709	2.624
1977	0.056	1.226
1978	7.709	7.920
1979	3.929	1.521
1980	3.934	1.515
1981	9.989	7.459
1982	8.653	7.904
1983	12.259	4.155
1984	3.081	1.503
1985	2.166	2.303
1986	3.186	1.300
1987	7.421	6.643
1988	1.650	1.464
1989	2.169	1.221
1990	1.382	1.287
1991	3.692	1.426
1992	4.204	1.303
1993	7.467	2.771
1994	6.894	5.504
1995	3.423	5.845
1996	10.572	9.421
1997	9.290	10.701
1998	7.497	1.383
1999	4.909	6.009
2000	3.001	1.111
2001	1.405	1.022
2002	9.075	1.518
2003	9.011	3.848
2004	1.504	1.356
2005	1.440	1.449
2006	6.494	1.444
2007	3.357	4.285
2008	2.930	2.480

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #3

Rank	Predeveloped	Mitigated
1	33.8072	11.2638
2	12.6944	11.1628
3	12.2591	10.7007
4	11.7059	9.6002
5	10.5715	9.4205

6	9.9892	7.9202
7	9.4819	7.9041
8	9.2904	7.4594
9	9.0745	6.6429
10	9.0110	6.4876
11	8.7094	6.0086
12	8.6528	5.8446
13	8.5256	5.5040
14	7.7087	5.4171
15	7.5012	5.1005
16	7.4968	4.6533
17	7.4667	4.2846
18	7.4211	4.1549
19	6.9509	3.8480
20	6.8943	3.5662
21	6.8073	3.3147
22	6.4936	3.2753
23	6.4674	2.7707
24	6.2086	2.6242
25	5.9084	2.5625
26	5.8500	2.5572
27	5.2345	2.5417
28	5.2009	2.5313
29	4.9842	2.4885
30	4.9092	2.4798
31	4.6614	2.3034
32	4.5764	2.2339
33	4.4476	1.9027
34	4.3403	1.7897
35	4.2039	1.6088
36	4.1497	1.5214
37	4.1450	1.5180
38	4.0655	1.5154
39	3.9338	1.5109
40	3.9290	1.5032
41	3.8520	1.5013
42	3.6920	1.4635
43	3.4228	1.4490
44	3.3567	1.4464
45	3.2859	1.4435
46	3.2810	1.4255
47	3.1859	1.4241
48	3.0812	1.4047
49	3.0594	1.3945
50	3.0012	1.3835
51	2.9363	1.3590
52	2.9304	1.3556
53	2.1694	1.3086
54	2.1661	1.3033
55	1.6496	1.3001
56	1.5037	1.2868
57	1.4398	1.2258
58	1.4054	1.2213
59	1.3819	1.1111
60	0.0559	1.0220

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Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
2.6474	977	706	72	Pass
2.7850	891	659	73	Pass
2.9226	806	599	74	Pass
3.0602	739	550	74	Pass
3.1978	677	503	74	Pass
3.3354	606	457	75	Pass
3.4730	545	423	77	Pass
3.6106	494	395	79	Pass
3.7482	457	365	79	Pass
3.8858	424	341	80	Pass
4.0234	383	316	82	Pass
4.1610	356	302	84	Pass
4.2985	323	288	89	Pass
4.4361	306	275	89	Pass
4.5737	281	258	91	Pass
4.7113	261	236	90	Pass
4.8489	248	223	89	Pass
4.9865	230	203	88	Pass
5.1241	216	189	87	Pass
5.2617	194	176	90	Pass
5.3993	179	164	91	Pass
5.5369	173	152	87	Pass
5.6745	160	136	85	Pass
5.8121	150	126	84	Pass
5.9497	142	120	84	Pass
6.0873	136	115	84	Pass
6.2249	125	105	84	Pass
6.3625	117	95	81	Pass
6.5000	105	88	83	Pass
6.6376	100	78	78	Pass
6.7752	95	73	76	Pass
6.9128	88	66	75	Pass
7.0504	83	61	73	Pass
7.1880	79	59	74	Pass
7.3256	72	53	73	Pass
7.4632	61	49	80	Pass
7.6008	52	42	80	Pass
7.7384	47	38	80	Pass
7.8760	47	38	80	Pass
8.0136	45	32	71	Pass
8.1512	41	30	73	Pass
8.2888	39	29	74	Pass
8.4264	33	29	87	Pass
8.5640	28	25	89	Pass
8.7015	27	25	92	Pass
8.8391	26	22	84	Pass
8.9767	24	19	79	Pass
9.1143	18	18	100	Pass
9.2519	17	17	100	Pass
9.3895	16	15	93	Pass
9.5271	13	12	92	Pass
9.6647	13	10	76	Pass
9.8023	12	10	83	Pass

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9.9399	11	9	81	Pass
10.0775	10	8	80	Pass
10.2151	10	7	70	Pass
10.3527	10	6	60	Pass
10.4903	10	5	50	Pass
10.6279	9	4	44	Pass
10.7655	9	2	22	Pass
10.9030	9	2	22	Pass
11.0406	9	2	22	Pass
11.1782	9	1	11	Pass
11.3158	9	0	0	Pass
11.4534	9	0	0	Pass
11.5910	8	0	0	Pass
11.7286	6	0	0	Pass
11.8662	6	0	0	Pass
12.0038	6	0	0	Pass
12.1414	6	0	0	Pass
12.2790	5	0	0	Pass
12.4166	5	0	0	Pass
12.5542	5	0	0	Pass
12.6918	5	0	0	Pass
12.8294	4	0	0	Pass
12.9670	4	0	0	Pass
13.1045	4	0	0	Pass
13.2421	4	0	0	Pass
13.3797	4	0	0	Pass
13.5173	4	0	0	Pass
13.6549	4	0	0	Pass
13.7925	4	0	0	Pass
13.9301	4	0	0	Pass
14.0677	4	0	0	Pass
14.2053	4	0	0	Pass
14.3429	4	0	0	Pass
14.4805	4	0	0	Pass
14.6181	4	0	0	Pass
14.7557	4	0	0	Pass
14.8933	4	0	0	Pass
15.0309	4	0	0	Pass
15.1685	4	0	0	Pass
15.3060	4	0	0	Pass
15.4436	4	0	0	Pass
15.5812	4	0	0	Pass
15.7188	4	0	0	Pass
15.8564	4	0	0	Pass
15.9940	4	0	0	Pass
16.1316	4	0	0	Pass
16.2692	3	0	0	Pass

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Water Quality

Water Quality BMP Flow and Volume for POC #3
On-line facility volume: 0 acre-feet
On-line facility target flow: 0 cfs.
Adjusted for 15 min: 0 cfs.
Off-line facility target flow: 0 cfs.
Adjusted for 15 min: 0 cfs.

POC #3 WQ Flow Rate = Full 2-yr flow

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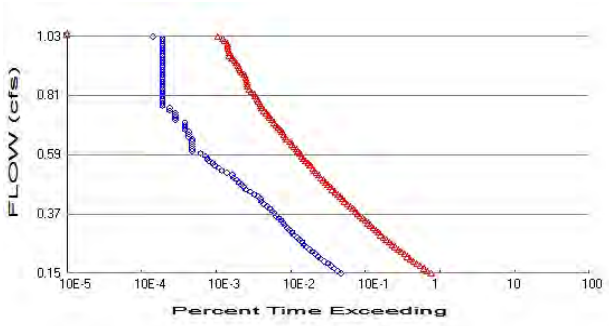
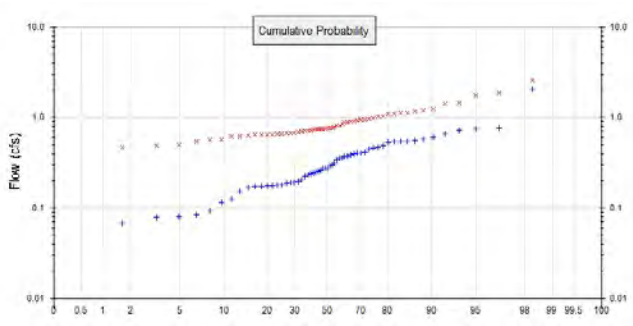
POC 4





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #4
Total Pervious Area: 2.186
Total Impervious Area: 0

Mitigated Landuse Totals for POC #4
Total Pervious Area: 0.62
Total Impervious Area: 1.566

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #4

Return Period	Flow(cfs)
2 year	0.305455
5 year	0.574091
10 year	0.739561
25 year	0.920254
50 year	1.033086
100 year	1.128738

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Flow Frequency Return Periods for Mitigated. POC #4

Return Period	Flow(cfs)
2 year	0.792081
5 year	1.079128
10 year	1.294511
25 year	1.597014
50 year	1.845479
100 year	2.114687

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #4

Year	Predeveloped	Mitigated
1949	0.245	1.183
1950	0.258	0.619
1951	0.493	0.908
1952	0.298	0.951
1953	0.249	0.725
1954	0.340	0.921
1955	0.177	0.548
1956	0.720	0.960
1957	0.368	0.723
1958	0.224	0.948
1959	0.168	0.570

1960	0.195	0.681
1961	0.408	0.749
1962	0.237	0.766
1963	0.275	0.650
1964	0.580	0.823
1965	0.311	0.680
1966	0.291	0.644
1967	0.278	0.780
1968	0.390	1.440
1969	0.356	1.107
1970	2.093	2.585
1971	0.180	0.985
1972	0.451	0.750
1973	0.194	0.843
1974	0.771	1.094
1975	0.354	0.720
1976	0.539	0.767
1977	0.002	0.376
1978	0.469	0.743
1979	0.152	1.039
1980	0.234	0.566
1981	0.604	0.900
1982	0.529	1.025
1983	0.755	1.121
1984	0.171	0.654
1985	0.115	0.669
1986	0.181	1.186
1987	0.455	0.617
1988	0.093	0.640
1989	0.126	0.696
1990	0.079	0.491
1991	0.206	0.750
1992	0.251	0.638
1993	0.417	1.120
1994	0.394	0.745
1995	0.190	0.894
1996	0.657	1.864
1997	0.544	1.406
1998	0.402	1.258
1999	0.274	0.655
2000	0.176	0.468
2001	0.080	0.496
2002	0.558	0.894
2003	0.549	0.820
2004	0.083	0.676
2005	0.067	0.649
2006	0.373	0.730
2007	0.189	0.772
2008	0.172	1.766

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #4

Rank	Predeveloped	Mitigated
1	2.0927	2.5849
2	0.7710	1.8637
3	0.7546	1.7663
4	0.7200	1.4397
5	0.6568	1.4055

6	0.6037	1.2584
7	0.5800	1.1856
8	0.5576	1.1835
9	0.5487	1.1211
10	0.5436	1.1195
11	0.5394	1.1066
12	0.5288	1.0945
13	0.4930	1.0393
14	0.4687	1.0251
15	0.4547	0.9845
16	0.4506	0.9604
17	0.4173	0.9506
18	0.4082	0.9483
19	0.4020	0.9212
20	0.3940	0.9078
21	0.3897	0.9004
22	0.3727	0.8944
23	0.3682	0.8939
24	0.3564	0.8427
25	0.3536	0.8235
26	0.3404	0.8199
27	0.3112	0.7802
28	0.2976	0.7722
29	0.2915	0.7670
30	0.2778	0.7656
31	0.2746	0.7505
32	0.2739	0.7503
33	0.2584	0.7487
34	0.2512	0.7453
35	0.2487	0.7427
36	0.2446	0.7298
37	0.2365	0.7246
38	0.2343	0.7228
39	0.2237	0.7202
40	0.2058	0.6963
41	0.1949	0.6812
42	0.1939	0.6802
43	0.1902	0.6763
44	0.1894	0.6691
45	0.1811	0.6549
46	0.1796	0.6539
47	0.1768	0.6503
48	0.1757	0.6489
49	0.1717	0.6438
50	0.1712	0.6399
51	0.1677	0.6382
52	0.1522	0.6188
53	0.1263	0.6174
54	0.1149	0.5704
55	0.0929	0.5664
56	0.0831	0.5485
57	0.0804	0.4961
58	0.0787	0.4910
59	0.0671	0.4676
60	0.0019	0.3762

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Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1527	983	16025	1630	Fail
0.1616	892	14291	1602	Fail
0.1705	808	12772	1580	Fail
0.1794	726	11447	1576	Fail
0.1883	665	10263	1543	Fail
0.1972	590	9263	1570	Fail
0.2061	536	8371	1561	Fail
0.2150	490	7715	1574	Fail
0.2239	447	7010	1568	Fail
0.2328	412	6381	1548	Fail
0.2417	380	5771	1518	Fail
0.2505	341	5274	1546	Fail
0.2594	320	4801	1500	Fail
0.2683	299	4399	1471	Fail
0.2772	276	4004	1450	Fail
0.2861	255	3667	1438	Fail
0.2950	230	3379	1469	Fail
0.3039	220	3145	1429	Fail
0.3128	204	2903	1423	Fail
0.3217	190	2684	1412	Fail
0.3306	178	2472	1388	Fail
0.3395	167	2276	1362	Fail
0.3484	156	2103	1348	Fail
0.3573	146	1932	1323	Fail
0.3661	135	1772	1312	Fail
0.3750	127	1656	1303	Fail
0.3839	120	1534	1278	Fail
0.3928	111	1422	1281	Fail
0.4017	101	1313	1300	Fail
0.4106	92	1205	1309	Fail
0.4195	86	1104	1283	Fail
0.4284	82	1029	1254	Fail
0.4373	77	963	1250	Fail
0.4462	68	896	1317	Fail
0.4551	60	828	1380	Fail
0.4640	53	765	1443	Fail
0.4729	49	710	1448	Fail
0.4818	46	658	1430	Fail
0.4906	42	617	1469	Fail
0.4995	40	570	1425	Fail
0.5084	36	529	1469	Fail
0.5173	35	498	1422	Fail
0.5262	29	459	1582	Fail
0.5351	25	433	1732	Fail
0.5440	23	416	1808	Fail
0.5529	20	384	1920	Fail
0.5618	19	361	1900	Fail
0.5707	17	330	1941	Fail
0.5796	16	309	1931	Fail
0.5885	15	293	1953	Fail
0.5974	13	280	2153	Fail
0.6062	10	263	2630	Fail
0.6151	10	251	2510	Fail
0.6240	10	232	2320	Fail

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0.6329	10	219	2190	Fail
0.6418	10	204	2040	Fail
0.6507	10	186	1860	Fail
0.6596	9	177	1966	Fail
0.6685	9	169	1877	Fail
0.6774	9	162	1800	Fail
0.6863	8	152	1900	Fail
0.6952	8	143	1787	Fail
0.7041	8	133	1662	Fail
0.7130	8	126	1575	Fail
0.7218	6	117	1950	Fail
0.7307	6	108	1800	Fail
0.7396	6	107	1783	Fail
0.7485	6	99	1650	Fail
0.7574	5	93	1860	Fail
0.7663	5	86	1720	Fail
0.7752	4	83	2075	Fail
0.7841	4	82	2050	Fail
0.7930	4	78	1950	Fail
0.8019	4	74	1850	Fail
0.8108	4	70	1750	Fail
0.8197	4	69	1725	Fail
0.8286	4	62	1550	Fail
0.8375	4	58	1450	Fail
0.8463	4	55	1375	Fail
0.8552	4	55	1375	Fail
0.8641	4	54	1350	Fail
0.8730	4	54	1350	Fail
0.8819	4	52	1300	Fail
0.8908	4	50	1250	Fail
0.8997	4	46	1150	Fail
0.9086	4	44	1100	Fail
0.9175	4	43	1075	Fail
0.9264	4	41	1025	Fail
0.9353	4	39	975	Fail
0.9442	4	37	925	Fail
0.9531	4	34	850	Fail
0.9619	4	32	800	Fail
0.9708	4	32	800	Fail
0.9797	4	31	775	Fail
0.9886	4	30	750	Fail
0.9975	4	30	750	Fail
1.0064	4	30	750	Fail
1.0153	4	27	675	Fail
1.0242	4	26	650	Fail
1.0331	3	22	733	Fail

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The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #4

On-line facility volume:	0.2271 acre-feet
On-line facility target flow:	0.3112 cfs.
Adjusted for 15 min:	0.3112 cfs.
Off-line facility target flow:	0.1701 cfs.
Adjusted for 15 min:	0.1701 cfs.

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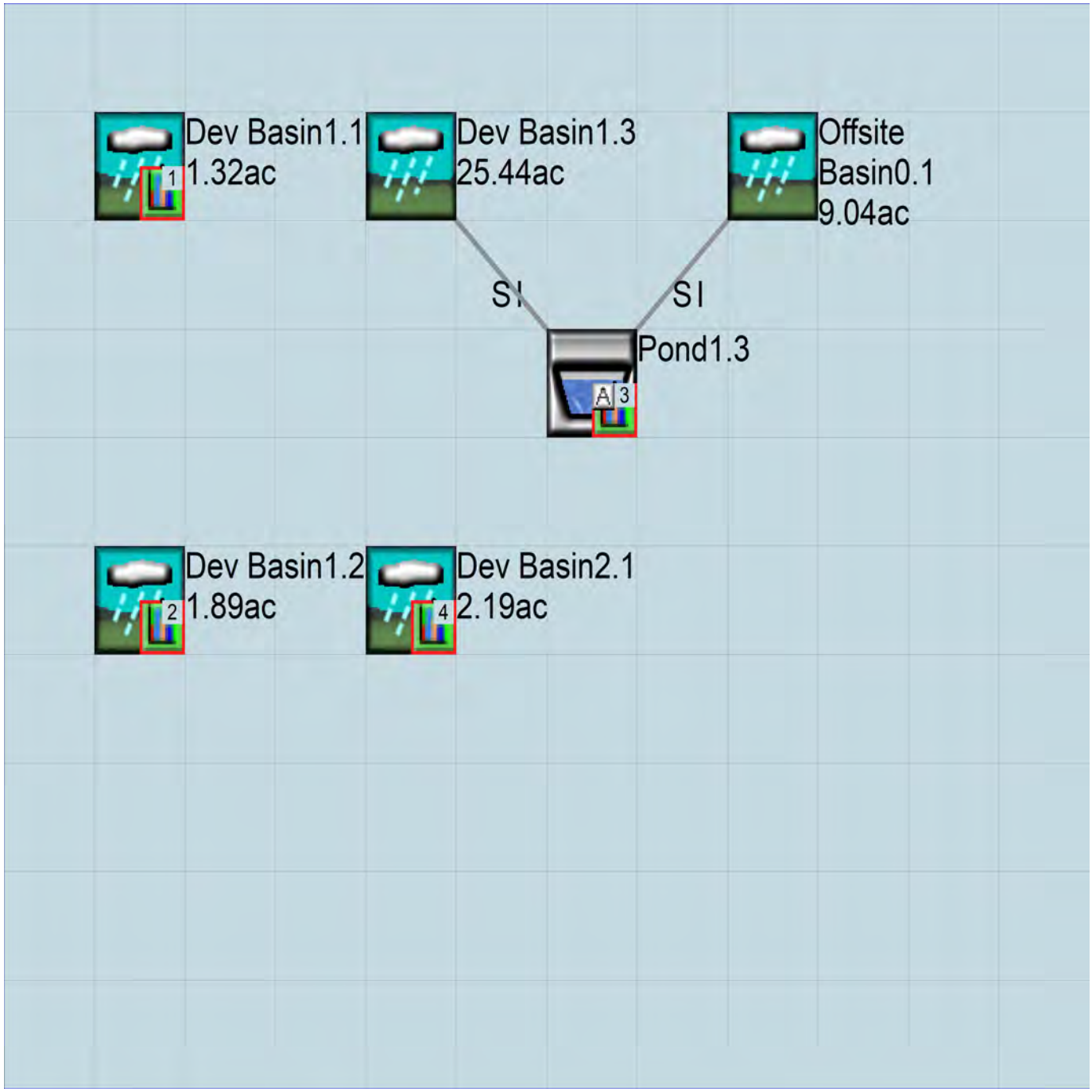
Appendix
Predeveloped Schematic



Mitigated Schematic



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Swale1.3 WQ

Subcat Reach Pond Link

Routing Diagram for 4373 Swale-PRELIM
Prepared by HP Inc., Printed 2/3/2020
HydroCAD® 10.00-22 s/n 05095 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.000	**0**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
0.000		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SBUH method, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Reach S1-WQ: Swale1.3 WQ Avg. Flow Depth=0.33' Max Vel=0.45 fps Inflow=2.52 cfs 3.134 af
n=0.240 L=250.0' S=0.0250 '/' Capacity=57.34 cfs Outflow=2.52 cfs 3.065 af

Summary for Reach S1-WQ: Swale1.3 WQ

Inflow = 2.52 cfs @ 5.00 hrs, Volume= 3.134 af, Incl. 2.52 cfs Base Flow
Outflow = 2.52 cfs @ 8.70 hrs, Volume= 3.065 af, Atten= 0%, Lag= 222.0 min

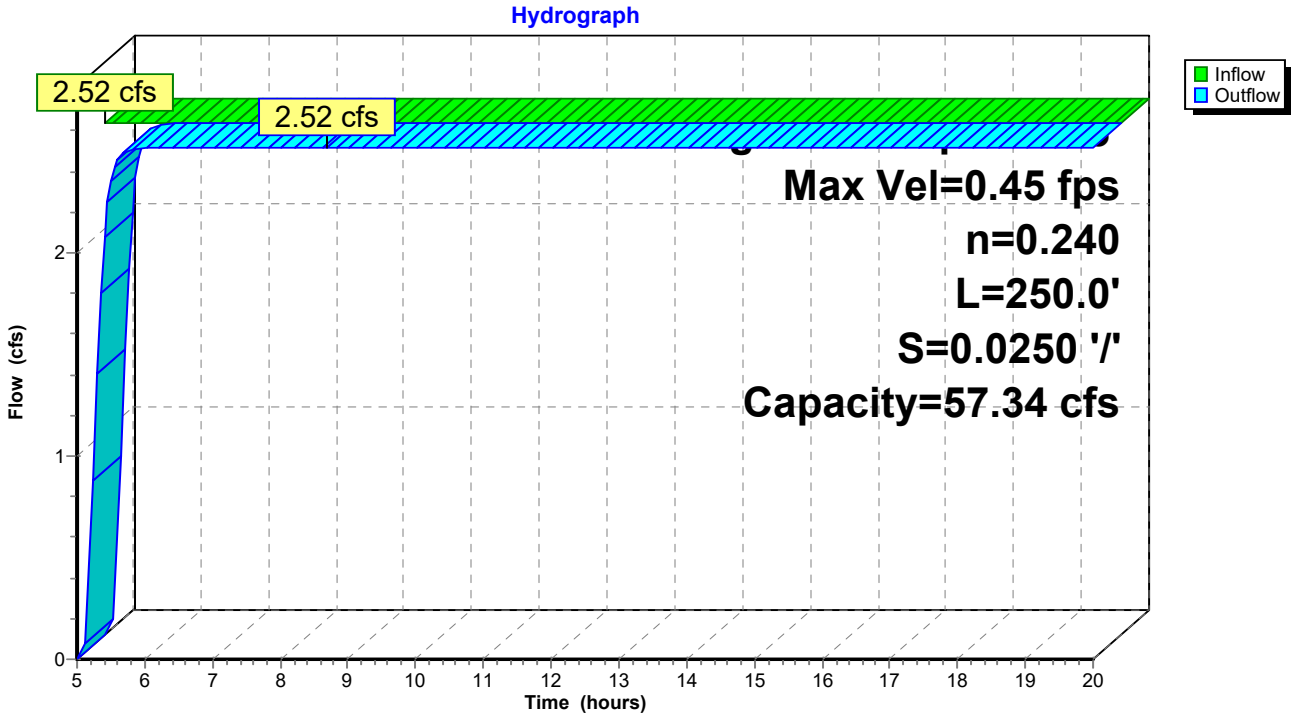
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.45 fps, Min. Travel Time= 9.3 min
Avg. Velocity = 0.45 fps, Avg. Travel Time= 9.3 min

Peak Storage= 1,403 cf @ 8.55 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 2.00' Flow Area= 44.0 sf, Capacity= 57.34 cfs

16.00' x 2.00' deep channel, n= 0.240
Side Slope Z-value= 3.0 '/' Top Width= 28.00'
Length= 250.0' Slope= 0.0250 '/'
Inlet Invert= 0.00', Outlet Invert= -6.25'



‡



Appendix G:
Soils Report

GEOTECHNICAL ENGINEERING STUDY

Proposed 179th Street Residential Subdivision
NW 179th Street & NW 11th Avenue
Ridgefield, Clark County, Washington
Tax Lot No's (182170000, 182168000 & 182164000)

Prepared for:

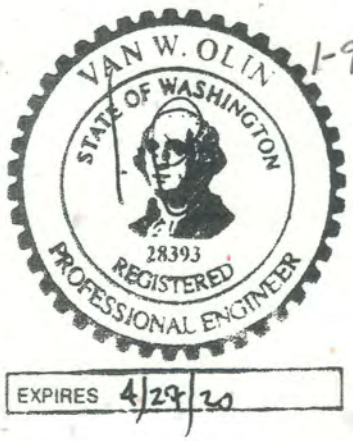
BTMC, LLC
7701 NE Greenwood Drive
Vancouver, Washington 98662

Prepared By:



Donald J. Bruno, EG
Engineering Geologist

Van W. Olin, PE
Project Engineer



Project No. G56-0515.18

{January 2019}

Earth Engineering, Inc.
PO Box 1512, Ridgefield, Washington 98642
(360) 600-6518

Earth Engineering, Inc.
Geotechnical & Environmental Consultants

Terry Wollam
BTMC, LLC
7701 NE Greenwood Drive
Vancouver, WA 98662

January 9th 2019
G56-0515.18

Subject: **Geotechnical Engineering Study**
Proposed Residential Subdivision
NW 179th St. & NW 11th Ave., Ridgefield, Clark County, Washington
(Parcel No.'s 182170000, 68000 & 64000)

Hello Terry,

We are pleased to submit our engineering report for the subject property located in Ridgefield, Washington. This report presents the results of our field exploration, selective laboratory tests, field infiltration testing and engineering analyses.

Based on the results of this study, it is our opinion that construction of the proposed residential development is feasible from a geotechnical standpoint, provided recommendations presented in this report are included in the project design.

We appreciate the opportunity to have been of service to you and look forward to working with you in the future. Should you have any questions about the content of this report, or if we can be of further assistance, please call.

Respectfully Submitted,
Earth Engineering Inc.,

Donald J. Bruno, EG
Engineering Geologist

Van W. Olin, PE
Project Engineer

INTRODUCTION

General

This report presents the results of the geotechnical engineering study completed by Earth Engineering, Inc. (EEI) for the proposed residential subdivision located in Ridgefield, Washington. The general location of the site is shown on the *Vicinity Map, Figure 1.* At the time our study was performed, the site and our exploratory locations were approximately as shown on the *Site Plan, Figure 2.*

The purpose of this study was to explore subsurface conditions at the site and based on the conditions encountered, provide geotechnical recommendations for the proposed construction.

Project Description

Based on the information that was provided to us by the project civil engineer (AKS) it is our understanding the proposed residential subdivision will consist of three hundred and fifteen (315) lots that will range from about 2800 to 3200 square feet in size. Site development will also include construction of a storm water system, subsurface utilities and asphalt-paved roadways.

Although no specific grading plan was available during the time of our study, some grading may be required for building pad and roadway construction. We anticipate cuts and fills up to eight feet. The residential buildings will most likely be constructed with wood frames, suspended floors and slab-on-grade garage floors.

It should be noted that due to the topography across the site it is possible that a daylight type basement foundation may be constructed at some of these lots. EEI should be contacted so we can provide basement retaining wall parameters specific to the proposed construction for each sloping lot.

Structural design loads were not available at the time this report was written. However, based on our experience with similar projects, we anticipate that wall and column loads will be approximately seven hundred and fifty (750) to one thousand five hundred (1500) pounds per lineal foot (maximum dead plus live loads). Slab-on-grade garage floor loads will most likely range from one hundred (100) to one hundred fifty (150) pounds per square foot (psf).

If any of the above information is incorrect or changes, we should be consulted to review the recommendations contained in this report. In any case, it is recommended that Earth Engineering, Inc. perform a general review of the final design for the proposed construction at each lot.

SITE CONDITIONS

Surface

The square shaped properties encompass approximately thirty eight (38) acres. An existing residence is located at the northeast area of the site. The adjacent properties consist of residences and small farms on acreage. A fire station facility is located along the northeast side of the site.

In general, the northern half slopes moderately downward from the north-northeast to the south-southwest to an east-west trending drainage channel. Gradients at the northern half range from about eight to thirteen percent (8-13%).

The western three-quarter section of the southern half slopes gently to moderately downward from a ridgeline to the north, south, east and west. Gradients at the southern half range from about six to seven percent (6-7%).

The northern half and southwest areas of the site are covered predominantly with pasture grass and some isolated areas of trees (evergreen and deciduous). The southeastern two-thirds section is heavily vegetated with trees and undergrowth.

Subsurface

For this study the site was explored by excavating twelve (12) test pits. Three of the pits were used for infiltration testing. The approximate locations of these test pits are shown on the *Site Plan, Figure 2.* All soil was classified following the Unified Soil Classification System (USCS). A USCS Legend is included as Plate A1. A description of the field exploration methods is included in Appendix A.

In general in our test pits we encountered approximately eight to eighteen (18) inches of organic duff and topsoil. The topsoil is underlain by stiff to very stiff native elastic Silt (MH) and lean Clay (CL) to the maximum exploration depth of ten feet below the existing ground surface. Please refer to the test pit logs, Plates A2 thru A13, for a more detailed description of the conditions encountered.

Groundwater

During the time of our field exploration (June 2015 and November 2018) heavy groundwater seepage was encountered in test pits TP-3 and TP-4. It should be noted these test pits are located along the lower elevation central drainage channel, at a depth of approximately three feet below the existing ground surface. Groundwater was not encountered in any other test pits.

Groundwater conditions are not static; fluctuations may be expected in the level and seepage flow depending on the season, amount of rainfall, surface water runoff, and other factors. Generally, the groundwater level is higher and seepage rate is greater in the wetter winter months (typically October through May).

General Regional Geology

General information about geologic conditions and soil in the vicinity of the site was obtained by reviewing the Geologic Map of Washington-Southwest Quadrant, Washington Division of Geology and Earth Resources, (Geologic Map GM-34, 1987). This map provides general information about geologic units in the Vancouver, Clark County, Washington area.

Our review of existing geological information indicates that soils in the vicinity of the subject site were formed from alluvial deposits during the Quaternary Period. Outburst flood deposits from glacial Lake Missoula deposited these sedimentary soils. The material encountered in our test pits consists predominantly fine grained elastic silt and lean clay.

LABORATORY TESTING

Laboratory tests were conducted on representative soil samples to verify or modify the field soil classification of the units encountered, and to evaluate the general physical properties as well as the engineering characteristics of the soils encountered. The following provides information about the testing procedures performed on representative soil samples and the general condition of subsurface soil conditions encountered:

- Moisture Content (ASTM-D2216-92) tests were performed on representative samples. The native elastic silt and lean clay has a moisture content ranging from seventeen to thirty-five percent (17-35%). The native organic silt (TP-3 & TP-4) has an average moisture content ranging from forty five to forty nine percent (45-49%).

- In-Situ Soil Density (ASTM-D4564-93) utilizing the sleeve method was performed on representative samples to determine the wet and dry density of native soil. The in-situ density provides a relative indication of soil support characteristics. The average wet density of the native elastic silt and lean clay is approximately one hundred and fifteen (115) pounds per cubic foot (pcf). The average dry density of this soil is ninety-two (92) pcf.

Laboratory testing confirms that subsurface soil consists predominantly of elastic silt and lean clay. All soils encountered are sensitive to changes in moisture content. Moisture sensitive soils are discussed in more detail in the *Site Preparation and Grading* section of this report.

The results of laboratory tests performed on specific samples are provided at the appropriate sample depth on the individual test pit logs. However, it is important to note that some variation of subsurface conditions may exist. Our geotechnical recommendations are based on our interpretation of these test results.

SEISMIC HAZARD EVALUATION

The following provides a seismic hazard evaluation for the subject site. Our evaluation is based on subsurface conditions encountered at the site during the time of our geotechnical study and a review of applicable geologic maps (Washington Department of Natural Resources, Geologic Map of Washington-Southwest Quadrant, 1987) and the International Building Code (IBC-2006) guidelines.

In general, supportive soil at the subject site consists predominantly of elastic silt and lean clay. Groundwater was only encountered along the central drainage channel. Near surface groundwater was not encountered at any other areas of the site. Geologic map indicates that no known active faults are located within one-mile of the subject site. Soils encountered at the site are classified as a type "D" soil in accordance with "Site Class Definitions (IBC 2006, Section 1613, Table 1613.5.2; page 303). For more detail regarding soil conditions refer to the test pit logs in Appendix A of this report.

Liquefaction:

Structures are subject to damage from earthquakes due to direct and indirect action. Shaking represents direct action. Indirect action is represented by foundation failures and is typified by liquefaction. Liquefaction occurs when soil loses all shear strength for short periods of time during an earthquake.

Ground shaking of sufficient duration results in the loss of grain to grain contact as well as a rapid increase in pore water pressure. This causes the soil to assume physical properties of a fluid. To have potential for liquefaction a soil must be loose, cohesion-less (generally sands and silts), below the groundwater table, and must be subjected to sufficient magnitude and duration of ground shaking. The effects of liquefaction may be large total settlement and/or large differential settlement for structures with foundations in or above the liquefied soil.

Based on the predominance of very stiff soil conditions (exclusive of the central drainage channel) and the absence of a near surface groundwater table, it is not likely that soil liquefaction would occur at the subject site during a seismic event. However, soils encountered along the central drainage channel (organic silt) have a high potential for liquefaction due to their water bearing condition and high groundwater table.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our study, it is our opinion the residential subdivision plat can be developed as planned provided the geotechnical recommendations contained in this report are incorporated into the final design. The proposed buildings can be supported on conventional shallow spread footings bearing either entirely on competent native soil or compacted structural fill. Supporting the proposed buildings on homogeneous material will significantly decrease the potential for differential settlement across the foundation area.

As previously discussed the central drainage channel is underlain by liquefiable soil. These soils will not provide adequate support for structural fill, building foundations or pavements. Preliminary plans indicate the channel will not be impacted by site grading and no building or pavements are planned to be constructed at this area. However, if unsuitable soil is encountered near the drainage channel or at any other areas of the site, it will be necessary to remove the unsuitable soil and replace the material with compacted structural fill.

This report has been prepared for specific application to this project only and in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area for the exclusive use of BTMC, LLC and their representatives. This report, in its entirety, should be included in the project documents for information to the contractor. No warranty, expressed or implied, is made.

Site Preparation and Grading

The site shall be stripped and cleared of all vegetation, organic matter and any other deleterious material. Stripped material should not be mixed with any soils to be used as fill. Stripped soil could potentially be used for topsoil at landscape areas after removing vegetation and screening out organic matter.

Building & Roadway Areas:

After clearing and grading, the building and pavement areas should be compacted to a dense non-yielding condition with suitable vibratory compaction equipment. This phase of earthwork compaction shall be performed prior to the placement of any structural fill, at the bottom of all foundation excavations, floor slab areas and driveways, before the placement of base rock.

Structural Fill:

Structural fill is defined as any soil placed under buildings or any other load bearing-areas. Structural fill placed under footings and slab on grade should be placed in thin horizontal lifts not exceeding eight inches and compacted to a minimum ninety-five percent (95%) of its maximum dry density (Modified Proctor ASTM D1557). The fill material should be placed within two to three percent of the optimum moisture content.

Fill under pavements should also be placed in lifts approximately eight inches in thickness, and compacted to a minimum of ninety percent (90%) of its maximum dry density (Modified Proctor ASTM D1557), except for the top twelve (12) inches which should be compacted to ninety-five percent (95%) of the maximum dry density.

We recommend that structural fill consist of a well graded granular material having a maximum size of two inches and no more than five percent (5%) fines passing the #200 sieve, based on the ¾ inch fraction. It is recommended that any structural fill planned for onsite use, be submitted for approval prior to import.

The placement and compaction of structural fill should be observed by a representative from our office to verify that fill has been placed and compacted in accordance with the approved project plans and specifications. It should be noted that the depth of excavation to competent soil at foundation footings and floor slab areas could be greater or less than anticipated depending on conditions encountered. Our test pits provide general information about subsurface soil and groundwater conditions.

Wet Weather Construction & Moisture Sensitive Soils:

Field observations and laboratory testing indicates that soil encountered at the site consists predominantly of moisture sensitive elastic silt and lean clay. As such in an exposed condition moisture sensitive soil can become disturbed during normal construction activity, especially when in a wet or saturated condition. Once disturbed, in a wet condition, these soils will be unsuitable for support of foundations, floor slabs and pavements.

Slab on Grade

The sub-grade for all concrete floor slab areas should be compacted to a dense non-yielding condition prior to the placement of base rock. It is important to note that the existing sub-grade soil may become too wet to re-compact due to weather conditions. If supportive soils become saturated it may be necessary to remove the unsuitable material and replace it with imported granular structural fill.

Interior floor slabs should be provided with a minimum of eight inches of compacted granular structural fill after compacting the sub-grade. In areas where moisture is undesirable, a vapor barrier such as an 8-mil plastic membrane should be placed beneath the slab.

Temporary Excavations

The following information is provided solely as a service to our client. Under no circumstances should this information be interpreted to mean that Earth Engineering, Inc. is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

In no case should excavation slopes be greater than the limits specified in local, state and federal safety regulations. Based on the information obtained from our field exploration and laboratory testing, the site soils expected to be encountered in excavations, stiff to very stiff elastic silt and lean clay would be classified as a Type "A" soil by OSHA guidelines.

Therefore, temporary excavations and cuts greater than four feet in height, should be sloped at an inclination no steeper than 3/4H:1V (horizontal:vertical) for type "A" soils. If slopes of this inclination, or flatter, cannot be constructed or if excavations greater than ten feet in depth are required, temporary shoring will be necessary.

Infiltration Testing

In June 2015, infiltration testing was performed at three locations at a depth of approximately four feet below the existing ground surface. The approximate location of the infiltration tests, I-1, I-2 and I-3 (also used for exploration test pits) is shown on the *Site Plan, Figure 2.*

Infiltration testing was conducted in general accordance with the Southwest Washington Storm Water Manual. The Encased Falling Head Test consists of driving a fifteen (15) inch long, six-inch diameter pipe six inches into the exposed ground surface at the bottom of the test pit. The pipe is filled with water as the soil around the bottom and below the pipe is saturated for several hours. The pipe is filled again and the amount of time required for the water to fall, per inch, for six inches, is recorded. This step is performed a minimum of three times. The test results are averaged and calculated in inches per hour.

It is important to note that this provides a relative indication of the average rate of groundwater infiltration at the site. The rate is dependent on the percentage of fines in the soil (i.e., silt and clay), the degree of soil saturation and the relative density of the in-situ soil.

Infiltration rates can vary across the site depending on conditions encountered. The following table provides the infiltration test results, soil classification and a summary of laboratory test results for soil encountered at the depth of proposed infiltration:

LOCATION	*USCS SOIL TYPE	AASHTO SOIL TYPE	DEPTH (FT.)	MOISTURE CONTENT %	% PASSING #200 SIEVE	FIELD INFILTRATION RATE	COEFFICIENT OF PERMEABILITY
I-1	MH-CL	A-7	4.0	23	100	0 iph	N/A
I-2	MH-CL	A-7	4.0	21	100	0 iph	N/A
I-3	MH-CL	A-7	4.0	23	100	0 iph	N/A

Based on the subsurface soil conditions encountered and our laboratory test results, it is our opinion the elastic silt (MH) and lean clay (CL), encountered in all of our test pits, is not suitable for storm water infiltration from the proposed development. It is important to note that some variation of subsurface conditions may exist. Our recommendations are based on our interpretation of these test results.

Site Drainage

The site should be graded so that surface water is directed off the site. Water should not be allowed to stand in any area where buildings or slabs are to be constructed. Loose surfaces should be sealed at the end of each workday by compacting the surface to reduce the potential for moisture infiltration into the soils. Final site grades should allow for drainage away from the building foundation. The ground should be sloped at a gradient of three percent for a distance of at least ten feet away from the buildings.

We recommend that a footing drain be installed around the perimeter of the buildings just below the invert of the footing with a gradient sufficient to initiate flow. Under no circumstances should the roof down spouts be connected to the footing drain system. We suggest that clean outs be installed at several accessible locations to allow for the periodic maintenance of the footing drain system. Details for the footing drain have been included on *Figure 3, Typical Footing Drain Detail.*

Interceptor Drain:

In addition to the foundation footing drains we recommend that an interceptor drain be installed adjacent to the toe of any slopes that have a downward gradient towards the proposed structures. This will facilitate in diverting stormwater away from the residences.

The drain should consist of a four-inch diameter perforated pipe with holes facing down and installed in an envelope of clean drain rock or pea gravel wrapped with free draining filter fabric. The drain should be a minimum of one foot wide and two feet deep with sufficient gradient to initiate flow. The drain should be routed to a suitable discharge area and rock spalls placed at the outlet to dissipate flow from the system.

A representative from our office can determine the location of the drains during construction at each individual lot. A *Typical Interceptor Drain Detail, Figure 4,* has been included with this report.

Utility Support and Back Fill

Based on the conditions encountered, the soil to be exposed by utility trenches should provide adequate support for utilities. Utility trench backfill is a concern in reducing the potential for settlement along utility alignments, particularly in pavement areas. It is also important that each section of utility line be adequately supported in the bedding material. The back fill material should be hand tamped to ensure support is provided around the pipe haunches.

Fill should be carefully placed and hand tamped to about twelve inches above the crown of the pipe before any compaction equipment is used. The remainder of the trench back fill should be placed in lifts having a loose thickness of eight inches.

A typical trench backfill section and compaction requirements for load supporting and non-load supporting areas is presented on *Figure 5, Utility Trench Backfill Detail.* Trench back fill may consist of imported granular fill provided the material is approved, placed and compacted near the optimum moisture content.

Imported granular material or on-site soil to be used as backfill should be submitted to our laboratory at least one week prior to construction so that we can provide a laboratory proctor for field density testing.

Pavements

The durability of pavements is related in part to the condition of the underlying sub grade. To provide a properly prepared sub grade for pavements, we recommend the sub grade be treated and prepared as described in the *Site Preparation and Grading* section of this report.

It is possible that some localized areas of soft, wet or unstable sub grade may still exist after this process. Before placement of any base rock, the sub grade should be compacted with suitable compaction equipment. Yielding areas that are identified should be excavated to firm material and replaced with compacted one and one quarter inch-minus clean-crushed rock. The following pavement sections are recommended for the proposed pavement areas:

- Three inches of Asphalt Concrete (AC) over ten inches of compacted Crushed Rock Base (CRB) material or,
- Three inches of Asphalt Concrete (AC) over eight inches of compacted Crushed Rock Base (CRB) material, over a geo-grid consisting of Tensar Triax or equivalent.

The geo-grid should be placed directly on the sub grade surface of the roadway prior to placement of base rock. Appropriate geo-textiles have been designed to increase the strength of the sub grade and extend pavement life.

Asphaltic Cement (AC) and Crushed Rock Base (CRB) materials should conform to WSDOT specifications. All base rock should be compacted to at least ninety five percent (95%) of the ASTM D1557-91 laboratory test standard.

We recommend that a minimum of eight inches of compacted CRB be placed below all exterior slabs. Exterior concrete slabs that are subject to vehicle traffic loads should be at least four inches in thickness. It is also suggested that nominal reinforcement such as "6x6-10/10" welded wire mesh be installed, near midpoint, in new exterior concrete slabs and paving. Fiber mesh concrete may be used in lieu of welded wire mesh.

Additional Services & Earthwork Monitoring

Earth Engineering, Inc. will be available to provide consultation services related to review of the final design to verify that the recommendations within our purview have been properly interpreted and implemented in the approved construction plans and specifications. A representative from our office will be available to attend a pre-construction meeting to discuss and/or clarify all geotechnical issues related to the proposed project.

In addition, it is suggested that our office be retained to provide geotechnical services during construction to observe compliance with the design concepts and project specifications and to allow design changes in the event subsurface conditions differ from those anticipated.

Our construction services would include monitoring and documenting the following:

- Laboratory proctor tests on structural fill and roadway area materials.
- Observe compaction and provide testing of structural fill at building & roadway areas.
- Observe compaction and provide testing of utility trench backfill.
- Observe excavation and condition of exposed bearing soils at the building areas.
- Provide footing inspection at buildings to verify soil-bearing capacity.
- Verify the installation of all building and site drainage elements.

LIMITATIONS

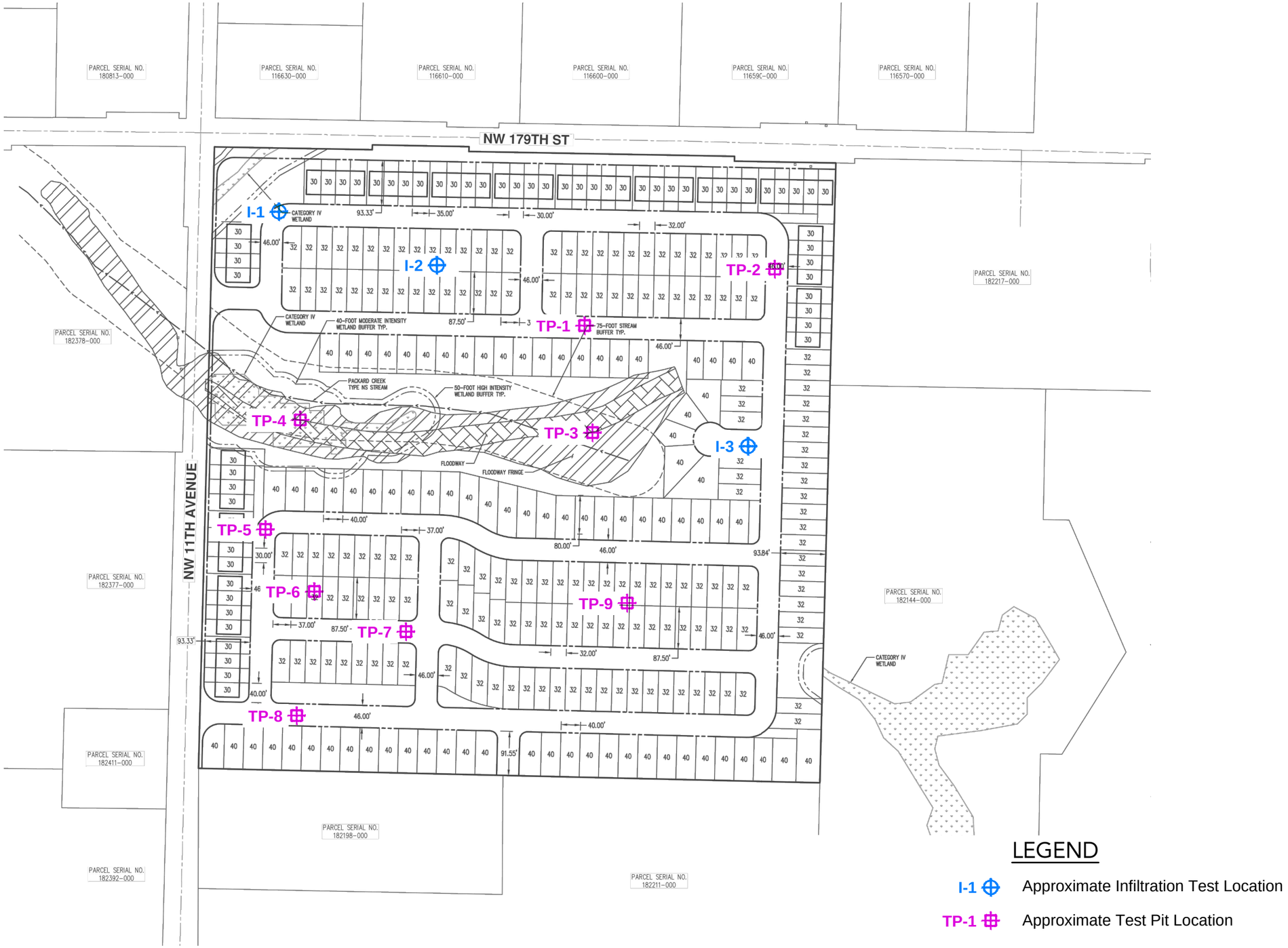
Our recommendations and conclusions are based on the site materials observed, selective laboratory testing, engineering analyses, the design information provided to Earth Engineering, Inc. and our experience as well as engineering judgment. The conclusions and recommendations are professional opinions derived in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty is expressed or implied.

The recommendations submitted in this report are based upon the data obtained from the test pit excavations. Soil and groundwater conditions may vary from those encountered. The nature and extent of variations may not become evident until construction. If variations do appear, Earth Engineering, Inc. should be requested to reevaluate the recommendations contained in this report and to modify or verify them in writing prior to proceeding with the proposed construction.

VICINITY MAP



Earth Engineering GEOTECHNICAL & ENVIRONMENTAL SERVICES	CLIENT: BTMC, LLC	DRAWN: CCK
	PROJECT: NW 179TH STREET SUBDIVISION NW 179TH STREET RIDGEFIELD, WA	DATE: 1/2019
		FIGURE: 1
		PRO. #: G56-0515.18



LEGEND

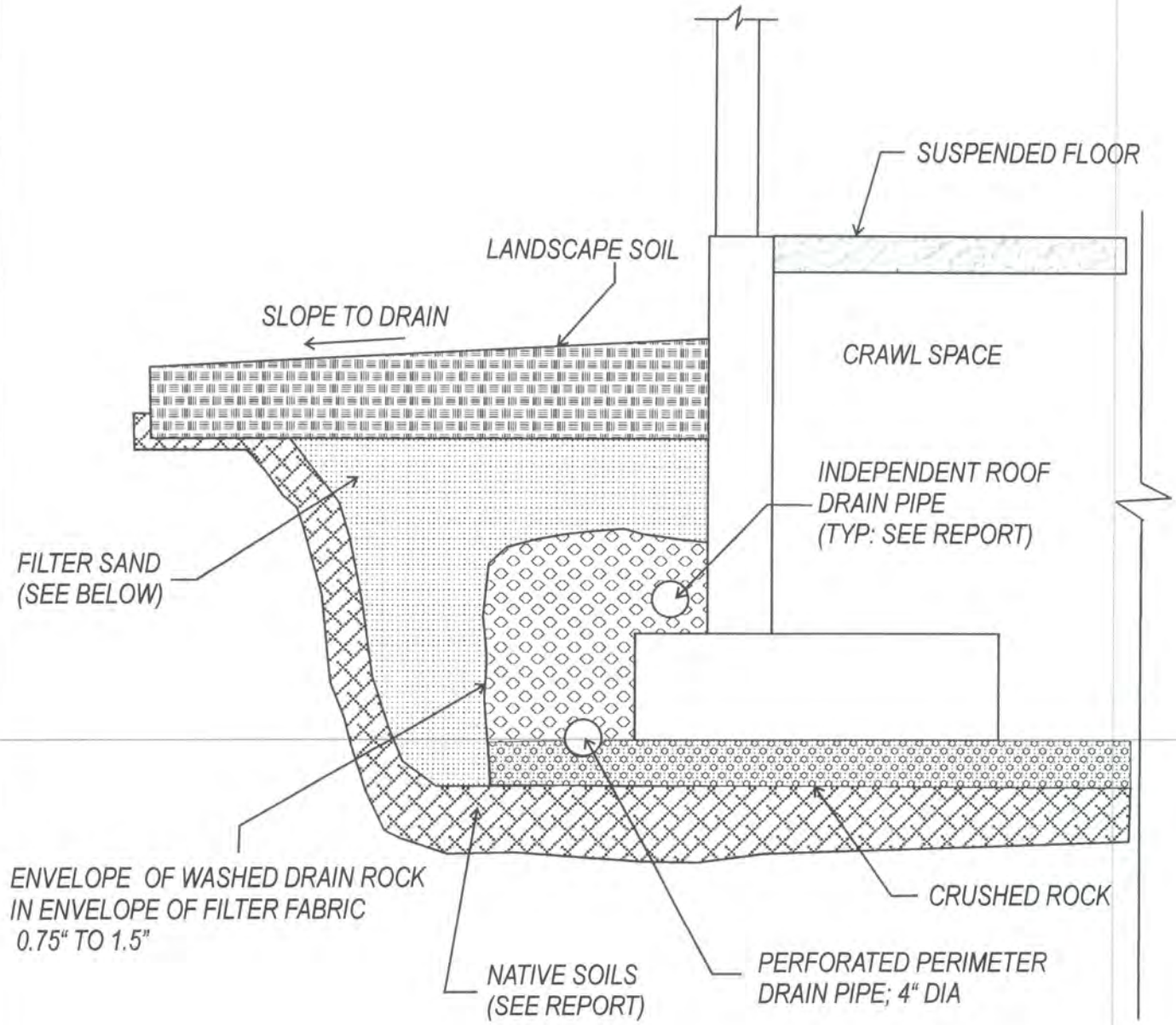
I-1 Approximate Infiltration Test Location

TP-1 Approximate Test Pit Location

Earth Engineering
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: WOLLAM & ASSOCIATES	DRAWN: CCK
PROJECT: NW 179TH STREET SUBDIVISION NW 179TH STREET RIDGEFIELD, WA	DATE: 1/2019
	FIGURE: 2
	PRO. #: G56-0515.18

H:\GE SERVICES\179th\Site Plan.dwg, 1/21/2019 8:22:40 PM, Chad Koya



NOTES:

1. FILTER SAND - FINE AGGREGATE FOR PORTLAND CEMENT; SECTION 9=03.1(2)
2. PERFORATED OR SLOTTED RIGID PVC PIPE WITH A POSITIVE DRAINAGE GRADIENT
3. FILTER FABRIC OPTIONAL IF FILTER SAND USED

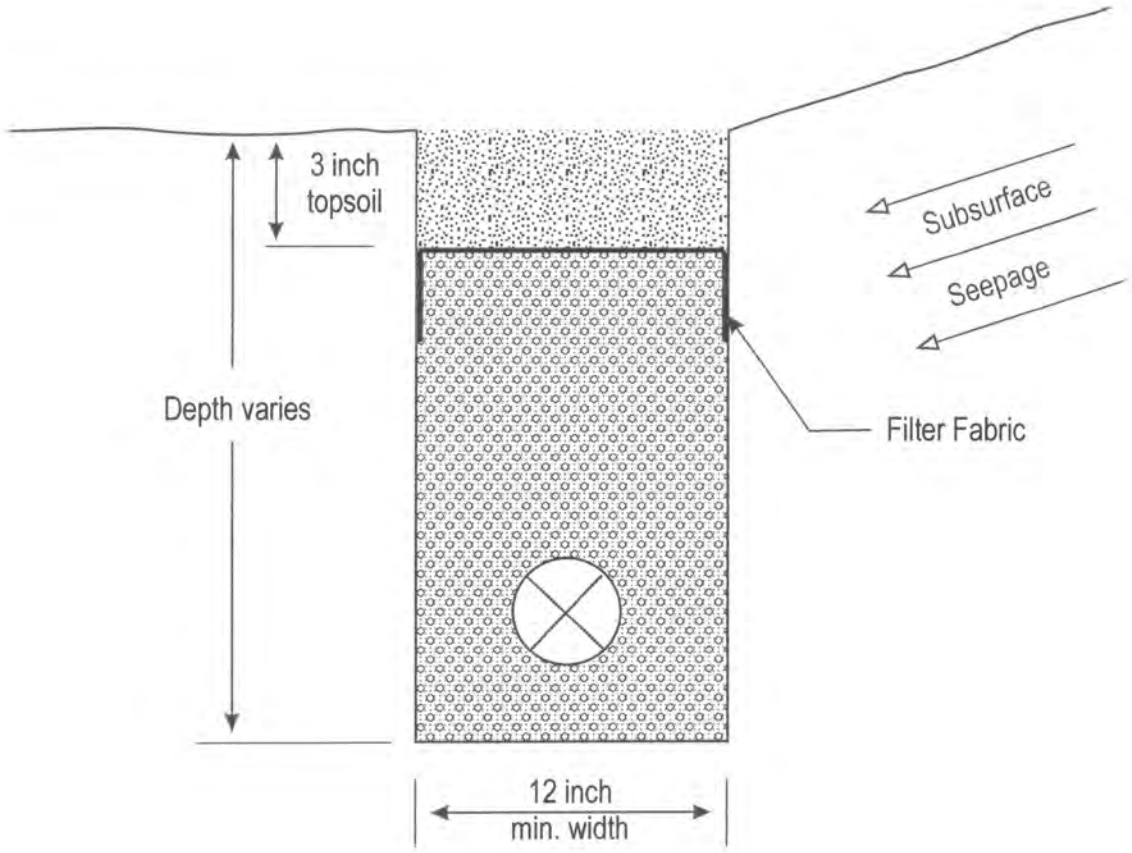
TYPICAL FOOTING DRAIN DETAIL

Not to Scale

Earth Engineering, Inc. GEOTECHNICAL & ENVIRONMENTAL SERVICES	CLIENT: BTMC, LLC.	DRAWN:	EG
	PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE:	2019
		FIGURE:	3
		PRO. #:	G56-0515.18

TYPICAL INTERCEPTOR DRAIN DETAIL

Not to Scale



Legend

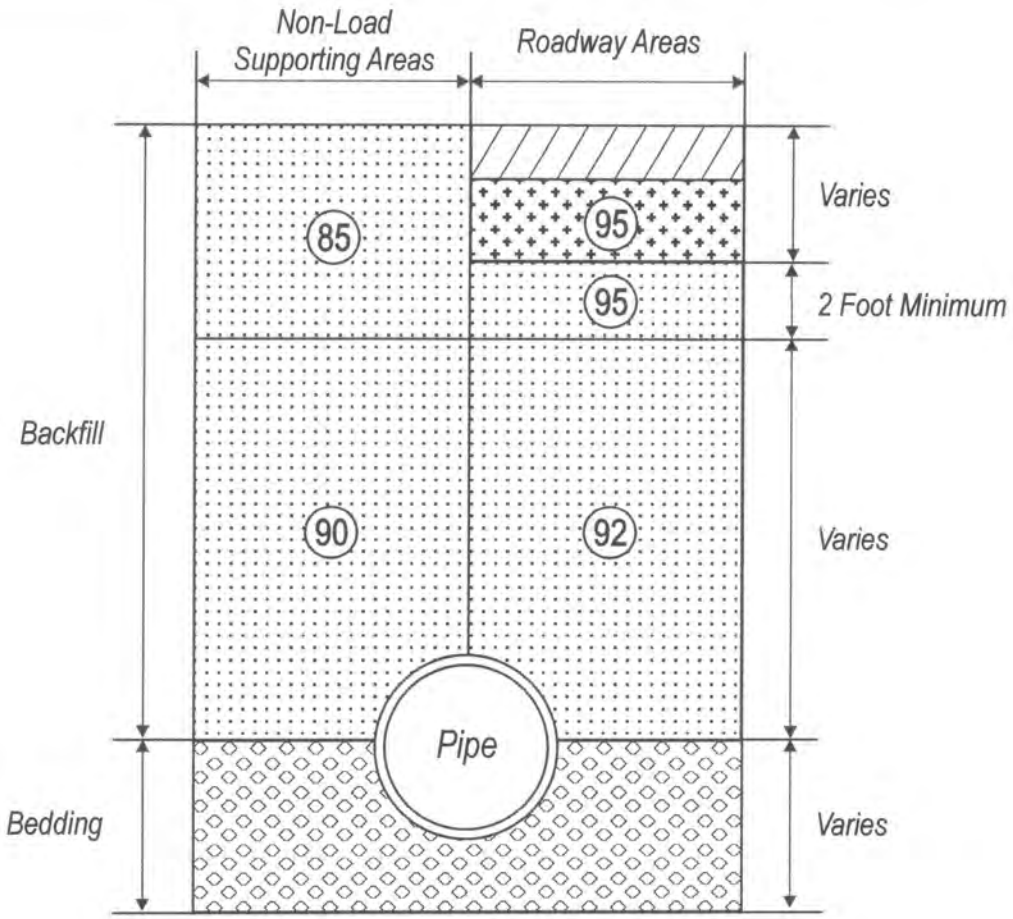
Native soil backfill.

Free-draining material composed of clean round gravel, pea gravel, etc.

Minimum 4 inch perforated pipe wrapped with free draining filter fabric or equivalent placed at a positive gradient to a suitable permanent discharge area.

Note: A field representative from this office should be present to establish the depth and lateral extent of the interceptor trench during construction.

Earth Engineering, Inc. GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS	CLIENT: BTMC, LLC.	DRAWN: EG
	PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE: 2019
		FIGURE: 4
		PRO. #: G56-0515.18



LEGEND

Asphalt or Concrete Pavement

Roadway Base Material or Base Rock

Backfill: Compacted on-site soil or imported select fill material as described in the site preparation of the general Earthwork Section of the attached report text.

92 — Minimum percentage of maximum Laboratory Dry Density as determined by ASTM Test method D1557 (Modified Proctor),unless otherwise specified in the attached report text.

Bedding Material: Material type depends on type of pipe and laying conditions. Bedding should conform to the manufacturer's recommendations for the type of pipe selected.

UTILITY TRENCH BACKFILL DETAIL

Not to Scale

Earth Engineering, Inc. GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS	CLIENT: BTMC, LLC. PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DRAWN: EG DATE: 2019 FIGURE: 5 PRO. #: G56-0515.18

FIELD EXPLORATION

Our field exploration was performed during June 2015 and November 2018. Subsurface conditions at the site were explored by excavating twelve test pits. Three of the test pits were used for infiltration testing. The test pits were excavated with a track-hoe to the maximum depth of ten (10) feet below the existing ground surface.

The test pits were located by pacing from property features. The locations are shown on the Site Plan, Figure 2. Field exploration was monitored by an EEI representative, who classified the soils that we encountered and maintained a log of each test pit, obtained representative samples, and observed pertinent site features. Representative soil samples were placed in closed containers and returned to the laboratory for further examination and testing.

All samples were identified using the Standard Classification of Soils for Engineering Purposes (ASTM D2487-93) in accordance with the Unified Soil Classification System (USCS), which is presented on Plate A1. The test pit logs are presented in Appendix A. The final log represents our interpretations of the field logs and the results of the laboratory tests on field samples.

UNIFIED SOIL CLASSIFICATION SYSTEM
LEGEND

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTION
Coarse Grained Soils	Gravel and Gravelly Soils More Than 50% Coarse Fraction Retained on No 4 Sieve	Clean Gravels (little or no fines)		GW gw	Well-Graded Gravels, Gravel-Sand Mixtures Little or no Fines
				GP gp	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
		Gravels with Fines (appreciable amount of fines)		GM gm	Silty Gravels, Gravel-Sand-Silt Mixtures
				GC gc	Clayey Gravels, Gravel-Sand-Clay Mixtures
More Than 50% Material Larger Than No 200 Sieve Size	Sand and Sandy Soils More Than 50% Coarse Fraction Passing No 4 Sieve	Clean Sand (little or no fines)		SW sw	Well-graded Sands, Gravelly Sands Little or no Fines
				SP sp	Poorly-Graded Sands, Gravelly Sands Little or no Fines
		Sands with Fines (appreciable amount of fines)		SM sm	Silty Sands, Sand-Silt Mixtures
				SC sc	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils	Silts and Clays	Liquid Limit Less than 50		ML ml	Inorganic Silts and Very Fine Sands, Rock Flour, Silty-Clayey Fine Sands; Clayey Silts w/ slight Plasticity
				CL cl	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean
				OL ol	Organic Silts and Organic Silty Clays of Low Plasticity
More Than 50% Material Smaller Than No 200 Sieve Size	Silts and Clays	Liquid Limit Greater than 50		MH mh	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils
				CH ch	Inorganic Clays of High Plasticity, Fat Clays
				OH oh	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils				PT pt	Peat, Humus, Swamp Soils with High Organic Contents

Topsoil		Humus and Duff Layer
Fill		Highly Variable Constituents

Earth Engineering Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT:	BTMC, LLC.	DRAWN: EG
PROJECT:	RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE: 2019
		PLATE: A-1
		PRO. #: G56-0515.18

LOG OF TEST PIT I-1

ELEVATION: **+/- 278 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **JUNE 2015**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•						23	-
3								
4		- Field infiltration rate of 0 inches per hour						
5		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff		
6								
7	•						18	-
8								
9								
10								

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-2
PRO. #: G56-0515.18

LOG OF TEST PIT I-2

ELEVATION: +/- 308 feet
EXPLORATORY EQUIPMENT: TRACK HOE
DATE: JUNE 2015

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•						21	-
3								
4		- Field infiltration rate of 0 inches per hour						
5		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff		
6								
7	•						19	-
8								
9								
10								

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.	DRAWN: EG
PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE: 02/2019
	PLATE: A-3
	PRO. #: G56-0515.18

LOG OF TEST PIT I-3

ELEVATION: **+/- 300 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **JUNE 2015**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•						23	-
3								
4		- Field infiltration rate of 0 inches per hour						
5		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff		
6								
7	•						20	-
8								
9								
10								

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-4
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-1

ELEVATION: +/- 302 feet
EXPLORATORY EQUIPMENT: TRACK HOE
DATE: JUNE 2015

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•	elastic Silt (ML) & lean Clay (CL)		Light Brown	Dry	Stiff to V. Stiff	20	-
3								
4								
5								
6	•				Moist		17	-
7								

Bottom of test pit at 7.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-5
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-2

ELEVATION: +/- 302 feet
EXPLORATORY EQUIPMENT: TRACK HOE
DATE: JUNE 2015

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•					Dry		23
3								
4		elastic Silt (ML) & lean Clay (CL)			Light Brown		Stiff to V. Stiff	
5								
6	•					Moist		19
7								

Bottom of test pit at 7.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-6
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-3

ELEVATION: **+/- 296 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **JUNE 2015**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1–3		10" Organic Duff & Topsoil **organic Silt (OH)**		Dark Brown	Sat	V. Soft	45	-
3–7		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff	21	-

Bottom of test pit at 7.0 feet below existing ground surface.
Heavy groundwater seepage encountered at 2 to 3 feet below surface.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.	DRAWN: EG
PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE: 02/2019
	PLATE: A-7
	PRO. #: G56-0515.18

LOG OF TEST PIT — TP-4

ELEVATION: **+/- 284 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **JUNE 2015**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1–3	● ▼	10" Organic Duff & Topsoil **organic Silt (OH)**		Light Brown	Sat	V. Soft	49	-
4–7	●	**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff	22	-

Bottom of test pit at 7.0 feet below existing ground surface.
Heavy groundwater seepage encountered at 2 to 3 feet below surface.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-8
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-5

ELEVATION: **+/- 288 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **JUNE 2015**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•						22	-
3								
4		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff		
5								
6	•						17	-
7								

Bottom of test pit at 7.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.	DRAWN: EG
PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE: 02/2019
	PLATE: A-9
	PRO. #: G56-0515.18

LOG OF TEST PIT **TP-6**

ELEVATION: **+/- 289 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **NOVEMBER 2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	X							
3		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff	24	-
4								
5	•						21	-
6								

Bottom of test pit at 6.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-10
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-7

ELEVATION: **+/- 281 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **NOVEMBER 2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2								
3	•	**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff	20	-
4								
5	•						19	-
6								

Bottom of test pit at 6.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-11
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-8

ELEVATION: **+/- 274 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **NOVEMBER 2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1–3	•	8" Organic Duff & Topsoil **elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff	18	-
4–7	•	**lean Clay (CL)**		Light Brown/ Gray	Dry	V. Stiff	15	-

Bottom of test pit at 7.5 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-12
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-9

ELEVATION: **+/- 265 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **NOVEMBER 2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1	•	12" Organic Duff & Topsoil **elastic Silt (MH)**		Brown	Sat	Soft	35	-
2								
3	•	**lean Clay (CL)**		Light Brown/ Gray	Moist	Stiff	27	-
4								
5								
6								

Bottom of test pit at 6.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-13
PRO. #: G56-0515.18

DISTRIBUTION

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2 Copies	**AKS Engineering & Forestry, LLC** **9600 NE 126th Ave., Ste. 2520** **Vancouver, Washington 98682** **Attention: Michael Andreotti**
2 Copies	**Terry Wollam** **BTMC, LLC** **7701 NE Greenwood Drive** **Vancouver, WA 98662**

Appendix H:
Wetlands Guidelines Checklist

Minimum Requirement 8 Review Checklist

Minimum Requirement 8 Checklist

Note: An additional Wetland Determination maybe required for wetlands that are not located on the project site.

A. Is there a direct or indirect stormwater discharge to a wetland?

- [X] Yes **– Go on to Question B**
- [ ] No **–Stop**

B. Is the wetland being included in a treatment or flow control BMP/Facility?

- [ ] Yes – Comply with Guide Sheets 1 and 2 in Appendix 1-~~K~~H. **Stop**
- [X] No **– Go on to Question C.**

C. Complete a Wetland Rating Form for the receiving wetland using the Washington State Wetland Rating System for Western Washington. Is the wetland classified by the rating form as Category I or Category II?

- [ ] Yes **– Complete the checklist below**
- [X] No **–Stop**

~~D~~E. Hydroperiod Analysis per Section 1.5.8

- [ ] Monthly change in total discharge volume is 15% or less (per the WWHM); and
- [ ] Change in total discharge volume from any single precipitation event is 20% or less (per the WWHM). **–Stop**
- [ ] Either discharge threshold exceeded. **– Go on to Section E**

~~E~~F. Minimum Requirement 8 is not met

D. Does the wetland provide habitat for threatened or endangered species?
If yes **complete the checklist below**.
If No **Stop**.

Appendix I:
LID Feasibility Checklist

LID Feasibility Checklist

Project Title and Case Number: North Haven PUD (PAC-2019-00183)

Applicant: BTMC, LLC.

Date: 02/05/2020 **TDA #:** 1

***Instructions** : Fill out a LID Feasibility Checklist for each TDA on the project. Submit the completed checklist with the Preliminary TIR (see Book 1, Section 1.8.1.5).*

Step 1: Indicate which mandatory list of LID BMPs is applicable to the project in accordance with Minimum Requirement #5 and the flow chart in Figure 2.1 in Book 1. Check the corresponding box in Section 1 below. For projects meeting the LID Performance Standard, this checklist does not apply.

Step 2: Indicate which type(s) of surfaces will be present within the TDA in Section 2.

Step 3: Consider feasibility criteria and setbacks in Section 3.

Section 1: Required LID BMPs

☐ List #1 (Table 32.1) ☒ List #2 (Table 32.2) ☐ BMPs in Table 32.3

Section 2: Surfaces

☒ Roofs ☒ Hard surfaces other than roofs

Section 3: Feasibility Criteria

For each type of surface selected in Section 2, consider BMPs in the order indicated in the required list or table selected in Section 1.

For each question, place a mark in either the Yes or No column. For each No answer, move on to the subsequent question within the BMP. If a Yes answer is given, then the BMP is not feasible in the TDA and is not required in accordance with Minimum Requirement #5. If No answers are given to all questions, then the BMP is feasible in the TDA and must be implemented in accordance with Minimum Requirement #5. When feasibility of the BMP has been determined, then select the appropriate box in the Determination section.

For each type of surface, stop at the first BMP that is feasible.

Answers to questions must consider site-specific information, and some may require professional written evaluation as justification. Please see Book 1, Chapter 2 for more information.

FULL DISPERSION BMP T5.30A	Roof		Surfaces	
Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
Will the project protect and maintain less than 65% of the TDA in a forested native condition?	X		X	
Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
Is the only location available for the discharge less than 100 feet upgradient of a septic system?				
Is the only area available for the required length of the BMP's flowpath on a slope greater than 20%				
Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined in CCC 40.430?				
Is the only area available to place the dispersion device or required flowpath less than 10 feet from any structure, property line, or sensitive area?				
Determination: Is this BMP feasible? ……		X		X

	DISPERSION TO PASTURE OR CROPLAND BMP T5.30B	Roof		Surfaces	
	Applicability and Setbacks	**YES**	**NO**	**YES**	**NO**
	Is the project site 22,000 square feet or less?		X		X
	Will the project protect and maintain less than 75% of the site or TDA as pasture or cropland or be covered in more than 15% impervious surfaces?	X		X	
	Does use of the pasture or cropland for purposes other than plant growth (e.g. unpaved roads, equipment storage, animal pens, haystacks, wheel lines, campsites, trails, etc.) take up more than 10% of the area to be used for dispersion?				
	Does the site prohibit a minimum dispersion flow path through pasture or cropland of 300 feet?				
	Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Is the only location available for the discharge less than 100 feet upgradient of a septic system?				
	Is the only area available for the required length of the BMP's flowpath on a slope greater than 5%?				
	Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
	Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
	Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined in CCC 40.430?				
	Is the only area available to place the dispersion device or required flowpath less than 10 feet from any structure, property line, or sensitive area?				
	Are crops other than grass, grain, row crops (including berries, nursery stock, and orchards) grown in the proposed flowpath?				
	Is the pasture/cropland under different ownership than the project site?				
	If the crop or pasture land is predominantly covered in soils with an infiltration rate greater than 4 inches per hour, was the pasture or cropland cleared after November 2009?				
	Is there less than 3 feet between the surface elevation along the dispersion flowpath and the average annual maximum groundwater elevation?				
Determination: Is this BMP feasible? ……			X		X

	ROOF DOWNSPOUT FULL INFILTRATION BMPs T5.10A and T5.10B	Roof			
	Feasibility Criteria and Setbacks	**YES**	**NO**		
Note: this BMP is not applicable to surfaces other than roofs.	Has a qualified professional determined that soils in the infiltration zone at the location of the infiltration BMP do not fall within USDA textural classes of coarse sand to medium sand, loam, or cobbles and gravels?	X			
	Is there less than 3 feet of permeable soil from the proposed finished ground elevation at the drywell or trench location to the seasonal high groundwater table?				
	Is there less than 1 foot of soil from the proposed bottom elevation of the roof downspout control to the groundwater elevation?				
	Is the proposed location on a slope of 25% (4:1) or greater and cannot reasonably be located elsewhere?				
	Is the proposed location less than 100 feet from a closed or active landfill and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from any small on-site sewage disposal drainfield, including reserve areas and grey water reuse systems, and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground, and cannot reasonably be located elsewhere?				
	Is the proposed location less than 100 feet upgradient of a septic system unless topography clearly prohibits subsurface flows from intersecting the drainfield and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from any structure, property line, or sensitive area and cannot reasonably be located elsewhere? [Note: this setback may be waived at the applicant's request in certain situations in accordance with Book 1, Section 2.5.1.4.]				
	Is the proposed location less than 200 feet from the top of any slope greater than 40% and cannot reasonably be located elsewhere? [Note: The Responsible Official may consider reducing this setback to 15 feet based on a geotechnical evaluation. If requested, submit a geotechnical report with this checklist for County review.]				
Determination: Is this BMP feasible? ……			X		

ERRATA September 2016

DOWNSPOUT DISPERSION BMP T5.10C		Roof			
	Setbacks	**YES**	**NO**		
Note: this BMP is not applicable to surfaces other than roofs.	Is the proposed location less than 10 feet from any sewage disposal drainfield, including reserve areas and grey water reuse systems, and cannot reasonably be located elsewhere?		X		
	Is the proposed discharge location less than 100 feet upgradient of a septic system drainfield, unless site topography clearly prohibits subsurface flows from intersecting the drainfield and cannot reasonably be located elsewhere?		X		
	Is the proposed discharge point less than 10 feet from any structure or property line and cannot reasonably be located elsewhere?	X			
	Is the proposed discharge point less than 50 feet from the top of any slope greater than 15% and cannot reasonably be located elsewhere? [Note: The Responsible Official may consider reducing this setback to 15 feet based on a geotechnical evaluation. If requested, submit a geotechnical report with this checklist for County review.]				
Determination: Is this BMP feasible? ……			X		

SHEET FLOW DISPERSION BMP T5.12 and CONCENTRATED FLOW DISPERSION BMP T5.11		Roof		Surfaces	
	Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?		X		X
	Is the only location available for the discharge location less than 100 feet upgradient of a septic system drainfield on the site?		X		X
	Is the only area available for the required length of the BMP's flowpath on a slope greater than 20%		X		X
	Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?		X		X
	Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?	X		X	
	Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined by CCC 40.430?				
	Is the only area available for the BMP less than 10 feet from any structure, property line, or sensitive area?				
Determination: Is this BMP feasible? ……			X		X

RAIN GARDEN BMP T5.14A and BIORETENTION BMP T5.14B		Roof		Surfaces	
	Infeasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Has the Responsible Official determined that the BMP is not compatible with surrounding drainage systems (e.g. projects draining to existing stormwater collection system whose elevation or locale precludes connection to a properly functioning bioretention system)?		X		X
	Is the land for the BMP within an area designated as an erosion hazard or landslide hazard by the geotechnical report or county critical areas mapping?		X		X
	Can the site not reasonably be designed to locate the BMP on slopes less than 8%?		X		X
	On properties with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and any of the following criteria:				
	o Is the proposed BMP within 100 feet of an area known to have deep soil contamination?		X		X
	o Is the site is in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater?		X		X
	o Is the proposed BMP located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area?		X		X
	o Is the BMP within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?		X		X
	[End soil / groundwater contamination sub-list.]				
	For a bioretention system or a rain garden that would serve a drainage area that is 1) less than 5,000 sq. ft. of pollution-generating impervious surface, and 2) less than 10,000 sq. ft. of impervious surface, and 3) less than ¾ acres of pervious surface, is the minimum vertical separation of one foot to seasonal high water table, bedrock or other impervious layer unable to be achieved below the BMP?		X		X
	For a bioretention system that would 1) serve a drainage area that is a) 5,000 sq. ft. or more of pollution-generating impervious surface, or b) 10,000 sq. ft. or more of impervious surface, or c) ¾ acres or more of pervious surface, and 2) cannot reasonably be broken down into amounts smaller than indicated in (1), is the minimum vertical separation of three feet to seasonal high water table, bedrock or other impervious layer unable to be achieved below the BMP?		X		X
	Does field testing indicates that soils have a measured (a.k.a. initial) native soil coefficient of permeability less than 0.3 inches per hour?	X		X	
	Is the BMP less than 50 feet from the top of a slope greater than 20% or with more than 10 feet of vertical relief and cannot reasonably be located elsewhere?				
Questions continue on following page.	Is the BMP less than 100 feet from a landfill (active or closed) and cannot reasonably be located elsewhere?				

	Is the BMP less than 100 feet from a drinking water well or a spring used for drinking water and cannot reasonably be located elsewhere?				
	Is the BMP less than 10 feet from any small on-site sewage disposal drain field, including reserve areas, and grey water reuse systems and cannot reasonably be located elsewhere? For setbacks from a "large on-site sewage disposal system," see Chapter 246-272B WAC.				
	Is the BMP less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground and when the capacity of the tank and pipe system is less than 1100 gallons and cannot reasonably be located elsewhere?				
	Is the BMP less than 100 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is underground and when the capacity of the tank and pipe system is greater than 1100 gallons and cannot reasonably be located elsewhere?				
	For a bioretention system or rain garden that would serve a drainage area of less than 5,000 sq. ft. of pollution-generating impervious surface and less than 10,000 sq. ft. of impervious surface, is the BMP less than 10 feet away from any structure or property line and cannot reasonably be located elsewhere?				
	For a bioretention system that would serve a drainage area of 5,000 sq. ft. or greater of pollution-generating impervious surface or 10,000 sq. ft. or greater of impervious surface or 3/4 acre or more of pervious surfaces, is the BMP less than 20 feet from the downslope side of any foundation, structure or property line and cannot reasonably be located elsewhere?				
	For a bioretention system that would serve a drainage area of 5,000 sq. ft. or greater of pollution-generating impervious surface or 10,000 sq. ft. or greater of impervious surface or 3/4 acre or more of pervious surfaces, is the BMP less than 100 feet from the upslope side of any foundation and cannot reasonably be located elsewhere?				
	The following require professional technical evaluation.				
	Does a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Does the site have groundwater that drains into an erosion hazard or landslide hazard area?				
	Is the only area available for siting the BMP threatening the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces?				
	Would infiltrating water threaten existing below grade basements?				
	Would infiltrating water threaten shoreline structures such as bulkheads?				
	Is the only area available for siting the BMP one that does not allow for a safe overflow pathway to the municipal separate storm sewer system or to a private storm sewer system?				
	Is the site a redevelopment project that lacks usable space for the BMP?				
	Is the site a public road project that lacks sufficient space within existing public right-of-way for the BMP?				
Determination: Is this BMP feasible? ……			X		X

	PERMEABLE PAVEMENT BMP T5.15	**Roof**		**Surfaces**	
	Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Is the surface to be paved a roadway with a projected average daily traffic volume of more than 400 vehicles?		X		X
	Is the surface to be paved a roadway that will be subject to through truck traffic (not including such traffic as weekly garbage and recycling pick-up, daily school bus use, or frequent use by mail/parcel delivery trucks and maintenance vehicles)?		X		X
	Is the surface to be paved a multi-level parking garage, a bridge, or roadway over a culvert?		X		X
	Is the area for permeable pavement likely to have long-term excessive sediment deposition after construction (e.g. construction and landscaping material yards)?		X		X
	Is the area for permeable pavement designated as an erosion hazard or landslide hazard?		X		X
	Is the surface to be paved on a property with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and meets any of the following criteria:				
	o Is the proposed BMP within 100 feet of an area known to have deep soil contamination?		X		X
	o Is the site in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater?		X		X
	o Is the proposed BMP located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area?		X		X
	o Is the BMP within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?		X		X
	[End soil / groundwater contamination sub-list.]				
Questions continue on the following page.	Can the site not reasonably be designed to have a porous asphalt surface at less than 5% slope, or a pervious concrete surface at less than 10% slope, or a permeable interlocking concrete pavement surface (where appropriate) at less than 12% slope, or a grid system at less than the manufacturer's recommended maximum slope limit (generally between 6% to 12%)?		X		X

	Would seasonal high groundwater or an underlying impermeable/low permeable layer create saturated conditions within 1 foot of the bottom of the lowest gravel base course?		X		X
	Are underlying soils unsuitable for supporting traffic loads when saturated? (Soils meeting a California Bearing Ratio of 5% are considered suitable for residential access roads.)		X		X
	Is the measured coefficient of permeability in the area for permeable pavement less than 0.3 inches per hour?	X		X	
	Is the project replacing existing impervious surface, unless the existing surface is a non-pollution generating surface over a soil with a saturated hydraulic conductivity of four inches per hour or greater?				
	Is the site defined as a high-use site in Appendix 1-A?				
	Is the area for permeable pavement used for an "industrial activity" as identified in 40 CFR 122.26(b)(14)?				
	Is the risk of concentrated pollutant spills more likely such as gas stations, truck stops, and industrial chemical storage sites?				
	Is the area for permeable pavement where routine, heavy applications of sand will occur in frequent snow zones to maintain traction during weeks of snow and ice accumulations?				
	If the area for permeable pavement would be a pollution-generating hard surface (e.g. roads, driveways, parking lots) does the soil underneath the proposed location fail any of the following criteria: - At least one foot depth of soil with the following characteristics: - Cation Exchange Capacity ≥ 5 milliequivalents CEC/100 g dry soil (USEPA Method 9081) - Organic Content > 1% - Measured coefficient of permeability < 9 inches/hour				
	Is the area to be paved less than 50 feet from the top of a slope greater than 20% or with more than 10 feet of vertical relief?				
	Is the area to be paved less than 100 feet from an active or closed landfill?				
	If the surface to be paved is a pollution-generating hard surface, is the area to be paved less than 100 feet from a drinking water well or a spring used for drinking water?				
	Is the area to be paved less than 10 feet from on-site sewage drainage?				
	Is the area to be paved less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground?				
	The following require professional technical evaluation.				
	Does a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Does the site have groundwater that drains into an erosion hazard or landslide hazard area?				
	Would infiltrating and ponded water below new permeable pavement area compromise adjacent impervious pavement?				
	Is the only area available for siting the BMP threatening the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces?				
	Would infiltrating water threaten existing below grade basements?				
	Would infiltrating water threaten shoreline structures such as bulkheads?				
	Is the area to be paved downslope of steep, erosion prone areas that are likely to deliver sediment?				
	Is the area to be paved over fill soils that can become unstable when saturated?				
	Is the area to be paved on excessively steep slopes and would the water within the aggregate base layer or at the sub-grade surface be uncontrollable by detention structures and therefore may cause erosion and structural failure, or would surface runoff velocities preclude adequate infiltration at the pavement surface?				
	Is the area to be paved in an area needed to support heavy loads at an industrial facility (such as a port) that exceed the strength of the permeable pavement?				
	Would installation of permeable pavement threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, or pre-existing road sub-grades?				
Determination: Is this BMP feasible? ……			X		X

LID Feasibility Checklist

Project Title and Case Number: North Haven PUD (PAC-2019-00183)

Applicant: BTMC, LLC.

Date: 02/05/2020 **TDA #:** 2

***Instructions** : Fill out a LID Feasibility Checklist for each TDA on the project. Submit the completed checklist with the Preliminary TIR (see Book 1, Section 1.8.1.5).*

Step 1: Indicate which mandatory list of LID BMPs is applicable to the project in accordance with Minimum Requirement #5 and the flow chart in Figure 2.1 in Book 1. Check the corresponding box in Section 1 below. For projects meeting the LID Performance Standard, this checklist does not apply.

Step 2: Indicate which type(s) of surfaces will be present within the TDA in Section 2.

Step 3: Consider feasibility criteria and setbacks in Section 3.

Section 1: Required LID BMPs

☐ List #1 (Table 3.2.1) ☒ List #2 (Table 3.2.2) ☐ BMPs in Table 3.2.3

Section 2: Surfaces

☒ Roofs ☒ Hard surfaces other than roofs

Section 3: Feasibility Criteria

For each type of surface selected in Section 2, consider BMPs in the order indicated in the required list or table selected in Section 1.

For each question, place a mark in either the Yes or No column. For each No answer, move on to the subsequent question within the BMP. If a Yes answer is given, then the BMP is not feasible in the TDA and is not required in accordance with Minimum Requirement #5. If No answers are given to all questions, then the BMP is feasible in the TDA and must be implemented in accordance with Minimum Requirement #5. When feasibility of the BMP has been determined, then select the appropriate box in the Determination section.

For each type of surface, stop at the first BMP that is feasible.

Answers to questions must consider site-specific information, and some may require professional written evaluation as justification. Please see Book 1, Chapter 2 for more information.

FULL DISPERSION BMP T5.30A	Roof		Surfaces	
Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
Will the project protect and maintain less than 65% of the TDA in a forested native condition?	X		X	
Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
Is the only location available for the discharge less than 100 feet upgradient of a septic system?				
Is the only area available for the required length of the BMP's flowpath on a slope greater than 20%				
Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined in CCC 40.430?				
Is the only area available to place the dispersion device or required flowpath less than 10 feet from any structure, property line, or sensitive area?				
Determination: Is this BMP feasible? ……		X		X

	DISPERSION TO PASTURE OR CROPLAND BMP T5.30B	Roof		Surfaces	
	Applicability and Setbacks	**YES**	**NO**	**YES**	**NO**
	Is the project site 22,000 square feet or less?		X		X
	Will the project protect and maintain less than 75% of the site or TDA as pasture or cropland or be covered in more than 15% impervious surfaces?	X		X	
	Does use of the pasture or cropland for purposes other than plant growth (e.g. unpaved roads, equipment storage, animal pens, haystacks, wheel lines, campsites, trails, etc.) take up more than 10% of the area to be used for dispersion?				
	Does the site prohibit a minimum dispersion flow path through pasture or cropland of 300 feet?				
	Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Is the only location available for the discharge less than 100 feet upgradient of a septic system?				
	Is the only area available for the required length of the BMP's flowpath on a slope greater than 5%?				
	Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
	Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
	Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined in CCC 40.430?				
	Is the only area available to place the dispersion device or required flowpath less than 10 feet from any structure, property line, or sensitive area?				
	Are crops other than grass, grain, row crops (including berries, nursery stock, and orchards) grown in the proposed flowpath?				
	Is the pasture/cropland under different ownership than the project site?				
	If the crop or pasture land is predominantly covered in soils with an infiltration rate greater than 4 inches per hour, was the pasture or cropland cleared after November 2009?				
	Is there less than 3 feet between the surface elevation along the dispersion flowpath and the average annual maximum groundwater elevation?				
Determination: Is this BMP feasible? ……			X		X

	ROOF DOWNSPOUT FULL INFILTRATION BMPs T5.10A and T5.10B	Roof			
	Feasibility Criteria and Setbacks	**YES**	**NO**		
Note: this BMP is not applicable to surfaces other than roofs.	Has a qualified professional determined that soils in the infiltration zone at the location of the infiltration BMP do not fall within USDA textural classes of coarse sand to medium sand, loam, or cobbles and gravels?	X			
	Is there less than 3 feet of permeable soil from the proposed finished ground elevation at the drywell or trench location to the seasonal high groundwater table?				
	Is there less than 1 foot of soil from the proposed bottom elevation of the roof downspout control to the groundwater elevation?				
	Is the proposed location on a slope of 25% (4:1) or greater and cannot reasonably be located elsewhere?				
	Is the proposed location less than 100 feet from a closed or active landfill and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from any small on-site sewage disposal drainfield, including reserve areas and grey water reuse systems, and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground, and cannot reasonably be located elsewhere?				
	Is the proposed location less than 100 feet upgradient of a septic system unless topography clearly prohibits subsurface flows from intersecting the drainfield and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from any structure, property line, or sensitive area and cannot reasonably be located elsewhere? [Note: this setback may be waived at the applicant's request in certain situations in accordance with Book 1, Section 2.5.1.4.]				
	Is the proposed location less than 200 feet from the top of any slope greater than 40% and cannot reasonably be located elsewhere? [Note: The Responsible Official may consider reducing this setback to 15 feet based on a geotechnical evaluation. If requested, submit a geotechnical report with this checklist for County review.]				
Determination: Is this BMP feasible? ……			X		

ERRATA September 2016

DOWNSPOUT DISPERSION BMP T5.10C		Roof			
	Setbacks	**YES**	**NO**		
Note: this BMP is not applicable to surfaces other than roofs.	Is the proposed location less than 10 feet from any sewage disposal drainfield, including reserve areas and grey water reuse systems, and cannot reasonably be located elsewhere?		X		
	Is the proposed discharge location less than 100 feet upgradient of a septic system drainfield, unless site topography clearly prohibits subsurface flows from intersecting the drainfield and cannot reasonably be located elsewhere?		X		
	Is the proposed discharge point less than 10 feet from any structure or property line and cannot reasonably be located elsewhere?	X			
	Is the proposed discharge point less than 50 feet from the top of any slope greater than 15% and cannot reasonably be located elsewhere? [Note: The Responsible Official may consider reducing this setback to 15 feet based on a geotechnical evaluation. If requested, submit a geotechnical report with this checklist for County review.]				
Determination: Is this BMP feasible? ……			X		

SHEET FLOW DISPERSION BMP T5.12 and CONCENTRATED FLOW DISPERSION BMP T5.11		Roof		Surfaces	
	Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?		X		X
	Is the only location available for the discharge location less than 100 feet upgradient of a septic system drainfield on the site?		X		X
	Is the only area available for the required length of the BMP's flowpath on a slope greater than 20%		X		X
	Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?		X		X
	Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?	X		X	
	Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined by CCC 40.430?				
	Is the only area available for the BMP less than 10 feet from any structure, property line, or sensitive area?				
Determination: Is this BMP feasible? ……			X		X

RAIN GARDEN BMP T5.14A and BIORETENTION BMP T5.14B		Roof		Surfaces	
	Infeasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Has the Responsible Official determined that the BMP is not compatible with surrounding drainage systems (e.g. projects draining to existing stormwater collection system whose elevation or locale precludes connection to a properly functioning bioretention system)?		X		X
	Is the land for the BMP within an area designated as an erosion hazard or landslide hazard by the geotechnical report or county critical areas mapping?		X		X
	Can the site not reasonably be designed to locate the BMP on slopes less than 8%?		X		X
	On properties with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and any of the following criteria:				
	o Is the proposed BMP within 100 feet of an area known to have deep soil contamination?		X		X
	o Is the site is in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater?		X		X
	o Is the proposed BMP located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area?		X		X
	o Is the BMP within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?		X		X
	[End soil / groundwater contamination sub-list.]				
	For a bioretention system or a rain garden that would serve a drainage area that is 1) less than 5,000 sq. ft. of pollution-generating impervious surface, and 2) less than 10,000 sq. ft. of impervious surface, and 3) less than ¾ acres of pervious surface, is the minimum vertical separation of one foot to seasonal high water table, bedrock or other impervious layer unable to be achieved below the BMP?		X		X
	For a bioretention system that would 1) serve a drainage area that is a) 5,000 sq. ft. or more of pollution-generating impervious surface, or b) 10,000 sq. ft. or more of impervious surface, or c) ¾ acres or more of pervious surface, and 2) cannot reasonably be broken down into amounts smaller than indicated in (1), is the minimum vertical separation of three feet to seasonal high water table, bedrock or other impervious layer unable to be achieved below the BMP?		X		X
	Does field testing indicates that soils have a measured (a.k.a. initial) native soil coefficient of permeability less than 0.3 inches per hour?	X		X	
	Is the BMP less than 50 feet from the top of a slope greater than 20% or with more than 10 feet of vertical relief and cannot reasonably be located elsewhere?				
Questions continue on following page.	Is the BMP less than 100 feet from a landfill (active or closed) and cannot reasonably be located elsewhere?				

	Is the BMP less than 100 feet from a drinking water well or a spring used for drinking water and cannot reasonably be located elsewhere?				
	Is the BMP less than 10 feet from any small on-site sewage disposal drain field, including reserve areas, and grey water reuse systems and cannot reasonably be located elsewhere? For setbacks from a "large on-site sewage disposal system," see Chapter 246-272B WAC.				
	Is the BMP less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground and when the capacity of the tank and pipe system is less than 1100 gallons and cannot reasonably be located elsewhere?				
	Is the BMP less than 100 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is underground and when the capacity of the tank and pipe system is greater than 1100 gallons and cannot reasonably be located elsewhere?				
	For a bioretention system or rain garden that would serve a drainage area of less than 5,000 sq. ft. of pollution-generating impervious surface and less than 10,000 sq. ft. of impervious surface, is the BMP less than 10 feet away from any structure or property line and cannot reasonably be located elsewhere?				
	For a bioretention system that would serve a drainage area of 5,000 sq. ft. or greater of pollution-generating impervious surface or 10,000 sq. ft. or greater of impervious surface or 3/4 acre or more of pervious surfaces, is the BMP less than 20 feet from the downslope side of any foundation, structure or property line and cannot reasonably be located elsewhere?				
	For a bioretention system that would serve a drainage area of 5,000 sq. ft. or greater of pollution-generating impervious surface or 10,000 sq. ft. or greater of impervious surface or 3/4 acre or more of pervious surfaces, is the BMP less than 100 feet from the upslope side of any foundation and cannot reasonably be located elsewhere?				
	The following require professional technical evaluation.				
	Does a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Does the site have groundwater that drains into an erosion hazard or landslide hazard area?				
	Is the only area available for siting the BMP threatening the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces?				
	Would infiltrating water threaten existing below grade basements?				
	Would infiltrating water threaten shoreline structures such as bulkheads?				
	Is the only area available for siting the BMP one that does not allow for a safe overflow pathway to the municipal separate storm sewer system or to a private storm sewer system?				
	Is the site a redevelopment project that lacks usable space for the BMP?				
	Is the site a public road project that lacks sufficient space within existing public right-of-way for the BMP?				
Determination: Is this BMP feasible? ……			X		X

	PERMEABLE PAVEMENT BMP T5.15	**Roof**		**Surfaces**	
	Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Is the surface to be paved a roadway with a projected average daily traffic volume of more than 400 vehicles?		X		X
	Is the surface to be paved a roadway that will be subject to through truck traffic (not including such traffic as weekly garbage and recycling pick-up, daily school bus use, or frequent use by mail/parcel delivery trucks and maintenance vehicles)?		X		X
	Is the surface to be paved a multi-level parking garage, a bridge, or roadway over a culvert?		X		X
	Is the area for permeable pavement likely to have long-term excessive sediment deposition after construction (e.g. construction and landscaping material yards)?		X		X
	Is the area for permeable pavement designated as an erosion hazard or landslide hazard?		X		X
	Is the surface to be paved on a property with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and meets any of the following criteria:				
	o Is the proposed BMP within 100 feet of an area known to have deep soil contamination?		X		X
	o Is the site in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater?		X		X
	o Is the proposed BMP located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area?		X		X
	o Is the BMP within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?		X		X
	[End soil / groundwater contamination sub-list.]				
Questions continue on the following page.	Can the site not reasonably be designed to have a porous asphalt surface at less than 5% slope, or a pervious concrete surface at less than 10% slope, or a permeable interlocking concrete pavement surface (where appropriate) at less than 12% slope, or a grid system at less than the manufacturer's recommended maximum slope limit (generally between 6% to 12%)?		X		X

	Would seasonal high groundwater or an underlying impermeable/low permeable layer create saturated conditions within 1 foot of the bottom of the lowest gravel base course?		X		X
	Are underlying soils unsuitable for supporting traffic loads when saturated? (Soils meeting a California Bearing Ratio of 5% are considered suitable for residential access roads.)		X		X
	Is the measured coefficient of permeability in the area for permeable pavement less than 0.3 inches per hour?	X		X	
	Is the project replacing existing impervious surface, unless the existing surface is a non-pollution generating surface over a soil with a saturated hydraulic conductivity of four inches per hour or greater?				
	Is the site defined as a high-use site in Appendix 1-A?				
	Is the area for permeable pavement used for an "industrial activity" as identified in 40 CFR 122.26(b)(14)?				
	Is the risk of concentrated pollutant spills more likely such as gas stations, truck stops, and industrial chemical storage sites?				
	Is the area for permeable pavement where routine, heavy applications of sand will occur in frequent snow zones to maintain traction during weeks of snow and ice accumulations?				
	If the area for permeable pavement would be a pollution-generating hard surface (e.g. roads, driveways, parking lots) does the soil underneath the proposed location fail any of the following criteria: - At least one foot depth of soil with the following characteristics: - Cation Exchange Capacity ≥ 5 milliequivalents CEC/100 g dry soil (USEPA Method 9081) - Organic Content > 1% - Measured coefficient of permeability < 9 inches/hour				
	Is the area to be paved less than 50 feet from the top of a slope greater than 20% or with more than 10 feet of vertical relief?				
	Is the area to be paved less than 100 feet from an active or closed landfill?				
	If the surface to be paved is a pollution-generating hard surface, is the area to be paved less than 100 feet from a drinking water well or a spring used for drinking water?				
	Is the area to be paved less than 10 feet from on-site sewage drainage?				
	Is the area to be paved less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground?				
	The following require professional technical evaluation.				
	Does a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Does the site have groundwater that drains into an erosion hazard or landslide hazard area?				
	Would infiltrating and ponded water below new permeable pavement area compromise adjacent impervious pavement?				
	Is the only area available for siting the BMP threatening the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces?				
	Would infiltrating water threaten existing below grade basements?				
	Would infiltrating water threaten shoreline structures such as bulkheads?				
	Is the area to be paved downslope of steep, erosion prone areas that are likely to deliver sediment?				
	Is the area to be paved over fill soils that can become unstable when saturated?				
	Is the area to be paved on excessively steep slopes and would the water within the aggregate base layer or at the sub-grade surface be uncontrollable by detention structures and therefore may cause erosion and structural failure, or would surface runoff velocities preclude adequate infiltration at the pavement surface?				
	Is the area to be paved in an area needed to support heavy loads at an industrial facility (such as a port) that exceed the strength of the permeable pavement?				
	Would installation of permeable pavement threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, or pre-existing road sub-grades?				
Determination: Is this BMP feasible? ……			X		X

Exhibit H

Clark County Stormwater Code and Manual Update

Clean Water Commission Briefing

December 3, 2025

1

Agenda

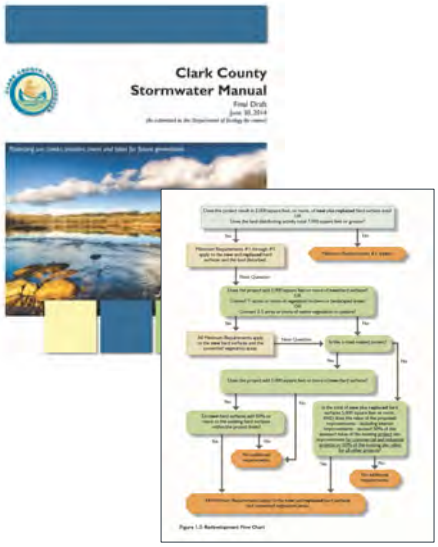
- Project Overview
- Ecology Submittal
- Technical and Other Changes Not Submitted to Ecology
- Training & Guidance
- Illicit Discharge Code Updates
- Next Steps

2

Project Overview

Improving water quality, ensuring compliance

- Department of Ecology issued new stormwater permit (2024) and Stormwater Manual (2024)
  - New requirements for new development and redevelopment (Appendix 10, Appendix 1)
  - Updated technical standards and guidance language (Manual)
- Update Clark County Stormwater Manual (CCSM) & Clark County Code (CCC)
  - Incorporate staff/DEAB suggestions
  - Evaluate infiltration testing requirements
- Training Needs Assessment



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Project Overview

Enforceable Documents to be Updated

- Clark County Code
  - 13.26A: Water Quality
  - 40.100: Definitions
  - 40.386: Stormwater and Erosion Control
  - 40.500: Procedures
- Clark County Stormwater Manual
  - Book 1, Book 2, Book 3, Book 4

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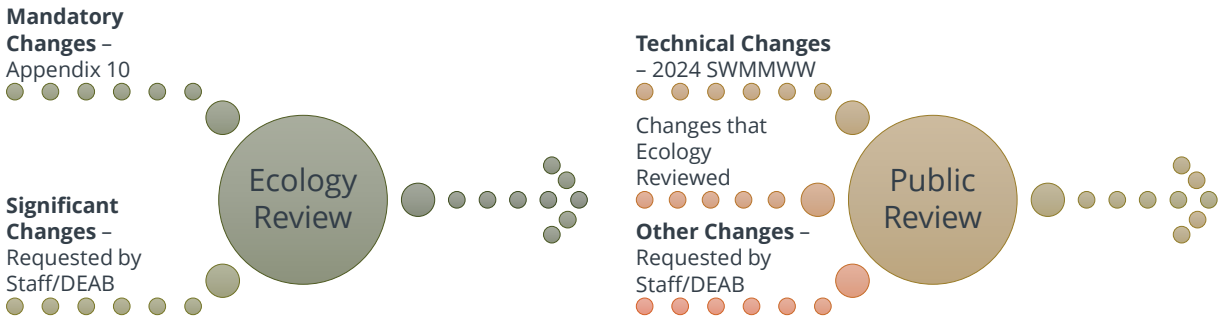
Process, Pt. 1



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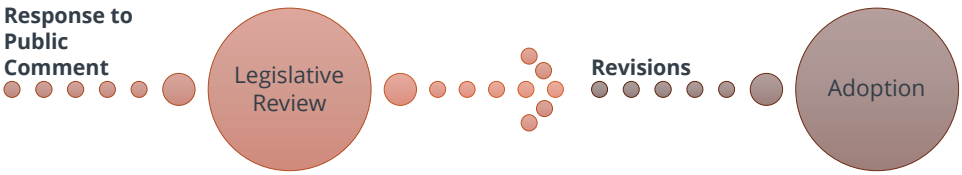
Process, Pt. 2



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Schedule

Ecology deadlines drive internal and public timelines



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Changes Submitted to Ecology

8

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Ecology Submittal

- Mandated Changes from Appendix 10
- Requests for manual/code updates collected over time from County staff and community that resulted in a “Significant” change to CCSM or County stormwater code
- Submitted to Ecology in June
- Expecting comments in December

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Ecology’s Significant Mandated Changes

1. Redevelopment Project Level Thresholds
2. Project Exemptions
3. Definitions Related to Minimum Requirements
4. Wetland Hydroperiod Protection Method 2
5. Runoff Treatment Performance Goal Threshold
6. Source Control BMPs – PCB Edits
7. High Performance Bioretention Soil Mix

Link to Appendix 10



Significant Changes

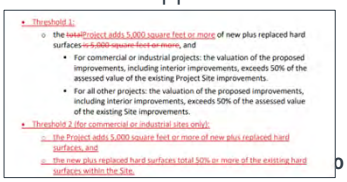
1. **Redevelopment Project Level Thresholds:** The “Project Level” thresholds for applying the Minimum Requirements to redevelopment projects have been updated.
   - Project Level - Redevelopment Thresholds / Road Related Projects

     The updated threshold for road related projects states that all Minimum Requirements apply to the new and replaced hard surfaces and converted vegetation areas if the project adds 5,000 square feet of new plus replaced hard surfaces AND the new plus replaced hard surfaces total 50% or more of the existing hard surfaces on the Site (underline shows the new language).
   - Project Level - Redevelopment Thresholds / Commercial or Industrial Projects

     The updates include a new threshold for commercial or industrial Sites. The new threshold states that all Minimum Requirements apply to the new and replaced hard surfaces and converted vegetation areas if the Project adds more than 5,000 square feet of new plus replaced hard surfaces AND the new plus replaced hard surfaces total 50% or more of the existing hard surfaces within the Site.

See **Section 3** of Appendix 1.

Link to Appendix 1



- Threshold 1:
  - the ~~total~~Project adds 5,000 square feet or more of new plus replaced hard surfaces ~~is 5,000 square feet or more~~, and
    - For commercial or industrial projects: the valuation of the proposed improvements, including interior improvements, exceeds 50% of the assessed value of the existing Project Site improvements.
    - For all other projects: the valuation of the proposed improvements, including interior improvements, exceeds 50% of the assessed value of the existing Site improvements.
- Threshold 2 (for commercial or industrial sites only):
  - the Project adds 5,000 square feet or more of new plus replaced hard surfaces, and
  - the new plus replaced hard surfaces total 50% or more of the existing hard surfaces within the Site.

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Notable Mandated Changes

- Redevelopment Thresholds (revised Figure 1.3)
  - Road-related redevelopment threshold now calculated on new + replaced hard surfaces, not just new hard surfaces
- Runoff Treatment Performance Goal
  - Require phosphorous control in all of Vancouver Lake/Lake River watershed and all of Lacamas watershed above the dam
- High Performance Bioretention Soil Mix (HPBSM)
  - Allows bioretention to be used near a phosphorous sensitive lake
  - Allows HPBSM as phosphorous treatment
  - Specifications are challenging to meet

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11

Notable Other Significant Updates

- Require soils log to 10-foot depth instead of 4-foot depth where downspout full infiltration is proposed
- State clearly the County policy of preferring infiltration
- Clarification of converted vegetation definition
- Prohibit use of Deep UICs

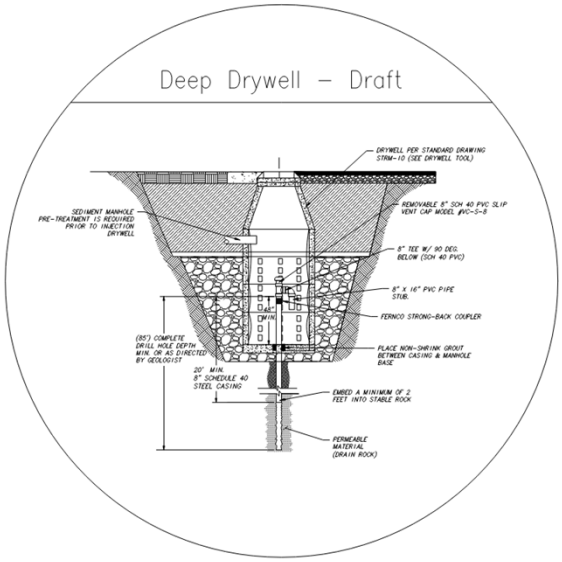
12

12

Notable Other Significant Updates

What is a Deep UIC Well?

- Typical drywell structure on top of a deep drilled shaft
- May extend deep underground
- Considered a high threat to groundwater due to lack of a geologic upper confining layer



13

13

Technical & Other Changes – Not Submitted to Ecology

14

14

Notable Technical & Other Changes

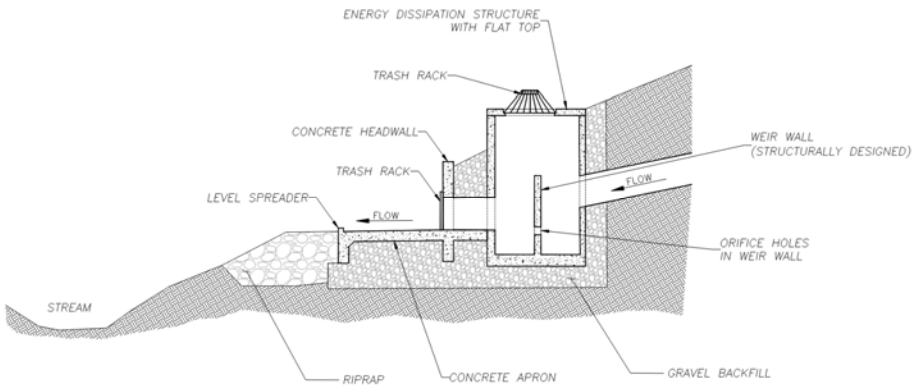
- Remove Mill Creek Alternative Flow Control Standard
- New guidance for designing with a ½-inch minimum orifice (appendix)
- Prohibit use of UICs and *underground* infiltration facilities for runoff treatment
- Improve soil and groundwater investigation for infiltration facilities

15

15

Notable Technical & Other Changes

- Improved guidance for designing outfalls and energy dissipators



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16

Notable Technical & Other Changes

- Manage placement of stormwater treatment and flow control BMPs / engineered stormwater facilities on private residential lots in subdivisions
  - Clarifying when allowed
  - Strengthen requirements for inspection access for Clark County
- Clarify that Media Filter Drain and Compost Amended Vegetated Filter Strips (CAVFS) cannot be used for Flow Control
- New Infiltration Swale BMP
- New Dispersion BMPs for channelized flows and light rail elevated guideways

17

17

Training / Guidance

18

18

Training / Guidance

- Infiltration Investigation Checklist
- Post-Construction Soil Quality and Depth Guide
- Identify other training topics
- Provide post-adoption training for staff and/or community

19

19

Water Quality Code Update

20

20

Illicit Discharge Regulations

Clark County Code, 13.26A Water Quality

- Update 13.26A.025.B, Allowable Discharges
  - Lawn watering using reclaimed water
  - Debromination of swimming pool, spa, and tub water
  - Additional PCB considerations for building washdowns
- Allowable non-stormwater discharges updated in 2024 Permit and changes must be made to the enforceable document by July 1, 2027

21

21

Next Steps

- 2-week review period for DEAB, CWS, and County staff in December
- County Council Work Session in January
- Formal Public Review begins in March
- Planning Commission April and May
- County Council May and June
- Adoption in June, Effective July 1
- Training or Guidance

22


Presented by Trista Kobluskie
Senior Stormwater Planner
Otak
Questions?
Otak
23

23

Exhibit I

COMMUNITY DEVELOPMENT
Land Use Review

Hearing Decision

Notice to Parties of Record

Project Name: Three Creeks East Subdivision

Case Number: PLD-2025-00077

The attached decision of the Land Use Hearing Examiner is final unless a motion for reconsideration is filed or an appeal is filed with Superior Court.

See the ***Appeals*** handout https://clark.wa.gov/media/document/57535 and https://clark.wa.gov/community-development/land-use-forms-and-fees for more information and fees.

Motion for Reconsideration

Any party of record to the proceeding before the hearings examiner may file with the responsible official a motion for reconsideration of an examiner's decision within fourteen (14) calendar days of written notice of the decision. A **party of record** includes the applicant and those individuals who signed the sign-in sheet or presented oral testimony at the public hearing, and/or submitted written testimony prior to or at the Public Hearing on this matter.

The motion must be accompanied by the applicable fee and identify the specific authority within the Clark County Code or other applicable laws, and/or specific evidence, in support of reconsideration. A motion may be granted for any one of the following causes that materially affects the rights of the moving party:

a. Procedural irregularity or error, clarification, or scrivener's error, for which no fee will be charged;
b. Newly discovered evidence, which the moving party could not with reasonable diligence have timely discovered and produced for consideration by the examiners;
c. The decision is not supported by substantial evidence in the record; or,
d. The decision is contrary to law.

Any party of record may file a written response to the motion if filed within fourteen (14) calendar days of filing a motion for reconsideration.

The examiner will issue a decision on the motion for reconsideration within twenty-eight (28) calendar days of filing the motion for reconsideration.

Mailed on: March 6, 2026

BEFORE THE LAND USE HEARINGS EXAMINER
OF CLARK COUNTY, WASHINGTON

Regarding an application by Ginn Group for preliminary plat approval to divide a 39.34- acres into200 lots as a PUD in the OR-22 and R-12 zones at 1804 NE 179th Street, in unincorporated Clark County, Washington	))))	**FINAL ORDER** **PLD-2025-00077** **(Three Creeks East PUD)**

A. SUMMARY

1. The applicant, Ginn Group , requests approval to divide the roughly 39.34-acre parcel into 200 lots for single-family dwellings and tracts for wetlands/open space, shared driveways, and stormwater facilities. The applicant proposed to develop the site as a Planned Unit Development ("PUD") with up to four phases.

a. The PUD parcel is located at 1804 NE 179th Street; also known as tax assessor Parcels 181218-000, 181208-000, 181253-000, and 181209-005 (the "site").

b. The southern roughly one-half of the site and abutting properties to the east are zoned OR-22 (Office Residential, 22-units per acre maximum density). The northern roughly one-half of the site and abutting properties to the north and east are zoned R-12 (Residential, 12-units per acre maximum density). Properties to the west and southwest of the south half are zoned GC (General Commercial). Properties to the south are zoned R-18 (Residential, 18-units per acre maximum density). Properties to the west of the north half are zoned MX (Mixed Use).

c. A natural gas pipeline easement bisects the site from southwest to northeast. The site is currently developed with a single family residence and two shops. The applicant proposed to remove all of the existing structures on the site.

d. Whipple Creek, a Type F Stream, crosses the southwest corner of the site and continues offsite to the northwest. Special Flood Hazard Area ("SFHA"), Riparian Priority Habitat ("RPH"), and Biodiversity Corridor areas associated with the creek extend onto the site. There is a Category II wetland in the northeast corner of the site, a Category I wetland in the southern portion of the site, and additional Category I wetlands associated with Whipple Creek. The applicant proposed to retain the stream SFHA, wetlands, and much of the associated buffers, RPH, and Biodiversity Corridor within proposed Tracts A and C. The applicant proposed to mitigate impacts to the critical areas by enhancing the remaining critical areas on the site.

e. Clark Public Utilities will provide public water service to the site and Clark Regional Wastewater will provide sewer service.

f. The applicant will dedicate right-of-way along the site's NE 179th Street frontage to accommodate a planned County capital improvement project to widen NE 179th Street. The applicant will extend a new north-south aligned public street, proposed

NE 18th Avenue, between NE 179th Street and the north boundary of the site to allow for further extension when the abutting property to the north redevelops. The applicant will construct the western portion of NE 19th Avenue abutting the northern portion of the east boundary of the site and continue this street north as a full-width improvement, intersecting proposed NE 187th Street in the northern portion of the site. The applicant will extend NE 183rd, NE 184th, and NE 187th Streets between NE 18th and NE 19th Avenues and the east boundary of the site. NE 183rd Street will connect to the existing stub of NE 183rd Street abutting the site. The other streets will be extended when abutting properties redevelop. The applicant will provide additional public streets and shared driveways within the site to access the proposed lots.

g. The applicant will collect, treat, and detain stormwater runoff from all impervious areas on the site. The applicant will discharge treated runoff into Tract A at less than predevelopment rates.

2. The County issued a Determination of Nonsignificance ("DNS") for the subdivision pursuant to the State Environmental Policy Act ("SEPA") on October 1, 2025. That determination was not appealed and is now final.

3. Clark County Hearing Examiner Joe Turner (the "examiner") conducted an online public hearing about the application. County staff recommended the examiner deny the proposed phasing plan and approve the proposed PUD subject to conditions. See the Type III Land Division and Environmental Review Staff Report and Recommendation to the Hearing Examiner dated January 7, 2026, (the "Staff Report") as amended by Exhibits 42, 43, and 48. The applicant accepted those findings and conditions, as amended, with certain exceptions. One person testified orally with questions and concerns about the development. Other persons testified in writing (Exhibits 45 and 53). Disputed issues or concerns in the case include the following:

a. Whether the applicant can be required to install barriers and/or signage prohibiting access to adjacent properties;

b. Whether the proposed development will cause or exacerbate flooding on adjacent properties;

c. Whether the applicant can be required to retain the existing trees on the site;

d. Whether the proposed phasing plan complies with CCC 40.540.040.B.4;

e. Whether a second access and/or sprinklers are required for this development; and

f. Whether the applicant can be prohibited from connecting to existing NE 183rd Street east of the site until the adjacent development closes its access to NE 179th Street.

4. Based on the findings provided or incorporated herein, the examiner approves the preliminary plat subject to the conditions at the end of this final order.

B. HEARING AND RECORD HIGHLIGHTS

1. The examiner received testimony at public hearing about this application on January 22, 2026. That testimony and evidence, including video recordings of the public hearings and the casefile maintained by the Department of Community Development ("DCD"), are included herein as exhibits, and they are filed at DCD. The following is a summary by the examiner of selected testimony and evidence offered at the hearings.

2. County planner Bryan Mattson summarized the Staff Report and his PowerPoint presentation, Exhibit 47.

a. He noted that the site is zoned R-12 and OR-22. A natural gas pipeline easement bisects the site from southwest to northeast. The majority of trees on the site were previously removed pursuant to a forest practices permit.

b. Although the overall development complies with the Code, there is insufficient information to determine whether each proposed phase complies with the overall density requirements for the site. Therefore, he recommended the examiner deny the proposed phasing plan. However, staff may change this recommendation based on information submitted during the open record period.

c. The applicant proposed to reduce the side yard setback for the zero lot line homes from eight feet to six feet. However, the applicant failed to provide sufficient support for this request. Therefore, he recommended the examiner deny this request.

d. The road modification team recommended denial of the applicant's road modification #7, which proposed constructing a portion NE 18th Avenue as a shed section due to the topography of the site.

e. The applicant may use the private road within the multifamily development to the east as an emergency access (provided that an easement is obtained) but may not construct phases for lots 100-200 until a secondary emergency or public road access is available for public use.

f. He noted that the applicant cannot construct a fence in the wetland or wetland buffer as requested by Mr. Barritt. The applicant will be required to demarcate the upland boundary of the buffer, which should limit the potential for trespass.

3. County wetland and habitat biologist Ariel Whitacre requested the examiner include an additional condition A-12 as set out in Exhibit 42. She noted that the applicant will be required to install and maintain signs and logs, a tree or hedge row, fencing, or other prominent physical marking to clearly demarcate the upland boundary of the

wetland buffers on the site. However, the on-site portion of the wetland buffers will be an open space tract owned by a Homeowners Association that the residents of the site have a right to use. Therefore, the applicant cannot prevent people from walking past the demarcation lines.

4. Planner David Taylor and attorney Steve Morash appeared on behalf of the applicant, Ginn Group.

a. Mr. Taylor responded to the findings and conditions in the Staff Report and public comments.

i. He noted that the applicant proposed to develop the site as a PUD, which allows the applicant to blend density between the OR-22 and R-12 zones. Although the overall development will meet minimum density requirements, the applicant cannot demonstrate that each individual phase meets density requirements, as required by condition A-8.a.

ii. The applicant is no longer requesting reduced side yard setback for the zero lot line homes.

iii. The applicant can install "No Parking" signs or otherwise demarcate areas for common solid waste and recycling collection areas. He requested the examiner add a condition of approval to that effect.

b. Mr. Morash also responded to the Staff Report and public comments.

i. He summarized his memorandum regarding secondary access through the apartment development east of the site. (Exhibit 44).

(A) He requested staff or the examiner clarify condition A-1.p consistent with the Fire Marshall's comment that the roads in the apartment development are adequate to provide secondary emergency access to the site. (Exhibit 25, attachment G).

(B) Condition A-1.q is unnecessary, as CCC 40.350.030.B.4.b(4)(c) authorizes the Fire Marshall to approve alternative access or fire protections in lieu of a secondary access.

(C) Condition A-1.r creates an unresolvable conflict, as it prohibits connection of this development to existing NE 183rd Street until the apartment development east of the site closes its access to NE 179th Street. However, the apartment owner cannot close the access to NE 179th Street until alternative access is available via NE 183rd Street. In addition, the applicant has no authority to require that the apartment owner close the NE 179th Street access; the applicant cannot be responsible for enforcing the conditions of approval imposed on the apartment development.

(D) He requested the examiner delete conditions A-1.q and r, or include alternative language as proposed in Exhibit 44.

5. David Barritt noted that NE 20th Avenue is his private driveway, providing access to his property abutting the northeast corner of the site, yet GIS maps frequently direct drivers who are trying to access the apartment development east of the site onto his property. Residents of the proposed development are likely to use the proposed walking path within the gas line easement to access his property, as the proposed path ends at the edge of the wetland buffer between the site and his property. He requested the applicant be required to construct a fence or other continuous barrier to prevent access to his property from the site.

6. At the conclusion of the hearing the examiner held the record open for three weeks, until February 12, 2026, to allow anyone to submit additional testimony and evidence, for a fourth week, until February 19, 2026, to allow anyone to respond to whatever was submitted during the prior open record period, and for a fifth week, until February 26, 2026, to allow the applicant to submit a final written argument. Exhibits 45-55 were submitted during the open record period.

C. FINDINGS:

Only issues and approval criteria raised during the application review, at the hearing, or before the close of the record are discussed in this section. All approval criteria not raised by staff, the applicant, or a party to the proceeding have been waived as contested issues, and no argument regarding these issues can be raised in any subsequent appeal. The examiner finds those criteria to be met, even though they are not specifically addressed in these findings. The following issues relate to the mandatory applicable approval criteria for this proposal and were addressed by county staff in their reports, by agency comments, by the applicant and others. The Examiner adopts the following findings regarding each:

Land Use

Finding 1 – Zoning Districts

The site lies within the R-12 and OR-22 zoning districts. The R-12 district is "[i]ntended to provide for medium and higher density residential development based upon consistency with the comprehensive plan and compatibility with surrounding land uses." (CCC 40.220.030.A.1). The OR-22 district is [i]ntended to provide for residential and professional office development based upon consistency with the comprehensive plan and compatibility with adjacent land uses." (CCC 40.220.030.A.2).

According to Table 40.220.020-1, the R-12 and OR-22 zones allow detached single-family units subject to the Narrow Lot Standards in 40.260.155, and residential Planned Unit Developments (PUD)'s are permitted subject to standards put forth in Section 40.520.080. Zero Lot Line Developments are also separately allowed in both the R-12 and OR-22 zones pursuant to the Special Use Standards found in 40.260.260.B.

The minimum lot, setback, building height, and lot coverage standards for single family detached units within the R-12 and R-18 zones are prescribed in Table 40.220.020-5:

Table 40.220.020-5. Single-Family Detached Lot Standards

Zoning District	Min. Lot Area	Min. Lot width[1]	Min. Lot Depth	Max. Building Height	Min. Front Setback	Min. Side Setback[2]	Min. Rear Setback	Max. Lot Cov.
R-12	2,800sf	35 feet	50 feet	35 feet	10 feet for dwelling & 18 feet for garage opening	8-foot minimum building separation between units in the development; otherwise, 5 feet to the site's perimeter	8-foot minimum building separation between units in the development; otherwise, 5 feet to the site's perimeter	50%
OR-22	1,500sf	25 feet	50 feet	45 feet	10 feet for dwelling & 18 feet for garage opening	8-foot minimum building separation between units in the development; otherwise, 5 feet to the site's perimeter	8-foot minimum building separation between units in the development; otherwise, 5 feet to the site's perimeter	50%

Additionally, Table 40.220.020-4 also states that the minimum and maximum density allowed for detached units is 8-12 units per acre in the R-12 zone and 15-22 units per acre in the OR-22 zone.

The applicant is proposing a Planned Unit Development which allows the applicant flexibility to vary from lot standards, such as the minimum lot size as well as providing a density increase. The applicant proposes to blend the density requirements for the R-12 and OR-22 districts to provide a cohesive development. This results in a proposed minimum lot size of 2,340 square feet with minimum lot widths of 26 feet. The applicant initially requested to reduce the required side yard building separation from eight feet to

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[1] *Applies to interior lots only – widths of corner lots shall be dependent upon the applicable narrow lot standards in Section 40.260.155(C)(2).*
[2] *May also use zero lot line provisions of Section 40.260.260.*

six feet, but the applicant withdrew that request at the hearing. No density increase is requested.

The net developable area of the site is 17.83 acres once right-of-way, critical areas, and the undevelopable gas easement are subtracted from the gross lot area. With 200 lots proposed, this corresponds to an overall density of 11.2 dwelling units per acre. The net developable area in the OR-22 zone is 6.2 acres and requires a minimum of 93 units. The net developable area in the R-12 zone is 11.6 acres and requires a minimum of 93 units. Overall, 186 units are required to meet minimum density requirements.

For purposes of calculating maximum density only ROW needs to be subtracted from the gross lot area. This results in a net developable area of 17.1 acres, which results in a maximum density of 376 units in the OR-22 zone. For the R-12 zone the net developable area is 16 acres, which results in a maximum density of 192 units. The overall maximum density of the site is 568 units.

The applicant proposes to develop the site with 200 units, which complies with the minimum and maximum density standards.

The proposed lot area, lot width, side yards, and density are further discussed under Land Use Finding 3 - Planned Unit Development standards. All other applicable base zone standards are proposed to be met.

Pursuant to 40.220.020.C.9, a minimum of twenty percent (20%) of the site shall be landscaped to an L1 standard as described in section 40.320.010. The applicant has proposed to meet this requirement for the development as a whole as allowed under the PUD standards *(PUD standards and approval criteria are discussed further under Land Use Finding 3 and landscaping and screening details are discussed under Land Use 6).*

Finding 2 – Phasing Plan

The applicant has proposed to construct the development in four (4) phases. Pursuant to 40.540.040.D.4:

> If a phasing plan is proposed, then the applicant shall show:
> a. The phasing plan includes all land within the preliminary plat;
> b. Each Phase is an independent planning unit with safe and convenient circulation and with facilities and utilities coordinated with requirements established for the entire subdivision; and
> c. All road improvement requirements are assured."

The applicant is proposing development of the site as follows:

- Phase 1 proposes the construction of the south portion of the project including a large portion of NE 18th Avenue, NE 183rd Street, NE 49th Avenue, NE 185th Avenue, NE 184th Street, and a short portion of NE 19th Avenue. Also Included in Phase 1 are both proposed stormwater facilities, Tract H which will include a

playground structure, and a large portion of the walking path proposed within the gas pipeline easement. Phase 1 includes lots 1-17, 73-126, 162-166, and 182-192.

- Phase 2 proposes the construction of the northerly portion of NE 18th and NE 19th Avenues, a short portion of NE 186th Street, and NE 187th Street. No additional amenities are proposed for Phase 2 aside from the undeveloped portion of the site within Tract K. Phase 2 includes lots 18-72, 127-161, and lot 171.

- Phase 3 proposes the construction of NE 20th Way and the remaining portion of the walking path lying within the gas pipeline easement. Phase 2 includes lots 167-170 and 193-200.

- Phase 4 proposes the construction of the remaining portion (cul-de-sac) of NE 186th Street and lots 172-181.

The phasing plan includes all land within the preliminary plat and will result in all road improvement requirements being constructed. Furthermore, staff have found that the amenities provided under Phase 1 will be sufficient for both Phases 1 and 2. Additionally, to qualify as an independent planning unit, Phase 1 and then Phase 2 with any subsequent Phases need to separately comply with all PUD standards including open space and density.

The applicant's Phasing plan *[See Exhibit 1, Tab 9]*, indicates that sufficient open space will be provided for each phase, but the applicant did not submit enough information in their submittal package to determine if the first phase and any subsequent phases will comply with the density standards independently.

The applicant submitted additional density analysis during the open record period (Exhibit 52). However, the examiner is unable to find that proposed Phase 1 will comply with the density standards independently. Based on the above density calculations, the minimum overall density is 186 units for the17.83 acre net developable area. This equates to a minimum density of 10.4 units per acre (186 units/17.83 acres = 10.4 units/acre). Exhibit 52 proposes a minimum density of 10.1 units/acre for Phase 1, which is insufficient to meet the minimum density requirement. All subsequent phases can meet minimum density requirements, based on Exhibit 52. But the Code requires that each phase meet density and other requirements. Therefore, the examiner denies the phasing plan. However, staff may grant approval for phasing if the applicant submits additional information or a modified phasing plan that demonstrates phasing plan density compliance prior to Final Construction Plan review, *(See Condition A-8.a)*.

Finding 3 – Planned Unit Development Standards

The intent of planned unit developments (PUD) is to allow flexibility in design and creative site planning, and in some cases density, while providing for the orderly development of the county that meets the comprehensive plan. Planned unit developments should allow for a mix of housing types, lot sizes, and uses.

CCC 40.520.080.A.

Pursuant to 40.520.080.B.1, planned unit developments are allowed in both the R-12 and OR-22 zones.

> Any use consistent with the zone districts designated for the parcel(s) within the proposed planned unit development boundary may be permitted in planned unit developments. The location of the uses in planned unit developments may vary from underlying zoning; provided that the total allowed uses (e.g., number of residential uses or area assigned to commercial use) was limited by the maximum allowed on each respectively zoned parcel.

CCC 40.520.080.B.2.

The applicant is using the PUD standards to blend the development across the split zoned site. Blending the uses across the development is allowed, provided that the overall development complies with the minimum and maximum density requirements The minimum density for this project is 186 units and the maximum density is 568 units. Because the applicant is proposing 200 units, the project complies with the density requirements allowed for the lots in each zone *(see also Land Use Finding 1 – Zoning Districts for further density details).*

Pursuant to 40.520.080.C.1:

> Zoning standards that may be varied without the need of a variance include, but are not limited to, lot standards, setbacks, landscaping, and parking. Design flexibility for transportation, stormwater, critical areas, and other nonland-use-related standards may be reviewed separately through other review processes such as a road modification or stormwater variance.

The applicant has proposed reducing the following zoning related minimum standards:

- Reducing the R-12 minimum lot area from 2,800 square feet to 2,320 square feet (this is an 18% variance to the standard); and
- Reducing the R-12 minimum lot width from 35 feet to 26 feet (this is a 26% variance to the standard),

The applicant justifies these requested reductions in the standard in their Applicant Response Letter to staff's Early Issues Memo *[See Exhibit 18]*, as modified at the hearing. In this letter the applicant states:

> *The requested modifications above seem significant because it assumes a modification of the R-12 standards and is a blanket request not tied to specific*

lots. In reality, these requested modifications are not applicable to a large number of lots within the subdivision,

...

Let's say that of the 200 proposed lots 107 are R-12 lots, and 93 are OR-22 lots that are blended in the overall development.

Of the 107 R-12 lots, 45 meet the base standard of the zone and have a minimum lot width and area of at least 35 feet and 2,800 square feet respectively. The remaining 62 R-12 lots meet the minimum lot area standards, but we are asking for an 8.6% modification to allow for a 32 foot wide lot. A modification of this scale can easily meet the approval criteria of a standard variance outside of the PUD process.

The 93 OR-22 lots meet all the required lot area and width standards of the zone. The only modification we are requesting for the OR-22 lots is a 25% reduction of the building separation standards for 25 of the lots. These lots are proposed as zero lot line homes and are limited to areas on the inside of the development or adjacent to existing multifamily development.

...

From our perspective the only modification that we are requesting that requires the PUD process for approval is the reduction of the building separation for 25 of the OR-22 lots. The 6 foot requested separation is standard for zero lot line developments in the City of Vancouver and will become more common in the county through the Compact lot development standards that allow the same separation. Most developments that are processed as a PUD request much more significant modifications than the applicant's proposal. It is not uncommon for developments to have a 50% reduction of the minimum lot size at the perimeter of the lot and up to a 66% lot size reduction on the interior of developments among other requests.

The applicant is providing an enhanced development with significant streetscape landscaping, street lighting, and usable open spaces. In return the applicant is requesting to blend the zoning designations, reduce building separation by 25% for 12.5% of the lots, and reduce lot width standards by 8.6% for 31% of the lots. We believe these minor modification requests meet the approval criteria for planned developments.

(Exhibit 18 at 1-5)

The examiner approves the proposed reductions in the R-12 minimum lot size and lot width. At the hearing the applicant withdrew their request to allow a reduction to the 8

foot building separation required for zero lot line developments. *(See Conditions A-8.b, A-8.c, D-5.b and E-4).*

Pursuant to 40.520.080.C.2:

> A PUD shall be located on a minimum site size of three (3) acres unless the responsible official finds that the site of the proposed use is adequate in size and shape to accommodate the proposed use and all setbacks, parking, loading, landscape/screening, and other features as required by this title.

This site exceeds the minimum three acre size limitation; therefore, the proposed development complies with this standard.

Pursuant to 40.520.080.C.3, "Maximum building height shall be that of the underlying zone; provided, that the maximum height may be exceeded if the minimum setback of the higher portion of the building is increased at a one-to-one (1:1) ratio (excess height in feet: extra setback in feet)." The applicant did not request any modifications to the height standards in the underlying zone; therefore, the building height will be controlled by the zone in which the majority of the lot lies *(See Condition E-5).*

All PUDs are required to provide a minimum of 12% of the net site area as open space for active or passive recreational purposes. These areas can include more active features such as jogging trails, child play equipment, open fields for pick-up games, game courts, swimming pools, club houses, picnic areas and pavilions. More passive recreation includes natural protected areas and open space with features like access trails, benches, interpretive signs and view corridors. All open space shall be conveyed to and permanently maintained by a home-owners association unless a public agency agrees to maintain the open space and any structures or improvements located within *(see Condition D-6.a).*

The net total area of the site is 33.12 acres; therefore, a minimum of 3.97 acres must be set aside as open space. The applicant indicates that they are providing 17.4 acres of passive and active open space, critical areas, and stormwater facilities which corresponds to 52% of the site. This significantly exceeds the minimum standard of open space.

Pursuant to 40.220.020.C.9, a minimum of twenty percent (20%) of the site shall be landscaped to an L1 standard as described in section 40.320.010. The applicant did not address how the proposal specifically meets this standard, but considering that approximately 14.5 acres of landscaping (37% of the site) will be subject to a conservation covenant over large portions of Tract A and K along the west portion of the site, the examiner finds that the project will meet this landscaping requirement though lands subject to critical areas protection.

In accordance with 40.520.080.C.5, all PUDs shall provide street trees on public and private roads, with one (1) street tree provided at an average of each twenty-four (24)

linear feet. Based on an examination of the narrow lot site plans it appears the proposal will meet this criterion. In order to comply with the PUD standards the applicant shall submit a landscape plan prior to Construction Plan Review that demonstrates a tree for every 24 feet. In the likely event the interval cannot be met due to miscellaneous infrastructure, the tree will still be required but placed as nearby as practical to the required spacing and are allowed to be grouped *(See Condition A-8.d).* Tree species shall be selected from the Clark County Standard Details Manual or specified by a certified landscape architect.

In accordance with 40.520.080.C.6, street lighting is required on all internal roadways. While the narrow lot site plans appear to show street lights throughout the development, a condition has been added to ensure compliance. An outdoor lighting plan in conformance with requirements put forth in 40.510.050-1(9)(c)((2))(n), shall be provided for staff review and approval that shows the areas of illumination for each outdoor light to ensure compliance with the PUD street lighting standard *(see Conditions A-8.e).*

In addition to the standards noted above, 40.520.080.D indicates that the Hearing Examiner shall find that the following three conditions exist:

1. The alternate design proposed will provide a plan equal or superior to the standard being varied;
2. Through lot size, setbacks, building orientation, and screening, the proposed PUD shall provide a gradual transition adjacent to lower density neighborhoods or nonresidential uses; and,
3. The applicant proposes design features that may include but are not limited to, design centered on protected natural areas, front porches/recessed garages, pedestrian-friendly orientation, benches/gazebos, water features, recreational areas, stormwater systems designed as features, and affordable housing.

The applicant's proposal to blend the development standards throughout the split zoned site (situate some of the OR-22 lots within the portion zoned R-12 which would result in a modification in minimum lot area in the R-12 zone), reduce lot width standards by 8.6% for 31% of the lots, and to reduce the minimum building separation by 25% for 12.5% of the lots while remaining in conformance with other PUD approval criteria will result in a plan equal or superior to the standards being varied. The examiner acknowledges that PUD standards can be somewhat subjective but accepts that the proposal provides a plan equal or superior to the standard being varied in large part because of the areas dedicated as open space, the associated amenities, and the pedestrian connections being proposed. Criterion 40.520.080.D.1 is met.

To address the gradual transition criterion, the applicant states:

> *We do not believe that any of the adjacent parcels qualify as a lower density neighborhood. There are two adjacent single-family homes that reside on 5-acre parcels. These homes and the other nearby homes were not created through a short plat or subdivision process, but likely were created through exempt land*

segregations on rural lands. There are also no distinguishing characteristics of the adjacent area that would set it apart as a specific neighborhood. The code specifically states the transition is required adjacent to lower density "neighborhoods", not lower density "properties". The adjacent properties are also zoned R-12 and will likely develop to a similar or higher density as the proposed project. Despite this, the site does contain a transition of lot sizes where the smallest lots are adjacent to the neighboring higher density apartment complex. Larger lots that all meet the minimum lot size requirements of the base zone are located adjacent to neighboring single family uses. The smallest lot adjacent to a neighboring R-12 zone is 2,880 square feet. The smallest internal lot is 2,340 square feet."

(Exhibit 18 at 2-3).

Without conceding the applicant's distinction that the rural properties in their singularity cannot comprise a neighborhood, the examiner finds that the proposed development provides a gradual transition. The critical areas along the west portion of this site form a transition between the site and adjacent development to the west. The parcel to the north is currently vacant and not subject to this standard. The existing multi-family development to the east of the site is not a lower density development; therefore, this shared border is exempt from this criterion. Additionally, staff have interpreted the gradual transition requirement to not require lot sizes in excess of what would normally be allowed by the underlying zoning; rather, the gradual transition should be one demonstrated by the lots in the center of the proposed development vs. the lots on the perimeter of the development next to lower density neighborhoods. As proposed, all lots on the perimeter of the development will meet the lot area standards of the underlying zoning. Lastly, the areas of the proposed development next to the larger single-family lots lying to the north and northeast of the site (that are not separated by the wetland and buffer at the northerly end of the gas pipeline easement), will be required to have a 5-foot wide L1 landscape buffer which provides a further transition. While no additional measures are required to meet the gradual transition standard, this does not mean that the minimum landscape buffer is not required in these sections *(see Land Use Finding 6 for more detail regarding the landscape buffers)*. The examiner finds that CCC 40.520.080.D.2 is met. A landscape plan showing the presence of the required landscape buffers shall be submitted for review and approval prior to final construction plan review. Landscape buffer are not required along protected critical areas that act as their own buffer *(See Condition A-8.g)*.

Lastly, the applicant addresses criterion 40.520.080.D.3 by stating:

The subdivision is designed to prioritize views of the open space for the general neighborhood. The view of the open space will be available from the main public road at the entrance of the site and will provide an attractive introduction to the new community. As stated previously, park amenities will be provided in a central location that will benefit the residential community.

(Exhibit 6 at 17)

Criterion 40.520.080.D.3 has been met.

Finding 4 – Narrow Lot Standards

The purpose of the Narrow Lot Standards is to guide development and alleviate conflicts that can arise from the platting of residential lots of less than forty (40) feet in width. Developments proposing more than twenty-five percent (25%) of residential lots with lot widths less than 40 feet are required to meet these standards, but they will only apply to lots in the land division less than 40 feet in width. Since every lot in the proposal is less than 40 feet in width, the narrow lot standards apply to all of them.

In accordance with Section 40.260.155(C), a final site plan is required to be submitted with the final land division application and incorporated into the final construction plans that incorporates items a - i *(See Conditions A-8.f and D-6.b).*

The examiner finds that the proposal can comply with the narrow lot standards, subject to the following:

a. Parking - CCC 40.220.155.C.3 requires 2.5 parking spaces for every narrow lot. With 182 proposed lots less than 40 feet in width, the applicant must provide a minimum of 61 parking spaces. The applicant's narrative and plan indicate that 67 parking spaces will be provided along the local access public streets, which exceeds the minimum standard. A condition has been added to identify at least 61 parking spaces on the Narrow Lot Site Plan to ensure compliance *(See Condition A-8.i).*

b. Street Trees - CCC 40.260.155.C.4 requires a minimum of one tree to be provided along the street frontage of each narrow lot or on the lot. The applicant's Narrow Lot plans demonstrate that the proposal will comply with this criterion. A condition has been added to identify the minimally required 1 street tree per lot on the Narrow Lot Site Plan to ensure compliance *(See Condition A-8.g).*

c. Solid Waste/Recycling - CCC 40.260.155.C.5 requires a designated common collection point where collection is not feasible on each lot. The applicant indicates that trash and recycling will be picked up from each individual lot via the existing streets and that collection locations are shown on the Narrow Lot plans for lots that are accessed by shared driveways. Staff have verified that the plan conforms with this criterion. The applicant should be required to install signs, pavement markings, or other demarcations to ensure that the common collection points accessed by shared driveways are accessible on collection days. *(See Condition E-7).*

d. Shared Driveways - The following shared driveway provisions apply only to narrow lots qualifying under this section:

1. Shared driveways may be used to provide access to a maximum of four (4) lots;

2. Shared driveway approaches for two (2) abutting lots sharing one (1) curb cut shall meet the specifications in Figure 40.260.155-4 or 40.260.155-5 and

3. Shared driveways which provide access to more than two (2) lots shall be at least twelve (12) feet wide and shall be within an easement at least twenty (20) feet wide.

The applicant has indicated that lots 78-79, 100-106, 171-172, 176-177, and 199-200 will utilize shared driveways. While the plan appears to comply with the shared driveway standards, a condition has been added to ensure compliance *(See Condition A-8.j).*

Finding 5 – Zero Lot Line Development Standards

The applicant's narrative indicates that 25 of the 200 homes are proposed with a zero foot side yard setback. The examiner finds that the proposal can comply with the zero lot line standards found in 40.260.260.C, subject to the following:

a. Site Plan Required – Preliminary plats proposing zero lot line provisions may not be approved without approval of a submitted site plan. Since a site plan is required anyway pursuant to the Narrow Lot Standards, this criterion will be met.

b. Zero Setbacks – Zero setbacks may only be applied to a side or rear property line provided that the setback on the lot abutting a zero setback line shall be at least eight (8) feet *(See Condition A-8.k).*

c. Plat Note - A note shall be placed on the final plat, and covenants running with the land shall be approved by the Prosecuting Attorney and recorded with the County Auditor to guarantee that the required setbacks are kept perpetually free of structures *(See Conditions D-5.c and D-4.a).*

d. Maintenance Easements - Easements for such purposes as maintenance or for building projection encroachments beyond a zero setback line, shall be shown on the plat *(See Condition D-6.c).*

Finding 6 – Landscape Standards

Pursuant to Table 40.320.010-1, basic landscape buffers are required for the development's perimeter apart from what is being proposed to meet the gradual transition requirement of PUD's. Beginning at the NE corner and moving counter-clockwise, the landscaping code (or PUD standards) require the following minimum type and width of buffers to be installed along the perimeter of the site:

- Along the northernmost property line – Lots 52-41: L1 – 5 foot wide.

The applicant's landscape plan complies with this standard.

- Along the west property lines of Lots 41-1: L3 – 10 foot wide.

Tracts A and K separate the western boundary of this development from the lots and streets and both tracts contain critical Habitat and Wetlands. Pursuant to 40.320.010.C.3, the responsible official may approve use of existing vegetation to fulfill landscaping and screening requirements of this section if that existing landscaping provides at least an equivalent level of screening as the standard required for the development in question. The examiner finds that these protected critical areas exceed the screening that the L3 ten-foot wide buffer would provide; making this landscape buffer unnecessary.

- Along the south property line abutting NE 179th Street: L2 – 10 foot wide.

The only portion of this development that will abut NE 179th Street will be the intersection of NE 18th Avenue. The remainder of the site frontage abutting NE 179th Street will be retained as open space in proposed Tract A. No homes or building lots are proposed that should be screened from view; therefore, no landscape buffer is required for this project in this location. In addition, NE 179th Street is on the Capital Project List for Clark County and will undergo extensive reconstruction in the near future. Once the street is reconstructed, either right-of-way plantings will be installed that will further screen views or the road will be elevated to extent that will make landscape screening unnecessary. The examiner finds that onsite landscape screening is not required along NE 179th Street.

- Along the east sides of lots 99-93 and 100-106: L1 – 5 foot wide.

While no buffer is required pursuant to Table 40.320.010-1, an L1 5 foot wide buffer is proposed by the applicant which helps the project meet the goal of providing a gradual transition to lower density neighborhoods. The examiner agrees that this buffer should be installed.

- Along the west frontage of NE 19th Avenue along Lots 107-118: No buffer is shown on the Narrow Lot site plan.

While Table 40.320.010-1 requires an L2 10 foot wide buffer, the examiner agrees that a buffer is unnecessary in this instance given the horizontal separation caused by extending the width of the street, the front setbacks to the proposed homes for this project from the neighboring multifamily development, and the PUD requirement for street trees on each lot.

- Along the south side of Lots 182-192: L1 5 foot wide.

The applicant's landscape plan complies with the minimum standard.

- Along the east sides of Lots 192-200: L1 5 foot wide.

The applicant's landscape plan complies with the minimum standard. No landscape buffers are proposed north of lot 200. The examiner finds, pursuant to 40.320.010.C.3, that the existing landscaping within the open space tract (Tract C) provides a greater degree of separation and natural vegetation between the proposed development and other existing uses to the east.

- Along the north side of Lots 178-181: L1 – five-foot wide.

The applicant's landscape plan complies with the minimum standard and helps to further a gradual transition as required under the PUD standards.

- Along the east side of Lots 151-148 and 52: L1 – five-foot wide.

The applicant's landscape plan complies with the minimum standard and helps to further a gradual transition as required under the PUD standards.

The applicant is required to submit a landscape plan prior to Final Construction Plan Review approval that matches the preliminary Narrow Lot Plan and the buffer requirements discussed above *(See Condition A-8.h)*.

Maintenance of landscaped areas is the ongoing responsibility of the property owner. Required landscaping must be continuously maintained in a healthy manner. Plants that die must be replaced with in-kind materials unless otherwise authorized by the responsible official. Vegetation shall be controlled by pruning, trimming or otherwise so that it will not interfere with the maintenance or repair of any public utility, restrict pedestrian or vehicular access, or obstruct sight distance at intersections as provided in Section 40.320.020 *(See Condition H-2)*.

Finding 7 - Pedestrian Facilities

Pursuant to 40.340.020.A.1, Access and Circulation Standards apply to all new developments that include bicycle or pedestrian circulation. While this subdivision includes sidewalks along all roads within the site, including a walking trail as an amenity, the plan does not include a pedestrian connection from NE 179th Street to the sidewalks proposed within the development. Pursuant to 40.340.020.A.3.c, "The developer shall extend pedestrian circulation routes to sidewalks and transit stops along streets abutting the site, to pedestrian facilities that extend to the edge of the site from off-site, and to the edge of the site in the direction of existing, approved or proposed off-site pedestrian and transit facilities." Additionally, pursuant to 40.340.020.A.3.f, "Where a pedestrian or bicycle route is parallel and adjoining an auto travel lane, the pedestrian or bicycle route must be safely separated from the auto travel lane by using a raised path, a raised curb, bollards, landscaping or other physical barrier." The south portion of NE 18th Street may be reconstructed in order to connect to the new construction of NE 179th Street. However, in order to ensure interim safe pedestrian access to NE 179th Street until the reconstruction of NE 179th Street occurs, the applicant shall install a pedestrian connection that connects the development's sidewalks to the right-of-way of NE 179th

Street. This connection shall comply with the standards of Pedestrian Circulation found in 40.340.020.A.3 and shall be shown on the final plat *(See Conditions A-8.l and D-6.d).*

Additionally, according to state platting laws (RCW 58.17.110) appropriate provisions shall be made to assure safe walking conditions for students who only walk to and from school unless they are a mile away from any facilities. The subject development is located within the Ridgefield School District, and specifically within the boundaries of South Ridge Elementary, View Ridge Middle, and Battle Ground High Schools. However, because all of these public schools are over a mile from this site, the applicant is exempt from assuring safe walking conditions to and from each school as the students will be bussed by the district.

Finding 8 Potential Encroachment

A boundary survey for the site identifies a potential fence encroachment along the northeast line of tax lot 36 (PIN: 181218-000). Based on information submitted with the application packet, it is unclear whether ownership of the area is under dispute. This situation needs to be resolved prior to filing of the final plat *(See Condition D-1).* It should be noted there are three possible ways to resolve the issue arising from the fence encroachment. These include:

a. The owner of the property being platted may deed the area beyond the fence to the neighboring property owner through a boundary line adjustment/quit claim deed.
b. Record a document signed by the other property owners stating that they recognize that it is not their property and will not attempt to take that property through an adverse possession claim.
c. If the neighbor will not accept a quit claim and will not sign an agreement to relinquish any claim, the final plat may show the gross area (to the deed line) and show the net area (to the fence or other encroached area) with the provision that the net area will meet minimum lot size and dimensions in the event of loss of the disputed area. A plat alteration process could still be required if platted property is lost.

Finding 9 - County State Platting Standards

As conditioned, the proposed subdivision will make appropriate provisions for the public health, safety and general welfare of the community. Connection to public water and sewer facilities, as well as treatment of any future stormwater runoff will be provided to protect groundwater supply and integrity. Impact fees will also be required to ensure that the development will contribute a proportionate share toward the costs of school, park and transportation facilities, maintenance and services.

Finding 10 - Tree Removal

The examiner acknowledges that the existing mature trees on this site served to buffer adjacent properties from strong winds. Clearing on this site eliminated that buffer effect, apparently exposing trees on adjacent properties to greater wind impacts and increasing the possibility that trees will be blown down during storms. However, the applicant has

no duty to retain trees on site in order to protect offsite trees from wind impacts and the Code does not require consideration of such potential impacts. The site is zoned for residential development. Removal of trees on the site is necessary to develop the site consistent with the current zoning. The examiner finds that, although clearing on this site may increase the potential for blowdown, the risk is not relevant to the applicable approval criteria.

Finding 11 – Boundary Fence

Mr. Barritt argued that the applicant should be required to install and maintain fencing or a similar barrier to separate the proposed development from his property northeast of the site. As discussed below, the applicant is required to install some form of permanent physical demarcation along the upland boundary of the wetland buffer and habitat areas, including the on-site portion of the wetland buffer between the site and Mr. Barritt's property. The applicant is also required to install signs on the upland boundary noting the presence of the wetland buffer and the requirement that it be retained in a natural state. The examiner has no authority to require additional text on the sign regarding adjacent private property.

There is no basis for concluding residents of the proposed subdivision will pose a hazard to the use of abutting properties or will be reasonably likely to trespass on abutting properties. The proposed walking path will terminate at the demarcated upland boundary of the wetland buffer, well short of the site boundaries. In addition, the walking path connects to the public sidewalk at the terminus of NE 20th Way, allowing pedestrians to loop back through the development on the public sidewalks. The owners of abutting properties have adequate legal (civil) recourse to address any trespass problems that may arise and they are free to install additional signage on their own properties.

Conclusion (Land Use)

The examiner concludes that the proposed preliminary plan, subject to conditions identified above, meets land use requirements of the Clark County Code.

Archaeology

Finding 1 - Applicability

The development site is located within moderate to moderate-high to high probability areas for the discovery of archaeological resources, as designated on the Archaeological Predictive Model Map of the Clark County. Also, because a SEPA was triggered, an Archaeological Predetermination was required.

Finding 2 - Pre-determination

The applicant has submitted an archaeological pre-determination to the Washington State Department of Archaeology and Historic Preservation (DAHP) prior to submittal of the application. DAHP was mailed the public notice along with a copy of the SEPA checklist and has not provided comment. However, The Cowlitz Indian Tribe provided comment indicating that the project lies within the Tribe's area of concern, and they requested that an Inadvertent Discovery Plan to be attached to the proposal *[See Exhibit 14].* In response to this request, county staff have required a note to be required on the final

construction plans and final plat that if resources are discovered during ground disturbance, work shall stop and both DAHP, The Cowlitz Indian Tribe, and the county shall be notified *(See Conditions A-7 and D-5.a).*

Conclusion (Archaeology)
The examiner finds that the proposed preliminary plan, subject to the condition identified above, meets archaeology requirements of the Clark County Code.

Transportation & Circulation
Finding 1 – Pedestrian/Bicycle Circulation Plan
Pedestrian circulation facilities in compliance with the Americans with Disabilities Act (ADA) and CCC 40.350.015 are required for this development. As conditioned, the proposal includes detached sidewalks on all internal roads. The applicant has submitted a road modification request for partial relief of street improvements for a portion of NE 18th Avenue and is proposing to defer frontage improvements with the construction of the future NE 179th Street improvements with the proposed capital improvement project (CRP #320122) *(See Condition A-1.a and Transportation Finding 7 – Major Road Modification: Request 4).*

Per the WSDOT design manual as adopted under CCC 40.350.030(C)(1)(b)(1) new construction projects shall provide curb ramps oriented in each direction of pedestrian travel within the width of the crosswalk it serves, and if receiving ramps do not exist, they shall be constructed as part of the new development. The applicant will need to show on final construction plans that pedestrian ramps will comply with the WSDOT Design Manual *(See Condition A-1.b).*

Finding 2 – Road Circulation Plan
Cross-circulation is required by CCC 40.350.030(B)(2). The proposal includes roadway improvements that are stubbed to the plat boundaries to the north, east and south that will meet block length and block perimeter in those directions. The applicant has submitted a major road modification request for relief from cross circulation standards to the west *(See Transportation Finding 7 – Major Road Modification, Request 3).*

Finding 3 – Roads
Road improvements and design are required to comply with CCC 40.350.030, CCC Table 40.350.030-2 and CCC Table 40.350.030-3.

NE 179th Street is classified as a 4-lane Principal Arterial with Center Left Turn and Bike Lanes, Pr-4cb. The required half-width improvements in compliance with Standard Detail Drawing 2, are: 50-foot right-of-way width, 36-foot paved roadway width, curb & gutter, and 5-foot detached sidewalk. This road is scheduled to be improved as part of the 2025-2030 six-year Clark County Transportation Improvement Program (TIP). In the event that required frontage road improvements are included as a portion of a county road project on the county's TIP scheduled to be undertaken within six (6) years, the developer, in lieu of constructing or guaranteeing the construction pursuant to Section 40.350.030(C)(4)(i) of such frontage improvements, may be permitted to contribute a

proportionate share towards the cost of such county road project by an agreement consistent with the requirements of RCW 82.02.020.

The applicant shall coordinate design and construction of improvements on NE 179th Street with the Clark County Public Works Department. The applicant is responsible for constructing the planned improvements in advance of the county capital improvement project (CRP #320122) unless the applicant and Clark County Public Works execute a deferral agreement in accordance with procedures of CCC 40.350.030(B)(5)(c) *(See Conditions A-1.c, A-1.d, A-1.e and D-2.a).*

NE 183rd Street and 19th Avenue are classified as Urban Neighborhood Circulators per the Arterial Atlas, and the applicant is proposing NE 18th Avenue to be an Urban Neighborhood Circulator. Full-width improvements are required per Standard Detail Drawing #12 and consist of 54 feet of right-of-way, 36 feet of roadway width, curb & gutter, and 5-foot sidewalks. The proposal includes a road modification request to construct NE 19th Avenue as an Urban Local Access (Standard Detail Drawing #13 and consist of 46 feet of right-of-way, 28 feet of roadway width, curb & gutter, and 5-foot sidewalks), with NE 18th Avenue providing the required Urban Neighborhood Circulator *(See Finding 7 – Technical Road Modification: Request 6).* The proposal includes a road modification request for partial width improvements to NE 18th Avenue from the intersection with NE 179th Street to approximately 200 feet north of the intersection *(See Finding 7 – Technical Road Modification: Request 4).* The proposal includes a request to construct a portion of NE 18th Avenue with a shed section *(See Finding 7 – Technical Road Modification: Request 7).* The proposal also includes full width improvements for NE 183rd Street and NE 18th Avenue consistent with Drawing 12 *(See Conditions A-1.f and D-2.b).*

NE 184th Street, NE 185th Street, NE 186th Street, NE 187th Street, and NE 20th Way are classified as Urban Local Access roads. Full-width improvements are required per Standard Detail Drawing #13 and consist of 46 feet of right-of-way, 28 feet of roadway width, curb & gutter, and 5-foot sidewalks. The proposal includes full width improvements consistent with Drawing #13 for the internal roads. NE 20th Way and NE 186th Street will end in Urban Cul-de-sacs that comply with Drawing #23 *(See Conditions A-1.g, A-1.h, D-2.c, and D-2.d).*

Parking is prohibited on any road less than 24 feet wide. Signing and Striping plans shall include appropriate measures on partial width roads and roads stubbed to the plat boundary. The applicant shall propose "No Parking" signs along both sides of the entire length of partial-width roads less than 24 feet in width *(See Conditions A-1.i, A-1.j, and A-1.k).*

Finding 4 – Access Management

NE 18th Avenue is the only outlet for this development and the neighboring development, because this development connects to the isolated public roads NE 183rd Street and NE 19th Avenue constructed with 179th Street Apartments West [PSR-2020-00098]. NE 18th Avenue is a Neighborhood Circulator and access management is under CCC

40.350.030.B.4.b(4) Maximum Dwelling Units Served by Access Roads. This development adds 200 lots, and the apartments will add 159 units, therefore, a second public access road to NE 179th Street or a different feeder road is required. The applicant has submitted a road modification request to utilize the adjacent apartments driveway access onto NE 179th Street as an emergency only access *(See Finding 7 – Technical Road Modification: Request 1).*

Full movement intersection spacing for roadways intersecting with a Principal Arterial is 600 feet. The proposed intersection of NE 179th Street/NE 18th Avenue is proposed as a full movement intersection, but it does not meet intersection spacing on NE 179th Street. The applicant has submitted a road modification request for relief from this standard *(See Finding 7 – Technical Road Modification: Request 8).*

Per CCC 40.350.030(B)(4)(b)(1)(a), excepting the bulbs of cul-de-sacs, driveways serving single-family residential lots shall be located a minimum of 5 feet from an interior side property line or zero feet as a shared driveway approach. The applicant has submitted a road modification request for relief from the 5 foot property line setback for the majority of driveways within the development *(See Finding 7 – Technical Road Modification: Request 5).*

The applicant's proposal includes shared driveways serving Lots 100-102, Lots 103-106, Lots 176-177 and Lots 199-200. Shared driveways can serve no more than 4 lots and must be a minimum of 12-feet wide and placed in a minimum of 20-foot wide easement *(See Conditions A-1.l and D-2.e).*

Per CCC 40.350.030(B)(4)(b)(1)(b), corner lot driveways (on local access roads) shall be a minimum of 40 feet from the projected curb line or edge of pavement, as measured to the nearest edge of the driveway, or in cases where lots less than 40 feet wide are allowed driveways shall be limited to 20 feet in width and located 5 feet from the property line farthest from the intersection. There are multiple corner lots within this subdivision and they are proposed to have a 20-foot wide driveway, 5 feet from the property line farthest from the intersection *(See Condition A-1.m).*

Finding 5 – Sight Distance

The approval criteria for sight distances are found in CCC 40.350.030(B)(8). This section establishes minimum sight distances at intersections and driveways. Additional building setbacks may be required for corner lots in order to maintain adequate sight distance. The final engineering plans shall show sight distance triangles for driveways that are proposed to remain. Landscaping, trees, utility poles, and miscellaneous structures will not be allowed to impede required sight distance requirements at all proposed driveway approaches and intersections.

The applicant has submitted a traffic study *[Exhibit 1, Tab 14]* prepared by Lancaster Mobley, dated June 24, 2025. This traffic study has reported that the proposed new intersection of NE 179th Street/NE 18th Avenue will meet intersection and stopping sight distance requirements for a posted speed of 40 mph.

The applicant will need to submit final construction drawings for review and approval. These plans will need to show sight distance triangles at the intersection of NE 179th Street/NE 18th Avenue and all new internal intersections. The plans will also need to show objects that are within the sight distance triangle. Notes on the plans shall indicate the vegetation within the sight distance triangle that needs to be maintained, trimmed, or removed (*See Conditions A-1.n, C-1.a and D-3).*

Finding 6 – Transportation Phasing

The applicant has proposed to develop the site in 4 phases. The applicant is responsible for providing all necessary transportation improvements required for each individual phase. The required transportation improvements for each proposed phase will be reviewed during final engineering review *(See Condition A-1.k).*

Finding 7 – Major Road Modification

Applicant's Discussion:

The applicant has submitted a major road modification narrative *[Exhibit 25]* prepared by PLS Engineering, dated October 20, 2025, providing justification for the following requests:

1. Partial relief from providing a secondary public access road for more than 200 lots/dwelling units.
2. Temporary relief to allow a private road to connect 2 public roads.
3. Relief from cross-circulation to the west.
4. Relief from frontage improvements on NE 179th Street and NE 18th Avenue.
5. Modification to driveway spacing on all lots from 5 feet to 4 feet for interior property lines.
6. Alteration to the Arterial Atlas to shift the Neighborhood Circulator from NE 19th Avenue to NE 18th Avenue.
7. Modify the cross section of NE 18th Avenue to a shed section through the intersections of NE 183rd Street and NE 185th Street.
8. Full Access Intersection Spacing.

Staff's Evaluation and Recommendation:

Staff recommends **Approval** for road modification requests #1, 3-6 and 8, and **Denial** of road modification request #7, subject to conditions.

The 2nd request is for relief from private road standards for a private drive aisle. Given that the private road standards do not apply to the drive aisle this request is neither approved nor denied.

The Development Engineer Division Manager has concurred with the staff's recommendations *[See Exhibit 35] and (See Conditions A-1.p - A-1.t, C-1.b and D-2.f).*

The examiner agrees with Staff's findings above. However, the examiner finds that proposed condition A-1.r, prohibiting the applicant from connecting to the existing stub of NE 183rd Street east of the site, is inappropriate.

County Land Use Decision PSR-2020-00098 approved the apartment development east of the site, including stubbing NE 183rd Street to the west boundary of the site. Condition A-1.f of that decision provides "The access to NE 179th Street is temporary and that when the interior road network is open and available for access, the NE 179th Street access location shall be restricted to emergency access only."

Proposed condition A-1.r precludes the apartment development from complying with Condition A-1.f of PSR-2020-00098, as condition A-1.r prohibits the Three Creeks East development from connecting to NE 183rd Street until the apartment access to NE 179th Street is closed and the apartment development cannot close its access to NE 179th Street until there is a connection to NE 183rd Street. These contradictory conditions of approval will preclude or significantly delay the planned connection of NE 183rd Street between the apartment development and the site until alternative access is available to the north or east.

In addition, proposed condition A-1.r improperly imposes on the applicant the duty to enforce Condition A-1.f of PSR-2020-00098. The applicant has no ability to require the apartment developer to close their access to 179th Street. The County does have that authority through its enforcement process once the Three Creeks East development provides a connection to the apartment development via NE 183rd Street.

Therefore, the examiner finds that proposed condition A-1.r should be deleted.

Conclusion (Transportation & Circulation)
The examiner concludes that the proposed preliminary transportation plan, subject to the conditions identified above, meet the transportation requirements of the Clark County Code.

Stormwater
Finding 1 - Stormwater Applicability
The provisions of Clark County Code Chapter 40.386, as amended by Ordinance No. 2021-06-02, shall apply to all new development, redevelopment, land disturbing activities and drainage projects consistent with the Clark County's NPDES Phase 1 Municipal Stormwater Permit and Clark County Stormwater Manual (2021). The project adds more than 5,000 square feet of new hard surface; therefore, the applicant shall comply with Minimum Requirements (MR) 1 through 9 *(See Condition A-3.a).*

No new development shall be allowed to materially increase or concentrate stormwater runoff onto an adjacent property or block existing drainage from adjacent lots (*See Condition A-3.b).* The applicant will grade the site to direct stormwater runoff towards collection facilities and away from adjacent properties. Stormwater facilities created by this development will collect stormwater runoff from all new impervious surfaces on the

site and direct it to the proposed detention facilities for treatment and detention. The applicant will discharge treated stormwater towards Whipple Creek west of the site at less than predevelopment rates. Clearing on the site will eliminate stormwater absorption provided by the existing trees, which will further increase the volume of runoff from the site. However, the applicant is required to release detained stormwater at or below the runoff rate for the historic forested condition of the site, so clearing and development on the site will not increase the rate of stormwater runoff.

Finding 2 – Stormwater Proposal

The applicant provided a revised Preliminary Technical Information Report *[Exhibit 27]* prepared by PLS Engineering, dated September 30, 2025. Proposed site improvements include 200 single family residential lots, public roads and associated improvements. This will result in 14.8 acres of proposed new hard surface.

On-site Stormwater Management (MR#5) will be addressed by using the first BMP deemed to be feasible per the order of List #2. Due to poor infiltration rates and limited space for dispersion on the new lots all BMPs were determined to be infeasible for the proposed hard surfaces per MR #5.

Runoff Treatment (MR#6) will be addressed with proprietary treatment catch basins to address all pollution generating hard surfaces. The treatment catch basins will be sized to meet the Basic Treatment requirement (*See Conditions A-3.c and A-3.d).*

Flow Control (MR#7) will be addressed with Detention Ponds (BMP D6.10) that will be sized to detain and release flows at pre-developed rates per the Standard Flow Control Requirement (*See Condition A-3.e).*

Wetlands Protection (MR#8) is triggered as the site discharges to an off-site Category I wetland. The applicant will be providing treatment prior to the discharge to the wetland and has provided modeling demonstrating compliance with Hydroperiod Protection Method 2 (*See Condition A-3.f).*

The stormwater facilities located within the public right-of-way and public tracts shall be owned and maintained by the county. Stormwater facilities located on individual lots or private tracts shall be owned and maintained by the homeowners *(See Conditions A-3.g, A-3.h, D-2.d, E-2, D-2.f and D-2.g).*

Final construction plans shall show that all setbacks are met for proposed stormwater facilities. The project is not exempt from MR #8; therefore, the applicant shall submit an off-site analysis with final engineering *(See Conditions A-3.i and A-3.j).*

Finding 3 – Stormwater Phasing

The applicant has proposed to develop the site in 4 phases. The applicant is responsible for providing all necessary stormwater mitigation improvements required for each individual phase. The required stormwater mitigation improvements for each proposed phase will be reviewed during final engineering review *(See Condition A-3.k).*

Conclusion (Stormwater)
The examiner concludes that the proposed preliminary stormwater plan, subject to the conditions above, is feasible. Therefore, the requirements of the preliminary plan review criteria are satisfied.

Flood Hazard Areas
Finding 1 – Applicability
Clark County GIS indicates that portions of the site are located in a regulated special flood hazard area (SFHA). All development activities with mapped SFHA on parcels part of a development shall comply with the provisions of CCC 40.420.

Finding 2 – Flood Hazard Assessment
The applicant provided a narrative *[Exhibit 1, Tab 6]* prepared by PLS Engineering, dated June 2025. Staff used FEMA FIRM Panel number {53011C0219D}, Clark County GIS data, and the submitted narrative and plan to confirm the location of the project and its position within the SFHA of the Whipple Creek.

Per the narrative, all development activities will be outside of the mapped SFHA of Whipple Creek. Therefore, the project will not place fill or construct any structures within a designated flood hazard area and will result in neither any increase to the base flood elevation nor any adverse downstream impacts. The applicant has demonstrated that all regulated development activity is outside the SFHA *(See Conditions A-10 and G-5)*.

Conclusion (Flood Hazard Areas)
Based upon the development site characteristics, the proposed site plan and FIRM, the examiner finds that the requirements of the County's flood hazard area ordinance have been satisfied, and flood hazard permit is not required.

Transportation Concurrency
Finding 1 - Trip Generation
County concurrency staff has reviewed the proposed Three Creeks East Traffic Impact Study dated June 24, 2025, prepared by Lancaster Mobley. The traffic study submitted indicates that the proposed development will divide 39.34 acres into 200 single-family detached houses. The applicant's traffic study has estimated the net new a.m. peak hour trip generation at 139 trips, p.m. peak-hour trip generation at 187 trips, and an average daily trip generation (ADT) of 1,876 trips. The trip generation was estimated using the nationally accepted data published by the *Institute of Transportation Engineers 11th Edition*. Concurrency staff determined that the applicant has submitted a traffic study under the provisions of Clark County Code section 40.350.020 (D)(1).

Finding 2 - Site Access
Traffic conditions are usually expressed using a scale that quantifies the ability of a facility to meet the needs and expectations of the driver. This scale is graded from A to F and is referred to as level-of-service (LOS). A driver who experiences a LOS A condition

would expect little delay. A driver who experiences a LOS E condition would expect significant delay, but the traffic facility would be just within its capacity to serve the needs of the driver. A driver who experiences a LOS F condition would expect significant delay with traffic demand exceeding the capacity of the facility with the result being growing queues of traffic.

Congestion, or concurrency, level of service (LOS) standards are not applicable to accesses that are not regionally significant; however, the LOS analysis provides information on the potential congestion and safety problems that may occur in the vicinity of the site.

The applicant's plan shows that a full-movement public neighborhood circulator road will be constructed to intersect NE 179th Street at the western property line. This proposed neighborhood circulator will serve as a primary public road access to the subject site.

The applicant's plan also shows an interior public local residential access road network will be constructed to serve as the primary public road access for the proposed lots within the development.

The applicant's study evaluated the level of service and found that the proposed new full-movement public road intersection with NE 179th Street will have an estimated LOS D or better in the 2028 build-out horizon. The study also shows that the LOS was evaluated during the a.m. and p.m. peak hour traffic conditions. County Staff concurs with the traffic study findings.

Finding 3 – Clark County Concurrency
The proposed development is required to meet the standards established in CCC 40.350.020(G) for corridors and intersections of regional significance within 2 miles of the proposed development.

Signalized Intersections:
Staff evaluated the operating levels and delay times for the regionally significant signalized intersections under Clark County jurisdiction. This analysis showed that individual movements during peak hour traffic conditions had approach delays that did not exceed the maximum 240 seconds, or 2 cycles, of delay in the build-out year.

Therefore, County Staff has determined that this development will comply with adopted Concurrency standards for signalized intersections.

Unsignalized Intersections:
Staff evaluated the operating levels and delay times for the regionally significant unsignalized intersections under Clark County jurisdiction. This analysis showed operating levels and standard delay times with a LOS better than the minimum allowable LOS E except for NE 179th Street/NE 50th Avenue and NE 179th Street/NE Delfel Road (North T-Intersection) in the PM peak hour.

NE 179th Street/NE 50th Avenue
The applicant's traffic study has analyzed the impacts of the proposed development on the intersection approaches at NE 179th Street/NE 50th Avenue. Staff used this information to determine if mitigation requirements would be warranted per CCC 40.350.020 (G)(1)(c), which states:

> *All unsignalized intersections of regional significance in the unincorporated county shall achieve LOS E standards or better (if warrants are not met). If warrants are met, unsignalized intersections of regional significance shall achieve LOS D standards or better. Intersection control or mitigation of unsignalized intersections shall be at the discretion of the Public Works Director and shall not obligate the county to meet this LOS standard. However, proposed developments shall not be required to mitigate their impacts in order to obtain a concurrency approval unless:*
>
> *(1) The proposed development adds at least five (5) peak period trips to a failing intersection approach; and*
>
> *(2) The worst movement on the failing approach is worsened by the proposed development. In determining whether the movement is worsened, the Public Works Director shall consider trip volume, delay, and any other relevant factors.*

Staff compared the anticipated impacts against the criteria in the code section listed above and found that none of the criterion was met. Because the criteria were not met, no mitigation is required at the intersection of NE 179th Street/NE 50th Avenue.

NE 179th Street/NE Delfel Road
The intersection NE 179th Street/NE Delfel Road is on the Clark County 6-year Transportation Improvement Program and considered reasonably funded. The improvements to the NE 179th Street/NE Delfel Road intersection will include: re-alignment of the existing north leg of the NE Delfel Road/NE 179th Street intersection approximately 500 feet west of the existing intersection, realigning the south leg of the intersection to match the Delfel Road north re-alignment, and replacing the existing traffic signal with a multi-lane roundabout.

Therefore, per Clark County Code (CCC) 40.350.020 (F)(6), the scheduled improvements can be considered in place and operational related to this project.

The County has determined that this development can comply with adopted Concurrency Standards for unsignalized intersections.

Concurrency Corridors:

Evaluation of the concurrency corridor capacity levels represented in the County Code yielded capacity at acceptable levels except for the NE 179th Street road segment between NE Delfel Road and Interstate 5; between Interstate 5 and NE 15th Avenue, the NE 10th Avenue road segment between NE 189th Street and NE 179th Street, between NE 199th Street to NE 194th Street; the NE 15th Avenue road segment between NE 179th Street and NE 174th Street; the NE 139th Street road segment between NE 20th Avenue and NE 23rd Avenue; and the NE Delfel Road segment between NE 189th Street and NE 179th Street in the buildout year.

The traffic study indicates that the above corridors will have a volume to capacity (v/c) ratio of greater than 0.9 in the 2028 buildout horizon.

Staff investigated the operations of these corridors to determine if mitigation measures were warranted.

Staff reviewed the LOS and volumes reported at the NE 179th Street intersections used in the corridor evaluation and found that, in the 2028 buildout horizon, the signalized intersections at the Interstate 5 Northbound and Southbound ramps had approach delays that did not exceed the maximum delay. Staff also evaluated the signalized intersections at NE 179th Street/NE 15th Avenue and NE 139th Street/NE 20th Avenue and found the approach delays did not exceed the maximum delay in the AM or PM peak hours. Staff has determined that these intersections will comply with the adopted Concurrency standards for signalized intersections.

Since the signalized and unsignalized intersections bounding the analyzed corridor segments are anticipated to operate at levels that meet or exceed concurrency standards in the buildout horizon, staff believes that the reported v/c ratio over the NE 179th Street, NE 10th Avenue, NE Delfel Road, NE 139th Street, and NE 15th Avenue corridors does not represent roadway deficiencies, rather corridor mobility facilitated with good intersection LOS. Therefore, staff concludes that no further analysis or mitigation is required with this development.

It should be noted that the reported v/c in the applicant's traffic study ought to be used as an indicator that these roadway segments should be subjected to site-specific study with a more detailed operational analysis before any major design, reconstruction, or investment decisions are made.

Summary:
The County has determined that this development can comply with adopted Concurrency Standards for corridors, signalized and unsignalized intersections under County jurisdiction.

SAFETY:
Where applicable, a traffic study shall address the following safety issues:

- traffic signal warrant analysis,
- turn lane warrant analysis,

- crash history analysis,
- roadside safety (clear zone) evaluation,
- vehicle turning movements, and
- any other issues associated with highway safety.

Mitigation for off-site safety deficiencies may only be a condition of approval on development in accordance with CCC 40.350.030(B)(6) The code states that "nothing in this section shall be construed to preclude denial of a proposed development where off-site road conditions are inadequate to provide a minimum level of service as specified in Section 40.350.020 or a *significant* traffic or safety hazard *would be caused or materially aggravated* by the proposed development; provided, that the applicant may voluntarily agree to mitigate such direct impacts in accordance with the provisions of RCW 82.02.020."

Finding 4 – Median and Channelization Policy

Medians and channelization are methods, or countermeasures, to promote safety and mobility. In order for the applicant to show that their development will not hinder mobility and add to a current safety issue there must be technical information, discussion and analysis provided by the applicant so that the County Engineer can make their determination. The technical information and evaluation necessary is outlined within the Median and Channelization Policy, CCC 40.350.030(B)(4)(d)(3).

The traffic engineering consultant for the Three Creeks East subdivision has submitted a Transportation Impact Study dated June 24, 2025, as well as a Technical Road Modification for Relief from the Median and Channelization Policy to provide the county analysis, discussion and justification for County Engineer consideration in compliance with CCC 40.350.030(B)(4)(d)(3).

Staff reviewed the regional significance of the new proposed intersection of NE 179th Street/NE 18th Avenue. Staff found that the only regionally significant classified road in the County's Arterial Atlas is NE 179th Street. NE 179th Street is classified as a Principal Arterial (Pr-4cb). NE 179th Street is regulated by the County's Concurrency Ordinance/Code (CCC 40.350.020). Because the proposed NE 18th Avenue is not identified in the County's Arterial Atlas as a full-movement access intersection with NE 179th Street, the Median and Channelization Policy applies.

Currently, NE 179th Street has no raised medians from NE Delfel Road to NE 50th Avenue with numerous private driveways that provide residential access to the principal arterial. Additionally, the applicant reported on the current and build out capacity of NE 179th Street between NE 15th Avenue and NE 29th Avenue and found that it will continue to operate well below the required volume/capacity threshold after buildout is completed.

Staff's review of the applicant's Median and Channelization Policy information and discussion yielded the following findings of fact:

- The new public road intersection of NE 179th Street/NE 18th Avenue is not considered regionally significant and is not regulated by the County's Concurrency Code
- Crash history along the NE 179th Street frontage is not indicative of a safety issue.
- NE 179th Street corridor capacity between NE 15th Avenue and NE 29th Avenue is at acceptable levels.
- NE 179th Street between NE 15th Avenue and NE 26th Avenue is on the 6-year TIP which plans to raise the elevation of NE 179th Street and construct a raised median along the center of NE 179th Street.

Based on the information above, staff supports a full-movement intersection at the proposed new NE 18th Avenue/ NE 179th Street intersection as an interim condition until the county's planned capital improvement project is constructed.

The applicant shall note that access to the development will be limited to right/in right/out with the future roadway improvements that will take place between NE 15th Avenue and NE 26th Avenue on NE 179th Street *(See Condition G-6).*

Finding 5 – Turn Lane Warrants

Turn lane warrants are evaluated at unsignalized intersections to determine if turn lanes are needed on the uncontrolled roadway.

The applicant's traffic study evaluated the need for turn lanes based on the Washington State Department of Transportation (WSDOT) Design Manual. The applicant's engineer concluded that left-turn lane warrants are projected to be met at the proposed site access intersection along NE 179th Street. However, according to the NE 179th Street Corridor Improvements project, NE 179th Street along the site frontage will be widened to a four-lane cross-section with a raised median. This will ultimately restrict left turns into and out of the site. Given the future improvements that will take place along NE 179th Street, construction of an eastbound left-turn lane at the site frontage is not necessary. Staff concurs with the applicant's findings.

Finding 6 – Historical Accident Situation

The Institute of Transportation Engineers (ITE) *Traffic Access and Impact Studies for Site Development – A Recommended Practice* states that "Accident rates vary, but any intersection will more than one accident per million entering vehicles is worth of additional analysis." This ITE recommended practice has been used by county staff to determine the scope or level of analysis required regarding crash history. Because of this, a crash rate of one crash per million entering vehicles has become the threshold to determine if further crash history evaluation is warranted. This is provided that staff has not identified a crash trend that would be exacerbated by the development regardless of the threshold.

The applicant's traffic study analyzed the crash history as obtained from the Washington State Department of Transportation (WSDOT) for the period between January 2019 through June 2024.

The intersection crash rates for the study intersections did not exceed one crash per million entering vehicles warranting additional analysis.

The applicant's study did not recommend any safety mitigations as a part of this development. Staff concurs with the applicant's finding.

Finding 7 - Roadside Safety *(Clear Zone)* Evaluation

The *Institute of Transportation Engineers (ITE) Traffic Engineering Handbook 6th Edition*, states that "The *clear roadside concept*... is applied to improve safety by providing an un-encumbered roadside recovery area that is as wide as practical…". Further, this concept "allows for errant vehicles leaving the roadway for whatever reason and supports a roadside designed to minimize the serious consequences of roadway departures."

Further, as adopted by Clark County Code (CCC) 40.350.030(C)(1)(b), the *Washington State Department of Transportation (WSDOT) Design Manual, Chapter 1600* states that

> A clear roadside border area is a primary consideration when analyzing potential roadside and median features. The intent is to provide as much clear, traversable area for a vehicle to recover as practicable given the function of the roadway and the potential tradeoffs. The Design Clear Zone is used to evaluate the adequacy of the existing clear area and proposed modifications of the roadside. When considering the placement of new objects along the roadside or median, evaluate the potential for impacts and try to select locations with the least likelihood of an impact by an errant vehicle.
>
> For managed access state highways within an urban area, it might not be practicable to provide the Design Clear Zone distances shown in Exhibit 1600-2. Roadways within an urban area generally have curbs and sidewalks and might have objects such as trees, poles, benches, trash cans, landscaping and transit shelters along the roadside.

The applicant shall consider the WSDOT Design Manual – Roadside Safety Mitigation Guidance (Section 1600.04) in the final engineering design of all proposed roadways and frontage improvements *(See Condition A-11.b)*.

Finding 8 – Vehicle Turning Movements

It shall be noted that the road and driveway approach standards listed in the Clark County Code are minimum criteria and are intended for normal conditions, per CCC 40.350.030 (C)(3). CCC 40.350.030 (C)(3) also states, "The responsible official may require higher standards for unusual site conditions."

The applicant will need to submit construction plans for review and approval that show that the design of the intersection geometry will accommodate all applicable design

vehicles. The plans will also need to show that all applicable design vehicles can enter and exit the development while minimizing impacts to opposing travel lanes. This may result in no on-street parking areas on local residential access roads, at/near public road intersections *(See Condition A-11.c)*.

Conclusion (Transportation Concurrency)
The examiner finds that the proposed preliminary plan, subject to conditions contained herein, meets the transportation concurrency requirements of the Clark County Code.

Wetland and Habitat
Finding 1 – Habitat Determination
The site is subject to three separate wetland and habitat predeterminations as follows:

Parcel 181218000 is vested to the habitat predetermination under WHR-2023-00285, issued on October 10, 2023. Parcel 181218000 contains a Type F (fish-bearing) stream and five Priority Snags and three Priority Logs, as defined by the Washington Department of Fish and Wildlife (WDFW). WHR-20203-00285 was issued prior to the adoption of the current Wetlands and Fish and Wildlife Habitat Conservation Areas ordinance (CCC 40.445) and is therefore subject to CCC 40.440 (Habitat Conservation). Under CCC 40.440.010.C.1.a, a Type F stream is afforded a Habitat Conservation Zone (HCZ) 200 feet landward on each side of the stream from the Ordinary High Water Mark (OHWM) or to the edge of the 100 year floodplain, whichever is greater. In this instance, the 200 foot HCZ is greater as shown in the predetermination map issued under WHR-2023-00285. Priority snags are defined as dead or dying trees that exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of > 51 centimeters (20 in) and are > 2 meters(6.5 feet) in height in Western Washington. Priority logs are > 30 centimeters (12 in) in diameter at the largest end, and > 6 meters(20 feet) long. During the site visit staff determined that many of the previously identified snags and logs did not meet WDFW criteria (i.e. snags were not at least 20-inches DBH and logs were not 12 inches in diameter and 20 feet long). However, staff identified a total of 5 WDFW priority snags and 3 priority logs contained on this property.

Parcels 181208000 and 181253000 are vested to the habitat predetermination under WHR-2024-00389, for which a revised decision was issued on March 5, 2025. Under WHR-2024-00389, the more recently adopted Wetlands and Fish and Wildlife Habitat Conservation Areas ordinance (CCC 40.445) is applicable. Both parcels contain Riparian Priority Habitat (RPH) associated with the type F stream. Under CCC 40.445.020.C.1.b, RPH is designated based on the estimated average two hundred (200) year site potential tree height, extending outward on each side of the stream from the ordinary high water mark (OHWM) to the distances in Table 40.445.020-1 for each site class by water type. In this case, the site contains Gee silt loam (0 to 8 percent slopes) soils, which are classified as Site Class II soils requiring a 235 foot RPH setback. It was additionally determined that portions of these parcels contain a WDFW Biodiversity Corridor. WDFW defines Biodiversity Corridors as areas of relatively undisturbed and unbroken tracts of vegetation that connect fish and wildlife habitat conservation areas, priority

habitats, areas identified as biologically diverse, or valuable habitats within a city or UGA.

Parcel 181209005 is vested to the habitat predetermination under WHR-2025-00030, issued on February 13, 2025. This parcel contains one priority snag located in the northwestern portion of the property. This parcel is subject to CCC 40.445.

Finding 2 – Wetland Determination

The site is subject to three separate wetland and habitat predeterminations as follows:

Parcel 181218000 is vested to the wetland predetermination under WHR-2023-00285, issued on October 10, 2023. Parcel 181218000 contains two Category I wetlands of high conservation value (WHCV) due to a confirmed rare plant population mapped nearby. Both wetlands (Wetlands A and B) were determined to have a habitat score of 7 points on the Wetland Rating Form. Under CCC Table 40.450.030-3 Wetlands A and B would normally require a 75-foot low land use intensity buffer, a 110-foot moderate intensity buffer, and a 150-foot high intensity buffer, however in both instances staff find that the maximum applicable buffer is the 50-foot minimum water quality buffer as allowed under CCC 40.450.030(E)(4)(c).

Parcels 181208000 and 181253000 are vested to the habitat predetermination under WHR-2024-00389, for which a revised decision was issued on March 5, 2025. Wetlands A and B extend onto these parcels for which the wetland rating did not change. However, the predetermination application for these parcels was made after adoption of CCC 40.440 (Wetlands and Fish and Wildlife Habitat Conservation Areas) and those portions of wetlands A and B on these parcels have differing applicable wetland buffers than the parcel to the East (# 181218000), which was vested to CCC 40.450 (Wetland Protection). Under CCC 40.445.020.B.5, wetland buffers are established by comparing the wetland rating category, the wetland rating habitat score, and the intensity of land uses proposed on development sites per Tables 40.445.020-1, 40.445.020-2 and 40.445.020-3. Based on the wetland habitat scores and proposed land use of the property, the current applicable wetland buffer for wetlands A and B is a 250-foot high land use intensity buffer. However, the applicant is proposing to reduce the wetland buffers to 190 feet as is allowed under CCC 40.445.030(C)(3), when certain criteria are met.

Parcel 181209005 is vested to the habitat predetermination under WHR-2025-00030, issued on February 13, 2025. This parcel contains one Category II Depressional wetland with a habitat score of 6 points. Under CCC 40.445.020(B)(5), this wetland is afforded a 150-foot high land use intensity buffer. Note that the applicable wetland buffer depends on the proposed development of the property. If the lot size, extent of impervious surface, or extent of naturalized vegetative cover on the site is proposed to change, then the applicable land use intensity buffer shall be determined by CCC Table 40.445.020-1.

Finding 3 – Habitat Impacts

While most impacts to the habitat areas on the project parcels have been avoided, all impacts were not completely avoidable due to the lot layout and the lack of a feasible

alternative location for road construction, as no alternative public access to the site is available. Impacts have been minimized by placing the access road along the eastern boundary of the site and by locating the majority of the development outside of the habitat areas. Based on the provided preliminary plans and the Revised Buffer Reduction & Onsite Mitigation Plan, dated November 12, 2025, the proposed development will result in approximately 30,097 square feet (0.691 acres) of permanent impacts to the RPH area, 16,419 square feet (0.377 acres) of impacts to the Biodiversity Corridor, and will impact three Priority Snags and three Priority Logs.

Finding 4 – Wetland Impacts

No direct wetland impacts are proposed. However, complete avoidance of wetland buffer impacts was not feasible due to the required road access and lot layout. The proposed development will result in approximately 2,599 square feet (0.060 acres) of indirect impacts to Wetland A, 3,503 square feet (0.080 acres) of indirect wetland impacts to Wetland C, and 3,744 square feet (0.086 acres) of temporary impacts to the wetland buffer of Wetland A due to grading. No impacts are proposed to Wetland B.

A Final Wetland and/or Habitat Permit will be required in the event that additional minor wetland or habitat buffer impacts are proposed during submittal of final construction plans *(See Condition A-12.e)*.

Finding 5 – Habitat Mitigation

The applicant has provided a Revised Buffer Reduction & Onsite Mitigation Plan, dated November 12, 2025, which proposes mitigating for the 0.691 acres of RPH impacts by enhancing 0.691 acres of the onsite RPH area and by additionally removing 0.137 acres of existing residential hard surfaces and structures within the RPH area. The Habitat Conservation Ordinance Mitigation Guidelines Program Policy recommends mitigating for impacts to herbaceous vegetation in the outer RPH area at a 1:1 ratio and mitigating for impacts to young forest canopy in the outer RPH area at a 2:1 ratio.

Staff have estimated that approximately 0.460 acres of the impacted RPH area consists of herbaceous vegetation and that the remaining 0.231 acres consists of young forest canopy. While the applicant is proposing an overall lower amount of mitigation enhancement than is recommended in the Mitigation Guidelines Program Policy, staff determined that a 0.25:1 (4:1) mitigation credit ratio could be applied for the removal of the existing residential structures when mitigating for impacts to herbaceous vegetation and a 0.5:1 (2:1) mitigation credit ratio could be applied when mitigating for impacts to young tree canopy. In this instance, staff find that the additional restoration of 0.137 acres of impervious surfaces is adequate to meet the required mitigation in addition to the proposed enhancement of 0.691 acres of the RPH area as shown in the Revised Mitigation Plan (Exhibit 29). Five trees and ten shrubs shall be required for every 1,000 square feet of the RPH mitigation enhancement area, which equates to 209 trees and 418 shrubs (627 plants); however, the provided Revised Mitigation Plan only proposes 588 plants. The minimum plant density requirement shall apply and will be added as a condition of approval.

The 0.377 acres of impacts to the Biodiversity Corridor will be mitigated through replacement: by redesignating an adjacent forested portion of the site as a Biodiversity Corridor and planting it with Douglas fir and big leaf maple trees to promote biodiversity and provide additional wildlife habitat.

The three impacted snags and three impacted logs will be replaced within the remainder Wetland and Habitat Tract on the site as shown in the provided Revised Mitigation Plan dated November 12, 2025. The mitigation snags shall be no less than 20-inches DBH and no less than 6.5 feet in height. The mitigation logs shall be no less than 20-inches in diameter at the larger end and shall be no less than 20 feet in length.

Finding 6 – Wetland Mitigation

Under CC Table 40.445.030-3, mitigation in the form of onsite enhancement is credited on a case-by-case basis when mitigating for impacts to Category I WHCVs. In this instance, since it was determined that Wetland A does not contain any rare plants, the applicable wetland mitigation ratio could be based off the wetland rating's functional score rather than special characteristics. Under Table 40.445.030-3, mitigation for impacts to Category I wetlands based on score for functions requires a 16:1 enhancement ratio. However, in following the Department of Ecology's (ECY) mitigation guidance, a 0.5 reduction ratio can be applied when mitigating for indirect wetland impacts. The applicant is proposing to mitigate indirect wetland impacts to Wetland A at an 8:1 ratio which is in alignment with the County and ECY's recommendations. Since temporary grading will occur within the remaining onsite portion of wetland A's buffer, the mitigation shall be located within the buffer of Wetland B. The 0.060 acres of indirect wetland impacts to Wetland A will be mitigated by enhancing approximately 0.480 acres of the remaining wetland buffers onsite as shown in the Revised Buffer Reduction & Onsite Mitigation Plan, dated November 12, 2025. The 0.080 acres of indirect wetland impacts to Wetland C will be mitigated at a 12:1 ratio with a 0.5 reduction multiplier for a total of 0.480 acres of enhancement. All temporary wetland buffer impacts shall be restored and reseeded.

Under CCC 40.4450.030(C)(2)(a)(3), the high intensity wetland buffers may be reduced to moderate intensity buffers when all of the minimization measures in Table 40.445.030-4 are applied to the extent that they are applicable to the site; and when a permanently protected, relatively undisturbed, vegetated corridor at least one hundred (100) feet wide is provided and the corridor is an area with equivalent habitat quality that is in permanent conservation status as recognized by WDFW.

Finding 7 – Maintenance and Monitoring

After installation of the mitigation, maintenance and monitoring are required in order to ensure long term performance of the mitigation. Routine maintenance of the site is necessary to ensure the integrity and success of the installed plants which includes, but is not limited to, removing invasive species and weeds, irrigation (if required), and plant replacement to meet the performance standards. Annual monitoring reports are required for a period of five growing seasons following approval of the as-built report. Annual review and inspection fees shall apply. Adaptive management and alternate species may

be considered if plantings appear to have massive failures; any changes shall be coordinated with Habitat/Wetland Review staff.

Finding 8 – Mitigation As-Built
A Mitigation As-Built report must be submitted to the County within 30 days of completion of construction and planting in the approved mitigation plan. The As-Built needs to include documentation of any revisions to or deviations from the approved plan, demonstrating that any changes meet the requirements of CCC 40.445.

Finding 9 – Financial Assurance
Unless the proposed mitigation is constructed and an as-built is approved, a performance assurance for the mitigation is required.

Finding 10 – Standard Conditions
Pursuant to CCC 40.445.030.B.2.d, a conservation covenant shall be recorded in a form approved by the Prosecuting Attorney as adequate to incorporate the other restrictions of this section and to give notice of the requirement to obtain a wetland and/or habitat permit prior to engaging in regulated activities within a wetland, wetland buffer, or designated habitat area. The covenant shall also include language limiting use of pesticides within 150 feet of wetlands and shall include fencing of property boundaries abutting wetland and habitat areas as required under CCC Table 40.445.030-4.

Pursuant to CCC 40.445.030.B.2.d, the Final Plat shall clearly show all wetland, wetland buffer, and priority habitat boundaries with a note referencing any required conservation covenant(s).

Pursuant to CCC 40.450.030.F, a permanent physical demarcation along the upland boundary of the wetland buffer and habitat area shall be installed and thereafter maintained. Such demarcation may consist of logs, a tree or hedge row, fencing, or other prominent physical marking approved by the responsible official.

Pursuant to CCC 40.450.030.F, small signs shall be posted at an interval of one (1) per lot or every one hundred (100) feet, whichever is less, and perpetually maintained at locations along the outer perimeter of the wetland buffer and habitat area approved by the responsible official worded substantially as follows:

"Wetland Buffer and Habitat –
Please retain in a natural state"

(See Conditions A-12, D-9, and G-7)

Conclusion (Wetland and Habitat)
The examiner finds that the proposed preliminary plan, subject to conditions A-12, D-9, and G7 contained herein, meets the Wetland and Habitat requirements of the Clark County Code.

Fire Protection

Finding 1 - Building Construction
Building construction occurring subsequent to this application shall be in accordance with the provisions of the county's building and fire codes. Additional specific requirements may be made at the time of building construction as a result of the permit review and approval process *(See Condition G-3).*

Finding 2 - Fire Flow
Fire flow in the amount of 1000 gallons per minute supplied at 20 psi for 60 minutes duration is required for this application. Prior to final approval submit proof from the water purveyor indicating that the required fire flow is available at the site. Water mains supplying fire flow and fire hydrants shall be installed, approved and operational prior to final plat approval *(See Conditions A-6.a, D-7.a, and D-7.b).*

Finding 3 - Fire Hydrants
Fire hydrants are required for this application. Either the indicated number or the spacing of the fire hydrants is inadequate. Provide fire hydrants such that the maximum spacing between hydrants does not exceed 700 feet and such that no lot or parcel is in excess of 500 feet from a fire hydrant as measured along approved fire apparatus access roads *(See Condition A-6.b).*

The local fire district chief approves the exact locations of fire hydrants. As a condition of approval, contact Fire District #6 at (360) 576-1195 to arrange for location approval. Unless waived by the fire district chief fire hydrants shall be provided with appropriate 'storz' adapters for the pumper connection. Provide and maintain a three (3) -foot clear space completely around every fire hydrant *(See Conditions A-6.c, A-6.e, A-6.f, D-7.d, F-1 and H-1.a).*

Finding 4 - Fire Apparatus Access
The Fire Marshall stated:

> Fire apparatus access is required for this application. The roadways and maneuvering areas as indicated in the application do not adequately provide required fire apparatus access. Provide fire apparatus access roads with an unobstructed width of not less than 20 feet, an unobstructed vertical clearance of not less than 13.5 feet, with an all-weather driving surface and capable of supporting the imposed loads of fire apparatus. With 200 lots, this proposal would need two public accesses or a plat note requiring sprinklers on all lots regardless of size with a second emergency only access.

(Exhibit 36).

The applicant proposed to modify this development to provide a maximum 199 lots on the site in order to avoid the need for sprinklers. (Exhibit 55 at 2). However, as noted in Transportation & Circulation Finding 4 above, the 159 dwelling units in the 179th Street Apartments West will also use proposed NE 18th Avenue as their only access once NE

183rd Street is connected to the east. Therefore, proposed NE 18th Avenue will serve as the only public access for 358 dwelling units: 200 lots created by this development and 159 apartment units. The County approved a road modification allowing use of the apartment driveway to NE 179th Street as a second emergency only access. However, CCC 40.350.030.B.4.b(4)(a) requires a second *non-emergency* access where more than 200 lots are served by a single access. Therefore, reducing this development to 199 lots would not ensure compliance with CCC 40.350.030.B.4.b(4)(a). However, the applicant did not request, and the County did not approve, a modification to allow NE 18th Avenue to serve as the sole public access for more than 200 lots or dwelling units.

CCC 40.350.030.B.4.b(4)(c) authorizes the Fire Marshall to require additional fire protections in lieu of a secondary access. The Fire Marshall stated that "With 200 lots, this proposal would need two public accesses or a plat note requiring sprinklers on all lots regardless of size with a second emergency only access." Unfortunately it is not clear whether the Fire Marshall intended to only require sprinklers if this development proposes more 200 lots or because the 200 lots proposed in this application combined with the 159 apartment units will be served by a single access. Therefore, the applicant should be required to comply with CCC 40.350.030.B.4.b(4)(a) unless the Fire Marshall approves an alternative pursuant to CCC 40.350.030.B.4.b(4)(c). *(See Conditions A-1.p, A-6.d, D-5.l, and H-1.b).*

Approved fire apparatus turnarounds are required for this project. The indicated provisions for turning around fire apparatus are adequate.

Finding 5 – Parking
Parking is prohibited on access roads that are less than twenty-four (24) feet wide. Roads that are less than twenty-four (24) feet wide shall be posted "NO PARKING-FIRE LANE" *(See Conditions A-6.g, D-7.c, and H-1.c).*

Finding 6 – Gates
While no gates are shown on the proposed plan, no gate may be installed across a required fire department access road or driveway without first obtaining and testing of the gate will be required. Split gates with a divided entry and exit side will need 15 feet on either side for a total gate width of 30 feet *(See Condition G-4).*

Finding 7 – Residential Fire Sprinklers
Homes exceeding 3600 square feet including attached garages will require additional fire protection features including a residential fire sprinkler system when adequate public water and a hydrant is not within required distances. If a residential fire sprinkler is required, it will require additional review and permitting by the Fire Marshal *(See Condition E-6).*

Conclusion (Fire Protection)
The examiner finds that the proposed preliminary plan, subject to conditions contained herein, meets the fire protection requirements of the Clark County Code.

Water and Sewer Service

Finding 1 – Sewerage Requirements

The proposed development is required to connect to public sanitary sewer. The site is located within the Clark Regional Wastewater District service area. A utility review letter from CRWWD was submitted as part of the application materials *(Exhibit 1, Tab 16)* which indicates that sewer is available for connection subject to CRWWD requirements. Prior to final plat approval, the applicant shall provide documentation from the district confirming that sanitary sewer connections have been installed and approved *(See Condition D-8.a).*

Finding 2 – Water Supply

The proposed development is required to connect to public water. The applicant has submitted a current utility review from Clark Public Utilities *(Exhibit 1 Tab 17)* confirming that water service is available to the site subject to CPU requirements. Prior to final plat approval, the applicant shall provide documentation from the district confirming that water connections have been installed and approved *(See Condition D-8.b).*

Conclusion (Utilities)

The examiner finds that the proposed preliminary plan, subject to the findings and conditions identified above, meets utility requirements of the Clark County Code.

Public Health

Finding 1 – On-site Sewage Treatment Systems

An existing individual on-site sewage system (OSS) is not listed on the application but there are county records indicating the existence of an on-site sewage system at the site. A site visit on April 24, 2025, did verify evidence of an on-site sewage system known as ON0047325; two septic tank lids were observed at the ground surface west of the home and the tank has a capped outlet. This septic system will be required to be abandoned prior to final plat approval *(See Condition D-8.e).*

These OSS tanks, as well as any OSS tanks or drywells discovered during development, must be properly abandoned per CCC 24.17.210, with written notification provided to CCPH and Online RME Pumper Reports or pumper receipts attached. All abandoned OSS tanks, whether filled or removed, shall be accounted for within written abandonment notifications submitted to CCPH. All abandoned OSS tank locations must be marked on the final plat *(See Conditions B-5 and D-8.c).*

The proposed development must be served by public sewer. A copy of the final acceptance letter (or equivalent) from CRWWD shall be submitted with the final plat *(See Condition D-8.a).*

Finding 2 – Water Systems

An existing well is not indicated on the application but there are county records indicating the existence of a well at the site and a site visit on April 24, 2025, did discover evidence of a well in a well house. County record WP0014284 was created to

track the well status. There is another possible well in the far SE corner of the project; there is a 6-inch steel casing pipe approximately 30 feet north of a fire hydrant along NE 179th Street (Health Department staff have requested of the applicant to have a well driller investigate it).

Additional water wells may exist at the site. These water wells and any wells discovered during development must be legally decommissioned by a licensed well driller per WAC 173-160-381, with written notice provided to CCPH and decommissioning well logs attached. Decommissioned well locations must be marked on the final plat *(See Conditions B-5 and D-8.d).*

The proposed development must be served by public water. A copy of the final acceptance letter (or equivalent) from CPU shall be submitted with the final plat *(See Condition D-8.b).*

Conclusion (Public Health)
The examiner finds that the proposed preliminary plan, subject to the findings and conditions identified above, meets Public Health requirements of the Clark County Code.

Impact Fees
Finding 1 - Applicability
Staff was only able to find evidence of one existing single family residence that will be removed in order to construct this development. With the exception of one (1) single family detached lot that the applicant shall identify on the face of the plat, the lots created by this development will produce impacts on schools, parks, and traffic, and are subject to School (SIF), Park (PIF), and Traffic Impact Fees (TIF) in accordance with CCC 40.610. The subject site is located within the following districts: Mt. Vista Transportation District, Ridgefield School District and Park District 10.

Impact Fees			
Type of dwelling unit	**Traffic Impact Fee**	**Parks Impact Fee**	**School Impact Fee**
Single family	$8,520.88	$3,852.00	$16,880.00

As provided in CCC 40.610.040, impact fees are calculated using the rates in effect at the time of building permit issuance *(See Conditions D-4.f, D-5.k, and E-1).*

Conclusion (Impact Fees)
The examiner finds that the proposed preliminary plan, subject to conditions identified above, meets impact fee requirements of the Clark County Code.

D. CONCLUSION

Based on the above findings and discussion, the examiner concludes that PLD-2025-00077 (Three Creeks East PUD) should be approved, because it does or can comply with the applicable standards of the Clark County Code and the Revised Code of the State of

Washington, subject to conditions of approval necessary to ensure the final plat and resulting development will comply with the Code.

E. DECISION

Based on the foregoing findings and except as conditioned below, the examiner hereby approves PLD-2025-00077 (Three Creeks East PUD) in general conformance with the applicant's preliminary plat and the related plans, reports, and proposal. The approval is granted subject to the requirements that the applicant, owner, or subsequent developer (the "developer") shall comply with all applicable code provisions, laws and standards and the following conditions. These conditions shall be interpreted and implemented consistently with the foregoing findings.

Conditions of Approval

A	**Final Construction Review for Land Division** **Review and Approval Authority: Development Engineering, Land Use & Fire Marshal**

Prior to construction, a Final Construction Plan shall be submitted for review and approval, consistent with the approved preliminary plan and the following conditions of approval:

A-1 **Final Transportation Plan/On-Site** - The applicant shall submit and obtain County approval of a final transportation design in conformance to CCC 40.350 and the following conditions of approval:

a. The applicant shall show all curb ramps will be constructed in compliance with ADA Standards *(See Transportation Finding 1).*

b. The applicant shall show all curb ramps will be constructed in compliance with the WSDOT Design Manual *(See Transportation Finding 1).*

c. The applicant shall coordinate design and construction of improvements on NE 179th Street with the Clark County Public Works Department. The applicant is responsible for constructing the planned improvements in advance of the county capital improvement project (CRP #320122) unless the applicant and Clark County Public Works execute a deferral agreement in accordance with procedures of CCC 40.350.030(B)(5)(c) *(See Transportation Finding 3).*

d. NE 179th Street is classified as a "Principal Arterial with Center Left and Bike Lanes" roadway and half-width improvements are required consisting of 50 feet of right-of-way dedication, 36 feet pavement width, curb/gutter, and 5-foot detached sidewalk. Unless a deferral agreement, per Condition A-1.c, is executed *(See Transportation Finding 3).*

e. The applicant shall dedicate additional right-of-way (or provide a public easement) at the intersection of NE 179th Street/NE 18th Avenue for the chord of the right-of-way radius *(See Transportation Finding 3).*

f. NE 183rd Street and NE 18th Avenue are classified as a "Neighborhood Circulator" roadways and full-width improvements are required consisting of 54 feet of right-of-way dedication, 36 feet pavement width, curb/gutter, and 5-foot sidewalk *(See Transportation Finding 3).*

g. NE 184th Street, NE 185th Street, NE 186th Street, NE 187th Street, NE 19th Avenue, and NE 20th Way are/will be classified as "Urban Local Access" roadways and full-width improvements are required consisting of 46 feet of right-of-way dedication, 28 feet pavement width, curb/gutter, and 5-foot sidewalk *(See Transportation Finding 3).*

h. NE 20th Way and NE 186th Street classified as a "Urban Cul-de-sac" roadways and full-width improvements for the bulb are required consisting of minimum 40 foot radius of right-of-way dedication, minimum 34.5 foot radius pavement width, thickened curb and 5-foot sidewalk *(See Transportation Finding 3).*

i. All roads shall have a minimum pavement width of 20 feet *(See Transportation Finding 3).*

j. All partial width roads less than 24 feet in width shall be marked with "No Parking" signs or similar control measures *(See Transportation Finding 3).*

k. All stubbed roads shall be terminated with approved barriers and include end of sidewalk ramps in compliance with ADA Standards *(See Transportation Finding 3).*

l. The applicant shall show on the final construction plans that all joint driveways are in a minimum of a 20 foot easement and serve no more than 4 lots *(See Transportation Finding 4).*

m. The applicant shall show on the final construction plans that all corner lot driveways will comply with CCC 40.350.030(B)(4(b)(1)(b) *(See Transportation Finding 4).*

n. The applicant shall show sight distance triangles at all intersections on the construction plans *(See Transportation Finding 5).*

o. The applicant is responsible for providing all necessary transportation improvements required for each individual phase *(See Transportation Finding 6).*

p. The applicant shall comply with the Fire Marshal requirements: With 200 lots this proposal would need two public accesses or a plat note requiring sprinklers on all lots regardless of size with a second emergency only access; unless subsequent approvals/decisions alter or change these conditions *(See Transportation Finding 7 and Fire Protection Finding 4).*

q. The applicant shall not construct phases for lots 100-200 until a secondary emergency only or public road access location is available for public use *(See Transportation Finding 7).*

r. The applicant may place the driveways at the interior property line building setback or within the 5 foot property line setback *(See Transportation Finding 7).*

s. The applicant shall provide a typical lot detail showing that the driveways with reduced property setbacks will not have overlapping wings and will be on their respective lots *(See Transportation Finding 7).*

t. NE 19th Avenue will be classified as an "Urban Local Access" roadway and half-width improvements are required consisting of 23 feet of right-of-way dedication, 14 feet pavement width, curb/gutter, and 5-foot sidewalk *(See Transportation Finding 7).*

A-2 **Transportation (Signing and Striping)** - The applicant shall submit a signing and striping plan and a reimbursable work order, authorizing County Road Operations to perform any signing and pavement striping required within the County right-of-way. This plan and work order shall be approved by the Department of Public Works prior to final plat or final site plan approval.

A-3 **Final Stormwater Plan** - The applicant shall submit and obtain County approval of a final stormwater plan designed in conformance to CCC 40.386 and the following conditions of approval:

a. The applicant shall submit final construction plan and a final Technical Information Report that addresses Minimum Requirements #1 through #9 *(See Stormwater Finding 1).*

b. The applicant shall demonstrate that the development will not materially increase or concentrate stormwater runoff onto an adjacent property or block existing drainage from adjacent lots *(See Stormwater Finding 1).*

c. The applicant shall submit documentation from the stormwater treatment system manufacturer indicating that any proprietary stormwater treatment devices were sited and sized appropriately *(See Stormwater Finding 2).*

d. The applicant shall provide a final Technical Information Report that demonstrates compliance with the Basic Treatment requirement *(See Stormwater Finding 2).*

e. The applicant shall provide a final technical information Report that demonstrates compliance with the Standard Flow Control requirement*(See Stormwater Finding 2).*

f. The applicant shall submit final construction plan and a final Technical Information Report that addresses the following levels of wetland protection: General Protection, Protection from Pollutants and Hydroperiod Protection: Method 2 *(See Stormwater Finding 2).*

g. The applicant shall identify on the final construction plans ownership responsibilities for each of the proposed stormwater facilities *(See Stormwater Finding 2).*

h. A stormwater easement shall be shown on all private/joint stormwater facilities not in the public right-of-way *(See Stormwater Finding 2).*

i. Stormwater facility setbacks shall be met and shown on the final construction plans, unless a reduced setback is recommended by a geotechnical engineer *(See Stormwater Finding 2).*

j. The applicant shall submit an offsite analysis with the Final TIR prepared in accordance with Book 1, Chapter 5 of the CCSM 2021 for all outfall locations from the site *(See Stormwater Finding 2).*

k. The applicant is responsible for providing all necessary stormwater mitigation improvements required for each individual phase *(See Stormwater Finding 3).*

A-4 **Erosion Control Plan -** The applicant shall submit and obtain County approval of a final erosion control plan designed in accordance with CCC 40.386.

A-5 **Excavation and Grading -** Excavation/grading shall be performed in compliance with CCC14.07.

A-6 **Fire Marshal Requirements**

a. The applicant shall submit plans showing the location of water lines and hydrants for review and approval by the Fire District Chief *(See Fire Protection Finding 2).*

b. Plans shall be submitted for review and approval showing fire hydrants such that the maximum spacing between hydrants does not exceed 700' and such

that no lot or parcel is in excess of 500' from a fire hydrant as measured along approved fire apparatus access roads *(See Fire Protection Finding 3).*

c. The fire district chief shall sign the engineering construction mylar indicating fire hydrant location has been reviewed and approved *(See Fire Protection Finding 3).*

d. Access roads shall have an unobstructed width of not less than 20 feet and an unobstructed vertical clearance of not less than 13.5 feet with an all-weather driving surface capable of supporting the imposed loads of fire apparatus *(See Fire Protection Finding 4).*

e. Plans showing a three (3) -foot clear space around the circumference of all fire hydrants shall be submitted for review and approval, *(See Fire Protection Finding 3).*

f. Unless waived by the fire district chief, hydrants shall be provided with appropriate "storz" adapters for the pumper connection, *(See Fire Protection Finding 3).*

g. Plans showing markings indicating that parking is prohibited on access roads that are less than twenty-four (24) feet wide shall be provided, *(See Fire Protection Finding 5).*

A-7 **Final Construction Plan (Archaeology) -** The applicant shall submit and obtain county approval of a final construction plan with the following note:

> If any cultural resources and/or human remains are discovered in the course of undertaking the development activity, the Department of Archaeology and Historic Preservation in Olympia, the Cowlitz Indian Tribe, and Clark County shall be notified. Failure to comply with these state requirements may constitute a Class C Felony, subject to imprisonment and/or fines.

(See Archaeological Finding 2).

A-8 **Land Use –** A final construction plan is required to be submitted and prior to Final Construction Plan approval and Land Use staff must verify:

a. Phased Plan: If the applicant requests to achieve the sequential 4-Phase Plan that was proposed, then information must be submitted that demonstrates that the initial phase plus any subsequent phases will comply with density requirements should the future phases not be constructed *(See Land Use Finding 2).*

b. PUD Lot Sizes: The applicant shall submit a Narrow Lot Site Plan that indicates that no lots will be less than 2,320 square feet and no less than 26 feet wide in the R-12 zone.

c. PUD Setbacks: The applicant shall submit a Narrow Lot Site Plan with setbacks in which all setbacks will comply with the R-12 and OR-22 zones.

d. PUD Street Trees: The applicant shall submit a landscape plan that demonstrates a tree for every 24 feet. In the likely event the interval cannot be met due to miscellaneous infrastructure, the tree will still be required but placed as nearby as practical and are allowed to be grouped *(See Land Use Finding 3).*

e. Street Lighting: An outdoor lighting plan in conformance with requirements put forth in Table 40.510.050-1, shall be provided for staff review and approval that shows the areas of illumination for each outdoor light to ensure compliance with the PUD street lighting standard *(See Land Use Finding 3).*

f. Narrow Lot Site Plan: In accordance with Section 40.260.155(C), a final site plan is required to be incorporated into the final construction plans that incorporates items a - i *(See Land Use Finding 4).FO*

g. Narrow Lot Street Trees: The applicant shall submit a landscape plan that identifies the minimally required 1 street tree per lot required by the Narrow Lot Standards *(See Land Use Finding 4).*

h. Landscape Buffers: The applicant is required to submit a landscape plan prior to Final Construction Plan Review approval that matches the preliminary and revised Narrow Lot Site Plans *(See Land Use Findings 3 and 6).*

i. On-Street Parking: The applicant shall identify at least 61 parking spaces on the Narrow Lot Site Plan *(See Land Use Finding 4).*

j. Shared Driveways: The applicant has indicated that lots 78-79, 100-106, 171-172, 176-177, and 199-200 will utilize shared driveways. These driveways shall comply with 40.260.155.C.7 *(See Land Use Finding 4).*

k. Zero Lot Lines: The Narrow Lot Site Plan shall indicate that the setback on the lot abutting a zero setback line shall be at least eight (8) feet *(See Land Use Findings 3 and 5).*

l. Pedestrian Connection with NE 179th Street: The applicant shall show a pedestrian connection on the Final Construction Plans that connect the sidewalks of NE 18th Avenue to the right-of-way of NE 179th Street. This connection shall comply with the standards of Pedestrian Circulation found in 40.340.020.A.3 *(See Land Use Finding 7).*

A-9 **Retaining Walls** - A building permit is required for retaining walls greater than 4 feet tall or when the wall is surcharged. All retaining walls shall be shown in sufficient detail on the engineering plans for staff to assess their impact on adjacent roads, structures, and public and private utilities.

A-10 **Flood Plain Hazard Area –** The applicant shall delineate the mapped Special Flood Hazard Area on the final engineering plans per the FEMA published FIRM Panel number {53011C0219D}, unless an updated FIRM is published prior to final engineering approval, and the following conditions of approval:

a. The applicant's plans shall show that there will be no impact to the Floodway or Floodway Fringe of Whipple Creek *(See Flood Hazard Finding 2).*

A-11 **Final Transportation Plan/Off-Site (Concurrency):**

a. The applicant shall submit a signing and striping plan for review and approval. This plan shall show signing and striping and all related features for required frontage improvements and any off-site improvements. The applicant shall obtain a work order with Clark County to reimburse the County for required signing and striping.

b. The applicant shall consider the WSDOT Design Manual – Roadside Safety Mitigation Guidance (Section 1600.04) in the final engineering design of all proposed roadways and frontage improvements *(See Transportation Concurrency Finding 7).*

c. The applicant shall submit construction plans that show the design of the intersection geometry that will accommodate all applicable design vehicles for review and approval, unless modified by the County Engineer. The plans will also need to show that all applicable design vehicles can enter and exit the development minimizing impact to opposing travel lanes. This may result in no parking and/or maneuvering areas near public road intersections. Please note that applicable design vehicles include but are not limited to passenger vehicles and waste management vehicles *(See Transportation Concurrency Finding 8).*

A-12 **Wetland and Habitat:**

a. The applicant shall remove 0.137 acres of the existing residential driveway, home and appurtenances and shall enhance 0.691 acres of the Riparian Priority Habitat area and 0.377 acres of the Biodiversity Corridor Replacement area as shown in the November 12, 2025 Revised Buffer Reduction and Mitigation Plan, except that a minimum of 209 native trees and 418 native shrubs (627 plants) shall be required within the RPH mitigation area. The three impacted snags and three impacted logs shall be mitigated

onsite by through placement of an equivalent number of snags and logs meeting WDFW PHS criteria.

b. The applicant shall enhance approximately 0.960 acres of wetland B's buffer as shown in the Revised Buffer Reduction & Onsite Mitigation Plan, dated November 12, 2025 except that a minimum of 209 native trees and 418 native shrubs (627 plants) shall be required within the mitigation planting area. The .086 acres of temporary wetland buffer impacts shall be restored and reseeded with a native herbaceous seed mix.

c. The applicant shall submit a Mitigation As-Built report to the County within 30 days of completion of the construction and planting in the approved mitigation plan.

d. Unless the proposed mitigation is constructed and an as-built is approved, a performance assurance for the mitigation is required.

d. In the event there are minor changes to the proposed construction plans, then a final wetland or habitat permit shall be required *(See Wetland and Habitat Finding 4).*

B	**Prior to Construction of Development** **Review and Approval Authority: Development Inspection & Clark County Public Health**

Prior to construction, the following conditions shall be met:

B-1 **Pre-Construction Conference -** Prior to construction or issuance of any grading or building permits, a pre-construction conference shall be held with the county.

B-2 **Traffic Control Plan** - Prior to issuance of any building or grading permits for the development site, the applicant shall obtain written approval from Clark County Department of Public Works of the applicant's Traffic Control Plan (TCP). The TCP shall govern all work within or impacting the public transportation system.

B-3 **Erosion Control** - Prior to construction, erosion/sediment controls shall be in place. Sediment control facilities shall be installed that will prevent any silt from entering infiltration systems. Sediment controls shall be in place during construction and until all disturbed areas are stabilized and any erosion potential no longer exists.

B-4 **Erosion Control -** Erosion control facilities shall not be removed without county approval.

B-5 **Septic Tank and Well Decommissioning -** Prior to provisional acceptance, if any septic systems, water wells or underground tanks are found during

construction, they shall be decommissioned in accordance with the procedures of the Clark County Public Health, *(See Water and Sewer Findings 1 and 2).*

B-6 **Road Closures** - Any request by the developer or developer's contractor to close a road will be reviewed by county staff. The developer shall provide a memorandum to the County Engineer justifying the reasons for needing the road closure, specifically including explanation as to why the closure is necessary and construction cannot occur under traffic, such as flagger controlled alternating one way traffic next to the construction. The memorandum shall include the ENG number and title of the project, location of the requested road closure, anticipated date of start of closure, requested closure time length, explanation of the public outreach that the contractor will perform, full detour mapping, and other information as appropriate. Road Closures are approved specifically by the County Council by resolution, as described in WAC 308-330-270(7).The process for county takes at least 6 weeks for writing the staff report, resolution and internal review. Depending on the complexity of the request from the developer and the council's time availability, this can take over 12 weeks to process from start to finish. It is the developer's responsibility to ensure that the process is completed prior to needing the road closure enacted. The contractor shall be responsible for all costs associated with county staff time to process the request via reimbursable work order and all notifications required by law in local newspapers as required by RCW 47.48 Notice of Closure or Restriction. Requesting a road closure is no guarantee that a road closure will be approved by the county.

C	**Provisional Acceptance of Development** **Review and Approval Authority: Development Inspection & Development Engineering**

Prior to provisional acceptance of development improvements, construction shall be completed consistent with the approved final construction / land division plan and the following conditions of approval:

C-1 **Required Documents (Transportation):**

a. Sight Distance: The applicant shall submit a sight distance certification letter signed and stamped by an engineer, licensed in the state of Washington, indicating the sight distance at the intersection of NE 179th Street/NE 18th Avenue, once constructed, complies with the county code *(See Transportation Finding 5).*

b. The applicant shall not connect their internal road network to the existing portion of NE 183rd Street until the apartment owner limits their access onto NE 179th Street as emergency only access. See Land Use Decision PSR-2020-00098 NE 179th Street Apartments West, Condition A-1.f. (*See Transportation Finding 7).*

D	**Final Plat Review & Recording** **Review and Approval Authority: Development Engineering, Fire Marshal, Clark County Public Health & Land Use**

Prior to final plat approval and recording, the following conditions shall be met:

D-1 **Potential Encroachment -** A boundary survey for the site identifies a potential fence encroachment along the northeast line of tax lot 36 (PIN: 181218-000). Based on information submitted with the application packet, it is unclear whether ownership of the area is under dispute. This situation needs to be resolved prior to filing of the final plat *(See Land Use Finding 8).*

D-2 **Right-of-ways/Easement** – All right-of-way dedications and easements shall be recorded with the final plat:

a. The required right-of-way dedication along NE 179th Street fronting the development, to achieve a minimum 50-foot half-width, must be conveyed to the county with the final plat. Additional right-of-way dedication (or public easement) at the intersection of NE 179th Street/NE 18th Avenue for the chord of the right-of-way radius, must be conveyed to the county with the final plat *(See Transportation Finding 3).*

b. The required right-of-way dedication for NE 183rd Street and NE 18th Avenue within the development, to achieve a minimum 54-foot full-width, must be conveyed to the county with the final plat *(See Transportation Finding 3).*

c. The required right-of-way dedication for NE 184th Street, NE 185th Street, NE 186th Street, NE 187th Street, NE 19th Avenue, and NE 20th Way within the development, to achieve a minimum 46-foot full-width, must be conveyed to the county with the final plat *(See Transportation Finding 3).*

d. The required right-of-way dedication for NE 20th Way and NE 186th Street within the development, to achieve a minimum 40-foot radius for the bulb of the cul-de-sac, must be conveyed to the county with the final plat *(See Transportation Finding 3).*

e. The joint driveway access easements for Lots 100-102, Lots 103-106, Lots 176-177 and Lots 199-200 shall be delineated on the final plat. A minimum 20-foot easement width is required. The lot numbers who have access to the joint driveway easements shall also be labeled *(See Transportation Finding 4).*

f. The required right-of-way dedication along NE 19th Avenue fronting the development, to achieve a minimum 23-foot half-width, must be conveyed to the county with the final plat *(See Transportation Finding 7).*

D-3 **Sight Distance -** The sight distance triangle, if located outside of right-of-way, shall be delineated on the final plat *(See Transportation Finding 5).*

D-4 **Developer Covenant** - A "Developer Covenant to Clark County" shall be submitted for recording to include the following:

a. Zero Lot Line Setbacks: "The required 8 foot setback for the zero lot line lots shall kept perpetually free of structures." *(See Land Use Finding 5).*

b. Joint Driveway Maintenance Covenant: A joint driveway maintenance covenant shall be submitted to the responsible official for approval and recorded with the County Auditor. The covenant shall set out the terms and conditions of responsibility for maintenance, maintenance methods, standards, distribution of expenses, remedies for noncompliance with the terms of the agreement, right of use easements, and other considerations, as required under 40.350.030(C)(4)(g).

c. Critical Aquifer Recharge Areas: "The dumping of chemicals into the groundwater and the use of excessive fertilizers and pesticides shall be avoided. Homeowners are encouraged to contact the State Wellhead Protection program at (206) 586-9041 or the Washington State Department of Ecology at 800-RECYCLE for more information on groundwater/drinking supply protection."

d. Erosion Control: "Building Permits for lots on the plat shall comply with the approved erosion control plan on file with Clark County Building Department and put in place prior to construction."

e. Responsibility for Stormwater Facility Maintenance: "For stormwater facilities for which the county will not provide long-term maintenance, the developer shall make arrangements with the existing or future (as appropriate) occupants or owners of the subject property for assumption of maintenance to the county's Stormwater Facilities Maintenance Manual as adopted by Chapter 13.26A. The responsible official prior to county approval of the final stormwater plan shall approve such arrangements. Final plats shall specify the party(s) responsible for long-term maintenance of stormwater facilities within the Developer Covenants to Clark County. The county may inspect privately maintained facilities for compliance with the requirements of this chapter. If the parties responsible for long-term maintenance fail to maintain their facilities to acceptable standards, the county shall issue a written notice specifying required actions to be taken in order to bring the facilities into compliance. If these actions are not performed in a timely manner, the county shall take enforcement action and recover from parties responsible for the maintenance in accordance with Section 32.04.060."

f. Impact Fees: Impact fees shall be assessed for impacts on schools, parks and transportation facilities based on the following districts: Ridgefield School District (SIF), Park District 10 (PIF) and Mt. Vista Transportation Sub-area (TIF). As found in CCC40.610.040, impact fees are calculated using the rates in effect at the time of building permit issuance.

D-5 **Plat Notes -** The following notes shall be placed on the final plat:

a. Inadvertent Discovery Language: "If any cultural resources and/or human remains are discovered in the course of undertaking the development activity, the Department of Archaeology and Historic Preservation in Olympia, the Cowlitz Indian Tribe, and Clark County shall be notified. Failure to comply with these state requirements may constitute a Class C Felony, subject to imprisonment and/or fines." *(See Archaeological Finding 2).*

b. Setbacks: "The building setbacks shall comply with the R-12 and OR-22 zone." *(See Land Use Finding 3).*

c. Zero Lot Line Setbacks: "The required 8 foot setback for the zero lot line lots shall kept perpetually free of structures." *(See Land Use Finding 5).*

d. Sidewalks: "Prior to issuance of occupancy permits, sidewalks shall be constructed along all the respective lot frontages."

e. Utilities: "An easement is hereby reserved under and upon all tracts and the exterior six (6) feet on all boundary lines of the lots and tracts adjacent to public/private roads and six (6) feet adjacent to access/utility easements for the installation, construction, renewing, operating and maintaining electric, telephone, tv, cable, water and sanitary sewer services. All lots containing padmount transformers are subject to the minimum clearances as defined by Clark Public Utilities construction standards. All proposed building designs on these lots must provide adequate clearance for all combustible materials. Also, a sidewalk easement, as necessary to comply with ADA slope requirements, shall be reserved upon the exterior six (6) feet along the front boundary lines of all lots and tracts adjacent to public streets."

f. Sight Distance: "Sight distance easement triangles shall be maintained and kept clear as required under CCC 40.350.030.B.8."

g. Driveways: "No direct access is allowed onto the following streets: NE 179th Street."

h. Driveways: "All residential driveway approaches entering public roads are required to comply with CCC 40.350."

i. Privately Owned Stormwater Facilities: "The following party(s) is responsible for long-term maintenance of the privately owned stormwater facilities: _____."

j. Roof and Crawl Space Drains: "Roof and crawl space drains for all lots of the development shall be installed in accordance with the approved As-Built plans, unless a revised plan is approved by the county. These stormwater systems will be owned and maintained by the property owner on whose lot the stormwater system is located."

k. Impact Fees: "With the exception of Lot ___, Impact fees shall be assessed for impacts on schools, parks and transportation facilities based for the following districts: Ridgefield School District (SIF), Park District 10 (PIF) and Mt. Vista Transportation Sub-area (TIF). As found in CCC40.610.040, impact fees are calculated using the rates in effect at the time of building permit issuance."

l. Fire Sprinklers Unless the Fire Marshall approves an alternative pursuant to CCC 40.350.030.B.4.b(4)(c), a plat note shall be added as follows: "Sprinklers shall be required on all lots regardless of size until a secondary public access connection is obtained."

D-6 Land Use:

a. Open Space: All open space shall be conveyed to and permanently maintained by a home-owners association unless a public agency agrees to maintain the open space and any structures or improvements located within *(see Land Use Finding 3).*

b. Narrow Lot Standards Site Plan: A final site plan is required to be submitted with the final land division application that was approved as part of the Final Construction Plans and that incorporates items a - i *(See Land Use Finding 4).*

c. Zero Lot Line Maintenance Easements: Easements for such purposes as maintenance, or for building projection encroachments beyond a zero setback line shall be shown on the plat *(See Land Use Finding 5).*

d. Pedestrian Connection with NE 179th Street: The applicant shall show a pedestrian connection on the Final Plat that connect the sidewalks of NE 18th Avenue to the right-of-way of NE 179th Street *(See Land Use Finding 7).*

D-7 Fire Marshal Requirements:

a. The applicant shall demonstrate that water mains supplying fire flow have been installed and approved *(See Fire Protection Finding 2).*

b. The applicant shall submit a current utility review letter from the water purveyor indicating required fire flow remains available at the site *(See Fire Protection Finding 2).*

c. Parking is prohibited on access roads that are less than twenty-four (24) feet wide. Roads that are less than 24 feet wide shall be posted, "NO PARKING – FIRE LANE" *(See Fire Protection Finding 5).*

d. Fire hydrants shall be provided with appropriate 'storz' adapters for the pumper connection prior to above-ground combustible construction *(See Fire Protection Finding 3).*

D-8 Sewer and Water Requirements:

a. The applicant shall produce documentation from the Clark Regional Wastewater District that sewer has been installed and approved *(See Water and Sewer Finding 1).*

b. The applicant shall produce documentation from Clark Public Utilities that water has been installed and approved *(See Water and Sewer Finding 2).*

c. Any cesspools, drywells, or pump chambers discovered on the site must also be abandoned in this manner and locations shown on the final plat *(See Public Health Finding 1).*

d. Any wells that are found during development of this plat shall be properly decommissioned by a licensed well driller with documentation submitted to CCPH prior to final plat approval and all decommissioned wells must be shown on the final plat *(See Public Health Finding 2).*

e. During the site visit an on-site sewage system known as ON0047325; two septic tank lids were observed at the ground surface west of the home and the tank has a capped outlet. This septic system will be required to be abandoned prior to final plat approval *(See Public Health Finding 1).*

D-9 Wetland and Habitat – Prior to Final Plat Approval:

a. The Best Management Practices listed in CCC Table 40.445.030-4 shall be included in the CC&Rs. A draft of the CC&Rs will need to be provided for review prior to final plat.

b. Pursuant to CCC 40.445.030.B.2.d, a conservation covenant shall be recorded in a form approved by the Prosecuting Attorney as adequate to incorporate the other restrictions of this section and to give notice of the requirement to obtain a wetland and/or habitat permit prior to engaging in regulated activities within a wetland, wetland buffer, or designated habitat area. The covenant shall also

include language limiting use of pesticides within 150 feet of wetland and shall include fencing of property boundaries abutting wetland and habitat areas as required under CCC Table 40.445.030-4.

c. Pursuant to CCC 40.445.030.B.2.d, the Final Plat shall clearly show all wetland, wetland buffer, and priority habitat boundaries with a note referencing any required conservation covenant(s).

d. *Pursuant to CCC 40.450.030.F, a permanent physical demarcation along the upland boundary of the wetland buffer and habitat area shall be installed and thereafter maintained. Such demarcation may consist of logs, a tree or hedge row, fencing, or other prominent physical marking approved by the responsible official.*

e. Pursuant to CCC 40.450.030.F, small signs shall be posted at an interval of one (1) per lot or every one hundred (100) feet, whichever is less, and perpetually maintained at locations along the outer perimeter of the wetland buffer and habitat area approved by the responsible official worded substantially as follows:

"Wetland Buffer and Habitat –
Please retain in a natural state"

E	**Building Permits** **Review and Approval Authority: Permit Services & Fire Marshal**

Prior to issuance of a building permit, the following conditions shall be met:

E-1 **Impact Fees** - Impact fees shall be assessed for impacts on schools, parks and transportation facilities based on the following districts: Ridgefield School District (SIF), Park District 10 (PIF) and Mt. Vista Transportation Sub-area (TIF). As found in CCC40.610.040, impact fees are calculated using the rates in effect at the time of building permit issuance.

E-2 **Roof and Crawl Space Drains** - Roof and crawl space drains shall be installed in accordance with the approved As-Built plans, unless a revised plan is approved by the county. These stormwater systems will be owned and maintained by the property owner on whose lot the stormwater system is located *(See Stormwater Finding 2).*

E-3 **Excavation and Grading** - Excavation and grading shall be performed in compliance with CCC 14.07.

E-4 **Setbacks** - The building setbacks shall comply with the R-12 and OR-22 zone *(See Land Use Finding 3).*

E-5 **Building Height** - The building height will be controlled by which zone in which the majority of the lot lies *(See Land Use Finding 3).*

E-6 **Residential Fire Sprinklers** - Homes exceeding 3600 square feet including attached garages will require additional fire protection features including a residential fire sprinkler system when adequate public water and a hydrant is not within required distances If a residential fire sprinkler is required, it will require additional review and permitting by the Fire Marshal *(See Fire Protection Finding 7).*

E-7 **Solid Waste and Recycling** – Signs, pavement markings, or other demarcations shall be installed to ensure that the common waste collection points serving lot accessed by shared driveways are accessible on collection days.

F	**Occupancy Permits** **Review and Approval Authority:**

Prior to issuance of an occupancy permit, the following conditions shall be met:

F-1 **Fire Protection** - A three (3) -foot clear space shall be provided around the circumference of all fire hydrants *(See Fire Protection Finding 3).*

G	**Development Review Timelines & Advisory Information** **Review and Approval Authority: None - Advisory to Applicant**

G-1 **Land Division** - Within seven (7) years of preliminary plan approval, a Fully Complete application for Final Plat review shall be submitted.

G-2 **Department of Ecology SEPA Comments**
Hazardous Waste and Toxics Reduction: Garret Peck (564) 669-0836
The applicant proposes to demolish an existing structure(s). In addition to any required asbestos abatement procedures, the applicant should ensure that any other potentially dangerous or hazardous materials present, such as PCB-containing lamp ballasts, fluorescent lamps, and wall thermostats containing mercury, are removed prior to demolition. It is important that these materials and wastes are removed and appropriately managed prior to demolition. It is equally important that demolition debris is also safely managed, especially if it contains painted wood or concrete, treated wood, or other possibly dangerous materials.

Please review the "Dangerous Waste Rules for Demolition, Construction, and Renovation Wastes," posted at Ecology's website, https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Dangerous-waste-guidance/Common-dangerous-waste/Construction-and-demolition. The applicant may also contact Katy Harvey of Ecology's Hazardous Waste and Toxics Reduction Program at katy.harvey@ecy.wa.gov for more information about safely handling dangerous wastes and demolition debris.

Solid Waste Management: Derek Rockett (360) 995-3176

All grading and filling of land must utilize only clean fill. All other materials may be considered solid waste and permit approval may be required from your local jurisdictional health department prior to filling. All removed debris resulting from this project must be disposed of at an approved site. Contact the local jurisdictional health department or Department of Ecology for proper management of these materials.

Permit for Construction Stormwater: A permit from the Department of Ecology (DOE) is required for any land disturbing activities such as clearing, grading, excavating, stockpiling of fill material, and/or demolition that:

- Disturbs one or more acres of land.; OR
- Are part of a common plan of development or sale that will ultimately disturb one or more acres of land. A common plan of development or sale is an area where multiple, separate, and distinct construction activities may be taking place on different schedules under one plan. In a common plan of development, the disturbed area of the entire plan is used to determine if a permit is required.; AND
- Discharge stormwater from the site into surface water(s) of the state or into storm drainage systems, including ditches, which discharge to state surface waters. Surface waters of the state: Include wetlands, ditches, rivers, unnamed creeks, rivers, lakes, estuaries, and salt water.

The applicant shall Contact the DOE for further information. https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormwater-permit

G-3 **Building and Fire Safety** - Building and fire, life, and safety requirements must be addressed through specific approvals and permits. This decision may reference general and specific items related to structures and fire, life, and safety conditions, but they are only for reference in regard to land use conditions. It is the responsibility of the owner, agent, tenant, or applicant to ensure that Building Safety and Fire Marshal requirements are in compliance or brought into compliance. Land use decisions do not waive any building or fire code requirements *(See Fire Protection Finding 1).*

G-4 **Future Gate(s) -** While no gates are shown on the proposed plan, no gate may be installed across a required fire department access road or driveway without first obtaining and testing of the gate will be required. Split gates with a divided entry and exit side will need 15 feet on either side for a total gate width of 30 feet *(See Fire Protection Finding 6).*

G-5 **Flood Plain Hazard Area –** Any disturbance in the mapped Special Flood Hazard Area associated with Whipple Creek shall be addressed for compliance with CCC 40.420 *(See Flood Hazard Finding 2).*

G-6 **Median and Channelization** - The applicant shall note that with the future scheduled capital project roadway improvements between NE 15th Avenue and NE 26th Avenue on NE 179th Street will restrict the site access intersection to right/in right/out turning movements only *(See Transportation Concurrency Finding 4).*

G-7 **Mitigation Maintenance and Monitoring Plan** - The applicant (or successor in ownership) shall implement the approved mitigation maintenance and monitoring plan and submit performance reports to the County for periodic inspection and approval as specified. The applicant shall maintain the performance standard of 90% survival after year one, 80% survival at year two, 75% plant survival at year three, and at least 30% native woody plant cover by year five. Any areas not meeting this standard shall be replanted, with maintenance and monitoring continuing until the standard has been met. Invasive species, including Armenian blackberry and English ivy, shall be <20% within the mitigation areas. Adaptive management using alternate species may be used in consultation with County Habitat/Wetland Review staff. Volunteer growth may count towards the final numbers required. Monitoring review fees will be required.

H	**Post Development Requirements** **Review and Approval Authority: As specified below**

H-1 **Fire Marshal Requirements** -

a. A three (3) –foot clear spaces shall be maintained around the circumference of all fire hydrants *(See Fire Protection Finding 3).*

b. Access roads shall maintain an unobstructed width of not less than 20 feet and an unobstructed vertical clearance of not less than 13.5 feet with an all-weather driving surface capable of supporting the imposed loads of fire apparatus *(See Fire Protection Finding 4).*

c. Parking is prohibited on access roads that are less than twenty-four (24) feet wide. "NO PARKING – FIRE LANE" signs shall be maintained *(See Fire Protection Finding 5).*

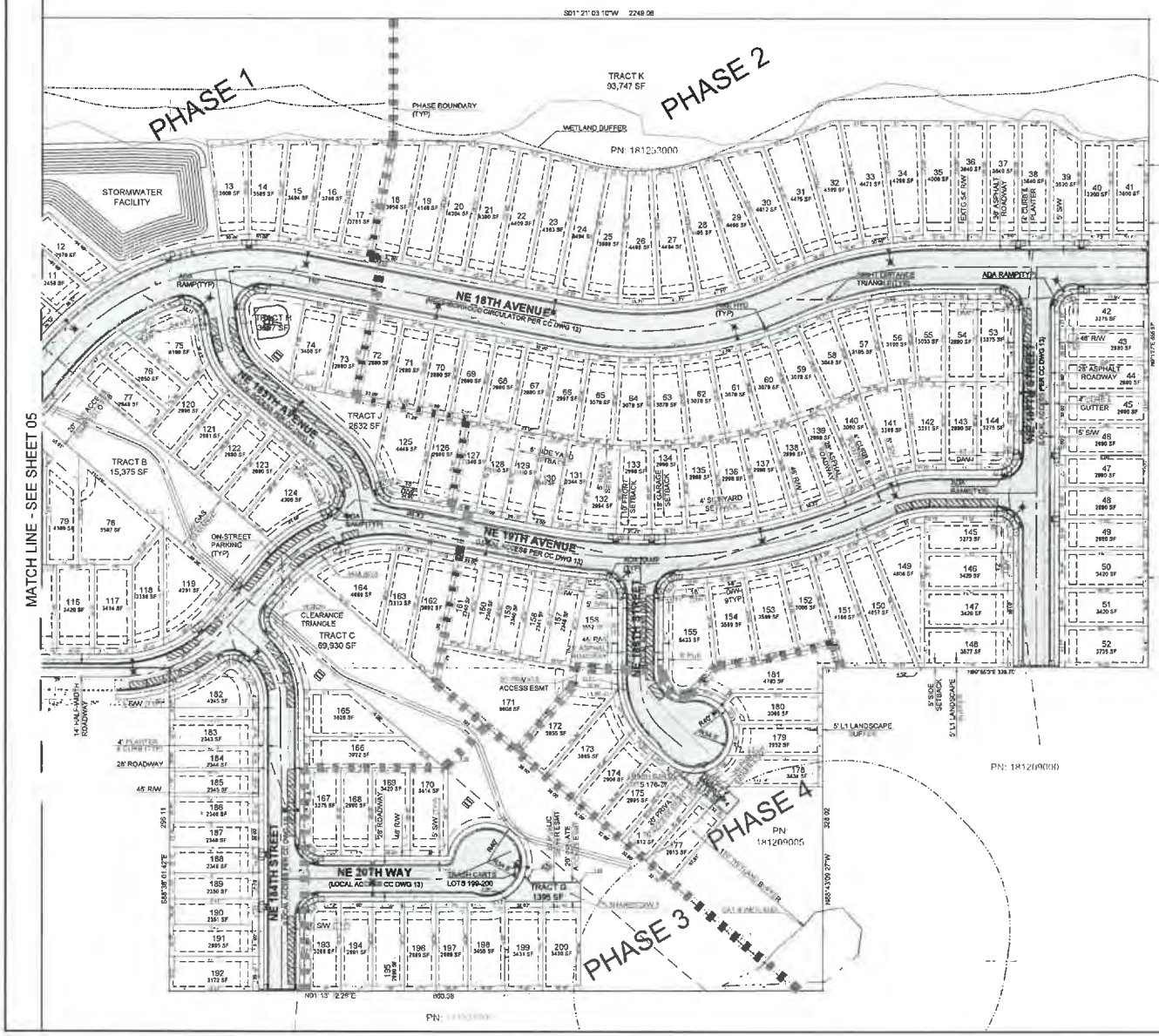
H-2 **Landscape Maintenance** - Maintenance of landscaped areas is the ongoing responsibility of the property owner. Required landscaping must be continuously maintained in a healthy manner. Plants that die must be replaced with in-kind materials unless otherwise authorized by the responsible official. Vegetation shall be controlled by pruning, trimming or otherwise so that it will not interfere with the maintenance or repair of any public utility, restrict pedestrian or vehicular access, or obstruct sight distance at intersections as provided in Section 40.320.020 *(See Land Use Finding 6).*

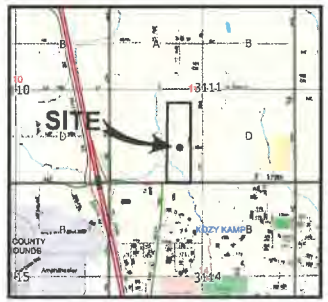
DATED this 6th day of March 2026

Joe Turner, AICP, Hearings Examiner

Three Creeks East Subdivision

Located in the SW ¼ of Section 11, T3N, R1E, W.M.
Clark County, Washington





VICINITY MAP
NOT TO SCALE

APPLICANT:
Ginn Group LLC
502 NE 72nd Street
Vancouver, WA 98685
(360) 768-5025
chad@ginngrp.com

OWNER:
Ginn Group LLC
502 NE 72nd Street
Vancouver, WA 98685

Terrence Wellner, Trustee
23 Westridge Drive
Lake Oswego, OR 97305

Mary Ann Moberly, Trustee
419 NW 209th Street
Ridgefield, WA 98642

CONTACT:
PLS Engineering
Jayson Taylor, PE
604 W Evergreen Blvd
Vancouver, WA 98660
(360) 944-6519
pm@plsengineering.com

SITE INFO:

Site Address:
1804 NE 179th Street
Ridgefield, Washington

Parcel #'s: 181218000, 181208000, 181209005, 181253000

Total Area
181218000 - 9.75 Acres (424,710 sqft)
181208000 - 9.72 Acres (423,333 sqft)
181253000 - 14.90 Acres (648,867 sqft)
181209005 - 4.97 Acres (216,698 sqft)

39.34 Acres
1,713,650 SQFT

Scale 1" = 50'

Legend
Proposed Asphalt Concrete
Proposed Cement Concrete
Future Cement Concrete
Grind and Overlay

811 Know what's **below.** **Call** before you dig.

PLS ENGINEERING

Narrow Lot Site Plan North For:

Three Creeks East Subdivision

A Subdivision Located In Clark County, Washington

Revisions	
1	JULY 2025
2	Preliminary Submittal
3	
4	
5	
6	

Project No. 3535
SCALE: H: 1" = 50'
V: N/A
DESIGNED BY: MAG
DRAFTED BY: MJB
REVIEWED BY: TGJ

06

07

Three Creeks East Subdivision

Located in the SW¼ of Section 11, T3N, R1E, W.M.
Clark County, Washington

LAND USE:
The applicant is proposing to develop the site with 200 single-family detached homes within the OR-22 and R-12 zone in two Phases. The subdivision is also proposed as a Planned Unit Development (PUD) and is subject to the narrow lot development standards and the zero lot line development standards.

Proposed Setbacks:
Front = 10' (18' garage)
Side Street = 10'
Side = 4' (8' between buildings), 5' to property boundary
Side for Zero Lot Line Homes: 0' / 6' (6' between buildings)
Rear = 5'

A site plan is required that demonstrates that utilities, driveways, street trees, and other features have been located and designed to minimize conflicts with one another. This Narrow lot plan shows the required features and demonstrates that conflicts have been minimized.

Narrow lot developments must provide a guest parking space for every three narrow lots. In total 67 spaces are required. These parking spaces are allowed to be located on local access streets. 73 on-street parking spaces are provided throughout the development and are shown on this plan.

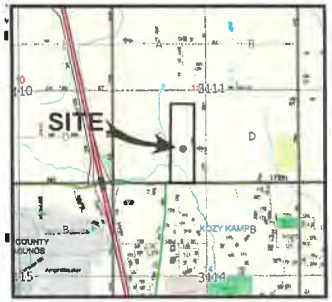
See the landscape plan sheet L1 for details on the location, species, and size of street trees, including the mature heights and crown widths.

Solid waste and recycling will be picked up on the street for all lots. Lots 78-79, 100-106, 171-172, 176-177, and 199-200 are located on shared driveways, and solid waste and recycling pickup locations for these lots are shown on the nearest public road.

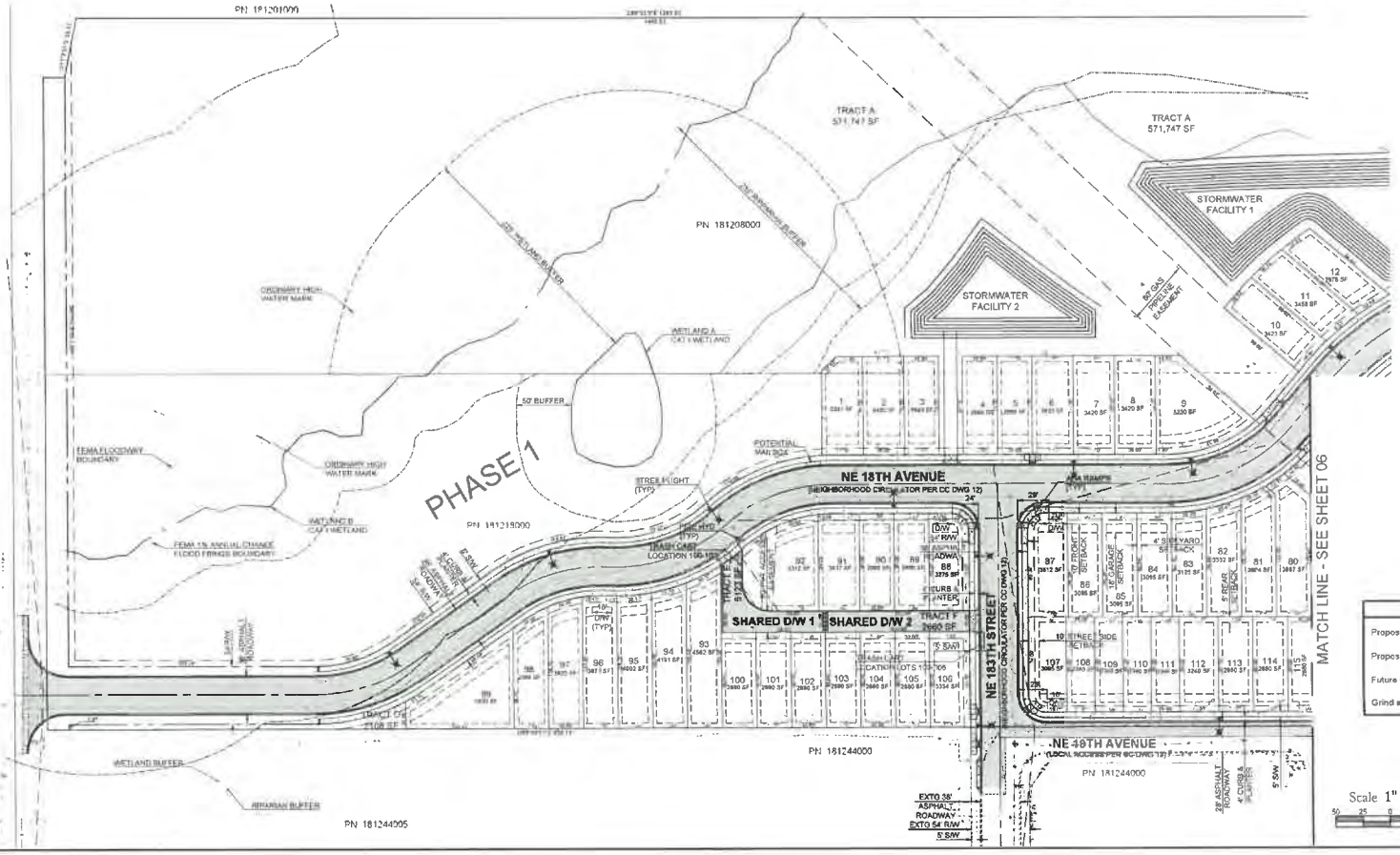
ADA ramps will have 5' landings per Clark County details. Length of ramp runs is unknown and will be determined during final engineering.

SYMBOL	BOTANICAL / COMMON NAME	SIZE	QUANTITY
TREES*			
	ACER BUERGERIANUM 'TROOST' MAPLE	2" cal. 10' HT. MIN.	5
	ACER GRANDIDENTATUM 'SCHMIDT' ROCKY MOUNTAIN ELDER MAPLE	2" cal. 10' HT. min.	39
	ACER RUBRUM 'ARMSTRONG' ARMSTRONG MAPLE	1 1/2" cal. 8' HT. min.	24
	CARPINUS BETULUS 'FASTIGIATA' PYRAMIDAL EUROPEAN HORNBEAM	2" cal. 10' HT. min.	39
	CARPINUS CAROLINIANA 'JFS-KW5' WAYNE FLAME AMERICAN HORNBEAM	1 1/2" cal. 8' HT. min.	31
	PARROTIA PERSICA 'PERSIAN SPIRE' PERSIAN SPIRE PARROTIA	2" cal. 10' HT. min.	39
	PARROTIA PERSICA 'VANESSA' VANESSA PERSIAN PARROTIA	2" cal. 10' HT. min.	64
	TILIA CORDATA 'GLELE' GLENLEE SPIRE LINDEN	2" cal. 10' HT. min.	6
	ZELKOVA SERRATA 'JFS-KW2' KEAMPFERI ZELKOVA	1 1/2" cal. 8' HT. min.	34
	ZELKOVA SERRATA 'JFS-KW9' CITY SPIRE ZELKOVA	2" cal. 10' HT. min.	43
GROUNDCOVER			
	RIVER ROCK OR BARK PER OWNER ADJUST AS NEED PER FINAL DRIVEWAY PLAN		
	LANDSCAPE PER OWNER		
	STORMWATER PLANTING, REFER TO CIVIL PLANS		

STREET TREE LOCATIONS PER FINAL DRIVEWAY PLAN



VICINITY MAP
NOT TO SCALE



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Future Cement Concrete	
Grind and Overlay	

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Know what's below. Call before you dig. 811

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chad@ginngrp.com

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39.34 Acres
1,713,650 SQFT

PLS ENGINEERING

Narrow Lot Site Plan South For:

Three Creeks East Subdivision

A Subdivision Located In Clark County, Washington

Revisions						
1	7/17/2025	Preliminary Submittal				
2						
3						
4						
5						
6						

Project No. 3855
SCALE: H: 1" = 50'
V: N/A
DESIGNED BY: MAG
DRAFTED BY: MAG
REVIEWED BY: TGT

05

07

Role	Company Name	Name	Address 1	Address 2	City	State	Zip Code	Email Address
Planner	Clark County	Bryan Mattson						
Applicant	Ginn Group		502 NE 72nd St		Vancouver	WA	98665	chad@ginngrp.com
Owner	Ginn Group		502 NE 72nd St		Vancouver	WA	98665	phil@ginngrp.com
Contact Person	PLS Engineering		604 W Evergreen Blvd		Vancouver	WA	98660	pm@plsengineering.com
N/H Association	Four Creeks Nbhd Assoc							fourcreeksna@gmail.com
	Clark County	Desiree de Monye						desiree.demonye@clark.wa.gov
Type II & III Decisions ONLY	Clark County	Susan Ellinger						susan.ellinger@clark.wa.gov
	Vancouver School Distrct	Gary Yarne						gary.yarne@vansd.org
		Jeff Roberts						jeff@crandallgroup.com
		Heidi Pozzo						hcpheidi@yahoo.com
Public Commenters								
		David Barritt and Cindy Hosszu	2021 NE 189th Street		Ridgefield	WA	98642	swkp.david@engineer.com
		Karen S. Gimse	17812 NE 17th Avenue		Ridgefield	WA	98642	jkgimse@msn.com
		Tina Eifert	18611 NE 20th Avenue		Ridgefield	WA	98642	eifertgirl@gmail.com

EXHIBIT LIST

oject Name: **Three Creeks East Subdivision**
ase Number: **PLD-2025-00077**

EXHIBIT NUMBER	DATE	SUBMITTED BY	DESCRIPTION
1	7/14/25	Applicant	Application Package
2	8/11/25	CC Land Use	Legal Lot Determination
3	8/25/25	CC Land Use	Fully Complete
4	8/28/25	CC Fire Marshal	Fire Marshal Comments (see Exhibit 36 for Revised FM Comments)
5	9/22/25	CC Development Engineering	Development Engineering Early Issues
6	9/29/25	CC Land Use	Early Issues Memo
7	10/1/25	CC Land Use	Notice of Type III Application
8	10/1/25	CC Land Use	Affidavit of Mailing - Exhibit 7
9	10/1/25	WA State Depart of Ecology	SEPA Submitted
10	10/1/25	WA State Depart of Ecology	SEPA Published
11	10/7/25	Applicant	Sign Posting Affidavit
12	10/13/25	David Barritt	Comments - Barritt
13	10/15/25	WA State Depart of Ecology	SEPA Comments
14	10/16/25	Cowlitz Indian Tribe	Cowlitz Indian Tribe Comments
15	10/20/25	Applicant	Applicant OK to postpone Hearing until Early Issues are resolved
16	10/22/25	CC Land Use	Notice of Hearing Cancellation
17	10/22/25	CC Land Use	Affidavit of Mailing - Exhibit 16
18	10/23/25	Applicant	Applicant Response Letter to Early Issues
19	10/23/25	Applicant	Revised Preliminary Plat -North
20	10/23/25	Applicant	Revised Narrow Lot Site Plan - North
21	10/23/25	Applicant	Revised Preliminary Grading Plan - South
22	10/23/25	Applicant	Revised Preliminary Grading Plan - North
23	10/23/25	Applicant	Neighbor Confirmation of Future Full-Width Arterial Requirement

Copies of these exhibits can be viewed at:
Department of Community Development
Development Services Division
1300 Franklin Street
Vancouver, WA 98666-9810

EXHIBIT NUMBER	DATE	SUBMITTED BY	DESCRIPTION
24	10/23/25	Applicant	Neighbor Confirmation of Grading Easement
25	10/23/25	Applicant	Revised Technical Road Modification Narrative
26	10/23/25	Karen S. Gimse	Public Comments from Karen S Gimse 10-25-25
27	10/23/25	Applicant	Revised Stormwater TIR 10-25-25
28	11/5/25	CC Wetland and Habitat Review	CC Wetland and Habitat Review staff revisions requested 11-5-25
29	11/12/25	Applicant	Revised Buffer Reduction and Onsite Mitigation Plan 11-12-25
30	11/13/25	CC Development Engineering	Continuing Early Issues and Design Notes 11/13/25
31	11/19/25	CC Wetland and Habitat Review and Applicant	Applicant acceptance of conditional approval to resolve Wetland and Habitat issues
32	11/25/25	CC Land Use	Notice of Hearing Date Change
33	11/25/25	CC Land Use	Affidavit of Mailing - Exhibit 32
34	12/8/25	Applicant	Hearing Sign with Updated Hearing Date
35	12/19/25	CC Development Engineering	Major Road Modification Report and Recommendation
36	12/22/25	CC Fire Marshal	REVISED Fire Marshal Comments
37	12/23/25	CC Wetland and Habitat Review	Wetland and Habitat Staff Report (WHR-2025-00191
38	12/24/25	CC Public Works	Transportation Concurency Staff Report
39	12/30/25	CC Development Engineering	Development Engineering Staff Report
40	1/7/26	CC Land Use	Staff Report and Recommendation
41	1/7/26	CC Land Use	Affidavit of Mailing - Exhibit 40
42	1/12/26	CC Wetland and Habitat Review	Wetland and Habitat Review staff's request for an additional condition
43	1/16/26	CC Wetland and Habitat Review	Wetland and Habitat Review staff's request to change Condition D-8.a code reference
44	1/20/26	Steve Morasch	Memo Regarding Secondary Emergency Access from Steve Morasch on behalf of the applicant dated 1-19-2026
45	1/29/26	Tina Eifert	Public Comments from Tina Eifert submitted 1-29-26
46	2/3/26	CC Land Use	Transcript
47	2/3/26	CC Land Use	PowerPoint
48	2/12/26	CC Development Engineering	Staff Memo regarding Exhibit 44 and Conditions A-1.q, A-1.r and A-1.p

Copies of these exhibits can be viewed at:
Department of Community Development
Development Services Division
1300 Franklin Street
Vancouver, WA 98666-9810

EXHIBIT NUMBER	DATE	SUBMITTED BY	DESCRIPTION
49	2/12/26	Applicant	PSR-2023-00158 South Ridge Central Apartments Staff Report and Decision
50	2/12/26	Applicant	PSR-2020-00098 NE 179th Street Apartments Staff Report and Decision
51	2/12/26	Applicant	179th Street Circulation and Access Management Plan
52	2/12/26	Applicant	Applicant's density breakdown for the phasing plan
53	2/19/26	David Barritt	Public Comments from David Barritt submitted 2-19-26
54	2/19/26	Applicant	Map of 179th Street Circulation and Access Management Plan with applicant notes submitted 2-19-26
55	2/25/26	Steve Morasch	Final Rebuttal submitted by Steve Morasch 2-25-26
56	3/6/26	CC Land Use	Examiner Decision
57	3/6/26	CC	Affidavit of Mailing - Exhibit 56

Copies of these exhibits can be viewed at:
Department of Community Development
Development Services Division
1300 Franklin Street
Vancouver, WA 98666-9810

Exhibit J

Type III Land Division and Environmental Review Staff Report and Recommendation

Project Name:	**Viers PUD**
Case Number:	**PLD-2022-00121**
Location:	*This parcel is not yet addressed but it abuts 4805 NE 174th Street, Vancouver, WA 98686 along the west and south sides.*
Parcel Number(s):	181682-000, located in the NE ¼ and SE ¼ of Section 13, Township 3 North, Range 1 East, Willamette Meridian
Request:	The applicant requests Subdivision and Shoreline Exemption approval to divide 44.87 acres into 84 single-family residential lots, utilizing the Planned Unit Development standards, in the R1-20 zone and the Mill Creek Overlay.
Applicant:	Hinton Development Services LLC 14010 A NE 3rd Court, Suite 106 Vancouver, WA 98685 rob@hintondevelopment.com
Owner:	H2 Viers LLC 14010 A NE 3rd Court, Suite 106 Vancouver, WA 98685 rob@hintondevelopment.com
Contact:	PLS Engineering 604 W Evergreen Blvd Vancouver, WA 98660 pm@plsengineering.com

Recommendation
Approval, Subject to Conditions

Land Use Review Manager's Initials: BD **Date issued: 5/8/2024**

Public Hearing date: 5/23/2024

Community Development
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Phone: (564) 397-2375 Fax: (564) 397-2011
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For an alternate format, contact the Clark County ADA Compliance Office.
Phone: (564)397-2322
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County Review Staff

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Biologist	Ariel Whitacre	564.397.4714	Ariel.whitacre@clark.wa.gov

Comprehensive Plan/Zoning/Zoning Overlay: Urban Low Density Residential/R1-20/Mill Creek Overlay

Applicable Laws

Clark County Code: Title 14 (Building Safety), Title 15 (Fire Prevention), Chapter 40.200 (General Provisions), Section 40.220.010 (Single-Family Residential Districts), Section 40.250.060 (Mill Creek Overlay District), Chapter 40.350 (Transportation & Circulation), Section 40.350.020 (Transportation Concurrency), Chapter 40.370 (Sewer and Water), Chapter 40.386 (Storm Water & Erosion Control), Chapter 40.440 (Habitat Conservation), Chapter 40.450 (Wetland Protection), Chapters 40.500 and 40.510 (Procedures), Section 40.520.010 (Legal Lot Determination), Section 40.520.080 (Planned Unit Development), Section 40.540.040 (Subdivisions), Section 40.550.010 (Road Modifications), Chapter 40.570 (SEPA), Section 40.570.080 (SEPA Archaeological), Chapter 40.610 (Impact Fees), Title 24 (Public Health), RCW 58.17, and the Clark County Comprehensive Plan.

Neighborhood Association and Contact

Four Creeks Neighborhood Association
fourcreeksna@gmail.com

Vesting

An application is reviewed against the subdivision, zoning, transportation, stormwater, and other land development codes in effect at the time a fully complete application for preliminary approval is submitted. If a pre-application conference is required, the application shall earlier contingently vest on the date the fully complete pre-application is filed. Contingent vesting requires that a fully complete application for substantially the same proposal is filed within 180 calendar days of the date the county issues its pre-application conference report. Contingent vesting does not apply to stormwater or concurrency standards.

An initial pre-application conference on this matter was held on 9/10/2020. However, a second preapplication conference was applied for and then held 9/15/2022. Neither the first nor second preapplication conferences were determined to be contingently vested.

The fully complete application was submitted on 12/30/2022 and determined to be fully complete on 1/24/2023. Given these facts, the application is vested to standards in effect on 12/30/2022, the date the fully complete application was submitted. Project vesting does not apply to stormwater standards. There are no disputes regarding vesting.

Time Limits
The application was determined to be fully complete on 1/24/2023 but was placed on hold for a total of 353 days. Therefore, the county code requirement for issuing a decision within 92 days lapses on 5/13/2024. The state requirement for issuing a decision within 120 calendar days, lapses on 6/10/2024.

Public Notice
A Notice of Application and public hearing was mailed to the applicant, the Four Creeks Neighborhood Association and property owners within 300 feet of the site on 3/9/2023 and a development sign was posted on the subject property on 4/16/2024.

Public Comments

Comment Submitted by	***Date Received***
Washington Department of Fish and Wildlife *5525 South 11th Street* *Ridgefield, WA 98642* *Fish and Wildlife staff discussed the potential for tributaries to support fish life and impacts to stream buffers, wetland buffers, and biodiversity areas [See Exhibit 13].*	*4/7/2023*

Staff Response
The application was placed on hold for a total of 353 days in part to revise their critical areas reports, mitigation plans and other submittal items that county Wetland and Habitat Review staff did not find sufficient or approvable. The recommended conditional approval of this Staff Report and Recommendation is a result of site visits and several revised iterations of the submittal items and this proposal. Please see the Habitat Preservation and Wetland Conservation sections of this report for greater detail.

Public Comments

Comment Submitted by	***Date Received***
State of Washington Department of Ecology *PO Box 47775* *Olympia, WA 98504* *Because two separate public notices were sent, Ecology responded twice. The Department of Ecology discussed Solid Waste Management, Toxics Cleanup, Water Quality/Watershed Resources, and listed construction activities that require coverage under the Department of Ecology Construction Stormwater General Permit, [See Exhibits 8 & 45].*	*3/23/2023 & 5/1/2024* *(two notices were sent)*

Staff Response
The applicant has been provided a copy of the Ecology letter and is required to meet their requirements and obtain any necessary permits. Ecology expressed concern with Solid Waste Management and Water Quality/Watershed Resources. County stormwater erosion control requirements mirror Ecology water quality standards and staff has made Ecology's comments part of the advisory conditions of approval (See Condition G-2).

Public Comments

Comment Submitted by	***Date Received***
Lower Columbia Fish Recovery Board *11018 NE 51st Circle* *Vancouver, WA 98682* *The LCRB discussed that the application materials lacked sufficient detail to support a detailed assessment of potential impacts to aquatic resources including ESA listed salmon and steelhead that occur on the project site. They also indicated that the SEPA checklist lacks meaningful information on potential impacts and mitigation measures and continued to provide several specific deficiencies, [See Exhibit 9].*	*3/24/2023*

Staff Response
The application was placed on hold for a total of 353 days in part to revise their critical areas reports, mitigation plans and other submittal items that county Wetland and Habitat Review staff did not find sufficient or approvable. The recommended conditional approval of this Staff Report and Recommendation is a result of site visits and several revised iterations of the submittal items and this proposal. Please see the Habitat Preservation and Wetland Conservation sections of this report for greater detail.

Comment Submitted by
Five (5) other separate comments were submitted from Dean Hergesheimer and David Gilroy during the comment periods for the initial and second notices and expressed concerns with the following issues [See Exhibits 17, 18, 42, 43, & 44]:

- *Concern that the proposal does not comply with emergency access provision of the county's development code that requires a second access road when more than 100 lots are served by a single road,*
- *Concern with not offering an in-person hearing option,*
- *Confusion with timelines as stated in the Notice,*
- *Requesting that the Pleasant Valley North Pump Station applied for separately under PSR-2022-00068 should be reviewed concurrently with this proposal,*
- *Concern that drainpipe has been installed previously and without approval to lessen the functionality and change staff's classification of the onsite wetlands, and*
- *Concern that Wetland H is the location of an old, buried waste disposal pit and should be investigated.*

Staff Response
Staff is limited to comment solely on whether the proposed development meets the minimum requirements of Clark County Code. Staff cannot comment on such topics such as: whether an

in-person hearing is required when it isn't required under the current development code, confusion regarding the timelines if the project is being reviewed in compliance with Section 40.510.030 Type III Process – Quasi-Judicial Decisions, or whether separate applications should be required to be reviewed concurrently when the code does not require it. Regarding the other concerns, the Transportation Findings section of this report clarifies the emergency access provisions of the County's development code and Development Engineering staff is not recommending a second access to NE 50th Avenue or NE 179th Street. Regarding the concern that drainpipe has been installed without approval beforehand, Clark County Code Enforcement staff visited the site as a result of this comment and did not determine there was enough evidence to take Code Enforcement action. Regarding the potential of an old buried waste disposal pit, it was not identified by Ecology, the Clark County Health Department, nor Community
Development staff during site visits; therefore staff did not take action to further require additional exploratory excavation.

However, staff has found that the proposal as conditioned, will meet the minimum standards for Land Use, Transportation and Circulation, Stormwater and Erosion Control, Wetland Protection, Habitat Conservation, the Shoreline Management Program, and other applicable code sections as conditioned in this report (please see the rest of the staff report for more detailed discussions on specific code requirements). Whether these standards are enough to mitigate all perceived negative impacts is not the function of this report; only whether the proposal meets the minimum standards in place at the time of vesting.

Project Overview

The applicant is requesting to subdivide 44.47 acres into 84 new single-family lots in the R1-20 zone and Mill Creek Overlay district using the Planned Unit Development standards.
The site is currently undeveloped except for a small single-story agricultural structure in the center of the site and a manure pond in the west-central portion of the site.

The main access to the site will be from NE 174th Street located on the north end of the site. This street is a Collector (C-2b) that is proposed to be developed to the applicable half-width standards. NE 45th Ave is a proposed public local access road that serves as the main access road into the subdivision from the exiting public roadway network. This road is proposed to intersect with NE 174th Street approximately 175' from the western property line. This is the only location along the site frontage where sight distance can be met due to the existing vertical curves on NE 174th Street. NE 50th Ave is a Minor Arterial (M-2cb) that is not currently proposed to be improved along the site frontage due to disproportional impacts of the overall frontage and cross-circulation requirements. The deficient vertical curves on the roadway, mill creek critical areas, and potentially deficient culvert make the cost of potential improvements of this roadway disproportional to the impacts created by proposal. NE 169th, 170th and 171st Circle are proposed private roadways that end in cul-de-sac turnarounds. The roadways are currently proposed to have a 28' width and attached sidewalk on one side. The remaining roadways proposed will be public local access roadways. Lastly, a northbound left turn lane from NE 50th Ave to NE 174th Street is proposed to be improved with this development.

Stormwater will be collected and treated onsite before being routed onsite detention facilities. Infiltration of stormwater is not feasible for the site.

Mill Creek runs through the eastern end of the site with its associated flood plain, fringe wetlands and buffers, riparian buffers, and shoreline designation. A few isolated wetlands are proposed to be filled with this application. Mitigation for impacts will be accomplished by preserving the high-quality wetland adjacent to Mill Creek. Riparian buffer averaging will be utilized to avoid impacts to the riparian areas. Major development is not proposed within the shoreline, so an exemption is included with this proposal.

Site vegetation primarily consists of grassy open areas with several coniferous trees in the north and south portions of the site and dense coniferous trees along the east side of the site. Topographically, the site is relatively flat to gently sloping terrain throughout the northwest half of the site with slope grades ranging from 0 to 15 percent. Slopes adjacent to Mill Creek in the southeast half of the site approach 80 percent and are identified as potential landslide hazards according to *Clark County Maps Online*. Site elevations generally range from 170 feet above mean sea level (amsl) at the base of Mill Creek in the southeast portion of the site to 250 feet in the northwest portion of the site. Lastly, the archaeological predictive indicator for the site is moderate to moderate-high.

The subject site is serviced by Clark-Cowlitz Fire Rescue, the Battle Ground School District, Clark Public Utility electrical and water systems, and the Clark County Regional Waste Water system.

The applicant submitted application materials including preliminary plans, a project narrative, a Stormwater Technical Information Report (TIR), Traffic Report, Road Modification Request, Critical Areas Report, Geotechnical Analysis, Sight Distance Certification, Proof of submittal to DAHP of an Archaeological Predetermination, A Shoreline Exemption request, and a State Environmental Policy Act (SEPA) checklist.

Comprehensive Plan, Zoning and Current Land Use

Compass	Comp Plan	Zoning[1]	Current Land Use
Site	UL	R1-20	Single Family Residence
North	UL	R1-7.5	Single Family Residences
East	Industrial	R-5 and BP	Single Family Residences and Critical Areas
South	UL	R1-20	Single Family Residences and Critical Areas
West	UL	R1-10	Single Family Residences and Vacant Land

Staff Analysis

Staff first analyzed the proposal in light of the 16 topics from the Environmental Checklist (see list below). The purpose of this analysis was to identify any potential adverse environmental impacts that may occur without the benefit of protection found within existing ordinances.

1. Earth
2. Air
3. Water
4. Plants
5. Animals
6. Energy and Natural Resources
9. Housing
10. Aesthetics
11. Light and Glare
12. Recreation
13. Historic and Cultural Preservation
14. Transportation

[1] It is important to note that the entire site is located within the Mill Creek Overlay District.

7. Environmental Health
8. Land and Shoreline Use
15. Public Services
16. Utilities

Staff then reviewed the proposal for compliance with applicable code criteria and standards in order to determine whether all potential impacts could be mitigated by the requirements of the code. Staff's analysis also reflects review of agency and public comments received during the comment period, and knowledge gained through a site visit.

Major Issues

Only the major issues, errors in the development proposal, and/or justification for any conditions of approval are discussed below. Staff finds that all other aspects of this proposal not discussed below comply with the applicable code requirements.

Land Use

Finding 1 – R1-20 Zoning Uses and Development Standards

According to Table 40.220.010-1, the R1-20 zone allows detached single-family residential dwellings outright and residential Planned Unit Developments (PUD)'s are permitted subject to standards put forth in Section 40.520.080.

The lot requirements and setbacks of the R1-20 zone will not be applied because the applicant is proposing a PUD. PUDs provide design flexibility and allow standards to be varied without the need for a variance. Zoning standards that may be varied without the need of a variance include, but are not limited to, lot standards, setbacks, landscaping, and parking *(See also Land Use Finding 3).*

Table 40.220.010-2 prescribes a residential density range for PUDs in the R1-20 zone of 2.2 – 1.4 dwelling units per acre. Density in this case, is calculated based on the gross area of the site minus any public rights-of-way, private road easements or street tracts. Therefore, with a net area of 39.11 acres (44.47 acres total area minus 4.15 acres of public right-of-way plus 1.21 acres of private roadway), the subject development is required to provide a minimum of 55 lots and is allowed a maximum of 86 lots. The applicant proposes 84 lots, which is within the prescribed density range for PUDs in the R1-20 zone.

Finding 2 – Mill Creek Overlay Standards

The subject parcel is located in the Mill Creek Overlay District, as depicted in CCC Figure 40.250.060-1. Therefore, the following additional standards shall apply to this development:

1. *New lots created adjacent[2] to urban subdivision lots existing at the time of the adoption of the Mill Creek Overlay District shall meet or exceed the average lot size of the abutting subdivision lots unless there are at least two hundred (200) feet of open space between the existing and proposed lots.*

The subject site is not located adjacent to any urban subdivision lots existing at the time of the adoption of the Mill Creek Overlay District; therefore, this standard is inapplicable.

[2] "Adjacent" means near, close; for example, an industrial district across the street or highway from a commercial district shall be considered as "adjacent."

2. *Prior to approval of any development that would add traffic to NE 37th Avenue, additional access via a public road connection to NE 40th Avenue or NE 174th Street must be assured.*

The proposal will not add traffic to NE 37th Avenue; therefore, this standard is inapplicable.

3. *A minimum lot size of nine thousand (9,000) square feet is required for all land divisions in the R1-10 and R1-20 districts proposing to develop under the density transfer provisions of Section 40.220.010(C)(5), or the planned unit development provisions of Section 40.520.080. The exceptions to lot sizes in Section 40.200.050 shall still apply.*

Because the proposal is for a PUD, this standard applies. No lots are less than 9,000 square feet in area.

Finding 3 – Planned Unit Development Standards
According to applicability standards put forth in Section 40.520.080, PUDs shall be located on a minimum site size of 6 acres. The subject site is approximately 44.87 acres; therefore, in compliance with this standard.

PUDs provide design flexibility and allow standards to be varied without the need for a variance. Zoning standards that may be varied without the need of a variance include, but are not limited to, lot standards, setbacks, landscaping, and parking.

The applicant proposes to vary from minimum lot standards of the R1-20 zone as prescribed in Table 40.220.010-2:

Table 40.220.010-2. Lot Requirements					
Zoning District	**Residential Density for PUDs (d.u./acre)[1]**	**Min. Lot Area (sq. ft.)**	**Max. Average Lot Area (sq. ft.)**	**Average[2,3] Min. Lot Width (feet)**	**Average[2,3] Min. Lot Depth (feet)**
R1-20	2.2 – 1.4	20,000	30,000	100	100

The applicant proposes to reduce the standard minimum lot area from 20,000 square feet to 9000 square feet and reduce the minimum lot width from 90 feet to 70 feet.

The applicant proposes to vary from the minimum setbacks of the R1-20 zone as prescribed in Table 40.220.010-3:

Table 40.220.010-3. Setbacks, Lot Coverage and Building Height						
Zoning District	Minimum Setbacks				Maximum Lot Coverage	Maximum Building Height (feet)
	Front[3] (feet)	Side		Rear (feet)		
		Street (feet)	Interior (feet)			
R1-20	10[3]	10	10[9]	20	50%[4]	35[7]

The applicant is proposing to reduce the side yard setback from 10 feet to 5 feet.

All PUDs are required to provide a minimum of 12% open space for active or passive recreational purposes which is based on the net site area. These areas can include more active features such as jogging trails, child play equipment, open fields for pick-up games, game courts, swimming pools, club houses, picnic areas and pavilions. More passive recreation includes natural protected areas and open space with features like access trails, benches, interpretive signs and view corridors. All open space shall be conveyed to and permanently maintained by a home-owners association unless a public agency agrees to maintain the open space and any structures or improvements located on it *(see Condition D-1.a)*.

A minimum of 12% open spaces based on net site area is required. The site is 44.47 acres in size. 190,135 square feet is proposed to be dedicated to the county for public right-of-way and 55,286 square feet is proposed for private roadway areas. The net total area is 39.25 acres, therefore a minimum of 4.71 acres must be set aside as open space.

Approximately 20 acres are proposed to be retained in a tract that will consist of active/passive open space, critical areas, and stormwater facilities. This corresponds to approximately 45% of the site. New trails will be installed that connect into the existing trails and pathways within the wooded areas of the site. The approximately 3000 lineal feet (over 0.5 miles) of trails will provide for ample active space for the future residents. A park area is located on the south end of the site that includes a grass play area and a play structure. Benches and picnic tables are also located throughout the open space to allow for additional passive uses of the open space. In summary, the provided active recreation includes jogging trails, child play equipment, and picnic areas. The provided passive recreation areas include significant natural protected areas including Mill Creek and associated wetlands, access trails, and benches that provide views of the natural areas. The usable open space provided in the development is approximately 2 acres in size and the remaining open space includes critical areas, steep slopes, and stormwater facilities. The proposed open space meets the minimum PUD standards.

In accordance with 40.520.080.C.5, all PUDs shall provide street trees on public and private roads, with one (1) street tree provided at an average of each twenty-four (24) linear feet. Based on the Preliminary Landscape Plans in Exhibit 29, it appears that trees are being proposed at 30-foot intervals. In order to comply with the PUD standards, the applicant shall submit a landscape plan prior to Construction Plan Review that indicates a tree every 24 feet, In the event the interval cannot be met due to miscellaneous infrastructure, the tree will still be

[3] Front setbacks for garage fronts in these zones shall be a minimum of eighteen (18) feet.
[4] Carports and solar energy systems are excluded from this provision; provided, that the total lot coverage limitation is not exceeded by more than ten percent (10%) as a result of these exceptions.

required but placed as nearby as practical *(See Condition A-9.a)*. Tree species shall be selected from the Clark County Standard Details Manual or specified by a certified landscape architect.

In accordance with 40.520.080.C.6, street lighting is required on all internal roadways. While the applicant states in the narrative that street lights are shown throughout the development to comply with the required PUD design elements, staff was not able to find this lighting plan. Therefore, an outdoor lighting plan in conformance with requirements put forth in Table 40.510.050-1, shall be provided for staff review and approval that shows the areas of illumination for each outdoor light to ensure compliance with the PUD street lighting standard *(see Conditions A-9.b)*.

In addition to the standards noted above, the Hearing Examiner shall find that the following three conditions exist:

a. The alternate design proposed will provide a plan equal or superior to the standard being varied;

b. Through lot size, setbacks, building orientation, and screening, the proposed PUD shall provide a gradual transition adjacent to lower density neighborhoods or nonresidential uses; and,

c. The applicant proposes design features that may include but are not limited to, design centered on protected natural areas, front porches/recessed garages, pedestrian-friendly orientation, benches/gazebos, water features, recreational areas, stormwater systems designed as features, and affordable housing.

Analysis
The applicant is proposing to modify three zoning standards to accommodate the allowed density within the buildable portions of the site. The applicant proposes to reduce the standard minimum lot area from 20,000 square feet to 9000 square feet, reduce the minimum lot width from 90 feet to 70 feet and reduce the side yard setback from 10 feet to 5 feet. The applicant's narrative indicates,

> *"The overall plan is superior to the standards of the base zone due to the additional amenities and design features that are provided within the site that otherwise would not be included. Street trees and streetlights will be provided along both the public and private roadways. A center island within the road as a design feature at the entrance of the site. Ample open space for active and passive recreation will be provided that will benefit the future residents. The subdivision is designed to prioritize views and access to the open space for the general neighborhood. Each of the cul-de-sac roadways end with views and access to the open space. This open space will be improved with play areas, picnic areas, and over 0.5 miles of trails.*
>
> *While there is no written limitation to modifying lot size in a planned development, similar planned development applications have had limitations imposed relating to approval criteria 1. The Lacamas Prairie Estates PUD was limited to a maximum lot size reduction of 50% along the site perimeter and a 67% reduction internal to the development. The Hearings Examiner found that lot reductions of up to 67% could be seen as being equal or superior to the standards. The 50% lot reduction along the perimeter was imposed to comply with approval criteria 3. The larger perimeter lots provide a gradual transition adjacent to lower density neighborhoods.*

While the PUD approval criteria is subjective and setting dependent, the similarities of the Lacamas Prairie PUD and the Vier PUD site are significant enough that the applicant feels that similar constraints should apply to the site to show that the applicable approval criteria has been met. The Lacamas Prairie PUD is located in the R1-20 zone, comprised of over 80 acres, and resulted in 120 lots. The location of the site is at the edge of the urban growth boundary and had large neighboring lots with both residences and agricultural uses. The site includes significant critical areas that were largely preserved in large open space tracts that are maintained by an HOA. Approximately 0.4 miles of trails within critical area buffers were provided as amenity space in addition to picnic areas and a small park area. Streetlights and street trees were also provided in the development. All of these features are similar to the proposed Viers PUD. Some features also that show the Viers PUD is superior to the standards that applied to the Lacamas Prairie PUD. While Viers site is smaller and has less lots, the amenities provided are similar or greater size. The Vires PUD also results in significantly less critical area impacts and wetland fill. The applicant is also not proposing as significant of a lot reduction. The lots are proposed to be reduced by a maximum of 55% on the interior of the site. All of these factors show that the Viers PUD complies with the applicable approval criteria."

Staff agrees with the applicant in regard to these PUD standards being somewhat subjective and also agrees that the Lacamas Prairie Estates PUD Decision can be used as a previous example for applying these standards. Staff accepts that the proposal provides a plan equal or superior to the standard being varied in large part because of the large area dedicated as open space and the associated amenities and connecting trails being proposed and/or retained. Furthermore, in the Lacamas Prairie PUD Decision, the Examiner indicated that lots no smaller than one third of the base zoning size should be accepted under PUD standards and still meet the equal or superior criterion. One third of 20,000 square feet is 6,600 square feet, and the smallest proposed lot in the applicant's proposal is 9,000 square feet. Therefore, staff find that the proposed plan provides an equal or superior plan than the base zoning standards being varied.

In further applying the Lacamas Prairie PUD Decision *(Exhibit 46),* the Hearing Examiner determined that a 50% lot reduction from the base standard would be acceptable for providing a gradual transition to lower density neighborhoods or nonresidential uses. All lots proposed along the perimeter are no less than 10,000 square feet; therefore, in compliance with this previous interpretation. Additionally, the applicant has proposed a rear 20' setback along all lots on the perimeter of the development that helps to further comply with this gradual transition requirement. However, Lots 1, 8, 4, 5, 70, 81, and 82 all have side setbacks of 5' proposed along the perimeter, which is a reduction of the standard R1-20 setback of 10 feet. Staff recommends increasing the side setback on these lots only on the side that abuts the perimeter to the standard 10 feet (all other lots can remain to use the proposed 5 foot reduced setback per PUD flexibility allowances). A condition has been added to add the minimum setbacks to the plat and to ensure compliance *(See Conditions D-1.b and E-4).*

Lastly, staff have determined that the applicant has included proposed design features listed by the third approval criterion by including design features such as designing lots and views centered on protected natural areas, proposing a pedestrian-friendly orientation, and including benches and recreational/picnic areas throughout the development.

Finding 4 - Pedestrian Facilities
According to state platting laws (RCW 58.17.110) appropriate provisions shall be made to assure safe walking conditions for students who only walk to and from school.

The subject development is located within the Battle Ground School District, and specifically within the boundaries of Pleasant Valley Primary School, Pleasant Valley Middle School and Prairie High School. The applicant provided a letter from the Executive Director of Facilities and Operations at the District. The letter indicates that all students will be bused from this location, with bus stops as yet undetermined; therefore, the applicant is not required to provide safe walking conditions, because school bus transport will be provided for all students living in this development.

Finding 5 - County State Platting Standards
With conditions of approval, staff finds the proposed subdivision will make appropriate provisions for the public health, safety and general welfare of the community. Connection to public water and sewer facilities, as well as treatment of any future stormwater runoff will be provided to protect groundwater supply and integrity. Impact fees will also be required to ensure that the development will contribute a proportionate share toward the costs of school, park and transportation facilities, maintenance and services.

Conclusion (Land Use)
Staff concludes that the proposed preliminary plan, subject to conditions identified above, meets land use requirements of the Clark County Code.

Archaeology
Finding 1 - Applicability
The development site is located within moderate to moderate-high to high probability areas for the discovery of archaeological resources, as designated on the Archaeological Predictive Model Map of the Clark County. Also, because a SEPA was triggered, an Archaeological Predetermination was required.

Finding 2 - Pre-determination
The applicant has submitted an archaeological pre-determination to the Washington State Department of Archaeology and Historic Preservation (DAHP) prior to submittal of the application. DAHP was mailed the public notice along with a copy of the SEPA checklist and has not provided comment. Therefore, a note will be required on the final construction plans and final plat that if resources are discovered during ground disturbance, work shall stop and both DAHP and the county shall be notified *(See Conditions A-8 and D-6.a).*

Conclusion (Archaeology)
Staff finds that the proposed preliminary plan, subject to the condition identified above, meets archaeology requirements of the Clark County Code.

Shoreline Management Program
Finding 1 - Applicability
Mill Creek is a protected waterbody under Clark County's Shoreline Management Program (SMP). The easterly portion of the site falls within Mill Creek's Urban Conservancy

designation. There is no development proposed within shoreline therefore the proposed subdivision is exempt from a Shoreline Substantial Development Permit (SSDP). There is a portion of existing trails that are located within the shoreline jurisdiction that will be retained within the open space but retaining these existing trails do not qualify as development. However, because this parcel is proposing a land division and a portion of the lot lies within the Shoreline Management Area (SMA), the applicant was required to submit a Shoreline Exemption to verify compliance with 40.460.630.K.9.

Finding 2 - Compliance
Pursuant to 40.460.630.K.9, Residential lots that are boundary line-adjusted or newly created through a land division shall be configured such that:

a. Structural flood hazard reduction measures are not required and will not be necessary during the life of the development or use;
b. Shoreline stabilization measures are not required; and
c. Any loss of shoreline ecological function can be avoided.

The proposal does not include flood hazard reduction measures, and none are expected during the life of this development. Additionally, no shoreline stabilization measures are proposed or necessary. Lastly, as conditioned *(See the Wetland and Habitat Findings section of this report),* all loss of shoreline ecological function will be avoided. Staff have determined that as conditioned, the proposal complies with 40.460.630.K.9.

Conclusion (Shoreline Management Program)
Staff finds that the proposed preliminary plan meets the requirements the Clark County's Shoreline Management Program.

Wetland Protection and Habitat Conservation
Finding 1 – Wetland Determination
Staff concurs with the wetland boundaries and ratings as provided in the 9/21/23 Critical Areas Report (CAR) prepared by ELS *(Exhibit 40)*. The site contains several wetlands as follows:

Wetland A is a Category I Riverine wetland with a habitat score of 8 points
Wetland B is a Category III Slope wetland with a habitat score of 7 points
Wetland C is a Category III Slope wetland with a habitat score of 7 points
Wetland D is a Category III Slope wetland with a habitat score of 7 points
Wetland E is a Category III Slope wetland with a habitat score of 5 points
Wetland F is a Category III Depressional wetland with a habitat score of 6 points
Wetland G is a Category III Slope wetland with a habitat score of 6 points
Wetland H is a Category III Depressional wetland with a habitat score of 6 points
Wetland M is a Category II Riverine wetland with a habitat score of 8 points
Wetland N is a Category I Riverine wetland with a habitat score of 7 points

Per CCC 40.450.030(E)(4)(c) [Maximum Buffer Area], except for streams, buffers shall be reduced as necessary so that total buffer area (on and off site) does not exceed two (2) times the total wetland area (on- and off-site); provided, the minimum buffer width at any point shall not be less than the water quality buffer widths for low intensity uses contained in Table 40.450.030-2. Based on this provision, Staff concur with the adjusted buffer widths provided within Table 1 of the 9/21/23 Revised CAR.

Under CCC 40.450.010(C)(2)(a), wetland F is an exempt wetland and does not require County regulation.

Finding 2 – Habitat Determination
The applicant has provided a Revised CAR, dated September 21st, 2023, authored by Ecological Land Services (ELS) *(Exhibit 40)*. The provided CAR report identified a riparian Habitat Conservation Zone (HCZ) and Shoreline Management Area (SMA) associated with Mill Creek, a Type S (Shoreline) water. Per the Critical Area Protection subsection of the Shoreline Master Program (CCC 40.460.530.F.1.a.3), Type S waters are afforded a riparian Habitat Conservation Zone (HCZ) that extends two hundred fifty (250) feet from the OHWM or to the edge of the one hundred year floodplain, whichever is greater. Per the Shoreline Master Program, this section of Mill Creek is designated as Urban Conservancy shoreline and is afforded a SMA that extends two hundred (200) feet from the OHWM or to the edge of the one hundred (100) year floodplain whichever is greater and shall include all hydrologically associated wetlands that are subject to the provisions of shoreline master program (CCC 40.460.210(A)(4)). In both instances the two hundred fifty (250) and two hundred (200) foot distances are greater.

The CAR additionally identified two Type Np (non fish bearing, perennial) streams that flow into Mill Creek. Under CCC 40.440.010.C.1.a, a Type Np stream is afforded a Habitat Conservation Zone (HCZ) 100 feet landward on each side of the stream from the Ordinary High Water Mark or to the edge of the 100 year floodplain, whichever is greater. In this instance, the 100' HCZ is greater. Lastly, the CAR identifies one Type Ns (non fish-bearing, seasonal) stream in the Western ROW, where proposed NE 169th street will intersect with NE 40th Avenue. Under CCC 40.440.010.C.1.a, a Type Ns stream is afforded a Habitat Conservation Zone (HCZ) 75 feet landward on each side of the stream from the Ordinary High Water Mark or to the edge of the 100 year floodplain, whichever is greater. In this instance, the 75' HCZ is greater.

County Wetland and Habitat Review Staff conducted site visits on 10/24/22, 01/09/23, and 3/20/23 to verify the provided CAR and concurs with the Ordinary High Water Mark (OHWM), riparian HCZs and SMA as shown in the 09/21/2023 CAR. However, Clark County GIS additionally shows the presence of a Washington Department of Fish and Wildlife (WDFW) Biodiversity Area and Corridors (BAC) on the site. Biodiversity Areas and Corridors have been identified as areas that contain habitat that is valuable to fish or wildlife and are mostly comprised of native vegetation. They are relatively vertically diverse (e.g., multiple canopy layers, snags, or downed wood), horizontally diverse (e.g., contains a mosaic of native habitats), or support a diverse community of species as identified by a qualified professional who has a degree in biology or closely related field and professional experience related to the habitats or species occurring in the biodiversity area. Based on observations and GPS data from the site visits, the BAC habitat area has been mapped and updated as shown in the attached predetermination map *(Exhibit 39)*.

Finding 3 – Wetland Impacts
Wetlands E, F (exempt wetland), and the onsite portion of wetland H will be filled and will result in .05 acres of direct wetland impacts and .052 acres of indirect wetland impacts as shown in the March 8th, 2024 Mitigation Plan *(Exhibit 30)*.

Finding 4 – Habitat Impacts
The proposed development will result in approximately .277 acres of riparian HCZ impacts. Of this, approximately .039 acres of impacts will occur within the inner 50% of the riparian HCZ and approximately .238 acres will occur within the outer riparian HCZ. No impacts are proposed to the SMA or the Biodiversity Area.

Finding 5 – Wetland Mitigation
The proposed wetland mitigation (Revised Mitigation Plan, 03/08/24, Ecological Land Services) will result in no net loss of wetland functions and values and meets the approval criteria in CCC 40.440.040. The applicant is proposing preservation of Wetland A in addition to purchase of .016 wetland mitigation bank credits from the Terrace Wetland Mitigation Bank to account for wetland impacts. The project site is not within the Bank Service Area of the Terrace Wetland Mitigation Site and an Out of Service Area Request has yet to be approved by the Interagency Review Team (IRT) for use of those bank credits. Therefore, the applicant has provided a fully contingent wetland mitigation plan in the event the Out of Service Areas Request is not approved. The wetland contingency mitigation plan proposes enhancement of .128 acres of enhancement of onsite wetland buffers in the event the Out of Service Area Request for Bank Credit Purchase is not approved *(See Condition A-10.a).*

Finding 6 – Habitat Mitigation
The proposed habitat mitigation (Revised Mitigation Plan, 03/08/24, Ecological Land Services) substantially maintains the level of habitat functions and values and meets the approval criteria in CCC 40.440.020. The applicant is proposing mitigation of .158 acres of outer riparian HCZ impact through HCZ replacement while the remaining .119 acres of HCZ impacts will be mitigated through enhancement of .279 acres of the riparian HCZ *(See Condition A-10.b).*

Finding 7 – Mitigation As-Built
A Mitigation As-Built report must be submitted to the County within 30 days of completion of construction and planting in the approved mitigation plan. The As-Built needs to include documentation of any revisions to or deviations from the approved plan, demonstrating that any changes meet the requirements of CCC 40.440 and 40.450 *(See Condition A-10.c).*

Finding 8 – Financial Assurance
Unless the proposed mitigation is constructed and an as-built is approved prior to the start of construction in wetlands, wetland buffers, or habitat areas, a performance assurance for the mitigation is required *(See Condition A-10.d).*

Finding 9 – Maintenance and Monitoring
After installation of the mitigation, maintenance and monitoring are required in order to ensure long term performance of the mitigation. Routine maintenance of the site is necessary to ensure the integrity and success of the installed plants which includes, but is not limited to, removing invasive species and weeds, irrigation (if required), and plant replacement to meet the performance standards. Annual monitoring reports are required for a period of 5 growing seasons following approval of the as-built report *(See Condition D-2.a).*

Finding 10 – Standard Conditions
Marking During Construction (pursuant to CCC 40.450.030.F). The location of the outer extent of the wetland buffers and habitat areas shall be marked in the field and such markings shall be maintained throughout construction.

Pursuant to CCC 40.450.030.F, a conservation covenant shall be recorded in a form approved by the Prosecuting Attorney as adequate to incorporate the other restrictions of this section and to give notice of the requirement to obtain a wetland or habitat permit prior to engaging in regulated activities within a wetland, wetland buffer, or regulated habitat area *(See Condition D-2.b).*

Pursuant to CCC 40.450.030.F, the Final Plat shall clearly show all wetland, wetland buffer, and priority habitat boundaries with a note referencing any required conservation covenant(s) *(See Condition D-2.c).*

Pursuant to CCC 40.450.030.F, small signs shall be posted at an interval of one (1) per lot or every one-hundred (100) feet, whichever is less, and perpetually maintained at locations along the outer perimeter of the wetland buffer and habitat areas approved by the responsible official worded substantially as follows:

Wetland and Habitat Areas –
Please retain in a natural state

(See Condition D-2.d).

Conclusion (Wetland Protection and Habitat Conservation)
Staff finds that the proposed preliminary plan as conditioned, meets the requirements the Clark County's Wetland Protection and Habitat Conservation codes.

Transportation & Circulation
Finding 1 – Pedestrian/Bicycle Circulation Plan
Pedestrian circulation facilities in compliance with the Americans with Disabilities Act are required in accordance with the provisions of Section CCC 40.350.015. The applicant has proposed sidewalk along the frontage of NE 174th Street and internally. The applicant has proposed relief from sidewalk along the frontage of NE 50th Avenue in a road modification request. The applicant will be required to construct end of sidewalk pedestrian ramps where the pedestrian facilities temporarily terminate at the plat boundaries. All proposed pedestrian facilities are required to be constructed to comply with ADA standards *(See Condition A-1.a and Transportation Finding 5 – Technical Road Modification, Request 4).*

Finding 2 – Road Circulation
The proposed subdivision is required to meet the block length requirement of between 100 and 800 feet while meeting the maximum allowable 3,200-foot block perimeter per CCC 40.350.030(B)(2). The applicant has proposed circulation to the north and south and relief from circulation to NE 50th Avenue to the east and relief from circulation to NE 40th Avenue to the west in a road modification request. An "Urban Neighborhood Circulator" roadway intersects with NE 174th Street from the north as part of the Arterial Atlas. The proposed intersection of NE 45th Avenue and NE 174th Street and the Arterial Atlas alignment intersecting with NE 174th Street from the north do not meet the minimum intersection spacing

requirement of 275 feet. It would have an intersection spacing distance of 150 feet, however, the Arterial Atlas alignment was adopted after the subject development, Viers PUD, became vested, therefore, not applicable. It has since been proposed by 174th Estates Subdivision, PAC-2024-00075, that the Arterial Atlas will be aligned with the proposed NE 45th Avenue intersection with NE 174th Street *(See Transportation Finding 5 – Technical Road Modification, Requests 1 & 5).*

Finding 3 – Roads/Frontage Improvements
Road improvements and design are required to comply with CCC 40.350.030, CCC Table 40.350.030-2 and CCC Table 40.350.030-3.

NE 50th Avenue is an "Urban Minor Arterial", M-2cb. The required half-width improvements include 50 feet of right-of-way dedication, 36 feet of paved width, curb, gutter, and a detached sidewalk. The applicant has requested relief from frontage requirements *(See Transportation Finding 5 – Technical Road Modification, Request 4).*

NE 174th Street is an "Urban Collector", C-2b, road requiring half-width improvements including 17 feet of paved width, curb, gutter, a detached sidewalk, and a minimum 30 feet of right-of-way dedication per Drawing #7. In compliance with CCC 40.350.030(B)(6)(b), any pre-existing roadway narrower than eighteen (18) feet with one (1) foot shoulders shall be widened to the full twenty (20) foot standard. This code section applies to NE 174th Street *(See Conditions A-1.b, A-1.c & D-4.a).*

40.350.030 (B)(4)(b)(4) restricts the number of lots to a maximum of 100 that can access a local access road unless that road is connected by a second vehicle access road to the same "feeder" road. The development will have access to NE 174th Street on site from NE 45th Avenue, and off site from NE 40th Avenue. The on-site public roadways shall conform to an "Urban Local Residential Access" road standard per Drawing #13, which requires 46 feet of right-of-way, 28 feet of paved width, curbs, gutters, and sidewalks unless where minimum partial width roadway standards shall apply with NE 43rd Place and NE 169th Street a minimum pavement width of 20 feet shall be provided. "No Parking" Signs shall be placed on each partial width roadway *(See Conditions A-1.d & D-4.b).*

A private loop road has been proposed in compliance with Drawing 16, and will have at least 28 feet of pavement width with sidewalk on 1 side within a minimum 34-foot wide tract *(See Conditions A-1.e & D-4.c).*

NE 45th Avenue will temporarily terminate at the southern plat boundary and will be greater than 150 feet in length and will require a temporary turnaround at the southern plat boundary. NE 173rd Street will temporarily terminate at the west and east plat boundaries and will be greater than 150 feet in length, the applicant has requested relief from the temporary turnaround requirement in a road modification request *(See Conditions A-1.f & D-6.b, and Transportation Finding 5 – Technical Road Modification, Request 2).*

Finding 4 – Access Management/Intersections
The minimum curb return radius at the public intersection with NE 174th Street shall be 35 feet and the chord of the right-of-way radius shall be 25 feet at a minimum. The Chord of the right-

of-way at the intersection of NE 174th Street and NE 45th Avenue shall be shown on the final engineering plans and dedicated with the final plat *(See Conditions A-1.g & D-4.d).*

Per CCC 40.350.030(B)(4)(b)(1)(a), excepting the bulbs of cul-de-sacs, driveways serving single-family residential lots shall be located a minimum of 5 feet from an interior side property line or zero feet as a shared driveway approach. The applicant proposes joint driveways to serve lots 20 & 21, 25-27, and 49 & 52 . Shared driveways can serve no more than 4 lots and must be a minimum of 12-feet wide and placed in a minimum 20-foot easement. Driveway approaches shall adhere to standard detail F14 or equivalent *(See Conditions A-1.h & D-4.e).*

Corner lot driveways shall be a minimum of forty (40) feet from the projected curb line or edge of pavement, as measured to the nearest edge of the driveway, or in cases where this may be impractical, the driveway may be limited to twenty (20) feet in width and located five (5) feet from the property line away from the intersection or as a twenty-five (25) foot wide shared driveway at this property line *(See Conditions A-1.i).*

Per CCC 40.350.030(B)(4), to provide adequate corner clearance, the tangent curb length between the nearest edge of a driveway on an intersecting side street and a collector roadway, or a driveway on a collector roadway and an intersection with a cross street, shall be fifty (50) feet *(See Conditions A-1.j).*

The transition from public improvements to private improvements shall include a clear delineation. In order to facilitate this delineation, the use of a driveway drop consistent with Standard Detail F16, F17 or approved equivalent at the public/private road transition will be required *(See Condition A-1.k).*

Finding 5 – Technical Road Modifications

The road modification consists of the following four requests:

1. Relief from cross-circulation to NE 50th Avenue.
2. Allow for relief from public turnarounds with proposed stub roadways.
3. Allow for a median in the public NE 45th Avenue near the intersection with NE 174th Street.
4. Relief from frontage improvements with NE 50th Avenue.
5. Relief from cross-circulation to NE 40th Avenue.

CCC 40.550.010(C)(2) - Approval Criteria

2. Modifications to the standards contained in Chapter 40.350 may be granted when the applicant demonstrates at least one (1) of the following:

   a. Topography, right-of-way, existing construction or physical conditions, or other geographic conditions make compliance with standards clearly impractical for the circumstances;
   b. A minor change to a specification or standard is required to address a specific design or construction problem which, if not enacted, will result in an unusual hardship;
   c. An alternative design is proposed which will provide a plan that is functionally equivalent or superior to the standards;

d. Application of the standards of Chapter 40.350 to the development would be grossly disproportional to the impacts created;
e. A change to a specification or standard is required to ensure consistency with existing features adjacent to or affected by the site where those existing features are not expected to change over time.

Applicant's Discussion
The applicant submitted road modification narrative *[Exhibit 20]* dated July 14, 2023 and prepared by PLS Engineering providing justification for the requests.

Staff's Evaluation
Request 1: Relief from cross-circulation to NE 50th Avenue:
Staff is supportive of the applicant's request for relief from frontage improvements per CCC 40.550.010(C)(2)(a) due to the environmental and existing physical constraints.

Request 2: Allow for relief from public turnarounds with NE 173rd Street stub roadways:
Staff is supportive of the applicant's request for relief from the turnarounds as the Clark County Fire Marshal's Office is in support without concerns per an e-mail from Jason Knoble dated March 25, 2024 *[Exhibit 31]*.

Request 3: Median in NE 45th Avenue near the intersection with NE 174th Street:
Staff is supportive of this request provided that:

a. A turning movement analysis shall be provided to ensure that design vehicles can maneuver within the provided 16-foot lanes without mounting the median on NE 45th Avenue. Design vehicles include but shall not be limited to a school bus, waste management vehicle, and fire truck *(See Condition A-1.l)*.

b. Street lighting shall be engineered to highlight the median/object in the roadway on NE 45th Avenue. The county will not be responsible for upkeep and/or maintenance of vegetation in the median island. If safety and/or mobility issues develop because of the median island in the public right-of-way, the median island may be removed with little or no notice *(See Condition A-1.m)*.

Request 4: Relief from frontage improvements with NE 50th Avenue:
Staff is supportive of this request to the environmental and physical constraints that exist per criterion (a), however, the applicant shall ensure that the 36 feet of half-width right-of-way is dedicated *(See Condition A-1.n & D-4.f)*.

Request 5: Relief from cross-circulation to NE 40th Avenue:
Staff is not supportive of this request believing it is feasible to provide the roadway connection to NE 40th Avenue. The on-site partial width roadway shall be consistent with what has been proposed including 20 feet of paved width, 35 feet of right-of-way, curb, gutter, and sidewalk. The required off-site 20-foot wide roadway connection to NE 40th Avenue will be located in 30 feet of right-of-way which has been platted per Pleasant Valley Acres, Book G, Page 591 *(See Condition A-1.o)*.

Recommendation

Staff recommends Approval of the road modification requests subject to the conditions above except Denial of the request to not circulate to NE 40th Avenue. The Development Engineering Services Manager has concurred with staff's recommendation and approved the four road modification requests *(The Technical Road Modification Staff Report and Recommendation will be submitted as a separate Exhibit).*

Finding 6 – Sight Distance
The approval criteria for sight distances are found in CCC 40.350.030(B)(8). This section establishes minimum sight distances at intersections and driveways. Additional building setbacks may be required for corner lots in order to maintain adequate sight distance. Landscaping, trees, utility poles, and miscellaneous structures will not be allowed to impede required sight distance requirements at all proposed driveway approaches and intersections.

The applicant submitted a sight distance analysis *[Exhibit 32]* prepared by PLS Engineering, dated March 28th, 2024. Sight distance analysis was performed at the intersection of NE 174th Street and NE 50th Avenue. The posted speed limit is 40 MPH and, the required controlled intersection sight distance of 400 feet is required in both directions. The applicant indicates that minimum 400 feet of controlled sight distance can be met in both north and south directions. The minimum stopping sight distance requirement of 205 feet can also be met in both directions per the applicant. Sight distance analysis was performed at the intersection of NE 174th Street and NE 45th Avenue. A speed limit of 25 MPH and, the required controlled intersection sight distance of 250 feet is required in both directions. The applicant indicates that minimum 250 feet of controlled sight distance can be met in both east and west directions. The minimum stopping sight distance requirement of 155 feet can also met in both directions per the applicant *(See Conditions A-1.p, C-1 & D-8, and D-6.e).*

Conclusion (Transportation & Circulation)
Staff concludes that the proposed preliminary transportation plan, subject to the conditions identified above, meet the transportation requirements of the Clark County Code.

Transportation Concurrency
The Transportation Concurrency Staff Report and Recommendation will be submitted as a separate Exhibit.

Stormwater
Finding 1 - Stormwater Applicability
The provisions of Clark County Code Chapter 40.386, as amended by Ordinance No. 2021-06-02, shall apply to all new development, redevelopment, land disturbing activities and drainage projects consistent with the Clark County's NPDES Phase I Municipal Stormwater Permit and Clark County Stormwater Manual (2021). The project adds more than 5,000 square feet of new hard surface; therefore, the applicant shall comply with Minimum Requirements (MR) 1 through 9 *(See Condition A-3.a).*

Finding 2 - Stormwater Proposal
The applicant provided a *Preliminary Stormwater Technical Information Report* (TIR) [Exhibit 1, Tab 11], dated December 30th, 2022, and a stormwater plan [Exhibit 1, Tab 12]. Both have been prepared by PLS Engineering proposing to comply with the standards of On-site Stormwater Management (MR#5, List #2), Runoff Treatment (MR#6) and Flow Control

(MR#7) of the Clark County Stormwater Manual (CCSM). The applicant proposes Washington GULD certified filter catch basins to be used and detention ponds (BMP D6.10). The applicant shall submit documentation from the stormwater treatment system manufacturer indicating that the selected proprietary stormwater filtration systems are sited and sized appropriately. Enhanced treatment is required with the frontage of NE 174th Street. The development shall not materially increase or concentrate runoff onto neighboring properties *(See Conditions A-3.b, A-3.c, & A-3.d).*

The applicant provided a *Geotechnical Site Investigation [Exhibit 1, Tab 10]*, dated November 29, 2021, which has been prepared by Columbia West Engineering and states the following:

"Groundwater was not observed within the test pits to the maximum explored depth of 15 feet bgs. According to Clark County Maps Online, groundwater depths within the vicinity of the site range from 0 to 10 feet bgs along Mill Creek and increase in depth to 30 feet or more in the northwest portion of the site. Groundwater levels are often subject to seasonal variance and may rise during extended periods of increased precipitation. Perched groundwater may also be present in localized areas. The presence of mapped wetlands and observed man-made surface water ditches and diversion channels suggest the presence of winter wet areas and seasonal perched shallow groundwater. Seeps and springs may become evident during site grading, primarily along slopes or in areas cut below existing grade. Structures, roads, and drainage design should be planned accordingly."

The geotechnical engineer shall determine if the proposed stormwater design requires mitigation as a result of the close proximities to geohazard areas. The geotechnical engineer shall determine if liners are necessary due to the relatively high groundwater *(See Condition A-3.e).*

The detention facilities shall be designed according to the design criteria specified for BMP D6.10. Offsite analysis shall be included *(See Condition A-3.f).*

The applicant shall identify on the final construction plans ownership responsibilities for each of the proposed stormwater facilities *(See Condition A-3.g).*

The site contains multiple wetlands with varying categories and habitat scores, including a Category I wetland, and will directly or indirectly discharge to these wetlands. All site discharges are subject to the following levels of wetland protection: General Protection, Protection from Pollutants, and Wetland Hydroperiod Protection (Method 2) *(See Condition A-3.h).*

Conclusion (Stormwater)

Staff concludes that the proposed preliminary stormwater plan, subject to the conditions above, meets the stormwater requirements of the Clark County Code.

Geologic Hazard Areas

Finding 9 – Applicability & Analysis:

All development activities in or adjacent (within 100 feet) to geologic hazard areas shall comply with the provisions of CCC 40.430. There are steep slopes and landslide hazards mapped with 100 feet of the southern property line. The applicant submitted a *Geotechnical Site Evaluation,*

prepared by Columbia West Engineering, dated November 29, 2021, in which they evaluated the mapped geologic hazards. They concluded that *"Clark County Unified Development Code Section 40.430.C.1 defines a steep slope hazard as areas where slope grades meet or exceed 40 percent. Based upon physical measurement and review of slope grade mapping published by Clark County Maps Online, the northwest- and southeast-facing slopes along Mill Creek contain vertical slope heights measured from toe to top-of-slope break that vary from approximately 25 to 55 feet and slope grades that range from approximately 5 to 60 percent with localized steeper areas. Therefore, some slopes located on the subject site appear to meet the definition of a steep slope hazard as defined by Clark County Code."* Additionally, it was determined that landslide hazard areas exist on the site *(See Condition A-11.a).*

A building permit is required for retaining walls greater than 4 feet tall or when the wall is surcharged. All retaining walls shall be shown in sufficient detail on the engineering plans for staff to assess their impact on adjacent roads, structures, and public and private utilities *(See Condition A-11.b).*

Conclusion (Geologic Hazard Areas)
Staff believes that the applicant has shown compliance with CCC 40.430 by submitting the Geotechnical Engineering Evaluation. Therefore, the requirements of the preliminary plan review criteria are satisfied.

Flood Hazard Area
Finding 1 - Flood Hazard Applicability
Clark County GIS indicates that portions of the site are located in a regulated special flood hazard area (SFHA). All development activities with mapped SFHA on parcels part of a development shall comply with the provisions of CCC 40.420.

Finding 2 – Flood Hazard Assessment
The applicant provided a narrative prepared by PLS Engineering, dated December 2022. Staff used FEMA FIRM Panel number *[53011C0376E],* Clark County GIS data, and the submitted narrative and plan to confirm the location of the project and its position within the SFHA of Mill Creek.

Per the narrative, no improvements are proposed near the mapped Special Flood Hazard Area. Therefore, the project will not place fill or construct any structures within a designated flood hazard area and will result in neither any increase to the base flood elevation nor in any adverse downstream impacts. The applicant has demonstrated that all regulated development activity is outside the SFHA *(See Conditions A-12 & G-5).*

Conclusion (Flood Hazard Area)
Based upon the development site characteristics, the proposed site plan and FIRM, the requirements of the County's flood hazard area ordinance have been satisfied and flood hazard permit is not required.

Fire Protection
Finding 1 - Building Construction
Building construction occurring subsequent to this application shall be in accordance with the provisions of the county's building and fire codes. Additional specific requirements may be

made at the time of building construction as a result of the permit review and approval process *(See Condition G-3).*

Finding 2 - Fire Flow
Fire flow in the amount of 1,000 gallons per minute supplied at 20 psi for 60 minutes duration is required for this application. Prior to final approval, submit proof from the water purveyor indicating that the required fire flow remains available at the site. A fire flow letter dated 9/13/2022 states there is 2,405 GPM in the area. Water mains supplying fire flow and fire hydrants shall be installed, approved and operational prior to final plat approval *(See Conditions A-7.a, D-3.a, & D-3.b).*

Finding 3 - Fire Hydrants
Fire hydrants are required for this application. Either the indicated number or the spacing of the fire hydrants is inadequate. Provide fire hydrants such that the maximum spacing between hydrants does not exceed 700 feet and such that no lot or parcel is in excess of 500 feet from a fire hydrant as measured along approved fire apparatus access roads *(See Condition A-7.b).*

The local fire district chief approves the exact locations of fire hydrants. As a condition of approval, contact Clark Cowlitz Fire & Rescue at (360) 887-4609 to arrange for location approval. Unless waived by the fire district chief fire hydrants shall be provided with appropriate 'storz' adapters for the pumper connection. Provide and maintain a three (3) -foot clear space completely around every fire hydrant *(See Conditions A-7.c, A-7.e, A-7.f, D-3.d, F-1, & H-1.a).*

Finding 4 - Fire Apparatus Access
Fire apparatus access is required for this application. The roadways and maneuvering areas as indicated in the application adequately provide required fire apparatus access. Provide fire apparatus access roads with an unobstructed width of not less than 20 feet, an unobstructed vertical clearance of not less than 13.5 feet, with an all-weather driving surface and capable of supporting the imposed loads of fire apparatus *(See Conditions A-7.d & H-1.b).*

Approved fire apparatus turnarounds are required for this project. The indicated provisions for turning around fire apparatus are adequate.

Finding 5 – Parking
Parking is prohibited on access roads that are less than twenty-four (24) feet wide. Roads that are less than twenty-four (24) feet wide shall be posted "NO PARKING-FIRE LANE" *(See Conditions A-7.g, D-3.c, & H-1.c).*

Finding 6 – Gates
While no gates are shown on the proposed plan, no gate may be installed across a required fire department access road or driveway without first obtaining and testing of the gate will be required. Split gates with a divided entry and exit side will need 15 feet on either side for a total gate width of 30 feet *(See Condition G-6).*

Finding 7 – Residential Fire Sprinklers
Homes exceeding 3600 square feet including attached garages will require additional fire protection features including a residential fire sprinkler system when adequate public water

and a hydrant is not within required distances (See Condition XX). If a residential fire sprinkler is required, it will require additional review and permitting by the Fire Marshal *(See Condition E-5)*.

Conclusion (Fire Protection)
Staff finds that the proposed preliminary plan, subject to conditions contained herein, meets the fire protection requirements of the Clark County Code.

Water and Sewer Service
Finding 1 – Sewerage Requirements
The proposed development is required to connect to public sanitary sewer. The site is located within the Clark Regional Wastewater District (CRWWD) service area. A utility review letter from the CRWWD was submitted as part of the application materials *(Exhibit 1, Tab 16)*. It indicates that *"The point of connection for the subject parcel is located approximately 180' north from the subject parcel's northeast property corner within NE 50th Avenue. It will require construction of Pleasant Valley North Pump Station C and a connection to the existing 6" force main in NE 50th Avenue once the acceptance of the Pleasant Valley North Pump Station D and Woodbrook Subdivision projects are complete.*

Note: In accordance with District code, Clark Regional Wastewater District will require that sewers be extended along the subject parcel's entire west property line, in NE 174th Street along the entire parcel frontage, to a point on the north property line approximately 390' west of the SE corner of parcel SN 181763-000, and in NE 50th Avenue along the entire parcel frontage."

Prior to final plat approval, the applicant shall provide documentation from the District confirming that sanitary sewer connections have been installed and approved *(See Condition D-7.a)*.

Finding 2 – Water Supply
The proposed development is required to connect to public water. The applicant has submitted a current utility review from the Clark Public Utilities *(Exhibit 1 Tab 17)* confirming that water service is available to the site in the form of in the form of *"an existing 8" PVC water main within NE 50th Avenue and an 8" water main stubbed near the intersection of NE 165th Cir and NE 40th Ave.*

For this development, depending on site access and layout, plan to connect to the existing 8" water main within NE 50th Avenue and extend a minimum sized 8" water main within the public access to and through the site. Also, public water mains may be required to be installed within NE 174th St from NE 50th Ave, and/or connecting to the public water main within NE 40th Ave and NE 165th Cir depending on system reliability and other related civil improvements proposed with this project. Install proper fire protection (i.e. hydrants and building sprinkler systems) as required by the Fire Marshal. The water system shall be sized depending on the anticipated fire protection and domestic demand requirements. The Engineer shall certify that the proposed water distribution design adequately provides proper domestic and fire protection services.

Any existing, unused services shall be properly capped and abandoned. All water mains and services (up to the meter) located within private property, shall be included in an easement granted to Clark Public Utilities. Proper state approved backflow devices will be required for all domestic, fire and landscape water services. All hot taps shall be performed by a Utility approved contractor. The Developer is responsible for costs associated with the service and Fire protection installation, right-of-way permitting, and any other needed water improvements."

Prior to final plat approval, the applicant shall provide documentation from the district confirming that water connections have been installed and approved *(See Condition D-7.a).*

Conclusion (Utilities): Staff finds that the proposed preliminary plan, subject to the findings and conditions identified above, meets utility requirements of the Clark County Code.

Public Health

Finding 1 – On-site Sewage Treatment Systems

No existing on-site sewage system (OSS) was indicated on the application and no existing on-site sewage system was observed in the field or identified in the Clark County Public Health record. However, On-site sewage system components may exist at the site. Any discovered during development must be properly abandoned per CCC 24.17.210 *(See Condition B-5).* Proper abandonment of the systems requires tank pumping by a licensed pumper, breaking in the tank lids, and filling the cavities with compacted soil. Any cesspools, drywells, or pump chambers discovered on the site must also be abandoned in this manner and locations shown on the final plat *(See Condition D-7.c).*

Finding 2 – Water Systems

No existing water wells are indicated on the application and no existing water wells were observed in the field or identified in the Clark County Public Health record. However, water wells may exist at the site. Any wells that are found during development of this plat shall be properly decommissioned by a licensed well driller with documentation submitted to CCPH prior to final plat approval and all decommissioned wells must be shown on the final plat *(See Conditions B-5 & D-6.d).*

Conclusion (Public Health): Staff finds that the proposed preliminary plan, subject to the findings and conditions identified above, meets Public Health requirements of the Clark County Code.

Impact Fees

Finding 1 - Applicability

The lots created by this development will produce impacts on schools, parks, and traffic, and are subject to School (SIF), Park (PIF), and Traffic Impact Fees (TIF) in accordance with CCC 40.610. The subject site is located within the following districts: MT. Vista traffic impact district, Battle Ground School District and Park District 10. As found in CCC 40.610.040, impact fees are calculated using the rates in effect at the time of building permit issuance *(See Conditions D-5.d, D-6.h, & E-1).*

Conclusion (Impact Fees)

Staff finds that the proposed preliminary plan, subject to conditions identified above, meets impact fee requirements of the Clark County Code.

SEPA Determination

As lead agency under the State Environmental Policy Act (SEPA) Rules [Chapter 197-11, Washington Administrative Code (WAC)], Clark County must determine if there are possible significant adverse environmental impacts associated with this proposal. The options include the following:

- **DS = Determination of Significance** - The impacts cannot be mitigated through conditions of approval and, therefore, require the preparation of an Environmental Impact Statement (EIS);

- **MDNS = Mitigated Determination of Non-Significance** - The impacts can be addressed through conditions of approval; or,

- **DNS = Determination of Non-Significance** - The impacts can be addressed by applying the Clark County Code.

The likely SEPA determination of Non-Significance (DNS) in the Revised Notice of Development Review Application issued on 4/12/2024 is hereby final.

SEPA Appeal Process

An appeal of this SEPA determination and any required mitigations, must be filed with the Department of Community Development within fourteen (14) calendar days from the date this notice.

The hearing examiner shall hear appeals in a public hearing. Notice of the appeal hearing shall be mailed to parties of record but shall not be posted or published.

A **procedural SEPA appeal** is an appeal of the determination (i.e., determination of significance, determination of non-significance, or mitigated determination of non-significance).

A **substantive SEPA appeal** is an appeal of the conditions required to mitigate for probable significant issues not adequately addressed by existing Clark County Code or other law.

Issues of compliance with existing approval standards and criteria can still be addressed in the public hearing without an appeal of this SEPA determination.

A **procedural or substantive appeal** must be filed within fourteen (14) calendar days of this determination, together with the appeal fee. Such appeals will be considered at a scheduled public hearing and decided by the Hearing Examiner in a subsequent written decision.

Appeals must be in writing and should contain the following information:

- Case number designated by the county
- Name of the applicant

- Name of each petitioner
- Signature of each petitioner or his or her duly authorized representative
- A statement showing the following:
  - That each petitioner is entitled to file the appeal as an interested party in accordance with CCC 40.510.020(H) or 40.510.030(H)
  - The reasons why the SEPA determination is in error
- The appeal fee

Refer to the *Appeals* handout for more information and fees.

The decision of the Hearing Examiner is final unless:

- A motion for reconsideration is filed within fourteen (14) days of written notice of the decision, as provided under Clark County Code, Section 2.51.160; or,
- An appeal is filed with Clark County Superior Court.

Staff Contact Person: Bryan Mattson, Project Planner, 564.397.5683

Responsible Official: April Furth, Community Development Director

Recommendation

Based upon the revised development plans known as Exhibits 29 & 40, and the findings and conclusions stated above, staff recommends the Hearing Examiner **APPROVES** this request, subject to the understanding that the application is required to adhere to all applicable codes and laws and is subject to the following conditions of approval.

Conditions of Approval

A	**Final Construction Review for Land Division** **Review and Approval Authority: Development Engineering, Land Use & Fire Marshal**

Prior to construction, a Final Construction Plan shall be submitted for review and approval, consistent with the approved preliminary plan and the following conditions of approval:

A-1 **Final Transportation Plan/On-Site -** The applicant shall submit and obtain County approval of a final transportation design in conformance to CCC 40.350 and the following conditions of approval:

a. All proposed pedestrian facilities are required to be constructed to comply with ADA standards. The applicant is required to construct end of sidewalk pedestrian ramps where the pedestrian facilities temporarily terminate at the plat boundaries *(See Transportation Finding 1).*

b. NE 174th Street is an "Urban Collector", C-2b, road requiring half-width improvements including 17 feet of paved width, curb, gutter, a detached sidewalk, and a minimum 30 feet of right-of-way dedication *(See Transportation Finding 3).*

c. In compliance with CCC 40.350.030(B)(6)(b), any pre-existing roadway narrower than eighteen (18) feet with one (1) foot shoulders shall be widened to the full twenty (20) foot standard *(See Transportation Finding 3).*

d. The on-site public roadways shall conform to an "Urban Local Residential Access" road standard which requires 46 feet of right-of-way, 28 feet of paved width, curbs, gutters, and sidewalks unless where minimum partial width roadway standards shall apply with NE 43rd Place and NE 169th Street where "No Parking" Signs shall be placed on each partial width roadway *(See Transportation Finding 3).*

e. The on-site private roadways shall conform to an "Urban Private Road" road standard which requires a minimum 30-foot tract, minimum 24-foot pavement, curb, gutter, and 5-foot sidewalk on one side *(See Transportation Finding 3).*

f. A temporary turnaround at the southern plat boundary shall be constructed in compliance with the Standard Detail Drawings 26, 27 or an approved equivalent. *(See Transportation Finding 3).*

g. The minimum curb return radius at the public intersection of NE 45th Avenue and NE 174th Street shall be 35 feet and the chord of the right-of-way radius shall be 25 feet at a minimum *(See Transportation Finding 4).*

h. Driveway approaches shall adhere to standard detail F14 or equivalent *(See Transportation Finding 4).*

i. Corner lot driveways shall be a minimum of forty (40) feet from the projected curb line or edge of pavement, as measured to the nearest edge of the driveway, or in cases where this may be impractical, the driveway may be limited to twenty (20) feet in width and located five (5) feet from the property line away from the intersection or as a twenty-five (25) foot wide shared driveway at this property line *(See Transportation Finding 4).*

j. Per CCC 40.350.030(B)(4), to provide adequate corner clearance, the tangent curb length between the nearest edge of a driveway on an intersecting side street and a collector roadway, or a driveway on a collector roadway and an intersection with a cross street, shall be fifty (50) feet. 40.350.030 (B)(4)(b)(4) restricts the number of lots to a maximum 100 that can access a local access road *(See Transportation Finding 4).*

k. The private road approach onto NE 130th Street shall be constructed per Standard Detail F16, F17 or approved equivalent *(See Transportation Finding 4).*

l. A turning movement analysis shall be provided to ensure that design vehicles can maneuver within the provided 16-foot lanes without mounting the median on NE 45th Avenue. Design vehicles include but shall not be limited to a school bus, waste management vehicle, and fire truck *(See Transportation Finding 5).*

m. Street lighting shall be engineered to highlight the median/object in the roadway on NE 45th Avenue. The county will not be responsible for upkeep and/or maintenance of vegetation in the median island. If safety and/or mobility issues develop because of the median island in the public right-of-way, the median island may be removed with little or no notice *(See Transportation Finding 5).*

n. NE 50th Avenue is classified as an "Urban Minor Arterial", M-2cb, which requires 36 feet of half-width right-of-way *(See Transportation Finding 5).*

o. Cross-circulation shall be provided to provide to NE 40th Avenue. The on-site partial width roadway shall be consistent with what has been proposed including 20 feet of paved width, 35 feet of right-of-way, curb, gutter, and sidewalk. The required off-site 20-foot wide roadway connection to NE 40th Avenue will be located in 30 feet of right-of-way which has been platted per Pleasant Valley Acres, Book G, Page 591 *(See Transportation Finding 5).*

p. Sight distance triangles for the intersection approach onto NE 174th Street shall be shown on the final construction plans *(See Transportation Finding 6).*

A-2 **Transportation (Signing and Striping)** - The applicant shall submit a signing and striping plan for review and approval. This plan shall show signing and striping and all installation or modifications to traffic control devices in the public right-of-way required for frontage improvements and any off-site improvements. The applicant shall obtain a work order with Clark County to reimburse the County for required signing, striping and all installation or modifications to traffic control devices in the public right-of-way. The final traffic control plans (signing, striping, signals, ITS, etc.) can be approved only after the developer provides signed reimbursable work order(s) to the county's traffic engineer reviewing the plans.

A-3 **Final Stormwater Plan** - The applicant shall submit and obtain County approval of a final stormwater plan designed in conformance to CCC 40.386 and the following conditions of approval:

a. The applicant shall submit final construction plans and a final Technical Information Report (TIR) that addresses Minimum Requirements #1 though #9 *(See Stormwater Finding 1).*

b. The applicant shall submit documentation from the stormwater treatment system manufacturer indicating that the stormwater treatment devices were sited and sized appropriately *(See Stormwater Finding 2).*

c. Enhanced treatment is required with the frontage of NE 174th Street *(See Stormwater Finding 2).*

d. The applicant shall demonstrate that the development will not materially increase or concentrate runoff onto neighboring properties or block existing drainage from adjacent lots *(See Stormwater Finding 2).*

e. The geotechnical engineer shall determine if the proposed stormwater design requires mitigation as a result of the close proximities to geohazard areas. The geotechnical engineer shall determine if liners are necessary due to the relatively high groundwater *(See Stormwater Finding 2).*

f. The detention facilities shall be designed according to the design criteria specified for BMP D6.10. Offsite analysis shall be included *(See Stormwater Finding 2).*

g. The applicant shall identify on the final construction plans ownership responsibilities for each of the proposed stormwater facilities *(See Stormwater Finding 2).*

h. The applicant shall submit a final TIR addressing General Protection, Protection from Pollutants, and Wetland Hydroperiod Protection (Method 2) for all site discharges *(See Stormwater Finding 2).*

A-4 Final Transportation Plan (Concurrency) – *The Transportation Concurrency Staff Report and Recommendation will be submitted separately as an Exhibit of the Public Record.*

A-5 Erosion Control Plan - The applicant shall submit and obtain County approval of a final erosion control plan designed in accordance with CCC 40.386.

A-6 Excavation and Grading - Excavation/grading shall be performed in compliance with CCC14.07.

A-7 Fire Marshal Requirements -

a. The applicant shall submit plans showing the location of water lines and hydrants for review and approval by the Fire District Chief *(See Fire Protection Finding 2).*

b. Plans shall be submitted for review and approval showing fire hydrants such that the maximum spacing between hydrants does not exceed 700' and such that no lot or parcel is in excess of 500' from a fire hydrant as measured along approved fire apparatus access roads *(See Fire Protection Finding 3).*

c. The fire district chief shall sign the engineering construction mylar indicating fire hydrant location has been reviewed and approved *(See Fire Protection Finding 3).*

d. Access roads shall have an unobstructed width of not less than 20 feet and an unobstructed vertical clearance of not less than 13.5 feet with an all-weather driving surface capable of supporting the imposed loads of fire apparatus *(See Fire Protection Finding 4).*

e. Plans showing a three (3) -foot clear space around the circumference of all fire hydrants shall be submitted for review and approval, *(See Fire Protection Finding 3).*

f. Unless waived by the fire district chief, hydrants shall be provided with appropriate "storz" adapters for the pumper connection, *(See Fire Protection Finding 3).*

g. Plans showing markings indicating that parking is prohibited on access roads that are less than twenty-four (24) feet wide shall be provided, *(See Fire Protection Finding 5).*

A-8 Final Construction Plan (Archaeology) - The applicant shall submit and obtain county approval of a final construction plan with the following note:

"If any cultural resources and/or human remains are discovered in the course of undertaking the development activity, the Department of Archaeology and Historic Preservation in Olympia, the Cowlitz Indian Tribe, and Clark County shall be notified. Failure to comply with these state requirements may constitute a Class C Felony, subject to imprisonment and/or fines." *(See Archaeological Finding 2).*

A-9 Land Use – A final construction plan is required to be submitted and Land Use staff must verify:

a. The applicant shall submit a landscaping plan that indicates that a street tree will be provided every 24 feet *(See Land Use Finding 3).*

b. The applicant shall submit a lighting plan to ensure compliance with the PUD street lighting standard *(See Land Use Finding 3).*

A-10 Wetland and Habitat Review:

a. The applicant shall provide proof of purchase of .016 wetland bank credits from the Terrace Wetland Mitigation Bank or, as a contingency, complete .128 acres of enhancement of the onsite wetland buffers as shown in the Approved Mitigation Plan *(See Wetland Protection and Habitat Conservation Finding 5).*

b. The applicant shall enhance .279 acres of the riparian HCZ as shown in the March 8th, 2024 Mitigation Plan *(See Wetland Protection and Habitat Conservation Finding 6).*

c. The applicant shall submit a Mitigation As-Built report to the County within 30 days of completion of the construction and planting in the approved mitigation plan *(See Wetland Protection and Habitat Conservation Finding 7).*

d. Unless the proposed mitigation is constructed and an as-built is approved, a performance assurance for the mitigation is required *(See Wetland Protection and Habitat Conservation Finding 8).*

A-11 Geologic Hazard Area - The applicant shall submit and obtain county approval of a final geotechnical engineering plan designed in accordance with the following conditions of approval:

a. The proposed project shall implement the recommendations identified in the Geotechnical Site Evaluation, prepared by Columbia West Engineering, dated November 29, 2021, in addition to an associated addendum dated September 6, 2022 *(See Geohazard Area Finding 1).*

b. A building permit is required for retaining walls greater than 4 feet tall or when the wall is intended to support unbalanced fill or a surcharge. All retaining walls shall be shown in sufficient detail on the engineering plans for staff to assess their impact on adjacent roads, structures, and public and private utilities *(See Geohazard Area Finding 1).*

A-12 Flood Plain Hazard Area – The applicant shall delineate the mapped Special Flood Hazard Area on the final engineering plans per the FEMA published FIRM Panel number (53011C0376E), unless an updated FIRM is published prior to final engineering approval *(See Flood Hazard Area Finding 2).*

B	**Prior to Construction of Development** **Review and Approval Authority: Development Inspection & Clark County Public Health**

Prior to construction, the following conditions shall be met:

B-1 Pre-Construction Conference - Prior to construction or issuance of any grading or building permits, a pre-construction conference shall be held with the county.

B-2 Traffic Control Plan - Prior to issuance of any building or grading permits for the development site, the applicant shall obtain written approval from Clark County Department of Public Works of the applicant's Traffic Control Plan (TCP). The TCP shall govern all work within or impacting the public transportation system.

B-3 Erosion Control - Prior to construction, erosion/sediment controls shall be in place. Sediment control facilities shall be installed that will prevent any silt from entering infiltration systems. Sediment controls shall be in place during construction and until all disturbed areas are stabilized and any erosion potential no longer exists.

B-4 Erosion Control - Erosion control facilities shall not be removed without county approval.

B-5 Septic Tank and Well Decommissioning - Prior to provisional acceptance, if any septic systems, water wells or underground tanks are found during construction, they shall be decommissioned in accordance with the procedures of the Clark County Public Health, *(See Water and Sewer Findings 1 & 2).*

B-6 Road Closures - Any request by the developer or developer's contractor to close a road will be reviewed by county staff. The developer shall provide a memorandum to the County Engineer justifying the reasons for needing the road closure, specifically including explanation as to why the closure is necessary and construction cannot occur under traffic, such as flagger controlled alternating one way traffic next to the construction. The memorandum shall include the ENG number and title of the project,

location of the requested road closure, anticipated date of start of closure, requested closure time length, explanation of the public outreach that the contractor will perform, full detour mapping, and other information as appropriate. Road Closures are approved specifically by the County Council by resolution, as described in WAC 308-330-270(7).The process for county takes at least 6 weeks for writing the staff report, resolution and internal review. Depending on the complexity of the request from the developer and the council's time availability, this can take over 12 weeks to process from start to finish. It is the developer's responsibility to ensure that the process is completed prior to needing the road closure enacted. The contractor shall be responsible for all costs associated with county staff time to process the request via reimbursable work order and all notifications required by law in local newspapers as required by RCW 47.48 Notice of Closure or Restriction. Requesting a road closure is no guarantee that a road closure will be approved by the county.

B-7 Wetlands and Habitat - Marking During Construction (pursuant to CCC 40.450.030.F). The location of the outer extent of the wetland buffers and habitat areas shall be marked in the field and such markings shall be maintained throughout construction.

C	**Provisional Acceptance of Development** **Review and Approval Authority: Development Inspection & Development Engineering**

Prior to provisional acceptance of development improvements, construction shall be completed consistent with the approved final construction / land division plan and the following conditions of approval:

C-1 Sight Distance Certification - The applicant shall provide a sight distance certification letter verifying that sight distance is met at the intersection of NE 174th Street and NE 45th Avenue, once constructed *(See Transportation Finding 6).*

D	**Final Plat Review & Recording** **Review and Approval Authority: Development Engineering, Wetland and Habitat Review, Fire Marshal, Clark County Public Health & Land Use**

Prior to final plat approval and recording, the following conditions shall be met:

D-1 Land Use:

a. All open space shall be conveyed to and permanently maintained by a home-owners association unless a public agency agrees to maintain the open space and any structures or improvements located on it *(see Land Use Finding 3).*

b. The applicant shall increase the building envelope side setback that abuts the perimeter of the development to 10 feet for Lots 1, 8, 4, 5, 70, 81, and 82 *(See Land Use Finding 3).*

D-2 Wetland Protection and Habitat Conservation:

a. The applicant (or successor in ownership) shall implement the approved mitigation maintenance and monitoring plan (Revised Mitigation Plan, 03/08/24, Ecological

Land Services) and submit performance reports to the County for a period of 5 years *(See Wetland Protection and Habitat Conservation Finding 9).*

b. Pursuant to CCC 40.450.030.F, a conservation covenant shall be recorded in a form approved by the Prosecuting Attorney as adequate to incorporate the other restrictions of this section and to give notice of the requirement to obtain a wetland or habitat permit prior to engaging in regulated activities within a wetland, wetland buffer, or regulated habitat area *(See Wetland Protection and Habitat Conservation Finding 10).*

c. Pursuant to CCC 40.450.030.F, the Final Plat shall clearly show all wetland, wetland buffer, and priority habitat boundaries with a note referencing any required conservation covenant(s) *(See Wetland Protection and Habitat Conservation Finding 10).*

d. "Pursuant to CCC 40.450.030.F, small signs shall be posted at an interval of one (1) per lot or every one hundred (100) feet, whichever is less, and perpetually maintained at locations along the outer perimeter of the wetland buffer and habitat areas approved by the responsible official worded substantially as follows:
"Wetland and Habitat Areas –
Please retain in a natural state"
(See Wetland Protection and Habitat Conservation Finding 10).

D-3 Fire Marshal Requirements:

a. The applicant shall demonstrate that water mains supplying fire flow have been installed and approved *(See Fire Protection Finding 2).*

b. The applicant shall submit a current utility review letter from the water purveyor indicating required fire flow remains available at the site *(See Fire Protection Finding 2).*

c. Parking is prohibited on access roads that are less than twenty-four (24) feet wide. Roads that are less than 24 feet wide shall be posted, "NO PARKING – FIRE LANE" *(See Fire Protection Finding 5).*

d. Fire hydrants shall be provided with appropriate 'storz' adapters for the pumper connection prior to above-ground combustible construction *(See Fire Protection Finding 3).*

D-4 Right-of-Way/Easements:

a. Right-of-way along the frontage of NE 174th Street to achieve a 30-foot half-width shall be conveyed to the county with the final plat, if necessary *(See Transportation Finding 3).*

b. Right-of-way dedication for all internal public roads shall be conveyed to the county with the final plat *(See Transportation Finding 3).*

c. The Private Road access easements or tracts shall be delineated on the final plat. A minimum 30-foot width is required. The lot numbers who have access to the private road shall also be labeled *(See Transportation Finding 3).*

d. The chords of the rights-of-way radii at the intersection of NE 45th Avenue and NE 174th Street shall be conveyed to the county with the final plat. The county will accept easements for these chords instead of dedication of right-of-way *(See Transportation Finding 4).*

e. All joint driveway access easements or tracts shall be delineated on the final plat. A minimum 20-foot width is required. The lot numbers who have access to the joint driveway easements shall also be labeled *(See Transportation Finding 4).*

f. Right-of-way along the frontage of NE 50th Avenue to achieve a 36-foot half-width shall be conveyed to the county with the final plat, if necessary *(See Transportation Finding 5).*

D-5 Developer Covenant - A *Developer Covenant to Clark County* shall be submitted for recording to include the following:

a. Critical Aquifer Recharge Areas: "The dumping of chemicals into the groundwater and the use of excessive fertilizers and pesticides shall be avoided. Homeowners are encouraged to contact the State Wellhead Protection program at (206) 586-9041 or the Washington State Department of Ecology at 800-RECYCLE for more information on groundwater /drinking supply protection."

b. Erosion Control: "Building Permits for lots on the plat shall comply with the approved erosion control plan on file with Clark County Building Department and put in place prior to construction."

c. Responsibility for Stormwater Facility Maintenance: A "Developer Covenant to Clark County" shall be submitted for recording that specifies the following Responsibility for Stormwater Facility Maintenance: For stormwater facilities for which the county will not provide long-term maintenance, the developer shall make arrangements with the existing or future (as appropriate) occupants or owners of the subject property for assumption of maintenance to the county's Stormwater Facilities Maintenance Manual as adopted by Chapter 13.26A. The responsible official prior to county approval of the final stormwater plan shall approve such arrangements. The county may inspect privately maintained facilities for compliance with the requirements of this chapter. An access easement to the private facilities for the purpose of inspection shall be granted to the county. If the parties responsible for long-term maintenance fail to maintain their facilities to acceptable standards, the county shall issue a written notice specifying required actions to be taken in order to bring the facilities into compliance. If these actions are not performed in a timely manner, the county shall take enforcement action and recover from parties responsible for the maintenance in accordance with Section 32.04.060.

d. Impact Fees: "In accordance with CCC 40.610 impact fees for each dwelling in this subdivision shall be assessed for impacts on schools, parks and transportation facilities based for the following districts: Battle Ground School District (SIF), Park District 10 (PIF) and Mt. Vista Transportation Sub-area (TIF). As found in CCC40.610.040, residential impact fees are calculated using the rates in effect at the time of building permit issuance.

e. Joint Driveway Maintenance Covenant: A private joint driveway maintenance covenant shall be submitted to the responsible official for approval and recorded with the County Auditor. The covenant shall set out the terms and conditions of responsibility for maintenance, maintenance methods, standards, distribution of expenses, remedies for noncompliance with the terms of the agreement, right of use easements, and other considerations, as required under 40.350.030(C)(4)(g).

f. Private Road Maintenance Covenant: A private road maintenance covenant shall be submitted to the responsible official for approval and recorded with the County Auditor. The covenant shall set out the terms and conditions of responsibility for maintenance, maintenance methods, standards, distribution of expenses, remedies for noncompliance with the terms of the agreement, right of use easements, and other considerations, as required under 40.350.030(C)(4)(g).

D-6 Plat Notes - The following notes shall be placed on the final plat:

a. Archaeological: "If any cultural resources and/or human remains are discovered in the course of undertaking the development activity, the Department of Archaeology and Historic Preservation in Olympia, the Cowlitz Indian Tribe, and Clark County Community Development shall be notified. Failure to comply with these State requirements may constitute a Class C Felony, subject to imprisonment and/or fines." *(See Archaeological Finding 2)*

b. Temporary Turnaround Easement: "The public easement associated with the temporary turnaround shall be extinguished once NE 45th Avenue is extended beyond the plat boundary to the south. Alternatively, a county approved public turnaround would need to be provided to the west of the temporary turnaround in order for the temporary turnaround easement to be extinguished." *(See Transportation Finding 3)*

c. Sidewalks: "Prior to issuance of occupancy permits, sidewalks shall be constructed along all the respective lot frontages."

d. Utilities: "An easement is hereby reserved under and upon all tracts and the exterior six (6) feet on all boundary lines of the lots and tracts adjacent to public/private roads and six (6) feet adjacent to access/utility easements for the installation, construction, renewing, operating and maintaining electric, telephone, tv, cable, water and sanitary sewer services. All lots containing padmount transformers are subject to the minimum clearances as defined by Clark Public Utilities construction standards. All proposed building designs on these lots must provide adequate clearance for all combustible materials. Also, a sidewalk easement, as necessary to

comply with ADA slope requirements, shall be reserved upon the exterior six (6) feet along the front boundary lines of all lots and tracts adjacent to public streets."

e. Sight Distance: "Sight distance easement triangles shall be maintained and kept clear as required under CCC 40.350.030.B.8." *(See Transportation Finding 6)*

f. Privately Owned Stormwater Facilities: "The following party is responsible for long-term maintenance of the privately owned stormwater facilities: _____."

g. Roof and Crawl Space Drains: "Roof and crawl space drains shall be installed in accordance with the approved As-Built plans, unless a revised plan is approved by the county. These stormwater systems will be owned and maintained by the property owner on whose lot the stormwater system is located."

h. Impact Fees: "In accordance with CCC 40.610 impact fees for each dwelling in this subdivision shall be assessed for impacts on schools, parks and transportation facilities based for the following districts: Battle Ground School District (SIF), Park District 10 (PIF) and Mt. Vista Transportation Sub-area (TIF). As found in CCC40.610.040, impact fees are calculated using the rates in effect at the time of building permit issuance."

i. Landscaped Median Island Maintenance Covenant: "The following party(s) is responsible for long-term maintenance of the landscape on the median island on NE 45th Avenue: _____."

j. Driveways: "No direct access is allowed onto the following streets: NE 174th Street and NE 50th Avenue."

k. Private Roads: "Clark County has no responsibility to improve or maintain the private roads contained within or private roads providing access to the property described in this development. Any private access street shall remain a private street unless it is upgraded to public street standards at the expense of the developer or abutting lot owners to include hard surface paving and is accepted by the county for public ownership and maintenance."

D-7 Sewer and Water Requirements -

a. The applicant shall produce documentation from Clark Regional Wastewater that sewer has been installed and approved *(See Water and Sewer Finding 1).*

b. The applicant shall produce documentation from Clark Public Utilities that water has been installed and approved *(See Water and Sewer Finding 2).*

c. Any cesspools, drywells, or pump chambers discovered on the site must also be abandoned in this manner and locations shown on the final plat *(See Public Health Finding 1).*

d. Any wells that are found during development of this plat shall be properly decommissioned by a licensed well driller with documentation submitted to CCPH prior to final plat approval and all decommissioned wells must be shown on the final plat *(See Public Health Finding 2).*

D-8 Sight Distance - The sight distance triangles shall be delineated on the final plat, if within the lot area *(See Transportation Finding 6).*

E	**Building Permits** **Review and Approval Authority: Permit Services & Fire Marshal**

Prior to issuance of a building permit, the following conditions shall be met:

E-1 Impact Fees –Impact fees shall be assessed for impacts on schools, parks and transportation facilities based for the following districts: Battle Ground School District (SIF), Park District 10 (PIF) and Mt. Vista Transportation Sub-area (TIF). As found in CCC40.610.040, impact fees are calculated using the rates in effect at the time of building permit issuance.

E-2 Roof and Crawl Space Drains - Roof and crawl space drains shall be installed in accordance with the approved As-Built plans, unless a revised plan is approved by the county. These stormwater systems will be owned and maintained by the property owner on whose lot the stormwater system is located *(See Stormwater Finding 2).*

E-3 Excavation and Grading - Excavation and grading shall be performed in compliance with CCC 14.07.

E-4 Setbacks - Any future construction on the newly created lots shall meet the following setbacks:

Front 18' garage, 10' house,
Steet Side 10',
Interior Side 5' (see note below regarding side lots abutting the perimeter of the development),
Rear 20'
Lots 1, 8, 4, 5, 70, 81, and 82 shall have a minimum side setback of 10' abutting the perimeter

(See Land Use Finding 3).

E-5 Residential Fire Sprinklers - Homes exceeding 3600 square feet including attached garages will require additional fire protection features including a residential fire sprinkler system when adequate public water and a hydrant is not within required distances If a residential fire sprinkler is required, it will require additional review and permitting by the Fire Marshal *(See Fire Protection Finding 7).*

F	**Occupancy Permits** **Review and Approval Authority:**

Prior to issuance of an occupancy permit, the following conditions shall be met:

F-1 **Fire Protection –** A three (3) -foot clear space shall be provided around the circumference of al fire hydrants *(See Fire Protection Finding 3).*

G	**Development Review Timelines & Advisory Information** **Review and Approval Authority: None - Advisory to Applicant**

G-1 **Land Division -** Within seven (7) years of preliminary plan approval, a Fully Complete application for Final Plat review shall be submitted.

G-2 **Department of Ecology Permit for Construction Stormwater -** A permit from the Department of Ecology (ECY) is required if:

Solid Waste Management: Derek Rockett (360) 407-6287
All grading and filling of land must utilize only clean fill. All other materials may be considered solid waste and permit approval may be required from your local jurisdictional health department prior to filling. All removed debris resulting from this project must be disposed of at an approved site. Contact the local jurisdictional health department for proper management of these materials.

Toxics Cleanup: Sam Meng (360) 999-9587
No confirmed or suspected cleanup sites awaiting cleanup within a quarter of mile from the project area.

Water Qualify/Watershed Resources Unit: Greg Benge (360) 690-4787
Erosion control measures must be in place prior to any clearing, grading, or construction. These control measures must be effective to prevent stormwater runoff from carrying soil and other pollutants into surface water or stormdrains that lead to waters of the state. Sand, silt, clay particles, and soil will damage aquatic habitat and are considered to be pollutants.

Any discharge of sediment-laden runoff or other pollutants to waters of the state is in violation of Chapter 90.48 RCW, Water Pollution Control, and WAC 173-201A, Water Quality Standards for Surface Waters of the State of Washington, and is subject to enforcement action.

The following construction activities require coverage under the Construction Stormwater General Permit:

1. Clearing, grading and/or excavation that results in the disturbance of one or more acres **and** discharges stormwater to surface waters of the State; and

2. Clearing, grading and/or excavation on sites smaller than one acre that are part of a larger common plan of development or sale, if the common plan of development or sale will ultimately disturb one acre or more **and** discharge stormwater to surface waters of the State.

a) This includes forest practices (including, but not limited to, class IV conversions) that are part of a construction activity that will result in the

disturbance of one or more acres, **and** discharge to surface waters of the State; and

3. Any size construction activity discharging stormwater to waters of the State that Ecology:

a) Determines to be a significant contributor of pollutants to waters of the State of Washington.

b) Reasonably expects to cause a violation of any water quality standard.

If there are known soil/ground water contaminants present on-site, additional information (including, but not limited to: temporary erosion and sediment control plans; stormwater pollution prevention plan; list of known contaminants with concentrations and depths found; a site map depicting the sample location(s); and additional studies/reports regarding contaminant(s)) will be required to be submitted. For additional information on contaminated construction sites, please contact Evan Wood at evan.wood@ecy.wa.gov, or by phone at (360) 706-4599.

Additionally, sites that discharge to segments of waterbodies listed as impaired by the State of Washington under Section 303(d) of the Clean Water Act for turbidity, fine sediment, high pH, or phosphorous, or to waterbodies covered by a TMDL may need to meet additional sampling and record keeping requirements. See condition S8 of the Construction Stormwater General Permit for a description of these requirements. To see if your site discharges to a TMDL or 303(d)-listed waterbody, use Ecology's Water Quality Atlas at: https://fortress.wa.gov/ecy/waterqualityatlas/StartPage.aspx.

The applicant may apply online or obtain an application from Ecology's website at: http://www.ecy.wa.gov/programs/wq/stormwater/construction/ - Application. Construction site operators must apply for a permit at least 60 days prior to discharging stormwater from construction activities and must submit it on or before the date of the first public notice. Ecology's comments are based upon information provided by the lead agency. As such, they may not constitute an exhaustive list of the various authorizations that must be obtained or legal requirements that must be fulfilled in order to carry out the proposed action.

If you have any questions or would like to respond to these comments, please contact the appropriate reviewing staff listed above.

G-3 **Building and Fire Safety** - Building and fire, life, and safety requirements must be addressed through specific approvals and permits. This decision may reference general and specific items related to structures and fire, life, and safety conditions, but they are only for reference in regard to land use conditions. It is the responsibility of the owner, agent, tenant, or applicant to ensure that Building Safety and Fire Marshal requirements are in compliance or brought into compliance. Land use decisions do not waive any building or fire code requirements *(See Fire Protection Finding 1).*

G-4 **Median in NE 174th Street** - As future traffic conditions and/or as development occurs along NE 174th Street, it may be necessary to construct raised median, or restrict turning movements on NE 174th Street. Access restrictions could be constructed at any time in the future as roadway volumes increase and/or safety issues become of concern. Access restrictions could be constructed for development mitigation or as a

county project. As a result, the applicant should acknowledge that access to NE 45th Avenue at NE 174th Street may be limited at some time in the future *(See Transportation Finding 5).*

G-5 Flood Plain Hazard Area – Any disturbance in the mapped Special Flood Hazard Area associated with Mill Creek shall be addressed for compliance with CCC 40.420.

G-6 Future Gates - While no gates are shown on the proposed plan, no gate may be installed across a required fire department access road or driveway without first obtaining and testing of the gate will be required. Split gates with a divided entry and exit side will need 15 feet on either side for a total gate width of 30 feet *(See Fire Protection Finding 6).*

H	**Post Development Requirements** **Review and Approval Authority: As specified below**

H-1 Fire Marshal Requirements -

a. A three (3) –foot clear spaces shall be maintained around the circumference of all fire hydrants *(See Fire Protection Finding 3).*

b. Access roads shall maintain an unobstructed width of not less than 20 feet and an unobstructed vertical clearance of not less than 13.5 feet with an all-weather driving surface capable of supporting the imposed loads of fire apparatus *(See Fire Protection Finding 4).*

c. Parking is prohibited on access roads that are less than twenty-four (24) feet wide. "NO PARKING – FIRE LANE" signs shall be maintained *(See Fire Protection Finding 5).*

H-2 Landscape Maintenance - Maintenance of landscaped areas is the ongoing responsibility of the property owner. Required landscaping must be continuously maintained in a healthy manner. Plants that die must be replaced with in-kind materials unless otherwise authorized by the responsible official. Vegetation shall be controlled by pruning, trimming or otherwise so that it will not interfere with the maintenance or repair of any public utility, restrict pedestrian or vehicular access, or obstruct sight distance at intersections as provided in Section 40.320.020 *(See Land Use Finding 3).*

Note: Any additional information submitted by the applicant within fourteen (14) calendar days prior to or after issuance of this report, may not be considered due to time constraints. In order for such additional information to be considered, the applicant may be required to request a "hearing extension" or "open record" and shall pay the associated fee.

Hearing Examiner Decision and Appeal Process

This report to the Hearing Examiner is a recommendation from the Land Use Review program of Clark County, Washington.

The examiner may adopt, modify or reject this recommendation. The examiner will render a decision within 14 calendar days of closing the public hearing. Clark County will mail a copy of

the decision to the applicant and neighborhood association within 7 days of receipt from the Hearing Examiner. All parties of record will receive a notice of the final decision within 7 days of receipt from the Hearing Examiner.

Motion for Reconsideration

Any party of record to the proceeding before the Hearing Examiner may file with the responsible official a motion for reconsideration of an examiner's decision within fourteen (14) calendar days of written notice of the decision. A party of record includes the applicant and those individuals who signed the sign-in sheet or presented oral testimony at the public hearing, and/or submitted written testimony prior to or at the Public Hearing on this matter.

The motion must be accompanied by the applicable fee and identify the specific authority within the Clark County Code or other applicable laws, and/or specific evidence, in support of reconsideration. A motion may be granted for any one of the following causes that materially affects their rights of the moving party:

- Procedural irregularity or error, clarification, or scrivener's error, for which no fee will be charged;
- Newly discovered evidence, which the moving party could not with reasonable diligence have timely discovered and produced for consideration by the examiners;
- The decision is not supported by substantial evidence in the record; or,
- The decision is contrary to law.

Any party of record may file a written response to the motion if filed within fourteen (14) calendar days of filing a motion for reconsideration.

The examiner will issue a decision on the motion for reconsideration within twenty-eight (28) calendar days of filing of a motion for reconsideration.

Appeal Rights

Any party of record to the proceeding before the hearings examiner may appeal any aspect of the Hearing Examiner's decision, except the SEPA determination (i.e., procedural issues), to the Superior Court.

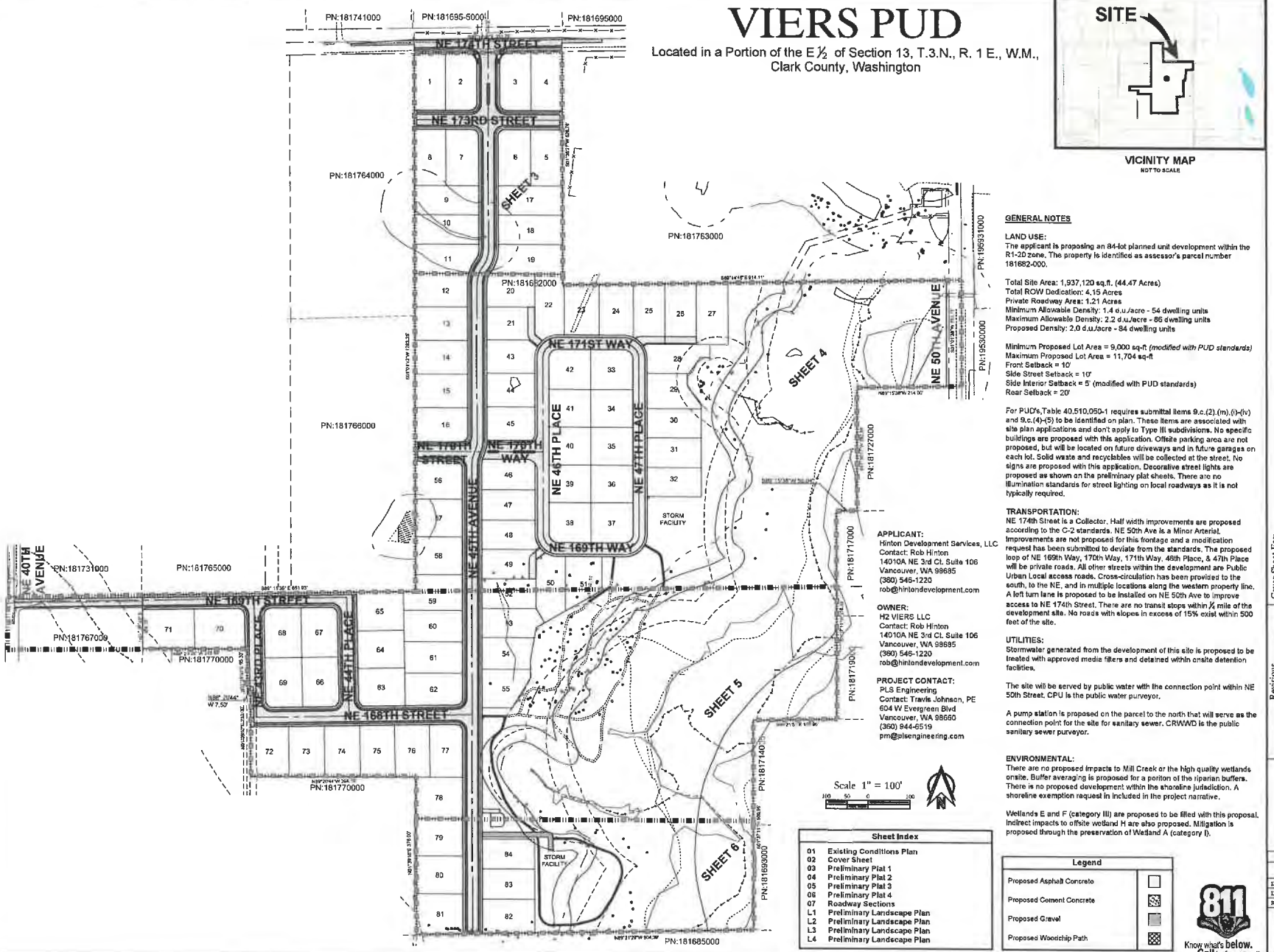
See the *Appeals* handout for more information and fees.

Attachments

- Copy of Preliminary Plan (from Exhibit 29)

VIERS PUD

Located in a Portion of the E ½ of Section 13, T.3.N., R. 1 E., W.M.,
Clark County, Washington



GENERAL NOTES

LAND USE:
The applicant is proposing an 84-lot planned unit development within the R1-20 zone. The property is identified as assessor's parcel number 181682-000.

Total Site Area: 1,937,120 sq.ft. (44.47 Acres)
Total ROW Dedication: 4.15 Acres
Private Roadway Area: 1.21 Acres
Minimum Allowable Density: 1.4 d.u./acre - 54 dwelling units
Maximum Allowable Density: 2.2 d.u./acre - 86 dwelling units
Proposed Density: 2.0 d.u./acre - 84 dwelling units

Minimum Proposed Lot Area = 9,000 sq-ft *(modified with PUD standards)*
Maximum Proposed Lot Area = 11,704 sq-ft
Front Setback = 10'
Side Street Setback = 10'
Side Interior Setback = 5' (modified with PUD standards)
Rear Setback = 20'

For PUD's,Table 40.510.050-1 requires submittal items 9.c.(2).(m).(i)-(iv) and 9.c.(4)-(5) to be identified on plan. These items are associated with site plan applications and don't apply to Type III subdivisions. No specific buildings are proposed with this application. Offsite parking area are not proposed, but will be located on future driveways and in future garages on each lot. Solid waste and recyclables will be collected at the street. No signs are proposed with this application. Decorative street lights are proposed as shown on the preliminary plat sheets. There are no illumination standards for street lighting on local roadways as it is not typically required.

TRANSPORTATION:
NE 174th Street is a Collector. Half width improvements are proposed according to the C-2 standards. NE 50th Ave is a Minor Arterial. Improvements are not proposed for this frontage and a modification request has been submitted to deviate from the standards. The proposed loop of NE 169th Way, 170th Way, 171th Way, 46th Place, & 47th Place will be private roads. All other streets within the development are Public Urban Local access roads. Cross-circulation has been provided to the south, to the NE, and in multiple locations along the western property line. A left turn lane is proposed to be installed on NE 50th Ave to improve access to NE 174th Street. There are no transit stops within ¼ mile of the development site. No roads with slopes in excess of 15% exist within 500 feet of the site.

UTILITIES:
Stormwater generated from the development of this site is proposed to be treated with approved media filters and detained within onsite detention facilities.

The site will be served by public water with the connection point within NE 50th Street. CPU is the public water purveyor.

A pump station is proposed on the parcel to the north that will serve as the connection point for the site for sanitary sewer. CRWWD is the public sanitary sewer purveyor.

ENVIRONMENTAL:
There are no proposed impacts to Mill Creek or the high quality wetlands onsite. Buffer averaging is proposed for a portion of the riparian buffers. There is no proposed development within the shoreline jurisdiction. A shoreline exemption request in included in the project narrative.

Wetlands E and F (category III) are proposed to be filled with this proposal. Indirect impacts to offsite wetland H are also proposed. Mitigation is proposed through the preservation of Wetland A (category I).

APPLICANT:
Hinton Development Services, LLC
Contact: Rob Hinton
14010A NE 3rd Ct. Suite 106
Vancouver, WA 98685
(360) 546-1220
rob@hintondevelopment.com

OWNER:
H2 VIERS LLC
Contact: Rob Hinton
14010A NE 3rd Ct. Suite 106
Vancouver, WA 98685
(360) 546-1220
rob@hintondevelopment.com

PROJECT CONTACT:
PLS Engineering
Contact: Travis Johnson, PE
604 W Evergreen Blvd
Vancouver, WA 98660
(360) 944-6519
pm@plsengineering.com

Sheet Index

01	Existing Conditions Plan
02	Cover Sheet
03	Preliminary Plat 1
04	Preliminary Plat 2
05	Preliminary Plat 3
06	Preliminary Plat 4
07	Roadway Sections
L1	Preliminary Landscape Plan
L2	Preliminary Landscape Plan
L3	Preliminary Landscape Plan
L4	Preliminary Landscape Plan

Legend

Proposed Asphalt Concrete	
Proposed Cement Concrete	
Proposed Gravel	
Proposed Woodchip Path	

811 Know what's **below.** **Call** before you dig.

PLS ENGINEERING

Cover Sheet For:
VIERS PUD
A Subdivision Located In Clark County, Washington

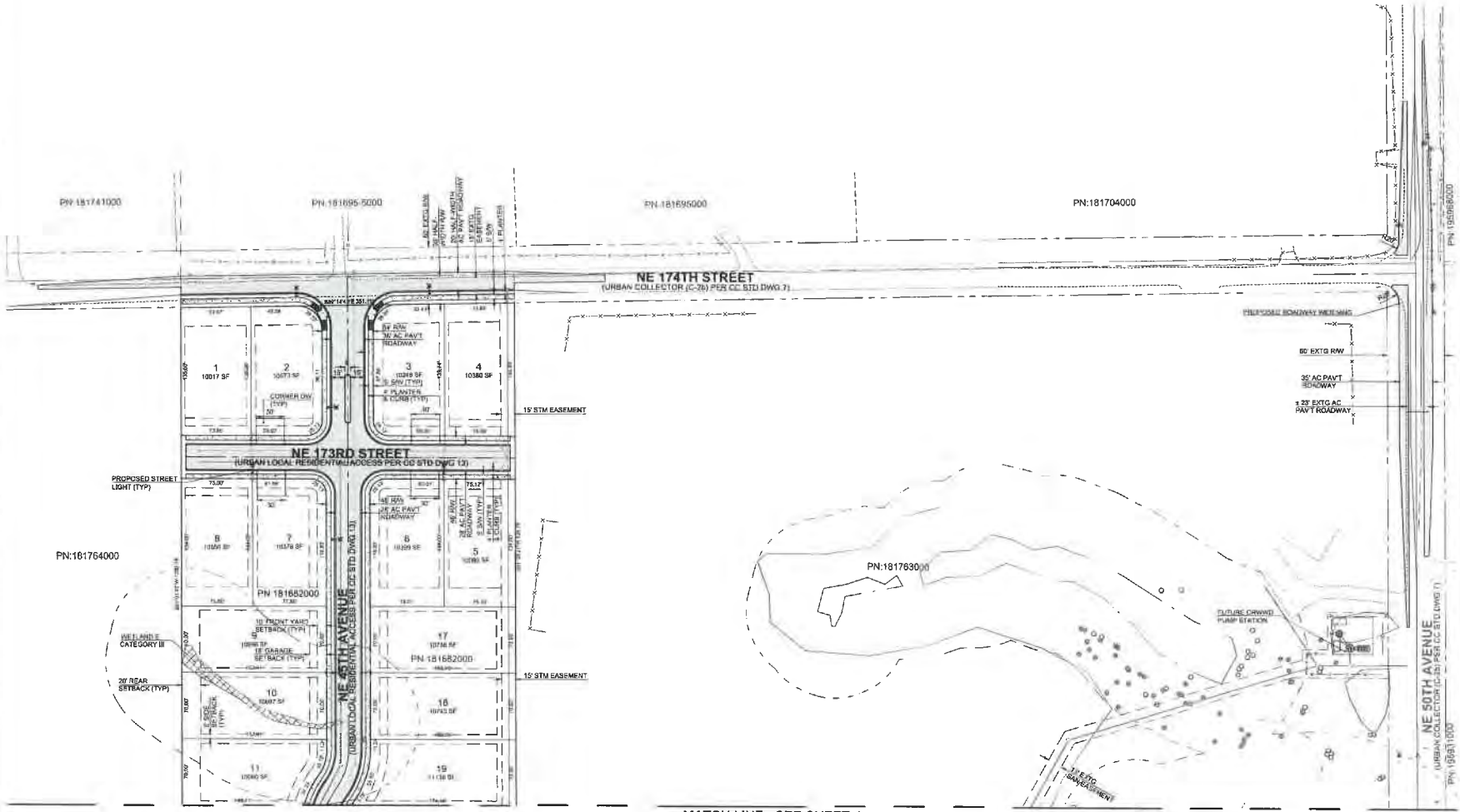
Revisions		
1	2023-12-06	
2		
3		
4		
5		
6		

Project No. 3000	
SCALE:	H: 1" = 100' V: N/A
DESIGNED BY:	DRL
DRAFTED BY:	XXX
REVIEWED BY:	TGJ

02
11

VIERS PUD

Located in a Portion of the E ½ of Section 13, T.3.N., R. 1 E., W.M.,
Clark County, Washington



Scale 1" = 50'

Legend
Proposed Asphalt Concrete
Proposed Cement Concrete
Proposed Gravel

811 Know what's below. Call before you dig.

PLS ENGINEERING

Preliminary Plat 1 For:

VIERS PUD

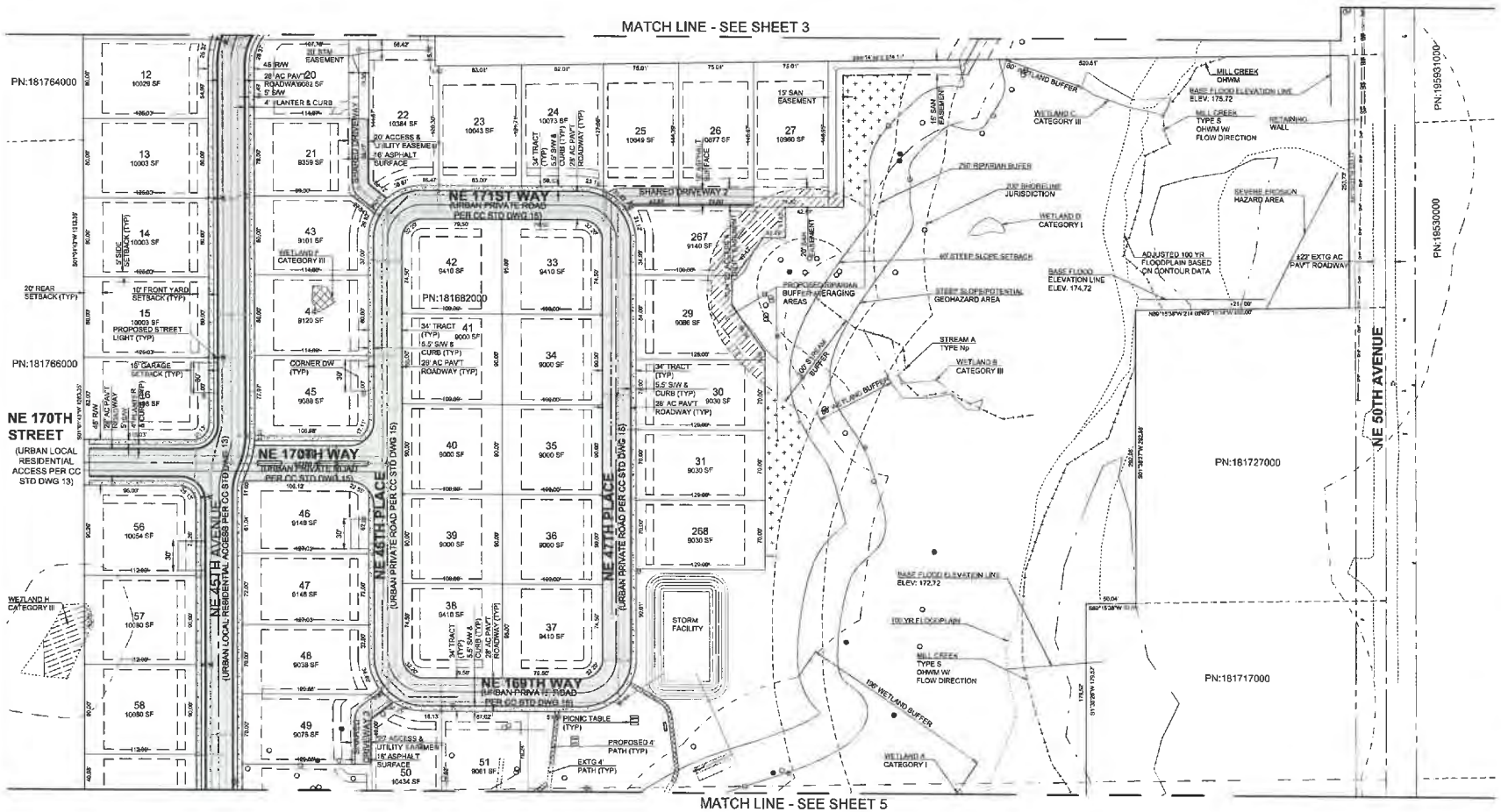
A Subdivision Located in Clark County, Washington

Revisions

Project No. 3000	
SCALE:	H: 1" = 50' V: N/A
DESIGNED BY:	DRL
DRAFTED BY:	XXX
REVIEWED BY:	TGJ

03

11



PLS ENGINEERING

Preliminary Plat 2 For:

VIERS PUD

A Subdivision Located In Clark County, Washington

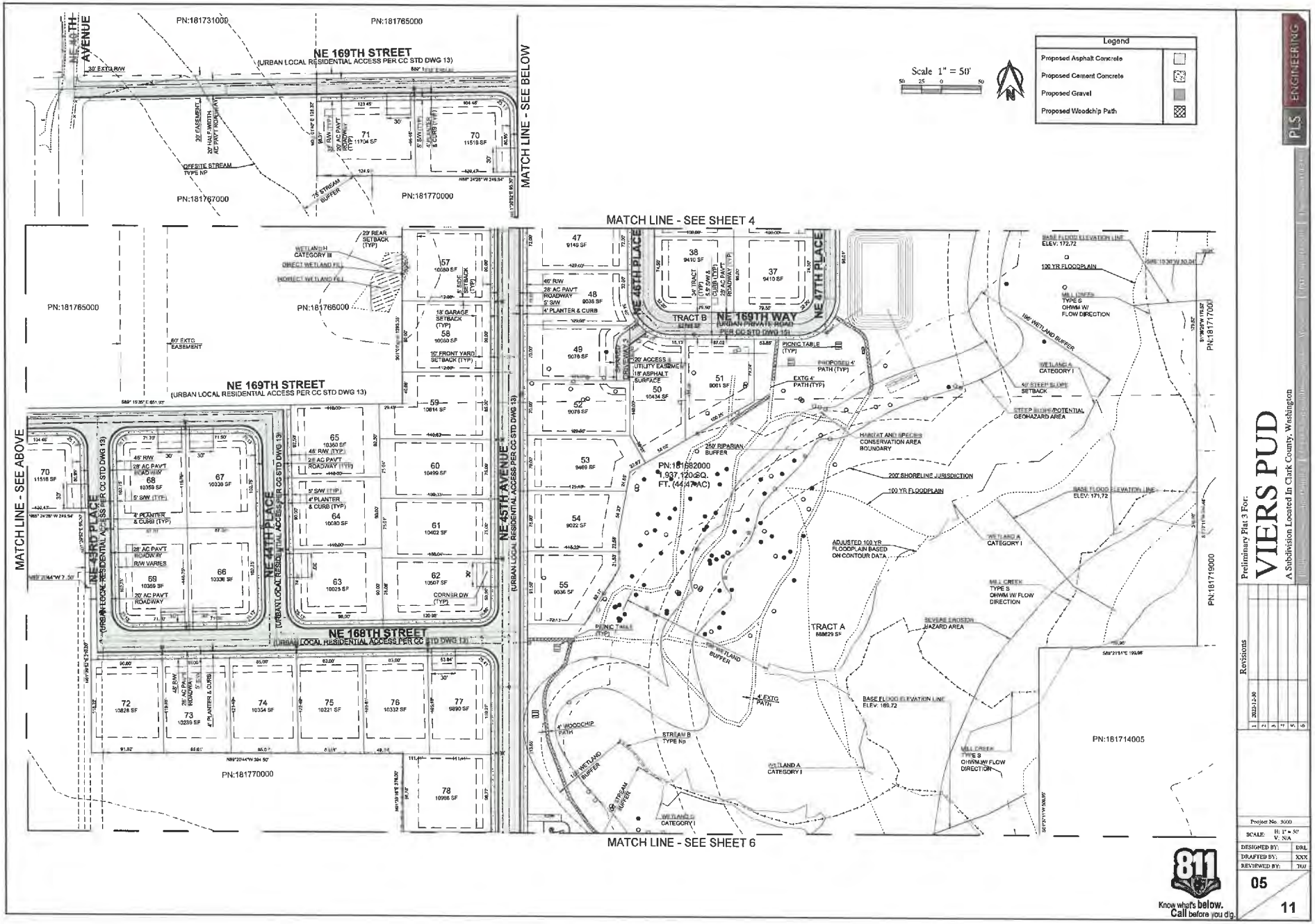
Revisions

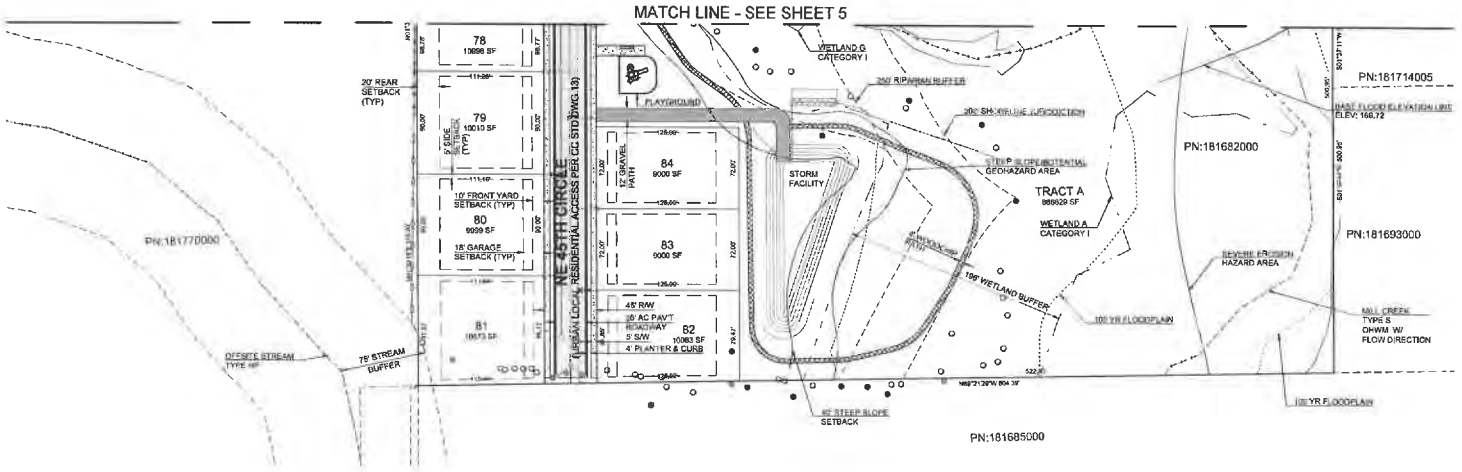
1	2022-12-30					

Project No.	3000
SCALE:	H: 1" = 50' V: N/A
DESIGNED BY:	DRL
DRAFTED BY:	XXX
REVIEWED BY:	TGJ

04

11


NE 46TH AVENUE
NE 169TH STREET
(URBAN LOCAL RESIDENTIAL ACCESS PER CC STD DWG 13)
PN:181731000
PN:181765000
PN:181767000
PN:181770000
MATCH LINE - SEE BELOW
MATCH LINE - SEE SHEET 4
MATCH LINE - SEE ABOVE
MATCH LINE - SEE SHEET 6
NE 43RD PLACE
NE 44TH PLACE
NE 45TH AVENUE
NE 46TH PLACE
NE 47TH PLACE
NE 168TH STREET
TRACT B
NE 169TH WAY
(URBAN PRIVATE ROAD PER CC STD DWG 15)
PN:181682000
1,937,120 SQ. FT. (44.47 AC)
TRACT A
888629 SF
PN:181719000
PN:181717000
PN:181714005
Scale 1" = 50'
Legend
Proposed Asphalt Concrete
Proposed Cement Concrete
Proposed Gravel
Proposed Woodchip Path
Preliminary Plat 3 For:
VIERS PUD
A Subdivision Located In Clark County, Washington
Revisions
Project No. 3000
SCALE: H: 1" = 50' V: N/A
DESIGNED BY: DRL
DRAFTED BY: XXX
REVIEWED BY: JMJ
05
11
Know what's below. Call before you dig.



Scale 1" = 50'

Legend	
Proposed Asphalt Concrete	
Proposed Cement Concrete	
Proposed Gravel	
Proposed Woodchip Path	

811 Know what's below. Call before you dig.

PLS ENGINEERING

Preliminary Plat 4 For:

VIERS PUD

A Subdivision Located In Clark County, Washington

Revisions						
	1	2023-12-20				
	#1					
	3					
	4					
	5					
	6					

Project No: 3000	
SCALE:	H: 1" = 50' V: N/A
DESIGNED BY:	DRL
DRAFTED BY:	XXX
REVIEWED BY:	TOJ

Exhibit K

10. Stormwater Technical Information Report and Stormwater Plan – Separately Bound

North Haven PUD
(PAC-2019-00183)

Preliminary Stormwater Report
Technical Information Report

Date: February 2020

Submitted to:
Clark County
Planning Department
1300 Franklin Street
Vancouver, WA 98660

Applicant:
BTMC, LLC.
Contact: Terry Wollam
7701 Glenwood Drive, Suite 100
Vancouver, WA 98662
(360) 798-5820 | terry@wollamassociates.com

Engineering Contact:
John Meier, PE
(360) 882-0419 | John@aks-eng.com

Prepared By:
AKS Engineering & Forestry, LLC
9600 NE 126th Avenue, Suite 2520
Vancouver, WA 98682

AKS Job Number: 4373

AKS ENGINEERING & FORESTRY

www.aks-eng.com

Certificate of the Engineer

North Haven PUD
Clark County, Washington
Preliminary Technical Information Report

This Technical Information Report (TIR) and the data contained herein were prepared by the undersigned, whose seal, as a Professional Engineer licensed to practice as such, is affixed below. All information required by Clark County Code (CCC) Chapter 40.386 is included in the proposed stormwater plan and the proposed facilities are feasible.



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Appendix E: BMP Details
Appendix F: WWHM and HydroCAD Analysis
Appendix G: Soils Report
Appendix H: Wetlands Guidelines Checklist
Appendix I: LID Feasibility Checklist

References

Clark County Stormwater Manual, November 2015, (Errata September 2016) – "2015 CCSM"

Preliminary Stormwater Report
NORTH HAVEN SUBDIVISION PLANNED UNIT DEVELOPMENT
CLARK COUNTY, WASHINGTON

Section A: Project Overview

Site Information

The North Haven Planned Unit Development (PUD) site is located on three parcels of land totaling approximately 38 acres at the corner of NW 179th Street and NW 11th Ave. The project is located in the northeast quarter of Section 15, Township 3 North, Range 1 East of the Willamette Meridian in Ridgefield, Washington, Property Serial Numbers: 182164-000, 182168-000 and 182170-000. All parcels are zoned Residential (R-12) with an Urban Holding 10 (UH-10) overlay. The site is surrounded by properties zoned Single-Family Residential (R1-10) to the north, Single-Family Residential (R1-20) to the south, Rural-10 (R-10) to the west, and Public Facilities to the east. See the Vicinity Map in Appendix A for the project location.

The existing site contains one residential structure located on parcel 182170-000. On parcel 182168-000, there is a mobile home, carport, a barn and three outbuildings. Parcel 182164-000 does not contain any structures. All three parcels contain portions of agriculture fields and pasturelands as well as some trees. According to Clark County Geographic Information System (GIS), there is an existing septic system and well on site. All existing septic systems and wells on-site will be decommissioned, and all structures are proposed to be removed with the development of this site.

Wetlands and Floodplains

According to Clark County GIS, there are wetlands, a stream, and steep slopes present on site. The site is located within a Category II Critical Aquifer Recharge Area (CARA 2). The archaeological predictive is high to moderate-high across the site. There are no mapping indicators for historic sites within the project. The existing site vegetation consists of evergreen and deciduous trees, grass, shrubs and pasture grass. Much of the existing vegetation will be removed during development with the exception to the vegetation within the critical areas. Protected vegetation within the critical areas will not be disturbed.

The locations of the wetlands and stream shown on the plans are based on mapped information provided by Ecological Land Services (ELS). There are three wetlands and a seasonal stream that includes a floodplain on-site. Wetland A is a category III wetland and the largest on-site along the NW 11th Avenue frontage. Wetland B is a category IV wetland near the northwest corner of the site near the intersection of NW 179th Street and NW 11th Avenue. Wetland C is an isolated wetland to the southeast of Wetland A. All site flow is currently within the Whipple Creek watershed. The project flows into two separate sub-basins of the Whipple Creek watershed; the Whipple Creek (Lower) and the Whipple Creek (Upper) sub-basins.

Packard Creek is a type Ns stream per the Washington Department of Natural Resources water typing standards and is located above and below Wetland A in a slight valley in the middle of the project site. There is an associated floodway and floodway fringe for Packard Creek that extends into the site as determined by Federal Emergency Management Agency (FEMA) flood mapping. No development lies

within the floodway. Some grading and a stormwater treatment swale are proposed within the limits of the floodway fringe.

Site Topography and Hydrology

The existing topography for the North Haven PUD site consists of varying slopes that generally direct drainage east to west towards the middle of the site. There is a slight ridge running east to west on parcel no. 182164-000 splitting the site drainage into two separate threshold discharge areas (TDAs). The natural drainage system's two outfalls are defined as Points of Compliance (POCs) to which post-developed discharge will be routed. The off-site neighboring properties' runoff from the east and northeast will be accounted for and are included in the hydraulic modeling for Basin 1.3.

Detention and Treatment in Post-Development Basins

Three detention ponds are being proposed for water quantity mitigation of project runoff. TDA #1 includes parcel nos. 182168-000, 182170-000, and a majority of parcel no. 182164-000 that flows through the middle of the site to a low point along NW 11th Avenue and totals approximately 39.9 acres. The POC for TDA #1 consists of four separate basins (Basin 0.1, Basin 1.1, Basin 1.2 & Basin 1.3), two detention ponds, a combination of mechanical filtration catch basins and a biofiltration swale for site stormwater treatment. Basins 1.1 and 1.2 will require mechanical filter catch basins and will include the use of stormwater service laterals to reduce the treatment area required for each catch basin. Basin 0.1 is the contributing off site areas that flow through Basin 1.3 and into Pond 1.3. Off site basin areas are summarized within Basin 0.1 for modeling purposes, see the Basin Maps, Appendix D, and the WWHM model, Appendix F, for more information.

TDA #2 includes the southern portion of parcel no. 182164-000 that flows south into the Whipple Creek (Upper) sub-watershed basin. The contributing area for TDA #2 is approximately 3.7 acres and includes only one basin (Basin 2.1), which is detained in a single pond after mechanical filtration and discharged to POC #2 along the southern boundary of the site. Stormwater service laterals will be used to reduce the treatment flow rates required for each mechanical treatment catch basins.

The stormwater system for the site is designed using a combination of the 2012 Western Washington Hydrology Model, Version 4.2.12 (WWHM) and Clark County Map Data, as well as HydroCAD version 10.00-20. HydroCAD was used to model the water quality biofiltration swale for Basin 1.3.

There are no surface waters, adjacent (within ¼ mile) critical areas, or adjacent developments that will be negatively affected by the project. The majority of stormwater from the neighboring parcels will remain off site, and on-site mitigated stormwater runoff will either be detained on-site at or below pre-developed release rates or sheet flow utilizing full dispersion. Runoff from neighboring parcels that flows toward the development will be included in the hydraulic model.

Development Overview

As shown on the preliminary land use plans included with this submittal, the applicant proposes to subdivide three parcels into 329 attached and detached single-family lots. Development will also include associated infrastructure and amenities required by Clark County for a PUD. Proposed site improvements will include sidewalks, sewer, water, public streets, open spaces, and trails. Lots will range from approximately 2,000 square feet to 4,700 square feet in area.

The site will be served by two entrances along NW 11th Avenue. NW 179th Street is classified as an Urban Principal Arterial (Pr-4cb) and NW 11th Avenue is classified as an Urban Minor Arterial (M-2cb), each will require half-street improvements and right-of-way dedication along the frontage of the development.

The development is proposed to be completed in 6 phases: Phase 1, Phase 2A, Phase 2B, Phase 3, Phase 4, and Phase 5. See the development plans, Appendix C, for more information.

Determination of Applicable Minimum Requirements

Proposed land disturbances will consist of grading and excavation of unsuitable soils for the construction of sidewalks, utilities, streets and 329 residential lots. Due to the amount of proposed hard surfaces (greater than 5,000 square feet), the project is required to meet Minimum Requirements (MRs) #1-9 per Figure 1.2 of the Clark County Stormwater Manual (CCSM; see Appendix B).

The tables in this section provide information pertaining to each stormwater basin within the project area. See the Stormwater Basin Plans in Appendix D for basin locations.

Table A.1: Proposed Hard Surface and Landscaping

Basin	Threshold Discharge Area (TDA)	Existing Hard Surfaces (acres)	New Hard Surfaces (acres)	Replaced Hard Surfaces (acres)	Native Vegetation Replaced with Landscaping (acres)	Total Land Disturbed (acres)
Basin 0.1[1]	1	0.00	0.00	0.00	0.00	0.00
Basin 1.1	1	0.40	1.23	0.40	0.09	1.32
Basin 1.2	1	0.00	2.98	0.00	0.84	3.82
Basin 1.3	1	0.31	18.88	0.31	6.56	25.44
Basin 2.1	2	0.00	2.61	0.00	1.04	3.65

Note: Areas listed are in acres. Assumes 500-square-foot driveways, and 1,600- square-foot roof area per lot. See the Post-Developed Basin Plan in Appendix D. Areas in the table include all areas within the basins.

[1]Basin 0.1 is the offsite area that will be collected and passed through Basin 1.3 stormwater detention and treatment. Existing conditions are assumed for pre- & post developed scenarios.

Tables A.2 and A.3 show the mitigated site basins differentiated between pollution- and non-pollution-generating surfaces. Based on the design, it is important to note that most, if not all, non-pollution-generating areas will directly mix or can mix with stormwater runoff from pollution-generating areas and are therefore considered to be pollution-generating.

Table A.2: Pollution Generating Surfaces

Basin	Hard Surfaces (acres)	Pervious (acres)	Total (acres)
Basin 0.1[1]	0.00	9.04	9.04
Basin 1.1	1.23	0.09	1.32
Basin 1.2	1.44	0.45	1.89
Basin 1.3	18.88	6.56	25.44
Basin 2.1	1.57	0.62	2.19

Note: Areas listed are in acres. Assumes 500-square-foot driveways, and 1,600- square-foot roof area per lot. See the Post-Developed Basin Plan in Appendix D. Areas in the table include all areas within the basins.

[1]Basin 0.1 is the offsite area that will be collected and passed through Basin 1.3 stormwater detention and treatment.

Table A.3: Non-Pollution-Generating Surfaces

Basin	Hard Surfaces (acres)	Pervious (acres)	Total (acres)
Basin 0.1[1]	0.00	0.00	0.00
Basin 1.1	0.00	0.26	0.26
Basin 1.2	1.54	0.39	1.93
Basin 1.3	0.00	0.00	0.00
Basin 2.1	1.17	0.29	1.46

Note: Areas listed are in acres. Assumes 500-square-foot driveways, and 1,600- square-foot roof area per lot. See the Post-Developed Basin Plan in Appendix D. Areas in the table include all areas within the basins. Roof areas will connect to the storm main through a service lateral to avoid mixing with pollution generating surfaces.

[1]Basin 0.1 is the offsite area that will be collected and passed through Basin 1.3 stormwater detention and treatment.

Each developed basin's effective hard surfaces and their applicability to meeting MRs #6-8 are summarized in Table A.4 below. An analysis of the basins using WWHM modeling software is included in Appendix F.

Table A.4: Effective Hard Surfaces

Basin	TDA	Hard Surfaces Area (acres)	MR#6 Required (Y/N)	MR#7 Required (Y/N)	MR#8 Required (Y/N)
Basin 0.1[1]	1	0.00	N	N	N
Basin 1.1	1	1.23	Y	Y	N
Basin 1.2	1	2.98	Y	Y	N
Basin 1.3	1	18.88	Y	Y	N
Basin 2.1	2	2.61	Y	Y	N

Note: Areas listed are in acres. Assumes 500-square-foot driveways, and 1,600- square-foot roof area per lot. See the Post-Developed Basin Plan in Appendix D. Areas in the table include all areas within the basins.

[1]Basin 0.1 is the offsite area that will collected and passed through Basin 1.3 stormwater detention and treatment.

Section B: Minimum Requirements

MR #1: Preparation of Stormwater Site Plans

Stormwater Engineering Plans have been submitted for review.

MR #2: Construction Stormwater Pollution Prevention Plan (SWPPP)

MR #2 is not applicable per 1.8.1.5 of the 2015 CCSM for the Preliminary TIR. A Stormwater Pollution Prevention Plan (SWPPP) will be provided during final engineering.

MR #3: Source Control of Pollution

In conformance with the requirements of CCC Chapter 13.26A, there will be no prohibited discharges planned from the site. Best management practices (BMPs) will be designed and indicated on the SWPPP and Erosion Control Plans, including details on preventing sediment-laden runoff from leaving the site and impacting any neighboring properties and County systems such as state waters. In addition, BMPs will be implemented as necessary to prevent pollutants from mixing with stormwater during construction. None of the development activities listed in Appendix 3-A of Book 3 of the 2015 CCSM are applicable to the project.

MR #4: Preservation of Natural Drainage Systems and Outfalls

Basins 0.1, 1.1, 1.2, and 1.3 surfaces currently sheet flow to the Type Ns Packard Creek drainage corridor. After development, most runoff will be collected via catch basins and stormwater laterals for roof runoff and conveyed to stormwater ponds where it will be detained to equal to, or below the pre-developed discharge rates. Discharge will occur at the natural drainage systems outfall at POC 1 and be equipped with energy dissipaters. Basin 1.3 will use weep holes in the curb for lot drainage to discharge into the street and convey to catch basins.

Basin 2.1 surface currently sheet flows in a southernly direction onto the neighboring property's pasture. After development, all runoff will be collected via catch basins and stormwater laterals for roof runoff and conveyed to a stormwater pond where it will be detained to equal to or below the pre-developed discharge rates. Discharge will occur at the natural drainage systems outfall to POC 2. The outfall will be equipped with an energy dissipater and a flow spreader.

The stormwater facilities will detain runoff at equal or below the pre-developed discharge rates from the TDA, as required per MR #7.

MR #5: On-Site Stormwater Management BMPs

General

The project proposes to use three detention ponds, flow control manholes, sedimentation manholes, mechanical water quality catch basin filters, basic biofiltration swale or wet biofiltration swale (BMP T9.10 and BMP T9.20), and/or biofiltration systems (proprietary BMP – StormFilter, PerkFilter, Filtera, or an approved equal). All roof runoff is proposed to either flow through weep holes into the right-of-way and mix with pollution-generating asphalt roadway surfaces or connect via a stormwater service lateral to the stormwater main line and bypass treatment. All crawl spaces, foundation drains, and incidental landscape runoff that is collected with grated drain basins will be collected and conveyed in the same manner. All driveways will flow into the right-of-way and mix roadway surfaces.

Per the Soil Survey of Clark County, Washington (U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS)), on-site soils consist of the following:

- HoB (Hillsboro silt loam, 3-8 % slopes), 23% of site
- SlB (Sara silt loam, 0-8% slopes), 5% of site
- SlD (Sara silt loam, 8-20% slopes), 72% of site

A County GIS soils map is included in Appendix A.

A preliminary geotechnical investigation dated January 2019, by Earth Engineering, Inc. (EEI) was completed for the site and includes infiltration testing. Of the 12 test pits dug at the site, testing was performed in three test pits, with the results of all three being 0.0 inches/hour. Groundwater was identified in only two of the test pits. These test pits were located along the central drainage channel of the site, and groundwater was met at approximately three feet below existing grade. Groundwater was not encountered in the remaining test pits for the site. The field investigation indicated approximately 8-18 inches of topsoil for the site.

See the Soils Map and Geotechnical Report in Appendix G for additional information.

All stormwater quality and quantity facilities for the site have been designed in conformance with the 2015 CCSM and are detailed on the Development Plans included in Appendix C. See Appendix E for additional design criteria for the proposed BMPs.

LID

From Figure 2.1: Flow Chart for Determining Low-Impact Development (LID) Minimum Requirement #5 Requirements of the CCSM, the project is required to meet the LID Performance Standard through use of any BMP(s) in the CCSM except for Rain Gardens, the LID Performance Standard is not being met. Mandatory List #2 (Table 2.2) was therefore used to evaluate LID BMPs to be considered for projects subject to MR#1-9.

Infiltration is not recommended for this site due to the very low permeability of the on-site infiltration testing performed during the preliminary geotechnical investigation, making most LID BMPs infeasible for this project. Due to site layout and unknown slopes at the rear of lots adjacent to on-site open spaces, dispersion of lot stormwater may be utilized during final engineering analysis once final site grading is determined. In lieu of the LID Performance Standard, the LID Feasibility Checklist is used for this project, see Appendix I. Due to the site being new development within an urban growth area (UGA), List #2 is used

for roofs and other hard surfaces. In following the checklists guidelines, all LID BMPs were determined to be infeasible for this project as a whole.

MR #6: Runoff Treatment Analysis and Design

The proposed stormwater facilities will provide basic runoff treatment for all the on-site pollution-generating impervious surfaces, which are totaled in Table A.2, above. The project proposed the use of a water quality treatment biofiltration swale (BMP T9.10), and a combination of mechanical water quality catch basin filters, and/or biofiltration systems (Proprietary BMP – StormFilter, Perkfilter, Filtera, or an approved equal) for water quality prior to discharging to site detention facilities. All roof runoff is proposed to either flow through weep holes into the right-of-way and mix with pollution-generating asphalt roadway surfaces or connect via a stormwater service lateral to the stormwater main line and bypass treatment. All crawl spaces, foundation drains, and incidental landscape runoff that is collected with grated drain basins will be collected and conveyed in the same manner. All driveways will flow into the right-of-way and mix roadway surfaces. Basin 1.3 will utilize a post-detention water quality biofiltration swale which is designed to pass the full 2-year flow rate for water quality treatment, see Appendix F for HydroCAD output for swale sizing.

All stormwater quality facilities for the site have been designed in conformance with the 2015 CCSM. The approximate location and size of the proposed runoff treatment facilities are shown on the Preliminary Development Plans in Appendix C.

MR #7: Flow Control

The proposed stormwater facilities in each basin will provide flow control for the increased runoff generated by the new developments impervious and pervious surfaces, the surfaces are totaled in Table A.1 above.

The project proposes to use three detention ponds, each equipped with a flow control manhole, to meet site flow control requirements. All roof, driveway and incidental landscape runoff is proposed to flow through site detention ponds. Location of site detention ponds are summarized in the Development Plans in Appendix C, while the site detention ponds were sized using WWHM (see Appendix F for WWHM model output). Infiltration BMPs were not selected based on infiltration testing done by Earth Engineering Inc., which indicated very low infiltration rates for on-site soils (Appendix G).

Each detention pond will be equipped with an emergency overflow spillway sized to pass the 100-year flow to prevent breaching of the pond embankment due to high inflows or blockage of the control manholes. The overflows will be located at or near the control manholes in a location nearest the points of discharge to the natural drainage flow paths. All stormwater quantity facilities for the site have been designed to conform with the CCSM.

MR #8: Wetlands Protection

The site contains three total on-site wetlands associated with the natural drainage ways on site. Wetland A is a category III, Wetlands B and C are a category IV. Any discharge to a wetland shall maintain the hydrologic conditions, hydrophytic vegetation, and substrate characteristics necessary to support existing and designated uses. All criteria from Appendix 1-H, Wetland Guidelines of the CCSM, have been met and a completed checklist is provided in Appendix H of this report.

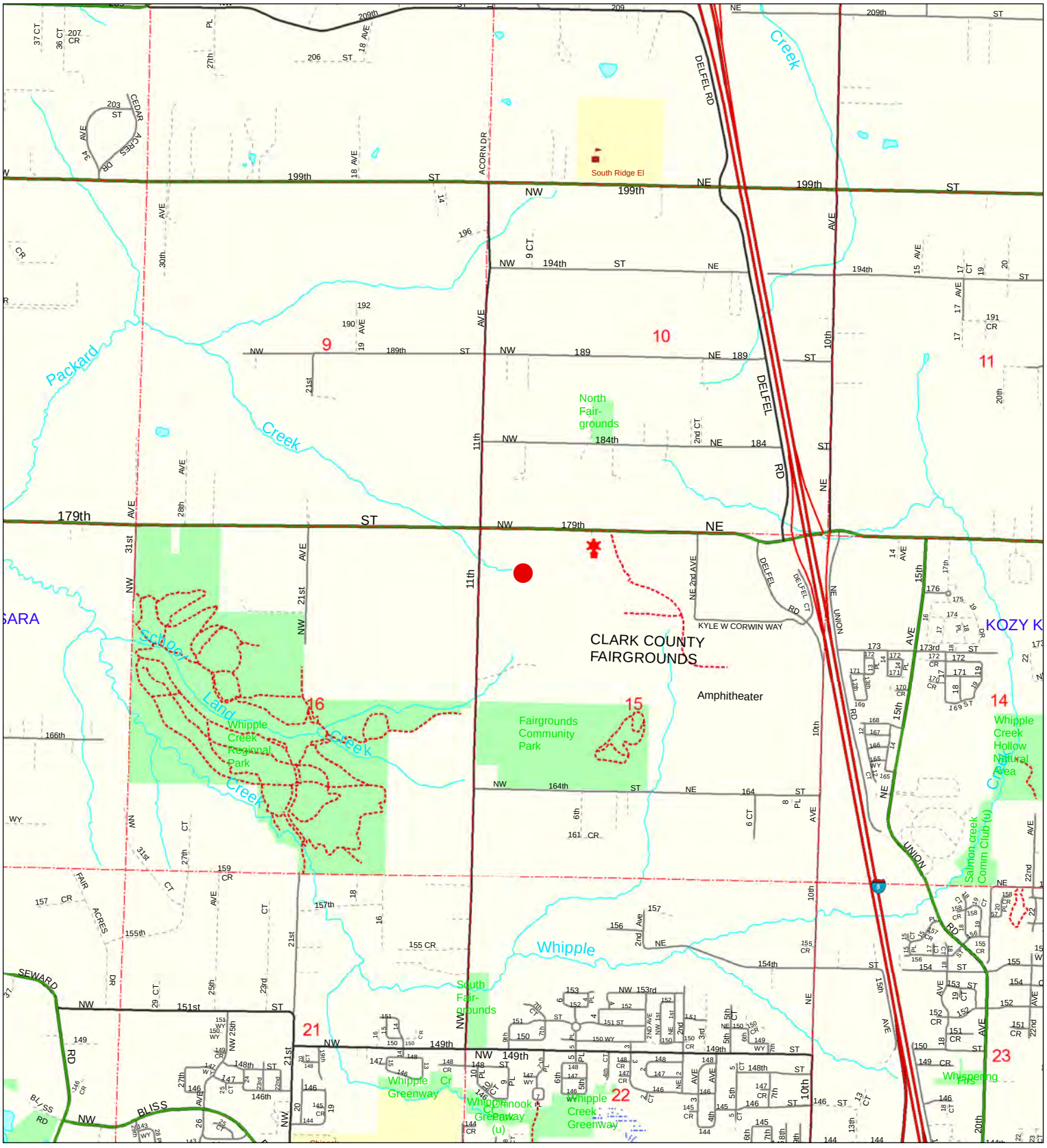
Stormwater treatment and flow control facilities are not proposed to be built within native vegetative buffers, except for necessary grading, conveyance, dispersion, and discharge systems as allowed within

Category III Wetlands per the Unified Development Code (UDC) 40.450, Wetland Protection. See separate Critical Areas Report prepared for BTMC, LLC. By Ecological Land Services dated February 2020 for complete impact and mitigation activities.

MR #9: Operation and Maintenance

All stormwater facilities located within the right-of-way or open-space tracts of land (detention ponds, mechanical filter catch-basins, biofiltration swales, manholes, catch basins, conveyance piping, conveyance ditching, culverts, and water quantity control structures, unless otherwise specified on the plans), will be owned and maintained by the County consistent with County policy. All other stormwater facilities located on private property (area drains, conveyance piping, and associated structures) are proposed to be maintained by the lot owners or the Homeowner's Association.

Appendix A:
Map Submittals

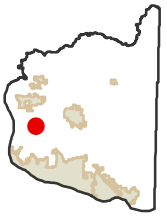


General Location

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

Location of Subject Property(s)

Printed on: August 19, 2019



CLARK COUNTY, WASHINGTON
Geographic Information System

0 1,000 2,000 Feet

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



Elevation Contours

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

Printed on: August 19, 2019

CLARK COUNTY, WASHINGTON
Geographic Information System

N

0 200 400 Feet

Subject Property(s)
Public Road
Transportation or Major Utility Easement
10' Elevation Contours
2' Elevation Contours

31109	31110	31111
31116	31115	31114
31121	31122	31123

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.

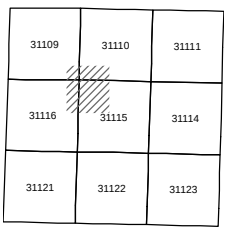


2016 Aerial Photography

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

Subject Property(s)

Printed on: August 19, 2019



CLARK COUNTY, WASHINGTON
Geographic Information System

N

0 200 400 Feet

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



2016 Aerial Photography with Elevation Contours

Printed on: August 19, 2019

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

CLARK COUNTY, WASHINGTON
Geographic Information System

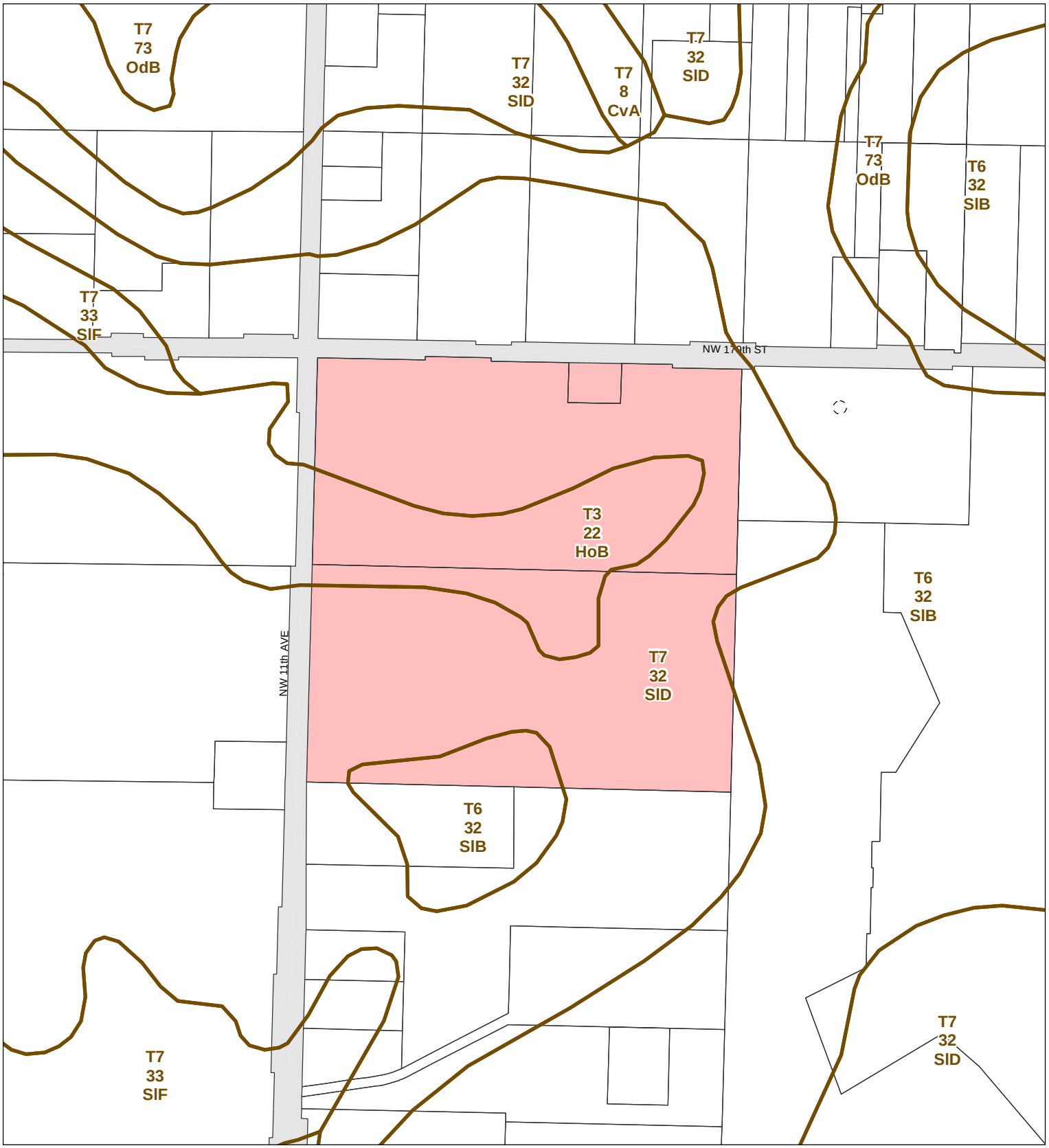
N

0 100 200 Feet

Subject Property(s)
2' Elevation Contours

31109	31110	31111
31116	31115	31114
31121	31122	31123

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



Soil Types

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

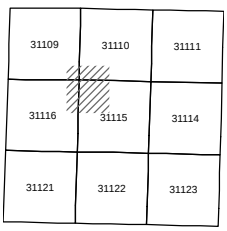
Printed on: August 19, 2019

CLARK COUNTY, WASHINGTON
Geographic Information System

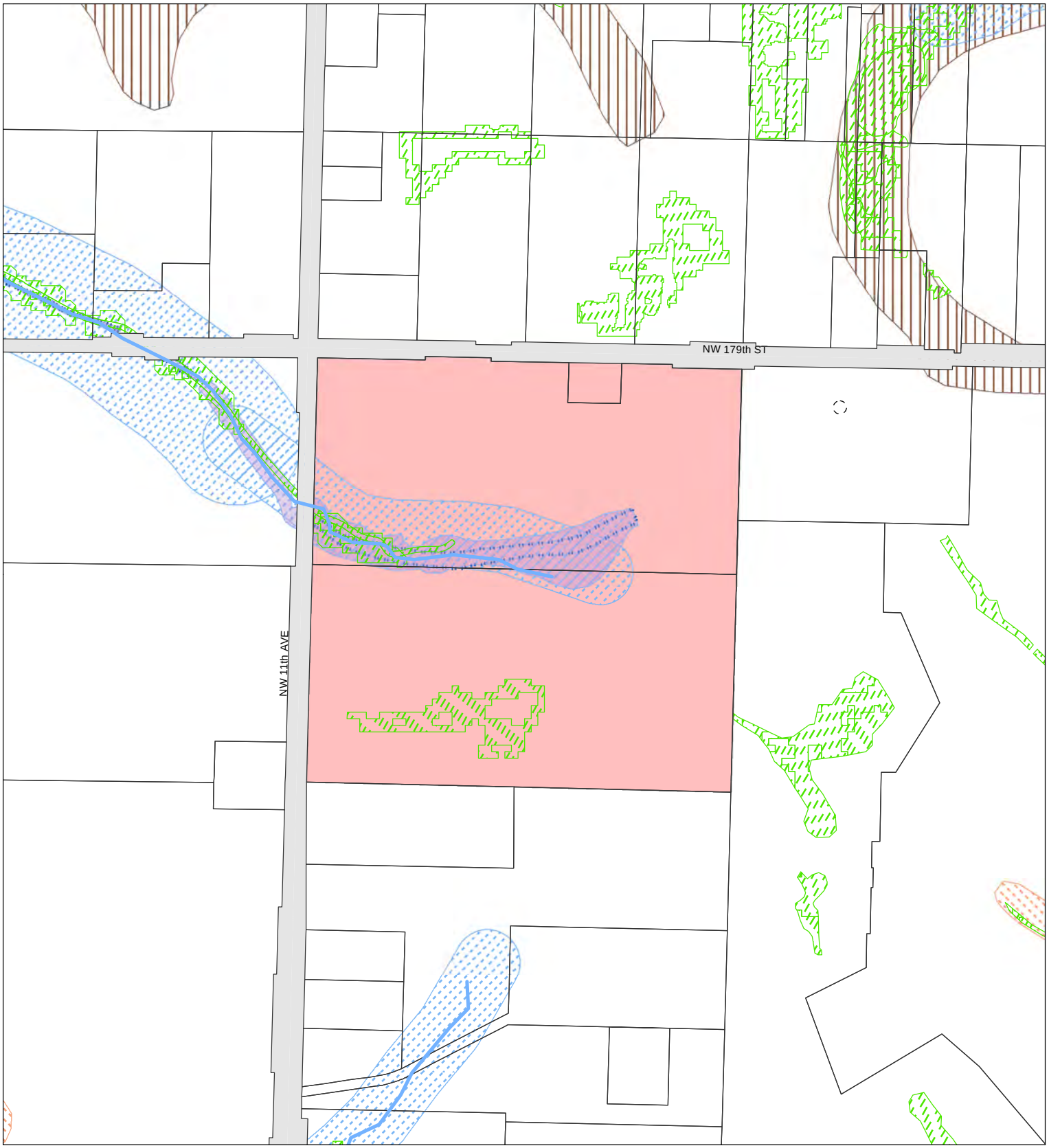
N

0 200 400 Feet

Subject Property(s)
Public Road
Transportation or Major Utility Easement
Soil Type Boundary



Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



Environmental Constraints I

Printed on: August 19, 2019

Account: 182170000, 182168000, 182164000
Owner: ROMINGER HOMEPLACE LLC
Address: 12112 NW 31ST AVE
C/S/Z: VANCOUVER, WA 98665

CLARK COUNTY, WASHINGTON
Geographic Information System

N

0 200 400 Feet

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.

- Subject Property(s)
- Public Road
- Transportation or Major Utility Easement
- Hydric Soils
- Wetland Inventory
- CARA Category 1
- Riparian Habitat or Species Area
- Non-Riparian Habitat or Species Area
- 100 year Floodplains
- Floodway
- Shorelines
- Stream

31109	31110	31111
31116	31115	31114
31121	31122	31123

Appendix B:
New Development Flow Chart

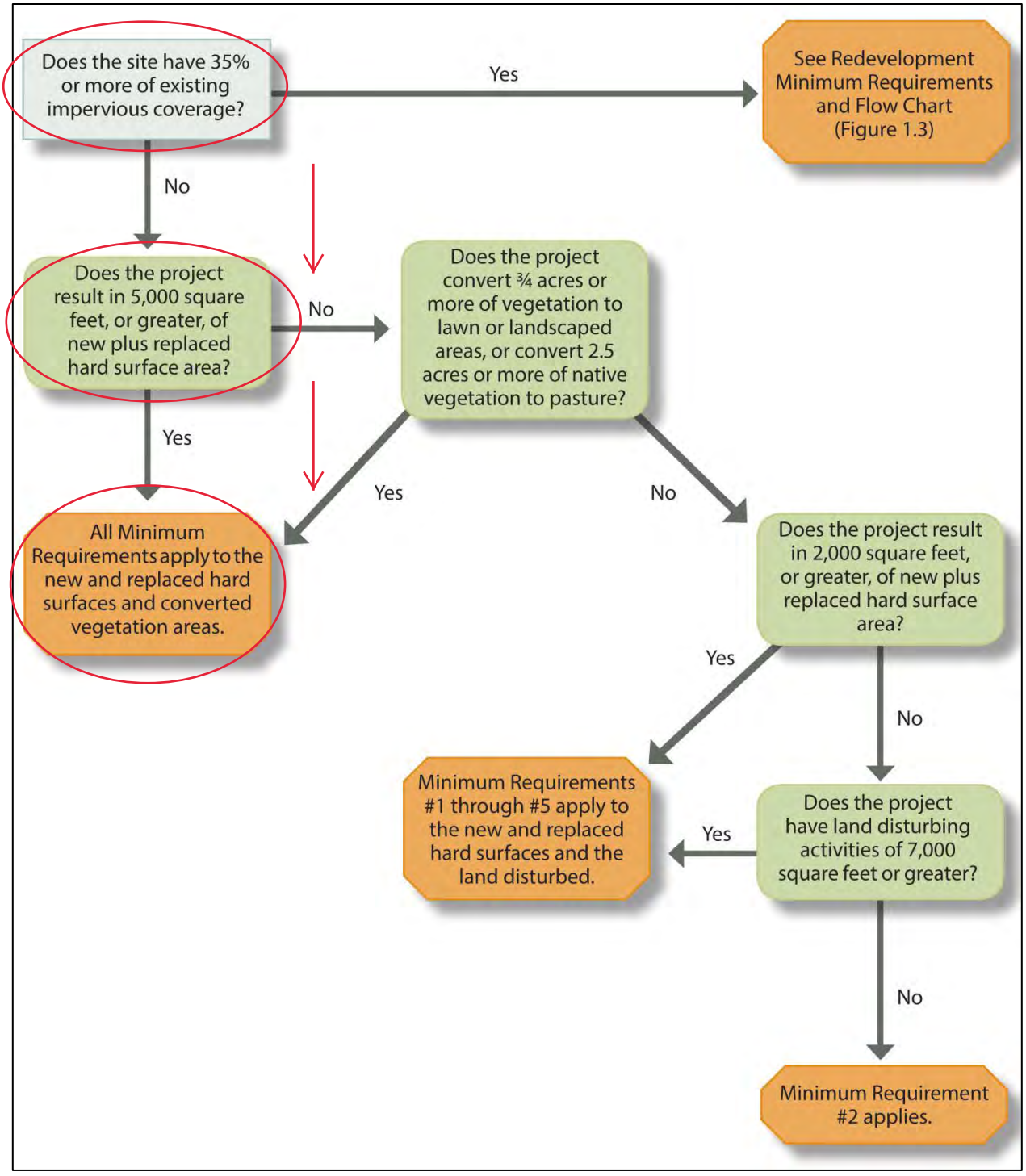


Figure 1.2: New Development Flow Chart

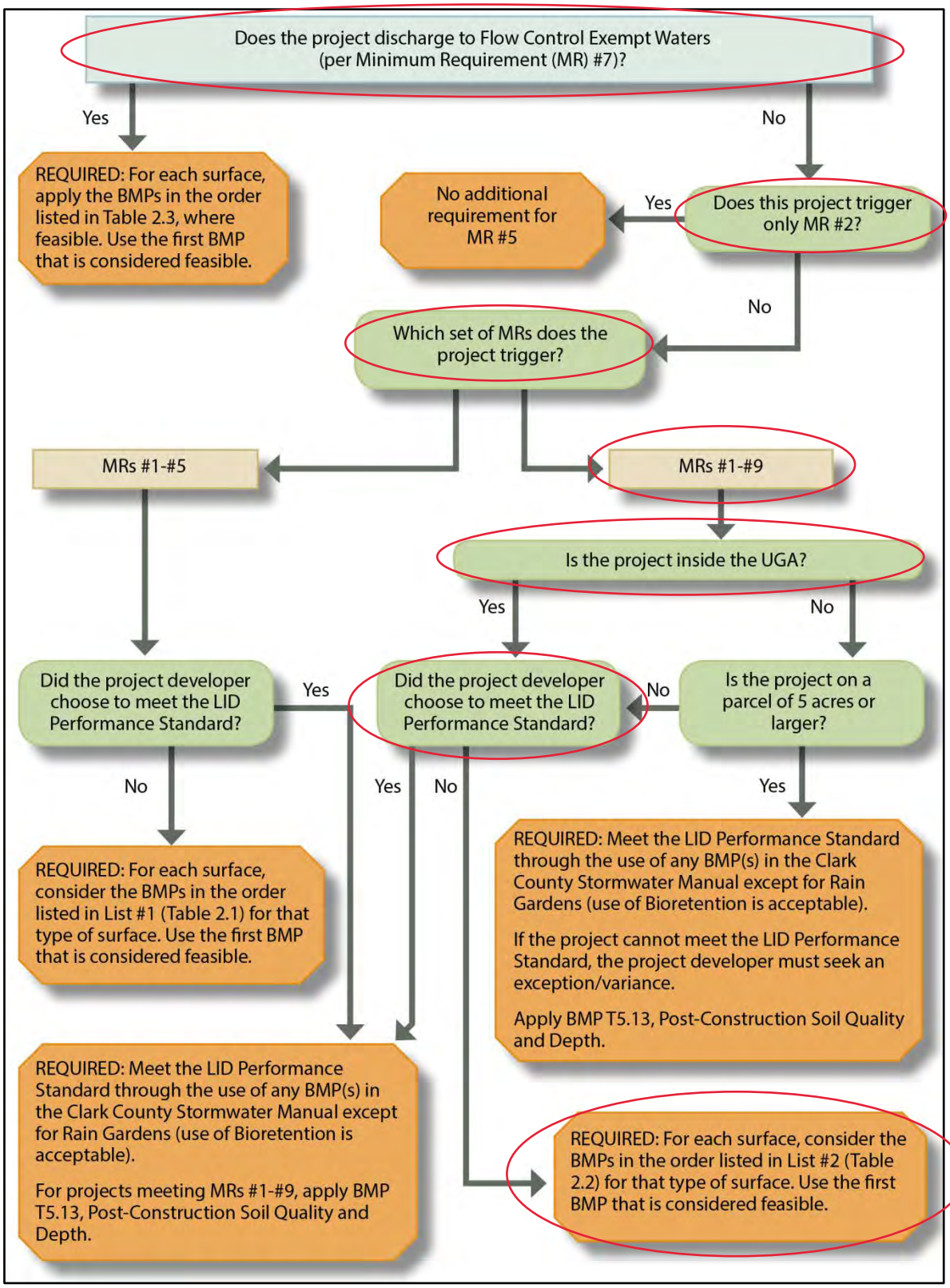


Figure 2.1: Flow Chart for Determining LID Minimum Requirement #5 Requirements

Appendix C:
Development Plans



PHASE 1		
LOT #	AREA	DESTINATION
1–16, 226–249, 257–266, 294–329, TRACTS C, D, E, F, K, R	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN PRIOR TO POND 1.3
17–30, TRACT G	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	FILTER CATCH BASIN PRIOR TO POND 2.1
TRACT A	PUMP STATION	FILTER CATCH BASIN TO DIRECT DISCHARGE

PHASE 2A		
LOT # / TRACT	AREA	DESTINATION
135, 136, 183–200, TRACT P, TRACT Q	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	FILTER CATCH BASIN PRIOR TO POND 1.2
70–76, 165–182, 201–214	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN PRIOR TO POND 1.3

PHASE 2B		
LOT # / TRACT	AREA	DESTINATION
TRACT N	LANDSCAPE, CRITICAL AREA	DIRECT DISCHARGE

PHASE 3		
LOT # / TRACT	AREA	DESTINATION
31–48, TRACT H	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	FILTER CATCH BASIN PRIOR TO POND 2.1
49–69, 215–225, 250–254, 267–272, 275–293	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN PRIOR TO POND 1.3

PHASE 4		
LOT # / TRACT	AREA	DESTINATION
77–118, 143–164, TRACT L, TRACT M, TRACT T	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN PRIOR TO POND 1.3
119–134, 137–142	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	FILTER CATCH BASIN PRIOR TO POND 1.2
NW 179TH STREET	LANDSCAPE, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN PRIOR TO POND 1.3

PHASE 5		
LOT # / TRACT	AREA	DESTINATION
255–256, 273–274, TRACT J	LANDSCAPE, ROOFS, DRIVEWAY, STREET FRONTAGE, AND SIDEWALK	CATCH BASIN AND DITCH INLET PRIOR TO POND 1.3

GENERAL NOTES:

1. UTILITIES SHOWN ARE BASED ON UNDERGROUND UTILITY LOCATE MARKINGS AS PROVIDED BY OTHERS PER UTILITY LOCATE TICKET NUMBER 18511980. THIS SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND LOCATES REPRESENT THE ONLY UTILITIES IN THE AREA. CONTRACTORS ARE RESPONSIBLE FOR VERIFYING ALL EXISTING CONDITIONS PRIOR TO BEGINNING CONSTRUCTION.
2. FIELD WORK WAS CONDUCTED DECEMBER, 2018 – JANUARY, 2019.
3. VERTICAL DATUM: ELEVATIONS ARE BASED ON NGVD29(47) CLARK COUNTY DATUM AND BENCHMARK "SARA 3" LOCATED THE CENTERLINE–CENTERLINE INTERSECTION OF NW 179TH STREET AND NW 11TH AVENUE WITH ELEVATION = 278.613 FEET.
4. THIS MAP DOES NOT CONSTITUTE A PROPERTY BOUNDARY SURVEY TO BE RECORDED WITH THE COUNTY. BOUNDARIES MAY BE PRELIMINARY AND SHOULD BE CONFIRMED WITH THE STAMPING SURVEYOR PRIOR TO RELYING ON FOR DETAILED DESIGN OR CONSTRUCTION.
5. CONTOUR INTERVAL IS 2 FOOT.
6. TREES ARE NOT SHOWN.
7. WETLAND BOUNDARIES WERE FLAGGED BY ENVIRONMENTAL LAND SERVICES AND PROFESSIONALLY SURVEYED BY AKS ENGINEERING & FORESTRY ON 01/14/2020.
8. OFF–SITE AREAS CONTRIBUTING TO RUNOFF INCLUDE NW 11TH AVENUE, NW 179TH STREET, PARCEL NO. 116610–000, PARCEL NO. 116600–000, PARCEL NO. 116590–000, PARCEL NO. 116570–000, PARCEL NO. 182217–000, AND PARCEL NO. 182144–000.

LEGEND

- EXISTING GROUND CONTOUR (2 FT)
- EXISTING GROUND CONTOUR (10 FT) —350—
- FINISHED GRADE CONTOUR (2 FT)
- FINISHED GRADE CONTOUR (10 FT) —350—
- WETLAND BOUNDARY —WL—WL—WL—WL—
- PHASE BOUNDARY
- TDA BOUNDARY
- STORM FACILITY ACCESS

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9600 NE 126TH AVE, STE 2520
VANCOUVER, WA 98682
360.882.0419
WWW.AKS-ENG.COM

ENGINEERING • SURVEYING • NATURAL RESOURCES
FORESTRY • PLANNING • LANDSCAPE ARCHITECTURE

PRELIMINARY STORMWATER PLAN
NORTH HAVEN PUD
BTMC, LLC
CLARK COUNTY, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	4373
DATE:	2/12/2020
DESIGNED BY:	CJS
DRAWN BY:	CJS
CHECKED BY:	JMM

P5.0

AKS DRAWING FILE: 4373 P5.0 STORMLDWG | LAYOUT: P5.0

Appendix D:
Stormwater Basin Plans



NOTE:

1. TDA #1 CONSISTS OF BASIN 0.1 AND BASIN 1.0
2. TDA #2 CONSISTS OF BASIN 2.0

N

SCALE: 1"=100 FEET

100 0 20 50 100

ORIGINAL PAGE SIZE: 24" x 36"

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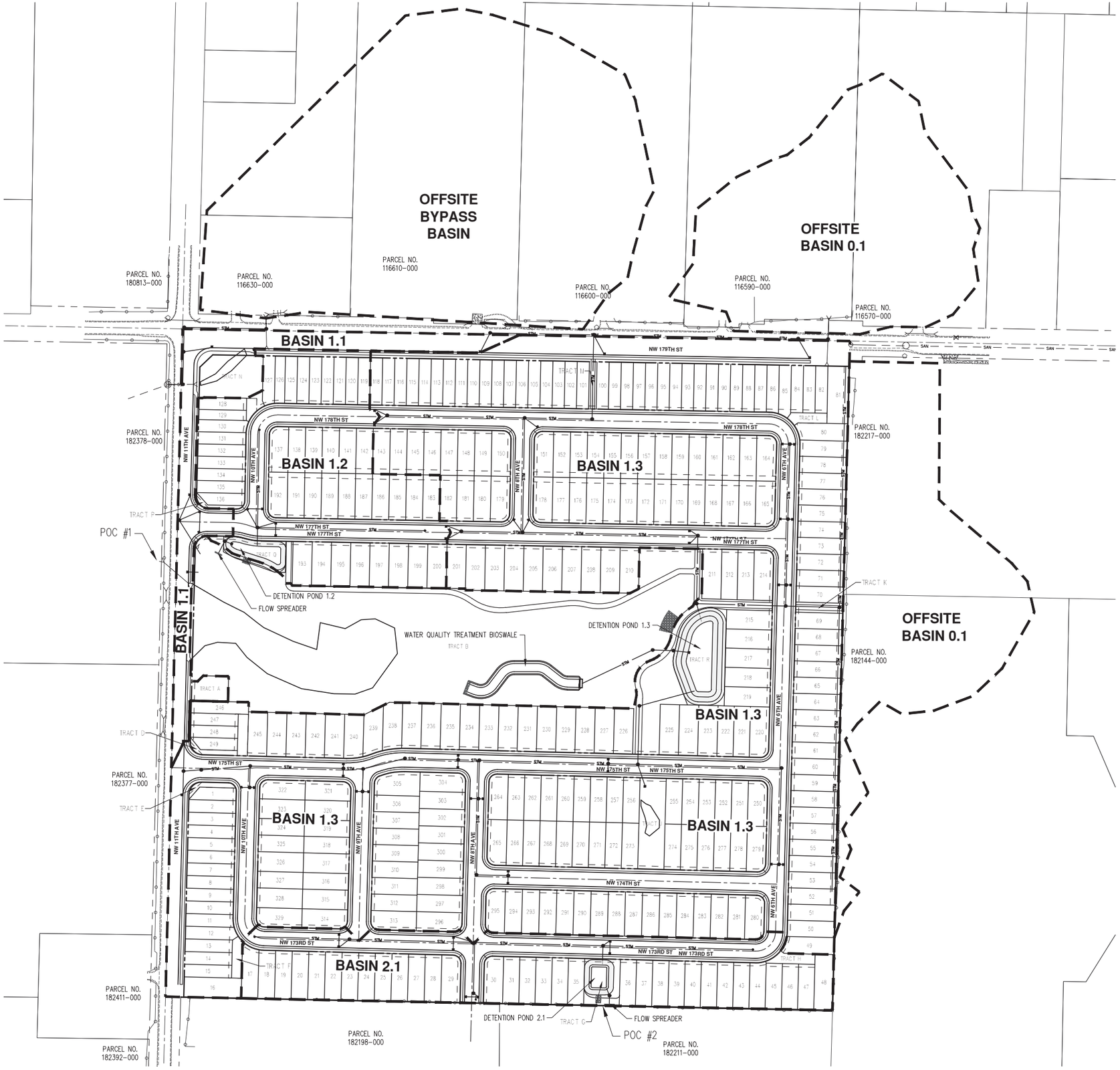
PRE-DEVELOPED BASIN PLAN
NORTH HAVEN PUD
BTMC, LLC
CLARK COUNTY, WASHINGTON

PRELIMINARY
NOT FOR
CONSTRUCTION

JOB NUMBER:	4373
DATE:	2/5/2020
DESIGNED BY:	CJS
DRAWN BY:	CJS
CHECKED BY:	JMM

ST-1

AKS DRAWING FILE: 4373 PRE-DEVELOPED.DWG | LAYOUT: PRE-DEV



NOTE:

1. TDA #1 CONSISTS OF BASIN 0.1, BASIN 1.1, BASIN 1.2 AND BASIN 1.3
2. TDA #2 CONSISTS OF BASIN 2.1

N

SCALE: 1"=100 FEET

100 0 20 50 100

ORIGINAL PAGE SIZE: 22" x 34"

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POST-DEVELOPED BASIN PLAN
NORTH HAVEN PUD
BTMC, LLC
CLARK COUNTY, WASHINGTON

PRELIMINARY
NOT FOR CONSTRUCTION

JOB NUMBER:	4373
DATE:	2/5/2020
DESIGNED BY:	CJS
DRAWN BY:	CJS
CHECKED BY:	JMM

ST-2

AKS DRAWING FILE: 4373 POST-DEVELOPED.DWG | LAYOUT: POST-DEV

Appendix E:
BMP Details

BMP T5.13: Post-Construction Soil Quality and Depth

Purpose and Description

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal topsoil and sod. Not only are these important stormwater functions lost, but such landscapes themselves become pollution generating pervious surfaces due to increased use of pesticides, fertilizers and other landscaping and household/industrial chemicals, the concentration of pet wastes, and pollutants that accompany roadside litter. Establishing soil quality and depth regains greater stormwater functions in the post development landscape, provides increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals, thus reducing pollution through prevention.

Cross Reference Guide

Soils Assessment	NA
Meets Minimum Requirements	#5
Related BMPs	None
Selection Criteria	Book 1, Sections 2.2 and 2.5.2
Maintenance	Book 4

Applications, Limitations and Setbacks

Establishing a minimum soil quality and depth is not the same as preservation of naturally occurring soil and vegetation. However, establishing a minimum soil quality and depth will provide improved onsite management of stormwater flow and water quality. Soil organic matter can be attained through addition of numerous materials such as compost, composted woody material, biosolids, and forest product residuals. It is important that the materials used to meet the soil quality and depth BMP be appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay fines. This BMP can be considered infeasible on slopes greater than 33 percent.

Soil and vegetation provide significant benefits, including:

- Water infiltration.
- Absorption of nutrients, sediments and pollutants.

BMP T9.10: Basic Biofiltration Swale

Purpose and Description

Biofiltration swales are typically shaped as a trapezoid or a parabola as shown below.

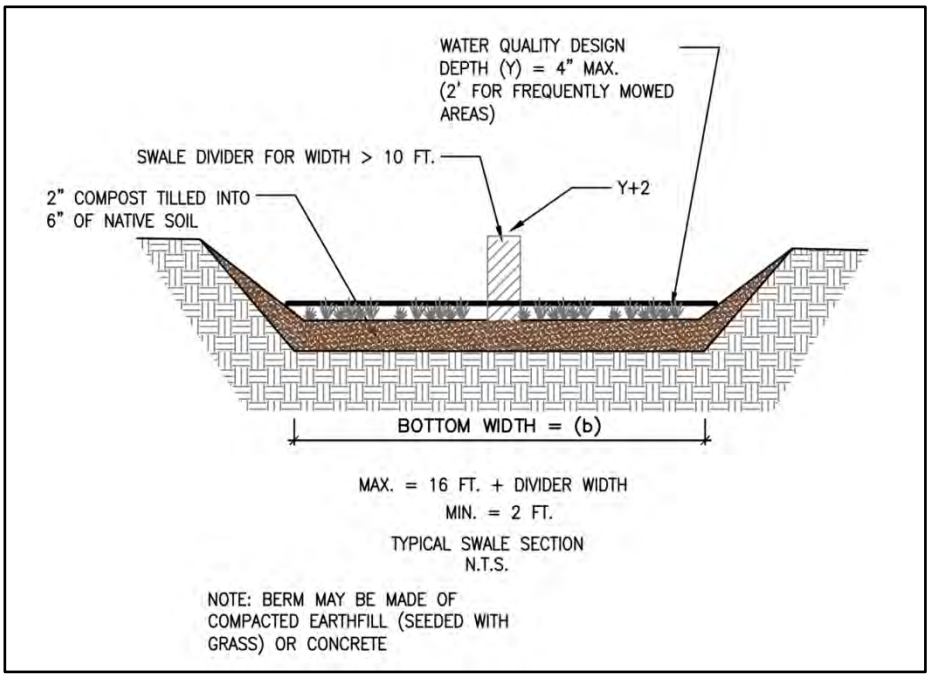


Figure 4.17: Typical Swale Section

(Source: redrawn from Stormwater Management Manual for Western Washington, 2014)

Cross Reference Guide

Soils Assessment	None
Minimum Requirements/ Treatment Type	MR #6 Meets Basic; Meets Enhanced and Phosphorus as part of a treatment train
Related BMPs	BMP T8.10 (Enhanced or Phosphorus), BMP T8.20 (Enhanced or Phosphorus), or BMP T8.40 (Enhanced) for a treatment train.
Selection/Infeasibility Criteria	Book 1, Section 3.2 and Section 3.4.4
Maintenance	Book 4

Application, Limitations and Setbacks

Data suggest that the performance of biofiltration swales is highly variable from storm to storm. Ecology recommends considering other treatment methods that perform more consistently, such as sand filters and wet ponds, before using a biofiltration swale. Biofiltration swales downstream of devices of equal or greater effectiveness can convey runoff; but do not consider them to offer a treatment benefit. (Horner, 2000).

Setbacks

See Section 3.1.4.

Design Criteria

- Table 4.5 specifies design criteria. Use a 9 minute hydraulic residence time at a multiple of the peak 15 minute Water Quality Design Flow Rate (Q) representing 91% runoff volume as determined by an approved continuous flow model.
- Check the hydraulic capacity/stability for inflows greater than design flows. Bypass high flows, or control release rates into the biofilter, if necessary.
- Install a Clark County Flow Spreader with Sediment Trap at the swale inlet (see Figure 3.3). Avoid the use of rock (e.g. quarry spalls) for energy dissipation within the swale because they make mowing and vegetation management difficult.
- Install concrete level spreaders at the head and every 50 feet in swales of ≥4 feet width. Include sediment cleanouts (weir, settling basin, or equivalent) at the head of the biofilter as needed.
- The use of riprap energy dissipaters due to increased downslopes must be approved by the Responsible Official.
- See Section 3.1.4 for information on allowable side slopes.

Guidance for Bypassing Off-line Facilities

Swales designed in an off-line mode should not engage a bypass until the flow rate exceeds a value determined by multiplying Q, the off-line water quality design flow rate predicted by an approved continuous flow model, by the ratio determined in Figure 4.3, Ratio of SBUH Peak/WQ Flow for Off-Line. This modified design flow rate is an estimate of the design flow rate determined by using SBUH procedures. The only advantage of designing a swale to be off-line is that the stability check, which may make the swale larger, is not necessary.

Sizing Procedure for Biofiltration Swales

This guide provides biofilter swale design procedures in full detail, along with examples.

Preliminary Steps (P)

- **P-1** Determine the Water Quality design flow rate (Q) in 15-minute time-steps using the WWHM. Use the correct flow rate, off-line or on-line, for the design situation.
- **P-2** Establish the longitudinal slope of the proposed biofilter.
- **P-3** Select a vegetation cover suitable for the site. Refer to Table 4.7 and Table 4.8 to select vegetation for western Washington.

Design Calculations for Biofiltration Swale

The procedure recommended here is an adaptation from the design procedure originated by Chow (Chow, 1959) for biofiltration applications in the Puget Sound region.

This procedure reverses Chow's order, designing first for capacity and then for stability. The capacity analysis emphasizes the promotion of biofiltration, rather than transporting flow with the greatest possible hydraulic efficiency. Therefore, it is based on criteria that promote sedimentation, filtration, and other pollutant removal mechanisms. Because these criteria include a lower maximum velocity than permitted for stability, the biofilter dimensions usually do not have to be modified after a stability check.

Design Steps (D)

- **D-1**. Select the type of vegetation, and design depth of flow, based on frequency of mowing and type of vegetation. Table 4.7 and Table 4.8 list suitable vegetation types.
- **D-2**. Select a value of Manning's n (Table 4.5 with footnote #3).

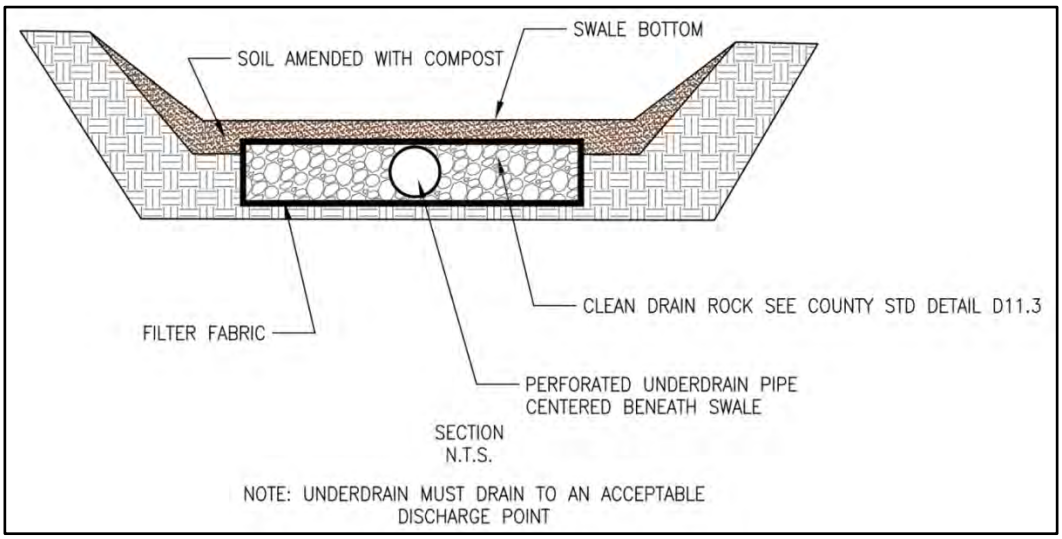


Figure 4.18: Biofiltration Swale Underdrain Detail

(Source: redrawn from WA State Dept. of Ecology)

Table 4.5: Biofiltration Swale Sizing Criteria

Design parameter	
Longitudinal Slope	0.015 - 0.025[1]
Maximum velocity	1 ft / sec (@ K multiplied by the WQ design flow rate ; for stability, 3 ft/sec max.
Maximum water depth[2]	2"- if mowed frequently; 4" if mowed infrequently
Manning coefficient (22)	(0.2 – 0.3)[3](0.24 if mowed infrequently)
Bed width (bottom)	(2 - 10 ft)[4]
Freeboard height	0.5 ft
Minimum hydraulic residence time at Water Quality Design Flow Rate	9 minutes (18 minutes for continuous inflow)
Minimum length	100 ft
Maximum sideslope	3 H : 1 V 4H:1V preferred
Max. tributary drainage flow path	---
Max. longitudinal slope of contributing area	---
Max. lateral slope of contributing area	---

1. For swales, if the slope is less than 1.5% install an underdrain using a perforated pipe, or equivalent. Amend the soil if necessary to allow effective percolation of water to the underdrain. Install the low-flow drain 6" deep in the soil. Slopes greater than 2.5% need check dams (riprap) at vertical drops of 12-15 inches. Underdrains can be made of 6 inch Schedule 40 PVC perforated pipe with 6" of drain gravel on the pipe. The gravel and pipe must be enclosed by geotextile fabric. (See Figure 4.18, underdrain detail, and Figure 4.19, low-flow drain detail.)
2. Below the design water depth install an erosion control blanket, at least 4" of topsoil, and the selected biofiltration mix. Above the water line use a straw mulch or sod.
3. This range of Manning's n can be used in the equation; b = Qn/1.49y(1.67) s(0.5) – Zy with wider bottom width b, and lower depth, y, at the same flow. This provides the designer with the option of varying the bottom width of the swale depending on space limitations. Designing at the higher n within this range at the same flow decreases the hydraulic design depth, thus placing the pollutants in closer contact with the vegetation and the soil.
4. For swale widths up to 16 feet the cross-section can be divided with a berm (concrete, plastic, compacted earth fill) using a flow spreader at the inlet (Figure 4.20, dividing berm).

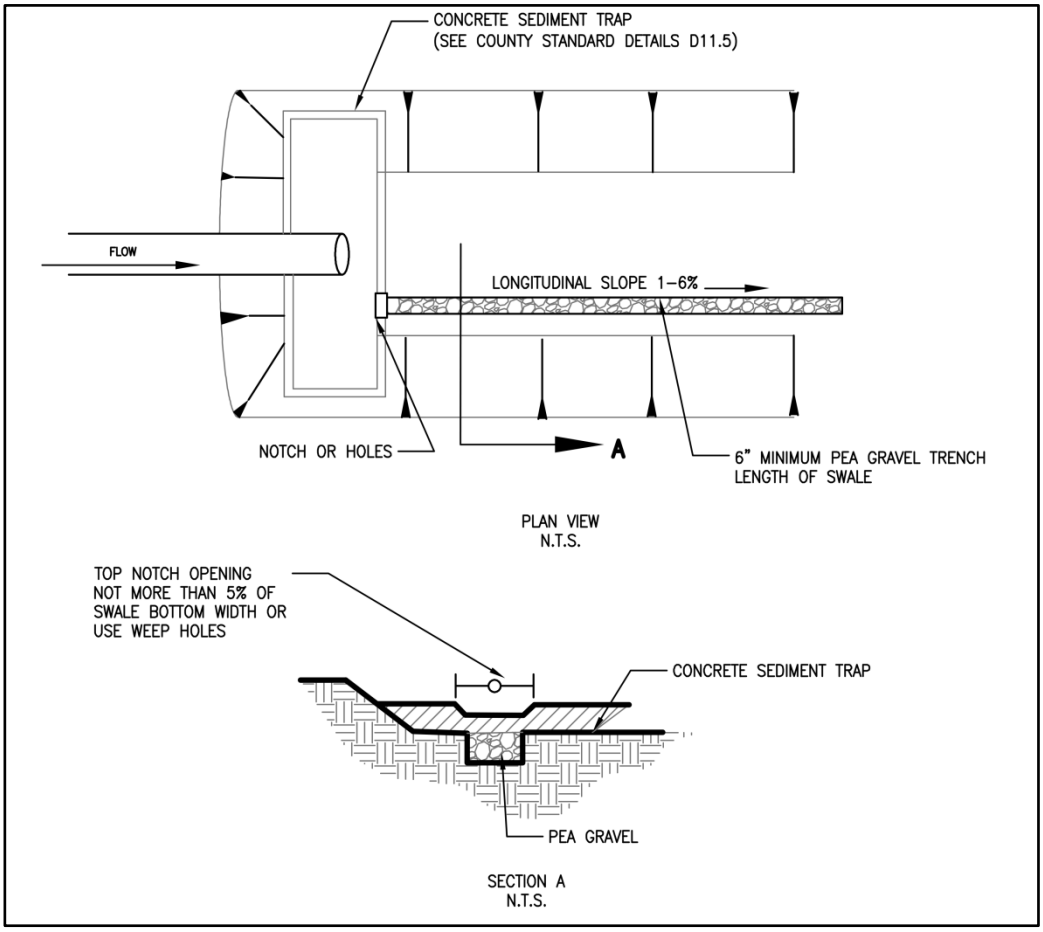


Figure 4.19: Biofiltration Swale Low-Flow Drain Detail

(Source: modified from WA State Dept. of Ecology)

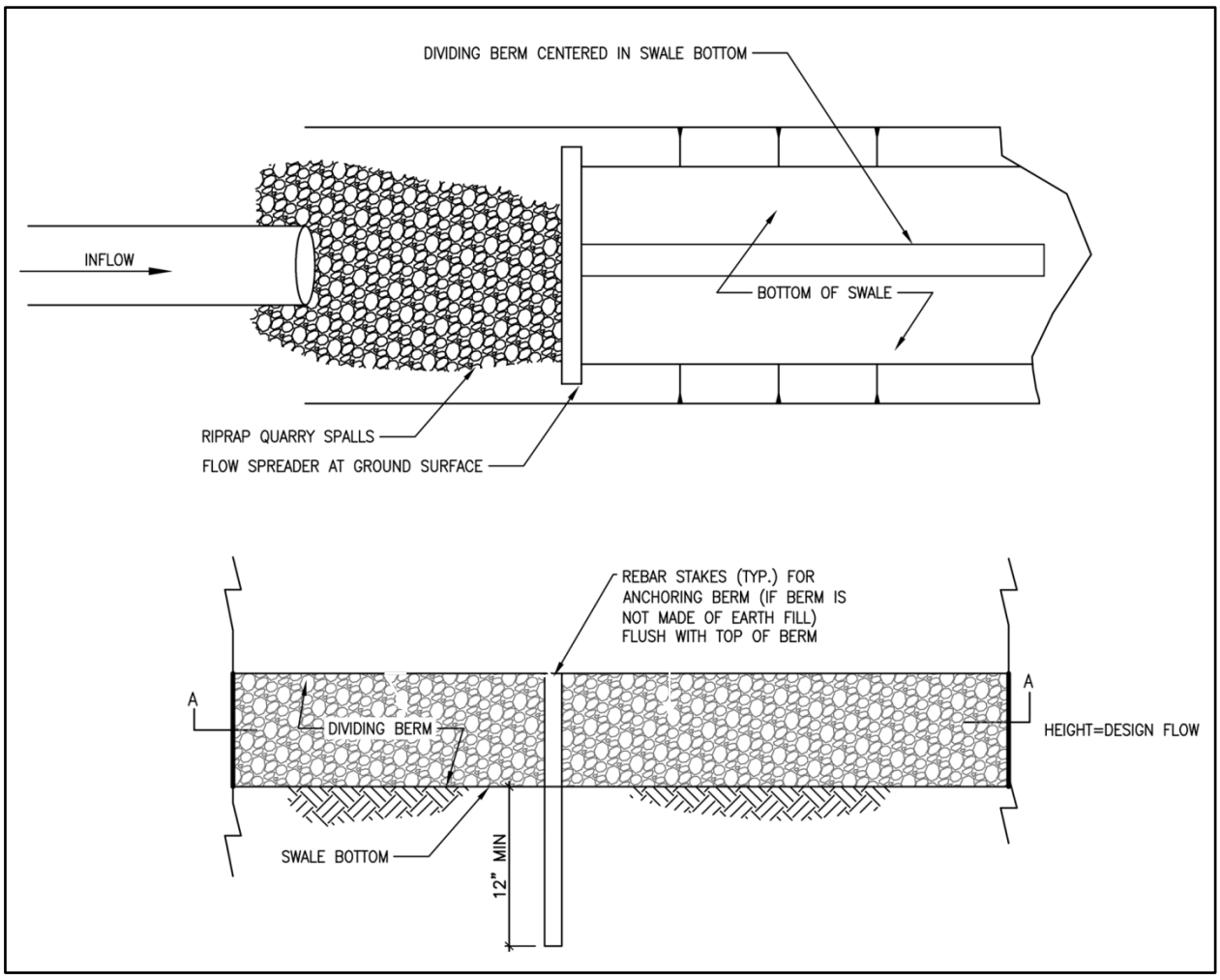


Figure 4.20: Swale Dividing Berm

(Source: redrawn from WA State Dept. of Ecology)

- **D-3**. Select swale shape-typically trapezoidal or parabolic.
- **D-4**. Use Manning's equation and first approximations relating hydraulic radius and dimensions for the selected swale shape to obtain a working value of a biofilter width dimension:

$$Q = \frac{1.49AR^{0.67}s^{0.5}}{n} \qquad \textbf{Equation 4-1}$$

$$A_{rectangle} = Ty \qquad \textbf{Equation 4-2}$$

$$R_{rectangle} = \frac{Ty}{T + 2y} \qquad \textbf{Equation 4-3}$$

Where:

- Q = Water Quality Design flow rate in 15-minute time steps based on WWHM, (ft^3/s, cfs)
- n = Manning's n (dimensionless)
- s = Longitudinal slope as a ratio of vertical rise/horizontal run (dimensionless)
- A = Cross-sectional area (ft^2)
- R = Hydraulic radius (ft)
- T = top width of trapezoid or width of a rectangle (ft)
- y = depth of flow (ft)
- b = bottom width of trapezoid (ft)

If Equations 4-2 and 4-3 are substituted into Equation 4-1 and solved for T, complex equations result that are difficult to solve manually. However, approximate solutions can be found by recognizing that T>>y and $Z^2>>1$, and that certain terms are nearly negligible. The approximation solutions for rectangular and trapezoidal shapes are:

$$R_{rectangle} \approx y, \qquad R_{trapezoid} \approx y, \qquad R_{parabolic} \approx 0.67y, \qquad R_v \approx 0.5y$$

Substitute $R_{trapezoid}$ and $A_{trapezoid}$ = by+Zy2 into Equation 4-1, and solve for the bottom width b (trapezoidal swale):

$$b \approx \frac{2.5Qn}{1.49y^{1.67}s^{0.5}} - Zy$$

Equation 4-4

For a trapezoid, select a side slope Z of at least 3. Compute b and then top width T, where T = b + 2yZ. (Note: Adjustment factor of 2.5 accounts for the differential between Water Quality design flow rate and the SBUH design flow. This equation is used to estimate an initial cross-sectional area. It does not affect the overall biofiltration swale size.)

If b for a swale is greater than 10 ft, either investigate how Q can be reduced, divide the flow by installing a low berm, or arbitrarily set b = 10 ft and continue with the analysis. For other swale shapes refer to Figure 4.21.

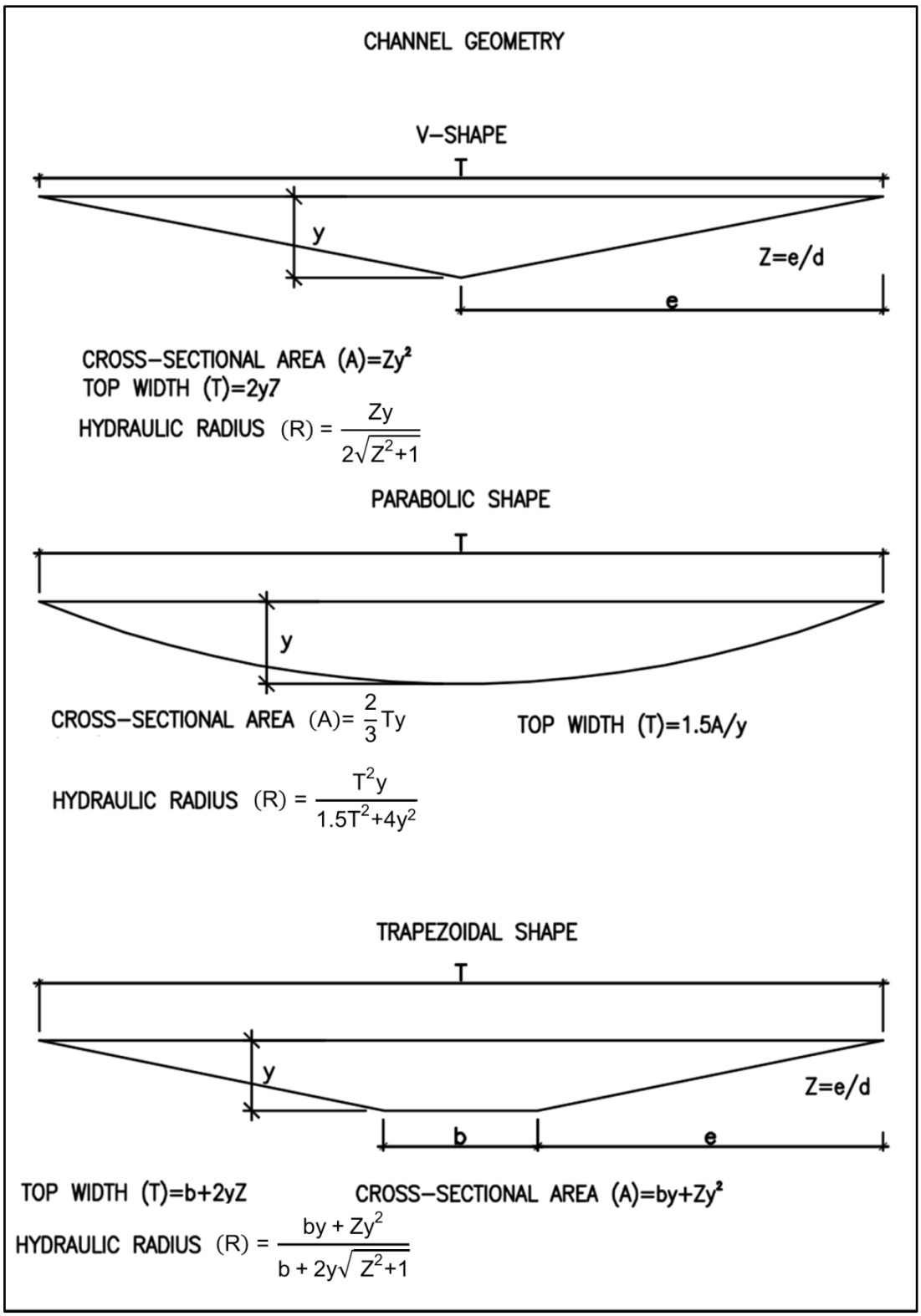


Figure 4.21: Geometric Formulas for Common Swale Shapes

(Source: redrawn from Livingston, et al, 1984)

- **D-5.** Compute A:

$$A_{rectangle} = Ty \quad \text{or} \quad A_{trapazoid} = by + Zy^2$$

$$A_{filter\ strip} = Ty$$

- **D-6.** Compute the flow velocity at design flow rate:

$$V = K\frac{Q}{A}$$

K = A ratio of the peak 10-minute flow predicted by SBUH to the water quality design flow rate estimated using the WWHM. The value of K is determined from Figure 4.2 for on-line facilities, or Figure 4.3 for off-line facilities.

If V >1.0 ft/sec (or V>0.5 ft/sec for a filter strip), repeat steps D-1 to D-6 until the condition is met. A velocity greater than 1.0 ft/sec was found to flatten grasses, thus reducing filtration. A velocity lower than this maximum value will allow a 9-minute hydraulic residence time criterion in a shorter biofilter. If the value of V suggests that a longer biofilter will be needed than space permits, investigate how Q can be reduced (e.g., use of low impact development BMPs), or increase y and/or T (up to the allowable maximum values) and repeat the analysis.

- **D-7.** Compute the swale length (L, ft)

$$L = Vt\ (60\ sec/min)$$

Where: t = hydraulic residence time (min)

Use t = 9 minutes for this calculation (use t = 18 minutes for a continuous inflow biofiltration swale). If a biofilter length is greater than the space permits, follow the advice in step D-6.

If a length less than 100 feet results from this analysis, increase it to 100 feet, the minimum allowed. In this case, it may be possible to save some space in width and still meet all criteria. This possibility can be checked by computing V in the 100 ft biofilter for t = 9 minutes, recalculating A (if V < 1.0 ft/sec) and recalculating T.

- **D-8**. If there is still not sufficient space for the biofilter, the project proponent should consider the following solutions (listed in order of preference):

    1. Divide the site drainage to flow to multiple biofilters.

    2. Use infiltration to provide lower discharge rates to the biofilter (only if the Site Suitability Criteria in Section 3.1.5.3 are met).

    3. Increase vegetation height and design depth of flow (note: the design must ensure that vegetation remains standing during design flow).

    4. Reduce the developed surface area to gain space for biofiltration.

5. Increase the longitudinal slope.

6. Increase the side slopes.

7. Nest the biofilter within or around another BMP.

Check for Stability (Minimizing Erosion)

The stability check must be performed for the combination of highest expected flow and least vegetation coverage and height. A check is not required for biofiltration swales that are located "off-line" from the primary conveyance/detention system. Maintain the same units as in the biofiltration capacity analysis.

- **SC-1**. Perform the stability check for the 100-year, return frequency flow using 15-minute time steps using an approved continuous flow model. Until WWHM peak flow rates in 15-minute time steps are available, use the WWHM 100-yr. hourly peak flows times with an adjustment factor of 1.6 to approximate peak flows in 15-minute time steps.
- **SC-2**. Estimate the vegetation coverage ("good" or "fair") and height on the first occasion that the biofilter will receive flow, or whenever the coverage and height will be least. Avoid flow introduction during the vegetation establishment period by timing planting or bypassing.
- **SC-3.** Estimate the degree of retardance from Table 4.6. When uncertain, be conservative by selecting a relatively low degree.

The maximum permissible velocity for erosion prevention (Vmax) is 3 feet per second.

- **SC-4.** Select a trial Manning's n for the high flow condition. The minimum value for poor vegetation cover and low height (possibly, knocked from the vertical by high flow) is 0.033. A good initial choice under these conditions is 0.04.
- **SC-5**. Refer to Figure 4.22, The Relationship of Manning's n with VR, to obtain a first approximation for VR of 3 feet/second
- **SC-6**. Compute hydraulic radius, R, from VR in Figure 4.22 and Vmax.
- **SC-7**. Use Manning's equation to solve for the actual VR.
- **SC-8.** Compare the actual VR from step SC-7 and first approximation from step SC-5. If they do not agree within 5 percent, repeat steps SC-4 to SC-8 until acceptable agreement is reached. If $n<0.033$ is needed to get agreement, set $n = 0.033$, repeat step SC-7, and then proceed to step SC-9.
- **SC-9.** Compute the actual V for the final design conditions: Check to be sure $V < V_{max}$ of 3 feet/second.
- **SC-10**. Compute the required swale cross-sectional area, A, for stability:
- **SC-11**. Compare the A, computed in step SC-10 of the stability analysis, with the A from the biofiltration capacity analysis (step D-5).

If less area is required for stability than is provided for capacity, the capacity design is acceptable. If not, use A from step SC-10 of the stability analysis and recalculate channel dimensions.

- **SC-12**. Calculate the depth of flow at the stability check design flow rate condition for the final dimensions and use A from step SC-10.
- **SC-13.** Compare the depth from step SC-12 to the depth used in the biofiltration capacity design (Step D-1). Use the larger of the two and add 0.5 ft. of freeboard to obtain the total depth (y_t) of the swale. Calculate the top width for the full depth using the appropriate equation.
- **SC-14.** Recalculate the hydraulic radius: (use b from Step D-4 calculated previously for biofiltration capacity, or Step SC-11, as appropriate, and y_t = total depth from Step SC-13)
- **SC-15.** Make a final check for capacity based on the stability check design storm (this check will ensure that capacity is adequate if the largest expected event coincides with the greatest retardance). Use Equation 1, a Manning's n selected in step D-2, and the calculated channel dimensions, including freeboard, to compute the flow capacity of the channel under these conditions. Use R from step SC-14, above, and $A = b(y_t) + Z(y_t)^2$ using b from Step D-4, D-15, or SC-11 as appropriate.

If the flow capacity is less than the stability check design storm flow rate, increase the channel cross-sectional area as needed for this conveyance. Specify the new channel dimensions.

Table 4.6: Guide for Selecting Degree of Retardance

Coverage	Average Grass Height (inches)	Degree of Retardance
Good	<2	E. Very Low
	2-6	D. Low
	6-10	C. Moderate
	11-24	B. High
	>30	A. Very High
Fair	<2	E. Very Low
	2-6	D. Low
	6-10	D. Low
	11-24	C. Moderate
	>30	B. High

See Chow (1959). In addition, Chow recommended selection of retardance C for a grass-legume mixture 6-8 inches high and D for a mixture 4-5 inches high. No retardance recommendations have appeared for emergent wetland species. Therefore, judgment must be used. Since these species generally grow less densely than grasses, using a "fair" coverage would be a reasonable approach.

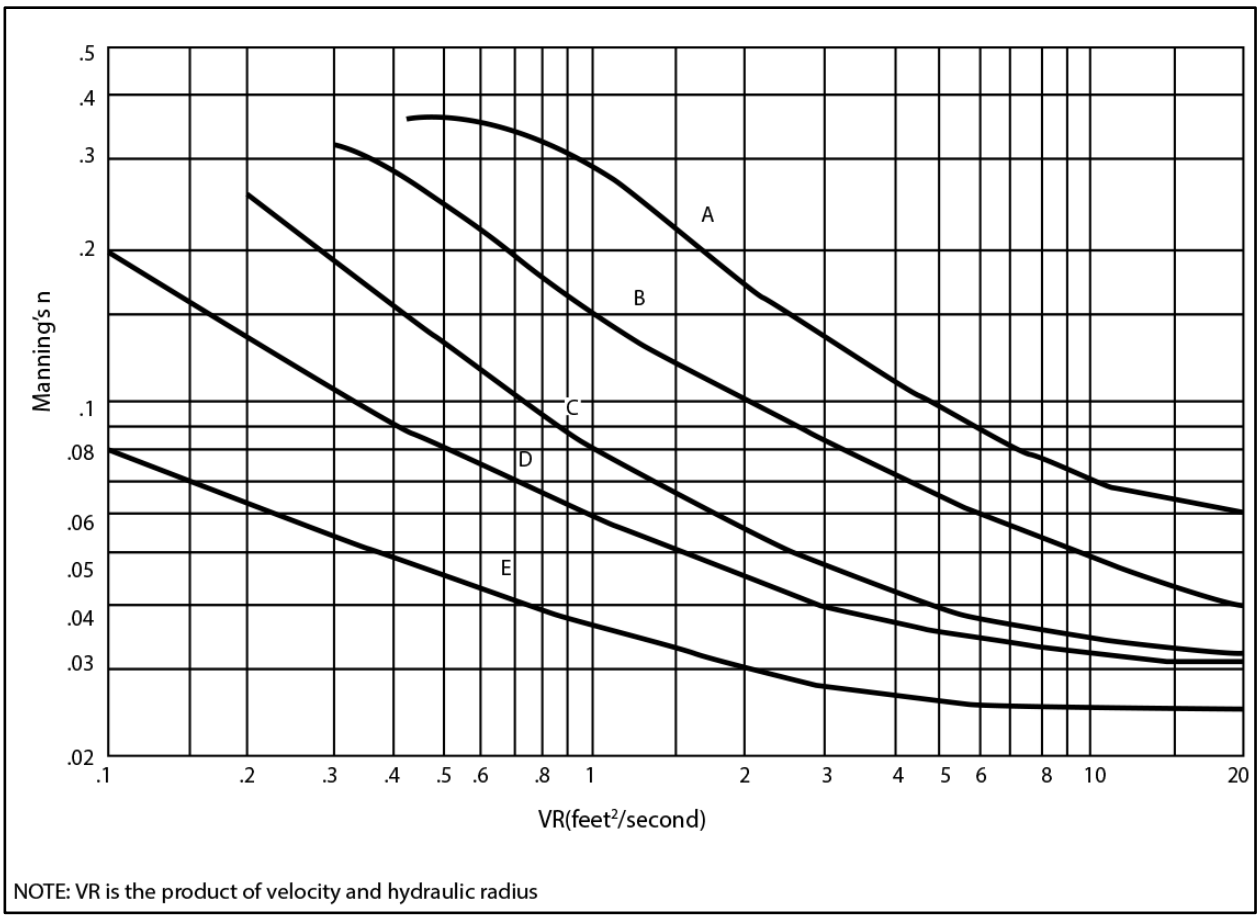


Figure 4.22: Relationship of Manning's n with VR

(Source: redrawn from Livingston, et al, 1984)

Completion Step (CO)

- **CO.** Review all of the criteria and guidelines for biofilter planning, design, installation, and operation above and specify all of the appropriate features for the application.

Soil Criteria

- The following top soil mix at least 8-inch deep:
    - Sandy loam 60-90 %
    - Clay 0-10 %
    - Composted organic matter, (excluding animal waste, toxics) 10-30 %

Use compost amended soil where practicable. Composted material shall meet the specifications for compost used in the Bioretention Soil Media (BMP ~~T7.30~~ 5.14B). This excludes use of biosolids and manures.

- Till to at least 8-inch depth

- For longitudinal slopes of < 2 percent use more sand to obtain more infiltration
- If groundwater contamination is a concern, seal the bed with clay or a geomembrane liner

Vegetation Criteria

See Table 4.7 and Table 4.8 for recommended grasses and groundcovers.

- Grass must be fine, turf-forming, water-resistant grasses where vegetative growth and moisture will be adequate for growth.
- Irrigate if moisture is insufficient during dry weather season.
- Use sod with low clay content and where needed to initiate adequate vegetative growth. Preferably sod should be laid to a minimum of one-foot vertical depth above the swale bottom.
- Consider sun/shade conditions for adequate vegetative growth Shade tolerant vegetation must be used when prolonged shading of any portion will occur.
- Stabilize soil areas upslope of the biofilter to prevent erosion
- Fertilizing a biofilter should be avoided if at all possible in any application where nutrient control is an objective. Test the soil for nitrogen, phosphorous, and potassium and consult with a landscape professional about the need for fertilizer in relation to soil nutrition and vegetation requirements. If use of a fertilizer cannot be avoided, use a slow-release fertilizer formulation in the least amount needed.

Table 4.7: Grass Seed Mixes Suitable for Biofiltration Swale Treatment Areas

Bioswale Dry Soil Conditions

Botanical Name	Common Name	% By Weight
Elymus glaucus	blue wildrye	50.00%
Agrostis exerata	spike bentgrass	10.00%
Bromus carinatus	California brome	10.00%
Festuca idahoensis	Idaho fescue	30.00%

Bioswale Wet or Dry Soil Conditions

Botanical Name	Common Name	%By Weight
Elymus glaucus	blue wildrye	60.00%
Hordeum brachyantherum	meadow barley	30.00%
Bromus carinatus	California brome	10.00%

Bioswale Wet Soil Conditions

Botanical Name	Common Name	% By Weight
Agrostis exerata	spike bentgrass	0.50%
Deschampsia cespitosa	tufted hairgrass	2.50%
Glyceria occidentalis	western mannagrass	25.00%
Juncus effusus	soft rush	8.00%
Beckmannia syzigachne	slough grass	4.00%
Alopecurus geniculatus	water foxtail	15.00%
Hordeum brachyantherum	meadow barley	45.00%

Selected plants shall not include any plants from the State of Washington Noxious Weed List. Refer to www.clark.wa.gov/environmental-services/vegetation-management for a current list of noxious weeds.

Table 4.8: Groundcovers and Grasses Suitable for Upper Side Slopes of a Swale

Groundcovers

Botanical Name	Common Name
Arctostaphylos uva-ursi	kinnikinnick
Fragaria chiloensis	strawberry
Lupinus latifolius	broadleaf lupine

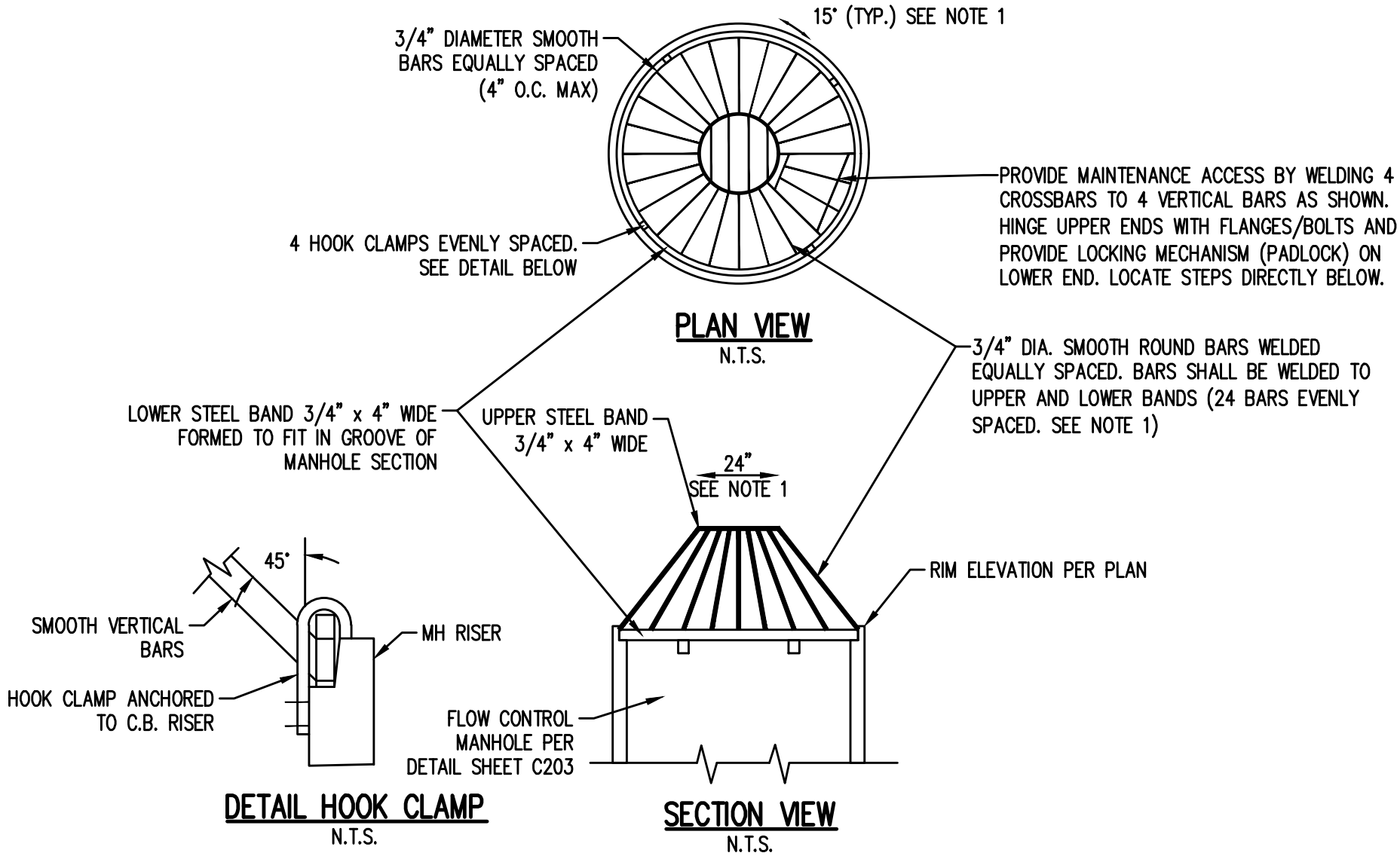
Grasses (drought-tolerant, minimum mowing

Botanical Name	Common Name
Festuca spp. (e.g., Many Mustang, Silverado)	dwarf tall fescues
Festuca ovina duriuscula (e.g., Reliant, Aurora)	hard fescue
Festuca amethystine	tufted fescue
Buchloe dactyloides	buffalo grass
Festuca rubra	red fescue
Festuca arundinacea	tall fescue grass
Helictotrichon sempervirens	blue oatgrass

Selected plants shall not include any plants from the State of Washington Noxious Weed List. Refer to www.clark.wa.gov/environmental-services/vegetation-management for a current list of noxious weeds.

Construction Criteria

The biofiltration swale should not be put into operation until areas of exposed soil in the contributing drainage catchment have been stabilized. Deposition of eroded soils can impede the growth of grass in the swale and reduce swale treatment effectiveness. The cost to restore a swale damaged by sediment deposition will be borne by the project or swale owner. Thus, effective erosion and sediment control measures should remain in place until the swale vegetation is established (see Book 1, Section 6.5 for selection of erosion and sediment control BMPs). Avoid compaction during construction. Grade biofilters to attain uniform longitudinal and lateral slopes.



NOTES:

1. DIMENSIONS ARE FOR ILLUSTRATION ON **54" DIAMETER MH**. FOR DIFFERENT DIAMETER MH'S, ADJUST TO MAINTAIN 45° ANGLE ON "VERTICAL" BARS AND 7" O.C. MAXIMUM SPACING OF BARS AROUND LOWER STEEL BAND.

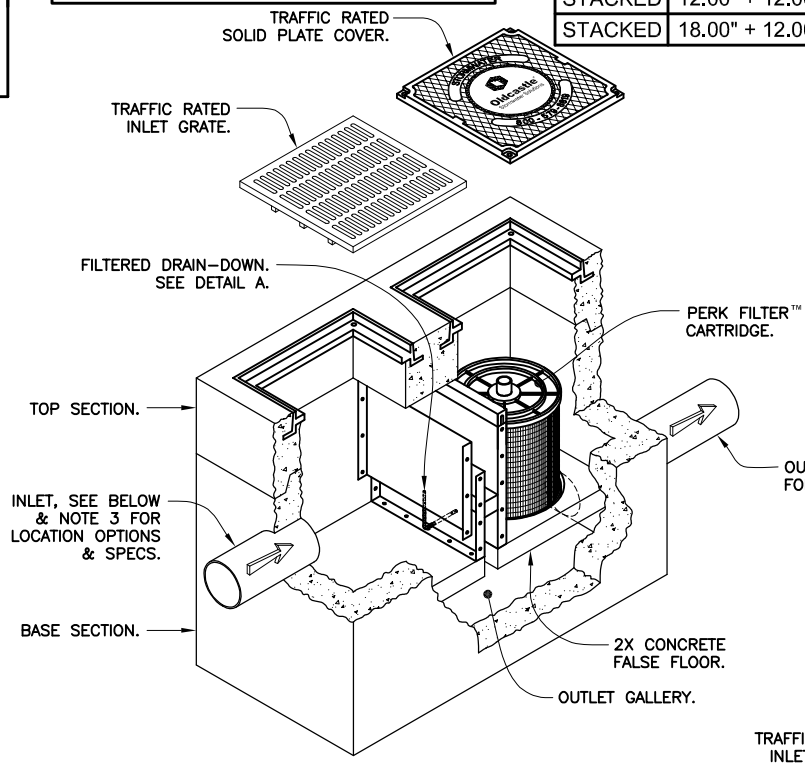
2. METAL PARTS MUST BE CORROSION RESISTANT; STEEL BARS MUST BE GALVANIZED.

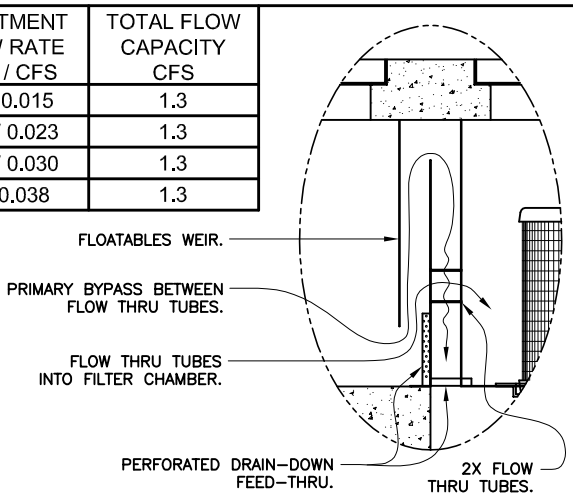
BIRDCAGE OVERFLOW STRUCTURE

PF-CCB-WA-0001

Washington GULD*

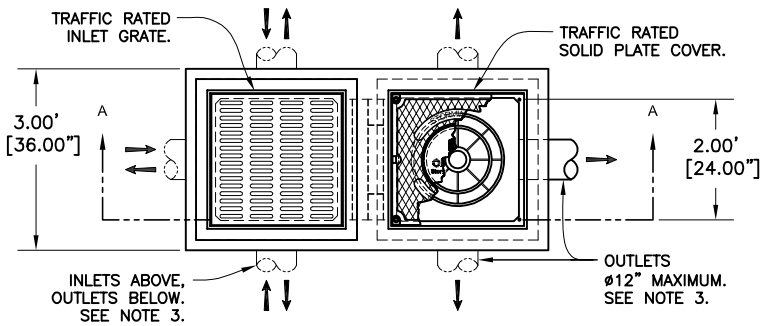
	CARTRIDGE SIZE	TREATMENT FLOW RATE GPM / CFS	TOTAL FLOW CAPACITY CFS
	12.00"	6.8 / 0.015	1.3
	18.00"	10.2 / 0.023	1.3
STACKED	12.00" + 12.00"	13.6 / 0.030	1.3
STACKED	18.00" + 12.00"	17 / 0.038	1.3





DETAIL A
INLET / BYPASS ASSEMBLY & DRAIN–DOWN SCALE: 2X

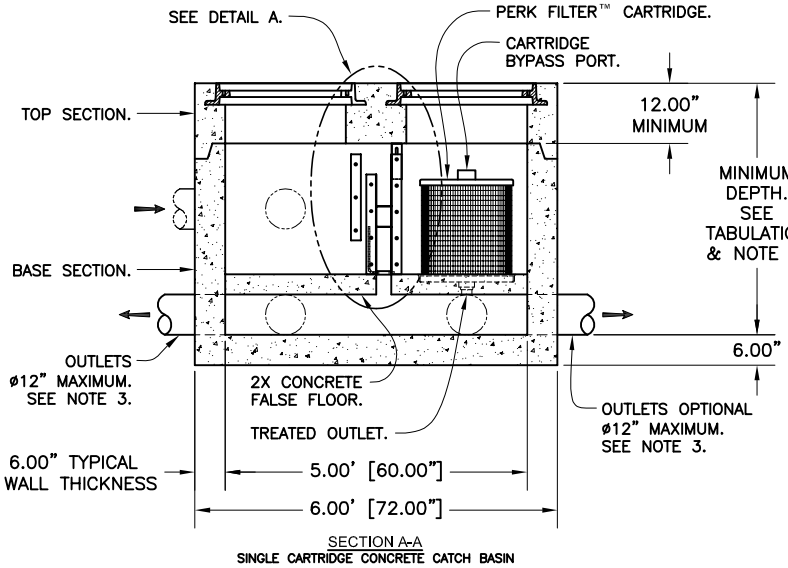
	MINIMUM DEPTHS (SEE NOTE 6)				
	CARTRIDGE SIZE	Ø 6.0" OUTLET PIPE (IN INCHES)	Ø 8.0" OUTLET PIPE (IN INCHES)	Ø 10.0" OUTLET PIPE (IN INCHES)	Ø 12.0" OUTLET PIPE (IN INCHES)
	12.00"	39	41	43	45
	18.00"	46	48	50	52
STACKED	12.00" + 12.00"	56	58	60	62
STACKED	18.00" + 12.00"	63	65	67	69



Notes:

1. Precast concrete structure shall be manufactured in accordance with ASTM Designation C857 and C858.
2. Perk Filter™ Catch basin shall be supplied with traffic rated (H20) bicycle-proof grates and solid plate cover.
3. Inlet pipe(s) may enter device on three sides of the inlet chamber. Outlet pipe(s) may exit on all four sides. All pipe is Ø 12" maximum.
4. Inlet chamber shall be supplied with a drain-down device designed to remove standing water between storm events.
5. Perk Filter™ cartridge shall be maintained in accordance with manufacturer recommendations.
6. For depths less than the specified minimum contact Oldcastle® Stormwater Solutions for engineering assistance.

*** Treatment Flow Rates shown conform to Washington State GULD Specifications.**



SECTION A-A
SINGLE CARTRIDGE CONCRETE CATCH BASIN

Media Filtration

Perk Filter™

Concrete Catch Basin

Washington State GULD

Single Cartridge

Oldcastle® Stormwater Solutions

7921 Southpark Plaza, Suite 200 | Littleton, CO | 80120 | Ph: 800.579.8819 | oldcastlestormwater.com

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DRAWING NO.	REV	ECO	DATE	
PF-CCB-WA-0001	E	ECO–0144 ZHD 8/26/16	JPR 3/2/11	SHEET 1 OF 1

Appendix F:
WWHM And HydroCad Analysis

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	4373 Prelim WWHM Flow Control
Site Name:	North Haven PUD-Quantity
Site Address:	179th St & 11th Ave
City:	Vancouver
Report Date:	1/30/2020
Gage:	Salmon Creek Treatment Plant
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.060
Version Date:	2018/10/10
Version:	4.2.16

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

DRAFT

Landuse Basin Data
Predeveloped Land Use

Pre Dev1.0

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Flat	30.846
Pervious Total	30.846
Impervious Land Use	acre
Impervious Total	0
Basin Total	30.846

Element Flows To:

Surface	Interflow	Groundwater

DRAFT

Offsite Basin0.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Field, Flat	9.041
Pervious Total	9.041

Impervious Land Use	acre
Impervious Total	0
Basin Total	9.041

Element Flows To:

Surface	Interflow	Groundwater

DRAFT

Pre Dev2.0

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Flat	3.651
Pervious Total	3.651
Impervious Land Use	acre
Impervious Total	0
Basin Total	3.651

Element Flows To:

Surface	Interflow	Groundwater

DRAFT

Mitigated Land Use

Dev Basin1.3

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	6.563
Pervious Total	6.563

Impervious Land Use	acre
ROADS FLAT	4.569
ROOF TOPS FLAT	9.366
DRIVEWAYS FLAT	2.927
SIDEWALKS FLAT	1.471
POND	0.547
Impervious Total	18.88
Basin Total	25.443

Element Flows To:

Surface	Interflow	Groundwater
Pond1.3	Pond1.3	

DRAFT

Dev Basin1.2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.839
Pervious Total	0.839

Impervious Land Use	acre
ROADS FLAT	0.591
ROOF TOPS FLAT	1.543
DRIVEWAYS FLAT	0.482
SIDEWALKS FLAT	0.21
POND	0.158
Impervious Total	2.984
Basin Total	3.823

Element Flows To:

Surface	Interflow	Groundwater
Pond1.2	Pond1.2	

DRAFT

Dev Basin1.1

Bypass:	Yes
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.353
Pervious Total	0.353

Impervious Land Use	acre
ROADS FLAT	1.227
Impervious Total	1.227
Basin Total	1.58

Element Flows To:

Surface	Interflow	Groundwater

DRAFT

Offsite Basin0.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Field, Flat	9.041
Pervious Total	9.041

Impervious Land Use	acre
Impervious Total	0
Basin Total	9.041

Element Flows To:

Surface	Interflow	Groundwater
Pond1.3	Pond1.3	

DRAFT

Dev Basin2.1

Bypass: No

GroundWater: No

Pervious Land Use	acre
SG4, Lawn, Flat	0.91
Pervious Total	0.91

Impervious Land Use	acre
ROADS FLAT	0.802
ROOF TOPS FLAT	1.175
DRIVEWAYS FLAT	0.367
SIDEWALKS FLAT	0.248
POND	0.149
Impervious Total	2.741
Basin Total	3.651

Element Flows To:

Surface	Interflow	Groundwater
Pond2.1	Pond2.1	

DRAFT

Mitigated Routing

Pond1.3

Bottom Length: 75.00 ft.
Bottom Width: 75.00 ft.
Depth: 13 ft.
Volume at riser head: 2.7994 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 12 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 1.100 ft.
Notch Height: 1.600 ft.
Orifice 1 Diameter: 4.2 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

DRAFT

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.129	0.000	0.000	0.000
0.1444	0.131	0.018	0.181	0.000
0.2889	0.133	0.037	0.257	0.000
0.4333	0.135	0.057	0.315	0.000
0.5778	0.137	0.076	0.363	0.000
0.7222	0.139	0.096	0.406	0.000
0.8667	0.141	0.117	0.445	0.000
1.0111	0.143	0.137	0.481	0.000
1.1556	0.145	0.158	0.514	0.000
1.3000	0.147	0.179	0.545	0.000
1.4444	0.149	0.201	0.575	0.000
1.5889	0.151	0.223	0.603	0.000
1.7333	0.154	0.245	0.630	0.000
1.8778	0.156	0.267	0.656	0.000
2.0222	0.158	0.290	0.680	0.000
2.1667	0.160	0.313	0.704	0.000
2.3111	0.162	0.336	0.727	0.000
2.4556	0.165	0.360	0.750	0.000
2.6000	0.167	0.384	0.771	0.000
2.7444	0.169	0.408	0.793	0.000
2.8889	0.172	0.433	0.813	0.000
3.0333	0.174	0.458	0.833	0.000
3.1778	0.176	0.483	0.853	0.000
3.3222	0.178	0.509	0.872	0.000
3.4667	0.181	0.535	0.891	0.000
3.6111	0.183	0.561	0.909	0.000
3.7556	0.186	0.588	0.927	0.000
3.9000	0.188	0.615	0.945	0.000
4.0444	0.190	0.643	0.962	0.000
4.1889	0.193	0.670	0.979	0.000
4.3333	0.195	0.698	0.996	0.000
4.4778	0.198	0.727	1.013	0.000

4.6222	0.200	0.756	1.029	0.000
4.7667	0.203	0.785	1.045	0.000
4.9111	0.205	0.814	1.060	0.000
5.0556	0.208	0.844	1.076	0.000
5.2000	0.210	0.874	1.091	0.000
5.3444	0.213	0.905	1.106	0.000
5.4889	0.215	0.936	1.121	0.000
5.6333	0.218	0.967	1.136	0.000
5.7778	0.221	0.999	1.150	0.000
5.9222	0.223	1.031	1.164	0.000
6.0667	0.226	1.064	1.179	0.000
6.2111	0.228	1.097	1.193	0.000
6.3556	0.231	1.130	1.206	0.000
6.5000	0.234	1.164	1.220	0.000
6.6444	0.236	1.198	1.233	0.000
6.7889	0.239	1.232	1.247	0.000
6.9333	0.242	1.267	1.260	0.000
7.0778	0.245	1.302	1.273	0.000
7.2222	0.247	1.338	1.286	0.000
7.3667	0.250	1.374	1.299	0.000
7.5111	0.253	1.410	1.311	0.000
7.6556	0.256	1.447	1.324	0.000
7.8000	0.258	1.484	1.336	0.000
7.9444	0.261	1.522	1.349	0.000
8.0889	0.264	1.560	1.361	0.000
8.2333	0.267	1.598	1.373	0.000
8.3778	0.270	1.637	1.385	0.000
8.5222	0.273	1.676	1.397	0.000
8.6667	0.276	1.716	1.409	0.000
8.8111	0.279	1.756	1.420	0.000
8.9556	0.281	1.796	1.432	0.000
9.1000	0.284	1.837	1.444	0.000
9.2444	0.287	1.879	1.455	0.000
9.3889	0.290	1.920	1.466	0.000
9.5333	0.293	1.963	1.478	0.000
9.6778	0.296	2.005	1.489	0.000
9.8222	0.299	2.048	1.500	0.000
9.9667	0.302	2.092	1.511	0.000
10.111	0.306	2.136	1.522	0.000
10.256	0.309	2.180	1.533	0.000
10.400	0.312	2.225	1.543	0.000
10.544	0.315	2.270	1.755	0.000
10.689	0.318	2.316	2.133	0.000
10.833	0.321	2.362	2.620	0.000
10.978	0.324	2.409	3.194	0.000
11.122	0.327	2.456	3.844	0.000
11.267	0.330	2.504	4.562	0.000
11.411	0.334	2.552	5.341	0.000
11.556	0.337	2.600	6.177	0.000
11.700	0.340	2.649	7.066	0.000
11.844	0.343	2.699	8.006	0.000
11.989	0.347	2.749	8.993	0.000
12.133	0.350	2.799	9.852	0.000
12.278	0.353	2.850	11.34	0.000
12.422	0.356	2.901	12.97	0.000
12.567	0.360	2.953	14.28	0.000
12.711	0.363	3.005	15.05	0.000
12.856	0.366	3.058	15.68	0.000

DRAFT

13.000	0.370	3.111	16.22	0.000
13.144	0.373	3.165	16.73	0.000

DRAFT

Pond1.2

Bottom Length: 45.00 ft.
Bottom Width: 45.00 ft.
Depth: 5 ft.
Volume at riser head: 0.2647 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 12 in.
Notch Type: Rectangular
Notch Width: 0.600 ft.
Notch Height: 0.750 ft.
Orifice 1 Diameter: 2.5 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Pond Hydraulic Table

DRAFT

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.046	0.000	0.000	0.000
0.0556	0.046	0.002	0.040	0.000
0.1111	0.047	0.005	0.056	0.000
0.1667	0.047	0.007	0.069	0.000
0.2222	0.048	0.010	0.080	0.000
0.2778	0.048	0.013	0.089	0.000
0.3333	0.049	0.016	0.097	0.000
0.3889	0.049	0.018	0.105	0.000
0.4444	0.050	0.021	0.113	0.000
0.5000	0.050	0.024	0.119	0.000
0.5556	0.051	0.027	0.126	0.000
0.6111	0.051	0.030	0.132	0.000
0.6667	0.052	0.032	0.138	0.000
0.7222	0.052	0.035	0.144	0.000
0.7778	0.053	0.038	0.149	0.000
0.8333	0.053	0.041	0.154	0.000
0.8889	0.054	0.044	0.159	0.000
0.9444	0.054	0.047	0.164	0.000
1.0000	0.055	0.050	0.169	0.000
1.0556	0.055	0.053	0.174	0.000
1.1111	0.056	0.056	0.178	0.000
1.1667	0.056	0.060	0.183	0.000
1.2222	0.057	0.063	0.187	0.000
1.2778	0.057	0.066	0.191	0.000
1.3333	0.058	0.069	0.195	0.000
1.3889	0.058	0.072	0.199	0.000
1.4444	0.059	0.076	0.203	0.000
1.5000	0.059	0.079	0.207	0.000
1.5556	0.060	0.082	0.211	0.000
1.6111	0.060	0.086	0.215	0.000
1.6667	0.061	0.089	0.219	0.000
1.7222	0.061	0.092	0.222	0.000
1.7778	0.062	0.096	0.226	0.000
1.8333	0.062	0.099	0.229	0.000

1.8889	0.063	0.103	0.233	0.000
1.9444	0.063	0.106	0.236	0.000
2.0000	0.064	0.110	0.239	0.000
2.0556	0.065	0.114	0.243	0.000
2.1111	0.065	0.117	0.246	0.000
2.1667	0.066	0.121	0.249	0.000
2.2222	0.066	0.125	0.252	0.000
2.2778	0.067	0.128	0.256	0.000
2.3333	0.067	0.132	0.259	0.000
2.3889	0.068	0.136	0.262	0.000
2.4444	0.068	0.140	0.265	0.000
2.5000	0.069	0.144	0.268	0.000
2.5556	0.070	0.147	0.271	0.000
2.6111	0.070	0.151	0.274	0.000
2.6667	0.071	0.155	0.277	0.000
2.7222	0.071	0.159	0.279	0.000
2.7778	0.072	0.163	0.282	0.000
2.8333	0.072	0.167	0.285	0.000
2.8889	0.073	0.171	0.288	0.000
2.9444	0.074	0.175	0.291	0.000
3.0000	0.074	0.180	0.293	0.000
3.0556	0.075	0.184	0.296	0.000
3.1111	0.075	0.188	0.299	0.000
3.1667	0.076	0.192	0.301	0.000
3.2222	0.076	0.196	0.304	0.000
3.2778	0.077	0.201	0.316	0.000
3.3333	0.078	0.205	0.357	0.000
3.3889	0.078	0.209	0.415	0.000
3.4444	0.079	0.214	0.486	0.000
3.5000	0.079	0.218	0.567	0.000
3.5556	0.080	0.223	0.657	0.000
3.6111	0.081	0.227	0.755	0.000
3.6667	0.081	0.232	0.862	0.000
3.7222	0.082	0.236	0.975	0.000
3.7778	0.083	0.241	1.095	0.000
3.8333	0.083	0.245	1.222	0.000
3.8889	0.084	0.250	1.354	0.000
3.9444	0.084	0.255	1.493	0.000
4.0000	0.085	0.259	1.636	0.000
4.0556	0.086	0.264	1.778	0.000
4.1111	0.086	0.269	2.031	0.000
4.1667	0.087	0.274	2.347	0.000
4.2222	0.087	0.279	2.692	0.000
4.2778	0.088	0.284	3.032	0.000
4.3333	0.089	0.289	3.334	0.000
4.3889	0.089	0.294	3.574	0.000
4.4444	0.090	0.299	3.743	0.000
4.5000	0.091	0.304	3.860	0.000
4.5556	0.091	0.309	4.007	0.000
4.6111	0.092	0.314	4.124	0.000
4.6667	0.093	0.319	4.235	0.000
4.7222	0.093	0.324	4.343	0.000
4.7778	0.094	0.329	4.446	0.000
4.8333	0.095	0.335	4.545	0.000
4.8889	0.095	0.340	4.642	0.000
4.9444	0.096	0.345	4.735	0.000
5.0000	0.097	0.351	4.826	0.000
5.0556	0.097	0.356	4.915	0.000

DRAFT

Pond2.1

Bottom Length: 32.00 ft.
Bottom Width: 32.00 ft.
Depth: 8 ft.
Volume at riser head: 0.3524 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 7 ft.
Riser Diameter: 15 in.
Notch Type: Rectangular
Notch Width: 0.250 ft.
Notch Height: 0.800 ft.
Orifice 1 Diameter: 1.8 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Pond Hydraulic Table

DRAFT

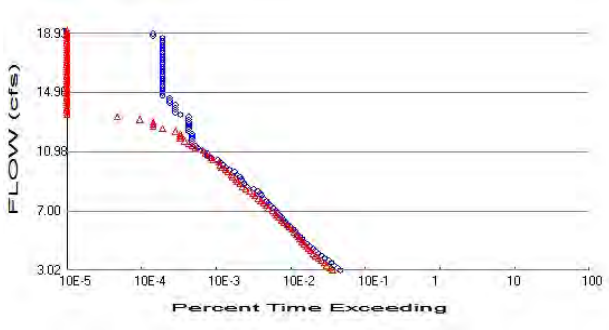
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.023	0.000	0.000	0.000
0.0889	0.024	0.002	0.026	0.000
0.1778	0.024	0.004	0.037	0.000
0.2667	0.025	0.006	0.045	0.000
0.3556	0.025	0.008	0.052	0.000
0.4444	0.026	0.011	0.058	0.000
0.5333	0.026	0.013	0.064	0.000
0.6222	0.027	0.015	0.069	0.000
0.7111	0.027	0.018	0.074	0.000
0.8000	0.028	0.020	0.078	0.000
0.8889	0.029	0.023	0.082	0.000
0.9778	0.029	0.025	0.086	0.000
1.0667	0.030	0.028	0.090	0.000
1.1556	0.030	0.031	0.094	0.000
1.2444	0.031	0.034	0.098	0.000
1.3333	0.032	0.036	0.101	0.000
1.4222	0.032	0.039	0.104	0.000
1.5111	0.033	0.042	0.108	0.000
1.6000	0.033	0.045	0.111	0.000
1.6889	0.034	0.048	0.114	0.000
1.7778	0.035	0.051	0.117	0.000
1.8667	0.035	0.054	0.120	0.000
1.9556	0.036	0.058	0.123	0.000
2.0444	0.037	0.061	0.125	0.000
2.1333	0.037	0.064	0.128	0.000
2.2222	0.038	0.068	0.131	0.000
2.3111	0.039	0.071	0.133	0.000
2.4000	0.039	0.075	0.136	0.000
2.4889	0.040	0.078	0.138	0.000
2.5778	0.041	0.082	0.141	0.000
2.6667	0.041	0.085	0.143	0.000
2.7556	0.042	0.089	0.146	0.000
2.8444	0.043	0.093	0.148	0.000
2.9333	0.043	0.097	0.150	0.000

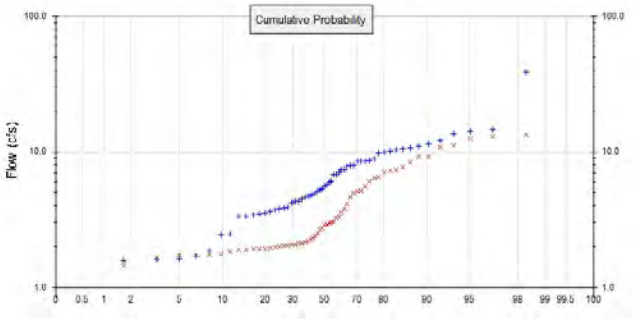
3.0222	0.044	0.101	0.152	0.000
3.1111	0.045	0.105	0.155	0.000
3.2000	0.046	0.109	0.157	0.000
3.2889	0.046	0.113	0.159	0.000
3.3778	0.047	0.117	0.161	0.000
3.4667	0.048	0.121	0.163	0.000
3.5556	0.049	0.126	0.165	0.000
3.6444	0.049	0.130	0.167	0.000
3.7333	0.050	0.135	0.169	0.000
3.8222	0.051	0.139	0.171	0.000
3.9111	0.052	0.144	0.173	0.000
4.0000	0.052	0.148	0.175	0.000
4.0889	0.053	0.153	0.177	0.000
4.1778	0.054	0.158	0.179	0.000
4.2667	0.055	0.163	0.181	0.000
4.3556	0.056	0.168	0.183	0.000
4.4444	0.056	0.173	0.185	0.000
4.5333	0.057	0.178	0.187	0.000
4.6222	0.058	0.183	0.189	0.000
4.7111	0.059	0.188	0.190	0.000
4.8000	0.060	0.194	0.192	0.000
4.8889	0.061	0.199	0.194	0.000
4.9778	0.061	0.204	0.196	0.000
5.0667	0.062	0.210	0.197	0.000
5.1556	0.063	0.216	0.199	0.000
5.2444	0.064	0.221	0.201	0.000
5.3333	0.065	0.227	0.203	0.000
5.4222	0.066	0.233	0.204	0.000
5.5111	0.067	0.239	0.206	0.000
5.6000	0.067	0.245	0.208	0.000
5.6889	0.068	0.251	0.209	0.000
5.7778	0.069	0.257	0.211	0.000
5.8667	0.070	0.263	0.213	0.000
5.9556	0.071	0.270	0.214	0.000
6.0444	0.072	0.276	0.216	0.000
6.1333	0.073	0.283	0.217	0.000
6.2222	0.074	0.289	0.222	0.000
6.3111	0.075	0.296	0.251	0.000
6.4000	0.076	0.302	0.293	0.000
6.4889	0.077	0.309	0.345	0.000
6.5778	0.078	0.316	0.404	0.000
6.6667	0.079	0.323	0.467	0.000
6.7556	0.080	0.330	0.534	0.000
6.8444	0.080	0.337	0.605	0.000
6.9333	0.081	0.345	0.677	0.000
7.0222	0.082	0.352	0.777	0.000
7.1111	0.083	0.359	1.223	0.000
7.2000	0.084	0.367	1.895	0.000
7.2889	0.085	0.374	2.661	0.000
7.3778	0.086	0.382	3.397	0.000
7.4667	0.087	0.390	3.992	0.000
7.5556	0.088	0.398	4.390	0.000
7.6444	0.089	0.406	4.694	0.000
7.7333	0.090	0.414	4.959	0.000
7.8222	0.092	0.422	5.208	0.000
7.9111	0.093	0.430	5.445	0.000
8.0000	0.094	0.438	5.670	0.000
8.0889	0.095	0.447	5.885	0.000

DRAFT

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 39.887
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 16.796
Total Impervious Area: 23.091

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	6.049988
5 year	10.923118
10 year	13.846482
25 year	16.991471
50 year	18.934885
100 year	20.571764

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Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	3.201077
5 year	5.703758
10 year	7.9626
25 year	11.649478
50 year	15.103013
100 year	19.25644

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	4.754	6.010
1950	5.086	3.797
1951	9.744	5.530
1952	5.720	4.116
1953	4.760	2.016
1954	6.750	2.299
1955	3.496	1.898
1956	13.486	11.194
1957	7.378	2.119
1958	4.618	3.291

1959	3.351	1.745
1960	3.763	1.960
1961	7.960	6.421
1962	4.925	1.908
1963	5.255	2.033
1964	10.916	2.957
1965	6.004	7.420
1966	5.921	2.639
1967	5.348	2.044
1968	7.771	2.905
1969	6.731	5.069
1970	38.980	13.336
1971	3.730	1.886
1972	8.615	2.998
1973	4.331	2.356
1974	14.600	12.991
1975	7.083	2.998
1976	10.043	3.232
1977	0.057	1.654
1978	8.867	9.285
1979	4.305	2.524
1980	4.509	2.006
1981	11.481	8.426
1982	9.960	9.246
1983	14.124	4.960
1984	3.504	2.048
1985	2.450	2.747
1986	3.633	2.245
1987	8.545	7.719
1988	1.873	1.950
1989	2.481	1.750
1990	1.574	1.743
1991	4.201	1.904
1992	4.825	1.725
1993	8.498	3.569
1994	7.868	6.453
1995	3.893	7.231
1996	12.195	10.778
1997	10.634	12.512
1998	8.490	2.188
1999	5.586	7.083
2000	3.435	1.450
2001	1.604	1.404
2002	10.453	2.155
2003	10.367	4.590
2004	1.709	1.831
2005	1.605	1.917
2006	7.415	2.117
2007	3.825	5.178
2008	3.355	2.874

DRAFT

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	38.9797	13.3362
2	14.6001	12.9909
3	14.1241	12.5115
4	13.4856	11.1940

5	12.1949	10.7775
6	11.4813	9.2851
7	10.9155	9.2457
8	10.6339	8.4255
9	10.4526	7.7185
10	10.3671	7.4202
11	10.0426	7.2309
12	9.9598	7.0828
13	9.7441	6.4534
14	8.8672	6.4213
15	8.6149	6.0095
16	8.5450	5.5298
17	8.4982	5.1776
18	8.4905	5.0693
19	7.9597	4.9605
20	7.8681	4.5901
21	7.7706	4.1158
22	7.4148	3.7973
23	7.3776	3.5686
24	7.0827	3.2908
25	6.7496	3.2320
26	6.7309	2.9983
27	6.0036	2.9981
28	5.9214	2.9568
29	5.7199	2.9050
30	5.5863	2.8736
31	5.3479	2.7469
32	5.2550	2.6387
33	5.0862	2.5241
34	4.9249	2.3561
35	4.8248	2.2993
36	4.7597	2.2445
37	4.7543	2.1877
38	4.6184	2.1548
39	4.5091	2.1188
40	4.3312	2.1168
41	4.3051	2.0480
42	4.2006	2.0439
43	3.8928	2.0325
44	3.8249	2.0157
45	3.7627	2.0064
46	3.7298	1.9597
47	3.6335	1.9497
48	3.5044	1.9169
49	3.4964	1.9078
50	3.4355	1.9041
51	3.3548	1.8975
52	3.3507	1.8857
53	2.4815	1.8315
54	2.4500	1.7495
55	1.8733	1.7454
56	1.7090	1.7433
57	1.6055	1.7250
58	1.6041	1.6543
59	1.5745	1.4504
60	0.0566	1.4039

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Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
3.0250	978	762	77	Pass
3.1857	889	705	79	Pass
3.3464	805	643	79	Pass
3.5071	735	590	80	Pass
3.6678	673	539	80	Pass
3.8285	602	494	82	Pass
3.9892	541	455	84	Pass
4.1499	492	416	84	Pass
4.3106	450	388	86	Pass
4.4713	418	360	86	Pass
4.6321	378	341	90	Pass
4.7928	354	322	90	Pass
4.9535	320	302	94	Pass
5.1142	300	281	93	Pass
5.2749	279	271	97	Pass
5.4356	258	250	96	Pass
5.5963	243	232	95	Pass
5.7570	228	217	95	Pass
5.9177	211	200	94	Pass
6.0784	192	187	97	Pass
6.2391	179	170	94	Pass
6.3998	171	159	92	Pass
6.5605	159	144	90	Pass
6.7212	149	136	91	Pass
6.8819	139	129	92	Pass
7.0426	134	120	89	Pass
7.2033	122	105	86	Pass
7.3641	112	99	88	Pass
7.5248	104	91	87	Pass
7.6855	99	84	84	Pass
7.8462	91	78	85	Pass
8.0069	86	70	81	Pass
8.1676	82	66	80	Pass
8.3283	76	59	77	Pass
8.4890	67	52	77	Pass
8.6497	54	47	87	Pass
8.8104	50	44	88	Pass
8.9711	47	40	85	Pass
9.1318	46	39	84	Pass
9.2925	44	35	79	Pass
9.4532	40	34	85	Pass
9.6139	37	30	81	Pass
9.7746	32	28	87	Pass
9.9354	28	25	89	Pass
10.0961	26	24	92	Pass
10.2568	24	23	95	Pass
10.4175	22	19	86	Pass
10.5782	18	18	100	Pass
10.7389	16	17	106	Pass
10.8996	16	15	93	Pass
11.0603	13	14	107	Pass
11.2210	12	11	91	Pass
11.3817	11	10	90	Pass

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11.5424	10	9	90	Pass
11.7031	10	8	80	Pass
11.8638	10	7	70	Pass
12.0245	10	7	70	Pass
12.1852	10	7	70	Pass
12.3459	9	6	66	Pass
12.5066	9	4	44	Pass
12.6674	9	3	33	Pass
12.8281	9	3	33	Pass
12.9888	9	3	33	Pass
13.1495	9	2	22	Pass
13.3102	9	1	11	Pass
13.4709	7	0	0	Pass
13.6316	6	0	0	Pass
13.7923	6	0	0	Pass
13.9530	6	0	0	Pass
14.1137	6	0	0	Pass
14.2744	5	0	0	Pass
14.4351	5	0	0	Pass
14.5958	5	0	0	Pass
14.7565	4	0	0	Pass
14.9172	4	0	0	Pass
15.0779	4	0	0	Pass
15.2386	4	0	0	Pass
15.3994	4	0	0	Pass
15.5601	4	0	0	Pass
15.7208	4	0	0	Pass
15.8815	4	0	0	Pass
16.0422	4	0	0	Pass
16.2029	4	0	0	Pass
16.3636	4	0	0	Pass
16.5243	4	0	0	Pass
16.6850	4	0	0	Pass
16.8457	4	0	0	Pass
17.0064	4	0	0	Pass
17.1671	4	0	0	Pass
17.3278	4	0	0	Pass
17.4885	4	0	0	Pass
17.6492	4	0	0	Pass
17.8099	4	0	0	Pass
17.9706	4	0	0	Pass
18.1314	4	0	0	Pass
18.2921	4	0	0	Pass
18.4528	4	0	0	Pass
18.6135	4	0	0	Pass
18.7742	3	0	0	Pass
18.9349	3	0	0	Pass

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Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

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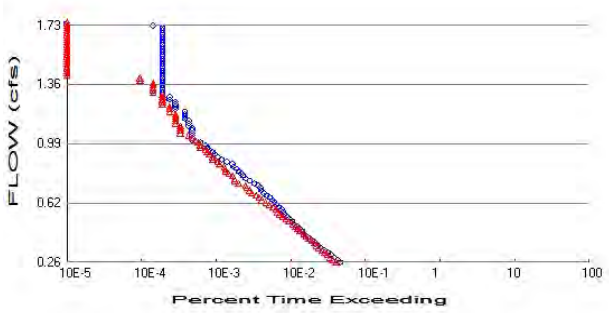
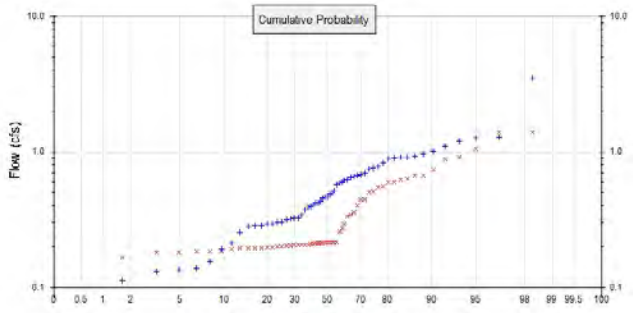
POC 2





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 3.651
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.91
Total Impervious Area: 2.741

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.510163
5 year	0.958832
10 year	1.235196
25 year	1.536985
50 year	1.725434
100 year	1.885189

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Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.287643
5 year	0.489946
10 year	0.670281
25 year	0.96233
50 year	1.234461
100 year	1.56071

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1949	0.409	0.511
1950	0.432	0.292
1951	0.823	0.440
1952	0.497	0.398
1953	0.415	0.205
1954	0.568	0.209
1955	0.295	0.197
1956	1.203	0.917
1957	0.615	0.205
1958	0.374	0.357
1959	0.280	0.180

1960	0.326	0.207
1961	0.682	0.597
1962	0.395	0.194
1963	0.459	0.213
1964	0.969	0.210
1965	0.520	0.597
1966	0.487	0.215
1967	0.464	0.204
1968	0.651	0.215
1969	0.595	0.627
1970	3.495	0.664
1971	0.300	0.193
1972	0.753	0.211
1973	0.324	0.215
1974	1.288	1.399
1975	0.591	0.214
1976	0.901	0.215
1977	0.003	0.182
1978	0.783	0.742
1979	0.254	0.215
1980	0.391	0.204
1981	1.008	0.668
1982	0.883	0.623
1983	1.260	0.259
1984	0.286	0.207
1985	0.192	0.334
1986	0.302	0.192
1987	0.759	0.442
1988	0.155	0.212
1989	0.211	0.182
1990	0.131	0.186
1991	0.344	0.199
1992	0.420	0.183
1993	0.697	0.272
1994	0.658	0.505
1995	0.318	0.891
1996	1.097	1.054
1997	0.908	1.403
1998	0.671	0.199
1999	0.457	0.558
2000	0.293	0.167
2001	0.134	0.154
2002	0.931	0.196
2003	0.916	0.342
2004	0.139	0.195
2005	0.112	0.204
2006	0.622	0.197
2007	0.316	0.547
2008	0.287	0.212

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	3.4952	1.4031
2	1.2877	1.3990
3	1.2603	1.0542
4	1.2026	0.9169
5	1.0970	0.8912

6	1.0082	0.7420
7	0.9687	0.6681
8	0.9312	0.6636
9	0.9164	0.6268
10	0.9078	0.6233
11	0.9009	0.5973
12	0.8832	0.5967
13	0.8234	0.5581
14	0.7829	0.5465
15	0.7595	0.5111
16	0.7526	0.5050
17	0.6970	0.4417
18	0.6817	0.4404
19	0.6715	0.3978
20	0.6580	0.3572
21	0.6509	0.3415
22	0.6225	0.3336
23	0.6150	0.2919
24	0.5952	0.2723
25	0.5906	0.2591
26	0.5684	0.2154
27	0.5197	0.2151
28	0.4971	0.2149
29	0.4868	0.2147
30	0.4639	0.2147
31	0.4586	0.2136
32	0.4575	0.2127
33	0.4315	0.2123
34	0.4196	0.2118
35	0.4154	0.2113
36	0.4086	0.2096
37	0.3950	0.2094
38	0.3912	0.2070
39	0.3736	0.2068
40	0.3437	0.2054
41	0.3255	0.2050
42	0.3238	0.2043
43	0.3176	0.2039
44	0.3164	0.2039
45	0.3024	0.1989
46	0.3000	0.1986
47	0.2952	0.1973
48	0.2935	0.1965
49	0.2868	0.1956
50	0.2860	0.1954
51	0.2800	0.1944
52	0.2542	0.1931
53	0.2109	0.1925
54	0.1919	0.1863
55	0.1551	0.1825
56	0.1387	0.1824
57	0.1343	0.1820
58	0.1314	0.1803
59	0.1120	0.1668
60	0.0032	0.1541

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Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.2551	973	847	87	Pass
0.2699	892	773	86	Pass
0.2848	805	697	86	Pass
0.2996	726	651	89	Pass
0.3145	665	601	90	Pass
0.3293	590	551	93	Pass
0.3442	536	498	92	Pass
0.3590	485	465	95	Pass
0.3739	444	433	97	Pass
0.3887	411	399	97	Pass
0.4036	380	369	97	Pass
0.4185	341	338	99	Pass
0.4333	318	316	99	Pass
0.4482	299	281	93	Pass
0.4630	276	262	94	Pass
0.4779	255	244	95	Pass
0.4927	232	223	96	Pass
0.5076	220	197	89	Pass
0.5224	204	181	88	Pass
0.5373	190	164	86	Pass
0.5521	177	151	85	Pass
0.5670	167	140	83	Pass
0.5818	157	133	84	Pass
0.5967	146	122	83	Pass
0.6115	135	108	80	Pass
0.6264	127	97	76	Pass
0.6412	119	87	73	Pass
0.6561	111	79	71	Pass
0.6709	100	72	72	Pass
0.6858	92	63	68	Pass
0.7006	86	59	68	Pass
0.7155	82	54	65	Pass
0.7303	77	52	67	Pass
0.7452	68	42	61	Pass
0.7601	59	38	64	Pass
0.7749	53	37	69	Pass
0.7898	48	35	72	Pass
0.8046	46	31	67	Pass
0.8195	42	28	66	Pass
0.8343	40	28	70	Pass
0.8492	36	27	75	Pass
0.8640	35	23	65	Pass
0.8789	29	22	75	Pass
0.8937	25	19	76	Pass
0.9086	22	19	86	Pass
0.9234	20	17	85	Pass
0.9383	19	16	84	Pass
0.9531	17	15	88	Pass
0.9680	16	13	81	Pass
0.9828	15	13	86	Pass
0.9977	13	12	92	Pass
1.0125	10	11	110	Pass
1.0274	10	10	100	Pass

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1.0422	10	9	90	Pass
1.0571	10	7	70	Pass
1.0719	10	7	70	Pass
1.0868	10	7	70	Pass
1.1016	9	7	77	Pass
1.1165	9	6	66	Pass
1.1314	9	6	66	Pass
1.1462	8	6	75	Pass
1.1611	8	6	75	Pass
1.1759	8	6	75	Pass
1.1908	8	5	62	Pass
1.2056	6	5	83	Pass
1.2205	6	5	83	Pass
1.2353	6	4	66	Pass
1.2502	6	4	66	Pass
1.2650	5	4	80	Pass
1.2799	5	4	80	Pass
1.2947	4	4	100	Pass
1.3096	4	3	75	Pass
1.3244	4	3	75	Pass
1.3393	4	3	75	Pass
1.3541	4	3	75	Pass
1.3690	4	3	75	Pass
1.3838	4	2	50	Pass
1.3987	4	2	50	Pass
1.4135	4	0	0	Pass
1.4284	4	0	0	Pass
1.4432	4	0	0	Pass
1.4581	4	0	0	Pass
1.4729	4	0	0	Pass
1.4878	4	0	0	Pass
1.5027	4	0	0	Pass
1.5175	4	0	0	Pass
1.5324	4	0	0	Pass
1.5472	4	0	0	Pass
1.5621	4	0	0	Pass
1.5769	4	0	0	Pass
1.5918	4	0	0	Pass
1.6066	4	0	0	Pass
1.6215	4	0	0	Pass
1.6363	4	0	0	Pass
1.6512	4	0	0	Pass
1.6660	4	0	0	Pass
1.6809	4	0	0	Pass
1.6957	4	0	0	Pass
1.7106	4	0	0	Pass
1.7254	3	0	0	Pass

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Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

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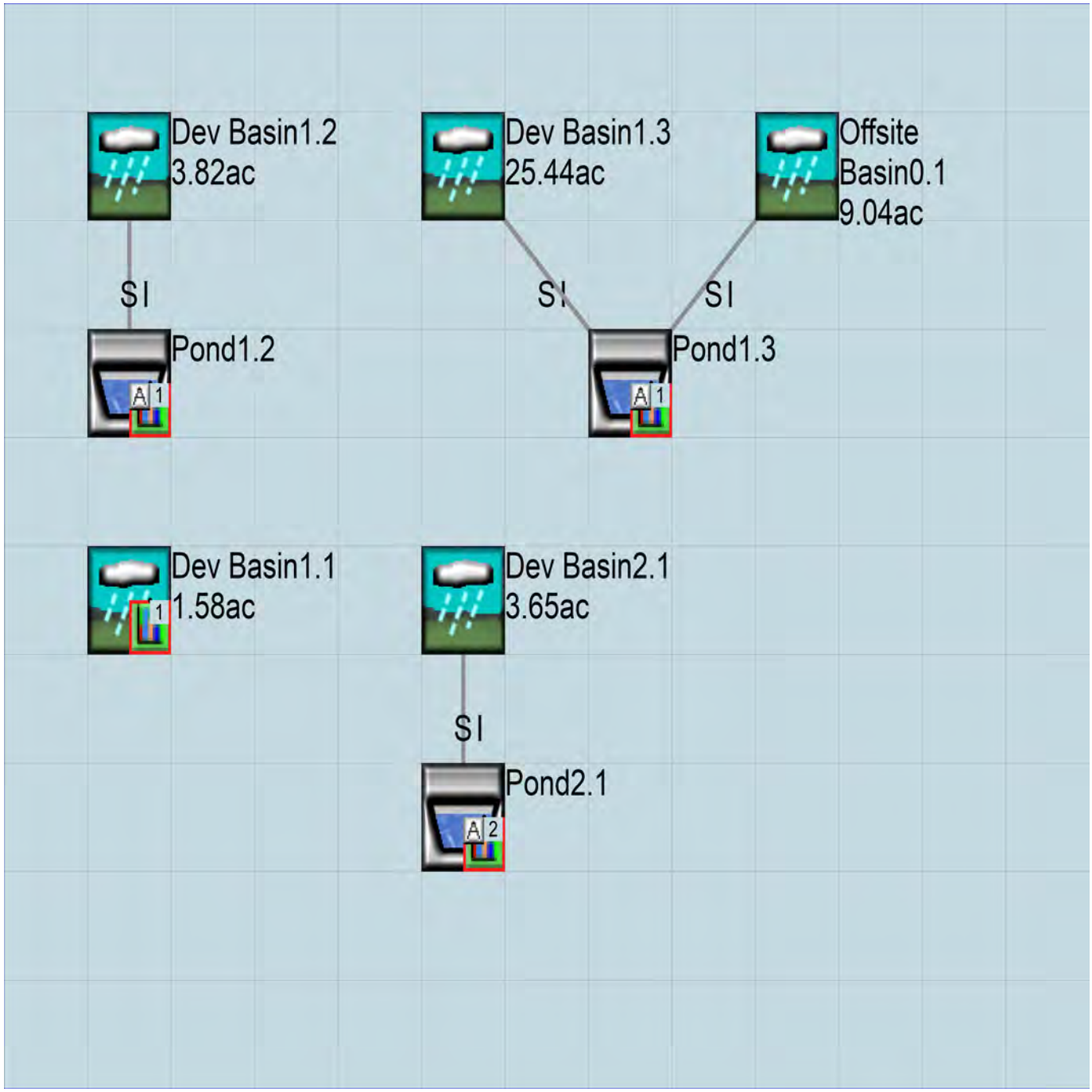
Appendix
Predeveloped Schematic



Mitigated Schematic



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WWHM2012

PROJECT REPORT

Water Quality
Calculations ONLY

General Model Information

Project Name:	4373 Prelim WWHM WQ
Site Name:	North Haven PUD-WQ
Site Address:	179th St & 11th Ave
City:	Vancouver
Report Date:	2/6/2020
Gage:	Salmon Creek Treatment Plant
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.060
Version Date:	2018/10/10
Version:	4.2.16

POC Thresholds

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Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year
Low Flow Threshold for POC3:	50 Percent of the 2 Year
High Flow Threshold for POC3:	50 Year
Low Flow Threshold for POC4:	50 Percent of the 2 Year
High Flow Threshold for POC4:	50 Year

Landuse Basin Data
Predeveloped Land Use

Pre Dev1.3

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Flat	25.443
Pervious Total	25.443
Impervious Land Use	acre
Impervious Total	0
Basin Total	25.443

Element Flows To:

Surface	Interflow	Groundwater

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Offsite Basin0.1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Field, Flat	9.041
Pervious Total	9.041
Impervious Land Use	acre
Impervious Total	0
Basin Total	9.041

Element Flows To:

Surface	Interflow	Groundwater

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Pre Dev2.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Forest, Flat	2.186
Pervious Total	2.186

Impervious Land Use	acre
Impervious Total	0
Basin Total	2.186

Element Flows To:

Surface	Interflow	Groundwater

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Pre Dev1.2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Flat	1.89
Pervious Total	1.89
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.89

Element Flows To:

Surface	Interflow	Groundwater

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Pre Dev1.1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Flat	1.32
Pervious Total	1.32
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.32

Element Flows To:

Surface	Interflow	Groundwater

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Mitigated Land Use

Dev Basin1.3

Bypass: No

GroundWater: No

Pervious Land Use	acre
SG4, Lawn, Flat	6.563
Pervious Total	6.563

Impervious Land Use	acre
ROADS FLAT	4.569
ROOF TOPS FLAT	9.366
DRIVEWAYS FLAT	2.927
SIDEWALKS FLAT	1.471
POND	0.547
Impervious Total	18.88
Basin Total	25.443

Element Flows To:

Surface	Interflow	Groundwater
Pond1.3	Pond1.3	

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Dev Basin1.2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.45
Pervious Total	0.45

Impervious Land Use	acre
ROADS FLAT	0.59
DRIVEWAYS FLAT	0.482
SIDEWALKS FLAT	0.21
POND	0.158
Impervious Total	1.44
Basin Total	1.89

Element Flows To:

Surface	Interflow	Groundwater

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Dev Basin1.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.09
Pervious Total	0.09

Impervious Land Use	acre
ROADS FLAT	1.23
Impervious Total	1.23
Basin Total	1.32

Element Flows To:

Surface	Interflow	Groundwater

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Offsite Basin0.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Field, Flat	9.041
Pervious Total	9.041

Impervious Land Use	acre
Impervious Total	0
Basin Total	9.041

Element Flows To:

Surface	Interflow	Groundwater
Pond1.3	Pond1.3	

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Dev Basin2.1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.62
Pervious Total	0.62

Impervious Land Use	acre
ROADS FLAT	0.802
DRIVEWAYS FLAT	0.367
SIDEWALKS FLAT	0.248
POND	0.149
Impervious Total	1.566
Basin Total	2.186

Element Flows To:

Surface	Interflow	Groundwater

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Mitigated Routing

Pond1.3

Bottom Length: 75.00 ft.
Bottom Width: 75.00 ft.
Depth: 13 ft.
Volume at riser head: 2.7994 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 12 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 1.100 ft.
Notch Height: 1.600 ft.
Orifice 1 Diameter: 4.2 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

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Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.129	0.000	0.000	0.000
0.1444	0.131	0.018	0.181	0.000
0.2889	0.133	0.037	0.257	0.000
0.4333	0.135	0.057	0.315	0.000
0.5778	0.137	0.076	0.363	0.000
0.7222	0.139	0.096	0.406	0.000
0.8667	0.141	0.117	0.445	0.000
1.0111	0.143	0.137	0.481	0.000
1.1556	0.145	0.158	0.514	0.000
1.3000	0.147	0.179	0.545	0.000
1.4444	0.149	0.201	0.575	0.000
1.5889	0.151	0.223	0.603	0.000
1.7333	0.154	0.245	0.630	0.000
1.8778	0.156	0.267	0.656	0.000
2.0222	0.158	0.290	0.680	0.000
2.1667	0.160	0.313	0.704	0.000
2.3111	0.162	0.336	0.727	0.000
2.4556	0.165	0.360	0.750	0.000
2.6000	0.167	0.384	0.771	0.000
2.7444	0.169	0.408	0.793	0.000
2.8889	0.172	0.433	0.813	0.000
3.0333	0.174	0.458	0.833	0.000
3.1778	0.176	0.483	0.853	0.000
3.3222	0.178	0.509	0.872	0.000
3.4667	0.181	0.535	0.891	0.000
3.6111	0.183	0.561	0.909	0.000
3.7556	0.186	0.588	0.927	0.000
3.9000	0.188	0.615	0.945	0.000
4.0444	0.190	0.643	0.962	0.000
4.1889	0.193	0.670	0.979	0.000
4.3333	0.195	0.698	0.996	0.000
4.4778	0.198	0.727	1.013	0.000

4.6222	0.200	0.756	1.029	0.000
4.7667	0.203	0.785	1.045	0.000
4.9111	0.205	0.814	1.060	0.000
5.0556	0.208	0.844	1.076	0.000
5.2000	0.210	0.874	1.091	0.000
5.3444	0.213	0.905	1.106	0.000
5.4889	0.215	0.936	1.121	0.000
5.6333	0.218	0.967	1.136	0.000
5.7778	0.221	0.999	1.150	0.000
5.9222	0.223	1.031	1.164	0.000
6.0667	0.226	1.064	1.179	0.000
6.2111	0.228	1.097	1.193	0.000
6.3556	0.231	1.130	1.206	0.000
6.5000	0.234	1.164	1.220	0.000
6.6444	0.236	1.198	1.233	0.000
6.7889	0.239	1.232	1.247	0.000
6.9333	0.242	1.267	1.260	0.000
7.0778	0.245	1.302	1.273	0.000
7.2222	0.247	1.338	1.286	0.000
7.3667	0.250	1.374	1.299	0.000
7.5111	0.253	1.410	1.311	0.000
7.6556	0.256	1.447	1.324	0.000
7.8000	0.258	1.484	1.336	0.000
7.9444	0.261	1.522	1.349	0.000
8.0889	0.264	1.560	1.361	0.000
8.2333	0.267	1.598	1.373	0.000
8.3778	0.270	1.637	1.385	0.000
8.5222	0.273	1.676	1.397	0.000
8.6667	0.276	1.716	1.409	0.000
8.8111	0.279	1.756	1.420	0.000
8.9556	0.281	1.796	1.432	0.000
9.1000	0.284	1.837	1.444	0.000
9.2444	0.287	1.879	1.455	0.000
9.3889	0.290	1.920	1.466	0.000
9.5333	0.293	1.963	1.478	0.000
9.6778	0.296	2.005	1.489	0.000
9.8222	0.299	2.048	1.500	0.000
9.9667	0.302	2.092	1.511	0.000
10.111	0.306	2.136	1.522	0.000
10.256	0.309	2.180	1.533	0.000
10.400	0.312	2.225	1.543	0.000
10.544	0.315	2.270	1.755	0.000
10.689	0.318	2.316	2.133	0.000
10.833	0.321	2.362	2.620	0.000
10.978	0.324	2.409	3.194	0.000
11.122	0.327	2.456	3.844	0.000
11.267	0.330	2.504	4.562	0.000
11.411	0.334	2.552	5.341	0.000
11.556	0.337	2.600	6.177	0.000
11.700	0.340	2.649	7.066	0.000
11.844	0.343	2.699	8.006	0.000
11.989	0.347	2.749	8.993	0.000
12.133	0.350	2.799	9.852	0.000
12.278	0.353	2.850	11.34	0.000
12.422	0.356	2.901	12.97	0.000
12.567	0.360	2.953	14.28	0.000
12.711	0.363	3.005	15.05	0.000
12.856	0.366	3.058	15.68	0.000

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13.000	0.370	3.111	16.22	0.000
13.144	0.373	3.165	16.73	0.000

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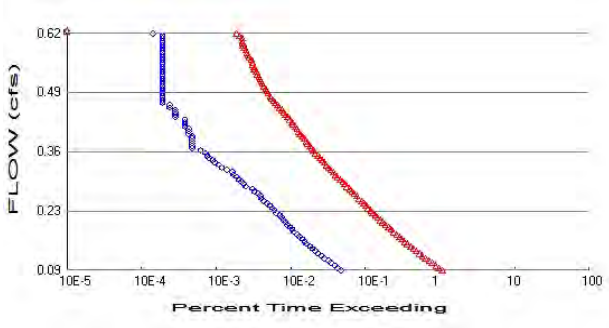
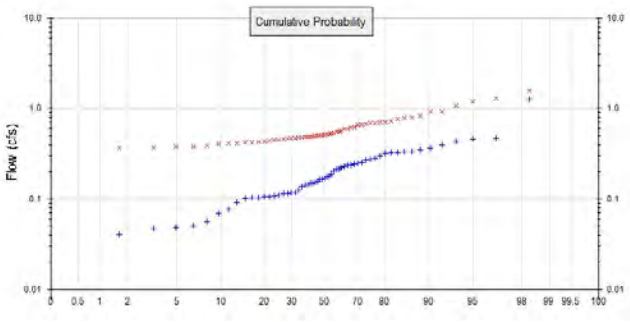
Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 1.32
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.09
Total Impervious Area: 1.23

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.184447
5 year	0.346661
10 year	0.446579
25 year	0.555689
50 year	0.623822
100 year	0.68158

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.541564
5 year	0.728563
10 year	0.867505
25 year	1.061083
50 year	1.218947
100 year	1.389013

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.148	0.929
1950	0.156	0.486
1951	0.298	0.568
1952	0.180	0.616
1953	0.150	0.487
1954	0.206	0.692
1955	0.107	0.419
1956	0.435	0.593
1957	0.222	0.450
1958	0.135	0.620

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1959	0.101	0.380
1960	0.118	0.504
1961	0.246	0.466
1962	0.143	0.489
1963	0.166	0.422
1964	0.350	0.511
1965	0.188	0.428
1966	0.176	0.406
1967	0.168	0.527
1968	0.235	1.073
1969	0.215	0.784
1970	1.264	1.583
1971	0.108	0.761
1972	0.272	0.589
1973	0.117	0.662
1974	0.466	0.676
1975	0.214	0.452
1976	0.326	0.479
1977	0.001	0.295
1978	0.283	0.465
1979	0.092	0.665
1980	0.141	0.373
1981	0.365	0.560
1982	0.319	0.718
1983	0.456	0.694
1984	0.103	0.439
1985	0.069	0.477
1986	0.109	0.826
1987	0.275	0.416
1988	0.056	0.500
1989	0.076	0.458
1990	0.048	0.380
1991	0.124	0.493
1992	0.152	0.411
1993	0.252	0.704
1994	0.238	0.465
1995	0.115	0.702
1996	0.397	1.296
1997	0.328	0.923
1998	0.243	0.800
1999	0.165	0.427
2000	0.106	0.367
2001	0.049	0.387
2002	0.337	0.561
2003	0.331	0.537
2004	0.050	0.531
2005	0.040	0.500
2006	0.225	0.519
2007	0.114	0.509
2008	0.104	1.195

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	1.2637	1.5828
2	0.4656	1.2960
3	0.4556	1.1953
4	0.4348	1.0726

5	0.3966	0.9295
6	0.3645	0.9228
7	0.3502	0.8257
8	0.3367	0.7997
9	0.3313	0.7836
10	0.3282	0.7615
11	0.3257	0.7178
12	0.3193	0.7044
13	0.2977	0.7020
14	0.2830	0.6939
15	0.2746	0.6918
16	0.2721	0.6763
17	0.2520	0.6648
18	0.2465	0.6616
19	0.2428	0.6200
20	0.2379	0.6163
21	0.2353	0.5932
22	0.2251	0.5888
23	0.2224	0.5682
24	0.2152	0.5609
25	0.2135	0.5600
26	0.2055	0.5372
27	0.1879	0.5311
28	0.1797	0.5268
29	0.1760	0.5193
30	0.1677	0.5112
31	0.1658	0.5088
32	0.1654	0.5035
33	0.1560	0.5004
34	0.1517	0.5002
35	0.1502	0.4930
36	0.1477	0.4890
37	0.1428	0.4870
38	0.1415	0.4860
39	0.1351	0.4788
40	0.1243	0.4772
41	0.1177	0.4663
42	0.1171	0.4653
43	0.1148	0.4648
44	0.1144	0.4582
45	0.1093	0.4522
46	0.1085	0.4503
47	0.1067	0.4391
48	0.1061	0.4278
49	0.1037	0.4269
50	0.1034	0.4221
51	0.1012	0.4188
52	0.0919	0.4163
53	0.0763	0.4110
54	0.0694	0.4055
55	0.0561	0.3867
56	0.0502	0.3802
57	0.0486	0.3796
58	0.0475	0.3730
59	0.0405	0.3672
60	0.0012	0.2953

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Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0922	979	22511	2299	Fail
0.0976	896	20407	2277	Fail
0.1030	822	18516	2252	Fail
0.1083	728	16488	2264	Fail
0.1137	672	14996	2231	Fail
0.1191	590	13431	2276	Fail
0.1244	542	12255	2261	Fail
0.1298	490	11241	2294	Fail
0.1352	444	10092	2272	Fail
0.1406	412	9261	2247	Fail
0.1459	381	8468	2222	Fail
0.1513	341	7666	2248	Fail
0.1567	322	7023	2181	Fail
0.1620	299	6450	2157	Fail
0.1674	277	5996	2164	Fail
0.1728	256	5523	2157	Fail
0.1781	230	5016	2180	Fail
0.1835	220	4660	2118	Fail
0.1889	205	4300	2097	Fail
0.1942	190	3917	2061	Fail
0.1996	180	3604	2002	Fail
0.2050	168	3347	1992	Fail
0.2104	157	3080	1961	Fail
0.2157	150	2870	1913	Fail
0.2211	135	2663	1972	Fail
0.2265	127	2493	1962	Fail
0.2318	120	2314	1928	Fail
0.2372	111	2150	1936	Fail
0.2426	101	2009	1989	Fail
0.2479	92	1861	2022	Fail
0.2533	86	1704	1981	Fail
0.2587	83	1610	1939	Fail
0.2641	77	1482	1924	Fail
0.2694	68	1394	2050	Fail
0.2748	64	1290	2015	Fail
0.2802	53	1188	2241	Fail
0.2855	49	1115	2275	Fail
0.2909	46	1053	2289	Fail
0.2963	42	965	2297	Fail
0.3016	40	891	2227	Fail
0.3070	36	824	2288	Fail
0.3124	35	778	2222	Fail
0.3178	29	720	2482	Fail
0.3231	25	671	2684	Fail
0.3285	23	626	2721	Fail
0.3339	20	591	2955	Fail
0.3392	19	554	2915	Fail
0.3446	17	518	3047	Fail
0.3500	16	487	3043	Fail
0.3553	15	447	2980	Fail
0.3607	13	427	3284	Fail
0.3661	10	399	3990	Fail
0.3714	10	379	3790	Fail
0.3768	10	357	3570	Fail

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0.3822	10	338	3380	Fail
0.3876	10	321	3209	Fail
0.3929	10	302	3020	Fail
0.3983	9	281	3122	Fail
0.4037	9	266	2955	Fail
0.4090	9	255	2833	Fail
0.4144	8	242	3025	Fail
0.4198	8	224	2800	Fail
0.4251	8	220	2750	Fail
0.4305	8	205	2562	Fail
0.4359	6	190	3166	Fail
0.4413	6	178	2966	Fail
0.4466	6	170	2833	Fail
0.4520	6	160	2666	Fail
0.4574	5	147	2940	Fail
0.4627	5	140	2800	Fail
0.4681	4	130	3250	Fail
0.4735	4	124	3100	Fail
0.4788	4	115	2875	Fail
0.4842	4	112	2800	Fail
0.4896	4	104	2600	Fail
0.4949	4	101	2525	Fail
0.5003	4	97	2425	Fail
0.5057	4	91	2275	Fail
0.5111	4	88	2200	Fail
0.5164	4	85	2125	Fail
0.5218	4	82	2050	Fail
0.5272	4	79	1975	Fail
0.5325	4	75	1875	Fail
0.5379	4	73	1825	Fail
0.5433	4	68	1700	Fail
0.5486	4	67	1675	Fail
0.5540	4	66	1650	Fail
0.5594	4	65	1625	Fail
0.5648	4	62	1550	Fail
0.5701	4	58	1450	Fail
0.5755	4	56	1400	Fail
0.5809	4	55	1375	Fail
0.5862	4	53	1325	Fail
0.5916	4	50	1250	Fail
0.5970	4	48	1200	Fail
0.6023	4	48	1200	Fail
0.6077	4	47	1175	Fail
0.6131	4	47	1175	Fail
0.6185	4	43	1075	Fail
0.6238	3	39	1300	Fail

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The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.15 acre-feet
On-line facility target flow:	0.2133 cfs.
Adjusted for 15 min:	0.2133 cfs.
Off-line facility target flow:	0.1195 cfs.
Adjusted for 15 min:	0.1195 cfs.

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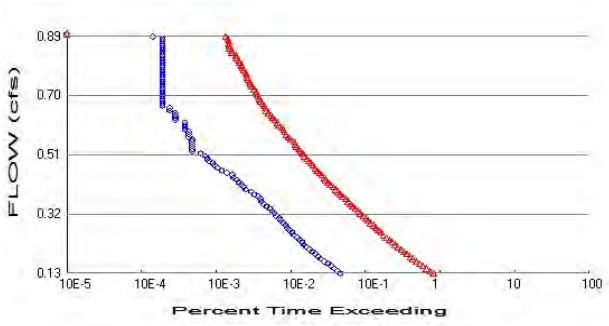
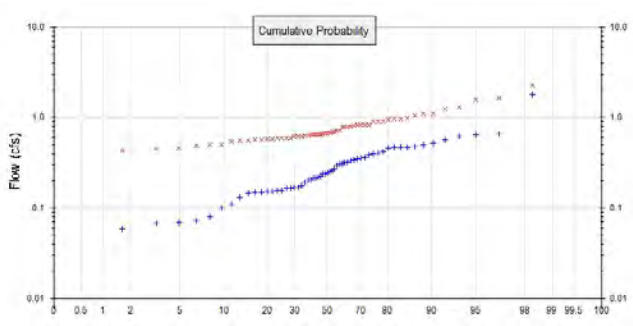
POC 2





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 1.89
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.45
Total Impervious Area: 1.44

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.264094
5 year	0.496355
10 year	0.639419
25 year	0.795645
50 year	0.893199
100 year	0.975898

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Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.70382
5 year	0.954672
10 year	1.142253
25 year	1.404972
50 year	1.620222
100 year	1.852978

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1949	0.212	1.088
1950	0.223	0.569
1951	0.426	0.791
1952	0.257	0.835
1953	0.215	0.641
1954	0.294	0.837
1955	0.153	0.491
1956	0.623	0.834
1957	0.318	0.629
1958	0.193	0.834
1959	0.145	0.504

1960	0.169	0.617
1961	0.353	0.652
1962	0.205	0.670
1963	0.237	0.570
1964	0.501	0.716
1965	0.269	0.593
1966	0.252	0.562
1967	0.240	0.687
1968	0.337	1.306
1969	0.308	0.992
1970	1.809	2.241
1971	0.155	0.902
1972	0.390	0.690
1973	0.168	0.775
1974	0.667	0.951
1975	0.306	0.628
1976	0.466	0.668
1977	0.002	0.346
1978	0.405	0.647
1979	0.132	0.907
1980	0.203	0.499
1981	0.522	0.783
1982	0.457	0.916
1983	0.652	0.974
1984	0.148	0.579
1985	0.099	0.598
1986	0.157	1.058
1987	0.393	0.547
1988	0.080	0.588
1989	0.109	0.613
1990	0.068	0.450
1991	0.178	0.661
1992	0.217	0.560
1993	0.361	0.977
1994	0.341	0.649
1995	0.164	0.822
1996	0.568	1.663
1997	0.470	1.236
1998	0.348	1.097
1999	0.237	0.576
2000	0.152	0.430
2001	0.070	0.455
2002	0.482	0.780
2003	0.474	0.722
2004	0.072	0.622
2005	0.058	0.594
2006	0.322	0.641
2007	0.164	0.680
2008	0.148	1.566

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	1.8094	2.2415
2	0.6666	1.6630
3	0.6524	1.5661
4	0.6225	1.3063
5	0.5679	1.2360

6	0.5219	1.0966
7	0.5015	1.0883
8	0.4821	1.0583
9	0.4744	0.9916
10	0.4700	0.9765
11	0.4664	0.9744
12	0.4572	0.9509
13	0.4262	0.9162
14	0.4053	0.9069
15	0.3931	0.9017
16	0.3896	0.8375
17	0.3608	0.8347
18	0.3529	0.8344
19	0.3476	0.8342
20	0.3406	0.8220
21	0.3370	0.7909
22	0.3222	0.7834
23	0.3184	0.7796
24	0.3081	0.7748
25	0.3058	0.7216
26	0.2943	0.7162
27	0.2690	0.6898
28	0.2573	0.6868
29	0.2520	0.6805
30	0.2402	0.6700
31	0.2374	0.6679
32	0.2368	0.6609
33	0.2234	0.6516
34	0.2172	0.6490
35	0.2150	0.6469
36	0.2115	0.6414
37	0.2045	0.6407
38	0.2025	0.6291
39	0.1934	0.6279
40	0.1779	0.6219
41	0.1685	0.6169
42	0.1676	0.6134
43	0.1644	0.5982
44	0.1638	0.5939
45	0.1566	0.5933
46	0.1553	0.5878
47	0.1528	0.5786
48	0.1519	0.5757
49	0.1485	0.5696
50	0.1480	0.5690
51	0.1450	0.5617
52	0.1316	0.5595
53	0.1092	0.5470
54	0.0993	0.5040
55	0.0803	0.4991
56	0.0718	0.4906
57	0.0695	0.4553
58	0.0680	0.4496
59	0.0580	0.4300
60	0.0017	0.3459

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Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1320	973	17153	1762	Fail
0.1397	895	15539	1736	Fail
0.1474	805	13869	1722	Fail
0.1551	724	12396	1712	Fail
0.1628	669	11226	1678	Fail
0.1705	593	10094	1702	Fail
0.1782	536	9097	1697	Fail
0.1859	490	8331	1700	Fail
0.1936	445	7563	1699	Fail
0.2012	411	6869	1671	Fail
0.2089	380	6322	1663	Fail
0.2166	341	5733	1681	Fail
0.2243	320	5236	1636	Fail
0.2320	300	4809	1603	Fail
0.2397	277	4401	1588	Fail
0.2474	255	3989	1564	Fail
0.2551	230	3650	1586	Fail
0.2627	220	3408	1549	Fail
0.2704	204	3141	1539	Fail
0.2781	190	2893	1522	Fail
0.2858	180	2695	1497	Fail
0.2935	167	2480	1485	Fail
0.3012	155	2293	1479	Fail
0.3089	149	2133	1431	Fail
0.3166	135	1972	1460	Fail
0.3243	127	1799	1416	Fail
0.3319	120	1683	1402	Fail
0.3396	111	1538	1385	Fail
0.3473	100	1429	1429	Fail
0.3550	92	1320	1434	Fail
0.3627	86	1222	1420	Fail
0.3704	82	1140	1390	Fail
0.3781	77	1048	1361	Fail
0.3858	68	976	1435	Fail
0.3935	62	911	1469	Fail
0.4011	53	841	1586	Fail
0.4088	49	780	1591	Fail
0.4165	46	713	1550	Fail
0.4242	42	665	1583	Fail
0.4319	40	624	1560	Fail
0.4396	36	590	1638	Fail
0.4473	35	545	1557	Fail
0.4550	29	509	1755	Fail
0.4626	25	472	1887	Fail
0.4703	22	446	2027	Fail
0.4780	20	415	2075	Fail
0.4857	19	392	2063	Fail
0.4934	17	364	2141	Fail
0.5011	16	341	2131	Fail
0.5088	15	322	2146	Fail
0.5165	13	300	2307	Fail
0.5242	10	283	2830	Fail
0.5318	10	269	2690	Fail
0.5395	10	254	2540	Fail

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0.5472	10	242	2420	Fail
0.5549	10	233	2330	Fail
0.5626	10	207	2070	Fail
0.5703	9	194	2155	Fail
0.5780	9	182	2022	Fail
0.5857	9	176	1955	Fail
0.5934	8	170	2125	Fail
0.6010	8	159	1987	Fail
0.6087	8	146	1825	Fail
0.6164	8	140	1750	Fail
0.6241	6	128	2133	Fail
0.6318	6	119	1983	Fail
0.6395	6	114	1900	Fail
0.6472	6	105	1750	Fail
0.6549	5	99	1979	Fail
0.6625	5	96	1920	Fail
0.6702	4	92	2300	Fail
0.6779	4	88	2200	Fail
0.6856	4	84	2100	Fail
0.6933	4	79	1975	Fail
0.7010	4	76	1900	Fail
0.7087	4	74	1850	Fail
0.7164	4	72	1800	Fail
0.7241	4	67	1675	Fail
0.7317	4	63	1575	Fail
0.7394	4	60	1500	Fail
0.7471	4	59	1475	Fail
0.7548	4	56	1400	Fail
0.7625	4	54	1350	Fail
0.7702	4	54	1350	Fail
0.7779	4	52	1300	Fail
0.7856	4	49	1225	Fail
0.7932	4	47	1175	Fail
0.8009	4	46	1150	Fail
0.8086	4	43	1075	Fail
0.8163	4	42	1050	Fail
0.8240	4	39	975	Fail
0.8317	4	39	975	Fail
0.8394	4	34	850	Fail
0.8471	4	34	850	Fail
0.8548	4	32	800	Fail
0.8624	4	31	775	Fail
0.8701	4	31	775	Fail
0.8778	4	31	775	Fail
0.8855	4	30	750	Fail
0.8932	3	28	933	Fail

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The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0.1094 acre-feet
On-line facility target flow:	0.0764 cfs.
Adjusted for 15 min:	0.0764 cfs.
Off-line facility target flow:	0.0399 cfs.
Adjusted for 15 min:	0.0399 cfs.

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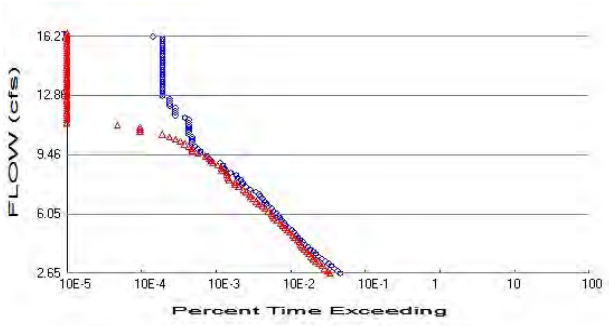
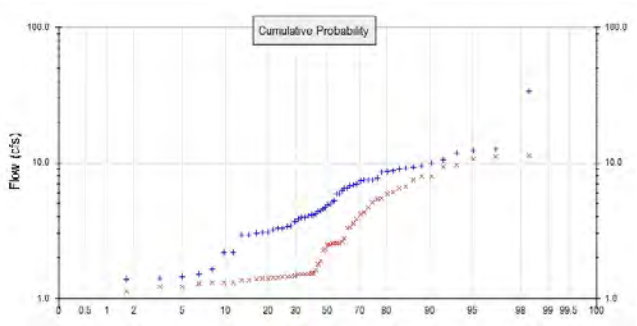
POC 3





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #3
Total Pervious Area: 34.484
Total Impervious Area: 0

Mitigated Landuse Totals for POC #3
Total Pervious Area: 15.604
Total Impervious Area: 18.88

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #3

Return Period	**Flow(cfs)**
2 year	5.294839
5 year	9.469017
10 year	11.957379
25 year	14.624914
50 year	16.2692
100 year	17.652006

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Flow Frequency Return Periods for Mitigated. POC #3

Return Period	**Flow(cfs)**	
2 year	2.522769	POC #3 WQ Flow Rate = Full 2-yr
5 year	4.736759	
10 year	6.769106	
25 year	10.120764	
50 year	13.282045	
100 year	17.099624	

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #3

Year	**Predeveloped**	**Mitigated**
1949	4.150	5.101
1950	4.448	3.275
1951	8.526	4.653
1952	4.984	3.315
1953	4.145	1.609
1954	5.908	1.903
1955	3.059	1.424
1956	11.706	9.600
1957	6.467	1.501
1958	4.066	2.531
1959	2.936	1.309

1960	3.281	1.405
1961	6.951	5.417
1962	4.340	1.359
1963	4.576	1.511
1964	9.482	2.542
1965	5.235	6.488
1966	5.201	2.234
1967	4.661	1.446
1968	6.807	2.488
1969	5.850	3.566
1970	33.807	11.264
1971	3.286	1.394
1972	7.501	2.557
1973	3.852	1.790
1974	12.694	11.163
1975	6.209	2.562
1976	8.709	2.624
1977	0.056	1.226
1978	7.709	7.920
1979	3.929	1.521
1980	3.934	1.515
1981	9.989	7.459
1982	8.653	7.904
1983	12.259	4.155
1984	3.081	1.503
1985	2.166	2.303
1986	3.186	1.300
1987	7.421	6.643
1988	1.650	1.464
1989	2.169	1.221
1990	1.382	1.287
1991	3.692	1.426
1992	4.204	1.303
1993	7.467	2.771
1994	6.894	5.504
1995	3.423	5.845
1996	10.572	9.421
1997	9.290	10.701
1998	7.497	1.383
1999	4.909	6.009
2000	3.001	1.111
2001	1.405	1.022
2002	9.075	1.518
2003	9.011	3.848
2004	1.504	1.356
2005	1.440	1.449
2006	6.494	1.444
2007	3.357	4.285
2008	2.930	2.480

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #3

Rank	Predeveloped	Mitigated
1	33.8072	11.2638
2	12.6944	11.1628
3	12.2591	10.7007
4	11.7059	9.6002
5	10.5715	9.4205

6	9.9892	7.9202
7	9.4819	7.9041
8	9.2904	7.4594
9	9.0745	6.6429
10	9.0110	6.4876
11	8.7094	6.0086
12	8.6528	5.8446
13	8.5256	5.5040
14	7.7087	5.4171
15	7.5012	5.1005
16	7.4968	4.6533
17	7.4667	4.2846
18	7.4211	4.1549
19	6.9509	3.8480
20	6.8943	3.5662
21	6.8073	3.3147
22	6.4936	3.2753
23	6.4674	2.7707
24	6.2086	2.6242
25	5.9084	2.5625
26	5.8500	2.5572
27	5.2345	2.5417
28	5.2009	2.5313
29	4.9842	2.4885
30	4.9092	2.4798
31	4.6614	2.3034
32	4.5764	2.2339
33	4.4476	1.9027
34	4.3403	1.7897
35	4.2039	1.6088
36	4.1497	1.5214
37	4.1450	1.5180
38	4.0655	1.5154
39	3.9338	1.5109
40	3.9290	1.5032
41	3.8520	1.5013
42	3.6920	1.4635
43	3.4228	1.4490
44	3.3567	1.4464
45	3.2859	1.4435
46	3.2810	1.4255
47	3.1859	1.4241
48	3.0812	1.4047
49	3.0594	1.3945
50	3.0012	1.3835
51	2.9363	1.3590
52	2.9304	1.3556
53	2.1694	1.3086
54	2.1661	1.3033
55	1.6496	1.3001
56	1.5037	1.2868
57	1.4398	1.2258
58	1.4054	1.2213
59	1.3819	1.1111
60	0.0559	1.0220

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Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
2.6474	977	706	72	Pass
2.7850	891	659	73	Pass
2.9226	806	599	74	Pass
3.0602	739	550	74	Pass
3.1978	677	503	74	Pass
3.3354	606	457	75	Pass
3.4730	545	423	77	Pass
3.6106	494	395	79	Pass
3.7482	457	365	79	Pass
3.8858	424	341	80	Pass
4.0234	383	316	82	Pass
4.1610	356	302	84	Pass
4.2985	323	288	89	Pass
4.4361	306	275	89	Pass
4.5737	281	258	91	Pass
4.7113	261	236	90	Pass
4.8489	248	223	89	Pass
4.9865	230	203	88	Pass
5.1241	216	189	87	Pass
5.2617	194	176	90	Pass
5.3993	179	164	91	Pass
5.5369	173	152	87	Pass
5.6745	160	136	85	Pass
5.8121	150	126	84	Pass
5.9497	142	120	84	Pass
6.0873	136	115	84	Pass
6.2249	125	105	84	Pass
6.3625	117	95	81	Pass
6.5000	105	88	83	Pass
6.6376	100	78	78	Pass
6.7752	95	73	76	Pass
6.9128	88	66	75	Pass
7.0504	83	61	73	Pass
7.1880	79	59	74	Pass
7.3256	72	53	73	Pass
7.4632	61	49	80	Pass
7.6008	52	42	80	Pass
7.7384	47	38	80	Pass
7.8760	47	38	80	Pass
8.0136	45	32	71	Pass
8.1512	41	30	73	Pass
8.2888	39	29	74	Pass
8.4264	33	29	87	Pass
8.5640	28	25	89	Pass
8.7015	27	25	92	Pass
8.8391	26	22	84	Pass
8.9767	24	19	79	Pass
9.1143	18	18	100	Pass
9.2519	17	17	100	Pass
9.3895	16	15	93	Pass
9.5271	13	12	92	Pass
9.6647	13	10	76	Pass
9.8023	12	10	83	Pass

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9.9399	11	9	81	Pass
10.0775	10	8	80	Pass
10.2151	10	7	70	Pass
10.3527	10	6	60	Pass
10.4903	10	5	50	Pass
10.6279	9	4	44	Pass
10.7655	9	2	22	Pass
10.9030	9	2	22	Pass
11.0406	9	2	22	Pass
11.1782	9	1	11	Pass
11.3158	9	0	0	Pass
11.4534	9	0	0	Pass
11.5910	8	0	0	Pass
11.7286	6	0	0	Pass
11.8662	6	0	0	Pass
12.0038	6	0	0	Pass
12.1414	6	0	0	Pass
12.2790	5	0	0	Pass
12.4166	5	0	0	Pass
12.5542	5	0	0	Pass
12.6918	5	0	0	Pass
12.8294	4	0	0	Pass
12.9670	4	0	0	Pass
13.1045	4	0	0	Pass
13.2421	4	0	0	Pass
13.3797	4	0	0	Pass
13.5173	4	0	0	Pass
13.6549	4	0	0	Pass
13.7925	4	0	0	Pass
13.9301	4	0	0	Pass
14.0677	4	0	0	Pass
14.2053	4	0	0	Pass
14.3429	4	0	0	Pass
14.4805	4	0	0	Pass
14.6181	4	0	0	Pass
14.7557	4	0	0	Pass
14.8933	4	0	0	Pass
15.0309	4	0	0	Pass
15.1685	4	0	0	Pass
15.3060	4	0	0	Pass
15.4436	4	0	0	Pass
15.5812	4	0	0	Pass
15.7188	4	0	0	Pass
15.8564	4	0	0	Pass
15.9940	4	0	0	Pass
16.1316	4	0	0	Pass
16.2692	3	0	0	Pass

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Water Quality

Water Quality BMP Flow and Volume for POC #3
On-line facility volume: 0 acre-feet
On-line facility target flow: 0 cfs.
Adjusted for 15 min: 0 cfs.
Off-line facility target flow: 0 cfs.
Adjusted for 15 min: 0 cfs.

POC #3 WQ Flow Rate = Full 2-yr flow

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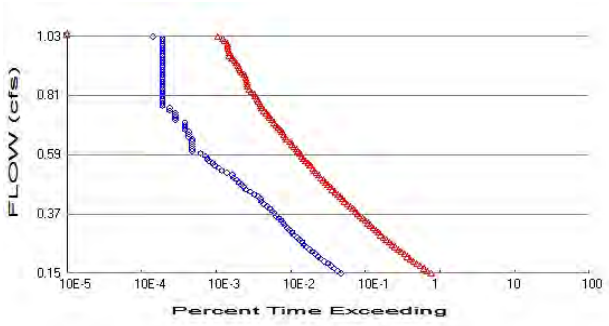
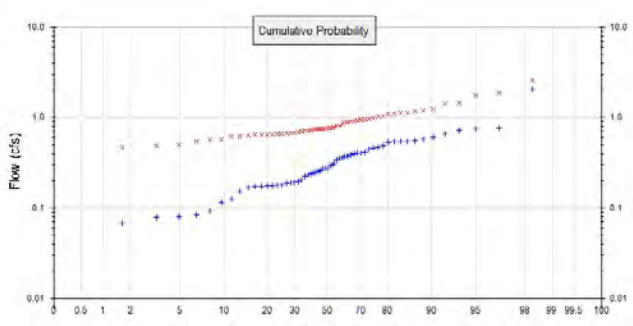
POC 4





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #4
Total Pervious Area: 2.186
Total Impervious Area: 0

Mitigated Landuse Totals for POC #4
Total Pervious Area: 0.62
Total Impervious Area: 1.566

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #4

Return Period	Flow(cfs)
2 year	0.305455
5 year	0.574091
10 year	0.739561
25 year	0.920254
50 year	1.033086
100 year	1.128738

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Flow Frequency Return Periods for Mitigated. POC #4

Return Period	Flow(cfs)
2 year	0.792081
5 year	1.079128
10 year	1.294511
25 year	1.597014
50 year	1.845479
100 year	2.114687

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #4

Year	Predeveloped	Mitigated
1949	0.245	1.183
1950	0.258	0.619
1951	0.493	0.908
1952	0.298	0.951
1953	0.249	0.725
1954	0.340	0.921
1955	0.177	0.548
1956	0.720	0.960
1957	0.368	0.723
1958	0.224	0.948
1959	0.168	0.570

1960	0.195	0.681
1961	0.408	0.749
1962	0.237	0.766
1963	0.275	0.650
1964	0.580	0.823
1965	0.311	0.680
1966	0.291	0.644
1967	0.278	0.780
1968	0.390	1.440
1969	0.356	1.107
1970	2.093	2.585
1971	0.180	0.985
1972	0.451	0.750
1973	0.194	0.843
1974	0.771	1.094
1975	0.354	0.720
1976	0.539	0.767
1977	0.002	0.376
1978	0.469	0.743
1979	0.152	1.039
1980	0.234	0.566
1981	0.604	0.900
1982	0.529	1.025
1983	0.755	1.121
1984	0.171	0.654
1985	0.115	0.669
1986	0.181	1.186
1987	0.455	0.617
1988	0.093	0.640
1989	0.126	0.696
1990	0.079	0.491
1991	0.206	0.750
1992	0.251	0.638
1993	0.417	1.120
1994	0.394	0.745
1995	0.190	0.894
1996	0.657	1.864
1997	0.544	1.406
1998	0.402	1.258
1999	0.274	0.655
2000	0.176	0.468
2001	0.080	0.496
2002	0.558	0.894
2003	0.549	0.820
2004	0.083	0.676
2005	0.067	0.649
2006	0.373	0.730
2007	0.189	0.772
2008	0.172	1.766

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Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #4

Rank	Predeveloped	Mitigated
1	2.0927	2.5849
2	0.7710	1.8637
3	0.7546	1.7663
4	0.7200	1.4397
5	0.6568	1.4055

6	0.6037	1.2584
7	0.5800	1.1856
8	0.5576	1.1835
9	0.5487	1.1211
10	0.5436	1.1195
11	0.5394	1.1066
12	0.5288	1.0945
13	0.4930	1.0393
14	0.4687	1.0251
15	0.4547	0.9845
16	0.4506	0.9604
17	0.4173	0.9506
18	0.4082	0.9483
19	0.4020	0.9212
20	0.3940	0.9078
21	0.3897	0.9004
22	0.3727	0.8944
23	0.3682	0.8939
24	0.3564	0.8427
25	0.3536	0.8235
26	0.3404	0.8199
27	0.3112	0.7802
28	0.2976	0.7722
29	0.2915	0.7670
30	0.2778	0.7656
31	0.2746	0.7505
32	0.2739	0.7503
33	0.2584	0.7487
34	0.2512	0.7453
35	0.2487	0.7427
36	0.2446	0.7298
37	0.2365	0.7246
38	0.2343	0.7228
39	0.2237	0.7202
40	0.2058	0.6963
41	0.1949	0.6812
42	0.1939	0.6802
43	0.1902	0.6763
44	0.1894	0.6691
45	0.1811	0.6549
46	0.1796	0.6539
47	0.1768	0.6503
48	0.1757	0.6489
49	0.1717	0.6438
50	0.1712	0.6399
51	0.1677	0.6382
52	0.1522	0.6188
53	0.1263	0.6174
54	0.1149	0.5704
55	0.0929	0.5664
56	0.0831	0.5485
57	0.0804	0.4961
58	0.0787	0.4910
59	0.0671	0.4676
60	0.0019	0.3762

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Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1527	983	16025	1630	Fail
0.1616	892	14291	1602	Fail
0.1705	808	12772	1580	Fail
0.1794	726	11447	1576	Fail
0.1883	665	10263	1543	Fail
0.1972	590	9263	1570	Fail
0.2061	536	8371	1561	Fail
0.2150	490	7715	1574	Fail
0.2239	447	7010	1568	Fail
0.2328	412	6381	1548	Fail
0.2417	380	5771	1518	Fail
0.2505	341	5274	1546	Fail
0.2594	320	4801	1500	Fail
0.2683	299	4399	1471	Fail
0.2772	276	4004	1450	Fail
0.2861	255	3667	1438	Fail
0.2950	230	3379	1469	Fail
0.3039	220	3145	1429	Fail
0.3128	204	2903	1423	Fail
0.3217	190	2684	1412	Fail
0.3306	178	2472	1388	Fail
0.3395	167	2276	1362	Fail
0.3484	156	2103	1348	Fail
0.3573	146	1932	1323	Fail
0.3661	135	1772	1312	Fail
0.3750	127	1656	1303	Fail
0.3839	120	1534	1278	Fail
0.3928	111	1422	1281	Fail
0.4017	101	1313	1300	Fail
0.4106	92	1205	1309	Fail
0.4195	86	1104	1283	Fail
0.4284	82	1029	1254	Fail
0.4373	77	963	1250	Fail
0.4462	68	896	1317	Fail
0.4551	60	828	1380	Fail
0.4640	53	765	1443	Fail
0.4729	49	710	1448	Fail
0.4818	46	658	1430	Fail
0.4906	42	617	1469	Fail
0.4995	40	570	1425	Fail
0.5084	36	529	1469	Fail
0.5173	35	498	1422	Fail
0.5262	29	459	1582	Fail
0.5351	25	433	1732	Fail
0.5440	23	416	1808	Fail
0.5529	20	384	1920	Fail
0.5618	19	361	1900	Fail
0.5707	17	330	1941	Fail
0.5796	16	309	1931	Fail
0.5885	15	293	1953	Fail
0.5974	13	280	2153	Fail
0.6062	10	263	2630	Fail
0.6151	10	251	2510	Fail
0.6240	10	232	2320	Fail

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0.6329	10	219	2190	Fail
0.6418	10	204	2040	Fail
0.6507	10	186	1860	Fail
0.6596	9	177	1966	Fail
0.6685	9	169	1877	Fail
0.6774	9	162	1800	Fail
0.6863	8	152	1900	Fail
0.6952	8	143	1787	Fail
0.7041	8	133	1662	Fail
0.7130	8	126	1575	Fail
0.7218	6	117	1950	Fail
0.7307	6	108	1800	Fail
0.7396	6	107	1783	Fail
0.7485	6	99	1650	Fail
0.7574	5	93	1860	Fail
0.7663	5	86	1720	Fail
0.7752	4	83	2075	Fail
0.7841	4	82	2050	Fail
0.7930	4	78	1950	Fail
0.8019	4	74	1850	Fail
0.8108	4	70	1750	Fail
0.8197	4	69	1725	Fail
0.8286	4	62	1550	Fail
0.8375	4	58	1450	Fail
0.8463	4	55	1375	Fail
0.8552	4	55	1375	Fail
0.8641	4	54	1350	Fail
0.8730	4	54	1350	Fail
0.8819	4	52	1300	Fail
0.8908	4	50	1250	Fail
0.8997	4	46	1150	Fail
0.9086	4	44	1100	Fail
0.9175	4	43	1075	Fail
0.9264	4	41	1025	Fail
0.9353	4	39	975	Fail
0.9442	4	37	925	Fail
0.9531	4	34	850	Fail
0.9619	4	32	800	Fail
0.9708	4	32	800	Fail
0.9797	4	31	775	Fail
0.9886	4	30	750	Fail
0.9975	4	30	750	Fail
1.0064	4	30	750	Fail
1.0153	4	27	675	Fail
1.0242	4	26	650	Fail
1.0331	3	22	733	Fail

DRAFT

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #4

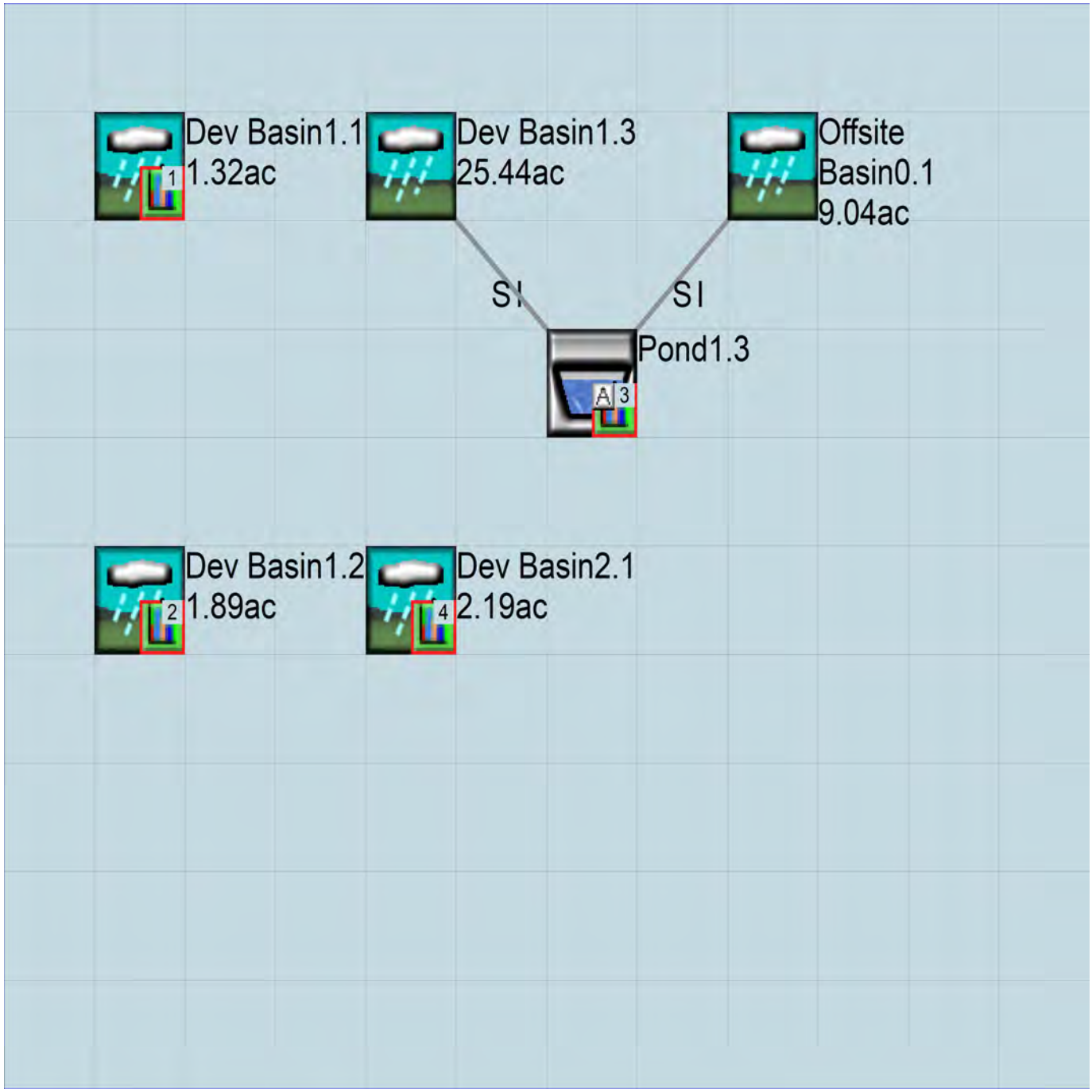
On-line facility volume:	0.2271 acre-feet
On-line facility target flow:	0.3112 cfs.
Adjusted for 15 min:	0.3112 cfs.
Off-line facility target flow:	0.1701 cfs.
Adjusted for 15 min:	0.1701 cfs.

DRAFT

Appendix
Predeveloped Schematic



Mitigated Schematic



Disclaimer

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DRAFT



Swale1.3 WQ

Subcat Reach Pond Link

Routing Diagram for 4373 Swale-PRELIM
Prepared by HP Inc., Printed 2/3/2020
HydroCAD® 10.00-22 s/n 05095 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.000	**0**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
0.000		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SBUH method, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Reach S1-WQ: Swale1.3 WQ Avg. Flow Depth=0.33' Max Vel=0.45 fps Inflow=2.52 cfs 3.134 af
n=0.240 L=250.0' S=0.0250 '/' Capacity=57.34 cfs Outflow=2.52 cfs 3.065 af

Summary for Reach S1-WQ: Swale1.3 WQ

Inflow = 2.52 cfs @ 5.00 hrs, Volume= 3.134 af, Incl. 2.52 cfs Base Flow
Outflow = 2.52 cfs @ 8.70 hrs, Volume= 3.065 af, Atten= 0%, Lag= 222.0 min

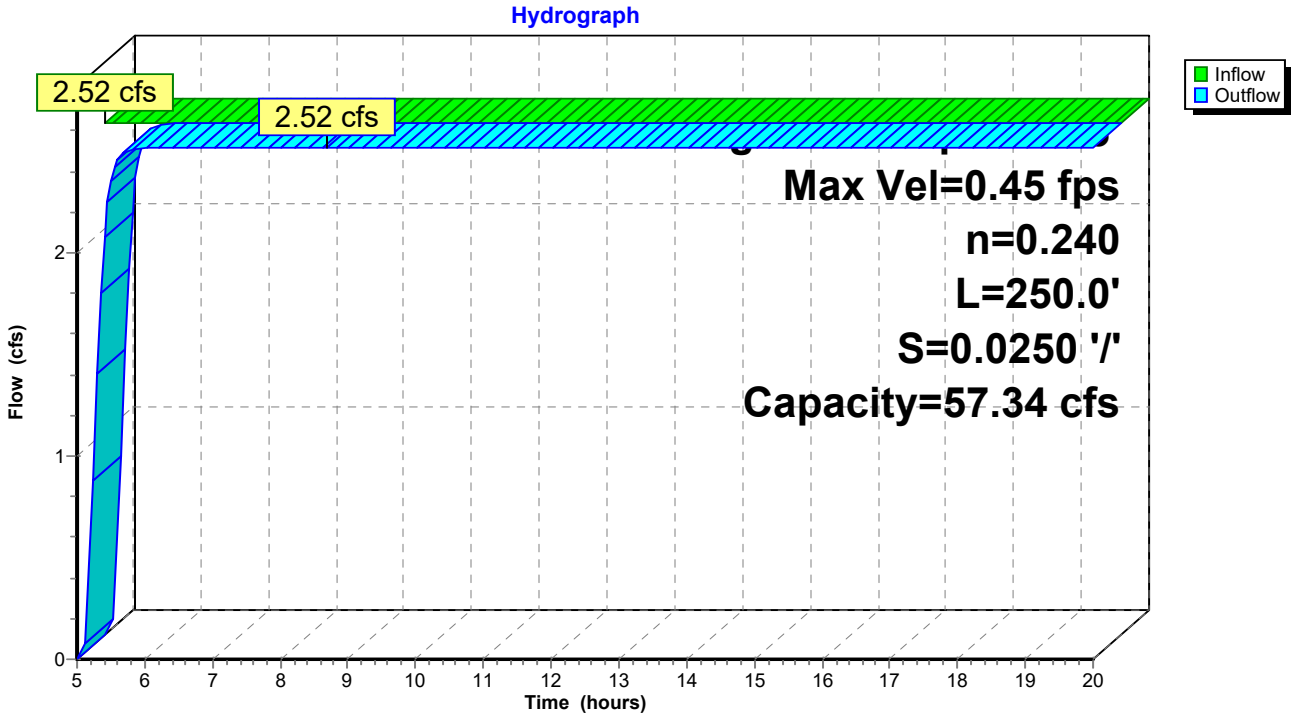
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.45 fps, Min. Travel Time= 9.3 min
Avg. Velocity = 0.45 fps, Avg. Travel Time= 9.3 min

Peak Storage= 1,403 cf @ 8.55 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 2.00' Flow Area= 44.0 sf, Capacity= 57.34 cfs

16.00' x 2.00' deep channel, n= 0.240
Side Slope Z-value= 3.0 '/' Top Width= 28.00'
Length= 250.0' Slope= 0.0250 '/'
Inlet Invert= 0.00', Outlet Invert= -6.25'



‡



Appendix G:
Soils Report

GEOTECHNICAL ENGINEERING STUDY

Proposed 179th Street Residential Subdivision
NW 179th Street & NW 11th Avenue
Ridgefield, Clark County, Washington
Tax Lot No's (182170000, 182168000 & 182164000)

Prepared for:

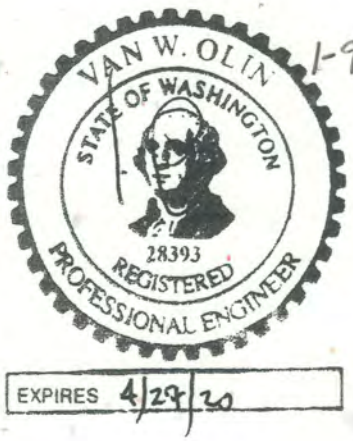
BTMC, LLC
7701 NE Greenwood Drive
Vancouver, Washington 98662

Prepared By:



Donald J. Bruno, EG
Engineering Geologist

Van W. Olin, PE
Project Engineer



Project No. G56-0515.18

{January 2019}

Earth Engineering, Inc.
PO Box 1512, Ridgefield, Washington 98642
(360) 600-6518

Earth Engineering, Inc.
Geotechnical & Environmental Consultants

Terry Wollam
BTMC, LLC
7701 NE Greenwood Drive
Vancouver, WA 98662

January 9th 2019
G56-0515.18

Subject: **Geotechnical Engineering Study**
Proposed Residential Subdivision
NW 179th St. & NW 11th Ave., Ridgefield, Clark County, Washington
(Parcel No.'s 182170000, 68000 & 64000)

Hello Terry,

We are pleased to submit our engineering report for the subject property located in Ridgefield, Washington. This report presents the results of our field exploration, selective laboratory tests, field infiltration testing and engineering analyses.

Based on the results of this study, it is our opinion that construction of the proposed residential development is feasible from a geotechnical standpoint, provided recommendations presented in this report are included in the project design.

We appreciate the opportunity to have been of service to you and look forward to working with you in the future. Should you have any questions about the content of this report, or if we can be of further assistance, please call.

Respectfully Submitted,
Earth Engineering Inc.,

Donald J. Bruno, EG
Engineering Geologist

Van W. Olin, PE
Project Engineer

INTRODUCTION

General

This report presents the results of the geotechnical engineering study completed by Earth Engineering, Inc. (EEI) for the proposed residential subdivision located in Ridgefield, Washington. The general location of the site is shown on the *Vicinity Map, Figure 1.* At the time our study was performed, the site and our exploratory locations were approximately as shown on the *Site Plan, Figure 2.*

The purpose of this study was to explore subsurface conditions at the site and based on the conditions encountered, provide geotechnical recommendations for the proposed construction.

Project Description

Based on the information that was provided to us by the project civil engineer (AKS) it is our understanding the proposed residential subdivision will consist of three hundred and fifteen (315) lots that will range from about 2800 to 3200 square feet in size. Site development will also include construction of a storm water system, subsurface utilities and asphalt-paved roadways.

Although no specific grading plan was available during the time of our study, some grading may be required for building pad and roadway construction. We anticipate cuts and fills up to eight feet. The residential buildings will most likely be constructed with wood frames, suspended floors and slab-on-grade garage floors.

It should be noted that due to the topography across the site it is possible that a daylight type basement foundation may be constructed at some of these lots. EEI should be contacted so we can provide basement retaining wall parameters specific to the proposed construction for each sloping lot.

Structural design loads were not available at the time this report was written. However, based on our experience with similar projects, we anticipate that wall and column loads will be approximately seven hundred and fifty (750) to one thousand five hundred (1500) pounds per lineal foot (maximum dead plus live loads). Slab-on-grade garage floor loads will most likely range from one hundred (100) to one hundred fifty (150) pounds per square foot (psf).

If any of the above information is incorrect or changes, we should be consulted to review the recommendations contained in this report. In any case, it is recommended that Earth Engineering, Inc. perform a general review of the final design for the proposed construction at each lot.

SITE CONDITIONS

Surface

The square shaped properties encompass approximately thirty eight (38) acres. An existing residence is located at the northeast area of the site. The adjacent properties consist of residences and small farms on acreage. A fire station facility is located along the northeast side of the site.

In general, the northern half slopes moderately downward from the north-northeast to the south-southwest to an east-west trending drainage channel. Gradients at the northern half range from about eight to thirteen percent (8-13%).

The western three-quarter section of the southern half slopes gently to moderately downward from a ridgeline to the north, south, east and west. Gradients at the southern half range from about six to seven percent (6-7%).

The northern half and southwest areas of the site are covered predominantly with pasture grass and some isolated areas of trees (evergreen and deciduous). The southeastern two-thirds section is heavily vegetated with trees and undergrowth.

Subsurface

For this study the site was explored by excavating twelve (12) test pits. Three of the pits were used for infiltration testing. The approximate locations of these test pits are shown on the *Site Plan, Figure 2.* All soil was classified following the Unified Soil Classification System (USCS). A USCS Legend is included as Plate A1. A description of the field exploration methods is included in Appendix A.

In general in our test pits we encountered approximately eight to eighteen (18) inches of organic duff and topsoil. The topsoil is underlain by stiff to very stiff native elastic Silt (MH) and lean Clay (CL) to the maximum exploration depth of ten feet below the existing ground surface. Please refer to the test pit logs, Plates A2 thru A13, for a more detailed description of the conditions encountered.

Groundwater

During the time of our field exploration (June 2015 and November 2018) heavy groundwater seepage was encountered in test pits TP-3 and TP-4. It should be noted these test pits are located along the lower elevation central drainage channel, at a depth of approximately three feet below the existing ground surface. Groundwater was not encountered in any other test pits.

Groundwater conditions are not static; fluctuations may be expected in the level and seepage flow depending on the season, amount of rainfall, surface water runoff, and other factors. Generally, the groundwater level is higher and seepage rate is greater in the wetter winter months (typically October through May).

General Regional Geology

General information about geologic conditions and soil in the vicinity of the site was obtained by reviewing the Geologic Map of Washington-Southwest Quadrant, Washington Division of Geology and Earth Resources, (Geologic Map GM-34, 1987). This map provides general information about geologic units in the Vancouver, Clark County, Washington area.

Our review of existing geological information indicates that soils in the vicinity of the subject site were formed from alluvial deposits during the Quaternary Period. Outburst flood deposits from glacial Lake Missoula deposited these sedimentary soils. The material encountered in our test pits consists predominantly fine grained elastic silt and lean clay.

LABORATORY TESTING

Laboratory tests were conducted on representative soil samples to verify or modify the field soil classification of the units encountered, and to evaluate the general physical properties as well as the engineering characteristics of the soils encountered. The following provides information about the testing procedures performed on representative soil samples and the general condition of subsurface soil conditions encountered:

- Moisture Content (ASTM-D2216-92) tests were performed on representative samples. The native elastic silt and lean clay has a moisture content ranging from seventeen to thirty-five percent (17-35%). The native organic silt (TP-3 & TP-4) has an average moisture content ranging from forty five to forty nine percent (45-49%).

- In-Situ Soil Density (ASTM-D4564-93) utilizing the sleeve method was performed on representative samples to determine the wet and dry density of native soil. The in-situ density provides a relative indication of soil support characteristics. The average wet density of the native elastic silt and lean clay is approximately one hundred and fifteen (115) pounds per cubic foot (pcf). The average dry density of this soil is ninety-two (92) pcf.

Laboratory testing confirms that subsurface soil consists predominantly of elastic silt and lean clay. All soils encountered are sensitive to changes in moisture content. Moisture sensitive soils are discussed in more detail in the *Site Preparation and Grading* section of this report.

The results of laboratory tests performed on specific samples are provided at the appropriate sample depth on the individual test pit logs. However, it is important to note that some variation of subsurface conditions may exist. Our geotechnical recommendations are based on our interpretation of these test results.

SEISMIC HAZARD EVALUATION

The following provides a seismic hazard evaluation for the subject site. Our evaluation is based on subsurface conditions encountered at the site during the time of our geotechnical study and a review of applicable geologic maps (Washington Department of Natural Resources, Geologic Map of Washington-Southwest Quadrant, 1987) and the International Building Code (IBC-2006) guidelines.

In general, supportive soil at the subject site consists predominantly of elastic silt and lean clay. Groundwater was only encountered along the central drainage channel. Near surface groundwater was not encountered at any other areas of the site. Geologic map indicates that no known active faults are located within one-mile of the subject site. Soils encountered at the site are classified as a type "D" soil in accordance with "Site Class Definitions (IBC 2006, Section 1613, Table 1613.5.2; page 303). For more detail regarding soil conditions refer to the test pit logs in Appendix A of this report.

Liquefaction:

Structures are subject to damage from earthquakes due to direct and indirect action. Shaking represents direct action. Indirect action is represented by foundation failures and is typified by liquefaction. Liquefaction occurs when soil loses all shear strength for short periods of time during an earthquake.

Ground shaking of sufficient duration results in the loss of grain to grain contact as well as a rapid increase in pore water pressure. This causes the soil to assume physical properties of a fluid. To have potential for liquefaction a soil must be loose, cohesion-less (generally sands and silts), below the groundwater table, and must be subjected to sufficient magnitude and duration of ground shaking. The effects of liquefaction may be large total settlement and/or large differential settlement for structures with foundations in or above the liquefied soil.

Based on the predominance of very stiff soil conditions (exclusive of the central drainage channel) and the absence of a near surface groundwater table, it is not likely that soil liquefaction would occur at the subject site during a seismic event. However, soils encountered along the central drainage channel (organic silt) have a high potential for liquefaction due to their water bearing condition and high groundwater table.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our study, it is our opinion the residential subdivision plat can be developed as planned provided the geotechnical recommendations contained in this report are incorporated into the final design. The proposed buildings can be supported on conventional shallow spread footings bearing either entirely on competent native soil or compacted structural fill. Supporting the proposed buildings on homogeneous material will significantly decrease the potential for differential settlement across the foundation area.

As previously discussed the central drainage channel is underlain by liquefiable soil. These soils will not provide adequate support for structural fill, building foundations or pavements. Preliminary plans indicate the channel will not be impacted by site grading and no building or pavements are planned to be constructed at this area. However, if unsuitable soil is encountered near the drainage channel or at any other areas of the site, it will be necessary to remove the unsuitable soil and replace the material with compacted structural fill.

This report has been prepared for specific application to this project only and in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area for the exclusive use of BTMC, LLC and their representatives. This report, in its entirety, should be included in the project documents for information to the contractor. No warranty, expressed or implied, is made.

Site Preparation and Grading

The site shall be stripped and cleared of all vegetation, organic matter and any other deleterious material. Stripped material should not be mixed with any soils to be used as fill. Stripped soil could potentially be used for topsoil at landscape areas after removing vegetation and screening out organic matter.

Building & Roadway Areas:

After clearing and grading, the building and pavement areas should be compacted to a dense non-yielding condition with suitable vibratory compaction equipment. This phase of earthwork compaction shall be performed prior to the placement of any structural fill, at the bottom of all foundation excavations, floor slab areas and driveways, before the placement of base rock.

Structural Fill:

Structural fill is defined as any soil placed under buildings or any other load bearing-areas. Structural fill placed under footings and slab on grade should be placed in thin horizontal lifts not exceeding eight inches and compacted to a minimum ninety-five percent (95%) of its maximum dry density (Modified Proctor ASTM D1557). The fill material should be placed within two to three percent of the optimum moisture content.

Fill under pavements should also be placed in lifts approximately eight inches in thickness, and compacted to a minimum of ninety percent (90%) of its maximum dry density (Modified Proctor ASTM D1557), except for the top twelve (12) inches which should be compacted to ninety-five percent (95%) of the maximum dry density.

We recommend that structural fill consist of a well graded granular material having a maximum size of two inches and no more than five percent (5%) fines passing the #200 sieve, based on the ¾ inch fraction. It is recommended that any structural fill planned for onsite use, be submitted for approval prior to import.

The placement and compaction of structural fill should be observed by a representative from our office to verify that fill has been placed and compacted in accordance with the approved project plans and specifications. It should be noted that the depth of excavation to competent soil at foundation footings and floor slab areas could be greater or less than anticipated depending on conditions encountered. Our test pits provide general information about subsurface soil and groundwater conditions.

Wet Weather Construction & Moisture Sensitive Soils:

Field observations and laboratory testing indicates that soil encountered at the site consists predominantly of moisture sensitive elastic silt and lean clay. As such in an exposed condition moisture sensitive soil can become disturbed during normal construction activity, especially when in a wet or saturated condition. Once disturbed, in a wet condition, these soils will be unsuitable for support of foundations, floor slabs and pavements.

Slab on Grade

The sub-grade for all concrete floor slab areas should be compacted to a dense non-yielding condition prior to the placement of base rock. It is important to note that the existing sub-grade soil may become too wet to re-compact due to weather conditions. If supportive soils become saturated it may be necessary to remove the unsuitable material and replace it with imported granular structural fill.

Interior floor slabs should be provided with a minimum of eight inches of compacted granular structural fill after compacting the sub-grade. In areas where moisture is undesirable, a vapor barrier such as an 8-mil plastic membrane should be placed beneath the slab.

Temporary Excavations

The following information is provided solely as a service to our client. Under no circumstances should this information be interpreted to mean that Earth Engineering, Inc. is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

In no case should excavation slopes be greater than the limits specified in local, state and federal safety regulations. Based on the information obtained from our field exploration and laboratory testing, the site soils expected to be encountered in excavations, stiff to very stiff elastic silt and lean clay would be classified as a Type "A" soil by OSHA guidelines.

Therefore, temporary excavations and cuts greater than four feet in height, should be sloped at an inclination no steeper than 3/4H:1V (horizontal:vertical) for type "A" soils. If slopes of this inclination, or flatter, cannot be constructed or if excavations greater than ten feet in depth are required, temporary shoring will be necessary.

Infiltration Testing

In June 2015, infiltration testing was performed at three locations at a depth of approximately four feet below the existing ground surface. The approximate location of the infiltration tests, I-1, I-2 and I-3 (also used for exploration test pits) is shown on the *Site Plan, Figure 2.*

Infiltration testing was conducted in general accordance with the Southwest Washington Storm Water Manual. The Encased Falling Head Test consists of driving a fifteen (15) inch long, six-inch diameter pipe six inches into the exposed ground surface at the bottom of the test pit. The pipe is filled with water as the soil around the bottom and below the pipe is saturated for several hours. The pipe is filled again and the amount of time required for the water to fall, per inch, for six inches, is recorded. This step is performed a minimum of three times. The test results are averaged and calculated in inches per hour.

It is important to note that this provides a relative indication of the average rate of groundwater infiltration at the site. The rate is dependent on the percentage of fines in the soil (i.e., silt and clay), the degree of soil saturation and the relative density of the in-situ soil.

Infiltration rates can vary across the site depending on conditions encountered. The following table provides the infiltration test results, soil classification and a summary of laboratory test results for soil encountered at the depth of proposed infiltration:

LOCATION	*USCS SOIL TYPE	AASHTO SOIL TYPE	DEPTH (FT.)	MOISTURE CONTENT %	% PASSING #200 SIEVE	FIELD INFILTRATION RATE	COEFFICIENT OF PERMEABILITY
I-1	MH-CL	A-7	4.0	23	100	0 iph	N/A
I-2	MH-CL	A-7	4.0	21	100	0 iph	N/A
I-3	MH-CL	A-7	4.0	23	100	0 iph	N/A

Based on the subsurface soil conditions encountered and our laboratory test results, it is our opinion the elastic silt (MH) and lean clay (CL), encountered in all of our test pits, is not suitable for storm water infiltration from the proposed development. It is important to note that some variation of subsurface conditions may exist. Our recommendations are based on our interpretation of these test results.

Site Drainage

The site should be graded so that surface water is directed off the site. Water should not be allowed to stand in any area where buildings or slabs are to be constructed. Loose surfaces should be sealed at the end of each workday by compacting the surface to reduce the potential for moisture infiltration into the soils. Final site grades should allow for drainage away from the building foundation. The ground should be sloped at a gradient of three percent for a distance of at least ten feet away from the buildings.

We recommend that a footing drain be installed around the perimeter of the buildings just below the invert of the footing with a gradient sufficient to initiate flow. Under no circumstances should the roof down spouts be connected to the footing drain system. We suggest that clean outs be installed at several accessible locations to allow for the periodic maintenance of the footing drain system. Details for the footing drain have been included on *Figure 3, Typical Footing Drain Detail.*

Interceptor Drain:

In addition to the foundation footing drains we recommend that an interceptor drain be installed adjacent to the toe of any slopes that have a downward gradient towards the proposed structures. This will facilitate in diverting stormwater away from the residences.

The drain should consist of a four-inch diameter perforated pipe with holes facing down and installed in an envelope of clean drain rock or pea gravel wrapped with free draining filter fabric. The drain should be a minimum of one foot wide and two feet deep with sufficient gradient to initiate flow. The drain should be routed to a suitable discharge area and rock spalls placed at the outlet to dissipate flow from the system.

A representative from our office can determine the location of the drains during construction at each individual lot. A *Typical Interceptor Drain Detail, Figure 4,* has been included with this report.

Utility Support and Back Fill

Based on the conditions encountered, the soil to be exposed by utility trenches should provide adequate support for utilities. Utility trench backfill is a concern in reducing the potential for settlement along utility alignments, particularly in pavement areas. It is also important that each section of utility line be adequately supported in the bedding material. The back fill material should be hand tamped to ensure support is provided around the pipe haunches.

Fill should be carefully placed and hand tamped to about twelve inches above the crown of the pipe before any compaction equipment is used. The remainder of the trench back fill should be placed in lifts having a loose thickness of eight inches.

A typical trench backfill section and compaction requirements for load supporting and non-load supporting areas is presented on *Figure 5, Utility Trench Backfill Detail.* Trench back fill may consist of imported granular fill provided the material is approved, placed and compacted near the optimum moisture content.

Imported granular material or on-site soil to be used as backfill should be submitted to our laboratory at least one week prior to construction so that we can provide a laboratory proctor for field density testing.

Pavements

The durability of pavements is related in part to the condition of the underlying sub grade. To provide a properly prepared sub grade for pavements, we recommend the sub grade be treated and prepared as described in the *Site Preparation and Grading* section of this report.

It is possible that some localized areas of soft, wet or unstable sub grade may still exist after this process. Before placement of any base rock, the sub grade should be compacted with suitable compaction equipment. Yielding areas that are identified should be excavated to firm material and replaced with compacted one and one quarter inch-minus clean-crushed rock. The following pavement sections are recommended for the proposed pavement areas:

- Three inches of Asphalt Concrete (AC) over ten inches of compacted Crushed Rock Base (CRB) material or,
- Three inches of Asphalt Concrete (AC) over eight inches of compacted Crushed Rock Base (CRB) material, over a geo-grid consisting of Tensar Triax or equivalent.

The geo-grid should be placed directly on the sub grade surface of the roadway prior to placement of base rock. Appropriate geo-textiles have been designed to increase the strength of the sub grade and extend pavement life.

Asphaltic Cement (AC) and Crushed Rock Base (CRB) materials should conform to WSDOT specifications. All base rock should be compacted to at least ninety five percent (95%) of the ASTM D1557-91 laboratory test standard.

We recommend that a minimum of eight inches of compacted CRB be placed below all exterior slabs. Exterior concrete slabs that are subject to vehicle traffic loads should be at least four inches in thickness. It is also suggested that nominal reinforcement such as "6x6-10/10" welded wire mesh be installed, near midpoint, in new exterior concrete slabs and paving. Fiber mesh concrete may be used in lieu of welded wire mesh.

Additional Services & Earthwork Monitoring

Earth Engineering, Inc. will be available to provide consultation services related to review of the final design to verify that the recommendations within our purview have been properly interpreted and implemented in the approved construction plans and specifications. A representative from our office will be available to attend a pre-construction meeting to discuss and/or clarify all geotechnical issues related to the proposed project.

In addition, it is suggested that our office be retained to provide geotechnical services during construction to observe compliance with the design concepts and project specifications and to allow design changes in the event subsurface conditions differ from those anticipated.

Our construction services would include monitoring and documenting the following:

- Laboratory proctor tests on structural fill and roadway area materials.
- Observe compaction and provide testing of structural fill at building & roadway areas.
- Observe compaction and provide testing of utility trench backfill.
- Observe excavation and condition of exposed bearing soils at the building areas.
- Provide footing inspection at buildings to verify soil-bearing capacity.
- Verify the installation of all building and site drainage elements.

LIMITATIONS

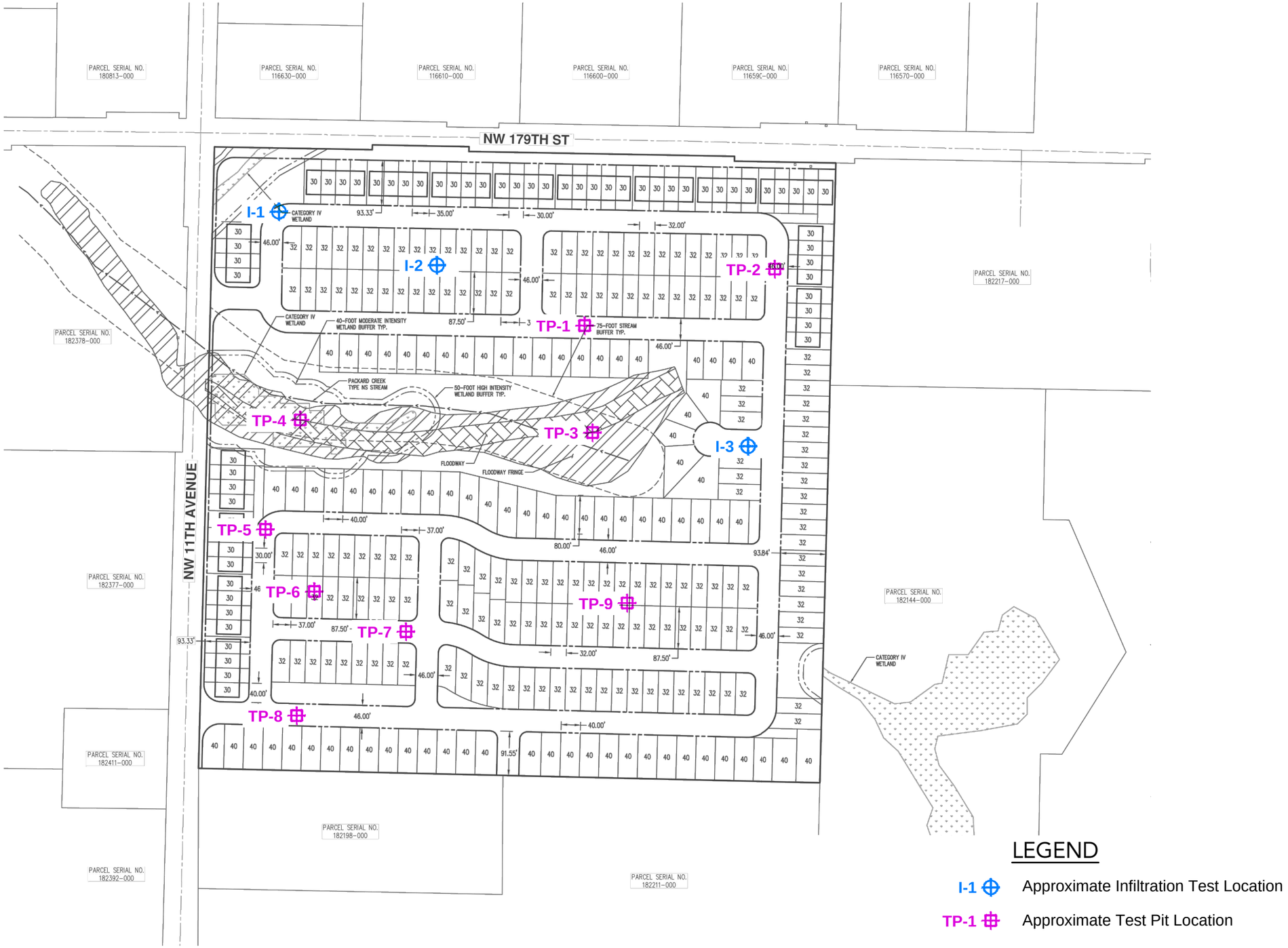
Our recommendations and conclusions are based on the site materials observed, selective laboratory testing, engineering analyses, the design information provided to Earth Engineering, Inc. and our experience as well as engineering judgment. The conclusions and recommendations are professional opinions derived in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty is expressed or implied.

The recommendations submitted in this report are based upon the data obtained from the test pit excavations. Soil and groundwater conditions may vary from those encountered. The nature and extent of variations may not become evident until construction. If variations do appear, Earth Engineering, Inc. should be requested to reevaluate the recommendations contained in this report and to modify or verify them in writing prior to proceeding with the proposed construction.

VICINITY MAP



Earth Engineering GEOTECHNICAL & ENVIRONMENTAL SERVICES	CLIENT: BTMC, LLC	DRAWN: CCK
	PROJECT: NW 179TH STREET SUBDIVISION NW 179TH STREET RIDGEFIELD, WA	DATE: 1/2019
		FIGURE: 1
		PRO. #: G56-0515.18



LEGEND

I-1 Approximate Infiltration Test Location

TP-1 Approximate Test Pit Location

Earth Engineering
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: WOLLAM & ASSOCIATES	DRAWN: CCK
PROJECT: NW 179TH STREET SUBDIVISION NW 179TH STREET RIDGEFIELD, WA	DATE: 1/2019
	FIGURE: 2
	PRO. #: G56-0515.18

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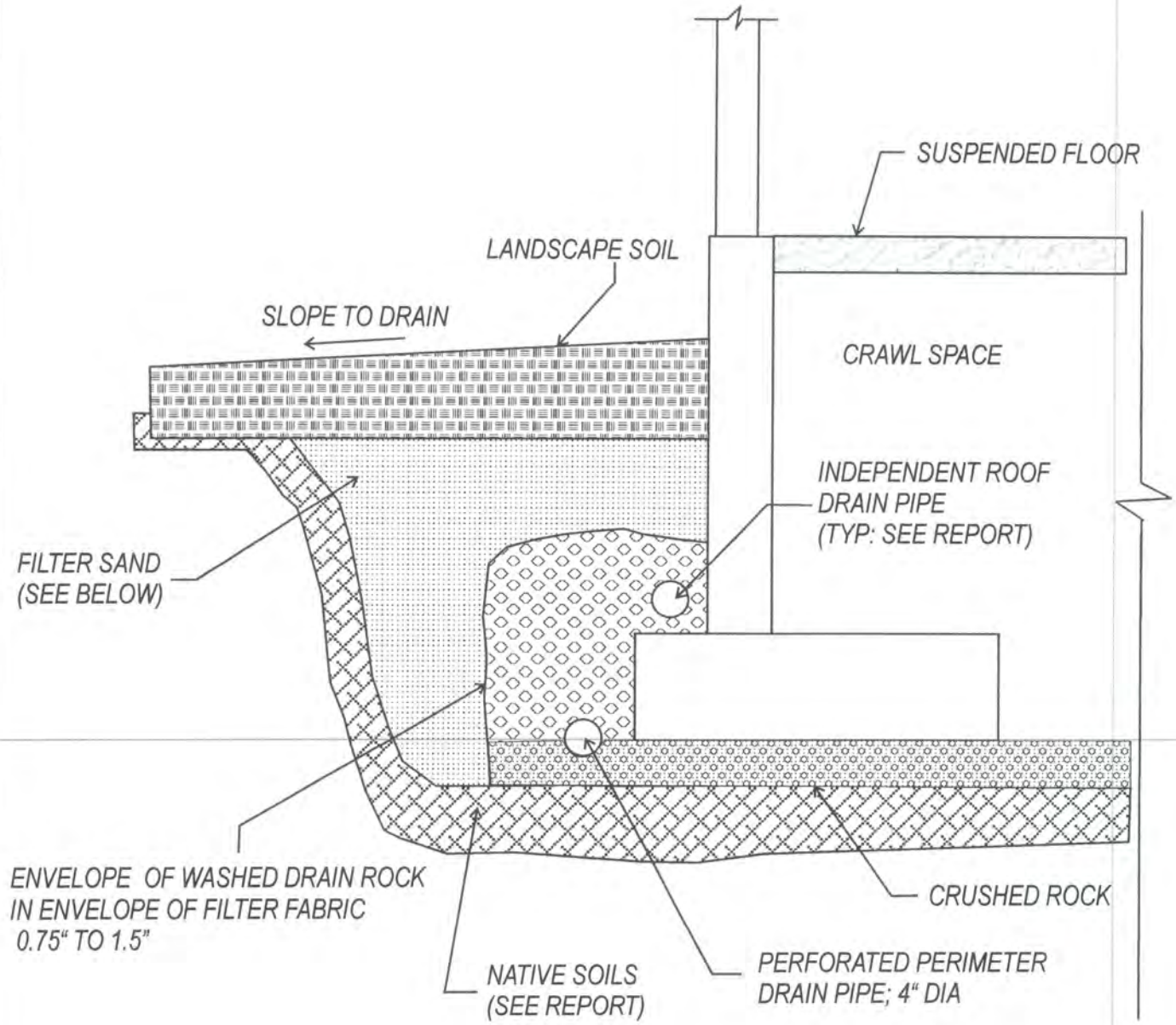


NOTES:

1. FILTER SAND - FINE AGGREGATE FOR PORTLAND CEMENT; SECTION 9=03.1(2)
2. PERFORATED OR SLOTTED RIGID PVC PIPE WITH A POSITIVE DRAINAGE GRADIENT
3. FILTER FABRIC OPTIONAL IF FILTER SAND USED

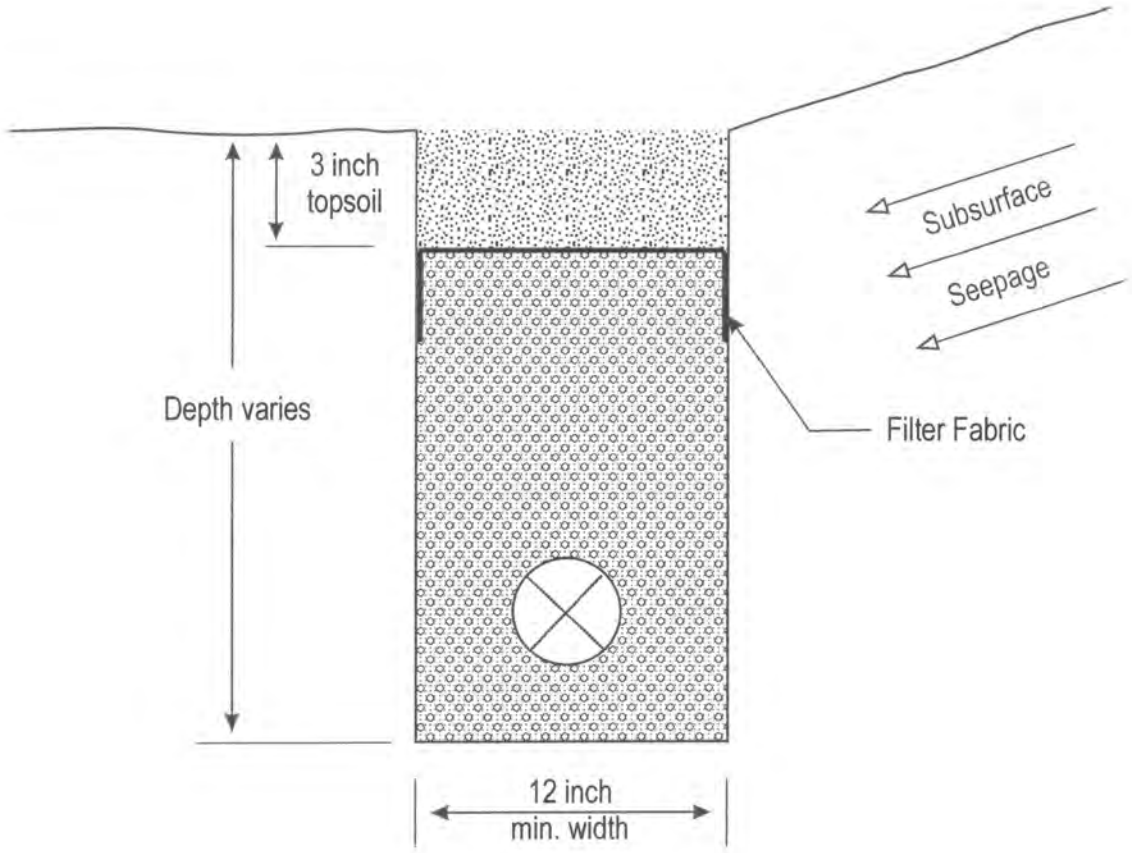
TYPICAL FOOTING DRAIN DETAIL

Not to Scale

Earth Engineering, Inc. GEOTECHNICAL & ENVIRONMENTAL SERVICES	CLIENT: BTMC, LLC.	DRAWN:	EG
	PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE:	2019
		FIGURE:	3
		PRO. #:	G56-0515.18

TYPICAL INTERCEPTOR DRAIN DETAIL

Not to Scale



Legend

Native soil backfill.

Free-draining material composed of clean round gravel, pea gravel, etc.

Minimum 4 inch perforated pipe wrapped with free draining filter fabric or equivalent placed at a positive gradient to a suitable permanent discharge area.

Note: A field representative from this office should be present to establish the depth and lateral extent of the interceptor trench during construction.

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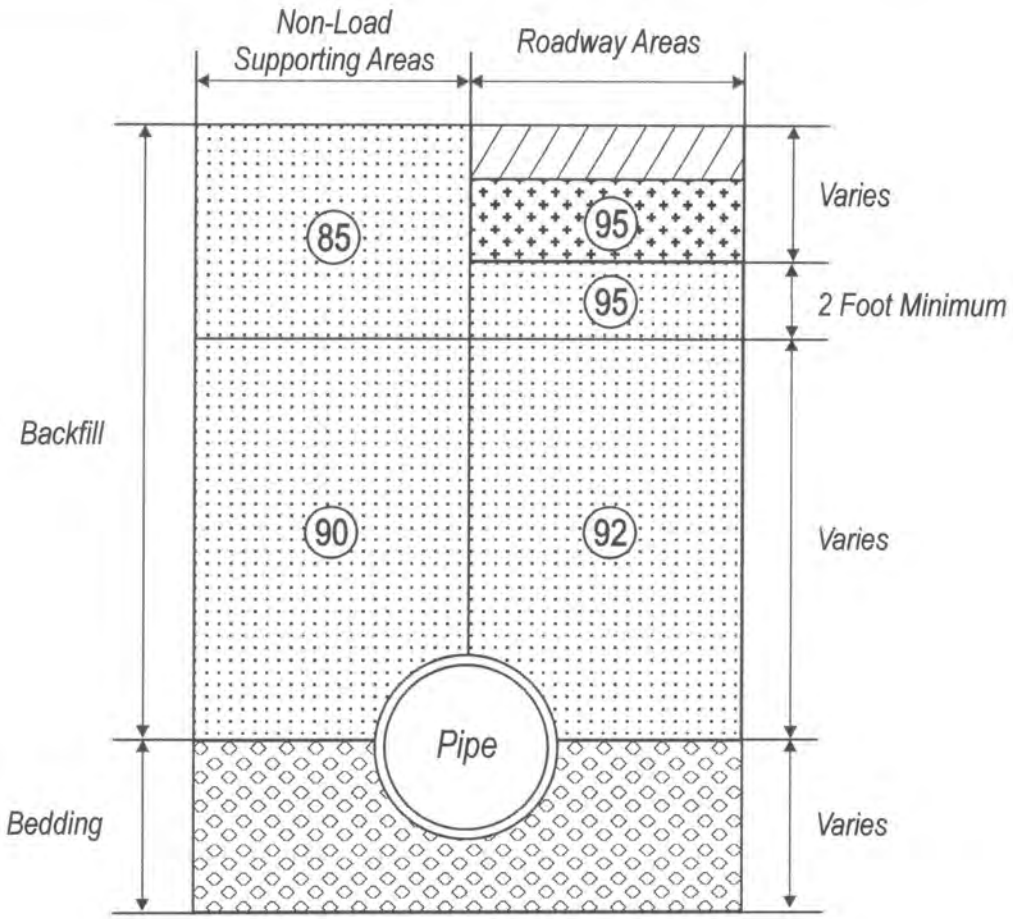
	PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE: 2019
		FIGURE: 4
		PRO. #: G56-0515.18



LEGEND

Asphalt or Concrete Pavement

Roadway Base Material or Base Rock

Backfill: Compacted on-site soil or imported select fill material as described in the site preparation of the general Earthwork Section of the attached report text.

92 — Minimum percentage of maximum Laboratory Dry Density as determined by ASTM Test method D1557 (Modified Proctor),unless otherwise specified in the attached report text.

Bedding Material: Material type depends on type of pipe and laying conditions. Bedding should conform to the manufacturer's recommendations for the type of pipe selected.

UTILITY TRENCH BACKFILL DETAIL

Not to Scale

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FIELD EXPLORATION

Our field exploration was performed during June 2015 and November 2018. Subsurface conditions at the site were explored by excavating twelve test pits. Three of the test pits were used for infiltration testing. The test pits were excavated with a track-hoe to the maximum depth of ten (10) feet below the existing ground surface.

The test pits were located by pacing from property features. The locations are shown on the Site Plan, Figure 2. Field exploration was monitored by an EEI representative, who classified the soils that we encountered and maintained a log of each test pit, obtained representative samples, and observed pertinent site features. Representative soil samples were placed in closed containers and returned to the laboratory for further examination and testing.

All samples were identified using the Standard Classification of Soils for Engineering Purposes (ASTM D2487-93) in accordance with the Unified Soil Classification System (USCS), which is presented on Plate A1. The test pit logs are presented in Appendix A. The final log represents our interpretations of the field logs and the results of the laboratory tests on field samples.

UNIFIED SOIL CLASSIFICATION SYSTEM
LEGEND

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTION
Coarse Grained Soils	Gravel and Gravelly Soils More Than 50% Coarse Fraction Retained on No 4 Sieve	Clean Gravels (little or no fines)		GW gw	Well-Graded Gravels, Gravel-Sand Mixtures Little or no Fines
				GP gp	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
		Gravels with Fines (appreciable amount of fines)		GM gm	Silty Gravels, Gravel-Sand-Silt Mixtures
				GC gc	Clayey Gravels, Gravel-Sand-Clay Mixtures
More Than 50% Material Larger Than No 200 Sieve Size	Sand and Sandy Soils More Than 50% Coarse Fraction Passing No 4 Sieve	Clean Sand (little or no fines)		SW sw	Well-graded Sands, Gravelly Sands Little or no Fines
				SP sp	Poorly-Graded Sands, Gravelly Sands Little or no Fines
		Sands with Fines (appreciable amount of fines)		SM sm	Silty Sands, Sand-Silt Mixtures
				SC sc	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils	Silts and Clays	Liquid Limit Less than 50		ML ml	Inorganic Silts and Very Fine Sands, Rock Flour, Silty-Clayey Fine Sands; Clayey Silts w/ slight Plasticity
				CL cl	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean
				OL ol	Organic Silts and Organic Silty Clays of Low Plasticity
More Than 50% Material Smaller Than No 200 Sieve Size	Silts and Clays	Liquid Limit Greater than 50		MH mh	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils
				CH ch	Inorganic Clays of High Plasticity, Fat Clays
				OH oh	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils				PT pt	Peat, Humus, Swamp Soils with High Organic Contents

Topsoil		Humus and Duff Layer
Fill		Highly Variable Constituents

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GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT:	BTMC, LLC.	DRAWN: EG
PROJECT:	RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE: 2019
		PLATE: A-1
		PRO. #: G56-0515.18

LOG OF TEST PIT I-1

ELEVATION: **+/- 278 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **JUNE 2015**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•						23	-
3								
4		- Field infiltration rate of 0 inches per hour						
5		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff		
6								
7	•						18	-
8								
9								
10								

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-2
PRO. #: G56-0515.18

LOG OF TEST PIT I-2

ELEVATION: +/- 308 feet
EXPLORATORY EQUIPMENT: TRACK HOE
DATE: JUNE 2015

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•						21	-
3								
4		- Field infiltration rate of 0 inches per hour						
5		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff		
6								
7	•						19	-
8								
9								
10								

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.	DRAWN: EG
PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE: 02/2019
	PLATE: A-3
	PRO. #: G56-0515.18

LOG OF TEST PIT I-3

ELEVATION: **+/- 300 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **JUNE 2015**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•						23	-
3								
4		- Field infiltration rate of 0 inches per hour						
5		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff		
6								
7	•						20	-
8								
9								
10								

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-4
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-1

ELEVATION: +/- 302 feet
EXPLORATORY EQUIPMENT: TRACK HOE
DATE: JUNE 2015

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•	elastic Silt (ML) & lean Clay (CL)		Light Brown	Dry	Stiff to V. Stiff	20	-
3								
4								
5								
6	•				Moist		17	-
7								

Bottom of test pit at 7.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-5
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-2

ELEVATION: +/- 302 feet
EXPLORATORY EQUIPMENT: TRACK HOE
DATE: JUNE 2015

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•					Dry		23
3								
4		elastic Silt (ML) & lean Clay (CL)			Light Brown		Stiff to V. Stiff	
5								
6	•					Moist		19
7								

Bottom of test pit at 7.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-6
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-3

ELEVATION: **+/- 296 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **JUNE 2015**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1–3		10" Organic Duff & Topsoil **organic Silt (OH)**		Dark Brown	Sat	V. Soft	45	-
3–7		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff	21	-

Bottom of test pit at 7.0 feet below existing ground surface.
Heavy groundwater seepage encountered at 2 to 3 feet below surface.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.	DRAWN: EG
PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE: 02/2019
	PLATE: A-7
	PRO. #: G56-0515.18

LOG OF TEST PIT — TP-4

ELEVATION: **+/- 284 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **JUNE 2015**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1–3	● ▼	10" Organic Duff & Topsoil **organic Silt (OH)**		Light Brown	Sat	V. Soft	49	-
4–7	●	**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff	22	-

Bottom of test pit at 7.0 feet below existing ground surface.
Heavy groundwater seepage encountered at 2 to 3 feet below surface.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-8
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-5

ELEVATION: **+/- 288 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **JUNE 2015**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	•						22	-
3								
4		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff		
5								
6	•						17	-
7								

Bottom of test pit at 7.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.	DRAWN: EG
PROJECT: RESIDENTIAL SUBDIVISION NW 179TH ST. & NW 11TH AVE. RIDGEFIELD, WA	DATE: 02/2019
	PLATE: A-9
	PRO. #: G56-0515.18

LOG OF TEST PIT **TP-6**

ELEVATION: **+/- 289 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **NOVEMBER 2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2	X							
3		**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff	24	-
4								
5	•						21	-
6								

Bottom of test pit at 6.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-10
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-7

ELEVATION: **+/- 281 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **NOVEMBER 2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1		8" Organic Duff & Topsoil						
2								
3	•	**elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff to V. Stiff	20	-
4								
5	•						19	-
6								

Bottom of test pit at 6.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-11
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-8

ELEVATION: **+/- 274 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **NOVEMBER 2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1–3	•	8" Organic Duff & Topsoil **elastic Silt (ML) & lean Clay (CL)**		Light Brown	Moist	Stiff	18	-
4–7	•	**lean Clay (CL)**		Light Brown/ Gray	Dry	V. Stiff	15	-

Bottom of test pit at 7.5 feet below existing ground surface.
No groundwater encountered.

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GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-12
PRO. #: G56-0515.18

LOG OF TEST PIT — TP-9

ELEVATION: **+/- 265 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **NOVEMBER 2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	LITHOLOGY (USGS)	COLOR	MOISTURE	CONSISTENCY	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200
1	•	12" Organic Duff & Topsoil **elastic Silt (MH)**		Brown	Sat	Soft	35	-
2								
3	•	**lean Clay (CL)**		Light Brown/ Gray	Moist	Stiff	27	-
4								
5								
6								

Bottom of test pit at 6.0 feet below existing ground surface.
No groundwater encountered.

Earth Engineering, Inc.
GEOTECHNICAL & ENVIRONMENTAL SERVICES

CLIENT: BTMC, LLC.
PROJECT: RESIDENTIAL SUBDIVISION
NW 179TH ST. & NW 11TH AVE.
RIDGEFIELD, WA

DRAWN: EG
DATE: 02/2019
PLATE: A-13
PRO. #: G56-0515.18

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2 Copies	**Terry Wollam** **BTMC, LLC** **7701 NE Greenwood Drive** **Vancouver, WA 98662**

Appendix H:
Wetlands Guidelines Checklist

Minimum Requirement 8 Review Checklist

Minimum Requirement 8 Checklist

Note: An additional Wetland Determination maybe required for wetlands that are not located on the project site.

A. Is there a direct or indirect stormwater discharge to a wetland?

- [X] Yes **– Go on to Question B**
- [ ] No **–Stop**

B. Is the wetland being included in a treatment or flow control BMP/Facility?

- [ ] Yes – Comply with Guide Sheets 1 and 2 in Appendix 1-~~K~~H. **Stop**
- [X] No **– Go on to Question C.**

C. Complete a Wetland Rating Form for the receiving wetland using the Washington State Wetland Rating System for Western Washington. Is the wetland classified by the rating form as Category I or Category II?

- [ ] Yes **– Complete the checklist below**
- [X] No **–Stop**

~~D~~E. Hydroperiod Analysis per Section 1.5.8

- [ ] Monthly change in total discharge volume is 15% or less (per the WWHM); and
- [ ] Change in total discharge volume from any single precipitation event is 20% or less (per the WWHM). **–Stop**
- [ ] Either discharge threshold exceeded. **– Go on to Section E**

~~E~~F. Minimum Requirement 8 is not met

D. Does the wetland provide habitat for threatened or endangered species?
If yes **complete the checklist below**.
If No **Stop**.

Appendix I:
LID Feasibility Checklist

LID Feasibility Checklist

Project Title and Case Number: North Haven PUD (PAC-2019-00183)

Applicant: BTMC, LLC.

Date: 02/05/2020 **TDA #:** 1

***Instructions** : Fill out a LID Feasibility Checklist for each TDA on the project. Submit the completed checklist with the Preliminary TIR (see Book 1, Section 1.8.1.5).*

Step 1: Indicate which mandatory list of LID BMPs is applicable to the project in accordance with Minimum Requirement #5 and the flow chart in Figure 2.1 in Book 1. Check the corresponding box in Section 1 below. For projects meeting the LID Performance Standard, this checklist does not apply.

Step 2: Indicate which type(s) of surfaces will be present within the TDA in Section 2.

Step 3: Consider feasibility criteria and setbacks in Section 3.

Section 1: Required LID BMPs

☐ List #1 (Table 32.1) ☒ List #2 (Table 32.2) ☐ BMPs in Table 32.3

Section 2: Surfaces

☒ Roofs ☒ Hard surfaces other than roofs

Section 3: Feasibility Criteria

For each type of surface selected in Section 2, consider BMPs in the order indicated in the required list or table selected in Section 1.

For each question, place a mark in either the Yes or No column. For each No answer, move on to the subsequent question within the BMP. If a Yes answer is given, then the BMP is not feasible in the TDA and is not required in accordance with Minimum Requirement #5. If No answers are given to all questions, then the BMP is feasible in the TDA and must be implemented in accordance with Minimum Requirement #5. When feasibility of the BMP has been determined, then select the appropriate box in the Determination section.

For each type of surface, stop at the first BMP that is feasible.

Answers to questions must consider site-specific information, and some may require professional written evaluation as justification. Please see Book 1, Chapter 2 for more information.

FULL DISPERSION BMP T5.30A	Roof		Surfaces	
Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
Will the project protect and maintain less than 65% of the TDA in a forested native condition?	X		X	
Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
Is the only location available for the discharge less than 100 feet upgradient of a septic system?				
Is the only area available for the required length of the BMP's flowpath on a slope greater than 20%				
Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined in CCC 40.430?				
Is the only area available to place the dispersion device or required flowpath less than 10 feet from any structure, property line, or sensitive area?				
Determination: Is this BMP feasible? ……		X		X

	DISPERSION TO PASTURE OR CROPLAND BMP T5.30B	Roof		Surfaces	
	Applicability and Setbacks	**YES**	**NO**	**YES**	**NO**
	Is the project site 22,000 square feet or less?		X		X
	Will the project protect and maintain less than 75% of the site or TDA as pasture or cropland or be covered in more than 15% impervious surfaces?	X		X	
	Does use of the pasture or cropland for purposes other than plant growth (e.g. unpaved roads, equipment storage, animal pens, haystacks, wheel lines, campsites, trails, etc.) take up more than 10% of the area to be used for dispersion?				
	Does the site prohibit a minimum dispersion flow path through pasture or cropland of 300 feet?				
	Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Is the only location available for the discharge less than 100 feet upgradient of a septic system?				
	Is the only area available for the required length of the BMP's flowpath on a slope greater than 5%?				
	Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
	Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
	Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined in CCC 40.430?				
	Is the only area available to place the dispersion device or required flowpath less than 10 feet from any structure, property line, or sensitive area?				
	Are crops other than grass, grain, row crops (including berries, nursery stock, and orchards) grown in the proposed flowpath?				
	Is the pasture/cropland under different ownership than the project site?				
	If the crop or pasture land is predominantly covered in soils with an infiltration rate greater than 4 inches per hour, was the pasture or cropland cleared after November 2009?				
	Is there less than 3 feet between the surface elevation along the dispersion flowpath and the average annual maximum groundwater elevation?				
Determination: Is this BMP feasible? ……			X		X

	ROOF DOWNSPOUT FULL INFILTRATION BMPs T5.10A and T5.10B	Roof			
	Feasibility Criteria and Setbacks	**YES**	**NO**		
Note: this BMP is not applicable to surfaces other than roofs.	Has a qualified professional determined that soils in the infiltration zone at the location of the infiltration BMP do not fall within USDA textural classes of coarse sand to medium sand, loam, or cobbles and gravels?	X			
	Is there less than 3 feet of permeable soil from the proposed finished ground elevation at the drywell or trench location to the seasonal high groundwater table?				
	Is there less than 1 foot of soil from the proposed bottom elevation of the roof downspout control to the groundwater elevation?				
	Is the proposed location on a slope of 25% (4:1) or greater and cannot reasonably be located elsewhere?				
	Is the proposed location less than 100 feet from a closed or active landfill and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from any small on-site sewage disposal drainfield, including reserve areas and grey water reuse systems, and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground, and cannot reasonably be located elsewhere?				
	Is the proposed location less than 100 feet upgradient of a septic system unless topography clearly prohibits subsurface flows from intersecting the drainfield and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from any structure, property line, or sensitive area and cannot reasonably be located elsewhere? [Note: this setback may be waived at the applicant's request in certain situations in accordance with Book 1, Section 2.5.1.4.]				
	Is the proposed location less than 200 feet from the top of any slope greater than 40% and cannot reasonably be located elsewhere? [Note: The Responsible Official may consider reducing this setback to 15 feet based on a geotechnical evaluation. If requested, submit a geotechnical report with this checklist for County review.]				
Determination: Is this BMP feasible? ……			X		

ERRATA September 2016

DOWNSPOUT DISPERSION BMP T5.10C		Roof			
	Setbacks	**YES**	**NO**		
Note: this BMP is not applicable to surfaces other than roofs.	Is the proposed location less than 10 feet from any sewage disposal drainfield, including reserve areas and grey water reuse systems, and cannot reasonably be located elsewhere?		X		
	Is the proposed discharge location less than 100 feet upgradient of a septic system drainfield, unless site topography clearly prohibits subsurface flows from intersecting the drainfield and cannot reasonably be located elsewhere?		X		
	Is the proposed discharge point less than 10 feet from any structure or property line and cannot reasonably be located elsewhere?	X			
	Is the proposed discharge point less than 50 feet from the top of any slope greater than 15% and cannot reasonably be located elsewhere? [Note: The Responsible Official may consider reducing this setback to 15 feet based on a geotechnical evaluation. If requested, submit a geotechnical report with this checklist for County review.]				
Determination: Is this BMP feasible? ……			X		

SHEET FLOW DISPERSION BMP T5.12 and CONCENTRATED FLOW DISPERSION BMP T5.11		Roof		Surfaces	
	Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?		X		X
	Is the only location available for the discharge location less than 100 feet upgradient of a septic system drainfield on the site?		X		X
	Is the only area available for the required length of the BMP's flowpath on a slope greater than 20%		X		X
	Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?		X		X
	Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?	X		X	
	Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined by CCC 40.430?				
	Is the only area available for the BMP less than 10 feet from any structure, property line, or sensitive area?				
Determination: Is this BMP feasible? ……			X		X

RAIN GARDEN BMP T5.14A and BIORETENTION BMP T5.14B		Roof		Surfaces	
	Infeasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Has the Responsible Official determined that the BMP is not compatible with surrounding drainage systems (e.g. projects draining to existing stormwater collection system whose elevation or locale precludes connection to a properly functioning bioretention system)?		X		X
	Is the land for the BMP within an area designated as an erosion hazard or landslide hazard by the geotechnical report or county critical areas mapping?		X		X
	Can the site not reasonably be designed to locate the BMP on slopes less than 8%?		X		X
	On properties with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and any of the following criteria:				
	o Is the proposed BMP within 100 feet of an area known to have deep soil contamination?		X		X
	o Is the site is in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater?		X		X
	o Is the proposed BMP located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area?		X		X
	o Is the BMP within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?		X		X
	[End soil / groundwater contamination sub-list.]				
	For a bioretention system or a rain garden that would serve a drainage area that is 1) less than 5,000 sq. ft. of pollution-generating impervious surface, and 2) less than 10,000 sq. ft. of impervious surface, and 3) less than ¾ acres of pervious surface, is the minimum vertical separation of one foot to seasonal high water table, bedrock or other impervious layer unable to be achieved below the BMP?		X		X
	For a bioretention system that would 1) serve a drainage area that is a) 5,000 sq. ft. or more of pollution-generating impervious surface, or b) 10,000 sq. ft. or more of impervious surface, or c) ¾ acres or more of pervious surface, and 2) cannot reasonably be broken down into amounts smaller than indicated in (1), is the minimum vertical separation of three feet to seasonal high water table, bedrock or other impervious layer unable to be achieved below the BMP?		X		X
	Does field testing indicates that soils have a measured (a.k.a. initial) native soil coefficient of permeability less than 0.3 inches per hour?	X		X	
	Is the BMP less than 50 feet from the top of a slope greater than 20% or with more than 10 feet of vertical relief and cannot reasonably be located elsewhere?				
Questions continue on following page.	Is the BMP less than 100 feet from a landfill (active or closed) and cannot reasonably be located elsewhere?				

	Is the BMP less than 100 feet from a drinking water well or a spring used for drinking water and cannot reasonably be located elsewhere?				
	Is the BMP less than 10 feet from any small on-site sewage disposal drain field, including reserve areas, and grey water reuse systems and cannot reasonably be located elsewhere? For setbacks from a "large on-site sewage disposal system," see Chapter 246-272B WAC.				
	Is the BMP less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground and when the capacity of the tank and pipe system is less than 1100 gallons and cannot reasonably be located elsewhere?				
	Is the BMP less than 100 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is underground and when the capacity of the tank and pipe system is greater than 1100 gallons and cannot reasonably be located elsewhere?				
	For a bioretention system or rain garden that would serve a drainage area of less than 5,000 sq. ft. of pollution-generating impervious surface and less than 10,000 sq. ft. of impervious surface, is the BMP less than 10 feet away from any structure or property line and cannot reasonably be located elsewhere?				
	For a bioretention system that would serve a drainage area of 5,000 sq. ft. or greater of pollution-generating impervious surface or 10,000 sq. ft. or greater of impervious surface or 3/4 acre or more of pervious surfaces, is the BMP less than 20 feet from the downslope side of any foundation, structure or property line and cannot reasonably be located elsewhere?				
	For a bioretention system that would serve a drainage area of 5,000 sq. ft. or greater of pollution-generating impervious surface or 10,000 sq. ft. or greater of impervious surface or 3/4 acre or more of pervious surfaces, is the BMP less than 100 feet from the upslope side of any foundation and cannot reasonably be located elsewhere?				
	The following require professional technical evaluation.				
	Does a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Does the site have groundwater that drains into an erosion hazard or landslide hazard area?				
	Is the only area available for siting the BMP threatening the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces?				
	Would infiltrating water threaten existing below grade basements?				
	Would infiltrating water threaten shoreline structures such as bulkheads?				
	Is the only area available for siting the BMP one that does not allow for a safe overflow pathway to the municipal separate storm sewer system or to a private storm sewer system?				
	Is the site a redevelopment project that lacks usable space for the BMP?				
	Is the site a public road project that lacks sufficient space within existing public right-of-way for the BMP?				
Determination: Is this BMP feasible? ……			X		X

	PERMEABLE PAVEMENT BMP T5.15	**Roof**		**Surfaces**	
	Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Is the surface to be paved a roadway with a projected average daily traffic volume of more than 400 vehicles?		X		X
	Is the surface to be paved a roadway that will be subject to through truck traffic (not including such traffic as weekly garbage and recycling pick-up, daily school bus use, or frequent use by mail/parcel delivery trucks and maintenance vehicles)?		X		X
	Is the surface to be paved a multi-level parking garage, a bridge, or roadway over a culvert?		X		X
	Is the area for permeable pavement likely to have long-term excessive sediment deposition after construction (e.g. construction and landscaping material yards)?		X		X
	Is the area for permeable pavement designated as an erosion hazard or landslide hazard?		X		X
	Is the surface to be paved on a property with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and meets any of the following criteria:				
	o Is the proposed BMP within 100 feet of an area known to have deep soil contamination?		X		X
	o Is the site in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater?		X		X
	o Is the proposed BMP located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area?		X		X
	o Is the BMP within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?		X		X
	[End soil / groundwater contamination sub-list.]				
Questions continue on the following page.	Can the site not reasonably be designed to have a porous asphalt surface at less than 5% slope, or a pervious concrete surface at less than 10% slope, or a permeable interlocking concrete pavement surface (where appropriate) at less than 12% slope, or a grid system at less than the manufacturer's recommended maximum slope limit (generally between 6% to 12%)?		X		X

	Would seasonal high groundwater or an underlying impermeable/low permeable layer create saturated conditions within 1 foot of the bottom of the lowest gravel base course?		X		X
	Are underlying soils unsuitable for supporting traffic loads when saturated? (Soils meeting a California Bearing Ratio of 5% are considered suitable for residential access roads.)		X		X
	Is the measured coefficient of permeability in the area for permeable pavement less than 0.3 inches per hour?	X		X	
	Is the project replacing existing impervious surface, unless the existing surface is a non-pollution generating surface over a soil with a saturated hydraulic conductivity of four inches per hour or greater?				
	Is the site defined as a high-use site in Appendix 1-A?				
	Is the area for permeable pavement used for an "industrial activity" as identified in 40 CFR 122.26(b)(14)?				
	Is the risk of concentrated pollutant spills more likely such as gas stations, truck stops, and industrial chemical storage sites?				
	Is the area for permeable pavement where routine, heavy applications of sand will occur in frequent snow zones to maintain traction during weeks of snow and ice accumulations?				
	If the area for permeable pavement would be a pollution-generating hard surface (e.g. roads, driveways, parking lots) does the soil underneath the proposed location fail any of the following criteria: - At least one foot depth of soil with the following characteristics: - Cation Exchange Capacity ≥ 5 milliequivalents CEC/100 g dry soil (USEPA Method 9081) - Organic Content > 1% - Measured coefficient of permeability < 9 inches/hour				
	Is the area to be paved less than 50 feet from the top of a slope greater than 20% or with more than 10 feet of vertical relief?				
	Is the area to be paved less than 100 feet from an active or closed landfill?				
	If the surface to be paved is a pollution-generating hard surface, is the area to be paved less than 100 feet from a drinking water well or a spring used for drinking water?				
	Is the area to be paved less than 10 feet from on-site sewage drainage?				
	Is the area to be paved less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground?				
	The following require professional technical evaluation.				
	Does a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Does the site have groundwater that drains into an erosion hazard or landslide hazard area?				
	Would infiltrating and ponded water below new permeable pavement area compromise adjacent impervious pavement?				
	Is the only area available for siting the BMP threatening the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces?				
	Would infiltrating water threaten existing below grade basements?				
	Would infiltrating water threaten shoreline structures such as bulkheads?				
	Is the area to be paved downslope of steep, erosion prone areas that are likely to deliver sediment?				
	Is the area to be paved over fill soils that can become unstable when saturated?				
	Is the area to be paved on excessively steep slopes and would the water within the aggregate base layer or at the sub-grade surface be uncontrollable by detention structures and therefore may cause erosion and structural failure, or would surface runoff velocities preclude adequate infiltration at the pavement surface?				
	Is the area to be paved in an area needed to support heavy loads at an industrial facility (such as a port) that exceed the strength of the permeable pavement?				
	Would installation of permeable pavement threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, or pre-existing road sub-grades?				
Determination: Is this BMP feasible? ……			X		X

LID Feasibility Checklist

Project Title and Case Number: North Haven PUD (PAC-2019-00183)

Applicant: BTMC, LLC.

Date: 02/05/2020 **TDA #:** 2

***Instructions** : Fill out a LID Feasibility Checklist for each TDA on the project. Submit the completed checklist with the Preliminary TIR (see Book 1, Section 1.8.1.5).*

Step 1: Indicate which mandatory list of LID BMPs is applicable to the project in accordance with Minimum Requirement #5 and the flow chart in Figure 2.1 in Book 1. Check the corresponding box in Section 1 below. For projects meeting the LID Performance Standard, this checklist does not apply.

Step 2: Indicate which type(s) of surfaces will be present within the TDA in Section 2.

Step 3: Consider feasibility criteria and setbacks in Section 3.

Section 1: Required LID BMPs

☐ List #1 (Table 3.2.1) ☒ List #2 (Table 3.2.2) ☐ BMPs in Table 3.2.3

Section 2: Surfaces

☒ Roofs ☒ Hard surfaces other than roofs

Section 3: Feasibility Criteria

For each type of surface selected in Section 2, consider BMPs in the order indicated in the required list or table selected in Section 1.

For each question, place a mark in either the Yes or No column. For each No answer, move on to the subsequent question within the BMP. If a Yes answer is given, then the BMP is not feasible in the TDA and is not required in accordance with Minimum Requirement #5. If No answers are given to all questions, then the BMP is feasible in the TDA and must be implemented in accordance with Minimum Requirement #5. When feasibility of the BMP has been determined, then select the appropriate box in the Determination section.

For each type of surface, stop at the first BMP that is feasible.

Answers to questions must consider site-specific information, and some may require professional written evaluation as justification. Please see Book 1, Chapter 2 for more information.

FULL DISPERSION BMP T5.30A	Roof		Surfaces	
Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
Will the project protect and maintain less than 65% of the TDA in a forested native condition?	X		X	
Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
Is the only location available for the discharge less than 100 feet upgradient of a septic system?				
Is the only area available for the required length of the BMP's flowpath on a slope greater than 20%				
Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined in CCC 40.430?				
Is the only area available to place the dispersion device or required flowpath less than 10 feet from any structure, property line, or sensitive area?				
Determination: Is this BMP feasible? ……		X		X

	DISPERSION TO PASTURE OR CROPLAND BMP T5.30B	Roof		Surfaces	
	Applicability and Setbacks	**YES**	**NO**	**YES**	**NO**
	Is the project site 22,000 square feet or less?		X		X
	Will the project protect and maintain less than 75% of the site or TDA as pasture or cropland or be covered in more than 15% impervious surfaces?	X		X	
	Does use of the pasture or cropland for purposes other than plant growth (e.g. unpaved roads, equipment storage, animal pens, haystacks, wheel lines, campsites, trails, etc.) take up more than 10% of the area to be used for dispersion?				
	Does the site prohibit a minimum dispersion flow path through pasture or cropland of 300 feet?				
	Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Is the only location available for the discharge less than 100 feet upgradient of a septic system?				
	Is the only area available for the required length of the BMP's flowpath on a slope greater than 5%?				
	Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
	Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
	Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined in CCC 40.430?				
	Is the only area available to place the dispersion device or required flowpath less than 10 feet from any structure, property line, or sensitive area?				
	Are crops other than grass, grain, row crops (including berries, nursery stock, and orchards) grown in the proposed flowpath?				
	Is the pasture/cropland under different ownership than the project site?				
	If the crop or pasture land is predominantly covered in soils with an infiltration rate greater than 4 inches per hour, was the pasture or cropland cleared after November 2009?				
	Is there less than 3 feet between the surface elevation along the dispersion flowpath and the average annual maximum groundwater elevation?				
Determination: Is this BMP feasible? ……			X		X

	ROOF DOWNSPOUT FULL INFILTRATION BMPs T5.10A and T5.10B	Roof			
	Feasibility Criteria and Setbacks	**YES**	**NO**		
Note: this BMP is not applicable to surfaces other than roofs.	Has a qualified professional determined that soils in the infiltration zone at the location of the infiltration BMP do not fall within USDA textural classes of coarse sand to medium sand, loam, or cobbles and gravels?	X			
	Is there less than 3 feet of permeable soil from the proposed finished ground elevation at the drywell or trench location to the seasonal high groundwater table?				
	Is there less than 1 foot of soil from the proposed bottom elevation of the roof downspout control to the groundwater elevation?				
	Is the proposed location on a slope of 25% (4:1) or greater and cannot reasonably be located elsewhere?				
	Is the proposed location less than 100 feet from a closed or active landfill and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from any small on-site sewage disposal drainfield, including reserve areas and grey water reuse systems, and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground, and cannot reasonably be located elsewhere?				
	Is the proposed location less than 100 feet upgradient of a septic system unless topography clearly prohibits subsurface flows from intersecting the drainfield and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from any structure, property line, or sensitive area and cannot reasonably be located elsewhere? [Note: this setback may be waived at the applicant's request in certain situations in accordance with Book 1, Section 2.5.1.4.]				
	Is the proposed location less than 200 feet from the top of any slope greater than 40% and cannot reasonably be located elsewhere? [Note: The Responsible Official may consider reducing this setback to 15 feet based on a geotechnical evaluation. If requested, submit a geotechnical report with this checklist for County review.]				
Determination: Is this BMP feasible? ……			X		

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DOWNSPOUT DISPERSION BMP T5.10C		Roof			
	Setbacks	**YES**	**NO**		
Note: this BMP is not applicable to surfaces other than roofs.	Is the proposed location less than 10 feet from any sewage disposal drainfield, including reserve areas and grey water reuse systems, and cannot reasonably be located elsewhere?		X		
	Is the proposed discharge location less than 100 feet upgradient of a septic system drainfield, unless site topography clearly prohibits subsurface flows from intersecting the drainfield and cannot reasonably be located elsewhere?		X		
	Is the proposed discharge point less than 10 feet from any structure or property line and cannot reasonably be located elsewhere?	X			
	Is the proposed discharge point less than 50 feet from the top of any slope greater than 15% and cannot reasonably be located elsewhere? [Note: The Responsible Official may consider reducing this setback to 15 feet based on a geotechnical evaluation. If requested, submit a geotechnical report with this checklist for County review.]				
Determination: Is this BMP feasible? ……			X		

SHEET FLOW DISPERSION BMP T5.12 and CONCENTRATED FLOW DISPERSION BMP T5.11		Roof		Surfaces	
	Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?		X		X
	Is the only location available for the discharge location less than 100 feet upgradient of a septic system drainfield on the site?		X		X
	Is the only area available for the required length of the BMP's flowpath on a slope greater than 20%		X		X
	Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?		X		X
	Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?	X		X	
	Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined by CCC 40.430?				
	Is the only area available for the BMP less than 10 feet from any structure, property line, or sensitive area?				
Determination: Is this BMP feasible? ……			X		X

RAIN GARDEN BMP T5.14A and BIORETENTION BMP T5.14B		Roof		Surfaces	
	Infeasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Has the Responsible Official determined that the BMP is not compatible with surrounding drainage systems (e.g. projects draining to existing stormwater collection system whose elevation or locale precludes connection to a properly functioning bioretention system)?		X		X
	Is the land for the BMP within an area designated as an erosion hazard or landslide hazard by the geotechnical report or county critical areas mapping?		X		X
	Can the site not reasonably be designed to locate the BMP on slopes less than 8%?		X		X
	On properties with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and any of the following criteria:				
	o Is the proposed BMP within 100 feet of an area known to have deep soil contamination?		X		X
	o Is the site is in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater?		X		X
	o Is the proposed BMP located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area?		X		X
	o Is the BMP within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?		X		X
	[End soil / groundwater contamination sub-list.]				
	For a bioretention system or a rain garden that would serve a drainage area that is 1) less than 5,000 sq. ft. of pollution-generating impervious surface, and 2) less than 10,000 sq. ft. of impervious surface, and 3) less than ¾ acres of pervious surface, is the minimum vertical separation of one foot to seasonal high water table, bedrock or other impervious layer unable to be achieved below the BMP?		X		X
	For a bioretention system that would 1) serve a drainage area that is a) 5,000 sq. ft. or more of pollution-generating impervious surface, or b) 10,000 sq. ft. or more of impervious surface, or c) ¾ acres or more of pervious surface, and 2) cannot reasonably be broken down into amounts smaller than indicated in (1), is the minimum vertical separation of three feet to seasonal high water table, bedrock or other impervious layer unable to be achieved below the BMP?		X		X
	Does field testing indicates that soils have a measured (a.k.a. initial) native soil coefficient of permeability less than 0.3 inches per hour?	X		X	
	Is the BMP less than 50 feet from the top of a slope greater than 20% or with more than 10 feet of vertical relief and cannot reasonably be located elsewhere?				
Questions continue on following page.	Is the BMP less than 100 feet from a landfill (active or closed) and cannot reasonably be located elsewhere?				

	Is the BMP less than 100 feet from a drinking water well or a spring used for drinking water and cannot reasonably be located elsewhere?				
	Is the BMP less than 10 feet from any small on-site sewage disposal drain field, including reserve areas, and grey water reuse systems and cannot reasonably be located elsewhere? For setbacks from a "large on-site sewage disposal system," see Chapter 246-272B WAC.				
	Is the BMP less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground and when the capacity of the tank and pipe system is less than 1100 gallons and cannot reasonably be located elsewhere?				
	Is the BMP less than 100 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is underground and when the capacity of the tank and pipe system is greater than 1100 gallons and cannot reasonably be located elsewhere?				
	For a bioretention system or rain garden that would serve a drainage area of less than 5,000 sq. ft. of pollution-generating impervious surface and less than 10,000 sq. ft. of impervious surface, is the BMP less than 10 feet away from any structure or property line and cannot reasonably be located elsewhere?				
	For a bioretention system that would serve a drainage area of 5,000 sq. ft. or greater of pollution-generating impervious surface or 10,000 sq. ft. or greater of impervious surface or 3/4 acre or more of pervious surfaces, is the BMP less than 20 feet from the downslope side of any foundation, structure or property line and cannot reasonably be located elsewhere?				
	For a bioretention system that would serve a drainage area of 5,000 sq. ft. or greater of pollution-generating impervious surface or 10,000 sq. ft. or greater of impervious surface or 3/4 acre or more of pervious surfaces, is the BMP less than 100 feet from the upslope side of any foundation and cannot reasonably be located elsewhere?				
	The following require professional technical evaluation.				
	Does a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Does the site have groundwater that drains into an erosion hazard or landslide hazard area?				
	Is the only area available for siting the BMP threatening the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces?				
	Would infiltrating water threaten existing below grade basements?				
	Would infiltrating water threaten shoreline structures such as bulkheads?				
	Is the only area available for siting the BMP one that does not allow for a safe overflow pathway to the municipal separate storm sewer system or to a private storm sewer system?				
	Is the site a redevelopment project that lacks usable space for the BMP?				
	Is the site a public road project that lacks sufficient space within existing public right-of-way for the BMP?				
Determination: Is this BMP feasible? ……			X		X

	PERMEABLE PAVEMENT BMP T5.15	**Roof**		**Surfaces**	
	Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
	Is the surface to be paved a roadway with a projected average daily traffic volume of more than 400 vehicles?		X		X
	Is the surface to be paved a roadway that will be subject to through truck traffic (not including such traffic as weekly garbage and recycling pick-up, daily school bus use, or frequent use by mail/parcel delivery trucks and maintenance vehicles)?		X		X
	Is the surface to be paved a multi-level parking garage, a bridge, or roadway over a culvert?		X		X
	Is the area for permeable pavement likely to have long-term excessive sediment deposition after construction (e.g. construction and landscaping material yards)?		X		X
	Is the area for permeable pavement designated as an erosion hazard or landslide hazard?		X		X
	Is the surface to be paved on a property with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and meets any of the following criteria:				
	o Is the proposed BMP within 100 feet of an area known to have deep soil contamination?		X		X
	o Is the site in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater?		X		X
	o Is the proposed BMP located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area?		X		X
	o Is the BMP within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?		X		X
	[End soil / groundwater contamination sub-list.]				
Questions continue on the following page.	Can the site not reasonably be designed to have a porous asphalt surface at less than 5% slope, or a pervious concrete surface at less than 10% slope, or a permeable interlocking concrete pavement surface (where appropriate) at less than 12% slope, or a grid system at less than the manufacturer's recommended maximum slope limit (generally between 6% to 12%)?		X		X

	Would seasonal high groundwater or an underlying impermeable/low permeable layer create saturated conditions within 1 foot of the bottom of the lowest gravel base course?		X		X
	Are underlying soils unsuitable for supporting traffic loads when saturated? (Soils meeting a California Bearing Ratio of 5% are considered suitable for residential access roads.)		X		X
	Is the measured coefficient of permeability in the area for permeable pavement less than 0.3 inches per hour?	X		X	
	Is the project replacing existing impervious surface, unless the existing surface is a non-pollution generating surface over a soil with a saturated hydraulic conductivity of four inches per hour or greater?				
	Is the site defined as a high-use site in Appendix 1-A?				
	Is the area for permeable pavement used for an "industrial activity" as identified in 40 CFR 122.26(b)(14)?				
	Is the risk of concentrated pollutant spills more likely such as gas stations, truck stops, and industrial chemical storage sites?				
	Is the area for permeable pavement where routine, heavy applications of sand will occur in frequent snow zones to maintain traction during weeks of snow and ice accumulations?				
	If the area for permeable pavement would be a pollution-generating hard surface (e.g. roads, driveways, parking lots) does the soil underneath the proposed location fail any of the following criteria: - At least one foot depth of soil with the following characteristics: - Cation Exchange Capacity ≥ 5 milliequivalents CEC/100 g dry soil (USEPA Method 9081) - Organic Content > 1% - Measured coefficient of permeability < 9 inches/hour				
	Is the area to be paved less than 50 feet from the top of a slope greater than 20% or with more than 10 feet of vertical relief?				
	Is the area to be paved less than 100 feet from an active or closed landfill?				
	If the surface to be paved is a pollution-generating hard surface, is the area to be paved less than 100 feet from a drinking water well or a spring used for drinking water?				
	Is the area to be paved less than 10 feet from on-site sewage drainage?				
	Is the area to be paved less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground?				
	The following require professional technical evaluation.				
	Does a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Does the site have groundwater that drains into an erosion hazard or landslide hazard area?				
	Would infiltrating and ponded water below new permeable pavement area compromise adjacent impervious pavement?				
	Is the only area available for siting the BMP threatening the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces?				
	Would infiltrating water threaten existing below grade basements?				
	Would infiltrating water threaten shoreline structures such as bulkheads?				
	Is the area to be paved downslope of steep, erosion prone areas that are likely to deliver sediment?				
	Is the area to be paved over fill soils that can become unstable when saturated?				
	Is the area to be paved on excessively steep slopes and would the water within the aggregate base layer or at the sub-grade surface be uncontrollable by detention structures and therefore may cause erosion and structural failure, or would surface runoff velocities preclude adequate infiltration at the pavement surface?				
	Is the area to be paved in an area needed to support heavy loads at an industrial facility (such as a port) that exceed the strength of the permeable pavement?				
	Would installation of permeable pavement threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, or pre-existing road sub-grades?				
Determination: Is this BMP feasible? ……			X		X

Exhibit L

POLLUTION CONTROL HEARINGS BOARD
STATE OF WASHINGTON

ROSEMERE NEIGHBORHOOD ASSOCIATION; COLUMBIA RIVERKEEPER; and NORTHWEST ENVIRONMENTAL DEFENSE CENTER, Appellants, v. WASHINGTON STATE DEPARTMENT OF ECOLOGY, and CLARK COUNTY, Respondents, BUILDING INDUSTRY ASSOCIATION OF CLARK COUNTY, Intervenor-Respondent.	**PCHB NO. 10-013** **FINDINGS OF FACT, CONCLUSIONS OF LAW, AND ORDER**

Appellants Rosemere Neighborhood Association, Columbia Riverkeeper, and Northwest Environmental Defense Center (―Appellants" or ―Rosemere") challenge Agreed Order No. 7273, entered into by the Respondents Washington State Department of Ecology (Ecology) and Clark County, related to achieving compliance with the National Pollution Discharge Elimination System Phase I Municipal Stormwater General Permit (Phase I Permit).

The Pollution Control Hearings Board (PCHB or Board) conducted a hearing in this matter on September 28 – October 1, 2010, at the Board's offices in Tumwater. Attorneys Jan Hasselman and Janette K. Brimmer, Earthjustice, represented Appellants. Assistant Attorney General Ronald L. Lavigne, Senior Counsel, represented Respondent Department of Ecology (―Ecology"). Chief Civil Deputy E. Bronson Potter, and Christine M. Cook, Deputy Prosecuting

Attorney, represented Clark County. Intervenor-Respondent Building Industry Association of Clark County (BIA Clark Co.) was represented by James D. Howsley, of Miller Nash LLP.

The Board hearing the case was comprised of Andrea McNamara Doyle, Presiding, and Kathleen D. Mix and William H. Lynch, Members. Court reporting services were provided by Kim Otis and Randi Hamilton of Olympia Court Reporters.

FINDINGS OF FACT

1.

This appeal challenges Agreed Order No. 7273, entered into by Ecology and Clark County, related to achieving compliance with one aspect of the National Pollution Discharge Elimination System (NPDES) Phase I Municipal Stormwater General Permit (Phase I Permit). The history and scope of the Phase I Permit are discussed at length in this Board's decision on review of that permit. *See Puget Soundkeeper Alliance v. Ecology*, PCHB Nos. 07-021, -026, -027, -028, -029, -030, -037 (2008) (hereinafter "Phase I Decision"). Ecology developed the Phase I Permit through an eight year long process. *Id.* at FOF 1. Several events delayed the issuance of the Phase I Permit, including the federal listing of Puget Sound Chinook Salmon in 1999, and Ecology's decision to revise the states' Stormwater Management Manuals. *Id.* at FOF 3. The Phase I Permit, a "programmatic permit," requires municipal permittees to implement area-wide stormwater management programs, rather than regulating discharges from individual outfalls. *Id.* at FOF 6. The heart of the Phase I Permit requires that permittees implement a Stormwater Management Program (SWMP), which has ten component parts,[1] including

[1] Listed in Condition S5.

requirements to map municipal systems, detect and eliminate illicit discharges, engage in structural retrofits, and require source controls at existing development. *Id.* at FOF 9. Of particular relevance to this case is the SWMP component that requires permittees, including Clark County, to implement a program to prevent and control the impacts of runoff from new development, redevelopment, and construction sites. The Phase I Permit anticipates that the permittees will adopt ordinances that require implementation of many aspects of the SWMP, either by the municipality or by the regulated community which discharges to the municipal storm sewer system.

2.

In the Phase I Permit, Ecology chose to regulate stormwater discharges from new development and redevelopment primarily through the imposition of a new flow control standard. Permit Condition S5.C.5.b.i. *Phase I Decision* at FOF 38. The flow control standard is set out in Ecology's 2005 Stormwater Management Manual (2005 Manual), and required for development projects over certain size thresholds. *Ex. J-16 (Phase I Permit)* at Condition S5.C.5.b.i.[2] Under this updated flow control requirement, Phase I permittees must require new development and redevelopment projects to control the rate at which stormwater is released from the site to match historical pre-developed (typically forested) conditions, rather than existing site

[2] Ex. J-16 is the version of the Phase I Permit issued on January 17, 2007, and modified on June 17, 2009. The most recent version of the Phase I Permit, Ex. J-23, was modified on September 1, 2010, to incorporate, among other things, the Agreed Order that is the subject of this appeal.

condition runoff.[3] The flow control standard, which is contained in the 2005 Manual, represents a "default" standard under the Phase I Permit. If certain criteria are met (discussed further in this opinion), a permittee can implement an alternative program to the flow control standard. Under the same section of the Phase I Permit addressing controlling runoff from new development, redevelopment, and construction sites, the permittee must also require use of non-structural preventive actions and source reduction approaches, including Low Impact Development (LID), to minimize the creation of impervious surfaces and the disturbance of soils and vegetation where feasible. *Ex. J-16* at Condition S5.C.5.b.iii. The Phase I Permit required the ordinances necessary to implement this section of the permit to be adopted no later than 18 months from the effective date of the permit, by August 16, 2008. *Id.* at Condition S.5.C.b.iv.

3.

On January 13, 2009, Clark County adopted Ordinance No. 2009-01-01, with an effective date of 90 days later, or April 13, 2009. Among other things, the ordinance requires the flow duration standard for high flows to be engineered to match the *existing* conditions on the site rather than historic, pre-development conditions, as required by the Phase I Permit. Clark Co. Code 40.385.020.C.2.a. Clark County did not offer their adopted ordinance to Ecology as an equivalent alternative program under the provision of the Phase I Permit that allows a variance from the default flow control standard. Instead, in adopting the January 2009 Ordinance, Clark County rejected the regulatory approach Ecology had implemented with the Phase I Permit, and

[3] The standard flow control requirement is to "match development discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow." *Id*. at Appendix 1, p. 24.

determined it would impose a less stringent standard for stormwater control at new development and redevelopment sites.

4.

On March 17, 2009, Ecology issued a Notice of Violation to Clark County alleging that the county violated the terms of the permit by "[a]dopting a flow control policy that Ecology determined does not provide equal or similar protection of receiving waters and equal or similar levels of pollutant control, as compared to Appendix 1 [the 2005 Stormwater Management Manual]. (CCC § 40.385.020.C.2.a)." *Ex. J-2* at 1. In addition to being late, Ecology also determined that Clark County's ordinances and manual adopted an exemption for infill and redevelopment projects from the 0.1 cubic feet per second flow increase threshold, also set out at Appendix 1 of the Phase I Permit. *Id.* In the Notice of Violation, Ecology stated that the purpose of the flow control requirement is to "reduce harmful impacts on fish, other aquatic life and streams caused by runoff from development." *Id.* Ecology concluded that Clark County's lesser standards and thresholds for control of runoff from new development and redevelopment would not provide an equivalent amount of protection to receiving waters and pollutant control, as required by the Phase I Permit. The Notice of Violation gave the County thirty (30) days to inform Ecology what steps it had or would take to control pollution and comply with the Order. *Id.* at 2.

5.

On January 6, 2010, Clark County and Ecology entered into Agreed Order No. 7273, the purpose of which was to "establish the actions necessary to bring the County into compliance

with Special Condition S5" of the Phase I Permit. *Ex. J-1* at 1. The Order requires Clark County to implement a flow control program for new development and redevelopment that Ecology concluded will result in an equivalent level of protection as the flow control requirement for new development and redevelopment in the Phase I Permit. Ecology stated that the Agreed Order ~~"w~~will provide an equivalent level of flow control" to that required under the Phase I Permit. Ecology also noted that ~~"[t~~]his approach is consistent with the Permit wherein Permittees are allowed the option of proposing alternative methods of achieving flow control standards." *Ex. J-1* at 3. Rosemere timely filed this appeal challenging the Agreed Order.[4]

6.

Concept of Agreed Order: Under the Agreed Order, Ecology approved Clark County's alternative flow control program on the condition that Clark County mitigate runoff from new development and redevelopment to the historic, pre-development condition through a capital flow control mitigation program undertaken at alternative sites selected by the County, and at County expense. *Ex. J-1* at 3-4. In other words, the Agreed Order allows Clark County to apply the lesser flow control standard to new and redevelopment projects in its jurisdiction, utilizing *existing* rather than pre-development conditions as the basis for application of the flow control standard, provided that Clark County ~~"m~~itigates," or makes up the difference, at another site in

[4]The parties filed cross motions for summary judgment on several of the legal issues in this appeal, all of which the Board denied. In denying summary judgment, the Board determined that it needed a better record in order to reach a decision about whether the Agreed Order provides equal or similar protection of receiving waters as the Phase I Permit. The Board concluded that Rosemere, as the appealing party, would continue to bear the burden of proof in challenging the Agreed Order but that Ecology also bore the burden of establishing the baseline against which it determined the equivalency of Clark County's alternative. *Order Denying Summary Judgment*, at 16-18.

the County. The Agreed Order allows the County to mitigate by building several types of flow control facilities as capital improvement projects. These include stormwater retention, infiltration and detention facilities, existing facility retrofits or reconstruction, including LID retrofits, and conversion of land cover to historical forest. *Ex. J-1* at Attachment A, pp. 4-7.

7.

Authority for Agreed Order: The Agreed Order entered into between Ecology and Clark County relies on that term of the Phase I Permit that allows there to be adjustment or variance of the flow control requirements, by use of ~~"m~~ore stringent requirements," and/or requirements that may be ~~"ta~~ilored to local circumstances through the use of basin plans or other similar water quality and quantity planning efforts." *Id*. at Condition S.5.C.5.b.i. The permit requires that any such local alternative standards ~~"s~~hall provide equal or similar protection of receiving waters and equal or similar levels of pollutant control" relative to the default standard. *Id.* Because this is the standard the Board must apply to evaluate the Agreed Order under appeal in this case, we first make findings related to whether the prerequisites under the Phase I Permit for allowing an adjustment or variance to the flow control standard have been met, then make findings related to the scope of the Agreed Order, followed by findings related to the requirements of the Phase I Permit, and the manner in which the County will implement the Agreed Order. These form the basis of our analysis and conclusions as to why the mitigation program of the Agreed Order fails to provide equal or similar protection to receiving waters and equal or similar levels of pollutant control to that required by the Phase I Permit.

8.

Metrics for calculating the mitigation obligation: The Agreed Order establishes an accounting system for the mitigation requirement based upon the existing project land use cover acreage for each of three categories of land use cover: effective impervious area, pasture, and lawn/landscape. Conversion of forest land does not trigger a mitigation obligation because the County Code requires development projects to fully mitigate for the project's cleared forest. The County will review all new development or redevelopment projects subject to the Agreed Order to determine the extent to which they fall short of mitigating to historical land cover conditions. The Agreed Order does not require the County to track or account for either the soil type or the slope of the new or redevelopment project site triggering the mitigation obligation, and it does not require the mitigation sites to have the same soil type or slope as the site of the new or development project. *Ex. J-1* at Attachment A.

9.

Tracking and Accounting mitigation obligation: The County will track the projects and, once construction or land disturbing activity starts, will incur a mitigation obligation. The mitigation obligation associated with each new or redevelopment project is measured as the difference between the flow control provided by the project to existing land cover and the amount of flow control required to meet minimum requirement #7 of the Phase I Permit's Appendix 1. *Id.* The County must construct flow control projects that achieve the additional amount of flow control necessary to match historic conditions. The Agreed Order sets out the acceptable procedures for performing the necessary calculations related to the stormwater

retention and detention facilities, which involve using the Western Washington Hydrology Model (WWHM) or the Clark County version of the WWHM. *Ex. J-1* at Attachment A, p. 5. Additional details regarding Clark County's tracking and accounting system for the mitigation requirement are specified in Attachment A of the Agreed Order. County's Development and Redevelopment Flow Control Mitigation Program ("Mitigation Program"). *Ex. J-1* at 4 & Attachment A.

10.

Location of Mitigation Projects: Mitigation projects to address the County's mitigation obligation must be built within the same Water Resource Inventory Area (WRIA), of which there are two in Clark County.[5] The Agreed Order states that "[T]o the *extent feasible*, the locations of Mitigation Projects *should* support identified needs and recommendation in existing resource management plans, and *should* also align with the County's policies on environmental mitigation. Projects s*hould* be prioritized by watershed and then WRIA, in consideration of the distribution of the County's Mitigation Obligation." (emphasis added.) *Ex. J-1* at Attachment A, p. 8. Clark County will use its current Stormwater Needs Assessment Program (SNAP) and Stormwater Capital Improvement Program (SCIP) to scope, prioritize, and plan flow control mitigation projects. *Id*. The Agreed Order gives the County considerable leeway in how it ultimately selects mitigation projects, stating as follows with respect to development and prioritization of mitigation projects: "Within the group of projects deemed most suitable to

[5] WRIA 27, which drains the northern portion of the County to the Lewis River and its tributaries, and WRIA 28, which drains the southern portion of the County to the Columbia River and its tributaries. *Beyerlein Testimony*.

watershed conditions, highest priority may be given to projects having the best cost/benefit ratios in terms of cost per unit of land cover, mitigated." *Id.* Ecology does not have a role in the review or approval of the prioritization process or the mitigation projects selected under the Agreed Order.

11.

Timing of mitigation: The County must meet its flow control mitigation obligation within two calendar years from the calendar year the development project being mitigated starts construction or land disturbing activity. *Ex. J-1* at Attachment A, p. 9. For example, a development project requiring mitigation that began construction anytime during calendar year 2009 must be mitigated by the end of calendar year 2011. *Id*. Since various types of subdivision and other construction approvals are valid for periods of two to seven years, and possibly longer with extensions, this will result in mitigation obligations extending well beyond the term of the current permit and into the future several years. *See e.g.,* RCW 58.17.170 and CCC 14.06.105.5.

12.

Use of Vesting, and Relevant Effective dates: Under the Agreed Order, the County incurs a potential mitigation obligation for any new or redevelopment project that meets threshold requirements for flow control facilities under the Phase I Permit and that ~~"v~~ested" under state vesting laws [6] on or after April 13, 2009. *Ex. J-1* at Attachment A. Stated another way, the Agreed Order does not require mitigation for all projects as of August 16, 2008, the Phase I Permit's deadline for adoption of ordinances, but rather provides the County an additional eight

[6] RCW 58.17.033 (subdivision code) and RCW 19.27.095 (building permits).

month delay before applying the flow control standard to new applications for development or redevelopment. The Agreed Order also allows the County to receive mitigation credits for any qualifying flow control mitigation projects completed after April 13, 2009, irrespective of when they were designed, approved, or started construction. *Ex. J-1* at Attachment A. In practice, this has allowed the County to receive a large amount of mitigation credit for a project that was well underway before the Agreed Order was executed or before the County incurred any mitigation obligations.[7] Numerous commercial and multifamily building permit applications, as well as numerous subdivision permit applications, vested for land use purposes between August 16, 2008, and April 13, 2009.[8] *Exs. A-58, A-59*. One of these subdivisions is approved for 103 single-family lots. *Snell Testimony, Ex. A-67*. EPA expressed concern that the delayed effective date under the Agreed Order provides less cumulative flow control over its term than the Phase I Permit. *Shrieve Testimony, Ex. A-22.* NMFS likewise expressed concerns over the lag time between August 2008 and April 2009, and stated that there is "no scientific justification" for this delay. *Shrieve Testimony, Ex. A-23.* Costs can be significant, however, if a project needs to be re-designed. *Killian Testimony*.

[7] The County has reported mitigation credit for 11 acres of Effective Impervious Area, 15 acres of Lawn/Landscape, and 2 acres of Pasture in connection with its completion in 2009 and 2010 of the 152nd St. project (aka "Encore North Phase I"), a project that has been on the County's capital projects list for several years. *Ex. J-20.*

[8] A subdivision will discharge into a municipal separate storm sewer system (MS4) approximately 80 to 90 percent of the time. *Gray Testimony*.

13.

Monitoring/Maintenance of mitigation projects: The Agreed Order does not include any requirements for the County to monitor or maintain the mitigation projects it constructs under the Mitigation Program. Clark County's Stormwater Facility Maintenance Manual, and its Stormwater Manual, set forth the requirements for monitoring, inspecting, and maintaining stormwater mitigation facilities. *Exs. R-29 & R-30*.

14.

Funding of Mitigation Program: The Agreed Order requires the County to maintain funding sources adequate to comply with the Agreed Order. *Ex. J-1* at p. 4. Parties to the Agreed Order anticipated that the County's Clean Water Fund would be used to plan and construct mitigation projects, although the Agreed Order provides that the County may use any allowable funds to pay for mitigation projects. *Ex. J-1* at Attachment A, p. 11.

15.

Reports to Ecology: Clark County will report to Ecology annually on the status of its Flow Control Mitigation Program, as an attachment to the annual report required by the General Permit. The Agreed Order sets out the elements of the annual report, and also requires the County to include a narrative describing the funding status of the mitigation program, identifying any anticipated shortfalls. Beyond this reporting requirement, Ecology has no role in selection of mitigation projects, and no responsibility for review or approval in project selection or prioritization. There is no requirement in the narrative reporting for the County to compare results achieved through the mitigation program against any criteria related to stream or basin

health or recovery, or to identify whether significant areas of salmon habitat are being mitigated to compensate for similar significant areas of salmon habitat where historic pre-development conditions are not being mitigated at the site of the new development or redevelopment. *Ex. J-1*, at Attachment A, p. 10.

16.

On September 1, 2010, Ecology modified the Phase I Permit to incorporate the substantive provisions of the Agreed Order into the permit. *Ex. J-23*. Rosemere timely filed an appeal of the Permit Modification.

17.

In coming to agreement with Clark County, Ecology evaluated the Agreed Order to determine if it was equivalent to Phase I Permit requirements under the terms of Condition S5.C.5.b. *O'Brien Testimony*. Ecology now contends that the Agreed Order does not change the default flow control standard, but rather provides a different administrative way to meet it, simply allowing it to be applied at a different site. *O'Brien Testimony*. The County and Ecology also attempt to recast the Agreed Order as something other than a ~~"m~~itigation" program, by stating the County is meeting its obligation to match the Phase I Permit flow control standard, just at an alternative location. *Gray Testimony*. If Ecology (and the County) is correct in this latter interpretation, then Clark County was not required to conduct basin planning or a similar water quality and quantity planning effort prior to Ecology's approval of the alternative flow control program under Condition S5.C.5.b. The Board will first consider the purpose of basin

planning and the purpose of the flow control standard, in developing its conclusions of law on this issue.

18.

Appendix 1 to the Phase I Permit and the Stormwater Management Manual for Western Washington provide further specificity on how basin plans, referenced in Condition S5.C. of the Phase I Permit as an alternative planning effort, are to be developed. Appendix 1 states that an alternative requirement for Western Washington may be established through application of *watershed-scale* hydrological modeling and supporting field observations. *Ex. J-17 at* Appendix 1 (Minimum Technical Requirements for New Development and Redevelopment), pp. 25 & 28.[9] Appendix 1 also requires that before a basin plan can modify the minimum requirements of the Phase I Permit: it must be formally adopted by all jurisdictions with responsibilities under the plan, all ordinances and regulations called for by the plan must be in effect, and the basin plan must be reviewed and approved by Ecology. *Id.* at p. 29.

19.

It is unrebutted that Clark County did not prepare a basin plan using watershed-scale hydrological modeling and supporting field observations, it did not adopt a basin plan, and Ecology did not review and approve a basin plan for Clark County as an underlying basis for the alternative program set out in the Agreed Order. Instead, Clark County will use its Stormwater Needs Assessment Program (SNAP) and Stormwater Capital Improvement Program (SCIP) to

[9]This is the same requirement as set forth as a minimum requirement for flow control in the Stormwater Management Manual for Western Washington. *Ex. J-19* at Vol. 1, §2.5.7, p. 2-33.

scope, prioritize, and plan flow control mitigation projects. *Ex. J-1* at Attachment A, p. 8. These planning documents relied upon by Clark County to justify its alternative flow regime, fall far short of what is contained in a basin plan. A basin plan includes several key components, including a discussion of zoning, projected build-out, an evaluation of every stream channel (each which has been walked), a hydrologic model, and water quality data that includes new sampling. Essential information such as hydrologic modeling is missing in many of the SNAP manuals. *Booth Testimony*. Rod Swanson, the NPDES Coordinator for Clark County, acknowledged the SNAP manuals are not basin plans. *Swanson Testimony.* Similarly, SCIP is a process whereby the County uses objective criteria to evaluate and prioritize the many possible stormwater capital improvement projects, allowing public input on the allocation of resources. *Ex. J-3.* It is not a basin plan in any sense of the word.

20.

The Phase I Permit requires that municipalities' Stormwater Management Programs (SWMP) must prevent and control the impacts of runoff from new and redevelopment activities. *Ex. J-16* at Condition S.5.C.5.a-b.ii. In order to do so, the Phase I Permit required implementation of a new, more stringent default flow control standard, with the attendant thresholds and definitions contained in Ecology's 2005 Stormwater Management Manual. This new standard was developed over a long period of time, and replaced the previous "peak" flow standard. *Ex. J-16* at Condition S.5.C.5. Under the Phase I Permit, municipal permittees are required to control stormwater flows from certain new and redevelopment projects to levels that match historical pre-developed (typically forested) conditions, under certain peak flow

conditions.[10] In other words, it requires facilities be engineered so that discharges are not predicted to exceed the predevelopment flow duration for a range of storm events. *O'Brien Testimony, Booth Testimony.* The Independent Science Panel, which reviewed Ecology's Stormwater Management Manual for Western Washington, determined the flow control standard and the requirement to match flows estimated for an historic land cover condition, was appropriate to use in all watersheds, regardless of a watershed's current level of development.[11] *Ex. R-77* at p. 11.

21.

A primary goal of the new flow control standard of the Phase I permit is to make progress in reducing high flows of stormwater from all new development, redevelopment, and construction sites that contribute to accelerated erosion of stream channels. *O'Brien Testimony, Booth Testimony.* Ecology identified the purpose of the flow control requirement (Condition S.5.C.5.b.ii) as being ~~"to~~ reduce negative impacts on water quality, fish, other aquatic life, and streams caused by increased runoff from new development and redevelopment and to reduce impacts from existing development." *Ex. J-1*. Stated another way, the Phase I permit's flow control standard is intended to ensure flows from new and redevelopment do not make existing conditions worse and, where existing conditions/flows are different from historic flows, require

[10] The standard flow control requirement is to "match development discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow." It applies to projects of a specified size or generating a specified amount of stormwater discharge. *Id*. at Appendix 1, p. 24.

[11] The Independent Science Panel was created by the Legislature in 1998 to provide scientific oversight and review of the State's salmon recovery efforts. *Ex. R-77, p. 1*.

that post-development flows restore flows to more natural conditions. While the flow control standard was not expected to restore aquatic habitat, or eliminate all erosion from a development site, it represented a substantial advancement in the effort to reduce adverse impacts to stream hydrology and water quality associated with stormwater runoff, and associated high flows, from ongoing urbanization, offering significant protections for streams from erosion and other adverse consequences. *Booth Testimony, O'Brien Testimony.* In discussing the objective of the flow control requirement and flow control BMPs, the Stormwater Management Manual for Western Washington states that "[m]aintaining the naturally occurring erosion rates within streams is vital, though by itself insufficient, to protect fish habitat and production." *Ex. J-19* at Vol. 1, §2.5.7, pp. 2-34.

22.

In the Phase I Decision, this Board discussed the need for the NPDES Phase I Permit to comply with the Clean Water Act requirement to reduce pollution to the maximum extent practicable (the "MEP" standard). The Board also concluded that state law had a similar requirement, wherein all waste discharge permits must incorporate permit conditions that require all known, available and reasonable methods of treatment to control discharges and protect water quality (the "AKART" standard) *Phase I Decision* at COL 12. The Board also found as follows with respect to the conditions of the Phase I Permit: "Ecology views these SWMP requirements, in the aggregate, to represent MEP standard; that is, permittees who implement all of the program requirements in combination with one another are considered by Ecology to be reducing pollutants to the maximum extent practicable…." *Phase I Decision* at FOF 8. Ultimately, the

Board concluded that the permit's reliance on a flow control standard as the primary method to control stormwater runoff from MS4s failed to reduce pollutants to the federal MEP standard, and did not represent application of all known, available and reasonable methods of treatment under state law because it placed insufficient reliance on the application of low impact development (LID) techniques in combination with the flow control standard. These findings and conclusion are discussed further below. *Phase I Decision*.

23.

Ecology determined that in order to satisfy MEP and AKART, permittees must adopt their updated flow control requirements no later than 18 months after the effective date of the permit (August 16, 2008), and begin applying those requirements within a reasonable period of time after adoption (30-90 days). The Phase I Permit's Appendix 1 does not specify a precise date by which the post-construction stormwater control facilities need to be operational relative to the start of construction or land-disturbing activity at development sites. As a practical matter, they are typically constructed as part of the site-development process, when the developer installs the infrastructure for the new or redevelopment. In a subdivision, for example, this means they are constructed when the roads and utilities are installed, prior to the construction of the individual residences within the subdivision. *O'Brien Testimony*.

24.

The Phase I Permit does not require either municipal permittees or developers to monitor the effectiveness of the stormwater control facilities constructed in compliance with the permit's default flow control standard in Condition S.5.C.b.ii. The permit requires that municipal

permittees' stormwater management programs must use qualified personnel to perform post-construction inspections of all development sites that meet the thresholds of the default flow control standard, provide for the development of maintenance plans for permanent stormwater facilities, and assign responsibility for such maintenance. *Ex. J-16* at Condition S.5.C.b.vi.

25.

The Board finds that the Agreed Order rests on no science as to the comparability of its mitigation metric in relation to the Phase I Permit's flow control approach, and has no requirement on a going forward basis that calls for a comparison of the benefits gained at a mitigation site, compared to the detrimental effects at a new development site where a lesser control standard is utilized. As discussed earlier, the Agreed Order allows the County considerable leeway in how it ultimately selects and sites flow control mitigation projects. The only restriction is that mitigation projects to address the County's flow control mitigation obligation must be built within the same WRIA. While the mitigation obligation is measured and tracked by acres for each of three land-cover types, it does not require the County to track or account for either the soil type or the slope of the new or redevelopment project site triggering the mitigation obligation, and it does not require the mitigation sites to have the same soil type or slope as the site of the new or development project. As discussed below, the acreage metric set forth in the Agreed Order, and the siting of flow control mitigation projects without any requirement for Clark County to address equivalent impacts to the environment and beneficial uses, lack a scientific basis and is inconsistent with directives to protect beneficial uses.

26.

The majority of the Board finds that the acreage metric is fundamentally flawed. Ecology believes this acreage metric is useful because it is straight-forward and is less likely for a permittee to be able to "play games with." *O'Brien Testimony.* While the acreage metric may be simpler and easier to implement, the majority finds it is critically flawed because it is based entirely upon a mathematical perspective and there are *no* data, studies, or scientific support to support its underlying assumption that harm caused to one stream can be mitigated through a project in a different subwatershed. Under this acreage metric, it is highly unlikely there will be any relationship between the harm and the benefit. *Winters Testimony*.

27.

The acreage metric also completely ignores the purpose of the flow control requirement in the first instance, which is to "reduce harmful impacts on fish, other aquatic life and streams caused by runoff from development." *Ex. J-2* at p. 1. Multiple witnesses stressed how the acreage metric fails to consider and mitigate for actual impacts on the environment, for example eroded stream banks and scoured substrates. *Booth Pre-Filed Testimony* at ¶33. Salmon and steelhead populations are influenced by the importance of the habitat affected, and the areas to be used for mitigation do not need to account for any of these attributes. *Rhodes Pre-Filed Testimony* at ¶36.

28.

The weight of expert testimony recognizes that streams, once degraded, can continue to degrade. "[T]he high flow durations from even a partially developed site will be highly disruptive to streams." *Booth Pre-Filed Testimony* at ¶24. "[D]amage to receiving waters from stormwater flow from developed areas is cumulative. Damage to a stream builds on itself each time it rains as the water flows faster, cuts stream banks and scours stream beds further, and the hydrograph becomes more extreme. In other words, a flow duration standard based on meeting only existing conditions (like Clark County's) [at new development sites] does not freeze the environmental conditions in place, but allows for ongoing cumulative degradation of the stream. Moreover, the status quo in Western Washington, including Clark County, is currently degraded … with many streams unable to support beneficial uses and even basic ecological function due in large part to stormwater runoff from developed areas." *Booth Pre-Filed Testimony* at ¶26. Doug Beyerlein, Clark County's expert witness on hydrology, did not disagree with Dr. Booth's research and agreed that Clark County streams are not stabilized. *Beyerlein Testimony.* Ecology's expert, Ed O'Brien, also acknowledged that streams are still degrading, that there is nothing unique about Clark County that precludes use of Ecology's default flow control standard, and that no part of Clark County qualifies as a highly urbanized area for purposes of applying a lesser standard. *O'Brien Testimony.* The Board finds that the streams in Clark County are subject to further degradation.

29.

Ecology recognizes that the flow control standard is a water-quality based standard and not just a technical standard. The flow control standard, therefore, goes beyond the state's requirement to implement AKART. Ecology also states that the flow control standard tries to address past harms to streams, but was not intended to address all biological factors. *O'Brien Testimony*. Simply because all biological factors are not meant to be addressed by the flow control standard, however, does not mean all biological factors on the ground can be ignored, especially given the purpose of the flow control standard to protect beneficial uses in the stream. Ecology has, in connection with this case, recognized the importance of preserving beneficial uses when evaluating flow control regimes. The Department stated that "[t]o relieve any developed area of a retrofit obligation for flow control, the County has to prove that a stretch of stream channel has not been altered by flows from existing development; *or that the altered stream channel is still compatible with preserving the necessary beneficial uses*." *Ex. A-50* (emphasis added.)

30.

The experts all agree that factors such as soil type, slope, and other conditions are highly variable from site to site, and those variables have consequences for how alteration to the site impacts the stream. "[V]ariables such as stream size, soils in stream beds and banks, slope and characteristics of stream banks, grade, vegetation in-stream and near-stream as well as previous damage can all result in different reactions by a stream to stormwater and attempts to address it. An amount or type of development that causes minimal damage in one stream may dramatically

alter the morphology of another. *Booth Pre-Filed Testimony* at ¶18. "Development on a highly infiltrative soil will likely result in particularly large increases in runoff. . . . Mitigation on a less-infiltrative soil somewhere else can never recover the loss of recharge or commensurately reduce the increase in stream discharge." *Booth Pre-Filed Testimony* at ¶34.

31.

In the Lower Columbia basin, several salmon and steelhead populations are listed as threatened or endangered under the federal Endangered Species Act. *Rhodes Pre-Filed Testimony* at ¶8. Clark County is one of the fastest growing counties within the state. *Ex. A-49* at p. 1. The evidence indicates that potential impacts to fish and other aquatic organisms from stormwater can be significant, and is essentially unrebutted. In 1999, the state of Washington identified stormwater runoff as a major factor in the degradation of salmon streams in developed areas in the" Statewide Strategy to Recover Salmon: Extinction is Not an Option" (Statewide Strategy). The Statewide Strategy recommended that Ecology update the 1992 Stormwater Management Manual to provide guidance for applying the most recent stormwater management science and technology to new development and redevelopment to comply with water quality standards and contribute to the protection of beneficial uses of the receiving waters. *Ex. R-77* at p. 1. The testimony of the experts echoes the relationship between stormwater and negative impacts to fish. "[C]ombined effects significantly reduce the survival and production of salmon and steelhead and can cause long-term degradation of what was once good spawning and rearing habitat to a degree that renders it unusable or unproductive." *Rhodes Pre-Filed Testimony* at ¶16.

32.

The majority of the Board finds that the terms of the Agreed Order are insufficient to protect beneficial uses. Under the terms of the Agreed Order, Clark County can allow an important spawning reach to be impacted by application of the old flow control standard, and then, a few years later, mitigate the same number of acres in a watershed area that may not be occupied by fish or that does not have as important spawning or rearing habitat. *Rhodes Pre-filed Testimony* at ¶32. The evidence before the Board supports this conclusion by stating as follows: "The Clark County standard is plainly insufficient to protect beneficial uses like salmon and other aquatic life, and healthy aquatic conditions generally." *Booth Pre-Filed Testimony* at ¶25. Clark County contends that its approach of targeting streams and watersheds for improvements where the greatest problems exist is the best approach for successful mitigation rather than mitigating all development at the development site. *Gray Testimony*. While the Board does not disagree with this statement, the majority finds that the Agreed Order does not require such targeting.

33.

Ecology acknowledges that the location of where flow enters a stream can impact the system. If the flow enters a higher portion of a stream, then generally there is a greater impact on the stream channel because there is an impact throughout the system. *O'Brien Testimony*. As noted by one of the Petitioners' experts, "There is nothing in the Agreed Order approach that would prevent the harm from occurring in the most ecologically valuable subwatersheds (for example, headwaters, riparian buffers, salmon habitat, etc.) in exchange for mitigation that is in

the least ecologically important areas (degraded, highly developed, far downstream, etc.), but that happens to meet the acreage requirement in the same WRIA." *Booth Pre-Filed Testimony* at ¶36. Viewed in a different context, if development occurred near a stream that ultimately discharged to an area of shellfish production that was in danger of being closed because of stormwater contaminants, allowing the mitigation of the historical damage to occur in an entirely different stream that discharged near an industrial area would easily be recognized as not being equivalent in its impact on beneficial uses.

34.

The United States Environmental Protection Agency (EPA) expressed multiple concerns over Clark County's proposed flow control program in a letter to Ecology. EPA emphasized that stormwater impacts to salmon bearing streams constitutes a significant limiting factor to the recovery of ESA listed salmon in Western Washington. EPA stated its belief that mitigating urban and urbanizing stormwater impacts will require a three prong approach: 1) state of the art methods to minimize the impacts from new development, 2) enhanced gradual improvement of baseline conditions as redevelopment occurs, and 3) enhanced investment in retrofit projects to reduce stormwater impact from developed land. *Ex. A-22.* The Agreed Order does not necessarily allow for gradual improvement of baseline conditions in areas that are significant to salmon. Furthermore, by subsidizing mitigation, Clark County's is not making the enhanced investment in retrofit projects called for by EPA (discussed further in this opinion).

35.

The National Marine Fisheries Service (NMFS) also sent a letter to Ecology expressing concerns over Clark County's proposed flow control program. NMFS emphasized the science that went into the development of the default flow control standard: "In Ecology's 2002 review material provided to the Independent Science Panel, Ecology stated that the use of the pre-developed, forested conditions standard was "… the most appropriate assumption necessary to help achieve the federal and state water pollution statutory and regulatory requirements to maintain beneficial uses." NMFS also noted that in the Notice of Violation Ecology issued to Clark County, Ecology stated that "*a flow control target is not defensible unless analyses of basin flows and stream geomorphology indicate it will produce a flow regime compatible with sustaining and restoring beneficial uses*." *Ex. A-23* at p. 2. NMFS also commented that while the Clark County program appeared to be aiming to provide equivalent effects to receiving water bodies, effects on specific river systems may not be equivalent, and expressed concern about the lack of guidelines in the mitigation program to address effects to listed salmon and steelhead as important factors to be considered in selecting mitigation sites. *Ex. J-18*. NMFS also described the adverse effects certain pollutants in stormwater discharge have upon salmon, and that reducing the volume of stormwater can help salmon avoid these detrimental effects. NMFS further concluded that "The expectation that mitigation based solely on acreage and land use type will be effective to adequately reduce flow control effects is not supported by best available science." *Ex. A-23* at p. 3.

36.

The Fact Sheet for the Phase I Permit discusses the wide range of impacts stormwater can have upon fish, invertebrates, and water quality. The Fact Sheet also recognizes that impacts from stormwater are highly site-specific and vary geographically due to differences in local land use conditions, hydrologic conditions, and the type of receiving water. *Ex. J-15* at p. 8. In addition, the Fact Sheet recognizes the link between permit requirements and the protection of beneficial uses by citing to RCW 90.48.010. This statute declares as the public policy of the state to maintain the highest possible standards to insure, among other ends, the propagation and protection of wild life, birds, game, fish, and other aquatic life. *Ex. J-15* at p. 16.

37.

Ecology's uncertainty regarding whether Clark County will undertake mitigation in areas that are ecologically valuable to salmon and other aquatic life, or which is otherwise important to water quality, is evident in Ecology's response to interrogatories. When asked whether the habitat/stream classification or status of water quality had any bearing in the mitigation provisions of the Agreed Order, Ecology responded: "The Agreed Order does not require habitat/stream classification or status of water quality, but Ecology *expects* the County will *consider* these factors in prioritizing mitigation projects." (emphasis added.) *Ex. A-4* at p. 16 (Interrogatory No. 21).

38.

In contrast to the lack of evaluation required in the Agreed Order for mitigation to be based on environmental impact, the Department of Ecology devotes five pages in its guidance on

wetland mitigation to the types of analyses that must be conducted to justify mitigation in that context. *Booth Pre-Filed Testimony* at ¶36. (citing Wetland Mitigation in Washington State – Part I: Agency Policies and Guidance (Version 1), 2006, pp. 55-59).

39.

In December 2008, Ecology issued "Making Mitigation Work"[12] as a shared vision by the Mitigation That Works Forum (Forum) for successful mitigation and to identify practical actions that could be taken to make all aspects of environmental mitigation work better and to improve outcomes. *Ex. A-25* at p. 2. The Forum found that many mitigation projects continue to be poorly sited, poorly designed and implemented, and poorly maintained, without sufficient attention being devoted to monitoring and adaptive management. Therefore, ecological values and functions continue to be lost, watershed conditions increasingly degrade, especially in developing areas. *Id.* at p. 3. One of the Forum's recommendations was the use of a compliance monitoring and inspection checklist for mitigation projects. The Forum recommends that when compliance monitoring shows that a mitigation project is not working, prompt efforts should be undertaken to correct the problems so that the mitigation project can provide environmental functions and values. *Id.* at p. 24. As discussed earlier, the Agreed Order fails to include any monitoring for its flow control mitigation projects. Monitoring of Clark County's mitigation projects under the Agreed Order has been described as "vital" by a hydrologist. *Rhodes Testimony*.

[12]Although Respondent Clark County tried to establish that this document was limited to wetland mitigation, a review of the document clearly shows this is not the case. See for example, Section 2.4, where mitigation for wetland, stream, shoreline and nearshore impacts is discussed. *Ex. A-25, p. 13-14*.

40.

In addition to establishing the new flow control standard, the same section of the Phase I Permit applicable to new development, redevelopment, and construction sites also requires that the permittees' stormwater management program "must require non-structural preventive actions and source reduction approaches including Low Impact Development techniques (LID) to minimize the creation of impervious surfaces, and measures to minimize the disturbance of soils and vegetation where feasible." *Ex. J-16* at Condition S5.C.5.b.iii. The Phase I Permit's modified conditions related to LID were the result of this Board's decision in the Phase I case. In that decision the Board made lengthy and specific findings that LID was a well-established concept, and the basic BMPs that constituted LID well-defined. The Board found that utilization of LID techniques "may be useful (or even in some cases necessary) to meet the flow control standard on a particular site." *Phase I Decision* at FOF 38. The Board's extensive, and unchallenged, findings of fact related to LID stated, among other findings that "[r]equiring municipalities to impose parcel and subdivision-level LID best management practices represents a cost effective, practical advancement in stormwater management." *Id.* at FOF 60. The Board concluded that LID methods are known and available method to address stormwater runoff at the site, parcel, and subdivision level, and ordered the Phase I permit modified to required LID, where feasible, in the SWMP of each municipal permittee. *Phase I Decision* at FOF 66.

41.

Ecology's Notice of Violation to Clark County originally identified a second problem with the County's compliance with the Phase I Permit's condition S5.C.5 requirements, in

addition to the ―existing" versus ―pre-development" conditions problem. Specifically, Ecology cited the County for adopting an exemption for certain development projects from one of the thresholds that triggers the duty to control high flow durations. *Ex. J-2*. The new stormwater ordinances adopted by the County in response to the Phase I Permit on January 13, 2009, included an exemption for infill and redevelopment projects from the one tenth (0.1) cubic feet per second (cfs) flow increase threshold identified in Minimum Requirement No. 7 of Appendix 1. As part of the Agreed Order, the County agreed to change its codes and manual during the County's fall 2009 Biannual Code Review to remove the exemption of infill and redevelopment projects from the 0.1 cfs flow increase threshold contained in Minimum Requirement 7, which would become effective no later than December 8, 2009. *Ex. J-1* at 4. However, during the window between the adoption of the non-compliant code and the subsequent removal of the exemption, many commercial projects and subdivisions vested under Clark County's land use regulations. *Exs. A-58, A-59*.

42.

In addition to establishing a flow control standard at new development sites and requiring implementation of LID where feasible, the Phase I Permit also required local governments to include a structural stormwater control program in their stormwater management program to prevent or reduce impacts to waters caused by discharges from the MS4. *Ex. J-16* at Condition S5.C.6. Sometimes referred to as the ―structural retrofit" program, this permit term required Phase I municipalities to consider impacts of stormwater discharges from existing development, and areas of new development. The program was to address impacts ―not adequately controlled

by the other required actions of the SWMP," and required proposed projects and an implementation schedule. The permit offered a number of examples of programs that could meet this requirement, such as regional flow control facilities, water quality treatment facilities, retrofits of existing facilities, and property acquisitions, among others. *Id.*

43.

As part of the minimum performance measures for the structural stormwater control program, each permittee must include the goals that are intended to be achieved; the planning process used to develop the program, including, among other factors, the type of characterization information considered and the amount budgeted for implementation; and a description of the prioritization process, procedures, and criteria used to select the structural stormwater control projects. For planned individual projects, and programs of small projects, the following detailed information must be provided: the estimated pollutant load reduction that will result from each project designed to provide stormwater treatment; the expected outcome of each project designed to provide flow control; any other expected environmental benefits; and if planned, the monitoring or evaluation of the project and the monitoring or evaluation results. *Ex. J-16* at Condition S5.C.6. Recognizing that mitigation projects under the Agreed Order are not structural control projects responsive to this Phase I Permit requirement, but to depict the contrast, Clark County is not required to even state what the expected outcomes will be for its flow mitigation projects under the Agreed Order.

44.

The Fact Sheet for the Phase I Permit states that the permit language pertaining to structural stormwater controls is drawn directly from EPA rules.[13] Although Ecology recognizes that it is not feasible to provide structural controls to mitigate for the impacts of all existing development, *"[p]ermittees will set priorities and address the highest-ranked problems subject to the limitations of available resources.*" (emphasis added.) *Ex. J-15* at p. 35.

45.

In recommending the Agreed Order, Ecology expected that Clark County would commit extra funding to the mitigation program of the Agreed Order, above and beyond that already dedicated to the structural stormwater control "retrofit" program as required by the Phase I permit. Ecology further understood from Clark County that the County would maintain at least the same level of effort for its existing structural retrofit program. Ecology expected that implementation of the Agreed Order would necessitate new projects, not simply a shifting or "counting" of projects that had already been planned by the County under existing capital plans. In short, Ecology expected that with the implementation of the mitigation program, Clark County would have an increased level of effort, above and beyond that already in place under the structural stormwater control program. *Moore Testimony, O'Brien Testimony*. Nevertheless, the Agreed Order contains no term that requires the County to provide additional funding above that historically spent and dedicated to the structural stormwater control program, nor does it limit the County's ability to reduce its level of effort on structural stormwater control. *Moore Testimony.*

[13] Citing 40 C.F.R. § 122.26(b)(2).

The County is merely required to "maintain funding sources adequate to comply" with the requirements of the Agreed Order. Ecology concedes that redirection of funds from the already required structural program to the mitigation obligation of the Administrative Order could result in an overall reduced level of effort in addressing urban stormwater management, as required by the Phase I Permit. *O'Brien Testimony*, *Exs. A-48 & A-55*.

46.

Both EPA and the National Marine Fisheries Service commented on this aspect of the proposed modification to the Phase I permit to incorporate Clark County's Agreed Order terms, in addition to their comments related to science-based concerns. NMFS stated its main concern with the structural stormwater control program to be a "possible reduction in projects, potentially providing less mitigation to listed salmon designated as primary populations in the LCR (Lower Columbia River) Recovery Plan." *Ex. J-18* at 2. Among other concerns, NMFS commented that "[I]f Clark County moves projects from the structural control program to the flow control mitigation program such that structural control projects are substantially reduced, it could result in a net reduction in mitigation overall." Thus, NMFS concludes that there is a need for careful implementation of both programs. *Ex. J-18.*

47.

EPA expressed similar concerns to those of NMFS in its comments on the amended Permit, but chose not to file a formal objection to the Phase I permit modification. EPA was concerned that without additional conditions, Clark County's flow control mitigation program would result in less overall stormwater flow control. EPA noted that Clark County had a well-

established stormwater capital improvement program to meet the Phase I structural stormwater control/retrofit program requirement of the permit, and went on to express concern that Clark County would reduce the level of investment directed to that program in order fund mitigation projects. Noting that the Phase I permit did not mandate a minimum investment level or amount of retrofits for the structural stormwater control program, EPA stated that ~~t~~the lack of such specificity should not be used to significantly reduce long standing investment toward the structural stormwater control requirement in order to establish a mitigation program" to meet other permit requirements applicable to new development. *Ex. A-22* at pp. 1-2. Ecology responded to EPA comments by stating that the comments went to issues that were not the subject of the permit modification (i.e. the structural stormwater requirements), and that Ecology was only looking to determine if Clark County was providing an equivalent program of flow control for new development and redevelopment. *Ex. J-21, Moore Testimony*. Thus, Ecology viewed the alternative flow control program in isolation from other permit requirements.

48.

The parties provided much evidence in an attempt to explain the County's planned funding of mitigation projects and structural stormwater improvement projects. The County's Stormwater Capital Improvement Program (SCIP) and Stormwater Needs Assessment Programs (SNAP) set out the County's budget and expenditure planning on stormwater projects. However, it is challenging, if not impossible, to make direct comparisons between the County's budget and expenditures on stormwater retrofit projects, and Agreed Order mitigation obligations, due to the variety of ways in which the information is tracked and reported, and because the County's

efforts are in a continuing state of flux. Differing amounts of money, and different prioritization of projects appears throughout the County's capital budget planning documents. This makes comparisons difficult both in terms of the County's historic budgets and expenditures toward either or both types of infrastructure over time and its relative budgets and expenditures between the two different of kinds of projects. *Gray Testimony, Swanson Testimony, Exs. A-43, A-74, A-75,*

49.

The County has only one budget for the combined structural stormwater/retrofit program and the flow control mitigation program, the Stormwater Capital Improvement Budget.[14] *Ex. A-43(Clark County's Supplemental Responses to Interrogatories)*. Although County witnesses initially stated that they received "supplemental appropriations" from the Board of County Commissioners for the Phase I permit requirements related to implementing the structural stormwater control program and the Agreed Order mitigation obligation, testimony clarified that there were not additional funds dedicated to the Agreed Order's flow mitigation program. Stormwater managers within the County received an increase in budget authority, or permission

[14] Clark County's Stormwater Management Program is funded primarily through its local Clean Water Fee, which raises about $4.5 million per year. Of that amount, approximately $1.5 million is budgeted for capital programs, including the structural stormwater retrofit program required by the Phase I Permit, while the remainder of the budget supports other stormwater-related activities. The fee is paid by residential, commercial, industrial, and governmental property owners in the County according to a tiered rate structure. Clark County's fee is approximately $30 per parcel, and the fees have not changed since 2000, although the County is proposing a cost of service study to evaluate the need for a fee increase. Other sources of funding are also used to support the County's Stormwater Management Program, but to a lesser degree. *Gray Testimony, Swanson Testimony, Ex. A-82.*

to spend more money from the fund balance in the Clean Water fund. New monies were not made available to fund an increased level of effort for mitigation projects. *Wierenga Testim*ony.

50.

The County's current Clean Water Fund balance is approximately $7-8 million. That fund balance is available for the total of all stormwater management in the County, not just capital programs. The balance has accumulated over the past decade as a result of spending less on the County's overall Clean Water Programs than the County has collected in fees. Historically, the County has spent on average approximately $800,000 per year on structural retrofit programs. *Gray Testimony*, *Wierenga Testimony*. The County has projected that it will cost approximately $360,000 during the remainder of this permit term to pay for the mitigation obligations incurred under the Agreed Order. *Gray Testimony, Swanson Testimony*. For this reason, the County projects that ongoing funding for the mitigation obligations taken on by the County under the Agreed Order is adequate. *Gray Testimony.* However, the Board finds that this projection is based on several assumptions: (1) that projects vested before August 2009 are not subject to the mitigation requirement, (2) that the County does not look beyond the terms of this permit, even though its mitigation obligation extends well into the future, and (3) that the projected rate of recessionary development which has resulted in a significant downturn in development in Clark County, continues. For example, Clark County issued approximately 550 single-family building permits in 2009, down from approximately 4,000 in 2007. *Snell Testimony*.

51.

The County will undertake more flow control mitigation projects relative to structural stormwater control projects under the Agreed Order, conceding that some existing "retrofit" projects will be shifted from the structural stormwater control program to the mitigation obligation. *Wierenga Testimony*. Three projects that had been on the structural stormwater control/retrofit program for some time were shifted to the mitigation obligation, including the 152nd Street/20th Avenue retrofit, the Teal Point retrofit, and the New Valley retrofit. *Wierenga Testimony, Gray Testimony*. It appears Clark County has identified only one structural stormwater control project for 2012.[15] *Ex. A-74*, p. 2.

52.

In meetings between Ecology and the County leading up to the Agreed Order, the parties discussed the question of whether the County could sustain the both the structural stormwater retrofit program and the mitigation obligation within existing funding. Ecology maintained that in order to meet the concept of "equivalency," Clark County should continue its current program. The County's position was that the current structural control program was "designed to spend down the capital reserve" and "was not sustainable under current funding and does not account for the flow control debt." At that point the County indicated that some part of a deficit, apparently referring to the flow control mitigation obligation, could be made up from projects in the structural control program *Ex. A-33*.

[15] Capital budgets fluctuate more than operating budgets. *Gray Testimony.*

53.

The Board finds that the Agreed Order allows a reduced level of effort in meeting the stormwater management goals of the Phase I Permit. The lack of any requirement to maintain a level of effort in the structural retrofit efforts, the ability to shift retrofit projects to the mitigation obligation, and the total discretion afforded the County in the implementation of the Agreed Order allow such an outcome.

54.

Implementation of LID under Agreed Order: It is unclear whether the Agreed Order is a substitute or alternative to all the requirements contained in Condition S5.C.5. of the Phase I permit, or only the flow control requirement contained in S5.C.5.b.i. Whether the LID requirements of that permit condition related to new development and redevelopment, are affected by the terms of the Agreed Order is unclear. County witnesses suggest LID requirements of the permit are met by possible implementation of LID at the mitigation sites. *Wierenga Testimony*. The Agreed Order mentions use of LID in relation to retrofit projects that will be undertaken as mitigation under the Order, describing how LID facilities may be used, and that LID best management practices may be used to achieve the flow control requirement of the permit, or to reduce the size of downstream flow control facilities. *Ex. J-1* at Attachment A, pp. 5 & 7. The Agreed Order does not clarify the extent to which LID will be required at new development or redevelopment sites. The record before the Board is simply unclear how, where, and to what extend LID will be implemented, prioritized, or required by the County in relation to the Agreed Order and how the Agreed Order changes the requirements of the Phase I Permit as it

applies to new development sites. In the Response to Comments on the Phase I Permit Modification for Clark County, Ecology addressed concerns that Clark County was no longer under a requirement to include LID practices. Ecology responded to comments by stating that the Board found the flow control standard to be adequate so long as low impact development was required where feasible. Ecology had concluded, however, that the County's alternative flow control method was equivalent, and the Board's ruling did not prohibit the use of equivalent flow control approaches. It becomes clear in Ecology's response to comments, that Ecology does not find it necessary for Clark County to use LID techniques under the terms of the Agreed Order. *Ex. J-21* at p. 8.

55.

Despite having concerns about whether the Agreed Order might result in less overall improvement in pollution control than if the default standard were met at development sites, and whether there would be a continued level of effort in the structural retrofit program, Ecology ultimately determined that the Agreed Order offered a local alternative that provides equivalent protection to receiving waters, as required by the Phase I Permit. *Schrieve Testimony*, *O'Brien Testimony, Moore Testimony, Exs. A-48, A-55.* Ecology approved the Agreed Order, allowing Clark County to exclude projects that had ~~"v~~ested" prior to April 13, 2009, from the mitigation obligation, and did not require the County to establish a new funding mechanism to raise new sources of revenue for mitigation projects or to maintain its previous level of effort for the structural retrofit program. *Moore Testimony*.

Any conclusion of law deemed to be a finding of fact is hereby adopted as such.

CONCLUSIONS OF LAW

1.

The Board has jurisdiction over the parties and the subject matter of this case pursuant to RCW 43.21B.300. The Board reviews the matter *de novo*, giving deference to Ecology's expertise in administering water quality laws and on technical judgments involving complex scientific issues. WAC 371-08-485(1), *Port of Seattle v. Pollution Control Hearings Board*, 151 Wn.2d 568, 593, 90 P.3d 659 (2004).

2.

As we have said in other decisions, the Clean Water Act requires Ecology to impose increasingly stringent requirements on the Phase I and Phase II jurisdictions under the NPDES general permit process. *Puget Soundkeeper Alliance v. Ecology,* PCHB Nos. 07-022, 07-023 (2009) (Phase II Decision) at FOF 29; *Cox v. Ecology,* PCHB No. 08-077 (Order Granting Summary Judgment, February 26, 2009). In the municipal stormwater context, stormwater discharges from municipal systems must reduce pollution to the maximum extent practicable (the MEP standard). *Phase I Decision* at COL 12-13. In prior decisions, this Board has recognized the uniqueness of this standard, and that it reflects both the difficulty of addressing stormwater on a system wide basis and the focus of regulation on prevention and control of municipal stormwater discharges. *Phase I Decision* at COL 13, citing *Save Lake Sammamish v. Ecology*, PCHB Nos. 95-78 & 121 (Order Granting Summary Judgment, December 12, 1995). The Board has noted that the MEP approach, by its nature, requires extensive planning and prioritization to

achieve the underlying goal of meeting water quality standards. *Id*. Similarly, the Board has held that the AKART standard of state law is, as defined by rule, "the most current methodology that can be reasonably required for preventing, controlling, or abating the pollutants associated with a discharge," and involves both technological and economic feasibility. WAC 173-201A-020. *Phase I Decision* at COL 14.

3.

The Phase I Permit represents a suite of requirements for municipalities that are practicable, feasible, available, and reasonable to prevent and control pollution from stormwater runoff in municipal stormwater systems. Ecology defines these requirements, including the flow control standard, as those necessary to meet the federal MEP standard, and the state AKART standard. *See Phase I Decision* at p. 10*; Puget Soundkeeper Alliance v. Ecology*, PCHB Nos. 07-022 & -023 (*Order on Summary Judgment, Phase II Municipal Stormwater General Permit, September 29, 2008)* at p. 12. In order to provide equal or similar protection of receiving waters and pollutant control, as set out in the Phase I Permit Condition S5.C.5., the Clark County Agreed Order must meet the federal MEP standard and apply AKART. The question before us is whether Clark County's alternative flow control mitigation program meets those legal standards by providing an equal or similar level of protection to receiving waters and equal or similar levels of pollution control, as required by the Phase I Permit.

4.

The Board concludes that the Agreed Order, as currently stated, does not provide equal or similar protection of receiving waters or equal or similar levels of pollutant control. Because it

does not do so, it also fails to meet the requirement for a municipality to ensure that the MS4 reduces pollutants to the federal MEP standard, and does not represent AKART under state law. A majority of the Board concludes it fails to do so for the following reasons. First, Ecology authorized an alternative to the flow control standard without following the requirements of the Phase I Permit. Section S5.C.5.b.i. requires a rigorous basin planning process, or similar planning effort, that combines the use of computer models and field work to support the models *before* Ecology can approve an alternative flow control standard or other program tailored to local circumstances. It is unrebutted that the required basin planning process or similar planning effort is absent in this case. Second, not only is the acreage metric used in the Agreed Order without a scientific basis, but the Agreed Order also fails to recognize potential impacts to beneficial uses, which is the stated purpose of the flow control standard. Third, by relying on the doctrine of vesting, and using a later date than specified in the Phase I Permit, the Agreed Order arbitrarily excludes a large number of projects from the mitigation requirement, and does not result in reduction of pollutants to the MEP standard, nor require application of AKART to many projects, in derogation of the terms of the permit. Fourth, as structured in the Agreed Order, the County can and has engaged in an impermissible reduction in the level of effort required under the structural retrofit program, by splitting and shifting available funds to the new mitigation requirements of the Order. Even if we could conclude that there was not reduction in the level of effort resulting from implementation of the Agreed Order, we conclude it suffers from another flaw, in that it gives Clark County sole discretion over how and where to apply the mitigation effort, and is consequently, impermissible self-regulation. Finally, by not clearly requiring LID

at either areas of new development, redevelopment, or construction sites, nor specifying that LID will be required or the manner in which it will be implemented at mitigation sites, the Order falls short of the requirements set out in this Board's Phase I decision and necessary to meet the MEP standard and apply AKART.

5.

Clark County, and to a lesser extent, Ecology would have the Board review the flow control obligations of the Agreed Order in the narrowest possible mathematical fashion in relation to the Phase I Permit, looking only to the technological aspects of flow control, and comparing flow control as set out in the Agreed Order to flow control set out in the Phase I Permit. These parties would have the Board exclude the relationship of the Agreed Order requirements to other aspects of the Phase I Permit, and from the very purpose of the flow control standard. The Board cannot read the alternative program of the Agreed Order in such isolation for several reasons. First, while the Phase I Permit clearly allows for alternative local programs if certain standards are met, the terms of the Agreed Order disconnect the flow control standard from the purposes which are implicit in its application to new development and redevelopment—to protect streams from degradation in an effort to protect beneficial uses. Second, the Agreed Order directly implicates the County's obligations under other terms or the Phase I Permit, particularly the structural stormwater retrofit program, and the County's obligations to implement Low Impact Development at new development sites. Additionally, the Board notes that the ramifications of the Clark County program go well beyond the borders of Clark County, and establish precedent for other municipal permittees. *See Ex. A-55.* Ecology

has amended the Phase I Permit to add the Clark County Agreed Order as "functionally equivalent" to Appendix I of the Permit, thereby determining not only that Clark County's program is equivalent to the Phase I Permit, but also making the program available to other NPDES permittees as an equivalent level of pollution prevention for runoff from new development or redevelopment in other settings.[16] *See Appendix 10 to Phase I Permit.* Thus, the Board will examine the Agreed Order in relation to other permit terms implicated by the Clark County program, and understanding that the terms of the Phase I Permit, as amended with the Clark County program, also become the baseline for the next iteration or round of municipal permits.

6.

The Phase I Permit allows municipalities to develop different performance measures and programs to control stormwater runoff from new development, redevelopment and construction sites. If they do so, the alternative program must meet the standard set forth in that section of the permit, as follows:

> More stringent requirements may be used, and/or certain requirements may be tailored to local circumstances *through the use of basin plans or other similar water quality and quantity planning efforts*. Such local requirements and thresholds shall provide *equal or similar protection of receiving waters and equal or similar levels of pollutant control* as compared to Appendix 1. (the SWMM) (emphasis added).

[16] We note that Condition S3.A.3. (p. 13) of the recently reissued Industrial Stormwater General Permit (effective through January 2015) allows permittees covered by that permit to select best management practices (BMPs) consistent with documents listed in Appendix 10 of the Phase I Municipal Stormwater Permit, and those documents are incorporated into the Industrial Permit.

Ex. J-16 at Condition S5.C.5.b.i. Thus, an alternative program, such as is embodied in the Agreed Order between Ecology and Clark County, is authorized by the Phase I Permit, provided that it meets the criteria set out for such a variance from the Permit's flow control standard. The Board must first determine whether Clark County was an alternative program, such that is was required to complete a basin planning process, or similar planning effort, prior to Ecology's approval of its alternative flow control program, and if so, whether the County engaged in such an effort as part of the alternative program approved in the Agreed Order.

7.

In analyzing whether the Agreed Order is properly authorized as an adjustment or variance to the flow control standard under Condition S.5.C.5.b.i. the Phase I Permit, it is important to understand the flow control standard in the context of how Ecology developed the Stormwater Management Program (SWMP) of the Phase I Permit for permittees. Ecology decided not to follow EPA's permitting strategy where each permittee proposes a SWMP for the permit term, but instead, prescribed the SWMP requirements in the Phase I Permit. Ecology determined that the development, implementation, and enforcement of SWMPs pursuant to the permit terms constituted what was necessary to reduce pollutant discharges to the maximum extent practicable (MEP), meet AKART, and protect water quality. *Ex. J-17* at Condition S5.B., *Ex. J-15* at p. 28.

8.

Ecology determined that the Phase I Permit was an effective way to be consistent with federal rule requirements to minimize the impacts of stormwater discharges from areas of new development and redevelopment by ~~u~~sing techniques that:

1) minimize the generation of stormwater runoff (low impact development);
2) reduce exposure of pollutants to precipitation and stormwater runoff (source control BMPS's);
3) remove pollutants in stormwater runoff (treatment BMP's); and
4) control either the volumetric flow rate of stormwater discharged (for discharges to streams), or control the volume of water discharged (if discharging to a wetland)."

Ex. J-15 at p. 32. Thus, implementation of the flow control standard at new development and redevelopment sites was integral to the suite of requirements that constituted MEP under the Phase I Permit.

9.

The Fact Sheet for the Phase I Permit also states that the Eastern and Western Stormwater Manuals are the latest technical guidance from Ecology for controlling the quantity and quality of stormwater runoff from new development and redevelopment, and that these manuals create a generic presumptive approach to meeting federal and state water quality requirements. *Ex. J-15* at p. 33. Although a permittee may adopt alternative minimum requirements if they have been approved by Ecology as equivalent, the ~~*p*~~*permittee is obligated to demonstrate* to Ecology's satisfaction that their alternative approaches will protect water quality, meet the ~~m~~maximum

extent practicable" requirement of federal statutes, and meet the all known, available and reasonable methods of prevention, control, and treatment requirements of the state's Water Pollution Control Act." (emphasis added.) *Ex. J-15* at pp. 33-34, *Ex. J-17* at Condition S.5.C.5.b.ii.

10.

Although the Ecology and County witnesses may have attempted to characterize Clark County's alternative flow control standard as the same as the default standard, only administered differently, we conclude that the language in the Agreed Order, the fact that Ecology reviewed it for needed equivalency from the outset, as well as the rest of the record, demonstrate that it is a different, and alternative standard, requiring a showing of equivalency, and consideration of impacts on beneficial uses. Because the Phase I Permit requires a permittee to demonstrate that using an alternative standard to the generic presumptive approach established in the Phase I Permit will meet federal and state water quality requirements, the permittee may only meet this requirement through a rigorous process. Condition S.5.C.5.b.i. requires the use of basin plans or other similar water quality and quantity planning efforts in order to use an alternative standard. The Board concludes that the plain language of the Phase I Permit condition that requires use of the flow control standard at new development or redevelopment sites, and the reasons behind that term, require any alternative program to be based on basin planning or a similar rigorous, science-based planning effort. Based on our Findings of Fact, above, we conclude that Clark County's budget planning and capital planning documents (SNAP and SCIP), do not meet the

Phase I Permit's required basin planning or other similar planning effort. The Agreed Order does not rest on such a planning effort, and therefore violates the terms of the Phase I Permit.

11.

The second question before the Board becomes whether the County's implementation of the flow control standard at alternative sites, not connected to new development or redevelopment in the County, is equivalent to the requirements of the Phase I Permit in any event. Again, the Board concludes that the failure of the Agreed Order to consider the underlying purposes of the flow control standard, and the failure to consider the connection between the updated flow control standard and beneficial uses, results in the invalidity of the Order. The history of the development of the flow control standard and a review of other documents leaves no doubt that the flow control standard was developed and reviewed through rigorous science, and that it may only be altered through a rigorous scientific process that focuses on the potential impact to beneficial uses. The Stormwater Management Manual for Western Washington states the primary objectives for basin/watershed planning are ~~to~~ reduce pollutant loads and hydrologic impacts to surface and ground waters *to protect beneficial uses*." (emphasis added.) Vol. 1, §2.5.9, pp. 2-38. This section further states that ~~"b~~[]asin planning provides a mechanism by which the minimum requirements and implementing BMPs can be evaluated and refined *based on an analysis of an entire watershed*. (emphasis added.) *Id.* The Independent Science Panel discussed the flow control standard in its review of the Stormwater Manual, and noted that the Stormwater Manual recognizes the need to control flows from many small sites because the cumulative effect of uncontrolled flows from many small sites can be as damaging

as those from a single large site. The Independent Science Panel then concluded that "[*w]atershed-scale* assessment and planning allows planners to identify where this may not be the case, by considering the size and location of proposed developments throughout a watershed and fully evaluating potential impacts." (emphasis added.) *Ex. R-77* at p. 7.

12.

Thus, implicit in the flow control standard is the concept that it will be applied at the site of new development or redevelopment where high flows of stormwater can be controlled, avoiding accelerated stream channel erosion, and resulting harm to beneficial uses. *Booth Testimony, O"Brien Testimony.* However, with approval of the Agreed Order, Ecology allowed the new flow duration standard to be applied at any site the County chooses, without consideration of the impact on such beneficial uses, and with the likelihood that the intended outcome will be different than if the new flow control standard were applied at a sites called for in the Phase I Permit.

13.

Ecology stated in the Agreed Order that it "will provide an equivalent level of flow control" to that required under the Phase I Permit, and that "[t]his approach is consistent with the Permit wherein Permittees are allowed the option of proposing alternative methods of achieving flow control standards." *Ex. J-1* at 3. However, in the Notice of Violation issued by Ecology to Clark County, Ecology clearly states that the purpose of the flow control requirement is to "reduce harmful impacts on fish, other aquatic life and streams caused by runoff from development." *Ex. J-2* at 1. A majority of the Board concludes that Ecology's approval of the

Agreed Order not only ignores the clear terms of Condition S5.C.5.b. which allows such an alternative only when tailored to local circumstances through the use of basin planning, or a similar planning effort, but also fails to consider the underlying purposes of the flow control standard in the first instance—to protect beneficial uses through the rigor of the flow control requirement, or through use of an equally rigorous alternative.

14.

Clark County would have the Board conclude that they are, in fact, implementing the same flow control standard in a fashion equivalent to the Phase I Permit, simply at another location selected through the County's capital budget planning efforts. They argue that their strategic choice of a location to implement flow control is superior to the Phase I method of requiring it at all new development, which is a more random placement of flow control. Thus the County concludes their alternative program represents AKART and MEP. The problem with this is that there are neither criteria applied at the front end, nor evaluation and monitoring results that can be reviewed at the back end, that require, or will demonstrate that the flow control implemented by the county will achieve the same level of protection of beneficial uses that flow control at new development or redevelopment sites will achieve. A flow control project implemented by the County at a retrofit project low in a watershed will not have the same effect as flow control placed in a sensitive, salmon-bearing stream higher in the watershed where there has been relatively little development.

15.

The Board concludes that the alternative approach of the Agreed Order will not provide similar or equal protection to receiving waters. Significant amounts of unrebutted expert testimony are in the record that the ecological impacts of Clark County's alternative flow control mitigation program are not only ignored, but that the potential impacts can be substantial. Clark County's fisheries expert opined that targeted mitigation actions in areas that can provide the most environmental benefit is the best method for undertaking mitigation. Unfortunately, there is no requirement in the Agreed Order that Clark County do so. The Agreed Order does not require Clark County to detail the expected outcome of its proposed flow control mitigation projects or to monitor to see if these results are being achieved. An expert referred to monitoring of these projects as ~~"v~~ital." Under the acreage metric, Clark County is not even required to identify and track significant areas of salmon habitat for potential mitigation. The Phase I Permit clearly required basin planning as a basis for and alternative program such as Clark County's, because as stated by the Independent Science Panel, a watershed scale assessment and planning allows planners to identify and fully evaluate potential impacts. While Ecology may be concerned that developing a proper tracking metric may prove difficult, Condition S.5.C.5.b.ii. makes it the obligation of the permittee to demonstrate to Ecology's satisfaction that their alternative approaches will protect water quality, meet the maximum extent practicable requirement of federal statutes, and meet the all known, available and reasonable methods of prevention, control, and treatment requirements of the state's Water Pollution Control Act. Ecology did not require Clark County to do so before approving the Agreed Order in this case.

16.

The Board understands that it must give deference to the technical expertise of Ecology. *Port of Seattle v. Pollution Control Hearings Board,* 151 Wn.2d 568, 90 P.3d 659 (2004). However, the Board concludes that Ecology is not entitled to deference in its characterization and agreement to Clark County's alternative flow control model as equivalent under the Phase I Permit because Ecology failed to follow the clear and unambiguous terms of the permit, and because Ecology's approval of the alternative program is unsupported by, and contrary to its own technical or science-based discussions and assessments of the flow control standard. *See Postema v. Pollution Control Hearings Board*, 142 Wn.2d 68, 77, 11 P.3d 726 (2000) (stating the principle that an agency's interpretation is accorded great weight only if there is ambiguity). Unambiguous terms of the Phase I Permit were violated when Clark County did not undergo the prerequisite basin planning or similar planning necessary to develop an alternative flow control requirement. Then, by simply allowing the flow control standard to be implemented at alternative sites, Clark County's acreage-based mitigation divorces the flow control standard from its impact upon beneficial uses, in contravention to Ecology's stated purpose for the flow control standard in the first instance. We recognize that the mitigation projects selected by Clark County could potentially adequately mitigate for historic flow control impacts and provide equal or better environmental protection for beneficial uses than the default standard in some instances. There is, however, neither a requirement in the Agreed Order, nor a guarantee this will occur, and Ecology does not have the information that this will occur. The flow control standard and other permit terms were developed after many years of scientific effort. The majority of the

Board's focus on the absence of information regarding habitat values at the points of development and mitigation, and the absence of information regarding what the mitigation projects are expected to achieve, is not holding Clark County's program to a higher standard. Instead, it is to determine whether the alternative approach under the Agreed Order is equivalent to the Phase I Permit. In *Friends of Grays Harbor v. City of Westport*, after first recognizing the Board provides deference to Ecology' technical expertise, the Environmental and Land Use Hearings Board refused to find that Ecology had reasonable assurance that water quality standards would be met under the proposed project because it lacked critical information regarding groundwater levels. Without this information, the Board concluded Ecology had insufficient data to make a reasoned decision. *Friends of Grays Harbor v. City of Westport,* ELUHB No. 03-001 *(De Novo) (Findings of Fact, Conclusions of Law and Order)(2005)* at pp. 34-35, 40. The Board concludes that the alternative flow control standard in the Agreed Order does not provide an equal or other similar protection of receiving waters and equal or similar levels of pollutant control as compared to the default standard. The alternative flow control standard and the mitigation program also significantly impact Clark County's efforts under the structural control program. Ecology is not entitled to any deference regarding this aspect of the Agreed Order because Ecology's own witnesses did not forsee a reduced level of effort in the structural control program. The Board also concludes that the alternative flow control standard in the Agreed Order does not constitute MEP, since it constitutes a lesser standard than what other permittees are expected to achieve.

17.

As stated in the Board's Order Denying Summary Judgment in this case, the Board never addressed the vesting issue in the Phase I case, and the Phase I Permit itself is silent as to vested rights. PCHB No. 10-013 (Order Denying Summary Judgment, August 26, 2010) p. 10. Ecology relied on the concept of "vesting" as a cut-off point for application of the new flow control standard on a going-forward basis.[17] The Board rejected Clark County's argument that the vested rights doctrine precluded the application of the new flow control standard to projects that vested for land use purposes prior to April 13, 2009. The Board stated that: For purposes of review of whether the Agreed Order is equivalent to the Phase I Permit, the Board must determine what constitutes MEP and AKART under the Phase I Permit. The Board reserved for hearing how and why Ecology selected the August 17, 2008 effective date for the new flow control standard, and the feasibility of using the new flow control standard at the sites exempted from providing mitigation under the Agreed Order. *Id.* at pp. 10, 16. We therefore analyze the Agreed Order in relation to that baseline of August 17, 2008.

18.

As we have found, Ecology established August 16, 2008, 18 months after the effective date of the permit, as the date by which permittees must adopt their updated flow control requirements. By that date, or within a reasonable period of time thereafter (30-90 days), Ecology expected municipalities to begin applying the flow control standard at new

[17] *Ex. J-15, p. 27; Ex. A-39, p. 143*. The Board also relies on the testimony of Bill Moore, who has stated that Ecology relied on vesting as a "cut-off" point, and informed regulated municipalities that vesting would be the trigger for obligations going forward under this part of the permit.

development, redevelopment, and construction sites. The Agreed Order allows Clark County to wait to apply the flow control standard, including the mitigation at alternative sites, until a date approximately eight months later than that defined in the Phase I Permit (April 13, 2009). Similarly, the Agreed Order also allows Clark County to wait to begin applying the ~~"0~~.1 cfs increase" threshold until several months after it was supposed to have implemented the new threshold, after it revised its ordinances to remove the unlawful exemption. A substantial number of proposed development projects were exempted from the mitigation requirement under the Agreed Order. There is no scientific basis to justify the delayed effective date for Clark County for either the flow control standard or the 0.1 cfs increase threshold, nor was there any evidence introduced to establish that either of these requirements could not be met at particular sites. On this basis, we conclude that the Agreed Order, on its face, fails to reduce the discharge of pollutants to the maximum extent practicable as represented by the Phase I Permit's default flow control standard because it fails to begin applying the more stringent flow control requirements until much later than demanded by the Phase I Permit. To satisfy the equivalency requirement, Clark County's mitigation obligation must begin no later than 30-90 days after the County was required to adopt its updated flow control requirements (*i.e.,* November 16, 2008).[18] The County's several month gap during which time it unlawfully exempted infill and redevelopment projects that increase flow beyond the 0.1 cfs threshold from applying the

[18] We do not find it relevant to consider that other municipalities may have had delays or negotiated other deadlines with Ecology for implementing flow control ordinances. To measure equivalency, we must look to the plain terms of the Phase I permit.

updated flow control requirements (or its mitigation obligations) is an additional basis for concluding that the Agreed Order is not equivalent to the Phase I Permit.

19.

Rosemere maintains that in addition to the project applications filed between August 16, 2008, and April 13, 2009 that were improperly excluded from meeting the mitigation requirement under the Agreed Order, other uncompleted projects should be reviewed on a case by case basis to determine whether any of these projects should meet the new flow control standard. The Board declines to extend the application of the new flow control standard beyond what Ecology established in the Phase I Permit. Although Ecology improperly used vesting as part of the basis for establishing what was required for permittees under the Phase I Permit, the Phase I Permit also represented Ecology's best judgment regarding what was reasonable for a group of permittees with differing problems and resources to accomplish. Ecology considered the expected implementation date of the Phase I Permit to be MEP and AKART, and the Board defers to Ecology's expertise on what permittees could reasonably accomplish within their resources. The Board concludes that using the expected implementation date of the Phase I Permit for the baseline to apply to projects is MEP and AKART.

20.

The lack of any term in the Agreed Order to require a sustained level of effort in the structural retrofit program as the County implements the Agreed Order, leads the Board to conclude that the Agreed Order fails to require an ongoing effort by the County to meet the MEP standard set out in the Phase I Permit. In discussing Condition S5.B. of the Phase I Permit, the

Fact Sheet provides that state and federal law requires a SWMP reduce the discharge of pollutants to the MEP and meet state AKART requirements. It also states: "Where appropriate, Permittees should continue implementation of existing stormwater management program components *that go beyond what is required in this permit* where they are necessary to reduce the discharge of pollutants to the MEP." *Ex. J-15* at p. 29. The Fact Sheet, therefore, recognizes that although a permit term may not specify a particular level of effort, Permittees should continue their activity under that permit term in a meaningful and sustained manner where necessary to meet MEP requirements. Clark County's ability to shift funds to the mitigation program, without maintaining continuing effort in the structural retrofit program, is a serious flaw in the County's required Stormwater Management Program, and results in an impermissible reduction in the level of effort to control runoff in urban and urbanizing areas of Clark County, as required by the Phase I Permit. This reduction in the level of effort results in a failure to meet the MEP standard, and thus the Agreed Order is invalid in this respect. *See* WAC 371-08-540(2) (Board will review terms of a General Permit to determine if it is "invalid in any respect.") To the extent the County defends the entire mitigation program as financially feasible based on the current level of recessionary development, it is difficult, if not impossible, to see how the mitigation program is sustainable as a going forward standard for the Phase I Permit program, other than at the complete expense of the existing level of effort for structural stormwater retrofits required under the Permit's other terms. EPA and the NMFS correctly assessed this deficiency in their comments on the amendments to the Phase I Permit.

21.

Clark County argues that the Board need only look to the remainder of the current permit term to determine whether there is adequate funding, sufficient to implement a program that is equivalent to the Phase I Permit. We disagree, for several reasons. First, the mitigation obligations of the Agreed Order do not end in February 2012, with the expiration date of this iteration of the Phase I Permit. Rather, the mitigation obligations incurred by Clark County during this term of the municipal permit, will stretch well into the next permit cycle. We have also found that the assumptions Clark County relies on to argue it has more than adequate funding for the Agreed Order are not well-founded, and based on either changeable conditions, or terms the Board has invalidated in this Order (reliance on a later effective date). Moreover, having been incorporated into the Phase I Permit as a functionally equivalent program for runoff control at new or redevelopment and construction site, the terms of the Agreed Order will become the baseline for the next round or iteration of general permit renewals, not just for Clark County, but for other municipal permittees. For these reasons, the Board concludes that the Agreed Order allows for an impermissible, overall reduction in the level of effort in those requirements that Ecology has said constitute MEP under the Phase I Permit.

22.

On several occasions this Board has concluded that a particular term or approach of a General Permit amounted to impermissible self-regulation, essentially leaving the choice of the pollution control program entirely to the discretion of the regulated entity, with no regulatory oversight to ensure the permittee in fact reduces pollutants as required by law, and acts

reasonably and in good faith. *Phase I Decision* at COL 29, *PSA v. Ecology*, PCHB Nos. 02-162 through 164, *(Industrial Stormwater General Permit, Order Granting Partial Summary Judgment, June 6, 2003)* at XVI. In reaching these decisions the Board has relied on at least one relevant decision in the municipal stormwater context. In review of the Phase II municipal stormwater rules, the Ninth Circuit Court of Appeals concluded that while it is laudable to involve regulated parties in the development of individualized stormwater pollution control programs, regulators are still required to ensure that, in every instance, the program is subject to meaningful review to ensure that the program reduces the discharge of pollutants to the maximum extent practicable. *Environmental Defense Center, Inc. v. U.S. E.P.A.*, 344 F.3d 832, 856 (9th Cir. 2003) In another context, the rules governing concentrated animal feeding operations (CAFOs), also to be implemented through a general permit, the Second Circuit Court of Appeals held that the failure of the rule to require regulatory oversight to ensure that each large CAFO, in fact, developed a nutrient management plan, was arbitrary and capricious. *Waterkeeper Alliance v. E.P.A.*, 399 F.3d 486 (2d. Circuit 2005).

23.

In its Phase I decision, this Board criticized the structural stormwater control program requirements of the Permit as impermissible self-regulation, stating that the ~~p~~program is left entirely to the discretion of the municipalities, not only with respect to which projects they initially select, but also in the timing and manner in which they implement the selected projects." *Phase I, COL 29*. The Board concluded that the permit failed ~~to~~ require a minimum level of effort for the permittees in the selection and prioritization of structural stormwater projects, and

provides no review and approval role for Ecology." *Id*. While neither the Permit, nor this Board, demanded a particular level of funding for the program, in order to ensure that MEP and AKART standards were met, the Board required a minimum level of effort in the selection and prioritization of the planned projects, a schedule for implementation, a role for Ecology in determining if the pollution reduction goals of the Phase I Permit were met by the efforts of a particular Phase I permittee and documented progress in meeting the goals of the program. These steps were necessary to ensure that the federal MEP standard was met by each municipality. *Phase I Decision*. Furthermore, in implementing structural stormwater controls, the Fact Sheet for the Phase I Permit directs Permittees to —set priorities and address the highest-ranked problems subject to the limitations of available resources." (emphasis added.) *Ex. J-15* at p. 35.

24.

The mitigation program of the Agreed Order suffers from the same problems the Board recognized in the Phase I decision related to the structural stormwater control condition of the that permit. The Clark County programs leaves it to Clark County to decide which mitigation projects will suffice to meet the demands of the Agreed Order, and complete discretion in deciding whether to move projects from the required structural retrofit program into the mitigation program. In implementing the structural control program, Permittees set priorities and address the highest-ranked problems subject to the limitations of available resources. There is no similar requirement for mitigation projects under the Agreed Order. The Agreed Order allows Clark County to provide highest priority to projects that provide the best cost/benefit ratio in

terms of cost per unit of land cover mitigated, within the entire group of projects deemed most suitable for mitigation. If Clark County develops a list of 50 proposed projects, nothing prevents Clark County from funding projects listed 45 through 50 in terms of suitability for mitigation because those projects are less expensive. Ecology plays no role in ensuring that mitigation projects actually achieve the goal of the Phase I flow control standard, and no role in ensuring that mitigation sites are selected in a reasoned manner, free of political or bad faith influences. There is no oversight to ensure that the County sustains an overall level of effort as between the structural retrofit program and the mitigation program.

25.

We disagree with the County and Ecology to the extent they argue that the flow control standard, as required by the Phase I permit, also requires no level of oversight by Ecology, and has not been found to suffer from the self-regulatory problems discussed above. By its terms, the Agreed Order sets out a ~~–m~~itigation" or alternative program, untested and with significant questions as to whether or not the selected mitigation sites will actually offset the environmental harm allowed at the site of new development. In the context of another type of mitigation, wetland mitigation, Ecology has concluded that there is a need to closely monitor mitigation sites, as many fail to achieve the intended goals because of lack of understanding of ecosystem processes and watershed processes. *Ex. A-25*. Given these considerations, and the lack of criteria to guide how mitigation projects will be selected, there is no effective review to determine if the goals of the Phase I Permit are met, and progress in protection of streams against

the detrimental effects of increased urbanization accomplished. The Agreed Order fails as an impermissible self-regulatory program.

26.

Furthermore, the Agreed Order raises concerns whether historic impacts will ever be addressed in a meaningful way in Clark County. The Agreed Order negatively impacts two of the three prongs EPA stated as necessary to mitigate for historic urban and urbanizing stormwater impacts: enhanced gradual improvement of baseline conditions as redevelopment occurs, and enhanced investment in retrofit projects to reduce stormwater impact from developed land. *Ex. A-22.* In considering whether MEP has been met, the Board considers the programmatic nature of the Phase I Permit and how the SWMP provisions are intended to operate as an aggregate level of effort. The Agreed Order's failure to address historic impacts in a meaningful and sustained manner for multiple components that are key to the programmatic Phase I Permit requires the Board to remand the Agreed Order. The Board recognizes that municipalities should have some flexibility in meeting the terms of the permit, and that more flexibility should be provided in an urbanized setting because there are more constraints. Alternative mechanisms, however, must be based in science and have some assurances that beneficial uses will have at least the same level of protection as provided by the permit terms.

27.

In the Phase I decision, this Board held that the permit's reliance on a flow control standard as the primary method to control stormwater runoff from MS4s fails to reduce pollutants to the federal MEP standard, and without greater reliance on LID, does not represent

AKART under state law. The Board concluded that indisputable evidence lead to the conclusion that application of LID techniques, at the parcel and subdivision level, is a currently known and existing methodology that is reasonable both technologically and economically to control discharges entering into MS4s covered by the Phase I Permit. The Board held that the Phase I permit "must require greater application of LID techniques, where feasible, in combination with the flow control standard, to meet the AKART standard." *Phase I Decision*, at COL 16. Underlying the Board's legal conclusion were factual findings, referenced above, to the effect that LID was a well-defined concept, and that the basic BMPs that constitute LID well-defined. The Board noted that utilization of LID techniques may be useful, or even in some cases necessary, to meet the flow control standard on a particular site. *Phase I Decision* at FOFs 38, 42.

28.

As we have found, the LID requirements of the Phase I Permit are found in the section of the permit applicable to "Controlling Runoff from New Development, Redevelopment and Construction Sites," Section S5.C.5.—the same section that contains the flow control standard. That section of the Phase I Permit is the section that takes municipal permittees to a new standard for prevention and control of stormwater runoff from new development, redevelopment, or construction sites. Meeting the advanced flow control standard *and* implementing LID at the time of new development, redevelopment, or at construction sites are both necessary to meet the MEP and AKART standards. *See Phase I Decision*. The Agreed Order fails to meet the MEP and AKART standards, or establish an equivalent program for new development, redevelopment,

or construction sites because it fails to adequately address compliance with the LID provisions of Phase I Permit. First, the Agreed Order it is silent on the County's obligation to require implementation LID at the site of the new development, even if the Permit's flow control standard is not met at those sites, but at alternative mitigation sites. Second, while the Agreed Order speaks to LID in relation to the flow control mitigation projects that the County will undertake, it does so only in the most permissive terms. Thus, it fails to impose a requirement comparable or equivalent to the Phase I Permit when it comes to LID. We also note that to the extent the Agreed Order allows new development to meet a more relaxed flow control standard, it fails to place an incentive on development to use LID, and therefore fails to require AKART and MEP.

29.

Any finding of fact deemed to be a conclusion of law is hereby adopted as such.

ORDER

The Agreed Order is reversed and remanded to Ecology for further actions consistent with this opinion.

SO ORDERED this 5th day of January, 2011.

POLLUTION CONTROL HEARINGS BOARD
___see concurrence and dissent_____
ANDREA MCNAMARA DOYLE, Presiding
WILLIAM H. LYNCH, Member
KATHLEEN D. MIX, Member

Exhibit M

CLARK COUNTY

2021 Stormwater Management Plan



2021 Stormwater Management Plan

Updated March 2021

CLARK COUNTY PUBLIC WORKS CLEAN WATER
1300 Franklin Street
PO BOX 5000
Vancouver, WA 98666-9810

www.clark.wa.gov/stormwater



For other formats, contact the Clark County ADA Office
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Acronyms and Glossary

AKART – all known, available and reasonable methods of prevention, control and treatment as the Ecology standard for the effort required to meet waste water discharge and NPDES permit requirements.

BMP – best management practices (controls for stormwater runoff)

Council – Clark County Council

CCPH – Clark County Public Health

CCPW – Clark County Public Works

CCSM – Clark County Stormwater Manual 2015 (Errata November 2016)

CCSWMP – Clark County Stormwater Management Plan

CIP – Capital Improvement Program

County Manager – Executive officer for Clark County

CWD – the Clean Water Division of Clark County Public Works

Ecology – Washington **State Department of Ecology**

EPA – Environmental Protection Agency

GIS – geographic information services

GMS – grounds maintenance specialist

IDDE – illicit discharge detection and elimination

Illicit Discharge – a non-stormwater discharge or illegal connection to the storm sewer system (e.g. a sanitary sewer line connected to storm sewer system)

LID – low impact development

LMS – Land Management System (replaces Tidemark)

MEP – maximum extent practicable
MMS – maintenance manual system (MainStar)

MS4 – municipal separate storm sewer system

NOAA Fisheries - National Oceanic and Atmospheric Administration, National Marine Fisheries Service

NOI – Notice of Intent

NPDES – National Pollutant Discharge Elimination Systems

PPGS – potential pollutant generating site

RCW – revised code of Washington

SCIP – Stormwater Capital Improvement Plan

SNAP – Stormwater Needs Assessment Program

StormwaterClk – a GIS database the county maintains for storm sewer infrastructure

SWMMPSB – 1992 Stormwater Management Manual for the Puget Sound Basin, published by Department of Ecology

SMMWW – 2014 Stormwater Management Manual for Western Washington, published by Ecology

SWMP – stormwater management program

SWPPP – stormwater pollution prevention plan

Tidemark – a database the county maintains to track permits and code enforcement. It was replaced by the LMS for current permitting activity.

TMDL – total maximum daily load

UIC – underground injection control

WAC – Washington Administrative Code

WQDB – Water Quality Database



Responsibility Index

CD = Community Development
CCPW = Clark County Public Works

ABBREVIATION	FULL STAFF TITLE	JOB DESCRIPTION
Applicant	(as stated)	Customer who utilizes the municipal code and stormwater manual to guide development projects
CCPW Answering Service	(as stated)	Coordinates after business hours service calls
CCPW Code Enforcement	(as stated)	Coordinates citizen complaints and code compliance
CCPW PIO	Public Information Officer	Supports the development and delivery of public outreach and educational materials
CCPW Construction Mgmt. Eng.	Construction Management Engineer	Reviews PW construction projects for compliance with approved plans and applicable regulations
CCPW Construction Mgmt. Inspectors	Construction Management Inspectors	Conducts on-site construction inspections to ensure compliance with approved plans and applicable regulations
CCPW Construction Mgmt. OA	Construction Management Office Assistant	Coordinates document management associated with project approvals
CCPW Construction Mgmt. Supervisor	Construction Management Supervisor	Oversees the compliance with inspections of development construction
CCPW Construction Supervisor	Construction Management	Oversees the compliance of development construction with approved plans and code
CCPW CWD Admin.	Clean Water Division Administration	Supports document control and recordkeeping
CCPW CWD Eng.	Clean Water Division Engineer	Coordinates design and engineering of Clean Water projects
CCPW CWD Infrastructure Mgr.	Clean Water Division Infrastructure Manager	Oversees / manages stormwater capital planning , infrastructure mapping and monitoring activities, coordinates stormwater infrastructure inspection and maintenance
CCPW CWD Mgr.	Clean Water Division Manager	Oversees and manages the Clean Water Division
CCPW CWD Natural Res. Specialist	Clean Water Division Natural Resource Specialist	Performs monitoring and illicit discharge field work and analysis
CCPW CWD NPDES Mgr.	Clean Water Division National Pollution Discharge Elimination System Permit Manager	Oversees compliance with the county's Phase I Municipal Stormwater Permit
CCPW CWD OA	Clean Water Division Office Assistant	Coordinates document control and recordkeeping
CCPW CWD Outreach Specialist	(as stated)	Coordinates, implements and evaluates outreach programs for Clean Water
CCPW CWD Professional Staff	(as stated)	Supports various work projects and products

ABBREVIATION	FULL STAFF TITLE	JOB DESCRIPTION
CCPW CWD Program Coordinator	(as stated)	Coordinates specific project tasks and work products, including outreach / education
CCPW CWD Source Control Specialist	Clean Water Division Source Control Specialist	Technical assistance with citizens and businesses to comply with facility maintenance and source control regulations
CCPW CWD Sr. Eng. Tech	Clean Water Division Senior Engineering Technician	Inventory and maps the stormwater system
CCPW CWD Sr. Operations Specialist	Clean Water Division Senior Environmental Operations Specialist	Technical assistance with citizens and businesses to comply with private stormwater facility maintenance
CCPW Dev. Inspectors	Development Inspectors	Coordinates inspections and education
CCPW Director	(as stated)	Designated director for permit compliance
CCPW Eng. Program Mgr.	Engineering Program Manager	Oversees PW engineer activities
CCPW Eng. Program Staff	Engineering Program Staff	Develops engineering related materials
CCPW Eng. Project Mgr.	Engineering Project Manager	Manages engineering related projects
CCPW Enhance. & Permitting Mgr.	Enhancement and Permitting Manager	Coordinates environmental permitting for the department
CCPW Land and Vegetation Mgr.	Land and Vegetation Manager	Oversees the operations and maintenance of the vegetation management program
CCPW Ops Admin.	Operations Administration	Provides support to various tasks, such as spill response and citizen complaints
CCPW Ops Crew Chief	Operations Crew Chief	Leads and coordinates road crew activities
CCPW Ops Mgr.	Operations Manager	Oversees all operation and maintenance responsibilities
CCPW Ops Road Crews	Operations Road Crews	Perform all necessary road maintenance and operations activities to meet applicable standards and regulations
CCPW Ops Road Super	Operations Road Superintendent	Oversees all elements associated road maintenance and operations
CCPW Parks and Lands Mgr.	Parks and Lands Manager	Oversees all of the administration, customer service, maintenance and operations of parks and other county land management
CCPW Parks Super.	Parks Superintendent	Oversees the maintenance and operations of the parks
CCPW Real Property Services	(as stated)	Coordinates property related information, such as titles, legal information, etc.
CCPW Regulated Facility Lead	(as stated)	Coordinates regulated facility inspection and technical assistance.
CCPW Survey	(as stated)	Coordinates all necessary survey data required for a project
CCPW Vegetation Mgmt. Crew	Vegetation Management Crew	Performs all tasks associated with operations of the program

ABBREVIATION	FULL STAFF TITLE	JOB DESCRIPTION
CD Building Official	(as stated)	Oversees customer application for development, all building permits and permit counter.
CD Building Safety	(as stated)	Enforces erosion control regulations and stormwater for residential building permits
CD Dev. Eng. Mgr.	Development Engineering Manager	Oversees the engineering review of development applications
CD Dev. Eng. Planning Tech	Development Engineering Planning Technician	Reviews development applications for compliance with county code and regulations. Coordinates bonds, compliance and final plat
CD Dev. Eng. Review Eng.	Development Engineering Review Engineer	Conducts the engineering development review and participates in application meetings
CD Dev. Services Mgr.	Development Services Manager	Coordinates a pre-application conference with potential applicants and provides planning approvals
CD Permit Services	(as stated)	Coordinates review of development applications
CD Permit Tech	Permit technician	Processes permit applications
CD Planner	(as stated)	Supports the pre-application process and land use approvals
Contract Services	Outside firm or agency contracted with Clark County	Hired to meet specific scope of work items per the appropriate fund and need
Council	Clark County Council	Legal Authority for budget, code revisions and contracts
County Mgr.	County Manager	Executive official for Clark County
CRWWD	Clark Regional Wastewater District	Supports the coordination of illicit discharge protection
Internal Services Facilities Crews	(as stated)	Performs all tasks associated with the operations of the program on county properties
Internal Services Facilities Mgr.	Facilities Manager	Oversees the facilities program for county properties
GIS	(as stated)	Supports the county's GIS system
Public Health	(as stated)	Coordinates illicit connection/discharge issues with CCPW staff



Moultan Falls on the Lewis River

CHAPTER 1
Introduction and Background

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Clark County Stormwater Management Plan

The Clark County Stormwater Management Plan (CCSWMP) describes the various ways the Clark County manages stormwater and related water resources issues in the unincorporated area. It acts as a resource for the public to learn about the county's efforts to reduce pollution in stormwater, an informative guide for staff, and a compliance measure for the county's municipal stormwater permit under permit requirement S5.C.3.a. and S5.A.

INTRODUCTION

As the county's unincorporated population continues to increase (over 234,000 in 2020 with 234,000 in the unincorporated Vancouver Urban Growth Area according to the Washington State Office of Financial Management data analyzed by Clark County GIS), Clark County is committed to responsible stormwater management to keep our waterways healthy for people, fish and wildlife.

The Clark County Public Works department (CCPW) utilizes the Clean Water Division (CWD) to protect surface water and groundwater resources from polluted stormwater and to coordinate compliance with state and federal water pollution laws.

Primary responsibilities of the overall stormwater program include planning and building stormwater control facilities, stormwater management planning, water quality monitoring of streams, public education and outreach, development and enforcement of water quality regulations, water quality compliance for businesses and private stormwater facility owners, coordination with other municipalities, and maintenance of the county's stormwater system.

STORMWATER AND NPDES PERMIT

Much of the pollution in Washington State's waters comes from many different, hard-to-trace sources with no obvious point of collection and discharge. It is called "nonpoint source pollution" and it travels to streams, lakes and other water bodies through polluted stormwater runoff carried by the county's storm sewer system.

Most U.S. cities and counties that collect stormwater runoff in municipal separate storm sewers and discharge it to surface waters are required to obtain a permit under the federal Clean Water Act. Clark County qualifies under the Environmental Protection Agency (EPA) stormwater regulations for the National Pollutant Discharge Elimination Systems (NPDES) Phase I Municipal Stormwater Per6mit program. In Washington State, the EPA has delegated to the Washington Department of Ecology (Ecology) the authority to develop and administer the NPDES permitting program.

Ecology issued the most recent NPDES Phase I Municipal Stormwater Permit to Clark County and other larger western Washington jurisdictions in July 2019, with an effective date of August 1, 2019. This permit is for a five-year period expiring on July 31, 2024.

Phase I permittees are cities and counties that operate large and medium municipal separate storm sewer systems (MS4s). Governmental bodies within their boundaries, such as state universities, public school districts and drainage districts, are also required to meet permit requirements. The permit regulates discharges to waters of Washington State from the permittees' MS4s in compliance with Washington Water Pollution Control Law (Chapter 90.48 RCW) and the federal Clean Water Act (Title 33 USC, Section 1251 et seq.).

PERMIT COMPLIANCE

The NPDES permit prescribes a variety of requirements and actions. It lists 21 general conditions; these include, among others, a requirement to notify Ecology of spills, a duty to avoid bypassing water quality treatment and flow control facilities, and a requirement to notify Ecology of a failure to comply with the permit.

The permit also lists nine special conditions that, among other things, specify permit coverage, list permittee responsibilities, and under Special Condition S5, prescribes an eleven-component stormwater management program (SWMP).

The SWMP consists of actions meeting the eleven required components and any additional actions and activities necessary to comply with Total Maximum Daily Load (TMDL) requirements. Clark County's SWMP is designed to reduce pollutant discharges to the federal maximum extent practicable (MEP) standard, meet state requirements for managing stormwater using all known, available and reasonable methods of prevention, control and treatment (AKART), and protect water quality.

The county is required to prepare a stormwater management program plan to inform the public of planned program activities for the upcoming calendar year. The SWMP plan must be updated annually to include program changes or revisions that occur and be submitted in part or in whole with the annual report to the Department of Ecology.

THE CLARK COUNTY STORMWATER MANAGEMENT PLAN AND STORMWATER MANAGEMENT PROGRAM

This Clark County Stormwater Management Plan (CCSWMP or Plan) encompasses efforts undertaken by Clark County, primarily in the Public Works and Community Development departments for the protection of water quality and the management of stormwater and related concerns. The Plan includes, as chapter 2, the NPDES stormwater management program required by Ecology.

THE CLEAN WATER DIVISION

The Clean Water Division (CWD) in Clark County's Public Works department is responsible for a majority of the county's NPDES compliance actions and activities, coordination and reporting. The program coordinates and contracts with county departments to achieve and facilitate compliance. The CWD is the primary author of reports and other documents required by Ecology.

In addition to activities addressing NPDES permit compliance and surface water resource management, the CWD manages other important stormwater-related activities, including managing stormwater injection wells regulated under the state's Underground Injection Control Rules (173-218 WAC) pursuant to the federal Safe Drinking Water Act, and giving engineering advice and support on flooding and drainage problems.

Funding and Budget

The Clean Water Division is funded primarily by an annual stormwater fee charged to developed parcels in the unincorporated area of the county. The county collects approximately $8 million annually from approximately 73,200 properties. Other sources of funding may include grants and the General Fund. The Road Fund provides support for stormwater management associated with county roadways.

Clean Water Fee

Residential and multifamily properties pay a fee based on each residential unit. Commercial properties, roads, churches and schools are assessed a fee based on the number of equivalent residential units (ERUs) of impervious surface measured on the parcel.

In July 2014, the Clark County Council adopted an update to the Clean Water Fee. Updated fees took effect in 2015 tax bills. The fee varies for residents in the Urban Growth Boundary versus rural areas.

Per Clark County Code 13.30A, fee revenues are used to fund stormwater management activities.

Beginning in August 2017, the Clean Water Division implemented updated requirements for schools wishing to receive a Clean Water Fee reduction (CCC 13.30A.050 D). Schools meeting four criteria including stormwater BMP training for staff, passing stormwater facility inspections, implementing educational activities related to stormwater, and disseminating stormwater messages to the broader school community, will receive a Clean Water Fee reduction. If all criteria are met during the school year, the Clean Water Fee will be waived for the later calendar year of the school year (e.g., 2017-2018 school year will apply to the 2018 Clean Water Fee).

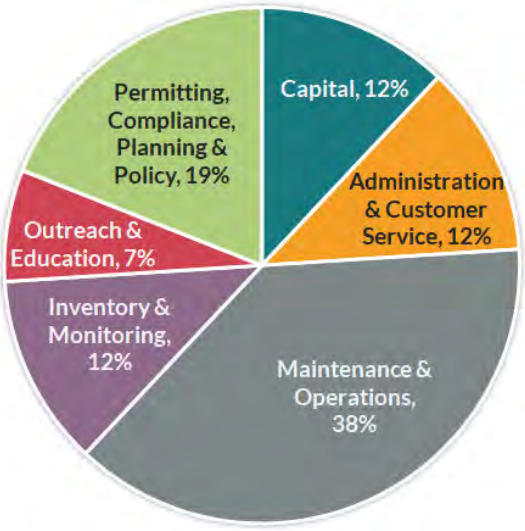
Clean Water Fund

Revenues from the Clean Water Fee, from grants awarded to the Clean Water Division and from fines are deposited into the Clean Water Fund by the Clark County Treasurer. Revenues in excess of annual operating expenses for maintenance, repair, enforcement, assessment, monitoring and education remain in the fund balance for use in constructing new public storm sewer infrastructure or in retrofitting inadequate stormwater control facilities.

The Road Fund provides support for stormwater management associated with county roadways.

Budget

Clark County budgets on a one-year cycle. The Clean Water Division budget is set at the beginning of each cycle and modified, if necessary, through requests for additional appropriations from the Clean Water Fund during the year.



2021 Clean Water Adopted Budget

The budget is approved by the elected Clark County Council. The Council sets the Clean Water Division budget in response to state priorities, expressed through the NPDES Municipal Stormwater Permit and local priorities.

Areas of greatest expenditure include maintenance and operation of storm sewer infrastructure and permitting, compliance, planning and policy.

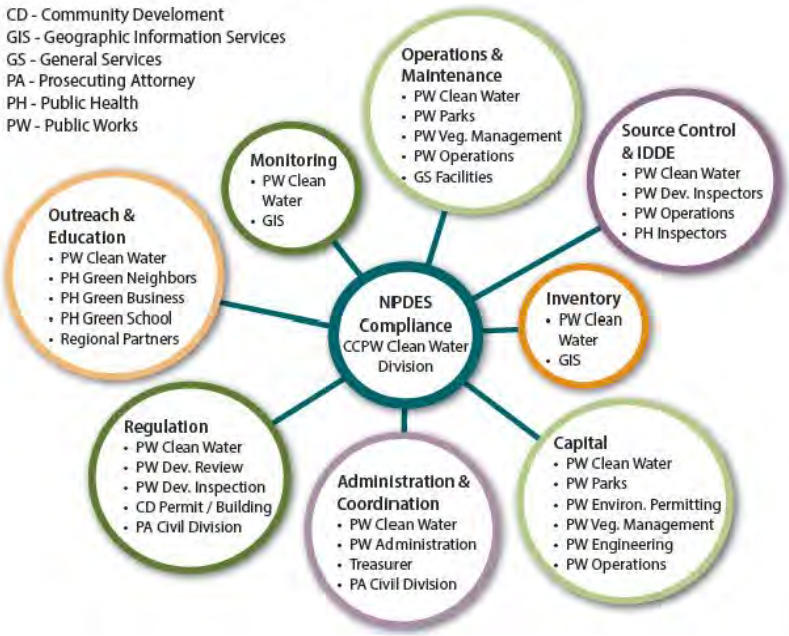
In recent years, a focus on building new stormwater facilities in underserved areas and on enhancing existing facilities has increased the overall budget and the proportion dedicated to capital construction. The total budget for 2021 is $8 million.

Organization & Staffing

The Clean Water Division employs a staff of 19 scientists, engineers, technical specialists, program coordinators and administrators who perform essential stormwater management functions. The program also coordinates with other Public Works divisions and county departments for additional essential stormwater services that fit within those division's or department's core services. This organizational structure allows the Clean Water Division to minimize expenses by engaging technical and professional experts such as design engineers, road maintenance crews and educators employed by other divisions or departments to complement a core staff of stormwater specialists.

The Clean Water Division is directly responsible for storm sewer system inventory; code and manual updates; watershed planning; source control inspections; illicit connection and discharge inspections; private stormwater facility inspections; stormwater facility maintenance compliance; stormwater capital planning; coordination with other jurisdictions and entities; and surface water and stormwater assessment, planning and monitoring.

The program coordinates with other Public Works divisions and county departments to



collect and process the Clean Water Fee; operate, inspect and maintain the storm sewer system; manage the design and construction of stormwater capital improvements; enforce development and building regulations related to NPDES permit compliance; inform and educate the public about stormwater problems and solutions; and support the Clean Water Division with database programming and analysis.

County departments are responsible for complying with NPDES permit requirements in their operational activities under the adopted stormwater plan and by interdepartmental agreements.

TASK CHECKLIST

STATUS	TASK
Ongoing	The Clean Water Division administers the NPDES Municipal Phase 1 Stormwater Permit for Clark County
2021	Clark County will review the Clean Water Fee program to assess appropriate revenue levels

For more information on the county's Clean Water Division, contact:

Jeff Schnabel, Interim Clean Water Division Manager
564.397.4583
jeff.schnabel@clark.wa.gov



Turbid urban runoff from Cougar Creek into Salmon Creek

CHAPTER 2
Stormwater Management Program

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Section 1 – Legal Authority

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.1 Legal Authority

The NPDES permit requires the county to demonstrate that it has the legal authority to control discharges to and from its municipal separate storm sewer system (MS4).

Legal Authority to Regulate

Clark County maintains the legal authority required by the permit to control discharges to and from its MS4.

Clark County Code Chapter 13.26A Water Quality

Chapter 13.26A prohibits illicit discharges and spills into the county's MS4, requires the control of industrial site runoff, and adopts source control requirements in the Clark County Stormwater Manual 2015. It maintains the county's authority to inspect and enforce its provisions.

Clark County Code Title 32 Enforcement

Title 32 permits Clark County to enforce any of its civil codes through inspection, surveillance, monitoring and enforcement actions.

Clark County Code Title 40 Unified Development Code

Title 40 contains a suite of requirements regulating the design, construction and operation of stormwater controls on development and re-development sites that will discharge to the MS4 or to waters of the state. Stormwater and erosion control measures are required under Chapter 40.386

Legislative Authority of the Clark County Council

Through the legislative authority of the Clark County Council, Clark County has the ability to enter into contracts and intergovernmental agreements with other permittees and secondary permittees for the purpose of controlling pollutants entering or leaving the county MS4.

TASK CHECKLIST:

STATUS	TASK
Ongoing	Maintain legal authority to control discharges to and from the MS4

For more information on the county's Clean Water Division, contact:

Jeff Schnabel, Interim Clean Water Division Manager
564.397.4583
jeff.schnabel@clark.wa.gov

Section 2 – Taking Inventory and Mapping the Storm Water Infrastructure

Clark County operates a municipal separate storm sewer system (MS4) within unincorporated Clark County. This system includes stormwater drainage ditches and pipes in county right-of-way and county-operated conveyances on easements.

An MS4 is a conveyance or system of conveyances that meets all of the following criteria:

1. Owned by a state, city, town, village, or other public entity that discharges to waters of the U.S. (and the state of Washington).
2. Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.).
3. Not a combined sewer.
4. Not part of a publicly owned treatment works (sewage treatment plant).



Stormwater Infrastructure Mapping

A related type of infrastructure used to manage stormwater is a Class V stormwater injection well, which allows stormwater to be disposed directly into the ground instead of to a surface water body.

Clark County inventories and maps its storm sewer infrastructure and Class V injection wells to serve a variety of purposes. The inventory is a primary source of information for inspection, operation and maintenance of the MS4, illicit discharge detection and removal, drainage and source control support, stormwater assessment and monitoring, and capital planning.

Clark County administers a comprehensive program to inventory the storm sewer system in a geographic information system (GIS) database called *StormwaterClk*. All known infrastructure is inventoried and mapped. An ongoing program inventories and maps storm sewer infrastructure built in the course of development and public capital improvement projects. The inventory includes all stormwater infrastructures inside of and outside of the county MS4, including:

- Flow control and water quality treatment facilities
- UIC-regulated Class V injection wells
- County outfall locations
- Conveyances (pipes, ditches and culverts)
- Interconnections with other municipal systems
- Connections to the county MS

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.2. Municipal Separate Storm Sewer Mapping and Documentation

The NPDES permit requires the county to map and document components of the MS4 including stormwater control facilities, receiving waters and land uses within the MS4.

Chapter 173-218 WAC Underground Injection Control (UIC) Program

Pursuant to Chapter 90.48 RCW, Washington Administrative Code requires owners of Class V injection wells (underground drywells and infiltration trenches with perforated pipes that dispose stormwater into the ground) to comply with regulations designed to protect groundwater quality for use as public water supplies. Clark County owns approximately 1,600 wells that are regulated under this rule.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 40.386 Stormwater and Erosion Control

Chapter 40.386 describes county regulations for ownership of stormwater facilities and the lands on which they are located. Section 40.386.030 sets forth requirements to submit record drawings for completed projects and requirements to document facility ownership.

Section 40.386.030(G) requires developers to submit record drawings to the county prior to 1) the issuance of building permits for single-family/duplex residential subdivisions, 2) the issuance of occupancy permits for site plan reviews, and 3) within sixty days following completion of construction for other types of development.

Clark County Code Chapter 40.540.070 Final Plat

Chapter 40.540.070 describes county regulations for information about dedications and easements for utilities that must be contained on a plat.

Revised Code of Washington Chapter 58.17.165 Plats – subdivisions – dedications

Washington state code prescribes information that must be shown on a plat when land is subdivided, including dedications of roadways and utilities and stormwater easements, tracts, or lots.

Public Project Record Drawings Policy

Clark County Public Works Engineering Program maintains a policy for the preparation and distribution of record drawings, also known as as-built drawings, after completion of county capital improvement projects such as roads, parks and stormwater facilities.

TOOLS

StormwaterClk

Clark County Public Works maintains a stormwater database called *StormwaterClk*. The database is administered by the GIS Department, while data is maintained and updated by the Clean Water Division. The GIS data can be accessed in Clark County MapsOnline in the utilities map site.

Land Development Records

Clark County Community Development maintains the *Land Management System*, a database of regulatory and enforcement cases, including permits for land division and development projects.

Annexation Tracker

Annexation Tracker is an application developed by the GIS Department that helps county departments track annexations.

ONGOING INVENTORY AND MAPPING

Purpose

Clark County maps and inventories stormwater treatment and control infrastructure because an accurate and complete inventory is critical to a successful program to inspect, maintain and regulate stormwater conveyances and stormwater treatment and flow control facilities.

As part of the process, new outfalls, Class V injection control wells, and connections also are documented.

Background

Most stormwater infrastructure and conveyances in the county are built by the private sector during residential and commercial development. Other facilities are built by the county to retrofit previously developed areas or to handle runoff from new roads, parks and other construction projects. The Clean Water Division builds a limited number of stormwater facilities to retrofit developed areas that lack adequate flow control or treatment. (See County Capital Improvements below.)

After a project is constructed, Clean Water Division staff inventory the new facility and its related conveyance infrastructure including pipes, catch basins and connections in *StormwaterClk*.

Responsibilities Matrix

Task	CCCD CWD Mgr.	CCPW CWD Infra. Mgr.	CCPW CWD Sr. Eng. Tech	CCCD Dev. Engineering Planning Tech	CCCD Dev. Engineering Mgr.	CCPW Construction Mgmt. Engineer	CCPW Construction Mgmt. OA	CCPW Construction Manager	CCPW Engineering Program Manager	CCPW Survey	CCPW Real Property Services
Notify CWD of new private development completion	O	O	I	P	A	O	O	O	O	O	O
Notify CWD of new county capital improvement project physical completion	O	O	I	O	O	O	P	A	O	I	O
Notify CWD of new county capital improvement project final acceptance	O	O	I	O	O	O	P	A	O	I	O
Gather project information	O	A	P	C	O	C	O	O	A	C	C
Notify CWD of county project As-built location	O	O	I	O	O	S	O	S	O	A/P	O
Make final decision on maintenance owner	O	A	P	O	S	C	O	O	O	C	C
Inventory/ Map infrastructure	O	A	P	O	O	O	O	O	O	O	O
Track progress	O	A	P	O	O	O	O	O	O	O	O
Transfer information to Operations	O	A	P	O	O	O	O	O	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Notification and Tracking

The first step of inventorying is becoming aware that a new development or county project, potentially with stormwater infrastructure, has been completed. The senior engineering technician will regularly query the LMS for new Development Inspection Numbers (DINs), which are created when engineering plans have been approved for construction.

The senior engineering technician will create a folder for the project on the Clean Water Division's network drive, where copies of relevant documents relating to the project's storm sewer infrastructure will be stored.

Private Sector Projects Notification

The CD Development Engineering planning technician will notify the CCPW CWD senior engineering technician that a new residential or commercial development has been completed by forwarding a copy of the completion of construction letter sent to the developer.

In some cases, the first notification to the Clean Water Division may be a different document, such as notice of a plat recording.

County Projects Notification - Physical Completion

The Public Works Engineering Program Construction Management section will notify the senior engineering technician that new public project is physically complete with a copy of the letter sent to the construction contractor.

Notification of Existing Projects

Infrequently, the senior engineering technician will discover engineering drawings or other evidence of an existing project that does not appear in the inventory. In those cases, the senior engineering technician will begin the mapping process as though it were a new facility by researching information about the project (see below), potentially using legacy data storage systems not discussed here.

Research

The senior engineering technician will research and assemble relevant documentation about the project from various sources, including Development Engineering and the Auditor.

To inventory and map the stormwater infrastructure, the senior engineering technician needs:

- Engineering drawings of the project.
- For private sector projects, the preferred source is a record drawing (sometimes also called an as-built). An acceptable alternate source is an approved construction plan.
- For county projects, the preferred source is a record drawing; however, most projects will be documented initially from the final construction plan with as-built notes from the construction manager.
- Geographic location of the infrastructure.
- Maintenance responsibility for the infrastructure.
- Ownership of tracts or parcels containing the facilities, if any.
- Location of easements containing the facilities and related infrastructure, if any.

Finding documentation may take several steps, outlined below.

Locate and Verify Engineering Drawings

For private sector projects, record drawings are submitted by the private developer to the Development Engineering program in electronic format. The senior engineering technician is then notified of the availability of record drawings.

For county capital improvement projects, Public Works Survey section maintains electronic copies of county projects and places them on the county Olympus server, where they are accessible to the senior engineering technician.

Determine Ownership and Maintenance Responsibility

The senior engineering technician will look for several types of information, including:

- The party responsible for maintaining the stormwater infrastructure.
- The owner of parcel(s) underlying any treatment or flow control facilities.
- The existence of easements for access to stormwater facilities and conveyances.

Responsibility for maintaining facilities may change over time. At this stage, the senior engineering technician will determine the current maintenance responsibility.

The senior engineering technician will evaluate information on legal documents such as the plat map, full plat recordings, covenants and recorded surveys. Ultimately, citing the owner of the land where a facility is located.

Inventory and Map (Digitize)

The senior engineering technician will find the project's location in the GIS. Using the assembled information, the technician will digitize the project's stormwater facilities and related infrastructure, such as conveyance and drywells, in *StormwaterClk*.

The senior engineering technician also will enter attributes of storm system features in the database. Attributes are unique to each feature type. Some of the most important attributes that are common to most types of features include:

- Subwatershed (auto-populated)
- Custodial county department
- Service status
- Installation date
- Elevations
- Dimensions (pipe diameter, length, etc.)
- Facility name (for facility polygons only)
- Serial number of the parcel containing the facility (if relevant)

Transfer Information

Information in *StormwaterClk* is weekly uploaded electronically into the Public Works Maintenance Management System (MMS) database which is used to track and schedule inspection and maintenance activities for stormwater infrastructure.

Outputs

- Updates to *StormwaterClk*
- Asset data in MMS

OTHER PERMIT-REQUIRED MAPPING / INVENTORY

Background

The NPDES permit requires both continuation of ongoing inventory/mapping activities (S5.C.2.a) and completion of several additional mapping tasks under (S5.C.2.b).

Specific requirements under permit section S5.C.2.a are addressed through already completed mapping efforts and the ongoing inventory and mapping program includes updates as new development is inventoried.

New mapping requirements under S5.C.2.b are partially addressed through already completed mapping efforts; additional efforts to address specific requirements are described below.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Sr. Eng. Tech	GIS
Map land use	O	O	O	A/P
Map connections to tributary conveyances	O	A	P	O
Map connections between BMPs and tributary conveyances	Completed – updated as needed (CCPW CWD Sr. Eng. Tech)			
Map receiving waters	* Completed *			
Map areas not draining to outfalls	* Completed *			
Map outfall catchments	Completed – updated as needed (CCPW CWD Sr. Eng. Tech)			
Map tributary conveyances	Completed – updated as needed (CCPW CWD Sr. Eng. Tech)			
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted				

Procedures

Map Tributary Conveyances

Clark County completed an inventory of the conveyance system in early 2010.

Map Connections to Tributary Conveyances

This effort primarily involves mapping private road ditch connections to public road ditches and now applies to areas outside the UGA where the public ditch leads to an outfall with nominal diameter of at least 24 inches. Most county roadside ditches have nominal diameters of 24 inches.

Map Connections between BMPs and Tributary Conveyances

Existing connections, including overflows between BMPs and tributary conveyances are mapped, and new connections will be mapped as part of the ongoing inventory and mapping program.

Map Outfall Catchments

In 2010, the Clean Water Division completed mapping catchments to most urban area outfalls. This includes nearly 500 outfalls, most of which are smaller than 24 inches of nominal diameter. Catchments to new outfalls will be mapped as outfalls are added.

Map Outfall Land Use

Known outfalls are mapped, and new outfalls will be mapped as part of the ongoing inventory and mapping. As a result of Clark County's function as a land use regulator, the Clark County Assessor maintains land use data at the parcel scale in GIS. To produce a map of land uses for outfalls, Clean Water Division staff or GIS Department staff will overlay land use data with outfall catchments and conveyance systems in the GIS upon request or as needed.

Map Areas Not Draining to Outfalls

In 2010, the CWD and GIS Department mapped areas served by the MS4 that do not drain to surface water within the UGA. For outfalls outside the UGA, areas not mapped as an outfall catch fulfill this requirement.

Outputs

- Updated inventory of Stormwater infrastructure in *StormwaterClk*
- Inventory of connections to tributary conveyances in *StormwaterClk*

INVENTORY QUALITY ASSURANCE AND REPORTING

Purpose

To continuously improve accuracy and data completeness in *StormwaterClk* and the Maintenance Management System.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Sr. Eng. Tech	GIS
Ongoing Data Updates	O	A	P	O
Reporting	O	A	P	S

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Ongoing Data Updates

The CWD Infrastructure manager and the senior engineering technician will verify accuracy of stormwater infrastructure in the GIS as annexations occur and as more accurate project plans are produced or discovered.

Annexation Updates

Annually, the Infrastructure manager will check *Annexation Tracker* to determine if stormwater infrastructure has been annexed to a city. The senior engineering technician will change facility ownership attributes and update county MS4 municipal connection points in *StormwaterClk* where infrastructure has been annexed.

Ongoing Corrections

As possible mistakes in inventory data or needed revisions are discovered, the senior engineering technician will keep a list of possible corrections, then periodically research and, if necessary, correct StormwaterClk. Possible sources of discovery include Public Works Operations and Maintenance personnel, annual stormwater facility inspectors and Clean Water Division engineers. These corrections are addressed in GIS and in updated links to facility assets in the maintenance management system.

Review of Older Paper Plans
The senior engineering technician will review the archive of older paper plan sets to fill gaps in mapping and attributes of existing infrastructure.

Outputs

- Data updates in *StormwaterClk*
- Reports from *StormwaterClk*

UNDERGROUND INJECTION CONTROL (UIC) REGISTRATION

Purpose

Pursuant to the Safe Water Drinking Act and Chapter 90.48 RCW, Washington Administrative Code 173-218 requires new UIC-regulated stormwater disposal wells, also called Class V injection wells, to be registered with the Department of Ecology prior to construction

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Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Sr. Eng. Tech	CCPW CWD Engineer	CCPW Project Mgr.	CCPW Const. Mgr.	Applicant	CD Dev Eng. Mgr.
Map new Class V injection wells	A	P	O	O	O	O	O
Locate unregistered Class V injection wells	A	P	I	O	O	O	O
Submit private project registrations to Ecology	O	O	O	O	O	P	A
Submit public project registrations to Ecology	O	O	O	P	A	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

UIC Registration for County Projects

The CCPW CWD senior engineering technician will add new UICs to *StormwaterClk* upon project completion as part of ongoing inventory and mapping activities.

UIC Registration for Private Projects Having Public UICs

For privately-built projects that include new UICs in the public ROW or that are intended to be turned over to the county, the developer will register the UICs with the Washington Department of Ecology. For all such UICs, Clark County will be designated the owner on the registration form. Registration materials must be submitted to Ecology prior to construction.

When a developer submits plans for review, CD Development Engineering staff will confirm if UIC-regulated systems are included and inform the applicant of registration requirements. Registrations are verified prior to construction by Development Engineering at the pre-construction conference.
The CCPW CWD senior engineering technician will add new UICs to StormwaterClk upon project completion as part of ongoing inventory and mapping activities.

Outputs

- Updates to *Stormwater Clk*
- UIC wells registered with Ecology

TASK CHECKLIST

STATUS	TASK
ONGOING	Map all known MS4 outfalls and receiving waters, and structural stormwater treatment and flow control BMPs operated by Clark County
ONGOING	Map connection points between the MS4 and other municipalities
ONGOING	Map existing 8" and greater connections to the MS4
ONGOING	Map tributary conveyances and associated drainage areas
ONGOING	Map geographic areas served by the MS4 that do not drain to surface water
ONGOING	Map connections between BMPs and tributary conveyances
ONGOING	Continue ongoing inventory and mapping
ONGOING	Continue to map connections to tributary conveyances

For more information on the county's Clean Water Division, contact:

Jeff Schnabel, Clean Water Division Infrastructure Manager
564.397.4583
jeff.schnabel@clark.wa.gov

Section 3 – Operating and Maintaining the Storm Sewer System, County Property and Roadways

The county inspects and maintains storm sewer infrastructure to maintain its ability to convey, detain, infiltrate and treat stormwater. Clark County also manages its properties and roadways to reduce stormwater impacts from potential pollutant sources such as erosion, fertilizers and pesticides.



County crew replacing filters in a stormwater filter vault system

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit – S5.C.10 Operations and Maintenance

The NPDES permit requires the county to manage its maintenance activities and regulate non-county stormwater facilities to prevent or reduce stormwater impacts. The program must include:

- Maintenance standards and schedules for public and private stormwater facilities including catch basins.
- Street operation and maintenance practices that reduce stormwater impacts.
- Policies and procedures to reduce pollution from pesticides, herbicides and fertilizers used by the county.
- Operational practices that reduce stormwater impacts for equipment yards and storage facilities.
- Staff training.

Stormwater Management Manual for Western Washington

The permit requires the use of source control BMPs equivalent to Volume IV of the *Stormwater Management Manual for Western Washington (SMMWW)* or an approved manual. The Clark County Stormwater Manual, Book 4 contains a more extensive maintenance standard listing than the *SMMWW*.

The permit also requires a stormwater facility maintenance inspection program equivalent to Appendix V-A of Volume V of the SMMWW.

Chapter 173-218 WAC – Underground Injection Control (UIC) Program

Pursuant to Chapter 90.48 RCW, Washington Administrative Code requires the county to comply with regulations controlling the discharge of fluids, such as stormwater, into Class V injection wells. Examples of wells that handle stormwater include drywells and infiltration trenches. The stormwater management program addresses the UIC Program requirement to maintain and address pollutant sources.

Endangered Species Act 4(d) Rule

The federal Endangered Species Act prohibits "take" of threatened or endangered salmon. Take is harassment, harm, wounding, or killing of an ESA-listed salmon, or harming the critical habitat upon which it depends. The 4(d) rule directly prohibits take without authorization. However, the prohibition is limited under 13 different programs that describe procedures and processes by which an activity may be conducted to contribute to the conservation of the species overall. Road maintenance is an activity that, when conducted according to the Regional Road Maintenance Forum guidelines, is certified by National Marine Fisheries Service to contribute to the conservation of listed salmon.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 40.386 – Stormwater and Erosion Control

Chapter 40.386 requires newly constructed stormwater treatment and flow control facilities to be maintained in accordance with the Clark *County Stormwater Manual 2015, Book 4* – Operations and Maintenance, and it gives the county authority to inspect privately-operated facilities for compliance.

The chapter also requires ownership and maintenance responsibility of private facilities to be noted on subdivision final plats.

The *Clark County Stormwater Manual's Book 3-Source Control* adopts source control and treatment standards for public and private properties equivalent to Volume IV of the 2014 *SMMWW*.

Clark County Code Chapter 13.26A – Water Quality

Chapter 13.26A requires inspection and maintenance of all public and private stormwater facilities and Class V injection wells in accordance with the *Clark County Stormwater Manual*, that provides BMPs for business and public agency activities such as materials handling, landscape management, trash management and building exterior maintenance.

ENFORCEMENT PROCEDURES FOR UN-MAINTAINED PRIVATE STORMWATER FACILITIES

The Clark County Clean Water Division has a written procedure for responding to non-compliant private regulated stormwater facilities.

Environmentally Responsible Purchasing Policy

Clark County adopted its Environmentally Responsible Purchasing Policy in 2004. One element addresses purchase of landscaping and vegetation maintenance products, including pesticides. The policy establishes a set of

criteria, any of which will disqualify a pesticide from purchase, and a waiver system, allowing chemicals with no equivalent that is more environmentally-friendly to be used within specific limiting guidelines.

ESA Regional Road Maintenance Forum

Clark County Public Works has been a member of the ESA Regional Road Maintenance Forum since 2003. The group assisted the county in developing a regional road maintenance program designed to meet the requirements of the Endangered Species Act (ESA). In 2004, NOAA Fisheries approved the program and determined that it was compliant with the ESA 4(d) rule. The program seeks to protect salmon and steelhead by relying on the extensive use of pre-approved BMPs for routine maintenance activities.

TOOLS

Maintenance Management System (MMS)

The *Maintenance Management System (MMS)* is a database operated by Public Works for tracking infrastructure assets, recording condition, and scheduling inspections and maintenance. The MMS was implemented in 2011 and continues to evolve. The MMS will be used to prioritize, schedule and track stormwater infrastructure inspections and maintenance by Public Works crews.

For stormwater facilities and related infrastructure, the inventory in MMS is uploaded directly from *StormwaterClk* (see Inventorying and Mapping the Storm Sewer Infrastructure on page 21).

INSPECTIONS

Purpose

Clark County inspects both county-owned and regulated non-county stormwater facilities to evaluate condition and function and to determine if maintenance or repairs are warranted. In the case of regulated non-county facilities, follow-up actions include technical support to the BMP owner and, in some cases, enforcement.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Inspectors	CCPW CWD Sr. Eng. Tech	CCPW Construction Mgmt . OA	CCPW Construction Mgmt. Supervisor	CCPW Construction Mgmt. Inspectors	CCPW Ops Road Crews	CCPW Ops Road Supervisor
Inspect Regulated Facilities	A	I	P	S	O	O	S	O	O
Inspect Facilities During Heaviest Home Construction	I	I	O	S	S	A	P	O	O
Inspect County-owned Facilities	I	I	O	S	S	A	P	O	O
Inspect Catch Basins	I	I	O	S	O	O	O	P	A

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Inspect Regulated Facilities

Regulated facilities are treatment and flow control facilities including low impact development BMPs owned and operated by private parties and non-county governmental bodies. Clark County plans to annually inspect 100 % of regulated facilities with a permit mandate to inspect at least 80% of regulated facilities connected to the MS4.

County responsibility for inspecting regulated facilities will begin at issuance of the completion of construction letter by CD Development Engineering or the occupancy permit for individual residence projects subject to maintenance requirements. (See Regulatory Program for Development, Redevelopment and Construction Projects on page 69)

For facilities not in compliance with maintenance standards, the county will follow procedures to compel compliance through follow-up technical assistance and enforcement actions if needed.

Track and Schedule Annual Inspections

Public Works Clean Water Division will use ESRI Collector and Survey 123 applications on iPad devices to schedule, log and track regulated facility inspections.

Inspection

Inspections will be completed by Public Works Clean Water Division operations specialists and natural resource specialists. Inspections are be combined with business source control inspections. The inspectors will compare facility condition with maintenance standards from the Clark County Stormwater Manual.



Facility inspection

Contact Owners of Non-Compliant Facilities

If an inspection shows that a facility is out of compliance, the Clean Water Division senior operations specialist will send a mailing to the owner(s) and/or responsible party. The mailing packet will include:

- Introductory letter.
- Property identification.
- Postcard to return for technical assistance.
- Facility defect report.
- *Managing Stormwater Facilities* pamphlet with links to additional information.

Recipients will be referred to Clean Water for questions or problems.

Facility ownership or homeowner association leadership may change. In some cases, no viable homeowner association exists. The Clean Water Division senior operations specialist will research and follow up in these cases.

Contact Owners of Compliant Facilities

If an inspection shows that a facility is compliant, the owner will be sent a postcard stating that the facility is compliant and thanking them.

Follow-Up Technical Assistance
The Clean Water inspectors will assist owners who reply to the initial letter by giving advice on maintenance. The assistance may include phone calls, additional correspondence and site visits. The inspector will facilitate compliance and use professional judgment to set deadlines for compliance activities.

Further Enforcement
If the owner or owners of a non-compliant facility are unresponsive, then the senior operations specialist will refer the case to the code enforcement officer.

The code enforcement officer will use progressive enforcement methods, terminating with a Notice and Order and issuance of fines and liens in cases of severe non-compliance.

Alternate Compliance Strategy
The county retains the option of maintaining the facility and billing the owner at any point after an inspection demonstrates that a facility is out of compliance. This is a costly and time-consuming option, so it is generally avoided.

Compliance Tracking
Public Works Clean Water will update facility records with compliance information on a regular basis, including inspection results, contact information and other relevant facility information. A spreadsheet system tracks correspondence to regulated facility owners and assistance provided. Follow-up and enforcement actions will be tracked by the Clean Water Division senior operations specialist and tracked as case files.

Facility Ownership Transfer
While it rarely occurs, the county has a policy, criteria and procedures for accepting ownership of private stormwater facilities serving residential subdivisions. Facilities must meet county maintenance, safety and access standards before acceptance.

Inspect Facilities During Heaviest Home Construction
Clark County will inspect permanent stormwater treatment and flow control facilities, including catch basins, in new residential developments every six months during the period of heaviest construction. The NPDES permit defines the period of heaviest construction as the time until 90 percent of the lots are built-out (see condition S5.C.5.b.vi.d).



Maintain Inspection List
Construction Management runs a report from permit tracking software listing the number of lots in the subdivision and the number of lots having active building permits.

Schedule Inspections
The Public Works Construction Management lead inspector will consult the inspection list monthly and schedule project sites requiring inspection for the following month. Any subdivision with less than 90 percent of the lots built out will be scheduled. The Public Works Construction Management lead inspector will schedule six-month inspections for each project using the inspection list.

Inspection
Public Works Construction Management inspectors will inspect project sites using standards from the *Clark County Stormwater Manual*

Track Inspections
The Public Works Construction Management inspector or office assistant will enter the inspection results into permit tracking software under the DIN (development inspection number). The electronic field inspection form is attached to the DIN case.

Enforcement
The method used to enforce maintenance compliance of a facility found to be out of compliance will depend on its ownership. When a private facility or catch basin is out of compliance, the standard process for enforcement on a regulated facility will be followed.

When a county-owned facility or catch basin on maintenance warranty is out of compliance, the inspector will refer the issue to the Public Works development inspector assigned to that development project.

When a county-owned facility or catch basin is out of compliance after the warranty period, the facility will be treated as any other county-owned facility.

Inspect County-Owned Facilities

The Clark County Public Works Construction Management Program annually will inspect at least 95% of county-owned stormwater treatment and flow control facilities. Facilities with known problems may be spot-checked by Public Works Operations and Maintenance after significant storm events in addition to routine inspections.

- For county capital improvement projects, inspection responsibility will transfer to the county at the issuance of the final acceptance letter to the contractor by Public Works Construction Management.
- For facilities constructed as part of a private-sector development project that did not include a warranty period, maintenance responsibility will transfer to the county two years after issuance of the completion of construction letter to the developer. (See Regulatory Program for Development, Redevelopment and Construction Projects on page 69.)

Inspection
Public Works Construction Management will inspect facilities using standards from *the Clark County Stormwater Manual*. Crews will note compliance and defects using the same field applications used for regulated facilities.

Spot Checks
After significant storms, Public Works crews will inspect facilities that have known problems associated with heavy rainfall.

Tracking
Public Works Construction Management inspection results are entered into the MMS using the iPad-based field applications.

Inspect and Clean Catch Basins

The Clark County Public Works Operations and Maintenance Program will inspect catch basins in road right-of-way annually. Each catch basin is inspected and those exceeding sediment depth standards are scheduled for cleaning.

Catch basins in parks and other county facilities will be inspected and cleaned as part of routine maintenance by Public Works.

Outputs

- MMS records of regulated facility inspections
- Updates to six-month inspection list
- Spot checks of public facilities after severe storms
- Catch basin cleaning
- MMS records of public facility inspections

COUNTY STORMWATER FACILITY AND CLASS-V INJECTION WELL MAINTENANCE

Purpose

Maintenance of stormwater facilities and stormwater disposal wells ensures that facilities continue to perform their important environmental and drainage functions. Clark County Public Works is responsible for maintenance of most county stormwater infrastructure when it fails to meet a maintenance standard established by permit and county standards.

Responsibility for maintaining county-owned stormwater treatment and flow control facilities will begin at issuance of the final acceptance letter for those constructed as part of a county capital improvement and at the end of the maintenance warranty period for those built as part of a private-sector development project. (See Regulatory Program for Development, Redevelopment and Construction Projects on page 69.)

The county does not maintain private stormwater facilities except in emergency situations or when pursuing an alternate compliance strategy for a non-compliant facility, whereby the county maintains the private facility at the owner's expense.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD NPDES Mgr.	CCPW CWD Sr. Eng. Tech	CCPW Road Ops and Parks Supers	CCPW Ops Roads and Parks Crews	Contract Services
Routine Facility Maintenance	I	I	S	A	P	O
Non-routine Facility Maintenance	C	C	S	A	P	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Typical Facility Maintenance

Clark County will perform routine maintenance, such as litter removal, mowing and weed control, on swales, ponds, filter strips and LID BMPs that it owns. Typical maintenance is regular activities that maintain a facility's function that can be accomplished primarily with hand tools, lawn mowers and weed whackers, and do not require engineering evaluation or heavy equipment. It does include cleaning sediment traps using vacuum trucks. The following procedure applies to stormwater facilities maintained by Public Works, such as those in subdivisions and road right-of-way. Maintenance of other county stormwater facilities located in parks and on county campuses is covered in the section pertaining to operation of county lands (below).



Stormwater facility maintenance

Schedule and Prioritize

Most of the typical facility maintenance will occur during the growing season (April to September). The Clark County Public Works water quality crew chief will schedule the work.

Maintenance

Mowing grass, controlling weeds and litter or debris removal are the primary typical maintenance activities. Other maintenance for defects including sediment accumulation in sediment traps, minor erosion, presence of trees in pond or swale bottoms, etc., is also part of typical maintenance.

Capital Construction Facility Maintenance

Prioritization and Budget

The Clean Water Division and Operations and Maintenance will develop an annual work plan for maintaining and repairing facilities that require capital construction under $25,000.

Individual maintenance projects estimated to cost more than $25,000 are referred to the Stormwater Capital Program (page 65).

Inspection Data Review

The Public Works NPDES road operations superintendent and crew chief will schedule facility maintenance requiring construction in consultation with the Clean Water Division Infrastructure Manager.



Filter Vault Cartridges

Implementation
Maintenance requiring construction is accomplished as resources and weather allow within permit timelines.

Drywell Maintenance

Public Works Operations and Maintenance Roads crews will maintain drywells (Class V stormwater injection wells) as necessary based on a visual inspection of defects. Drywells in stormwater facilities will be inspected annually as part of routine facility inspections. Drywells in streets and roads will be inspected at the time catch basins are inspected.

Outputs

- Stormwater facilities maintained and repaired to meet county standards.
- List of projects referred to the capital planning program for repairs greater than $25,000.
- Database records of facility maintenance work (MMS).

USE OF WATER QUALITY BMPS DURING ROADWAY AND COUNTY PROPERTY OPERATION AND MAINTENANCE

Purpose

Clark County maintains its properties and roadways in a manner that prevents or reduces stormwater impacts.



Stormwater facility

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Permit Mgr.	CCPW CWD Sr. Operations Specialist	CCPW Ops and Parks Mgrs	CCPW Road Ops Super	CCPW Ops Roads Crews	CCPW Parks Super	CCPW Parks Crews	CCPW Land and Vegetation Mgr.	CCPW Vegetation Mgmt. Crews	General Services, Facilities Mgr.	General Services, Facilities Crews
Annually inspect and maintain catch basins in parks	I	I	O	A	O	O	A	P	O	O	O	O
Annually inspect and maintain catch basins on campuses	I	I	O	C	O	O	A	P	O	O	A	O
Road maintenance practices	I	I	O	A	C	P	O	O	O	O	O	O
Landscape maintenance on campuses	I	I	C	C	O	O	A	P	O	O	A	O
Landscape maintenance in parks	I	I	C	A	O	O	A	P	O	O	O	O
Noxious weed removal practices	I	I	C	O	O	O	O	S	A	P	O	O
Exterior building and grounds maintenance	I	I	C	O	O	O	O	S	O	O	A	P
Training road maintenance crews	I	S	S	A	P	I	O	O	O	O	O	O
Training parks maintenance crews	I	S	S	A	O	O	P	I	O	O	O	O
Training weed management crews	I	S	S	O	O	O	O	O	A	P	O	O
Training Facilities Maintenance crews	I	S	S	O	O	O	O	O	O	O	A	P
Check SWPPPs	I	S	O	A	O	P	O	O	O	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Maintain Roadways

Road maintenance and operation will be conducted by the Public Works Road Maintenance and Operations Division.

Clark County will maintain roadways and other traveled surfaces using pollution reduction practices defined by the ESA Regional Road Maintenance Program and in Clark County Stormwater Manual.

Specific pollution-reduction activities include:

- Periodic removal of litter from conveyances, such as ditches.
- Catch basin cleaning.

Practices to prevent pollution will be implemented whenever the following maintenance activities are conducted:

- Pipe cleaning
- Culvert cleaning
- Ditch maintenance
- Street cleaning
- Road repair and resurfacing, including pavement grinding
- Snow and ice control
- Utility installation
- Maintaining roadside areas, including vegetation management
- Dust control
- Pavement striping maintenance
- Application of fertilizers, pesticides and herbicides
- Sediment and erosion control
- Landscape maintenance and vegetation disposal
- Trash and pet waste management



Street sweeper with clean water message

Maintain Parks

Parks may contain any or all of the following types of land cover: pavement, landscaped areas, natural areas, structures and stormwater facilities. Parks will be maintained by Public Works Parks and Lands Division.

Clark County will maintain park vegetation and structures according to *Clark County Stormwater Manual* and current pesticide application rules. Pesticides will be purchased according to the county's Environmentally Responsible Purchasing Policy. Parks maintenance crew members are trained under the ESA Regional Forum and are state licensed pesticide operators.

Parks crews will inspect catch basins within parks during routine park maintenance and will clean them as needed.

Parks crews will mow and remove litter from stormwater facilities within parks frequently during routine park maintenance. Public Works Road Maintenance and Operations will provide the balance of the maintenance.

Maintain County Property

County campuses are managed by the General Services department. General Service's personnel maintain pavement and building exteriors; General Services has an agreement with Public Works Parks and Lands Division for most outdoor vegetation management activities.



Clark County will maintain landscaping and hard surfaces on its campuses according to the *Clark County Stormwater Manual*. Pesticides will be purchased according to the county's Environmentally Responsible Purchasing Policy. Parks maintenance crew members are trained under the ESA Regional Forum and are state licensed pesticide operators.

Parks crews will inspect and maintain catch basins on county campuses.

Parks crews will mow and remove litter from stormwater facilities on county campuses as needed based on visual inspection.

Clark County implements a Stormwater Pollution Prevention Plan (SWPPP) for each of its heavy equipment and materials storage yards, operated by Public Works. Copies of the SWPPPs are kept at each site.

Control Weeds on County Property

State regulated noxious weed control on county properties is provided by Public Works Parks and Lands Division.

Clark County will control weeds according to current pesticide application rules. Pesticides will be purchased and used according to the county's Environmentally Responsible Purchasing Policy.

Vegetation Management field crews are state licensed pesticide operators.

For some areas, such as mitigated wetlands and properties with Legacy Lands designation, Vegetation Management will compose a Site Specific Plan to ensure that compliance with all environmental regulatory requirements, including NPDES permit requirements, will be achieved.



Employee Training

Crews from Public Works Operations and Maintenance and Public Works Parks and Lands are trained under the ESA Regional Road Maintenance tracks 2 and 3. Track 2 coursework describes the biology of endangered fish and how road and park maintenance activities can harm them; it is generally provided to supervisors and managers. Track 3 provides crew chiefs and crew members with maintenance guidelines and procedures to protect endangered species during maintenance work.

In addition to task specific training, county personnel who as part of their field work may encounter a spill or non-stormwater discharge are trained on how to respond.

Train New Personnel

Clark County Public Works will provide ESA Regional Road Maintenance training using an approved vendor for new or promoted staff, as necessary.

Outputs

- Maintenance of county property using proper BMP manuals
- Employee training
- Stormwater Pollution Prevention Plan at each heavy equipment and storage yard

TASK CHECKLIST

STATUS	TASK
ONGOING	Spot check facilities with known problems after significant storms
ONGOING	Annually inspect and clean, if needed, county-owned catch basins
ONGOING	Implement established practices to reduce stormwater impacts from property and landscape maintenance activities
December 31, 2022	Document practices to reduce stormwater impacts from property and landscape maintenance activities for county property
ONGOING	Employee training
ONGOING	Update SWPPPs for county equipment yards
ONGOING	Adopt and implement maintenance standards equivalent to the SMMWW
ONGOING	Require maintenance of regulated facilities to the SMWW
ONGOING	Implement program to annually inspect all regulated facilities
ONGOING	Inspect all new facilities in new residential developments every 6 months during the period of heaviest construction
ONGOING	Inspect all county-owned facilities annually

For more information on county operation and maintenance of the MS4:

Jeff Schnabel, Clean Water Division Infrastructure Manager,
564-397-4583
Jeff.Schnabel@clark.wa.gov

Section 4 – Detecting and Reducing Pollutants and Contamination

Contaminants may enter the MS4 through improper connections and through discharge of contaminants from sites with private storm systems that are connected to the MS4.

Eliminating illicit connections and discharges of contaminants is an important part of the county's Stormwater Management Program.

Improper non-stormwater connections may be discovered through routine screening of the system, site inspections or by complaint. When an improper connection is discovered, removal and disconnection is a high priority.

Regular and wide-spread inspections of business and multi-family sites helps ensure that sites are properly managing potential contaminants, maintaining catch basins and conveyance systems, and preventing non-stormwater discharges into their private systems that discharge to the MS4.

Along with meeting NPDES permit requirements, the program also addresses sources that do not discharge to the Permit-regulated MS4, including discharges to Class V injection wells, non-county storm drains and other conveyances to surface water and groundwater.

Source Control Program

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.8 – Source Control Program for Existing Development

The NPDES permit requires the county to reduce pollutants in runoff from areas that discharge to the MS4 by applying operational, structural source control and treatment Best Management Practices (BMPs); enforcing proper BMPs on commercial, industrial and multifamily properties; enforcing water quality ordinances; and reducing pollutants from pesticides, herbicides and fertilizers entering the MS4.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 40.386 – Stormwater and Erosion Control

Chapter 40.386 adopts the *Clark County Stormwater Manual* as the technical manual for meeting the Minimum Requirements of the Permit, including Minimum Requirement 3, Pollution Source Controls.

Clark County Code Chapter 13.26A – Water Quality

Clark County prohibits non-stormwater discharges to the MS4 and regulates the discharge of contaminants to surface water, stormwater and groundwater to protect the county's surface and groundwater quality. The code and stormwater manual provide requirements for reducing and controlling the discharge of contaminants by requiring all sites and activities to utilize source control Best Management Practices (BMPs) to control release of contaminants.

Chapter 13.26A also adopts the *Clark County Stormwater Manual* that provides BMPs for materials handling, landscape management, trash management and building exterior maintenance.

Clark County Stormwater Manual

The *Clark County Stormwater Manual* contains technical requirements for meeting Minimum Requirement 3, Source Control of Pollution under county code Chapter 40.386 for development projects The manual also applies to existing land uses under Chapter 13.26A.



INVENTORY POTENTIAL POLLUTANT GENERATING SITES

Purpose

The Potential Pollutant Generating Site inventory helps target education and enforcement of source control requirements on commercial, industrial and multifamily sites. The site inventory also meets a requirement of the NPDES permit.

Responsibilities Matrix

Task	CCPW CWD Source Control Specialist	GIS	CCPW CWD NPDES Mgr.
Update inventory of sites	**S**	**P**	**A**
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted			

Inventory Maintenance

The Clean Water Division uses several sources to identify commercial, industrial and multifamily sites in the county that have impervious surfaces.

The database is derived from the Clark County Assessor personal property tax database and fire marshal inspection data. As inspections progress to include most permanent business sites, the site inventory is refined based on site-specific information. The inventory is also updated as new business sites are built or complaint-driven sites are added.

Outputs

- Inventory of business and multifamily sites

SOURCE CONTROL AT BUSINESS AND MULTIFAMILY SITES

Purpose

Clark County inspects business sites and many multifamily sites for compliance with source control requirements to ensure pollutants are not discharged to the MS4 or groundwater via Class V stormwater infiltration wells.



Responsibilities Matrix

Task	CCPW CWD NPDES Mgr.	CCPW CWD Source Control Specialist	CCPW Code Enforcement Officer	CCPW CWD Outreach / Education	CCPW CWD OA
Site selection	A	P	O	O	O
Inspection / education	A	P	S	S	O
Follow-up for compliance	A	P	P	O	O
Referral	A	P	P	O	O
Recordkeeping	A	P	P	O	P
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted					

Site Selection

Each year, a group of sites are selected for inspection based on land use risk and results from past inspections.

Inspection and Education

Inspections are conducted by qualified county staff. Currently, Clean Water Division source control specialists inspect sites.



At each business site, county staff will approach the owner, manager, or other employees to obtain access to the storm system on the site and to ask questions about source control practices, drainage plumbing, materials storage, and, if relevant, structural source control BMPs.

Staff will note inspection findings using the i-pad field form and enter results into the Local Source Control database in Secure Access Washington (SAW).

During the visit, county staff will provide education and technical assistance as judged necessary or beneficial. Education or assistance could include brochures, BMP handouts, general information on stormwater pollution topics, copies of the county's water quality ordinance, *Clark County Stormwater Manual*, or referrals to maintenance companies.

Follow-up Actions for Compliance

If a business is not in compliance, the source control specialist will work with the manager or owner to reach compliance. Follow-up actions may include phone calls, additional site visits and letters. County staff may give additional

technical assistance such as locating engineering drawings, providing handouts from the *Clark County Stormwater Manual* or Ecology and recommending new source control BMPs.

The source control specialist will set deadlines as necessary for compliance actions (e.g. cleaning catch basins).

Follow-up actions will also be recorded using the iPad field form, which is stored in a county database and entered into the Local Source Control database on SAW.

CATCH BASIN CLEANING ASSISTANCE

In late 2018, a new program was implemented to provide catch basin cleaning services for a fixed rate of $45 per catch basin. Out of compliance businesses are referred to the county webpage where businesses can register for the service. The contractor then performs the catch basin cleaning, properly disposes of waste material and invoices the business and provides a manifest of proper waste disposal. Mailers were sent to all business sites draining to the county storm sewer system

Referral

If necessary to gain compliance, the source control specialist will refer the case to another agency such as Clark County Public Health, Ecology or the Clark Regional Wastewater District. The source control specialist will continue to follow the case to conclusion.

Further Enforcement Actions

Further enforcement will be provided by Clean Water Division Code Enforcement or by referral to Ecology in cases of continued inaction.

Recordkeeping

Information is stored in a database linked to the iPad Survey 123 and Collector applications. Non-stormwater discharges are logged in the county IDDE database and site visit information is logged in the state SAW database for Local Source Control contract compliance. .

Training

All county employees who conduct field work need to be aware of spill response procedures and protocols. A training program is established using the county's Gensuite training tracker online program. Field personnel from multiple departments will be required to complete the training annually to ensure they are familiar with illicit discharge, illicit connections, use of spill kits, and what to look for in the field.

Outputs

- Records of inspections and follow-up cases
- Report of numbers of inspections and referrals
- Case files



WATER QUALITY COMPLAINT INVESTIGATIONS

Purpose

Clark County investigates all legitimate complaints about water quality problems to reduce contamination of stormwater, surface water and groundwater as well as to comply with its NPDES Permit

Responsibilities Matrix

Task	CCPW CWD NPDES Mgr.	CCPW CWD Source Control Specialist	CCPW CWD OA	CCPW CWD Natural Res. Specialist	
Open case	A	P	O	O	
Investigation	A	P	O	S	
Education and compliance	A	P	O	O	
Recordkeeping	A	P	S	S	

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Open Case

Water quality complaints may arrive in a variety of ways, including the 24-hour water quality complaint line, referral from other agencies, referrals from Community Development Code Enforcement Officers, e-mail to the Clean Water Division general address, and phone calls to the Clean Water Division. Complaints may be made by the general public or agency staff.

Complaints will be referred or forwarded to the Public Works Clean Water Division source control specialist.

Investigation

The source control specialist will investigate every legitimate complaint beginning with a phone call and site visit.

For business sites, the source control specialist will fill out the "Clark County Stormwater Business Site Visit Report" field form and begin a case file.

For residential sites, the source control specialist will fill out the field form but generally will not begin a case file. In difficult or egregious cases, the specialist will begin a case file.

Education and Compliance

If a water quality or source control violation is found, the source control specialist will work with the property owner or property manager on compliance or refer the case to another agency. The source control specialist generally follows the procedures for source control

follow-up (above), and, if necessary, further enforcement actions.

Recordkeeping

A Public Works Clean Water Division source control specialist will enter the data into the IDDE tracking database and maintain a case file.

Outputs

- Records of complaints, investigations and follow-up
- Case files

Training

Clean Water Division and Code Enforcement personnel have been performing source control inspections and enforcement since 2000. When applicable, new staff will be trained on enforcing the Water Quality Ordinance, including legal basis, BMPs, inspection procedures, enforcement process and recordkeeping. When changes to manuals or procedures are made, all appropriate staff will be trained.

TASK CHECKLIST

STATUS	TASK
ONGOING	Source control inspections and enforcement
ONGOING	Staff training for source control
ONGOING	Update inventory of pollution-generating sites
ONGOING	Inspect sites, enforce and respond to complaints
2021	Update county municipal code per permit requirements
2021	Update county stormwater manual per permit requirements

For more information on the Source Control program:

Rod Swanson, Clean Water Division NPDES Permit Manager,
564-397-4581
Rod.Swanson@clark.wa.gov

Illicit Connections And Illicit Discharges Detection And Elimination (IDDE)

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.9 – Illicit Connections and Illicit Discharges Detection and Elimination (IDDE)

The NPDES permit requires the county to have a program to detect, remove and prevent illicit connections and illicit discharges, including spills, into the MS4. Illicit connections are man-made conveyances connected to the MS4 without a permit, such as sanitary sewers and floor drains that can carry materials other than stormwater. Illicit discharges are discharges to the MS4 not composed entirely of storm water, except where allowed by a state waste discharge permit.

The Permit designates timelines for beginning an investigation of a suspected illicit connection and for terminating a confirmed illicit connection.

Revised Code of Washington Chapter 90.48 – State Water Pollution Control Act

The State Water Pollution Control Act prohibits the discharge of contaminants to waters of the state.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 13.26A – Water Quality

Chapter 13.26A prohibits the discharge of contaminants into surface water, stormwater or groundwater, and it defines contaminants and illicit connections. It gives inspection and enforcement authority to authorized representatives of the County Manager s to enforce that chapter.

Clark County Code Chapter 13.10 – Use of Sewer

Chapter 13.10 requires the use of sewers to dispose of liquid wastes and water carrying waste materials.

Clark County NPDES Illicit Discharge Detection and Elimination Screening Quality Assurance Project Plan

The Project Plan addresses project design, schedule, methods of data collection and management, quality assurance and control requirements, data analysis, thresholds for further investigation, and reporting for the county's program to screen the MS4 for illicit connections.

ILLICIT DISCHARGE AND CONNECTION SCREENING

Purpose

Screening for evidence of illicit discharges and connections helps county staff identify outfalls or points in the MS4 that appear to convey something other than stormwater, as well as meeting Permit requirements for ongoing screening.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD NPDES Mgr.	CCPW CWD Natural Res. Specialist
Screening area selection	A	S	P
Outfall selection	A	I	P
Site visits / screening	A	I	P
Sampling / evaluation	A	I	P
Recordkeeping	A	I	P
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted			

Ongoing Work

Clark County carried out an extensive screening program in each year and has screened the entire urban area and several rural subwatersheds at least once.

Public Works Clean Water Division natural resource specialists will continue effectiveness monitoring on illicit connections discovered during previous field screening operations (see Illicit Connection and Discharge Response and Removal on page 53). In addition, a natural resource specialist or source control specialist will respond to any complaints and referrals.

Source control inspections are an important element of illicit discharge detection (see Source Control Program on page 43).

In 2021, a Clean Water Division natural resource specialist will select urbanized subwatersheds for screening based on professional judgment and watershed management objectives. This area will include at least 12 percent of the MS4 urban stormwater conveyance systems as identified by the presence of an MS4 outfall.

Outfall Selection and Scheduling

A Clean Water Division natural resource specialist will use the county stormwater infrastructure inventory GIS database, *StormwaterClk*, to locate and map all outfalls within chosen screening area. Staff will schedule site visits using this information.

Screening Site Selection

Site Visits
During the summer season, a natural resource specialist will screen outfalls for indicators of illicit connections, such as flow or deposits.

Sampling and Evaluation
The natural resource specialist will take samples at flowing outfalls, use field tests and send them for laboratory analysis, and then evaluate the results using defined protocols to determine if an investigation is warranted. In cases where an investigation is warranted, the discharge is called a suspected illicit discharge or connection.

Investigations and follow-ups are part of the Illicit Connections and Discharge Response program (below).



Recordkeeping
The natural resource specialist will track all information regarding screening, illicit connection investigations and response to illicit discharges if applicable, in the IDDE screening iPad application. Database fields based on those described in the 2019 permit.

Reporting
Each year, the natural resource specialist will complete a report describing the year's work from planning through removal of any discovered illicit connections or discharges, including those discovered by source control inspections. The report will be stored in the project folders by year.

Awareness Training
A new training program has been established using the county's Gensuite training tracker online program. Field personnel from multiple departments will be required to complete the training annually to ensure they are familiar with illicit discharge, illicit connections, use of spill kits, and what to look for in the field.

Outputs

- Records in the IDDE screening database
- Annual written summary of screening activities, investigations and results
- Report of number of inspections and follow-ups
- Laboratory data and field measurements entered in the Water Quality Database

ILLICIT CONNECTION AND DISCHARGE RESPONSE AND REMOVAL

Purpose

Clark County responds to all suspected illicit discharges and connections to the MS4 that it identifies through screening or other methods. Response is designed to eliminate the source of the discharge or the connection.

Responsibilities Matrix

Task	CCPW CWD NPDES Mgr.	CCPW CWD Natural Res. Specialist	CCPW CWD Source Control Specialist	Public Health	CRWWD	Ecology
Open case	A	I	P	O	O	O
Investigation	A	S	P	S	S	S
Follow-up / removal	A	I	P	S	S	S
Continued follow-up	A	S	P	S	S	S
Recordkeeping	A	P	S	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Suspected Illicit Connection and Discharge Response

The CCPW Clean Water Division and Public Works Operations Division will receive and respond to reports of suspected illicit discharges; however, some illicit connections or discharges due to on-site sewage treatment systems are discovered and terminated by Clark County Public Health. The process described here is that used by the Clean Water Division and Public Works.

Notify Ecology

The county immediately will notify Ecology if an illicit discharge or connection poses a threat to human health or the environment.

Open Case

The process begins with notification about a suspected illicit discharge or connection through referral from illicit detection screening (above), discovery through source control inspections (above), or complaint.

The source control specialist will open a case file.

Investigation

Within 21 days, the Clean Water Division source control specialist and a natural resource specialist will attempt to trace a suspected illicit discharge or connection back to its source to identify the problem. If tracing back to the source is not possible, they may elect to follow other protocols established in the IDDE Project Plan.

The source control specialist will confirm the presence or absence of the suspected illicit discharge or connection based on the findings, and, when possible, will specify the source.

Follow-up and Removal

For confirmed illicit discharges or connections, the source control specialist will work with the property owner and, if necessary, other county departments or agencies to eliminate the illicit connection. If relevant, Clark Regional Wastewater District, Public Health, cities, or the Department of Ecology may be requested to assist in areas where they have responsibility.

Addressing illicit discharges will follow standard source control procedures for follow-up actions (e.g. personal contacts) and further enforcement by a Code Enforcement Officer, if necessary.

Removal of illicit connections will be completed within six months of confirmation of an illicit connection through field verification.

Continued Follow-up

Following the IDDE Project Plan, questionable outfalls require continued follow up, which may include effectiveness monitoring at sites where illicit connections or discharges were found, repeat screening where low levels of pollutants were found, or additional visits by the source control specialist to verify that actions leading to an illicit discharge have ceased.

Recordkeeping

The source control specialist will inform the natural resource specialist of the results of the follow-up actions involving illicit discharge or connection abatement. The natural resource specialist will enter information into the IDDE screening database.

If the case is a suspected illicit connection, the date it was first discovered or reported will be used to track the requirement to initiate an investigation with 21 days.

After the illicit connection is confirmed, the requirement to terminate the connection within six-months will apply. If the suspected connection was identified through field observation, source control inspection, or complaint, the discovery date is the date the observation or complaint was made. If the suspected connection was identified through laboratory analysis, the discovery date is the date of the official laboratory report. Discovery dates will be recorded and tracked in the IDDE screening database.

A record is kept for every illicit connection referred to Ecology as a severe threat to human health or the environment.



Outputs

- Removal of illicit connections and reduction of illicit discharges to the MS4
- Entries in the IDDE screening database

SPILL RESPONSE

Clark County responds to spills on surfaces, such as roadways, that discharge to the MS4, surface water or groundwater, and to improper dumping into the MS4.

Purpose

The purpose is to reduce and prevent contamination of surface water, groundwater and stormwater.

Responsibilities Matrix

Task	CCPW Ops Admin.	CCPW Ops Crew Chief	CCPW Ops Road Crews	CCPW Operations OA
Open case	I	A	I	P
Spill response / clean-up	I	A	P	O
Notify Ecology	A	P	S	P
Recordkeeping	A	P	C	S

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Notification

Spill notification can arrive in a variety of ways, including detection by Public Works Operations and Maintenance roads crews or citizen complaint to Clark County or Ecology.

Clark County staff receiving notification of a spill will immediately notify Public Works Operations and Maintenance dispatch. Public Works Operation and Maintenance staff will then notify the Clean Water Division senior operations specialist. For spills responded to by Public Works crews, the Crew Chief will call Ecology's spill response team in the Vancouver Field office, if necessary. The Clean Water Division senior operations specialist will also be responsible for ensuring spills are reported to Ecology's 24-hour spill reporting number.

County personnel also will immediately refer significant spills to Department of Ecology

Response

Spill reports received by Public Works generate a Maintenance Management System work order, the appropriate crew responds to work order and, if necessary, they call Ecology or notify the Clean Water Division senior operations specialist who will report the spill to Ecology. For urgent complaints arriving after hours via telephone, the answering service will page the Public Works Operations and Maintenance on-call crew chief, who will determine the level of response following established Public Works guidelines.

Recordkeeping

Records of spill incidents and responses will be kept in the Public Works customer service database. If the Clean Water Division senior operations specialist responds, the spill will be recorded in the IDDE tracking database. The Public Works phone operator enters the phoned-in spill report into the tracking system. The crew chief enters all follow-up information and closes out the work order.

Outputs

- Spill clean-up
- Records of incidents responses

Purpose

Clark County advertises Ecology's spill response hotline as a water quality complaint line. The line gives citizens an opportunity to report spills, dumping and other water quality concerns at any time. The Clark County webpage also includes a web-form to report a spill or environmental problem in the home page "How do I" tab. The webpage includes contacts for non-emergency concerns and has phone numbers for emergencies and spill reporting at: www.clark.wa.gov/public-works/report-stormwater-erosion-or-drainage-concerns.

WATER QUALITY PROBLEM REPORTING

Responsibilities Matrix

Task	CCPW Ops Admin.	CCPW Ops OA	CCPW Answering Service	CWD Code Enforcement Officer	Public Health	CCPW CWD Source Control Specialist
Take calls during business hours	A	P	O	P	P	P
Take calls after hours	A	I	P	O	O	O
Receive web comment form via email	A	P	I	O	O	P
Referral	A	P	P	P	P	P
Log calls in database	A	P	O	P	O	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Complaint and Referral

Complaints arriving on the Public Works 24-hour line are logged to the Public Works customer service database by Public Works office assistants. Incidents are generally routed to the Public Works source control specialist or Department of Ecology, depending upon the nature of the incident.

Web form comments, at site noted above, are sent via email to the Clean Water Division who directs the report to the appropriate response staff as per phone call protocols.

Water quality complaints are also received by other agencies or county departments including Ecology, Clark County Code Enforcement and Clark County Public Health.

Response to complaints is described under Water Quality Complaint Investigation.

Outputs

- Report of number of calls and emails to the general customer service line
- Water quality complaint response report records

TASK CHECKLIST

STATUS	TASK
ONGOING	Continue implementing on-going program to prevent, identify and respond to illicit connections and illicit discharges
ONGOING	Screen an annual average of 12% of MS4
ONGOING	Procedures for addressing pollutants entering MS4 from interconnected MS4s
ONGOING	Staff training
ONGOING	Implement procedures to respond to spills
ONGOING	Operate a water quality citizen complaint line
ONGOING	Revise program to include new Ecology guideance

For more information on the program to detect and eliminate illicit connections and discharges to the MS4:

Rod Swanson, Clean Water Division NPDES Permit Manager, 564-397-4581
Rod.Swanson@clark.wa.gov

Section 5 – Expanding and Improving the Stormwater Management Infrastructure

As county population and development increase, the primary means of controlling runoff from areas of new growth and for fixing problems caused by uncontrolled runoff from existing developed areas is by expanding and improving the existing stormwater management infrastructure.

In Clark County, stormwater management infrastructure is expanded in two ways:

COUNTY STORMWATER CAPITAL IMPROVEMENT PROJECTS

The county has a program to plan and construct new stormwater infrastructure and improve existing infrastructure to better control and treat runoff from areas where existing development does not include adequate stormwater controls. This addresses the permit requirement to mitigate for stormwater impacts from existing development.

REGULATION OF DEVELOPMENT, REDEVELOPMENT AND CONSTRUCTION PROJECTS

Private entities and government agencies develop the land, and the county regulates the design and construction of stormwater controls on it, many of which eventually become part of the county's own stormwater infrastructure.

The process for each of these types of projects is described in this section.



Roadway flooding during winter storm, 2007

COUNTY STORMWATER CAPITAL IMPROVEMENTS

Past stormwater management and drainage practices and development regulations have proven inadequate to prevent impacts of runoff on surface water, and thousands of developed acres in Clark County contribute to problems in streams, lakes and rivers. Accordingly, the county has a program to construct stormwater capital improvements primarily to control and treat stormwater from areas of existing development with inadequate stormwater controls. In addition, the county may take opportunities to expand the treatment and flow control capacity of existing facilities when making repairs. These activities all are part of the county's stormwater capital improvement program.



REGULATORY REQUIREMENTS SUMMARY

NPDES Permit – S5.C.7. Structural Stormwater Controls

The NPDES permit requires the county to implement a structural stormwater controls program to prevent or reduce impacts to waters of the state caused by discharges from the MS4. The program considers projects including new flow control facilities, new water quality treatment facilities, retrofits of existing facilities, property acquisition and maintenance with capital construction costs greater than $25,000 to provide water quality or flow control benefits. Other means to reduce impacts are also considered, including riparian habitat acquisition, restoration of forest in upland areas and in riparian buffers, and floodplain reconnection projects. Small-scale projects that are not planned in advance may also be included in meeting this requirement.

The SWMP must include a list of planned individual projects updated in each annual report to the state.

In 2020, Public Works Clean Water Division will update its stormwater capital plan for the 2021 to 2026 period.

The description of the structural stormwater control program in the SWMP must include the program's goals and the planning process, including budget and public involvement. A table describing the 2020-2025 capital projects is included in the 2020-2025 Stormwater Capital Plan. The capital plan will be included in the March 2020 annual report.

It includes a detailed program description and can be found at: https://www.clark.wa.gov/sites/default/files/dept/files/public-works/Stormwater/Capital_Projects/Stormwater%20Capital%20Plan%202019-2024%20FINAL.pdf

Chapter 173-218 WAC – Underground Injection Control (UIC) Program

Pursuant to Chapter 90.48 RCW, the state's requirements for stormwater infiltration wells may result in capital improvements associated with county systems that are found to pose a threat to groundwater.

COUNTY POLICIES, RULES AND REGULATIONS

The Clean Water Division has the following policies for county stormwater capital improvements:

- Meet NPDES Permit requirements for the structural stormwater control program through stormwater capital planning and capital construction.
- County goals for stormwater capital improvements include:
- Protect and enhance streams and wetlands in Clark County through planning and constructing modifications to the stormwater infrastructure.
- Minimize the degradation of receiving waters from impacts attributable to stormwater runoff in existing developed areas.
- Maximize public benefits of county-owned land by providing multiple uses, including recreation, and by leveraging funding from multiple sources.

GUIDING PRINCIPLES

In support of county policies and goals, the capital planning process strives to:

- Prioritize projects with the greatest potential to support multiple county programs and goals, including local and regional fish recovery, habitat enhancement, and water cleanup goals.
- Ensure a reliable scientific and engineering basis for projects.
- Establish that each project in the plan is needed, feasible and cost-effective.
- Focus limited resources on the most pressing concerns and the most cost-beneficial solutions.
- Incorporate environmental benefits into needed infrastructure repair projects.
- Maintain a sufficient list of potential projects to enable replacement of any projects found to be infeasible and to take advantage of funding opportunities.
- Utilize partnerships, where feasible, to meet multiple community goals.

As-Built Plan Preparation

Clark County Public Works follows a management practice for the production of record drawings at the final acceptance of a public capital project.

STORMWATER CAPITAL PLANNING

Purpose

Planning ensures that stormwater capital improvements meet the county's goals.

Capital planning is a process for identifying potential projects, deciding if they are feasible, selecting the best for further development, and tracking their progress from inception through construction. The stormwater capital plan will

list projects scheduled for implementation on a six-year horizon.

- The proposed projects are considered to comply with requirements under Permit Condition S5.C.7.
- Projects reflect what Clark County is best able to implement within its available funding and demands for structural control projects.
- Projects address stormwater impacts not adequately controlled by other permit-required actions, chiefly those caused by uncontrolled or untreated runoff from existing development, and habitat degradation that has already occurred.

By complying with permit condition S5.C.7, together with all of the remaining other permit requirements; Clark County complies with MEP and AKART as set forth in the county's NPDES Municipal Stormwater Permit condition S4.E.

Clark County applied lessons learned from its 2013 permit work on the Whipple Creek watershed-scale plan to its stormwater capital planning program. A key finding was that it is infeasible to restore forested stream hydrology in basins where LID is infeasible. This led to a subwatershed scale review of Vancouver UGA subwatershed to identify areas where detention retrofit projects should be avoided.

Clean Water plans to lead a process in 2020 to develop the next 6-year stormwater capital program covering 2021-2026.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Eng.	CCPW Eng. Program Mgr.	CCPW Eng. Program Staff	Council	CCPW Director
Accept referrals	A/P	P/S	O	O	O	O
ID potential projects	A/P	P/S	O	S	O	O
Database entry & updates	A/P	P/S	O	O	O	O
List of potential projects	A/P	P/S	I	C	O	O
Formulate selection criteria	A	P	I	S	C	C
Apply selection criteria	A	P	C	S	O	C
Scoping and Selection	A	P	O	S	O	I
Six-year capital plan	A	P	C	S	C	C

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Referrals

Project ideas may be referred to the Clean Water Division from several sources, including field work completed by the Assessment and Monitoring Section, CWD engineer review of watershed plans and water quality reports, problems identified by Road Operations crews and projects suggested by the public.

Referrals can arrive continuously throughout the year.

Project Tracking / Capital Planning Database

CWD infrastructure manager will enter potential capital projects selected for further consideration into the *Capital Planning Database* as they are evaluated.

The database tracks stormwater capital projects from inception to construction and close-out, or their status as shelved or dropped, including the following attributes:

- Project category/type.
- Description and basis of the project and the problem being addressed.
- Estimated project benefits including flow control, pollutant load reduction, habitat enhancements and other environmental benefits.
- Status of preliminary engineering and construction.
- Funding summary.
- Types of potential environmental impacts, including wetland, priority habitat, cultural resource, floodplain impacts, etc.

As projects advance and more information is developed, CWD infrastructure manager will update the database with new details on a regular basis.

Project Identification

Stormwater capital projects typically originate from systematic capital planning efforts, routine stormwater facility inspections, observations by maintenance crews, or evaluation of underground injection control wells.

Clean Water completed significant county-wide project identification and screening efforts between 2006 and 2011 under the Stormwater Needs Assessment Program (SNAP). The program identified many potential project opportunities, which formed the basis for much of the stormwater capital plan through 2018. During that time, most priority opportunities identified through the SNAP have either been constructed or were found to be infeasible. The remaining potentially viable projects from the SNAP effort are being re-evaluated in light of updated priorities during sub-basin retrofit studies.

Sub-basin retrofit studies follow up on earlier stream assessments, refining county efforts to plan and build stormwater controls that meet permit requirements and reduce pollutant discharges to receiving waters. The process for sub-basin retrofit studies was developed in 2018 and first applied to Cougar and Suds Creeks in the Salmon Creek watershed. Additional high-priority drainages will be evaluated beginning in 2019.

Studies identify an array of projects that will improve stream conditions, applying consistent objectives and specific project types tailored to the goals for each sub-basin. The process incorporates information from multiple county capital efforts and is intended to promote collaboration between county programs.

The studies apply a series of tools to identify projects, including a series of project area maps depicting existing conditions and needs, long-plots of high traffic roadway corridors, stormwater outfall verification, review of underutilized and county lands, headwater wetland project assessment, right-of-way retrofitting assessment, and channel/floodplain restoration project assessment.

Results are managed in a series of project maps and spreadsheets, and highly-rated projects are promoted to the Capital Planning Database for possible inclusion in the 6-year Stormwater Capital Plan.

A Project Identification Worksheet is first compiled, identifying purpose and level of need (1-5) for each identified project and performing a preliminary high-level verification. The end result is a list of all identified projects shown in three categories: viable; needs more information, or; rejected.

Project Verification

Viable projects from the identification spreadsheet are run through a more detailed verification process in a second spreadsheet called the Project Verification Worksheet.

The primary verification checks are based on detailed Technical Information Report maps automatically generated for each project. These maps inform project verification with current information and also identify whether additional field visits are necessary to perform verification. The end result is a list of projects shown in three categories: verified; additional field information needed, or; rejected.

Verified projects with a need level of 1, 2, or 3 are carried over into the database for consideration in the 6-year plan.

Programming Projects

Programming applies regulatory requirements and available funding to the list of scoped projects to develop a six-year program matrix that can meet Permit requirements and program goals. Permit requirements for structural stormwater controls are stated in the 2019 permit as a number of “retrofit incentive points”.,. Where specific projects have not yet been identified for implementation, placeholder values for projected spending are included in the matrix as ongoing programs.

Funding

The anticipated budget for the 2020-2025 plan is approximately $13.8 million. Completion of these projects is dependent on funding through the Clean Water Fee, Road Fund, Conservation Futures Fund and grants.

Outputs

- Database entries of potential and scoped projects and detailed project attributes for consideration in subsequent years
- Submittal of NPDES permit report Appendix 12
- Six-year capital plan with funding allocation



Construction of the Thomas Wetland East Stormwater Facility

CAPITAL PROJECT CONSTRUCTION PROGRAM

Purpose

The construction program is the engine for designing, permitting and building stormwater capital projects. The Public Works Engineering and Construction Division leads the effort through established project management systems.

The Public Works Engineering and Construction Division designs and oversees construction of all types of capital improvement projects, including county stormwater projects. Their services include project management, survey, property acquisition, engineering and construction management.

The program is responsible for the advancement of stormwater capital projects from the Stormwater Capital Plan to construction. The responsibilities and procedures for this program are briefly reviewed below.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Eng.	CCPW Enhance. and Permitting Mgr.	CCPW Env. Permitting Mgr.	CCPW Eng. Program Mgr.	CCPW Eng. Project Mgmt. Mgr.	CCPW Eng. Project Mgr.	CCPW Eng. Program Engs	CCPW Eng. Construction Mgr.	CCPW Eng. Construction Mgmt. Staff	CCPW Comm. Specialist Sr.
Assign Project Team	I	I	S	S	A	P	S	S	S	S	O
Schedule and Budget	S	S	S	S	A	C	P	S	S	S	I
Preliminary Engineering	I	O	O	O	A	S	S	P	O	O	O
Permitting	I	O	A	P	I	O	I	C	C	O	O
Construction Management	I	I	I	C	I	S	S	C	A	P	O
Public Outreach	S	O	I	I	I	S	I	O	O	O	A/P
Project Close Out	I	S	I	C	A	I	P	C	C	C	I
Update Capital Planning Database	A/P	S	O	O	O	O	O	O	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Team, Schedule and Budget

The manager of the Project Management section will assign a team of professionals, led by a project manager.

The project manager, with the help of the team, will develop a detailed scope, schedule and budget for his/her assigned projects. The project manager will monitor each item closely throughout the life of each project.

Preliminary Engineering and Environmental Permitting

Public Works engineers will create engineering plans, design specifications and cost estimates for each project in the plan. Public Works Permitting Coordinators will guide each project through local, state and federal permitting processes.

As projects near completion of engineering design, the Engineering Program manager, in consultation with the Clean Water Infrastructure manager, will make the final decision to advance selected projects to construction.



Encore Stormwater Facility Retrofit

Bid

The project manager will coordinate with the Clean Water Division Infrastructure Manager and the team to prepare and execute a project bid schedule.

Construction Management

The Public Works Engineering Program Construction Management team will review bids and prepare an award recommendation for the Clark County Council.
Once the contract is awarded, Construction Management will administer it and oversee construction.

As a project reaches completion, the construction manager will send a copy of the letter of physical completion to the Clean Water Division and Public Works Operations and Maintenance program. The Clean Water Division also will be copied on the letter of final acceptance.

Receipt of the physical completion and final acceptance letters by the Clean Water Division will initiate stormwater inventory tasks. Receipt of the final acceptance letter by Operations will initiate maintenance and operations tasks.

Public Outreach

The Public Works Public Information Officer will coordinate outreach about the project including news releases, information on the Public Works website and signage.

Close Out

The project manager and construction manager will coordinate preparation of close out documents, including final expenditures.

CWD engineers will update the Capital Planning Database with metrics from the final report.

Construction Management will oversee the production of record drawings, and Survey staff will notify the Clean Water Division of their location. The receipt of record drawings by Clean Water Division will initiate tasks to verify the stormwater infrastructure inventory.

Outputs

- Project plans, specifications and estimates
- Completed stormwater capital projects
- As-built drawings (record drawings)
- Final expenditures and metrics for each project

TASK CHECKLIST

STATUS	TASK
ONGOING	Implement structural stormwater controls program
ONGOING	Stormwater capital planning
ONGOING	Annual reporting on capital projects
ONGOING	Update structural stormwater controls projects
ONGOING	Update Stormwater Capital Plan
ONGOING	Annual reporting on capital projects

For more information on planning and building county stormwater infrastructure:

Jeff Schnabel, Clean Water Division Infrastructure Manager,
564-397-4583
Jeff.Schnabel@clark.wa.gov

Regulatory Program for Development, Redevelopment and Construction Projects

The county is the local land use regulator in unincorporated Clark County. As such, the NPDES Permit requires the county to regulate the discharge of runoff from new development, redevelopment and construction activities in the county.

In 2013, the county began a project to update its regulations in response to the newly issued 2013-2018 NPDES Permit. During 2015, Clark County completed the equivalent code and manual adoption and implementation under the schedule prescribed by the Permit. The 2015 manual will be updated in 2021 to include permit mandated changes and other changes proposed by manual users.

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.5.a & b. – Controlling Runoff from New Development, Redevelopment and Construction Sites

The NPDES Permit requires the county to have a program to prevent and control the impacts of runoff from new development, redevelopment and construction activities. The program applies to all development activity, including private-sector development and county projects such as roads and parks. The program enforces development regulations that provide protection equivalent to the minimum requirements, thresholds and definitions in Appendix 1 of the NPDES Phase I stormwater permit and design standards equivalent to the December 2014 version of the *Stormwater Management Manual for Western Washington*. The program also revised code and manuals to make low impact development the standard approach for stormwater management.

The 2019 Permit requires specific updates set forth in Appendix 10 and for the county to document significant changes. Both of these were submitted to Ecology for approval in 2020 and are part of the code and manual update going forward.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code 40.386 – Stormwater and Erosion Control

Clark County regulates stormwater runoff and erosion control on development, redevelopment and construction sites primarily in Chapter 40.386 Stormwater and Erosion Control. The purpose of the code is to safeguard public health, safety and welfare by protecting the quality of surface water and groundwater for drinking water supply, recreation, fishing and other beneficial uses through the application of best management practices (BMPs) for stormwater management and erosion control. It was adopted to minimize the degradation of

receiving waters from impacts attributable to stormwater runoff, thereby not precluding the preservation of future restoration of beneficial uses.

The regulations generally apply to all development and construction projects, including county roads and parks that have complete development applications after January 7, 2016, whether or not they discharge to county storm sewers or to waters of the state.

Clark County Code 40.385 – Stormwater and Erosion Control

For development, redevelopment and construction sites with a complete application before January 8, 2016, Clark County regulates stormwater runoff and erosion control under Chapter 40.385 Stormwater and Erosion Control (Clark County Code). Although this code has been superseded by Chapter 40.386 it remains in effect for the few projects that remain vested under it. Under the Permit, projects approved under 40.385 will lose their stormwater approval if they have not started construction by July 1, 2021.

Clark County Code 40.430 – Geologic Hazard Areas

Geohazard code regulates development at sites where geologic concerns such as high soil erosion risk, potential landslides and steep slopes will influence preparation of erosion control and stormwater site plans.

Clark County Stormwater Manual

The *2015 Clark County Stormwater Manual* is adopted under Chapter 40.386 and contains the technical and administrative standards that project proponents follow to meet the minimum requirements of the Permit and county stormwater management requirements for development and construction projects in the county. The manual contains county requirements and procedures specific to Clark County, is equivalent to the 2014 SMMWW, and is referenced in Permit Appendix 10.

Clark County Code 40.450 and 40.440 – Wetlands and Habitat Protection

Chapters 40.450 Wetland Protection and 40.440 Habitat Conservation regulate some stormwater discharges and the placement of treatment and control facilities in habitat and wetland buffers.

Clark County Code 40.510 – Application and Review Requirements

Applications for development, redevelopment and construction require different levels of review depending on their impacts to the community, which are defined in Chapter 40.510. The levels of review are ministerial decisions (Type I), administrative decisions (Types II and II-A) and quasi-judicial decisions (Type III).

Stormwater Review and Enforcement of Development and Construction Applications

Purpose

Clark County has a system of ordinances, technical manuals, plan review, inspection and enforcement to apply the NPDES Permit minimum requirements to development, redevelopment and construction projects.

For stormwater, the purpose of the review is to determine:

- Applicability of the stormwater and erosion control minimum requirements.
- Compliance with applicable minimum requirements.
- Compliance with other county-specific stormwater requirements listed in the Clark County Stormwater Manual .

Inspection and enforcement strives to ensure that construction sites correctly and consistently use erosion control BMPs to prevent sediment-laden runoff from leaving

the sites, and that permanent stormwater conveyance systems and BMPs for LID, treatment and flow control are properly installed, constructed and transferred in good condition to the ultimate owners/operators with a maintenance manual for each facility.

Interdepartmental Responsibilities Summary

Responsibility for implementing the stormwater code is shared by several departments and is guided by interdepartmental MOUs. Public Works will update and maintain these agreements.

Community Development Department – Permit Services

Permit Services will accept development and construction applications and determine if applications include the required submittals. Permit Services staff review residential building permit applications and accept and review stormwater small project site plans for stormwater compliance and condition building permits for stormwater requirements.

Community Development Department – Building Safety

Building Safety will inspect building construction sites for compliance with erosion control, source control, preservation of natural drainage and post-construction stormwater management BMPs.

Community Development Department – Development Engineering

Development Engineering staff will provide engineering review of stormwater and erosion control plans on development sites, including residential and non-residential development sites. Development Engineering staff will oversee the issuance of the plat, the final engineering as-built documents (record drawings) and the maintenance warranty, if applicable.

Public Works Department – Construction Management

Construction Management staff will inspect development sites, including county projects, for compliance with stormwater engineering plans and erosion control plans. Construction Management also inspects residential subdivisions for facility maintenance during the period of new home construction.

Public Works Department – Clean Water Division

Clean Water Division staff will support decision-making regarding interpretation of the code and manuals, providing documentation of their findings.

Public Works Department Clean Water Division– Code Enforcement

Code Enforcement will enforce erosion control violations on development and building construction sites as needed.

Responsibilities Matrix

The review and enforcement process varies depending on complexity and scope of the project. For stormwater review purposes, projects generally can be divided into residential development projects (subdivisions), non-residential development projects, residential construction projects (individual home construction) and Public Works projects.

The matrix on next page describes responsibilities at the department and division level.

Overview of Regulatory Review and Enforcement Responsibilities

Task	CD Permit Services	CD Building Safety	CD Building Official	CCPW Code Enforcement Officer	CD Dev. Eng.	CD Dev. Eng. Mgr.	CCPW Construction Mgmt.	CCPW Construction Mgr.	CCPW CWD
Plan Review - residential construction	P/A	I	O	O	O	O	O	O	S
Inspect building construction sites	I	P	A	O	O	O	O	O	I
Engineering review - development	S	O	O	O	P	A	C	O	I
Inspect development sites	O	O	O	O	S	O	P	A	I
Inspect Public Works sites	O	O	O	O	S	O	P	A	I
Enforce erosion control	I	P	A	P	O	O	P	A	I
Maintenance warranty inspection	O	O	O	O	S	O	P	A	I
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted									

Residential Development Project Review

Residential development projects are divisions of land to create individual lots and construction of infrastructure such as roads and storm sewer. Many aspects of residential development project review will not concern stormwater; only aspects concerning stormwater are covered in this plan.

Pre-Application Phase

Applicants typically submit initial information and may meet with a planner, engineer and other pertinent staff in a Pre-application Conference (PAC) before an applicant submits a completed development application. The PAC will help determine options and likely requirements for stormwater control, among many other regulations and requirements.

Preliminary Land Division and Preliminary Engineering Review Phase

The applicant will submit an application for residential land division (subdivision or short plat) to the Permit Center along with a preliminary stormwater plan in accordance with section 1.8.1 of *Clark County Stormwater Manual - Book 1*.

Development Engineering staff will review the preliminary stormwater plan to evaluate whether the proposal for stormwater controls is feasible given existing site conditions and constraints. The engineer's Findings and Conditions of Approval will appear in the Staff Report, which will be forwarded to the applicant.

Findings describe the engineer's determination of whether or not each aspect of the stormwater proposal meets county code. Conditions of Approval list the engineer's requirements for how to meet code, in cases where the proposal does not meet it, and they must be met in the final engineering plan.

Final Engineering Review Phase

The applicant will submit final plans for the residential development, including a final stormwater plan in accordance with section 1.8.2 *of Clark County Stormwater Manual - Book 1*. The final stormwater plan will provide final engineering design (Technical Information Report) and construction drawings for the stormwater aspects of the proposed project and a *construction Stormwater Pollution Prevention Plan (SWPPP*).

Development Review engineers will:

- Ensure that the Conditions of Approval from the preliminary land division have been met.
- Verify that applicable county and NPDES permit requirements have been met.
- Review engineering calculations of stormwater flows, sizing of stormwater facilities, and sizing of conveyances.
- Verify adequacy of erosion control BMPs.
- Perform any other engineering review required for stormwater.

Responsible officials from Public Works, Community Development and Public Health will sign the final plans. The Development Engineering manager will make the final approval. Then the planning technician will return the approved plans to the applicant.

The Development Engineering office assistant will open a development inspection case in LMS in preparation for the next phase of the process.

Development Inspection Phase

During development inspection, the applicant will construct the development's infrastructure, including grading, roads and stormwater controls, according to the approved final plans. Public Works development inspectors will inspect the site for conformity with the plans.

The process begins when the applicant submits the final construction plan and application for development inspection.

The assigned development inspector will hold a Preconstruction Conference with the applicant. During the Preconstruction Conference, the inspector will review erosion control requirements, including requirements related to a high potential for sediment to be discharged from the site with the applicant and will receive the name of the Certified Erosion Control and Sediment Lead (CECSL) for the site. The inspector will reiterate storm system requirements and additional inspection-related policies for storm system installation. Department of Ecology state construction stormwater permit enforcement staff are also invited to each Preconstruction Conference. After the conference, the development inspector will give approval to begin constructing the project after completion of a preconstruction inspection to verify proper installation of erosion control BMPs.

During construction of the development, the development inspector will inspect the site to ensure that erosion control measures are operational and effective. The inspector will work with the developer to achieve compliance, using correction notices and stop work orders if necessary. If there is evidence of continued neglect, the inspector will call a code enforcement officer to enforce erosion control measures through citations and penalties. Referral to Ecology for enforcement under the NPDES Construction Stormwater General Permit is also an option.

The development inspector also will verify that stormwater facilities are constructed as designed.

At the end of construction, the applicant will submit record drawings and a maintenance bond, if applicable, for any public improvements. (Public improvements are roads and stormwater conveyance and facilities that will fall into public ownership upon acceptance of the development.) A Development Engineering engineer will approve the record drawing and then a Development Engineering planning technician will accept the maintenance bond, if applicable.

Development Engineering staff will provide an electronic record drawing file to Public Works, and then send the Mylar plan to the state archives.

After these steps are complete, the planning technician will issue a notice of completion of construction to the applicant and copy it to several departments, including the Clean Water Division and Public Works Maintenance and Operations. The notice signals the start of the stormwater facility maintenance warranty period, if applicable (see below).

The notice of completion of construction constitutes provisional county acceptance of the public infrastructure, including public stormwater facilities. In the case of private facilities, completion of construction is the end of county involvement in construction and the regulated facility operation and maintenance inspection process will begin.

Receipt of the notice of completion of construction will initiate some stormwater mapping tasks (see Mapping the Storm Sewer Infrastructure on page 21) and some maintenance inspection tasks (see Operating and Maintaining the Storm Sewer System, County Property and Roadways on page 33).

Final Land Division Phase

The final land division will begin after the development inspection phase begins but before it ends.

The applicant will submit the final land division application and the draft plat. The plat will contain required information describing facility ownership and maintenance responsibility, stormwater tracts and drainage easements. The plat will be routed to several departments for review and approval. If there are private stormwater facilities, an HOA will be formed.

After approval of the draft plat, the applicant will submit a Mylar version that will be signed by the Planning Director, the County Engineer and the Clark County Council. Development Engineering staff then will record the final plat with the Auditor and issue a plat notification to the developer, copied to several departments, including the Clean Water Division.

Receipt of the plat notification by Clean Water Division may initiate some stormwater mapping tasks (see Mapping the Storm Sewer Infrastructure on page 21).

The final plat must be recorded before building permits for home construction will be issued for lots in the development (see Residential Construction Project Review on page 93).

Maintenance Warranty Period

Most, but not all, residential developments will have public improvements, including public stormwater infrastructure.

For residential developments with public improvements, a two-year maintenance warranty period will begin at completion of construction. During the maintenance warranty period, the developer will be responsible for continued maintenance of the stormwater facilities. During the 22nd month of the maintenance warranty, a development inspector will inspect the public stormwater facilities for compliance with maintenance standards.

If the stormwater facilities are found to be in good condition and properly maintained, the development inspector will recommend release of the maintenance bond. The Development Engineering planning technician will release the bond and notify the Clean Water Division and Public Works Maintenance and Operations.

If the facility has components that fail the maintenance inspection, the planning technician and development inspector will work with the developer to obtain needed repairs. If the developer fails to make repairs, the planning technician will demand the bond from the surety company.

After repairs are made, the Clean Water Division will update stormwater mapping tasks, if necessary (see Mapping the Storm Sewer Infrastructure on page 10), and Public Works Maintenance and Operations will initiate maintenance and operations tasks (see Operating and Maintaining the Storm Sewer System, County Property and Roadways on page 33).

Under the Clark County Stormwater Manual, private stormwater facilities will be maintained by the applicant for two years.

Non-Residential Development Project Review

Non-residential developments include commercial and industrial projects as well as schools, churches and other non-residential land uses. These projects construct infrastructure such as roads and stormwater along with the buildings. Multifamily housing projects also are reviewed using this process. Occasionally, commercial projects may also go through a land division. Many aspects of non-residential development project review will not concern stormwater and are not covered in this plan. Also, many projects do not trigger stormwater requirements because they do not add or replace a sufficient amount of impervious surface; examples include cell tower placement, sign construction and building façade replacement.

Pre-Application Phase

Applicants typically submit initial information and meet with a planner, engineer and other pertinent staff in a Pre-application Conference (PAC) before submitting a completed development application. The PAC will help determine options and tentative requirements for stormwater control, among many other regulations and requirements.

Preliminary Site Plan and Preliminary Engineering Phase

To begin the process, the applicant submits an application for preliminary site review to the Permit Center along with a preliminary stormwater plan in accordance with section 1.8.1. of the *Clark County Stormwater Manual Book 1*.

The assigned Development Engineering engineer will review the preliminary stormwater plan to evaluate whether the proposal for stormwater controls is feasible given the available information on existing site conditions and constraints. The engineer's Findings and Conditions of Approval will appear in the Staff Report and Decision (or Land Use Hearing Examiner Decision), which will be forwarded to the applicant.

Findings describe the engineer's determination of whether or not each aspect of the stormwater proposal meets county code. Conditions of Approval list the engineer's requirements for how to meet code, in cases where the proposal does not meet it, and they must be met in the final engineering plan.

Final Site Plan and Final Engineering Review Phase

The applicant will submit final plans for the development, including a final stormwater plan in accordance with section 1.8.2 of Clark County Stormwater Manual - Book 1. The final stormwater plan will provide final engineering design and construction drawings for the stormwater aspects of the proposed project and a construction Stormwater Pollution Prevention Plan (SWPPP).

The assigned Development Review engineer will:

- Ensure that the Conditions of Approval from the Final Decision have been met.
- Verify that applicable NPDES permit and county code minimum requirements have been met.
- Review engineering calculations of stormwater flows, sizing of stormwater facilities, and sizing of conveyances.
- Verify adequacy of erosion control BMPs.
- Perform any other engineering review required for stormwater.

Responsible officials from Public Works, Community Development and Public Health will sign the final plans. The Development Engineering manager will make the final approval. The approved plans are returned to the applicant.

Development Engineering will open a development inspection case in LMS in preparation for the next phase of the process.

Building Permit Review

The applicant will submit building permit applications to Permit Services. Construction of structures will be concurrent with construction of the development; therefore, most stormwater review will have already occurred.

The building permit must be issued before construction of structures may begin.

Development Inspection Phase

During development inspection, the applicant will construct the development's infrastructure, including grading, roads and stormwater controls. The project's buildings are also erected during this phase.

The process begins when the applicant submits the final construction plans and application for development inspection.



The assigned Public Works development inspector will hold a Preconstruction Conference with the applicant. The inspector will review erosion control requirements with the applicant, including requirements related to a high potential for sediment to be discharged from the site and will receive the name of the Certified Erosion Control and Sediment Lead worker (CECSL) for the site. Department of Ecology state construction stormwater permit enforcement staff are also invited to each Preconstruction Conference. The inspector will reiterate storm system requirements and additional inspection-related policies for storm system installation. After the conference, the development inspector will give approval to begin constructing the project after completion of a preconstruction inspection to verify proper installation of erosion control BMPs.

During construction, the development inspector will inspect the site as needed to ensure that erosion control measures are operational and protective. If necessary, a code enforcement officer will be called to enforce erosion control measures. If the project has a state-issued NPDES construction permit, then violations may be referred to Ecology.

The inspector also will ensure that stormwater facilities are constructed as designed.

At the end of construction, the inspector will verify that the facility was built as shown on approved design plans. The applicant will submit record drawings and, if applicable, a maintenance bond for any public improvements in the right-of-way. A Public Works engineer will review the record drawings for accuracy before approving it. After approval of the completed facilities and record drawings, a Development Engineering planning technician will accept the maintenance bond.

When a record drawing is received, Development Engineering staff will give an electronic file to Public Works and send the Mylar plan to the state archives.

The planning technician will issue the notice of completion of construction to the applicant and copy it to several county agencies, including the Clean Water Division. The notice signals the start of the maintenance warranty period, if applicable.

Receipt of the completion of construction by the Clean Water Division will initiate some stormwater mapping tasks for projects with either public or private stormwater facilities (see Mapping the Storm Sewer Infrastructure on page 21).

Maintenance Warranty Period

The maintenance warranty period is relevant for those few non-residential developments that have public stormwater infrastructure in public right-of-way. However, with increasing use of LID BMPs such as bioretention facilities in county right-of-way, they will become more common.

A two-year maintenance warranty period will begin at completion of construction. During the period, the developer will be responsible for continued maintenance of the stormwater facilities.

During the 22nd month of the warranty, a development inspector will inspect the public stormwater facilities for compliance with maintenance standards.

If the stormwater facilities are found to be in good condition and properly maintained, the development inspector will authorize release of the maintenance bond and will notify the Clean Water Division and Public Works Maintenance and Operations that the bond has been released.

Receipt of the bond release notification will initiate maintenance and operations tasks (see Operating and Maintaining the Storm Sewer System, County Property and Roadways on page 33).

If the facility has components that fail the maintenance inspection, the planning technician and development inspector will require the developer to obtain needed maintenance and repairs. If the developer fails to make repairs, the county will demand the bond from the surety company.

After repairs are made, the Clean Water Division will update stormwater mapping tasks, if necessary (see Mapping the Storm Sewer Infrastructure on page 21), and Public Works Maintenance and Operations will initiate maintenance and operations tasks (see Operating and Maintaining the Storm Sewer System, County Property and Roadways on page 33).

Under the *Clark County Stormwater Manual 2015*, all private stormwater facilities will be maintained by the applicant for two years.

Single Lot Residential Construction Project Review

Single lot residential construction projects include construction or expansion of single-family and duplex homes and their appurtenances, such as decks, garages and driveways, and outbuildings. Many aspects of residential construction project review will not concern stormwater and are not addressed here.

Building Permit Application Review – Stormwater

The applicant will submit a residential building permit application including a stormwater site plan showing proposed building footprint(s), erosion control measures and on-site stormwater control BMPs to the Permit Center. Projects triggering Minimum Requirements 1-9 are referred to Development Engineering for review.

The permit technician will review the residential building permit application to verify applicability of the minimum requirements and selection and use of allowed stormwater BMPs and erosion control BMPs. They will also check for the mapped presence of steep slopes or geo-hazard areas. If they conflict with the proposed stormwater BMPs, the applicant will be required to consult a licensed geotechnical engineer to design stormwater controls.

If the residential construction site is within an existing subdivision with an approved stormwater plan that provides flow control and treatment, then the permit technician will recommend that the applicant consult the development project's engineering plans to determine stormwater requirements, such as roof drain infiltration and amended soils, for the lot. In those cases, the permit technicians also will include requirements from the recorded plat and subdivision engineering drawings and attach them as conditions on the building permit. For projects approved under the Clark County Stormwater Manual 2015, each lot will have an engineered stormwater site plan as part of the final engineering plans.

If the residential construction site is not part of an existing subdivision with an approved stormwater plan, then applicants will follow minimum requirements applicable to their projects. If minimum requirements 1- 5 apply, the applicant can complete the stormwater plan or hire a contractor. If minimum requirements 1-9 apply, the applicant must use an engineer to complete a stormwater plan that complies with county code under an engineering review by Development Engineering.

The Permit Center will issue the building permit before construction may begin.

Construction Inspection

Before construction is allowed to begin on the site, a Building Safety Division inspector will inspect the site as part of a foundation inspection to also verify that the erosion control BMPs are properly installed and that any unusual site conditions that might lead to sediment transport off site are addressed.
All sites are required to maintain an erosion control log with an attached site plan and form that includes the required onsite stormwater management BMPs.

Public Works Project Review

Projects built by the Public Works department, including roads, parks and stormwater facilities will be reviewed by the Public Works Engineering and Design Group independently from the design team for compliance with county stormwater standards. Many Public Works projects will not require land use review, including roadways through existing right-of-way; therefore, the process will frequently begin at the final engineering review phase. Those that require land use review will begin at the preliminary site plan and preliminary engineering phase (above).

Additionally, the development inspection phase is replaced by a construction management phase. Public Works will use its own construction inspectors to oversee the construction of the project to ensure that it is built as designed and bid. Enforcement of erosion control and other measures is through contract management.

Before completion of a project, the construction engineer will invite stakeholders, including the Public Works Maintenance and Operations water quality crew chief, to a walk-through of the new roadways and/or facilities. The construction manager also will copy the Clean Water Division and the Public Works Operations and Maintenance program on the letters of physical completion and final acceptance of the project.

At the final acceptance, Public Works will develop a record drawing according to its *As-Built Plan Preparation Policy*, dated May 7, 2009.



OUTPUTS

General Outputs:

- Stormwater site plans that meet county standards
- Construction site management
- Completed projects include stormwater facilities meeting county standards
- Assigned ownership and maintenance responsibility for stormwater control facilities
- Record drawings are completed
- Completed project notifications to programs

Residential Development Project Review Outputs:

- Final Decision denying, approving, or approving with conditions the proposed development project
- Technical Information Report
- Approved final construction plan
- SWPPP
- Record drawings
- Approved final plat
- Notice of completion of construction
- Maintenance bond release letter, if applicable

Non-Residential Development Project Review Outputs:

- Final Decision denying, approving, or approving with conditions the proposed development project
- Technical Information Report
- Approved Final Site Plan
- Approved final construction plan
- SWPPP
- Record drawings
- Erosion control log
- Building plan
- Notice of completion of construction
- Maintenance bond release letter, if applicable

Residential Construction Project Review Outputs:

- Building Permit including site plan with stormwater requirements
- Erosion control plan
- Erosion control log
- Building Plans

Public Works Project Review Outputs:

- Technical Information Report
- Approved final construction plan
- Record drawings
- Completion of Construction notice
- Physical Completion letter
- Final Acceptance letter

CODE AND MANUAL REVISIONS

Updates to Implement Permit Requirement S5.C.5.b and Clark County Updates

The 2019 NPDES permit requires Clark County to update its development code and stormwater manual to include changes listed in permit Appendix 10, Part 2. Clark County also has a list of proposed changes to the manual and code that were developed as the manual was implemented.

Clark County Clean Water will place the draft code and manual before the planning commission for review and approval in March 2021 and before the County Council in May 2021.

The adoption and implementation date is July 1, 2021.

Outputs

- Draft updates Stormwater and Erosion Control Chapter 40.386.
- Draft updates to Chapter 13.26A Water Quality.
- Draft *2021 Clark County Stormwater Manual.*
- Adopted stormwater and Erosion Control Chapter 40.386.
- Adopted Chapter 13.26A Water Quality.
- Adopted *2021 Clark County Stormwater Manual.*


HIDDEN FALLS

TASK CHECKLIST

STATUS	TASK
ONGOING	Legal authority to require maintenance of facilities
ONGOING	NOI forms available
ONGOING	Legal authority to require maintenance of facilities
ONGOING	Procedures to implement the SMMWW
ONGOING	Staff training on SMMWW
ONGOING	Enforce stormwater regulations
2022	Complete catchment-scale stormwater plan
2021	Revise stormwater regulations for equivalent of Appendix 10

For more information on how development, redevelopment and construction sites are regulated for stormwater and erosion control:
Rod Swanson, Clean Water Division Permit Manager,
564-397-4581
Rod.Swanson@clark.wa.gov

Stormwater Planning

The 2019 added a new component for stormwater planning. The stormwater planning component has three elements:

- Establish an interdisciplinary team
- Coordination of stormwater activities with other long-range planning
- LID code review
- Stormwater Management Action Planning (SMAP)

Each element is described separately in the following pages.

Regulatory Requirement

NPDES phase I permit requirement S5.C.6. a-d.

Establish an interdisciplinary team

Clark County Clean Water will establish a team consisting of staff from:

- Public Works Engineering and Construction Division
- Public Works Clean Water Division
- Community Planning
- Community Development

Schedule

This task will take place during 2020 and be completed by July 31, 2020.

Outputs

- List of team members
- Correspondence and meeting records

Long-Range Planning Coordination

Purpose

The long-range planning coordination is intended to create a report describing how stormwater management needs and receiving water health are informing comprehensive land use planning under GMA and any other county long-range land use planning efforts. Other efforts include Regional Transportation Council planning, Clark County transportation planning, Clark County Parks planning and Legacy Lands planning. Stormwater planning efforts include the Whipple Creek study and Stormwater Structural Controls planning under the permit.

Planning Document Review

The NPDES permit manager and Clean Water infrastructure manager will meet to discuss how their plans consider stormwater. The planning mandates and goals will be listed and their relationship to stormwater management and receiving water protection will be documented.

The required report should address all of the questions in Appendix 3 regarding planning coordination.

Schedule

The planning coordination report can be completed and submitted any time up to the March 31, 2022 annual report submittal for calendar year 2021.

Outputs

- Long-range planning coordination report

Annual LID Barrier Assessment

Purpose

The permit goal is to make LID the preferred approach to site development. This task will annually document any newly discovered barriers to LID development.

LID Barrier Review

The NPDES permit manager in collaboration with staff from CD Development Engineering, CD Building Safety, and Permit Center, and PW Construction Management, will review current status of LID implementation and identify any current barriers. The LID barrier review from the 2013 permit will be reviewed to assess if there are remaining barriers from that code review.

The review should produce a document suitable to address the questions in Appendix 3 with each reporting year after 2019.

Schedule

This effort will be completed each year starting in 2020.

Outputs

- Meeting notes or other documentation from staff review
- Short report to support annual report question response

Stormwater Management Action Planning (SMAP)

The SMAP is a detailed plan considering all options for managing land use and stormwater with a to meet specific objectives for receiving water health. The permit references the August 1, 2019 SMAP guidance document as identifying SMAP content.

Purpose

The SMAP requirement is intended to be an extension of the stormwater planning required by the 2013 permit. This includes describing the describing how the Whipple Creek plan informs stormwater structural control project selection and a sub-basin catchment for completing the SMAP. Clark County is selecting a catchment in a sub-basin other than Whipple Creek based on the results of that study and county priorities.

Sub-basin Prioritization and Selection

The Whipple Creek study found that the level of existing rural and urban development, coupled with basin geology making LID BMPs largely infeasible suggested the management goal of restoring forested hydrology was unattainable. Also, there is very little salmon habitat or use in Whipple Creek due to poor water quality conditions, lack of gravel channel beds and significant migration barriers in the main stem and tributaries.

Lessons from the Whipple Creek Study

Clark County found that areas where LID was infeasible are impossible to use flow control BMPs to restore healthy, or forested stream flows. Instead the study suggested the much cheaper option of projects to add channel complexity and reconnect flood plains to manage higher storm flows. This led Clean Water to evaluate streams in the urban area for flow control retrofit suitability. The evaluation found that almost none of the Vancouver UGA streams are suitable for flow control retrofits using detention ponds. This led to a focus on water quality retrofits for high traffic areas and promotion of infiltration retrofits where condition permit.

Catchment Selection/Sub-basin Prioritization

Clean Water will mainly use existing data and reports as the principle tools to complete the analysis. Examples include steam health data, the detention facility retrofit suitability report, ESA priorities, inventoried fish use, RTC traffic model vehicle trip density, and percent urban and rural area. Clean Water will consult with WDFW and the LCFRB.

SMAP

Clean Water will use the SMAP guidance as a tool to create the permit-required report. . In 2021 Clark County will finalize the work plan, complete the watershed inventory, sub-basin prioritization, catchment selection and hydrology modeling.

Outputs

- Watershed Inventory
- Sub-basin prioritization
- Selected Study Catchment
- Project plan
- Draft 6-year plan
- Final 6-year plan
- Draft 20-year plan
- Final 20-year plan

TASK CHECKLIST

STATUS	TASK
Completed	Describe how Whipple Creek planning is used for SSC planning)
2020	Sub-basin prioritization and catchment selection
2022	Complete SMAP report

For more information on how development, redevelopment and construction sites are regulated for stormwater and erosion control:
Rod Swanson, Clean Water Division Permit Manager, 564-397-4581
Rod.Swanson@clark.wa.gov

Section 6 – Public Involvement, Education and Outreach

Clark County provides ongoing opportunities for the public to review and comment on the stormwater management program through various mechanisms. Public input is one way to tailor policy within the guidelines of the NPDES permit. The county also offers numerous stormwater education opportunities for the public. The education program is aimed at various audiences and is designed to help raise awareness to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts.

Public Information, Involvement and Participation (S5.C.4)

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C. 4 Public Involvement and Participation

The NPDES permit requires the county to provide ongoing opportunities for public involvement in the stormwater management program development and implementation. The public, including overburdened communities, must have opportunities to participate in the development, implementation and update of the *Stormwater Management Plan* and the county must consider public comments on it. The SWMP, annual report and other submittals required by the permit must be posted on the Clean Water Division's website.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 13.30A.040 Clean Water Commission

County Code Chapter 13.30A.040 defines the role of the Clark County Clean Water Commission (CWC), a citizen commission formed to advise the Clark County Council. The CWC will advise the Council on the focus of the SWMP, the effectiveness of the SWMP, program service levels, financing, policies on surface and stormwater issues, and citizen outreach.

PUBLIC INFORMATION

Purpose

The Clean Water Division provides information to the public about the stormwater management program to publicize the program's services to rate payers and keep the community abreast of current stormwater management issues at: www.clark.wa.gov/stormwater.

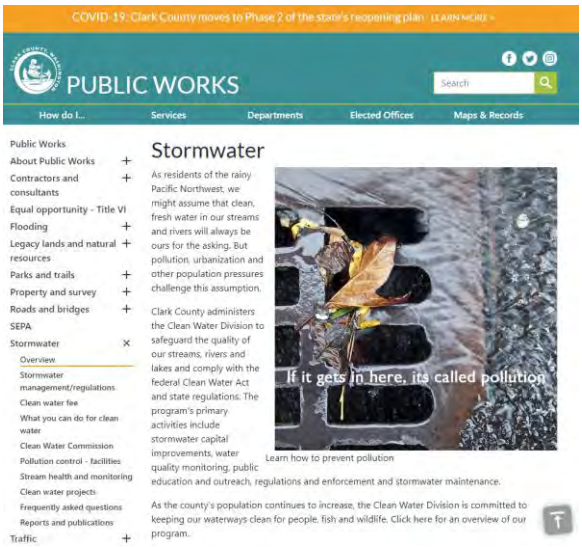
Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW CWD Program Coordinator	CCPW CWD Outreach Specialist	CCPW CWD Professional Staff
Provide content	A	I	I	P	P
Web updates	I	C	S	P	S
Write media releases	S	A	S	P	S

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Clean Water Division Website

Clark County Public Works Clean Water Division's website offers an opportunity for the public to review program activities, services and documents, as well as receive educational messages about stormwater. The website address is: www.clark.wa.gov/stormwater. Older technical reports and information formerly on the web are available to the public upon request.



Media Releases

The Clean Water Division releases information on various topics to the media to publicize noteworthy events. The Clean Water Division manager will call for a media release on timely matters. The outreach specialist will write the release with the support of the Public Works public information officer. Releases will be reviewed, edited and distributed to the media by the Communications Office.

Outputs

- Content on CWD website
- Media releases

PUBLIC INVOLVEMENT AND PARTICIPATION

Purpose

The purpose of involving the public in the SWMP is to make an effort to tailor the program, while considering the prescriptive nature of the permit, to the local community's priorities. Public feedback about program effectiveness and the public's needs also helps the Clark County Council set policies for stormwater management.

Responsibilities Matrix

Task	Council	CCPW CWD Mgr.	CCPW CWD Outreach Specialist	CCPW CWD NPDES Permit Mgr.	CCPW CWD OA	CCPW CWD Program Asst.	CCPW Enhance. and Permitting Mgr.	CCPW Enviro. Permitting Coordinator
Appoint Clean Water Commission	A / P	I	I	I	I	S	O	O
CWC liaison	C	A	S	S	S	P	O	O
CWC secretary	O	A	S	O	S	P	O	O
Respond to SWMP public comments	I	A	S	P	I	I	O	O
Respond to SEPA comments for stormwater capital projects	I	I	O	O	O	S	A	P
Community presentations	I	A	P	S	S	S	O	O
Other code update coordination	I	A	responsibilities assigned as needed				O	O
Customer service adaptive management	I	A	any CWD staff may be primary in his/her area				O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Clean Water Commission

The Clean Water Commission (CWC) is a nine-member advisory panel appointed by the County Manager and confirmed by the Clark County Council. It provides a forum for public participation in the stormwater management program and also informs the Council about stormwater topics and policy recommendations.

Staff Support

Clean Water Division staff support the CWC in a variety of ways. A program assistant is the primary staff liaison to the CWC. The liaison will attend each meeting to take notes, distribute meeting materials, provide minimal facilitation when required, and respond to requests for information from CWC members. The CWC webpages will be updated with current commission member information and terms, agendas, meeting summary notes and audio files, as well as any handouts.

Other Clean Water Division staff members may attend meetings, as required, to present updates on program activities or documents.

Member Appointments
Public notice of openings on the CWC will be listed in a news release issued by the Communications Office. Interested applicants, including incumbents seeking another term, must submit a letter of interest and a resume to the Clean Water Division manager. Clean Water Division staff and Clean Water Commissioners will conduct interviews and select candidates to fill vacant positions. Selected candidates are recommended to the County Manager for approval and submitted to the Clark County Council for confirmation.

Public Meetings
The CWC will hold a minimum of six public meetings each year, every other month starting in January. Meetings are held on the first Wednesday of the month at 6:30 pm in the Public Service Center, 1300 Franklin St., Vancouver, Washington. Public notice of meetings are issued in the county paper of record (The Columbian) the Sunday prior to the meeting date, as well in The Camas-Washougal Post-Record (east county) and The Reflector (north county).

Discussion topics will include updates from staff on the stormwater management program, education and outreach activities, surface water / stormwater monitoring, capital project planning and regulatory changes.

At meetings, the CWC will review and discuss major stormwater policy recommendations. All meetings will be documented with a meeting summary (.pdf file) and an audio recording (.mp3 file). The meeting documentation will be available on the CWC webpage.

The CWC will hear public comment at the meeting.

Communications with Clark County Council
Each year, the CWC will provide an annual report to the County Manager and Clark County Council in a public meeting during the first quarter of the year. The annual report should summarize CWC discussions, actions and recommendations from the previous year, as well as include a work plan for the upcoming year.

The CWC may elect to communicate with the Council at any time via letter, memorandum, or during scheduled public comment periods at Council Work Sessions and Hearings.

Stormwater Management Plan Review and Input

Clark County places its *Stormwater Management Plan* each year on the Clean Water Division website for review and comment by the public at: www.clark.wa.gov/public-works/clark-county-stormwater-management-plan.

The Clean Water Division manager or a designee will respond to comments.

Stormwater Capital Projects SEPA

As the Clean Water Division builds stormwater capital projects (see County Stormwater Capital Projects in Section 5), each project will be subject to public review and comment under the Washington State Environmental Policy Act (SEPA).

The CCPW Public Works Environmental Permitting coordinator assigned to the project will write and distribute to stakeholders a Determination of Significance or a Determination of Non-Significance. The required public comment period will be held. The coordinator will respond to any comments received, and if warranted, require changes to the project's design.

Each capital project may also include a package of outreach materials to inform potentially impacted citizens and stakeholders of the project. Typical products include a "Heads-up" notice to citizens in the immediate project area, a detailed project letter to adjacent property owners (describing project timeline and potential impacts), a project sign at the construction site and informational fliers. Materials may also be posted on the CWD stormwater capital project webpage.

Community Presentations

As requested, Clean Water Division staff will provide information on the program's activities to community, neighborhood and civic groups, at times in concert with the Clean Water Commission, to distribute information about the stormwater management program and get feedback on community priorities. A program slideshow is available for presentations.

Code Updates

Code revisions for water quality, stormwater and erosion control and Clean Water Fee regulations require extensive public outreach, review and comment, which will be coordinated by the Clean Water Division.

Per the 2013-2019 NPDES Municipal Stormwater Permit, a public outreach plan was developed to inform the public about stormwater code and manual updates. Any code updates utilize a variety of outreach strategies including emails to internal and external stakeholders, as well as website updates.

Customer Service / Adaptive Management

The Clean Water Division and its designees maintain regular contact with the public through daily programmatic activities such as customer service for the Clean Water Fee, source control inspections (Section 4), inspections of regulated stormwater control facilities at businesses and subdivisions (Section 3), information requests, social media and complaint response. Staff receives feedback during these contacts and frequently incorporates suggestions into their daily procedures and processes.

For example, as a result of public feedback, the Clean Water Division provides a program to educate residential subdivision homeowners associations about proper maintenance of their stormwater facilities at: www.stormwaterpartners.com/facilities.

Outputs

- Clean Water Commission notes including public comments
- Clean Water Commission Annual Report to the County Manager and Clark County Council
- Log of public comments on the Stormwater Management Plan
- Log of public comments from community presentations
- SEPA file for each stormwater capital project
- Media releases
- Email updates
- Web content

TASK CHECKLIST

STATUS	TASK
ONGOING	Create opportunities to the public, including overburdened communities, to participate in the decision-making process involving the development, implementation and update of the SWMP
ONGOING	Implement processes to involve public in the SWMP
ONGOING	Display SWMP and other NPDES submittals on the website
ONGOING	Continue ongoing outreach programs
2021	Develop behavior change campaign and program evaluation plan
2024	Evaluate and report on behavior change campaign

For more information on efforts to inform and involve the public in the stormwater management program:

Jeff Schnabel , Interim Clean Water Division Manager
564.397.4483
jeff.schnabel@clark.wa.gov

Education and Outreach Program (S5.C.11)

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.11 Education and Outreach Program

The NPDES permit requires the county to have an educational program to raise general awareness about methods to address and reduce stormwater runoff and effect behavior change to reduce or eliminate stormwater pollution. The Clean Water Division also provides stewardship opportunities to encourage residents to participate in stormwater related activities.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 13.26A.005 Education and Technical Assistance

County Code Section 13.26A.005 describes the use of education and technical assistance to business owners and the general public as a primary means of implementing a successful pollution source control and prevention program.

Clark County Code Chapter 13.30A.050(D) Clean Water Fee Reduction Program for Schools

Section 13.30A.050(D) describes the Clean Water Fee program including the need and uses for the fee. It states that "many of the difficulties in managing of surface and stormwater problems result in part from the general lack of public knowledge about the relationship between human actions and surface and stormwater management. In order to achieve a comprehensive approach to surface and stormwater management, the county should provide general information to the public about land use and human activities that affect surface and stormwater management."

The code identifies schools as playing an important role for achieving this goal and allows a program for schools to reduce their Clean Water Fees for providing activities that further this effort. Schools meeting four tasks including stormwater BMP training for staff, passing stormwater facility inspections, implementing educational activities related to stormwater, and disseminating stormwater messages to the broader school community, will receive a reduction in their Clean Water Fees.

EDUCATION FOR THE GENERAL PUBLIC

Purpose

The goal of the stormwater education and outreach program is to build general awareness and influence behavior changes to reduce or eliminate contribution to adverse stormwater impacts. The support and awareness of the general public is crucial to achieving this goal, including options to deliver selected messages to target audiences in languages other than English. Education for the general public will focus on the following topics:

- Importance of clean water for local waterways.
- General impacts of stormwater flows into surface waters, including watershed management.
- Impacts from impervious surfaces.
- How people contribute to the problem through daily activities.
- Each person's ability to help protect and improve the quality of Clark County's water resources through source control BMPs and environmental stewardship.
- Low impact development principles and practices.
- General information about water quality and stream health.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW CWD Program Coordinator	CCPW CWD Outreach Specialist	Partner Agencies / Contractors
Coordinate education programs	A	C	P	P	C
Track and measure deliverables	A	C	P	P	S
Create messages, programs and collateral	A	C	P	P	P
Distribute messages and collateral	A	C	P	P	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Canines for Clean Water

The Canines for Clean Water program provides information to dog owners about proper management and disposal of pet waste. The program's webpage provides educational information, directions for properly managing and disposing of pet waste, and a pledge for owners to pick up after their dogs.

An outreach specialist will oversee the program and complete the majority of the tasks including receiving pledges, mailing materials, keeping program materials up to date, having a table at events, and coordinating with local partners to share the message.





The program webpage also provides information for community members to work in their neighborhood to support pet waste pick-up. Signs are available to place in yards and common pet walking areas.

Public Works also partners with Community Development to educate the public on the need to pick up pet waste (stormwater protection and solid waste management issues) through the promotion of the Pet Waste Scoop code. Informational fliers are sent out in every pet license update notification.

Green Neighbors Program

Clark County launched the Green Neighbors program in 2012. Promoting sustainable practices (including stormwater pollution prevention) to homeowners via their webpage www.clarkgreenneighbors.org, the program also hosts workshops and other educational events. The program is administered within the Public Health Department, in partnership with Public Works, to provide timely messaging of upcoming events and activities, including a community event calendar.

Website

The Clean Water Division maintains a website at www.clark.wa.gov/stormwater, as well as specific program webpages, that showcase information about stormwater pollution and prevention techniques aimed at all audiences. The site contains information on endangered species at www.clark.wa.gov/public-works/endangered-species-act , with multiple links to additional resources on endangered species.

A webpage dedicated to "What you can do for clean water" includes educational information and stewardship opportunities for home projects, community projects, schools, businesses and property managers.

The website is updated on a monthly basis or as needed by the Public Works Clean Water Division staff.

Publications and Displays

Clean Water Division staff produce displays and publications generally as part of specific program areas, such as pet waste management, natural gardening to reduce pesticide use, pollution prevention techniques, watershed education and others.

Many displays and publications are in stock and ready for distribution. Staff continues to display and distribute materials at community events, targeted environmental events, Clean Water Division presentations and Clean Water Commission meetings.



Other displays include interpretive signs on county capital projects and park trails. Interpretive / educational messages are tailored to each site. Typical messaging includes information on watersheds, the value of the stormwater project, the value of protecting water quality, and contact information for the Green Neighbors program.

Clean Water Division staff also refer residents to the 2010 Stream Health report for information about their local watersheds, especially teachers and neighborhoods.

Outreach Events

Public Works Clean Water Division sponsor and staff informational booths at a variety of community events, such as the Earth Day Fest, Klineline Kids Fishing Derby, and Columbia River Watershed Festival. Outreach includes information about water quality, the effects of stormwater pollution, pollution prevention and other targeted environmental protection messages. Participation will be limited to events adhering to COVID-19 restrictions,

Social Media



Public Works utilizes several forms of social media to increase outreach messaging effectiveness including:

- Facebook – Various divisions author posts including the Clean Water Division at https://www.facebook.com/clarkcowa.pwand by the end of 2020 the page had 2,211 followers.
- Twitter – The Twitter handleis at www.twitter.com/ClarkCoWa_PW, and as of the end of 2020 has 2,861 followers.
- Instagram – Various divisions use the Public Work Instagram account, @clarkcowa_pw, including the Clean Water Division and by the end of 2020 had 1,168 followers.
- Nextdoor.com – The Clean Water Division posts on the Clark County Communications agency account, which had more than 116,000 followers at the end of 2020.

Stormwater Partners of SW Washington

Public Works Clean Water Division is promoting and staffing the Stormwater Partners of SW Washington to include local jurisdictions and other local / regional agencies and organizations which provide stormwater education and outreach. The county coordinates and facilitates an annual symposium and periodic meetings, as needed, focused on maximizing education and outreach effectiveness through the sharing of resources, collaboration on projects, and the development of consistent messaging.

The Stormwater Partners website (www.stormwaterpartners.com) includes resources from previous collaborations on stormwater facility maintenance and LID, in addition to pollution prevention resources pertinent to audiences including businesses, residents, schools and developers. The latest collaboration includes a story map titled Explore Your Watershed.

The partnership collectively applies for grants to fund activities and pools resources where applicable.

Regional Clean Water Campaigns

The Clean Rivers Coalition is a group of Oregon and Southwest Washington cities, counties, stormwater utilities and nonprofit organizations committed to water quality and protection. An identified need is development of a strategy connecting regional messaging to local programs to increase the effectiveness of behavior change messages. The Clean Water Division is collaborating with Clean Rivers Coalition partners and KPTV - Fox 12 on a regional media campaign promoting stormwater pollution prevention for residents.

Outputs

- Clean Water Division webpages www.clark.wa.gov/stormwater and www.cleanwaterdogs.com
- Public contacts at events
- Fact sheets / brochures / informational signage
- Pledges to pick up pet waste
- Promotional materials such as water bottles, pens, etc.
- Social media outreach
- Stormwater Partners of SW Washington
- Regional clean water campaigns

EDUCATION AND TECHNICAL ASSISTANCE FOR BUSINESSES

Purpose

Education for businesses helps meet county goals for assisting commercial, industrial and governmental enterprises in preventing contribution of pollutants to stormwater runoff or to receiving waters.

Outreach and assistance will focus on:

- General stormwater issues
- Information about illicit discharges
- Preventing and controlling the discharge of contaminants through proper use of Best Management Practices (BMPs)
- Equipment maintenance

Responsibilities

Most activities for this requirement are conducted concurrently or in association with procedures described elsewhere in the SWMP to complete source control inspections and follow-up technical assistance. Responsibilities are described in their respective sections.

Clark County Green Business Program

Clark County's Green Business Program (www.clarkgreenbiz.com) recognizes and promotes local businesses that document "green" practices, including stormwater BMPs. The program currently supports 78 local businesses that have completed sustainability assessments and have met the requirements to be a local Green Business. This program is now managed through Clark County Public Health. An integral part of the program is the technical assistance visits and education to promote proper handling and disposal of toxic and hazardous materials and stormwater BMPs.

Targeted Messaging

The Clean Water Division has identified a number of businesses that would benefit from targeted messaging on how their business can modify everyday practices to minimize pollution to stormwater. A series of brochures developed in 2017 are used to educate businesses and assist in finding solutions to their pollution prevention strategy. The brochures include messaging in Spanish and Russian.



Targeted business practices inserts include:

- Dumpster/Compactor management
- Spill kit / drum lid use
- Landscaping
- Surface cleaning

Staff created English and Spanish language mop bucket management posters for businesses that routinely mop floors, such as restaurants. In the 2015 fuel station assessment program, messaging tools specific to fueling stations were developed.

Local Source Control Pollution Prevention

The Clean Water Division, through a Department of Ecology Pollution Prevention grant, provides targeted outreach to businesses to address pollution source control. There are several aspects to the project, including technical assistance visits, messaging and materials. Available materials include 5-gallon emergency spill kits and drum lid covers, as part of the "Keep a lid on it" program.

In 2021, Clean Water Division staff will develop for business and property managers an oil/water separator user's guide covering function, inspection and maintenance.

Catch Basin Cleanout Program

The Clean Water Division will continue the Catch Basin Cleanout Program aimed at increasing routine maintenance of privately owned catch basins. The program partners with a vendor to provide catch basin cleaning for an agreed upon price of $45 per catch basin. The vendor then performs the catch basin cleaning, properly disposes of waste material, invoices the business, and provides a manifest of appropriate waste disposal.

Clean Water Division staff created a webpage where owners of private catch basins sign up to have catch basins cleaned for the fixed rate (www.clark.wa.gov/catchbasincleanout). Out of compliance businesses are referred to the county.

In 2018, Clean Water Division staff mailed postcards to nearly 500 high priority businesses with stormwater facilities and catch basins draining to the county storm sewer system that need maintenance. The cards promoted the program and reminded businesses that they can save money and prevent pollution by performing regular maintenance.



The next mailing is planned for the 2021 NPDES permit term.

Outputs

- www.clarkgreenbiz.com
- Other outputs listed in relevant sections
- Targeted business materials, spill response, etc.
- Pollution Prevention Assistance brochures
- Pollution Prevention Assistance oil/water separator user's guide
- Catch Basin Cleanout Program www.clark.wa.gov/catchbasincleanout

EDUCATION FOR HOMEOWNERS, LANDSCAPERS AND PROPERTY MANAGERS

Purpose

Homeowners, landscapers and property managers are caretakers for a large percentage of the county's impervious surfaces, such as roofs and driveways, as well as lawn and landscaped areas that may contribute pollutants to runoff. Education messages will focus on the following topics:

- Impacts of stormwater on surface waters.
- Rural property management techniques.
- Yard care techniques.
- Proper storage and use of pesticides, fertilizers and other chemicals.
- Proper maintenance of stormwater treatment and flow control facilities.
- Low Impact Development principles and practices.
- Proper maintenance of vehicles, equipment and home/buildings.
- Proper techniques for carpet cleaning and auto repair.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW CWD Program Coordinator	CCPW CWD Outreach Specialist	Agencies Providing Services
Coordinate education programs	A	C	P	P	C
Track and measure deliverables	A	C	P	P	S
Create messages, programs and collateral	A	C	P	P	P
Distribute messages and collateral	A	C	P	P	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Small Acreage Education Program

The Small Acreage program, funded by the Clean Water Division in partnership with WSU Clark County Extension, provides educational workshops and other outreach to residents on water quality topics unique to rural properties. Topics include mud and manure management, pasture management, wells and septic maintenance, and fencing for livestock.

The goal of the Small Acreage program is to reduce pollution entering storm and surface water coming from residential and agricultural properties by giving residents the knowledge and skills necessary to manage their land and animals.



WSU Clark County Extension will provide one full-time program coordinator and oversight by an Extension faculty member. The coordinator will facilitate workshops, training sessions and follow-up activities. The coordinator also will

attend community events to recruit new trainees.

Clark County Public Works staff track deliverables of the program and negotiate the annual scope of work with the Extension director. WSU Clark County Extension submits quarterly and annual reports detailing deliverables.

Pesticide Reduction Outreach Campaign

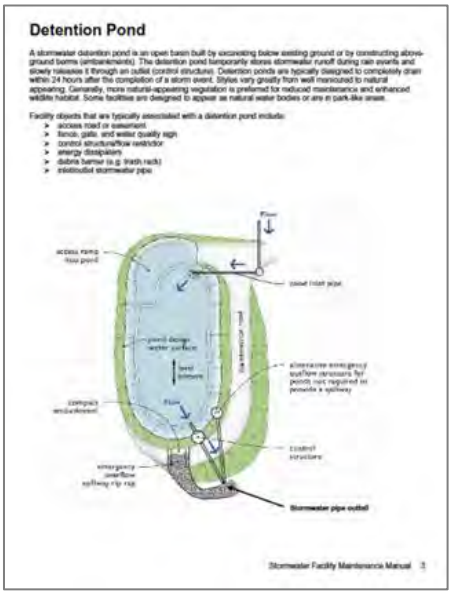
The Clean Water Division has joined Clean Rivers Coalition partners on a Pesticide Reduction Outreach (PRO) Campaign funded by a grant from the EPA Columbia River Basin Restoration Funding Assistance Program. The campaign targets pesticides commonly used in landscaping and agriculture. Building on prior research with community-based social marketing and Latinx community workshops and focus groups, the Coalition will develop videos and social media materials with consistent messaging across multiple languages.

Targeted Outreach for Agency Partners

Clark County participates in the Local Interagency Networking Cooperative (LINC), a regulatory-focused education and outreach partnership between Clark County departments of Public Works and Public Health, City of Vancouver Department of Public Works, Clark Regional Wastewater District, Southwest Washington Clean Air Agency, and the Washington State Departments of Agriculture, Ecology and Labor & Industries.

Regulated Facility Maintenance Inspections

Clark County combines site visits for regulated stormwater facility maintenance inspections with delivery of technical assistance materials such as relevant pages from the Stormwater Facility Maintenance Manual. Refer to the section Operating and Maintaining the Storm Sewer System, County Property, and Roadways on page 21 for a complete description of the process.



Stormwater Facility Assistance & Stormwater Partners

Clark County continues to partner with municipalities and regional partners within the county through Stormwater Partners of SW Washington, a program to provide common stormwater messages, education and guidance to the public on how to properly maintain privately owned stormwater treatment and flow control facilities.

The Stormwater Partners website (www.stormwaterpartners.com) contains how-to videos and user-friendly outreach materials.

The Clean Water Division outreach specialist will continue to work with the Stormwater Partners to develop this program. Periodic meetings and an annual symposium will be ongoing and include partners who have a role in educating the public about stormwater.

Low Impact Development (LID) Training

Clark County staff have several tools for educating the public on LID, including a tour book of LID sites in Clark County. The book is in hard copy, as well as a Google map on the Stormwater Partners webpage.

The Clean Water Division, with Stormwater Partners, plans to review and update outreach materials related to LID education. The program will create information on specific stormwater features to share with various audiences including realtors, landscape professionals, contractors, single family residential homeowners and property managers. Some of the materials may be presented in workshops and trainings, including in collaboration with partners such as Community Development.

Homeowner Targeted Messaging

- Grasscycling – Natural yard care to maintain healthy lawns without chemicals.
- Natural Garden Demonstration Site – A demonstration home garden site has been established at a local park (Pacific Community Park) to show how to manage diverse home landscapes while conserving and protecting water. More information is on the project webpage at: clarkgreenneighbors.org.
- Technical Assistance for Natural Gardening – The Naturally Beautiful Backyard program offers technical assistance through a web-based platform to homeowners to improve yards and minimize water use, pesticides and runoff. It also aims to encourage the use of native plants and creation of wildlife habitat.
- Backyard Habitat Certification Program – Provides technical assistance, incentives, resources, and recognition to owners of private property sized up to one acre focusing on habitat enhancements in five key areas including pesticide reduction and stormwater management.

Related Messaging

Other Clean Water Division efforts distribute information about water quality, the effects of stormwater pollution, and pollution prevention techniques as integral parts of their program outreach and education messages to the general public. Many of these messages are with partner agencies, such as Public Health.

- Naturally Beautiful Backyards curriculum delivered through a contract with WSU Clark County Extension's Master Gardeners program – less toxic gardening and yard care
- Master Composter Recyclers – less toxic gardening and yard care
- Hazardous Waste Reduction – proper disposal of household and business hazardous wastes
- Recycling A-Z website at www.recyclinga-z.com – proper disposal of tires, electronics and household hazardous waste
- Clark County Community Development - Building Safety – information for homeowners on erosion and stormwater requirements
- Green Apartment Living – pollution prevention assistance webinar series for multifamily property managers
- Other local grant programs provide additional messaging about stormwater management and pollution prevention.

Outputs

- Fact sheets
- Workshops
- Videos
- Landowner trainings
- Staff LID training
- LID educational materials
- Homeowner targeted materials

- Collateral materials

EDUCATION FOR DEVELOPMENT AND CONSTRUCTION COMMUNITY, COUNTY PLANNERS AND REVIEWERS

Purpose

The individuals, businesses and agencies involved in development project planning and construction (both regulated communities and the regulators) have great influence on the impacts of stormwater from new development and redevelopment. Education to these communities will focus on the following topics:

- Technical standards for stormwater site and erosion control plans
- Low impact development techniques
- Stormwater treatment and flow control BMPs and facilities

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Program Coordinator	CCPW CWD Permit Mgr.	CCPW CWD Natural Res. Specialist	CD Dev. Services Mgr.	CCPW Dev. Eng.
Code update outreach	A	P	P	O	I	S
Construction Management training	A	O	P	O	O	O
Facility inspection training	A	O	S	P	O	O
WWHM training	A	O	S	O	I	I
CD website	O	O	O	O	A / P	C
Pre-application conference	O	O	O	O	A / P	P
Small Projects BMP handout	A	S	S	O	P	O
DEAB	I	O	O	O	I	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

WORKSHOPS AND PRESENTATIONS

Stormwater Facility Inspection Training

Public Works Construction Management has an ongoing stormwater facility inspection program. Training will be provided to new inspectors or when there is a change in procedures or manual requirements. Staff are trained to be certified erosion and sedimentation control leads.

Training on Demand

Clean Water Division staff will provide training, code interpretation, BMP manual interpretation and informational materials to technical, professional and field workers as requested. Clark County departments with employees who work with the development community are trained by CWD staff on topics such as understanding "Pollution by Design" conflicts in development designs (e.g., dumpsters that include covers and separate drain systems).

Education Delivered Through Development Review

Many active development community stakeholders receive educational and outreach messages about water quality, stormwater and erosion control topics as an integral aspect of the regulatory development review process, including individual residential building permits.

For detailed information on the development review process, see Regulatory Program for Development, Redevelopment and Construction Projects on page 77.

Community Development Website

The Clark County department of Community Development hosts a website devoted to compliance with erosion control measures at: www.clark.wa.gov/community-development/erosion-control.

Pre-Application Conference

All Type II and Type III development applications require the applicant to attend a pre-application conference with county planners and engineers where, among other topics, stormwater, erosion control and submittal requirements are reviewed.

Clark County Stormwater Manual

The Clark County Stormwater Manual 2015, which guides applicants for development and new development through stormwater and submittal requirements, contains educational messages about the importance of stormwater management. Training materials are posted on the county stormwater manual webpage at: www.clark.wa.gov/public-works/stormwater-code-and-manual.

Small Project BMP Handouts for Permit Center

Clark County provides BMP packet handouts for small projects that are required to have stormwater site plans, erosion controls and on-site stormwater management BMPs but don't require an engineered design. The target audience is mainly applicants for single family residential building permits and other small building projects.

Development Engineering Advisory Board

The Development Engineering Advisory Board (DEAB) is a technical and policy review body reporting to the Clark County Council. The DEAB also serves as a mechanism for coordinating with the development community and consulting engineers to distribute information and organize training.

Outputs

- Presentations
- Employee training
- Development community training
- Small Project BMP Handout
- Sustainable and affordable development reports
- Educational messages in Clark County Stormwater Manual 2015

EDUCATION FOR STUDENTS

Purpose

Students are the next generation to own property, own or manage businesses, or simply live, work and recreate in Clark County. Education for students will focus on the following topics:

- Raising awareness of the importance of clean water.
- Introducing the idea of pollutants entering water through stormwater.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Program Coordinator	CCPW CWD Outreach Specialist	Agencies Providing Services
Coordinate education programs	A	P	P	C
Track and measure deliverables	A	P	P	S
Create messages, programs and collateral	A	P	P	P
Distribute messages and collateral	A	P	P	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Student Watershed Monitoring Network Program

In partnership with the City of Vancouver, Clark County involves students grade K-12 in water quality monitoring of sites near their schools. Teachers and students receive mentoring in water quality and macroinvertebrate monitoring and conduct stream studies. Students share their findings with peers and the community at an annual culminating event in late spring.

For more than two decades, the annual culminating event has been the Student Watershed Congress, with about 250 students participating each year. Planned changes to the annual event intend to optimize available resources, increase the event's sustainability and equity, provide opportunities for more teachers and students to participate, and incorporate more activities with real world relevance. Due to the impacts of COVID-19 restrictions, the event in spring 2021 will be virtual.

Program activities and outreach will be conducted primarily by City of Vancouver staff. Clark County staff will negotiate the annual scope of work and track deliverables.

County staff may participate in the annual culminating event where needed.

Student Outreach Program

In 2014, Clark County partnered with the City of Vancouver to receive an Ecology Grant of Regional or Statewide Significance to expand student monitoring and educational outreach, "Connecting Schools and Families to Healthy Stormwater Actions." The grant provided the following additional activities for students in the Clark County school districts. All materials are available to teachers and students on the City's webpage: www.cityofvancouver.us/publicworks/page/w

atershed-monitoring-network-investigations-and-resources.

- Land-based stormwater impact monitoring investigations (tied to Washington K-12 Learning Standards). The field investigations cover several key topics, such as soils, plants and water quality.
- Hands-on toolkits to build stormwater projects on or near school sites (i.e., rain gardens, etc.).

Student Video Contest

Stormwater Partners of SW Washington is collaborating with Oregon's Regional Coalition of Clean Rivers and Streams on The River Starts Here student video contest (www.stormwaterpartners.com/video-contest). Open to middle and high school students in the 4-county Portland-Vancouver metro area, contest submissions will be 25 or 55-second videos on topics related to pollution prevention, stewardship and their connection to local waterways. Prizes will be awarded for five categories: clean water actions short and long videos, community storytelling, BIPOC filmmaker and a people's choice. Winning videos will be promoted publicly on social media and at movie in the park events this summer.

Clark County Green Schools

Clark County Public Health continues to manage the local Green Schools program. The Seattle non-profit organization EarthGen, formerly Washington Green Schools, runs the program full-time with financial support from Clark County and other entities. The web address is earthgenwa.org.

Schools complete assessments in six environmental categories, including water and school grounds. More than 65 schools in Clark County currently participate in the program. An outreach specialist serves as a resource for local participating Green Schools.

The School Grounds Assessment covers stormwater management and use, as well as natural landscaping techniques to reduce chemical use, on school grounds. The Water Assessment covers watershed identification, path of stormwater from the school campus, LID or stormwater facilities, and possible sources of pollution. Outreach staff has created activity sheets related to stormwater to assist schools with completing the forms. Activity sheets are available on the "What You Can Do for Clean Water" webpage. Clean Water Division staff also participate in the annual teacher trainings and student summits to offer advice on their assessments and "make a lasting change" projects.

Experience Vancouver Lake

Clark County partners with the Port of Vancouver to fund the Experience Vancouver Lake project that provides a variety of outreach activities. Adapting to changing COVID-19 restrictions, hands-on education science kits and online lessons with companion hands-on activities about watersheds, invasive plant species, water quality and human-environment connections in the context of Vancouver Lake continue to be developed. A Vancouver Lake Virtual field trip was produced in 2020. Planned is a 4-hour field trip for 14 classes to Vancouver Lake for nature hikes, water quality monitoring, stewardship projects and educational messaging about the lake. Community events target residents and their families to visit the lake. Nine on-water community paddles are planned and depend on COVID-19 restrictions. They will focus on providing opportunities for overburdened community members to get on the lake with no paddling skills required. An alternative community and school resource in

development is a highly visual, illustrated trail map.

Watershed Storytelling

In an effort to support schools that want to provide watershed, stream and water quality educational sessions to large groups, the Clean Water Division has contracted with regional storytelling expert Will Hornyak. He will be available to large school groups, school assemblies and student focused events, such as the annual Columbia River Watershed Festival. He was awarded the Brimstone Grant by the National Storytelling Network for his watershed education assembly "Living Streams: Stories for Healthy Watersheds," which has been performed for over 60,000 students throughout the Northwest. This program will continue in 2020. A new contract will be negotiated to support at least 10 schools with watershed stories.

Enviroscape

The Clean Water Division has an Enviroscape watershed model available for schools to use for watershed and stream health studies. Utilized by both elementary and middle schools, the model includes a variety of "pollutant" types such as soaps, dirt, oils and pet waste.



Outputs

- Student Watershed Monitoring Network and Watershed Congress
- Washington Green Schools (school grounds and water activity sheets)
- Experience Vancouver Lake student and community outreach activities
- Watershed Storytelling school assemblies
- Enviroscape models for classroom use

STEWARDSHIP OPPORTUNITIES

Purpose

Clark County creates stewardship opportunities and/or partners with existing organizations to encourage residents to participate in educational activities. The county offers hands-on activities including the following:

- Storm drain marking – kits are available to citizens, businesses, scouts and community groups to mark drains on private property or local roads with speed limits less than 25 miles per hour (both metal medallions and paint stencil kits). In 2020, one volunteer group engaged 18 volunteers to mark 80 drains in high priority neighborhoods before COVID-19 restrictions went into effect.
- River-friendly car wash kit – This kit is available to businesses that host charity car washes for local community groups.
- Build bat boxes at stormwater facilities – A great project for neighborhoods or scouts, the county is encouraging the location of bat boxes in the urban area to promote habitat. Educational signage is then installed at the site.
- Other individual site projects – Other projects are available based on the site, such as informational kiosk construction. Community-led projects build the kiosk and the county provides signage / poster /

educational materials about the site, the watershed and key messages.
- Informational sign installations – Scouts are great partners to install watershed specific messaging signs.
- Planting projects are available to residents through local organizations such as the Watershed Alliance of Southwest Washington, Clark Public Utilities StreamTeam and the Lower Columbia Estuary Partnership along riparian areas and critical habitat zones.
- Clark County Parks – beach clean ups and invasive plant removal events are offered in many county parks.

Other Community Partner Stormwater Outreach

There are numerous agencies and nonprofits that provide stormwater education throughout Clark County, including in the jurisdictional area of Clark County. Many of these programs offer education messaging, raising awareness and stewardship opportunities. Clark County does not partner on funding, but these programs continue to increase awareness of stormwater related issues in our community.

Some of the programs anticipated to continue in 2020 include:

- Clark Conservation District – Best Management Practices program (providing technical assistance for agricultural properties to manage pollution sources).
- Clark Conservation District – Watershed Stewards learn about watershed topics and return service hours in the community.
- Clark Public Utilities – StreamTeam (tree plantings, invasive species removal, education/outreach, events).
- Columbia Springs Environmental Education Center – hosts various outreach events and programs including Salmon in the Classroom (raise and release baby salmon) and community events focused on river health.
- Lower Columbia Estuary Partnership – provides restoration projects, outreach and education, including big canoe tours and working with students in classroom education.
- City of Vancouver Water Resources Education Center – hosts a number of programs to schools and the community about water, water quality, fish and other environmental messages.

BEHAVIOR CHANGE PROGRAM

Purpose

Develop an education and outreach program based on local water quality information to demonstrate a change in behavior of at least one target audience and one best management practice (BMP). Regional collaboration on a behavior change program enables development and promotion of consistent messaging and leverages resources.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW CWD Program Coordinator	CCPW CWD Outreach Specialist	Agencies Providing Services
New evaluation of ongoing behavior change program	A	O	P	P	C
Develop campaign strategy, schedule and evaluation plan	A	I	P	P	S
Implement campaign strategy	A	C	P	P	P
Evaluate and report	A	O	P	P	S

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Evaluate Existing Program

Clean Water Division staff conducted a high-level comparative review of four possible existing programs to further evaluate. The decision to proceed with a more thorough evaluation of the Canines for Clean Water program was based on the following conclusions:

- Long-standing outreach program with potential for more effective implementation and a new target audience.
- Addresses known water quality issues.
- Potential to strengthen regional messaging and partner involvement.

Two questions guided the purpose of the evaluation:

- Understand the effectiveness of existing outreach efforts for producing the desired behavior change – that pet owners pick up after their dogs and properly dispose of the waste in a trash receptacle.
- How is the Canines for Clean Water program raising awareness about the importance of picking up pet waste, as measured by the number of people reached through social media activities and the number of households receiving pet licensing reminders with a Canines promotional flyer.

The evaluation provided evidence that there is opportunity to change and enhance the Canines for Clean Water program effectiveness as an ongoing behavior change program.

Pet Waste Behavior Change Campaign Plan

The plan describes the strategies and schedule to meet Phase I and II Municipal Stormwater Permit outreach and education requirements S5.C.11.ii and S5.C.2.ii, respectively. Clark County and the cities of Battle Ground, Camas

and Washougal will partner to more effectively implement an existing regional pet waste behavior change program, or for those jurisdictions without a behavior change program addressing pet waste, to target a new audience and BMP campaign. Each permittee in this partnership will implement the strategies described in this plan in their own jurisdiction.

Social marketing strategies are outlined to encourage higher rates of dog owners picking up and properly disposing of pet waste, and the process by which these efforts will be evaluated is defined.

The selected behavior is for dog owners using public trails to pick up pet waste in a bag and dispose of it in a trash receptacle.

The target audience is female dog owners using trails to walk their dogs. Literature review research and data from the existing program evaluation indicates that females usually take the lead caring for dogs.

Research conducted by Clean Water Division staff and partners included interviews with other jurisdictions that had implemented pet waste behavior change programs, two focus groups and two intercept surveys.

The two focus groups were composed of the target audience, with one exclusively for female dog owners also identifying as part of the Latinx community and moderated by a Latina. The focus groups provided insights to barriers and benefits of picking up pet waste in public. The groups were also used to gain feedback on motivations, strategy ideas, messaging and potential incentives.

Two intercept surveys targeting dog owners walking their dogs in public areas provided additional insights on the barriers and benefits to picking up after their pets on walks, as well as who their most trusted sources for information about dog care are.

Strategies to address pet waste will be focused on high priority trails – those with known pet waste issues and near or draining via the MS4 to water bodies with known bacteria and E. coli issues.

Public Trails Strategies

Kiosk at trailhead

- Will house photos of trail walkers who pledge to pick up after their dog
- Graphic/poster promoting Canines for Clean Water with a QR code linking to online pledge
- Prompts trail users to bring a bag

Trail signs

- Temporary signs encouraging people to pick up pet waste and take the pledge

Outreach

- Tabling once per month June-August to promote pledge and campaign

This campaign will be piloted from June to August 2021 on two similar trails. One trail will receive the kiosk and tabling events, while the other will be used as a control and will not receive the additional strategies.

Two metrics will be used to evaluate the effectiveness of the behavior change strategies along public trails – changes in the numbers of pet waste piles left along the trail and the number of pledges taken at the locations.

Evaluation results of the pilot will inform broader implementation of the strategies in 2022.

Outputs

- Internal report evaluating ongoing behavior change program.
- Campaign strategy, schedule and evaluation plan submitted to Ecology with the 2020 annual report.
- Campaign promotion materials – posters, trail signs, bag holders with a roll of bags that attach to a leash and a clip to carry full bags on a leash.
- Report on changes in adoption of targeted behaviors and changes to make it more effective submitted to Ecology with the 2023 annual report.

TASK CHECKLIST

STATUS	TASK
ONGOING	Educate the general public
ONGOING	Educate businesses
ONGOING	Educate residents, landscapers and property managers
ONGOING	Educate the development and land use planning community
ONGOING	Provide and advertise stewardship opportunities
ONGOING	Increase awareness and education of homeowners, landscapers and property managers
ONGOING	Affect behavior through hands on activities, workshops, trainings and stewardship
2021	Apply social marketing practices and methods
2024	Report on changes in adoption of targeted behaviors and changes to make it more effective

For more information on programs providing education and outreach about stormwater and the SWMP:
Jeff Schnabel, Interim Clean Water Division Manager
564.397.4583
jefff.schnabel@clark.wa.gov

Section 7 – Coordination

Clark County coordinates internally and with other local governments and agencies on a variety of environmental and planning topics.

Regulatory Requirements Summary

NPDES Permit S5.C.3 – Coordination

The NPDES permit requires the county to coordinate among its own departments and with neighboring jurisdictions to eliminate barriers to permit compliance and to encourage coordinated stormwater policies, programs and projects within a watershed.

COUNTY POLICIES, RULES AND REGULATIONS

The following policies and regulations promote permit implementation by county departments.

Clark County Code Chapter 13.26A – Water Quality

Chapter 13.26A requires inspection and maintenance of all public and private stormwater facilities and stormwater disposal wells in accordance with the Clark County Stormwater Manual that provides source control BMPs for materials handling, landscape management, trash management and building exterior maintenance. This manual is equivalent to maintenance standards in Volume V and source control standards in Volume IV of the SMMWW.

Environmentally Responsible Purchasing Policy

Clark County adopted its Environmentally Responsible Purchasing Policy in 2004. One element addresses purchase of landscaping and vegetation maintenance products, including pesticides. The policy establishes a set of criteria, any of which will disqualify a pesticide from purchase. A waiver process requires further examination of the pesticide by the Environmentally Responsible Purchasing Team to determine if a more environmentally-friendly alternative exists. If no alternative is found, the pesticide can be purchased and used within specific limiting guidelines. The policy promotes a coordinated approach to the pesticide and fertilizer use reduction.

Regional Road Maintenance Program

Clark County has been a member of the ESA Regional Road Maintenance Forum since 2003. The group assisted the county in developing a Regional Road Maintenance Program that is designed to meet the requirements of the Endangered Species Act (ESA). In 2004, NOAA Fisheries approved Clark County's Regional Road Maintenance Program and determined that it was compliant with the ESA. The program seeks to protect salmon and steelhead by relying on the extensive use of pre-approved BMPs for routine maintenance activities. The program promotes systematic adherence to pollution control standards for road operations.

Intra-governmental Coordination

Purpose

Intra-governmental coordination helps ensure cooperation of all Clark County departments in meeting the terms of the NPDES Municipal Stormwater Permit and in protecting local water resources.

Responsibilities

Responsibility for negotiating interdepartmental and programmatic agreements lies with the Clean Water Division manager or a designee and with managers of coordinating programs and departments.

Responsibilities for implementing the agreed upon activities are shown in detail in responsibility matrices and program descriptions in the appropriate sections.

Agreements

The Clean Water Division coordinates the county's NPDES permit compliance efforts. Although the program coordinates with other departments, it is not responsible for all compliance actions. The Clean Water Division maintains memoranda of understanding or other agreement mechanisms with several county departments to support compliance. Agreements include services provided for payment by the CWD and description of permit requirements that must be met by departments.

Public Works Road and Parks Maintenance Divisions

Public Works completed an intra-departmental agreement between the Clean Water Division and the Road and Parks Maintenance Divisions to implement requirements under permit requirements S5.C.9, Operations and Maintenance Program, including:

- Standards and schedules for stormwater facility and catch basin maintenance.
- Practices for operating streets, roads and highways.
- Spill response practices.
- Private facility inspection and enforcement.
- Water quality BMPs for maintaining public land.
- Training.
- Stormwater Pollution Prevention Plans (SWPPs) for heavy equipment yards.
- Recordkeeping.
- Reporting requirements for the NPDES permit annual report.

Public Works Engineering and Construction Division

Public Works provides services to implement permit requirements under S5.C.5, S5.C.6 and S5.C.7.

Public Works provides the following services:

- Project management for stormwater capital improvements.
- Design and construction management for stormwater capital improvements.
- Capital planning assistance.
- Development site inspection.
- Program to inspect stormwater facilities during maintenance warranty.
- Enforce stormwater, erosion control and water quality codes.
- Inspection program recordkeeping.
- County facility annual maintenance inspection.
- Training for staff whose primary job duties include design, construction site inspection and enforcement.

Community Development

Department of Public Works maintains an interdepartmental agreement with Community Development to implement requirements under permit requirement S5.C.5, including:

- Accept development applications.

- Review site plans for residential building projects that do not require engineered designs.
- Review and inspect erosion controls, on-site stormwater controls at residential building sites, primarily single-family residential construction sites.
- Enforce stormwater, erosion control and water quality codes.
- Maintain records of applications, reviews, inspections and enforcement actions.
- Training for staff whose primary job duties include permitting and plan review.
- Referring water quality complaints to the Clean Water Division.

Community Development

Community Development provides development review services for enforcing Clark County Code Chapter 40.386 Stormwater and Erosion Control and its predecessor, Chapter 40.385.
Community Development provides the following services:

- Review and approval of development project applications.
- Administration of development project recordkeeping.
- Training for staff whose primary job duties include permitting and plan review.

Internal Services Facilities

The Clean Water Division has an interdepartmental agreement with General Services that includes operation and maintenance of stormwater facilities, use of source control BMPs, and technical assistance and training from Public Works. In early 2019, the General Services Department was dissolved and the department's facilities management functions were moved into a new facilities division of the newly-formed Internal Services Department. Public Works will update the agreement to reflect the new department structure, while retaining the same performance requirements.

Public Health

The Clean Water Division coordinates with Clark County Public Health on spill responses, illicit discharge investigations and other environmental complaints.
Public Health's agreement includes referring illicit discharges to Clean Water Division when discovered during routine work such as restaurant inspections, swimming pool inspections and other field activities that may discover illicit discharges. Field staff are trained to report spills and refer sites having illicit discharges to the Clean Water Division. Public Health is also responsible for addressing illicit discharges caused by on-site sewage disposal facilities.

GIS Department and Application Services

Department of Public Works maintains an agreement with the GIS Department for various services that support SWMP implementation, including administration of the county's storm sewer infrastructure asset database, StormwaterClk, the stormwater asset Maintenance Management System, stormwater fee database administration, software support, GIS data used for capital planning and monitoring studies, developing Web applications and internet access to program information, and database development.

Other Intra-governmental Coordination

The Clean Water Division also coordinates informally with other county programs and departments on various stormwater-related and environmental efforts and projects such as development code and comprehensive plan updates .

Outputs

- Interdepartmental memoranda of understanding for services and permit requirements performed.

INTERGOVERNMENTAL COORDINATION PURPOSE

Clark County informally coordinates with Phase II permittees and other local organizations to control pollutants between physically interconnected storm sewer systems, to attempt to provide consistent stormwater management for shared water bodies, and to collaborate on permit implementation tools and TMDL implementation.

Responsibilities Matrix

Task	CCPW Director	CCPW CWD Mgr.	CCPW CWD NPDES Permit Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Program Coordinator
Vancouver Lake Partnership	I	A	O	S	P
Provide input to TMDL DIPs	O	A	S	P	O
TMDL advisory committees rep.	O	A	S	P	O
Local permittee coordination	A	I	P	I	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Coordination to Clarify Roles and Responsibilities for Interconnected Systems

The Clean Water Division has identified approximately 500 connection points between the county MS4 and other municipal entities such as cities and WSDOT right of way. Within the urban area, the Clean Water Division assesses the potential for intersystem pollutant discharges using IDDE procedures.

Clark County has informal discussions with NPDES Phase II permittees regarding mapping and illicit discharge screening programs.

General Intergovernmental Coordination

Clark County participates with other local governments and agencies on several joint efforts, including:

- Shared education and outreach programs with the City of Vancouver.
- A regional education program covering facility maintenance to stormwater facility owners within Vancouver, Battle Ground, Camas, Washougal, Ridgefield and La Center.
- Operation of the regional street waste decant facility with WSDOT, Vancouver, Battle Ground, Camas and Washougal.
- Hosting quarterly Southwest Washington permittee meetings to coordinate activities including roles and responsibilities for our interconnected systems.

Coordination for Shared Water Bodies: Vancouver Lake Watershed Partnership

The Vancouver Lake Watershed Partnership (VLWP) is no longer meeting. However, the original funding partners (Clark County, City of Vancouver and Port of Vancouver) continue to provide financial support for community outreach, education and volunteer activities focused on Vancouver Lake under a contract with the Lower Columbia Estuary Partnership (LCEP). The Clean Water Division program coordinator administers the contract with LCEP, and the Clean Water Division manager serves as representative to coordinate with the other funding partners.

TMDL Coordination

Clark County coordinates with other local entities on TMDL implementation. Upon request, the NPDES Permit manager will provide input to Ecology in development and update of Detailed Implementation Plans. The Stormwater Infrastructure manager will continue to participate on the local advisory committees for the following existing or emerging TMDL water bodies:

- Burnt Bridge Creek Watershed
- East Fork Lewis River
- Gibbons Creek
- Salmon Creek
- Lacamas Creek

In 2020, the focus will be on a partnership developing a cleanup plan for bacteria in the East Fork Lewis River in collaboration with Ecology and local stakeholders. Other work includes working with stakeholders to develop a plan in response to the East Fork Lewis River temperature TMDL and continued work at bacteria source identification in 303(d)-listed Whipple Creek watershed.

Clark County complies with TMDL requirements by implementing its Stormwater Management Program.

Outputs

- Various outputs from education and outreach programs (see section 6)
- Notes and summaries from each TMDL's Advisory Committee meetings

For more information on ways the county coordinates with other jurisdictions and permittees:
Jeff Schnabel, Interim Clean Water Division Manager
564.397.4483
jeff.schnabel@clark.wa.gov



County staff monitoring water quality at the Jones Creek stream gauge

CHAPTER 3

Assessment and Monitoring

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Assessment and Monitoring

Clark County is a regional leader in natural resource monitoring and assessment. The Assessment and Monitoring section implements a variety of projects to collect scientific data about stormwater, surface waters, stream corridor condition and habitat to support and implement NPDES permit requirements.

The core goal is to provide information leading to successful on-the-ground actions that improve natural resources in Clark County. The program utilizes sound science and data collection practices to inform the county's policy and program management decisions and provide information vital to the success of Clark County programs.

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit – S8 Monitoring

The NPDES permit no longer requires the county to develop and implement a monitoring program.

In 2020, Clean Water will complete the final report and data submittal to Ecology.

TOOLS THAT SUPPORT PERMIT COMPLIANCE

The Assessment and Monitoring section provides the tools and staffing to support completion of permit-required Watershed-Scale Stormwater Planning technical analysis and the permit's S8 stormwater monitoring requirements. These are standard procedures for collecting environmental data, database systems for storing data, quality assurance and quality control procedures, and methods to analyze and present data results.



Stream bed stability testing in the Mill Creek sub-watershed, 2009

Standard Procedures for Monitoring Activities

The Clean Water Division maintains the Standard Procedures for Monitoring Activities for use in guiding field and laboratory work. It details the protocols and means used to generate data.

Water Quality Database

The Water Quality Database (WQDB) is a centralized repository for the Clean Water Division's water quality and benthic macroinvertebrate data. The WQDB is a SQL 2000® database with Access® interfaces for data entry and retrieval. A batch uploading tool enables rapid entry of large datasets.

Quality Assurance Project Plans

Each monitoring project follows a Quality Assurance Project Plan or QAPP to ensure that data are of adequate quality to meet project objectives. Each QAPP follows guidelines published by Ecology.

Hydrology Databases

Data from the county's hydrologic and stormwater monitoring sites (storm flow, stream flow and rainfall gages) is stored in an Aquarius® database.

Outputs

- Annual stormwater data reports and pollutant loads for two sites
- Enter stormwater data into the Ecology EIM database

BMP EFFECTIVENESS MONITORING

Clark County is not conducting Best Management Practice Effectiveness Monitoring as a permit requirement. The project 2013 permit effectiveness project began implementation in late 2015 and was completed under the 2013 permit in 2018.



Crews install weir at a treatment wetland BMP monitoring site

ILLICIT DISCHARGE MONITORING

This activity is described in detail in Illicit Connections and Illicit Discharges Detection and Elimination (IDDE) on page 56.

Monitoring Resource Center

Purpose

The Volunteer Monitoring Resource Center lends monitoring equipment to volunteers who wish to monitor water bodies in Clark County. The program loans sampling equipment and professional-grade field meters. Staff scientists provide limited overview of how to use the equipment for their project.

Method

Staff assemble, calibrate and track equipment on loan to qualified borrowers. Citizens can visit the volunteer website for equipment checklists and resource information to support a successful project. The webpage is: www.clark.wa.gov/environmental-services/volunteer-monitoring-resources.

Outputs during Permit Term

- Log of Monitoring Resource Center borrowers
- Log of data requests
- Equipment checkouts to individuals, agencies and groups

For more information on services provided by the Assessment and Monitoring section:
Jeff Schnabel, Interim Clean Water Division Manager, 564-397-4583
Jeff.Schnabel@clark.wa.gov

Appendix 12. Capital Projects List

Project Name	Project Type	Status	Cost Estimate	Basin Area (ac)	LID Equiv Area	LID Point Factor	RT Equiv. Area	RT Point Factor	FC Equiv. Area	FC Point Factor	Other Project Area (ac or mi)	Other Point Factor	Total SSC Points	Lat	Long	Receiving Water Body	Comments
NE 99th St at Cougar Cr WQ Retrofit	2	C/M	$ 440,000	3.2	na	0	-	1.5	na	na	na	na	4.9	45.692914	-122.674503	Cougar Creek	
Gregory Place SWF Retrofit	4	C/M	$ 53,000	3.4	na	0	-	1.5	na	na	na	na	5.2	45.678971	-122.686123	Vancouver Lake	
Spring Haven SWF Retrofit	4	C/M	$ 20,000	1.4	na	0	-	1.5	na	na	na	na	2.1	45.687657	-122.652768	Salmon Creek	
Sweeping for WQ 2019	11	C/M	$ 240,000	-	na	0	-	na	na	na	-	-	-	-	-	various	
2020 Catch Basin Retrofits	2	C/M	$ 300,000	18.8	na	0	-	1.5	na	na	na	na	28.2	45.678595	-122.692817	Vancouver Lake	
East Fork Lewis River - Mason Creek acquisition	5	D	$ 730,000	na	na	0	-	na	na	na	65	0.5	32.5	45.834806	-122.634068	Mason Creek	
Wet Pond Repairs >25K (5 ponds)	6	C/M	$ 138,000	71.0	na	0	-	na	na	na	na	0.25	17.8	-	-	various	
Sweeping for WQ 2020	11	C/M	$ 240,000	-	na	0	-	na	na	na	-	-	-	-	-	various	
Skyview Condos SWF Repair	6	D	$ 31,000	4.4	na	0	-	na	na	na	na	0.25	1.1	45.721207	-122.678798	Salmon Creek	
NE 122nd St- HWY 99 Pre-Treatment Vault	4	D	$ 50,000	37.5	na	0	-	na	na	na	na	0.25	9.4	45.709058	-122.650808	Salmon Creek	
Padden Downs SWF Repair	6	D	$ 60,000	5.6	na	0	-	na	na	na	na	0.25	1.4	45.681919	-122.578777	Curtin Creek	
Vista Woods SWF Retrofit	4	D	$ 39,000	10.0	na	0	-	na	na	na	na	0.25	2.5	45.727467	-122.645393	Whipple Creek	
Whipple Creek Place SWF Repair	6	D	$ 220,000	39.5	na	0	-	na	na	na	na	0.25	9.9	45.731419	-122.677780	Whipple Creek	
Mt Vista 8 SWF Retrofit	4	D	$ 225,000	39.7	na	0	-	1.5	-	1.5	na	na	119	45.729309	-122.645759	Salmon Creek	75% Ecology grant; 25% County
NE Hazel Dell Ave Cougar Cr to 94th St WQ Retrofit	2	D	$ 455,000	3.0	na	0	-	1.5	-	-	na	na	4.5	45.684771	-122.669342	Cougar Creek	75% Ecology grant; 25% County
NE Hwy 99 WQ Retrofit (68th to 78th)	2	D	$ 811,000	7.3	na	0	-	1.5	na	na	na	na	11	45.679172	-122.664600	Cougar Creek	
NE Hazel Dell Ave 78th to Cougar Cr WQ Retrofit	2	D	$ 532,000	3.0	na	0	-	1.5	na	na	na	na	4.5	45.681142	-122.669149	Cougar Creek	
Cougar Creek 3 Enhancement	9	D	$ 1,000,000	5.4	na	0	-	1.5	na	na	na	na	2.4	45.704735	-122.682648	Cougar Creek	

"-" indicates data to be added when available
"na" indicates item is not applicable
Total SSC Points are estimates only - further calculations depend on further design

Exhibit N

CLARK COUNTY

2020 Stormwater Management Plan



2020 Stormwater Management Plan

Updated March 2020

CLARK COUNTY PUBLIC WORKS CLEAN WATER
1300 Franklin Street
PO BOX 5000
Vancouver, WA 98666-9810

www.clark.wa.gov/stormwater



For other formats, contact the Clark County ADA Office
Voice 564.397.2322 / **Relay** 711 or 800.833.6388
Fax 360.397.6165 / **Email** ADA@clark.wa.gov

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Acronyms and Glossary

AKART – all known, available and reasonable methods of prevention, control and treatment as the Ecology standard for the effort required to meet waste water discharge and NPDES permit requirements.

BMP – best management practices (controls for stormwater runoff)

Council – Clark County Council

CCPH – Clark County Public Health

CCPW – Clark County Public Works

CCSM – Clark County Stormwater Manual 2015 (Errata November 2016)

CCSWMP – Clark County Stormwater Management Plan

CIP – Capital Improvement Program

County Manager – Executive officer for Clark County

CWD – the Clean Water Division of Clark County Public Works

Ecology – Washington **State Department of Ecology**

EPA – Environmental Protection Agency

GIS – geographic information services

GMS – grounds maintenance specialist

IDDE – illicit discharge detection and elimination

Illicit Discharge – a non-stormwater discharge or illegal connection to the storm sewer system (e.g. a sanitary sewer line connected to storm sewer system)

LID – low impact development

MEP – maximum extent practicable
MMS – maintenance manual system (MainStar)

MS4 – municipal separate storm sewer system

NOAA Fisheries - National Oceanic and Atmospheric Administration, National Marine Fisheries Service

NOI – Notice of Intent

NPDES – National Pollutant Discharge Elimination Systems

PPGS – potential pollutant generating site

RCW – revised code of Washington

SCIP – Stormwater Capital Improvement Plan

SNAP – Stormwater Needs Assessment Program

StormwaterClk – a GIS database the county maintains for storm sewer infrastructure

SWMMPSB – 1992 Stormwater Management Manual for the Puget Sound Basin, published by Department of Ecology

SMMWW – 2014 Stormwater Management Manual for Western Washington, published by Ecology

SWMP – stormwater management program

SWPPP – stormwater pollution prevention plan

Tidemark – a database the county maintains to track permits and code enforcement

TMDL – total maximum daily load

UIC – underground injection control

WAC – Washington Administrative Code

WQDB – Water Quality Database



Responsibility Index

CD = Community Development
CCPW = Clark County Public Works

ABBREVIATION	FULL STAFF TITLE	JOB DESCRIPTION
Applicant	(as stated)	Customer who utilizes the municipal code and stormwater manual to guide development projects
CCPW Answering Service	(as stated)	Coordinates after business hours service calls
CCPW Code Enforcement	(as stated)	Coordinates citizen complaints and code compliance
CCPW PIO	Public Information Officer	Supports the development and delivery of public outreach and educational materials
CCPW Construction Mgmt. Eng.	Construction Management Engineer	Reviews PW construction projects for compliance with approved plans and applicable regulations
CCPW Construction Mgmt. Inspectors	Construction Management Inspectors	Conducts on-site construction inspections to ensure compliance with approved plans and applicable regulations
CCPW Construction Mgmt. OA	Construction Management Office Assistant	Coordinates document management associated with project approvals
CCPW Construction Mgmt. Supervisor	Construction Management Supervisor	Oversees the compliance with inspections of development construction
CCPW Construction Supervisor	Construction Management	Oversees the compliance of development construction with approved plans and code
CCPW CWD Admin.	Clean Water Division Administration	Supports document control and recordkeeping
CCPW CWD Eng.	Clean Water Division Engineer	Coordinates design and engineering of Clean Water projects
CCPW CWD Infrastructure Mgr.	Clean Water Division Infrastructure Manager	Oversees / manages stormwater capital planning , infrastructure mapping and monitoring activities, coordinates stormwater infrastructure inspection and maintenance
CCPW CWD Mgr.	Clean Water Division Manager	Oversees and manages the Clean Water Division
CCPW CWD Natural Res. Specialist	Clean Water Division Natural Resource Specialist	Performs monitoring and illicit discharge field work and analysis
CCPW CWD NPDES Mgr.	Clean Water Division National Pollution Discharge Elimination System Permit Manager	Oversees compliance with the county's Phase I Municipal Stormwater Permit
CCPW CWD OA	Clean Water Division Office Assistant	Coordinates document control and recordkeeping
CCPW CWD Outreach Specialist	(as stated)	Coordinates, implements and evaluates outreach programs for Clean Water
CCPW CWD Professional Staff	(as stated)	Supports various work projects and products

ABBREVIATION	FULL STAFF TITLE	JOB DESCRIPTION
CCPW CWD Program Coordinator	(as stated)	Coordinates specific project tasks and work products, including outreach / education
CCPW CWD Source Control Specialist	Clean Water Division Source Control Specialist	Technical assistance with citizens and businesses to comply with facility maintenance and source control regulations
CCPW CWD Sr. Eng. Tech	Clean Water Division Senior Engineering Technician	Inventory and maps the stormwater system
CCPW CWD Sr. Operations Specialist	Clean Water Division Senior Environmental Operations Specialist	Technical assistance with citizens and businesses to comply with private stormwater facility maintenance
CCPW Dev. Inspectors	Development Inspectors	Coordinates inspections and education
CCPW Director	(as stated)	Designated director for permit compliance
CCPW Eng. Program Mgr.	Engineering Program Manager	Oversees PW engineer activities
CCPW Eng. Program Staff	Engineering Program Staff	Develops engineering related materials
CCPW Eng. Project Mgr.	Engineering Project Manager	Manages engineering related projects
CCPW Enhance. & Permitting Mgr.	Enhancement and Permitting Manager	Coordinates environmental permitting for the department
CCPW Land and Vegetation Mgr.	Land and Vegetation Manager	Oversees the operations and maintenance of the vegetation management program
CCPW Ops Admin.	Operations Administration	Provides support to various tasks, such as spill response and citizen complaints
CCPW Ops Crew Chief	Operations Crew Chief	Leads and coordinates road crew activities
CCPW Ops Mgr.	Operations Manager	Oversees all operation and maintenance responsibilities
CCPW Ops Road Crews	Operations Road Crews	Perform all necessary road maintenance and operations activities to meet applicable standards and regulations
CCPW Ops Road Super	Operations Road Superintendent	Oversees all elements associated road maintenance and operations
CCPW Parks and Lands Mgr.	Parks and Lands Manager	Oversees all of the administration, customer service, maintenance and operations of parks and other county land management
CCPW Parks Super.	Parks Superintendent	Oversees the maintenance and operations of the parks
CCPW Real Property Services	(as stated)	Coordinates property related information, such as titles, legal information, etc.
CCPW Regulated Facility Lead	(as stated)	Coordinates regulated facility inspection and technical assistance.
CCPW Survey	(as stated)	Coordinates all necessary survey data required for a project
CCPW Vegetation Mgmt. Crew	Vegetation Management Crew	Performs all tasks associated with operations of the program

ABBREVIATION	FULL STAFF TITLE	JOB DESCRIPTION
CD Building Official	(as stated)	Oversees customer application for development, all building permits and permit counter.
CD Building Safety	(as stated)	Enforces erosion control regulations and stormwater for residential building permits
CD Dev. Eng. Mgr.	Development Engineering Manager	Oversees the engineering review of development applications
CD Dev. Eng. Planning Tech	Development Engineering Planning Technician	Reviews development applications for compliance with county code and regulations. Coordinates bonds, compliance and final plat
CD Dev. Eng. Review Eng.	Development Engineering Review Engineer	Conducts the engineering development review and participates in application meetings
CD Dev. Services Mgr.	Development Services Manager	Coordinates a pre-application conference with potential applicants and provides planning approvals
CD Permit Services	(as stated)	Coordinates review of development applications
CD Permit Tech	Permit technician	Processes permit applications
CD Planner	(as stated)	Supports the pre-application process and land use approvals
Contract Services	Outside firm or agency contracted with Clark County	Hired to meet specific scope of work items per the appropriate fund and need
Council	Clark	County Council
Legal authority for permit compliance		
County Mgr.	County Manager	Executive official for Clark County
CRWWD	Clark Regional Wastewater District	Supports the coordination of illicit discharge protection
General Services Facilities Crews	(as stated)	Performs all tasks associated with the operations of the program on county properties
General Services Facilities Mgr.	Facilities Manager	Oversees the facilities program for county properties
GIS	(as stated)	Supports the county's GIS system
Public Health	(as stated)	Coordinates illicit connection/discharge issues with CCPW staff



Moultan Falls on the Lewis River

CHAPTER 1
Introduction and Background

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Clark County Stormwater Management Plan

The Clark County Stormwater Management Plan (CCSWMP) describes the various ways the Clark County manages stormwater and related water resources issues in the unincorporated area. It acts as a resource for the public to learn about the county's efforts to reduce pollution in stormwater, an informative guide for staff, and a compliance measure for the county's municipal stormwater permit under permit requirement S5.C.3.a. and S5.A.

INTRODUCTION

As the county's unincorporated population continues to increase (over 222,000 in 2018 according to the Washington State Office of Financial Management), Clark County is committed to responsible stormwater management to keep our waterways healthy for people, fish and wildlife.

The Clark County Public Works department (CCPW) utilizes the Clean Water Division (CWD) to protect surface water and groundwater resources from polluted stormwater and to coordinate compliance with state and federal water pollution laws.

Primary responsibilities of the overall stormwater program include planning and building stormwater control facilities, stormwater management planning, water quality monitoring of stormwater and streams, public education and outreach, development and enforcement of water quality regulations, water quality compliance for businesses and private stormwater facility owners, coordination with other municipalities, and maintenance of the county's stormwater system.

STORMWATER AND NPDES PERMIT

Much of the pollution in Washington State's waters comes from many different, hard-to-trace sources with no obvious point of collection and discharge. It is called "nonpoint source pollution" and it travels to streams, lakes and other water bodies through polluted stormwater runoff carried by the county's storm sewer system.

Most U.S. cities and counties that collect stormwater runoff in municipal separate storm sewers and discharge it to surface waters are required to obtain a permit under the federal Clean Water Act. Clark County qualifies under the Environmental Protection Agency (EPA) stormwater regulations for the National Pollutant Discharge Elimination Systems (NPDES) Phase I Municipal Stormwater Per6mit program. In Washington State, the EPA has delegated to the Washington Department of Ecology (Ecology) the authority to develop and administer the NPDES permitting program.

Ecology issued the most recent NPDES Phase I Municipal Stormwater Permit to Clark County and other larger western Washington jurisdictions in July 2019, with an effective date of August 1, 2019. This permit is for a five-year period expiring on July 31, 2024.

Phase I permittees are cities and counties that operate large and medium municipal separate storm sewer systems (MS4s). Governmental bodies within their boundaries, such as state universities, public school districts and drainage districts, are also required to meet permit requirements. The permit regulates discharges to waters of Washington State from the permittees' MS4s in compliance with Washington Water Pollution Control Law (Chapter 90.48 RCW) and the federal Clean Water Act (Title 33 USC, Section 1251 et seq.).

PERMIT COMPLIANCE

The NPDES permit prescribes a variety of requirements and actions. It lists 21 general conditions; these include, among others, a requirement to notify Ecology of spills, a duty to avoid bypassing water quality treatment and flow control facilities, and a requirement to notify Ecology of a failure to comply with the permit.

The permit also lists nine special conditions that, among other things, specify permit coverage, list permittee responsibilities, and under Special Condition S5, prescribes an eleven-component stormwater management program (SWMP).

The SWMP consists of actions meeting the eleven required components and any additional actions and activities necessary to comply with Total Maximum Daily Load (TMDL) requirements. Clark County's SWMP is designed to reduce pollutant discharges to the federal maximum extent practicable (MEP) standard, meet state requirements for managing stormwater using all known, available and reasonable methods of prevention, control and treatment (AKART), and protect water quality.

The county is required to prepare a stormwater management program plan to inform the public of planned program activities for the upcoming calendar year. The SWMP plan must be updated annually to include program changes or revisions that occur and be submitted in part or in whole with the annual report to the Department of Ecology.

THE CLARK COUNTY STORMWATER MANAGEMENT PLAN AND STORMWATER MANAGEMENT PROGRAM

This Clark County Stormwater Management Plan (CCSWMP or Plan) encompasses efforts undertaken by Clark County, primarily in the Public Works and Community Development departments for the protection of water quality and the management of stormwater and related concerns. The Plan includes, as chapter 2, the NPDES stormwater management program required by Ecology.

THE CLEAN WATER DIVISION

The Clean Water Division (CWD) in Clark County's Public Works department is responsible for a majority of the county's NPDES compliance actions and activities, coordination and reporting. The program coordinates and contracts with county departments to achieve and facilitate compliance. The CWD is the primary author of reports and other documents required by Ecology.

In addition to activities addressing NPDES permit compliance and surface water resource management, the CWD manages other important stormwater-related activities, including managing stormwater injection wells regulated under the state's Underground Injection Control Rules (173-218 WAC) pursuant to the federal Safe Drinking Water Act, and giving engineering advice and support on flooding and drainage problems.

Funding and Budget

The Clean Water Division is funded primarily by an annual stormwater fee charged to developed parcels in the unincorporated area of the county. The county collects approximately $8 million annually from approximately 73,200 properties. Other sources of funding may include grants and the General Fund. The Road Fund provides support for stormwater management associated with county roadways.

Clean Water Fee

Residential and multifamily properties pay a fee based on each residential unit. Commercial properties, roads, churches and schools are assessed a fee based on the number of equivalent residential units (ERUs) of impervious surface measured on the parcel.

In July 2014, the Clark County Council adopted an update to the Clean Water Fee. Updated fees took effect in 2015 tax bills. The fee varies for residents in the Urban Growth Boundary versus rural areas.

Per Clark County Code 13.30A, fee revenues are used to fund stormwater management activities.

Beginning in August 2017, the Clean Water Division implemented updated requirements for schools wishing to receive a Clean Water Fee reduction (CCC 13.30A.050 D). Schools meeting four criteria including stormwater BMP training for staff, passing stormwater facility inspections, implementing educational activities related to stormwater, and disseminating stormwater messages to the broader school community, will receive a Clean Water Fee reduction. If all criteria are met during the school year, the Clean Water Fee will be waived for the later calendar year of the school year (e.g., 2017-2018 school year will apply to the 2018 Clean Water Fee).

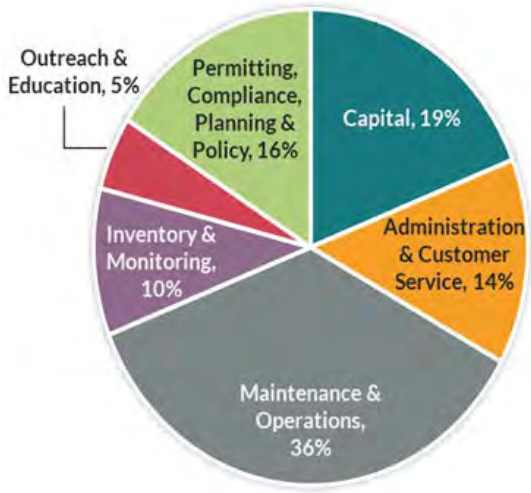
Clean Water Fund

Revenues from the Clean Water Fee, from grants awarded to the Clean Water Division and from fines are deposited into the Clean Water Fund by the Clark County Treasurer. Revenues in excess of annual operating expenses for maintenance, repair, enforcement, assessment, monitoring and education remain in the fund balance for use in constructing new public storm sewer infrastructure or in retrofitting inadequate stormwater control facilities.

The Road Fund provides support for stormwater management associated with county roadways.

Budget

Clark County budgets on a one-year cycle. The Clean Water Division budget is set at the beginning of each cycle and modified, if necessary, through requests for additional appropriations from the Clean Water Fund during the year.



2020 Clean Water Adopted Budget

The budget is approved by the elected Clark County Council. The Council sets the Clean Water Division budget in response to state priorities, expressed through the NPDES Municipal Stormwater Permit and local priorities.

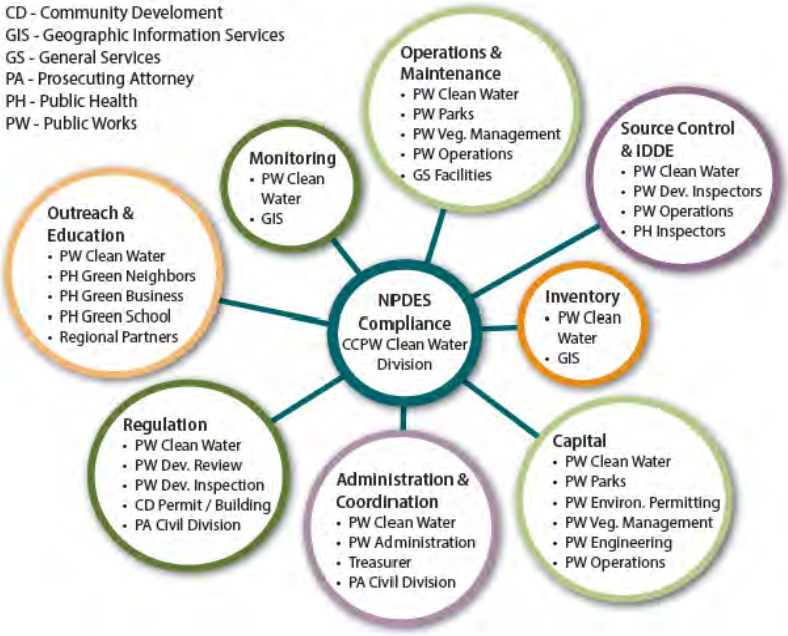
Areas of greatest expenditure include maintenance and operation of storm sewer infrastructure, stormwater capital construction, and assessment and monitoring of surface water and stormwater.

In recent years, a focus on building new stormwater facilities in underserved areas and on enhancing existing facilities has increased the overall budget and the proportion dedicated to capital construction. The total budget for 2020 is $8 million.

Organization & Staffing

The Clean Water Division employs a staff of 18 scientists, engineers, technical specialists, program coordinators and administrators who perform essential stormwater management functions. The program also coordinates with other Public Works divisions and county departments for additional essential stormwater services that fit within those division's or department's core services. This organizational structure allows the Clean Water Division to minimize expenses by engaging technical and professional experts such as design engineers, road maintenance crews and educators employed by other divisions or departments to complement a core staff of stormwater specialists.

The Clean Water Division is directly responsible for storm sewer system inventory; code and manual updates; watershed planning; source control inspections; illicit connection and discharge inspections; private stormwater facility inspections; stormwater facility maintenance compliance; stormwater capital planning; coordination with other jurisdictions and entities; and surface water and stormwater assessment and monitoring.



The program coordinates with other Public Works divisions and county departments to collect and process the Clean Water Fee; operate, inspect and maintain the storm sewer system; manage the design and construction of stormwater capital improvements; enforce development and building regulations related to NPDES permit compliance; inform and educate the public about stormwater problems and solutions; and support the Clean Water Division with database programming and analysis.

County departments are responsible for complying with NPDES permit requirements in their operational activities under the adopted stormwater plan and by interdepartmental agreements

TASK CHECKLIST

STATUS	TASK
Ongoing	The Clean Water Division administers the NPDES Municipal Phase 1 Stormwater Permit for Clark County
2020	Clark County will review the Clean Water Fee program to assess appropriate revenue levels

For more information on the county's Clean Water Division, contact:
Greg Shafer, Interim Clean Water Division Manager
564.397.4064
greg.shafer@clark.wa.gov



Turbid urban runoff from Cougar Creek into Salmon Creek

CHAPTER 2
Stormwater Management Program

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Section 1 – Legal Authority

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.1
Legal Authority

The NPDES permit requires the county to demonstrate that it has the legal authority to control discharges to and from its municipal separate storm sewer system (MS4).

Legal Authority to Regulate

Clark County maintains the legal authority required by the permit to control discharges to and from its MS4.

Clark County Code
Chapter 13.26A
Water Quality

Chapter 13.26A prohibits illicit discharges and spills into the county's MS4, requires the control of industrial site runoff, and adopts source control requirements in the Clark County Stormwater Manual 2015. It maintains the county's authority to inspect and enforce its provisions.

Clark County Code
Title 32
Enforcement

Title 32 permits Clark County to enforce any of its civil codes through inspection, surveillance, monitoring and enforcement actions.

Clark County Code
Title 40
Unified Development Code

Title 40 contains a suite of requirements regulating the design, construction and operation of stormwater controls on development and re-development sites that will discharge to the MS4 or to waters of the state. Stormwater and erosion control measures are required under Chapter 40.386

Legislative Authority of the Clark County Council

Through the legislative authority of the Clark County Council, Clark County has the ability to enter into contracts and intergovernmental agreements with other permittees and secondary permittees for the purpose of controlling pollutants entering or leaving the county MS4.

TASK CHECKLIST:

STATUS	TASK
Ongoing	Maintain legal authority to control discharges to and from the MS4

For more information on the county's Clean Water Division, contact:

Greg Shafer, Interim Clean Water Division Manager
564.397.4064
greg.shafer@clark.wa.gov

Section 2 – Taking Inventory and Mapping the Storm Water Infrastructure

Clark County operates a municipal separate storm sewer system (MS4) within unincorporated Clark County. This system includes stormwater drainage ditches and pipes in county right-of-way and county-operated conveyances on easements.

An MS4 is a conveyance or system of conveyances that meets all of the following criteria:

1. Owned by a state, city, town, village, or other public entity that discharges to waters of the U.S.
2. Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.).
3. Not a combined sewer.
4. Not part of a publicly owned treatment works (sewage treatment plant).



Stormwater Infrastructure Mapping

A related type of infrastructure used to manage stormwater is a Class V stormwater injection well, which allows stormwater to be disposed directly into the ground instead of to a surface water body.

Clark County inventories and maps its storm sewer infrastructure and Class V injection wells to serve a variety of purposes. The inventory is a primary source of information for inspection, operation and maintenance of the MS4, illicit discharge detection and removal, drainage and source control support, stormwater assessment and monitoring, and capital planning.

Clark County administers a comprehensive program to inventory the storm sewer system in a geographic information system (GIS) database called *StormwaterClk*. All known infrastructure is inventoried and mapped. An ongoing program inventories and maps storm sewer infrastructure built in the course of development and public capital improvement projects. The inventory includes all stormwater infrastructures inside of and outside of the county MS4, including:

- Flow control and water quality treatment facilities
- UIC-regulated Class V injection wells
- County outfall locations
- Conveyances (pipes, ditches and culverts)
- Interconnections with other municipal systems
- Connections to the county MS

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.2. Municipal Separate Storm Sewer Mapping and Documentation

The NPDES permit requires the county to map and document components of the MS4 including stormwater control facilities, receiving waters and land uses within the MS4.

Chapter 173-218 WAC Underground Injection Control (UIC) Program

Pursuant to Chapter 90.48 RCW, Washington Administrative Code requires owners of Class V injection wells (underground drywells and infiltration trenches with perforated pipes that dispose stormwater into the ground) to comply with regulations designed to protect groundwater quality for use as public water supplies. Clark County owns approximately 1,600 wells that are regulated under this rule.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 40.386 Stormwater and Erosion Control

Chapter 40.386 describes county regulations for ownership of stormwater facilities and the lands on which they are located. Section 40.386.030 sets forth requirements to submit record drawings for completed projects and requirements to document facility ownership.

Section 40.386.030(G) requires developers to submit record drawings to the county prior to 1) the issuance of building permits for single-family/duplex residential subdivisions, 2) the issuance of occupancy permits for site plan reviews, and 3) within sixty days following completion of construction for other types of development.

Clark County Code Chapter 40.540.070 Final Plat

Chapter 40.540.070 describes county regulations for information about dedications and easements for utilities that must be contained on a plat.

Revised Code of Washington Chapter 58.17.165 Plats – subdivisions – dedications

Washington state code prescribes information that must be shown on a plat when land is subdivided, including dedications of roadways and utilities and stormwater easements, tracts, or lots.

Public Project Record Drawings Policy

Clark County Public Works Engineering Program maintains a policy for the preparation and distribution of record drawings, also known as as-built drawings, after completion of county capital improvement projects such as roads, parks and stormwater facilities.

TOOLS

StormwaterClk

Clark County Public Works maintains a stormwater database called *StormwaterClk*. The database is administered by the GIS Department, while data is maintained and updated by the Clean Water Division. The GIS data can be accessed in Clark County MapsOnline in the utilities map site.

Land Development Records

Clark County Community Development maintains the *Land Management System*, a database of regulatory and enforcement cases, including permits for land division and development projects.

Annexation Tracker

Annexation Tracker is an application developed by the GIS Department that helps county departments track annexations.

ONGOING INVENTORY AND MAPPING

Purpose

Clark County maps and inventories stormwater treatment and control infrastructure because an accurate and complete inventory is critical to a successful program to inspect, maintain and regulate stormwater conveyances and stormwater treatment and flow control facilities.

As part of the process, new outfalls, Class V injection control wells, and connections also are documented.

Background

Most stormwater infrastructure and conveyances in the county are built by the private sector during residential and commercial development. Other facilities are built by the county to retrofit previously developed areas or to handle runoff from new roads, parks and other construction projects. The Clean Water Division builds a limited number of stormwater facilities to retrofit developed areas that lack adequate flow control or treatment. (See County Capital Improvements below.)

After a project is constructed, Clean Water Division staff inventory the new facility and its related conveyance infrastructure including pipes, catch basins and connections in *StormwaterClk*.

Responsibilities Matrix

Task	CCCD CWD Mgr.	CCPW CWD Infra. Mgr.	CCPW CWD Sr. Eng. Tech	CCCD Dev. Engineering Planning Tech	CCCD Dev. Engineering Mgr.	CCPW Construction Mgmt. Engineer	CCPW Construction Mgmt. OA	CCPW Construction Manager	CCPW Engineering Program Manager	CCPW Survey	CCPW Real Property Services
Notify CWD of new private development completion	O	O	I	P	A	O	O	O	O	O	O
Notify CWD of new county capital improvement project physical completion	O	O	I	O	O	O	P	A	O	I	O
Notify CWD of new county capital improvement project final acceptance	O	O	I	O	O	O	P	A	O	I	O
Gather project information	O	A	P	C	O	C	O	O	A	C	C
Notify CWD of county project As-built location	O	O	I	O	O	S	O	S	O	A/P	O
Make final decision on maintenance owner	O	A	P	O	S	C	O	O	O	C	C
Inventory/ Map infrastructure	O	A	P	O	O	O	O	O	O	O	O
Track progress	O	A	P	O	O	O	O	O	O	O	O
Transfer information to Operations	O	A	P	O	O	O	O	O	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Notification and Tracking

The first step of inventorying is becoming aware that a new development or county project, potentially with stormwater infrastructure, has been completed. The senior engineering technician will regularly query the Tidemark database or the LMS for new Development Inspection Numbers (DINs), which are created when engineering plans have been approved for construction.

The senior engineering technician will create a folder for the project on the Clean Water Division's network drive, where copies of relevant documents relating to the project's storm sewer infrastructure will be stored.

Private Sector Projects Notification

The CD Development Engineering planning technician will notify the CCPW CWD senior engineering technician that a new residential or commercial development has been completed by forwarding a copy of the completion of construction letter sent to the developer.

In some cases, the first notification to the Clean Water Division may be a different document, such as notice of a plat recording.

County Projects Notification - Physical Completion

The Public Works Engineering Program Construction Management section will notify the senior engineering technician that new public project is physically complete with a copy of the letter sent to the construction contractor.

Notification of Existing Projects

Infrequently, the senior engineering technician will discover engineering drawings or other evidence of an existing project that does not appear in the inventory. In those cases, the senior engineering technician will begin the mapping process as though it were a new facility by researching information about the project (see below), potentially using legacy data storage systems not discussed here.

Research

The senior engineering technician will research and assemble relevant documentation about the project from various sources, including Development Engineering and the Auditor.

To inventory and map the stormwater infrastructure, the senior engineering technician needs:

- Engineering drawings of the project.
- For private sector projects, the preferred source is a record drawing (sometimes also called an as-built). An acceptable alternate source is an approved construction plan.
- For county projects, the preferred source is a record drawing; however, most projects will be documented initially from the final construction plan with as-built notes from the construction manager.
- Geographic location of the infrastructure.
- Maintenance responsibility for the infrastructure.
- Ownership of tracts or parcels containing the facilities, if any.
- Location of easements containing the facilities and related infrastructure, if any.

Finding documentation may take several steps, outlined below.

Locate and Verify Engineering Drawings

For private sector projects, record drawings are submitted by the private developer to the Development Engineering program in electronic format. The senior engineering technician is then notified of the availability of record drawings.

For county capital improvement projects, Public Works Survey section maintains electronic copies of county projects and places them on the county Olympus server, where they are accessible to the senior engineering technician.

Determine Ownership and Maintenance Responsibility

The senior engineering technician will look for several types of information, including:

- The party responsible for maintaining the stormwater infrastructure.
- The owner of parcel(s) underlying any treatment or flow control facilities.
- The existence of easements for access to stormwater facilities and conveyances.

Responsibility for maintaining facilities may change over time. At this stage, the senior engineering technician will determine the current maintenance responsibility.

The senior engineering technician will evaluate information on legal documents such as the plat map, full plat recordings, covenants and recorded surveys. Ultimately, citing the owner of the land where a facility is located.

Inventory and Map (Digitize)

The senior engineering technician will find the project's location in the GIS. Using the assembled information, the technician will digitize the project's stormwater facilities and related infrastructure, such as conveyance and drywells, in *StormwaterClk*.

The senior engineering technician also will enter attributes of storm system features in the database. Attributes are unique to each feature type. Some of the most important attributes that are common to most types of features include:

- Subwatershed (auto-populated)
- Custodial county department
- Service status
- Installation date
- Elevations
- Dimensions (pipe diameter, length, etc.)
- Facility name (for facility polygons only)
- Serial number of the parcel containing the facility (if relevant)

Transfer Information

Information in *StormwaterClk* is weekly uploaded electronically into the Public Works Maintenance Management System (MMS) database which is used to track and schedule inspection and maintenance activities for stormwater infrastructure.

Outputs

- Updates to *StormwaterClk*
- Asset data in MMS

OTHER PERMIT-REQUIRED MAPPING / INVENTORY

Background

The NPDES permit requires both continuation of ongoing inventory/mapping activities (S5.C.2.a) and completion of several additional mapping tasks under (S5.C.2.b).

Specific requirements under permit section S5.C.2.a are addressed through already completed mapping efforts and the ongoing inventory and mapping program includes updates as new development is inventoried.

New mapping requirements under S5.C.2.b are partially addressed through already completed mapping efforts; additional efforts to address specific requirements are described below.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Sr. Eng. Tech	GIS
Map land use	O	O	O	A/P
Map connections to tributary conveyances	O	A	P	O
Map connections between BMPs and tributary conveyances	Completed – updated as needed (CCPW CWD Sr. Eng. Tech)			
Map receiving waters	* Completed *			
Map areas not draining to outfalls	* Completed *			
Map outfall catchments	Completed – updated as needed (CCPW CWD Sr. Eng. Tech)			
Map tributary conveyances	Completed – updated as needed (CCPW CWD Sr. Eng. Tech)			
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted				

Procedures

Map Tributary Conveyances

Clark County completed an inventory of the conveyance system in early 2010.

Map Connections to Tributary Conveyances

This effort primarily involves mapping private road ditch connections to public road ditches and now applies to areas outside the UGA where the public ditch leads to an outfall with nominal diameter of at least 24 inches. Most county roadside ditches have nominal diameters of 24 inches.

Map Connections between BMPs and Tributary Conveyances

Existing connections, including overflows between BMPs and tributary conveyances are mapped, and new connections will be mapped as part of the ongoing inventory and mapping program.

Map Outfall Catchments

In 2010, the Clean Water Division completed mapping catchments to most urban area outfalls. This includes nearly 500 outfalls, most of which are smaller than 24 inches of nominal diameter. Catchments to new outfalls will be mapped as outfalls are added.

Map Outfall Land Use

Known outfalls are mapped, and new outfalls will be mapped as part of the ongoing inventory and mapping. As a result of Clark County's function as a land use regulator, the Clark County Assessor maintains land use data at the parcel scale in GIS. To produce a map of land uses for outfalls, Clean Water Division staff or GIS Department staff will overlay land use data with outfall catchments and conveyance systems in the GIS upon request or as needed.

Map Areas Not Draining to Outfalls

In 2010, the CWD and GIS Department mapped areas served by the MS4 that do not drain to surface water within the UGA. For outfalls outside the UGA, areas not mapped as an outfall catch fulfill this requirement.

Outputs

- Updated inventory of Stormwater infrastructure in *StormwaterClk*
- Inventory of connections to tributary conveyances in *StormwaterClk*

INVENTORY QUALITY ASSURANCE AND REPORTING

Purpose

To continuously improve accuracy and data completeness in *StormwaterClk* and the Maintenance Management System.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Sr. Eng. Tech	GIS
Ongoing Data Updates	O	A	P	O
Reporting	O	A	P	S

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Ongoing Data Updates

The CWD Infrastructure manager and the senior engineering technician will verify accuracy of stormwater infrastructure in the GIS as annexations occur and as more accurate project plans are produced or discovered.

Annexation Updates

Annually, the Infrastructure manager will check *Annexation Tracker* to determine if stormwater infrastructure has been annexed to a city. The senior engineering technician will change facility ownership attributes and update county MS4 municipal connection points in *StormwaterClk* where infrastructure has been annexed.

Ongoing Corrections

As possible mistakes in inventory data or needed revisions are discovered, the senior engineering technician will keep a list of possible corrections, then periodically research and, if necessary, correct StormwaterClk. Possible sources of discovery include Public Works Operations and Maintenance personnel, annual stormwater facility inspectors and Clean Water Division engineers. These corrections are addressed in GIS and in updated links to facility assets in the maintenance management system.

Review of Older Paper Plans
The senior engineering technician will review the archive of older paper plan sets to fill gaps in mapping and attributes of existing infrastructure.

Outputs

- Data updates in *StormwaterClk*
- Reports from *StormwaterClk*

UNDERGROUND INJECTION CONTROL (UIC) REGISTRATION

Purpose

Pursuant to the Safe Water Drinking Act and Chapter 90.48 RCW, Washington Administrative Code 173-218 requires new UIC-regulated stormwater disposal wells, also called Class V injection wells, to be registered with the Department of Ecology prior to construction
.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Sr. Eng. Tech	CCPW CWD Engineer	CCPW Project Mgr.	CCPW Const. Mgr.	Applicant	CD Dev Eng. Mgr.
Map new Class V injection wells	A	P	O	O	O	O	O
Locate unregistered Class V injection wells	A	P	I	O	O	O	O
Submit private project registrations to Ecology	O	O	O	O	O	P	A
Submit public project registrations to Ecology	O	O	O	P	A	O	O
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted							

UIC Registration for County Projects

The CCPW CWD senior engineering technician will add new UICs to *StormwaterClk* upon project completion as part of ongoing inventory and mapping activities.

UIC Registration for Private Projects Having Public UICs

For privately-built projects that include new UICs in the public ROW or that are intended to be turned over to the county, the developer will register the UICs with the Washington Department of Ecology. For all such UICs, Clark County will be designated the owner on the registration form. Registration materials must be submitted to Ecology prior to construction.

When a developer submits plans for review, CD Development Engineering staff will confirm if UIC-regulated systems are included and inform the applicant of registration requirements. Registrations are verified prior to construction by Development Engineering at the pre-construction conference.
The CCPW CWD senior engineering technician will add new UICs to StormwaterClk upon project completion as part of ongoing inventory and mapping activities.

Outputs

- Updates to *Stormwater Clk*
- UIC wells registered with Ecology

TASK CHECKLIST

STATUS	TASK
ONGOING	Map all known MS4 outfalls and receiving waters, and structural stormwater treatment and flow control BMPs operated by Clark County
ONGOING	Map connection points between the MS4 and other municipalities
ONGOING	Map existing 8" and greater connections to the MS4
ONGOING	Map tributary conveyances and associated drainage areas
ONGOING	Map geographic areas served by the MS4 that do not drain to surface water
ONGOING	Map connections between BMPs and tributary conveyances
ONGOING	Continue ongoing inventory and mapping
ONGOING	Continue to map connections to tributary conveyances

For more information on the county's Clean Water Division, contact:

Jeff Schnabel, Clean Water Division Infrastructure Manager
564.397.4583
jeff.schnabel@clark.wa.gov

Section 3 – Operating and Maintaining the Storm Sewer System, County Property and Roadways

The county inspects and maintains storm sewer infrastructure to maintain its ability to convey, detain, infiltrate and treat stormwater. Clark County also manages its properties and roadways to reduce stormwater impacts from potential pollutant sources such as erosion, fertilizers and pesticides.



County crew replacing filters in a stormwater filter vault system

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit – S5.C.9 Operations and Maintenance

The NPDES permit requires the county to manage its maintenance activities and regulate non-county stormwater facilities to prevent or reduce stormwater impacts. The program must include:

- Maintenance standards and schedules for public and private stormwater facilities including catch basins.
- Street operation and maintenance practices that reduce stormwater impacts.
- Policies and procedures to reduce pollution from pesticides, herbicides and fertilizers used by the county.
- Operational practices that reduce stormwater impacts for equipment yards and storage facilities.
- Staff training.

Stormwater Management Manual for Western Washington

The permit requires the use of source control BMPs equivalent to Volume IV of the *Stormwater Management Manual for Western Washington (SMMWW)* or an approved manual. The Clark County Stormwater Manual, Book 4 contains a more extensive maintenance standard listing than the *SMMWW*.

The permit also requires a stormwater facility maintenance inspection program equivalent to Chapter 4 of Volume V of the SMMWW.

Chapter 173-218 WAC – Underground Injection Control (UIC) Program

Pursuant to Chapter 90.48 RCW, Washington Administrative Code requires the county to comply with regulations controlling the discharge of fluids, such as stormwater, into Class V injection wells. Examples of wells that handle stormwater include drywells and infiltration trenches. The stormwater management program addresses the UIC Program requirement to maintain and address pollutant sources.

Endangered Species Act 4(d) Rule

The federal Endangered Species Act prohibits "take" of threatened or endangered salmon. Take is harassment, harm, wounding, or killing of an ESA-listed salmon, or harming the critical habitat upon which it depends. The 4(d) rule directly prohibits take without authorization. However, the prohibition is limited under 13 different programs that describe procedures and processes by which an activity may be conducted to contribute to the conservation of the species overall. Road maintenance is an activity that, when conducted according to the Regional Road Maintenance Forum guidelines, is certified by National Marine Fisheries Service to contribute to the conservation of listed salmon.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 40.386 – Stormwater and Erosion Control

Chapter 40.386 requires newly constructed stormwater treatment facilities to be maintained in accordance with the Clark *County Stormwater Manual 2015, Book 4* – Operations and Maintenance, and it gives the county authority to inspect privately-operated facilities for compliance.

The chapter also requires ownership and maintenance responsibility of private facilities to be noted on subdivision final plats.

The *Clark County Stormwater Manual's Book 3-Source Control* adopts source control and treatment standards for public and private properties equivalent to Volume IV of the 2014 *SMMWW*.

Clark County Code Chapter 13.26A – Water Quality

Chapter 13.26A requires inspection and maintenance of all public and private stormwater facilities and Class V injection wells in accordance with the *Clark County Stormwater Manual*, that provides BMPs for business and public agency activities such as materials handling, landscape management, trash management and building exterior maintenance.

ENFORCEMENT PROCEDURES FOR UN-MAINTAINED PRIVATE STORMWATER FACILITIES

The Clark County Clean Water Division has a written procedure for responding to non-compliant private regulated stormwater facilities.

Environmentally Responsible Purchasing Policy

Clark County adopted its Environmentally Responsible Purchasing Policy in 2004. One element addresses purchase of landscaping and vegetation maintenance products, including pesticides. The policy establishes a set of

criteria, any of which will disqualify a pesticide from purchase, and a waiver system, allowing chemicals with no equivalent that is more environmentally-friendly to be used within specific limiting guidelines.

ESA Regional Road Maintenance Forum

Clark County Public Works has been a member of the ESA Regional Road Maintenance Forum since 2003. The group assisted the county in developing a regional road maintenance program designed to meet the requirements of the Endangered Species Act (ESA). In 2004, NOAA Fisheries approved the program and determined that it was compliant with the ESA 4(d) rule. The program seeks to protect salmon and steelhead by relying on the extensive use of pre-approved BMPs for routine maintenance activities.

TOOLS

Maintenance Management System (MMS)

The *Maintenance Management System (MMS)* is a database operated by Public Works for tracking infrastructure assets, recording condition, and scheduling inspections and maintenance. The MMS was implemented in 2011 and continues to evolve. The MMS will be used to prioritize, schedule and track stormwater infrastructure inspections and maintenance by Public Works crews.

For stormwater facilities and related infrastructure, the inventory in MMS is uploaded directly from *StormwaterClk* (see Inventorying and Mapping the Storm Sewer Infrastructure on page 21).

INSPECTIONS

Purpose

Clark County inspects both county-owned and regulated non-county stormwater facilities to evaluate condition and function and to determine if maintenance or repairs are warranted. In the case of regulated non-county facilities, follow-up actions include technical support to the BMP owner and, in some cases, enforcement.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Inspectors	CCPW CWD Sr. Eng. Tech	CCPW Construction Mgmt . OA	CCPW Construction Mgmt. Supervisor	CCPW Construction Mgmt. Inspectors	CCPW Ops Road Crews	CCPW Ops Road Supervisor
Inspect Regulated Facilities	A	I	P	S	O	O	S	O	O
Inspect Facilities During Heaviest Home Construction	I	I	O	S	S	A	P	O	O
Inspect County-owned Facilities	I	I	O	S	S	A	P	O	O
Inspect Catch Basins	I	I	O	S	O	O	O	P	A

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Inspect Regulated Facilities

Regulated facilities are treatment and flow control facilities including low impact development BMPs owned and operated by private parties and non-county governmental bodies. Clark County plans to annually inspect 100 % of regulated facilities with a permit mandate to inspect at least 80% of regulated facilities connected to the MS4.

County responsibility for inspecting regulated facilities will begin at issuance of the completion of construction letter by CD Development Engineering or the occupancy permit for individual residence projects subject to maintenance requirements. (See Regulatory Program for Development, Redevelopment and Construction Projects on page 69)

For facilities not in compliance with maintenance standards, the county will follow procedures to compel compliance through follow-up technical assistance and enforcement actions if needed.

Track and Schedule Annual Inspections

Public Works Clean Water Division will use ESRI Collector and Survey 123 applications on iPad devices to schedule, log and track regulated facility inspections.

Inspection

Inspections will be completed by Public Works Clean Water Division operations specialists and natural resource specialists. Inspections may be combined with business source control inspections. The inspectors will compare facility condition with maintenance standards from the Clark County Stormwater Manual.



Facility inspection

Contact Owners of Non-Compliant Facilities

If an inspection shows that a facility is out of compliance, the Clean Water Division senior operations specialist will send a mailing to the owner(s) and/or responsible party. The mailing packet will include:

- Introductory letter.
- Property identification.
- Postcard to return for technical assistance.
- Facility defect report.
- *Managing Stormwater Facilities* pamphlet with links to additional information.

Recipients will be referred to Clean Water for questions or problems.

Facility ownership or homeowner association leadership may change. In some cases, no viable homeowner association exists. The Clean Water Division senior operations specialist will research and follow up in these cases.

Contact Owners of Compliant Facilities

If an inspection shows that a facility is compliant, the owner will be sent a postcard stating that the facility is compliant and thanking them.

Follow-Up Technical Assistance
The Clean Water inspectors will assist owners who reply to the initial letter by giving advice on maintenance. The assistance may include phone calls, additional correspondence and site visits. The inspector will facilitate compliance and use professional judgment to set deadlines for compliance activities.

Further Enforcement
If the owner or owners of a non-compliant facility are unresponsive, then the senior operations specialist will refer the case to the code enforcement officer.

The code enforcement officer will use progressive enforcement methods, terminating with a Notice and Order and issuance of fines and liens in cases of severe non-compliance.

Alternate Compliance Strategy
The county retains the option of maintaining the facility and billing the owner at any point after an inspection demonstrates that a facility is out of compliance. This is a costly and time-consuming option, so it is generally avoided.

Compliance Tracking
Public Works Clean Water will update facility records with compliance information on a regular basis, including inspection results, contact information and other relevant facility information. A spreadsheet system tracks correspondence to regulated facility owners and assistance provided. Follow-up and enforcement actions will be tracked by the Clean Water Division senior operations specialist and tracked as case files.

Facility Ownership Transfer
While it rarely occurs, the county has a policy, criteria and procedures for accepting ownership of private stormwater facilities serving residential subdivisions. Facilities must meet county maintenance, safety and access standards before acceptance.

Inspect Facilities During Heaviest Home Construction
Clark County will inspect permanent stormwater treatment and flow control facilities, including catch basins, in new residential developments every six months during the period of heaviest construction. The NPDES permit defines the period of heaviest construction as the time until 90 percent of the lots are built-out (see condition S5.C.5.b.vi.d).



Maintain Inspection List
Construction Management runs a report from permit tracking software listing the number of lots in the subdivision and the number of lots having active building permits.

Schedule Inspections
The Public Works Construction Management lead inspector will consult the inspection list monthly and schedule project sites requiring inspection for the following month. Any subdivision with less than 90 percent of the lots built out will be scheduled. The Public Works Construction Management lead inspector will schedule six-month inspections for each project using the inspection list.

Inspection
Public Works Construction Management inspectors will inspect project sites using standards from the *Clark County Stormwater Manual*

Track Inspections
The Public Works Construction Management inspector or office assistant will enter the inspection results into permit tracking software under the DIN (development inspection number). The electronic field inspection form is attached to the DIN case.

Enforcement
The method used to enforce maintenance compliance of a facility found to be out of compliance will depend on its ownership. When a private facility or catch basin is out of compliance, the standard process for enforcement on a regulated facility will be followed.

When a county-owned facility or catch basin on maintenance warranty is out of compliance, the inspector will refer the issue to the Public Works development inspector assigned to that development project.

When a county-owned facility or catch basin is out of compliance after the warranty period, the facility will be treated as any other county-owned facility.

Inspect County-Owned Facilities

The Clark County Public Works Construction Management Program annually will inspect at least 95% of county-owned stormwater treatment and flow control facilities. Facilities with known problems may be spot-checked by Public Works Operations and Maintenance after significant storm events in addition to routine inspections.

- For county capital improvement projects, inspection responsibility will transfer to the county at the issuance of the final acceptance letter to the contractor by Public Works Construction Management.
- For facilities constructed as part of a private-sector development project that did not include a warranty period, maintenance responsibility will transfer to the county two years after issuance of the completion of construction letter to the developer. (See Regulatory Program for Development, Redevelopment and Construction Projects on page 69.)

Inspection
Public Works Construction Management will inspect facilities using standards from *the Clark County Stormwater Manual*. Crews will note compliance and defects using the same field applications used for regulated facilities.

Spot Checks
After significant storms, Public Works crews will inspect facilities that have known problems associated with heavy rainfall.

Tracking
Public Works Construction Management inspection results are entered into the MMS using the iPad-based field applications.

Inspect and Clean Catch Basins

The Clark County Public Works Operations and Maintenance Program will inspect catch basins in road right-of-way annually. Each catch basin is inspected and those exceeding sediment depth standards are scheduled for cleaning.

Catch basins in parks and other county facilities will be inspected and cleaned as part of routine maintenance by Public Works.

Outputs

- MMS records of regulated facility inspections
- Updates to six-month inspection list
- Spot checks of public facilities after severe storms
- Catch basin cleaning
- MMS records of public facility inspections

COUNTY STORMWATER FACILITY AND CLASS-V INJECTION WELL MAINTENANCE

Purpose

Maintenance of stormwater facilities and stormwater disposal wells ensures that facilities continue to perform their important environmental and drainage functions. Clark County Public Works is responsible for maintenance of most county stormwater infrastructure when it fails to meet a maintenance standard established by permit and county standards.

Responsibility for maintaining county-owned stormwater treatment and flow control facilities will begin at issuance of the final acceptance letter for those constructed as part of a county capital improvement and at the end of the maintenance warranty period for those built as part of a private-sector development project. (See Regulatory Program for Development, Redevelopment and Construction Projects on page 69.)

The county does not maintain private stormwater facilities except in emergency situations or when pursuing an alternate compliance strategy for a non-compliant facility, whereby the county maintains the private facility at the owner's expense.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD NPDES Mgr.	CCPW CWD Sr. Eng. Tech	CCPW Road Ops and Parks Supers	CCPW Ops Roads and Parks Crews	Contract Services
Routine Facility Maintenance	I	I	S	A	P	O
Non-routine Facility Maintenance	C	C	S	A	P	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Typical Facility Maintenance

Clark County will perform routine maintenance, such as litter removal, mowing and weed control, on swales, ponds, filter strips and LID BMPs that it owns. Typical maintenance is regular activities that maintain a facility's function that can be accomplished primarily with hand tools, lawn mowers and weed whackers, and do not require engineering evaluation or heavy equipment. It does include cleaning sediment traps using vacuum trucks. The following procedure applies to stormwater facilities maintained by Public Works, such as those in subdivisions and road right-of-way. Maintenance of other county stormwater facilities located in parks and on county campuses is covered in the section pertaining to operation of county lands (below).



Stormwater facility maintenance

Schedule and Prioritize

Most of the typical facility maintenance will occur during the growing season (April to September). The Clark County Public Works water quality crew chief will schedule the work.

Maintenance

Mowing grass, controlling weeds and litter or debris removal are the primary typical maintenance activities. Other maintenance for defects including sediment accumulation in sediment traps, minor erosion, presence of trees in pond or swale bottoms, etc., is also part of typical maintenance.

Capital Construction Facility Maintenance

Prioritization and Budget

The Clean Water Division and Operations and Maintenance will develop an annual work plan for maintaining and repairing facilities that require capital construction under $25,000.

Individual maintenance projects estimated to cost more than $25,000 are referred to the Stormwater Capital Program (page 65).

Inspection Data Review

The Public Works NPDES road operations superintendent and crew chief will schedule facility maintenance requiring construction in consultation with the Clean Water Division Infrastructure Manager.



Filter Vault Cartridges

Implementation
Maintenance requiring construction is accomplished as resources and weather allow within permit timelines.

Drywell Maintenance
Public Works Operations and Maintenance Roads crews will maintain drywells (Class V stormwater injection wells) as necessary based on a visual inspection of defects. Drywells in stormwater facilities will be inspected annually as part of routine facility inspections. Drywells in streets and roads will be inspected at the time catch basins are inspected.

Outputs
- Stormwater facilities maintained and repaired to meet county standards.
- List of projects referred to the capital planning program for repairs greater than $25,000.
- Database records of facility maintenance work (MMS).

USE OF WATER QUALITY BMPS DURING ROADWAY AND COUNTY PROPERTY OPERATION AND MAINTENANCE

Purpose
Clark County maintains its properties and roadways in a manner that prevents or reduces stormwater impacts.



Stormwater facility

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Permit Mgr.	CCPW CWD Sr. Operations Specialist	CCPW Ops and Parks Mgrs	CCPW Road Ops Super	CCPW Ops Roads Crews	CCPW Parks Super	CCPW Parks Crews	CCPW Land and Vegetation Mgr.	CCPW Vegetation Mgmt. Crews	General Services, Facilities Mgr.	General Services, Facilities Crews
Annually inspect and maintain catch basins in parks	I	I	O	A	O	O	A	P	O	O	O	O
Annually inspect and maintain catch basins on campuses	I	I	O	C	O	O	A	P	O	O	A	O
Road maintenance practices	I	I	O	A	C	P	O	O	O	O	O	O
Landscape maintenance on campuses	I	I	C	C	O	O	A	P	O	O	A	O
Landscape maintenance in parks	I	I	C	A	O	O	A	P	O	O	O	O
Noxious weed removal practices	I	I	C	O	O	O	O	S	A	P	O	O
Exterior building and grounds maintenance	I	I	C	O	O	O	O	S	O	O	A	P
Training road maintenance crews	I	S	S	A	P	I	O	O	O	O	O	O
Training parks maintenance crews	I	S	S	A	O	O	P	I	O	O	O	O
Training weed management crews	I	S	S	O	O	O	O	O	A	P	O	O
Training Facilities Maintenance crews	I	S	S	O	O	O	O	O	O	O	A	P
Check SWPPPs	I	S	O	A	O	P	O	O	O	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Maintain Roadways

Road maintenance and operation will be conducted by the Public Works Road Maintenance and Operations Division.

Clark County will maintain roadways and other traveled surfaces using pollution reduction practices defined by the ESA Regional Road Maintenance Program and in Clark County Stormwater Manual.

Specific pollution-reduction activities include:

- Periodic removal of litter from conveyances, such as ditches.
- Catch basin cleaning.

Practices to prevent pollution will be implemented whenever the following maintenance activities are conducted:

- Pipe cleaning
- Culvert cleaning
- Ditch maintenance
- Street cleaning
- Road repair and resurfacing, including pavement grinding
- Snow and ice control
- Utility installation
- Maintaining roadside areas, including vegetation management
- Dust control
- Pavement striping maintenance
- Application of fertilizers, pesticides and herbicides
- Sediment and erosion control
- Landscape maintenance and vegetation disposal
- Trash and pet waste management



Street sweeper with clean water message

Maintain Parks

Parks may contain any or all of the following types of land cover: pavement, landscaped areas, natural areas, structures and stormwater facilities. Parks will be maintained by Public Works Parks and Lands Division.

Clark County will maintain park vegetation and structures according to *Clark County Stormwater Manual* and current pesticide application rules. Pesticides will be purchased according to the county's Environmentally Responsible Purchasing Policy. Parks maintenance crew members are trained under the ESA Regional Forum and are state licensed pesticide operators.

Parks crews will inspect catch basins within parks during routine park maintenance and will clean them as needed.

Parks crews will mow and remove litter from stormwater facilities within parks frequently during routine park maintenance. Public Works Road Maintenance and Operations will provide the balance of the maintenance.

Maintain County Property

County campuses are managed by the General Services department. General Service's personnel maintain pavement and building exteriors; General Services has an agreement with Public Works Parks and Lands Division for most outdoor vegetation management activities.



Clark County will maintain landscaping and hard surfaces on its campuses according to the *Clark County Stormwater Manual*. Pesticides will be purchased according to the county's Environmentally Responsible Purchasing Policy. Parks maintenance crew members are trained under the ESA Regional Forum and are state licensed pesticide operators.

Parks crews will inspect and maintain catch basins on county campuses.

Parks crews will mow and remove litter from stormwater facilities on county campuses as needed based on visual inspection.

Clark County implements a Stormwater Pollution Prevention Plan (SWPPP) for each of its heavy equipment and materials storage yards, operated by Public Works. Copies of the SWPPPs are kept at each site.

Control Weeds on County Property

State regulated noxious weed control on county properties is provided by Public Works Parks and Lands Division.

Clark County will control weeds according to current pesticide application rules. Pesticides will be purchased and used according to the county's Environmentally Responsible Purchasing Policy.

Vegetation Management field crews are state licensed pesticide operators.

For some areas, such as mitigated wetlands and properties with Legacy Lands designation, Vegetation Management will compose a Site Specific Plan to ensure that compliance with all environmental regulatory requirements, including NPDES permit requirements, will be achieved.



Employee Training

Crews from Public Works Operations and Maintenance and Public Works Parks and Lands are trained under the ESA Regional Road Maintenance tracks 2 and 3. Track 2 coursework describes the biology of endangered fish and how road and park maintenance activities can harm them; it is generally provided to supervisors and managers. Track 3 provides crew chiefs and crew members with maintenance guidelines and procedures to protect endangered species during maintenance work.

In addition to task specific training, county personnel who as part of their field work may encounter a spill or non-stormwater discharge are trained on how to respond.

Train New Personnel

Clark County Public Works will provide ESA Regional Road Maintenance training using an approved vendor for new or promoted staff, as necessary.

Outputs

- Maintenance of county property using proper BMP manuals
- Employee training
- Stormwater Pollution Prevention Plan at each heavy equipment and storage yard

TASK CHECKLIST

STATUS	TASK
ONGOING	Spot check facilities with known problems after significant storms
ONGOING	Annually inspect and clean, if needed, county-owned catch basins
ONGOING	Implement established practices to reduce stormwater impacts from property and landscape maintenance activities
December 31, 2022	Document practices to reduce stormwater impacts from property and landscape maintenance activities for county property
ONGOING	Employee training
ONGOING	Update SWPPPs for county equipment yards
ONGOING	Adopt and implement maintenance standards equivalent to the SMMWW
ONGOING	Require maintenance of regulated facilities to the SMWW
ONGOING	Implement program to annually inspect all regulated facilities
ONGOING	Inspect all new facilities in new residential developments every 6 months during the period of heaviest construction
ONGOING	Inspect all county-owned facilities annually

For more information on county operation and maintenance of the MS4:

Jeff Schnabel, Clean Water Division Infrastructure Manager,
564-397-4583
Jeff.Schnabel@clark.wa.gov

Section 4 – Detecting and Reducing Pollutants and Contamination

Contaminants may enter the MS4 through improper connections and through discharge of contaminants from sites with private storm systems that are connected to the MS4.

Eliminating illicit connections and discharges of contaminants is an important part of the county's Stormwater Management Program.

Improper non-stormwater connections may be discovered through routine screening of the system, site inspections or by complaint. When an improper connection is discovered, removal and disconnection is a high priority.

Regular and wide-spread inspections of business and multi-family sites helps ensure that sites are properly managing potential contaminants, maintaining catch basins and conveyance systems, and preventing non-stormwater discharges into their private systems that discharge to the MS4.

Along with meeting NPDES permit requirements, the program also addresses sources that do not discharge to the Permit-regulated MS4, including discharges to Class V injection wells, non-county storm drains and other conveyances to surface water and groundwater.

Source Control Program

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.8 – Source Control Program for Existing Development

The NPDES permit requires the county to reduce pollutants in runoff from areas that discharge to the MS4 by applying operational, structural source control and treatment Best Management Practices (BMPs); enforcing proper BMPs on commercial, industrial and multifamily properties; enforcing water quality ordinances; and reducing pollutants from pesticides, herbicides and fertilizers entering the MS4.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 40.386 – Stormwater and Erosion Control

Chapter 40.386 adopts the *Clark County Stormwater Manual* as the technical manual for meeting the Minimum Requirements of the Permit, including Minimum Requirement 3, Pollution Source Controls.

Clark County Code Chapter 13.26A – Water Quality

Clark County prohibits non-stormwater discharges to the MS4 and regulates the discharge of contaminants to surface water, stormwater and groundwater to protect the county's surface and groundwater quality. The code and stormwater manual provide requirements for reducing and controlling the discharge of contaminants by requiring all sites and activities to utilize source control Best Management Practices (BMPs) to control release of contaminants.

Chapter 13.26A also adopts the *Clark County Stormwater Manual* that provides BMPs for materials handling, landscape management, trash management and building exterior maintenance.

Clark County Stormwater Manual

The *Clark County Stormwater Manual* contains technical requirements for meeting Minimum Requirement 3, Source Control of Pollution under county code Chapter 40.386 for development projects The manual also applies to existing land uses under Chapter 13.26A.



INVENTORY POTENTIAL POLLUTANT GENERATING SITES

Purpose

The Potential Pollutant Generating Site inventory helps target education and enforcement of source control requirements on commercial, industrial and multifamily sites. The site inventory also meets a requirement of the NPDES permit.

Responsibilities Matrix

Task	CCPW CWD Source Control Specialist	GIS	CCPW CWD NPDES Mgr.
Update inventory of sites	**S**	**P**	**A**
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted			

Inventory Maintenance

The Clean Water Division uses several sources to identify commercial, industrial and multifamily sites in the county that have impervious surfaces.

The database is derived from the Clark County Assessor personal property tax database and fire marshal inspection data. As inspections progress to include most permanent business sites, the site inventory is refined based on site-specific information. The inventory is also updated as new business sites are built or complaint-driven sites are added.

Outputs

- Inventory of business and multifamily sites

SOURCE CONTROL AT BUSINESS AND MULTIFAMILY SITES

Purpose

Clark County inspects business sites and many multifamily sites for compliance with source control requirements to ensure pollutants are not discharged to the MS4 or groundwater via Class V stormwater infiltration wells.



Responsibilities Matrix

Task	CCPW CWD NPDES Mgr.	CCPW CWD Source Control Specialist	CCPW Code Enforcement Officer	CCPW CWD Outreach / Education	CCPW CWD OA
Site selection	A	P	O	O	O
Inspection / education	A	P	S	S	O
Follow-up for compliance	A	P	P	O	O
Referral	A	P	P	O	O
Recordkeeping	A	P	P	O	P
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted					

Site Selection

Each year, a group of sites are selected for inspection based on land use risk and results from past inspections.

Inspection and Education

Inspections are conducted by qualified county staff. Currently, Clean Water Division source control specialists inspect sites.



At each business site, county staff will approach the owner, manager, or other employees to obtain access to the storm system on the site and to ask questions about source control practices, drainage plumbing, materials storage, and, if relevant, structural source control BMPs.

Staff will note inspection findings using the i-pad field form and enter results into the Local Source Control database in Secure Access Washington (SAW).

During the visit, county staff will provide education and technical assistance as judged necessary or beneficial. Education or assistance could include brochures, BMP handouts, general information on stormwater pollution topics, copies of the county's water quality ordinance, *Clark County Stormwater Manual*, or referrals to maintenance companies.

Follow-up Actions for Compliance

If a business is not in compliance, the source control specialist will work with the manager or owner to reach compliance. Follow-up actions may include phone calls, additional site visits and letters. County staff may give additional

technical assistance such as locating engineering drawings, providing handouts from the *Clark County Stormwater Manual* or Ecology and recommending new source control BMPs.

The source control specialist will set deadlines as necessary for compliance actions (e.g. cleaning catch basins).

Follow-up actions will also be recorded using the iPad field form, which is stored in a county database and entered into the Local Source Control database on SAW.

CATCH BASIN CLEANING ASSISTANCE

In late 2018, a new program was implemented to provide catch basin cleaning services for a fixed rate of $45 per catch basin. Out of compliance businesses are referred to the county webpage where businesses can register for the service. The contractor then performs the catch basin cleaning, properly disposes of waste material and invoices the business and provides a manifest of proper waste disposal. Mailers were sent to all business sites draining to the county storm sewer system

Referral

If necessary to gain compliance, the source control specialist will refer the case to another agency such as Clark County Public Health, Ecology or the Clark Regional Wastewater District. The source control specialist will continue to follow the case to conclusion.

Further Enforcement Actions

Further enforcement will be provided by Clean Water Division Code Enforcement or by referral to Ecology in cases of continued inaction.

Recordkeeping

Information is stored in a database linked to the iPad Survey 123 and Collector applications. Non-stormwater discharges are logged in the county IDDE database and site visit information is logged in the state SAW database for Local Source Control contract compliance. .

Training

All county employees who conduct field work need to be aware of spill response procedures and protocols. A training program is established using the county's Gensuite training tracker online program. Field personnel from multiple departments will be required to complete the training annually to ensure they are familiar with illicit discharge, illicit connections, use of spill kits, and what to look for in the field.

Outputs

- Records of inspections and follow-up cases
- Report of numbers of inspections and referrals
- Case files



WATER QUALITY COMPLAINT INVESTIGATIONS

Purpose

Clark County investigates all legitimate complaints about water quality problems to reduce contamination of stormwater, surface water and groundwater as well as to comply with its NPDES Permit

Responsibilities Matrix

Task	CCPW CWD NPDES Mgr.	CCPW CWD Source Control Specialist	CCPW CWD OA	CCPW CWD Natural Res. Specialist	CCPW Code Enforcement Officer
Refer potential cases to CWD	O	I	O	O	P
Open case	A	P	O	O	O
Investigation	A	P	O	S	O
Education and compliance	A	P	O	O	O
Recordkeeping	A	P	S	S	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Open Case

Water quality complaints may arrive in a variety of ways, including the 24-hour water quality complaint line, referral from other agencies, referrals from Community Development Code Enforcement Officers, e-mail to the Clean Water Division general address, and phone calls to the Clean Water Division. Complaints may be made by the general public or agency staff.

Complaints will be referred or forwarded to the Public Works Clean Water Division source control specialist.

Investigation

The source control specialist will investigate every legitimate complaint beginning with a phone call and site visit.

For business sites, the source control specialist will fill out the "Clark County Stormwater Business Site Visit Report" field form and begin a case file.

For residential sites, the source control specialist will fill out the field form but generally will not begin a case file. In difficult or egregious cases, the specialist will begin a case file.

Education and Compliance

If a water quality or source control violation is found, the source control specialist will work with the property owner or property manager on compliance or refer the case to another agency. The source control specialist generally follows the procedures for source control

follow-up (above), and, if necessary, further enforcement actions.

Recordkeeping

A Public Works Clean Water Division source control specialist will enter the data into the IDDE tracking database and maintain a case file.

Outputs

- Records of complaints, investigations and follow-up in Tidemark
- Case files

Training

Clean Water Division and Code Enforcement personnel have been performing source control inspections and enforcement since 2000. When applicable, new staff will be trained on enforcing the Water Quality Ordinance, including legal basis, BMPs, inspection procedures, enforcement process and recordkeeping. When changes to manuals or procedures are made, all appropriate staff will be trained.

TASK CHECKLIST

STATUS	TASK
ONGOING	Source control inspections and enforcement
ONGOING	Staff training for source control
ONGOING	Update inventory of pollution-generating sites
ONGOING	Inspect sites, enforce and respond to complaints
2021	Update county municipal code per permit requirements
2021	Update county stormwater manual per permit requirements

For more information on the Source Control program:

Rod Swanson, Clean Water Division NPDES Permit Manager,
564-397-4581
Rod.Swanson@clark.wa.gov

Illicit Connections And Illicit Discharges Detection And Elimination (IDDE)

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.9 – Illicit Connections and Illicit Discharges Detection and Elimination (IDDE)

The NPDES permit requires the county to have a program to detect, remove and prevent illicit connections and illicit discharges, including spills, into the MS4. Illicit connections are man-made conveyances connected to the MS4 without a permit, such as sanitary sewers and floor drains that can carry materials other than stormwater. Illicit discharges are discharges to the MS4 not composed entirely of storm water, except where allowed by a state waste discharge permit.

The Permit designates timelines for beginning an investigation of a suspected illicit connection and for terminating a confirmed illicit connection.

Revised Code of Washington Chapter 90.48 – State Water Pollution Control Act

The State Water Pollution Control Act prohibits the discharge of contaminants to waters of the state.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 13.26A – Water Quality

Chapter 13.26A prohibits the discharge of contaminants into surface water, stormwater or groundwater, and it defines contaminants and illicit connections. It gives inspection and enforcement authority to authorized representatives of the Public Works Director or other department heads specified in established procedures to enforce that chapter.

Clark County Code Chapter 13.10 – Use of Sewer

Chapter 13.10 requires the use of sewers to dispose of liquid wastes and water carrying waste materials.

Clark County NPDES Illicit Discharge Detection and Elimination Screening Quality Assurance Project Plan

The Project Plan addresses project design, schedule, methods of data collection and management, quality assurance and control requirements, data analysis, thresholds for further investigation, and reporting for the county's program to screen the MS4 for illicit connections.

ILLICIT DISCHARGE AND CONNECTION SCREENING

Purpose

Screening for evidence of illicit discharges and connections helps county staff identify outfalls or points in the MS4 that appear to convey something other than stormwater, as well as meeting Permit requirements for ongoing screening.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD NPDES Mgr.	CCPW CWD Natural Res. Specialist
Screening area selection	A	S	P
Outfall selection	A	I	P
Site visits / screening	A	I	P
Sampling / evaluation	A	I	P
Recordkeeping	A	I	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Ongoing Work

Clark County carried out an extensive screening program in each year and has screened the entire urban area and several rural subwatersheds at least once.

Public Works Clean Water Division natural resource specialists will continue effectiveness monitoring on illicit connections discovered during previous field screening operations (see Illicit Connection and Discharge Response and Removal on page 53). In addition, a natural resource specialist or source control specialist will respond to any complaints and referrals.

Source control inspections are an important element of illicit discharge detection (see Source Control Program on page 43).

Screening Site Selection

In 2020, a Clean Water Division natural resource specialist will select urbanized subwatersheds for screening based on professional judgment and watershed management objectives. This area will include at least 12 percent of the MS4 urban stormwater conveyance systems.

Outfall Selection and Scheduling

A Clean Water Division natural resource specialist will use the county stormwater infrastructure inventory GIS database, *StormwaterClk*, to locate and map all outfalls within chosen screening area. Staff will schedule site visits using this information.

Site Visits
During the summer season, a natural resource specialist will screen outfalls for indicators of illicit connections, such as flow or deposits.

Sampling and Evaluation
The natural resource specialist will take samples at flowing outfalls, use field tests and send them for laboratory analysis, and then evaluate the results using defined protocols to determine if an investigation is warranted. In cases where an investigation is warranted, the discharge is called a suspected illicit discharge or connection.

Investigations and follow-ups are part of the Illicit Connections and Discharge Response program (below).



Recordkeeping
The natural resource specialist will track all information regarding screening, illicit connection investigations and response to illicit discharges if applicable, in the IDDE screening iPad application. Database fields based on those described in the 2019 permit.

Reporting
Each year, the natural resource specialist will complete a report describing the year's work from planning through removal of any discovered illicit connections or discharges, including those discovered by source control inspections. The report will be stored in the project folders by year.

Awareness Training
A new training program has been established using the county's Gensuite training tracker online program. Field personnel from multiple departments will be required to complete the training annually to ensure they are familiar with illicit discharge, illicit connections, use of spill kits, and what to look for in the field.

Outputs

- Records in the IDDE screening database
- Annual written summary of screening activities, investigations and results
- Report of number of inspections and follow-ups
- Laboratory data and field measurements entered in the Water Quality Database

ILLICIT CONNECTION AND DISCHARGE RESPONSE AND REMOVAL

Purpose

Clark County responds to all suspected illicit discharges and connections to the MS4 that it identifies through screening or other methods. Response is designed to eliminate the source of the discharge or the connection.

Responsibilities Matrix

Task	CCPW CWD NPDES Mgr.	CCPW CWD Natural Res. Specialist	CCPW CWD Source Control Specialist	Public Health	CRWWD	Ecology
Open case	A	I	P	O	O	O
Investigation	A	S	P	S	S	S
Follow-up / removal	A	I	P	S	S	S
Continued follow-up	A	S	P	S	S	S
Recordkeeping	A	P	S	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Suspected Illicit Connection and Discharge Response

The CCPW Clean Water Division and Public Works Operations Division will receive and respond to reports of suspected illicit discharges; however, some illicit connections or discharges due to on-site sewage treatment systems are discovered and terminated by Clark County Public Health. The process described here is that used by the Clean Water Division and Public Works.

Notify Ecology

The county immediately will notify Ecology if an illicit discharge or connection poses a threat to human health or the environment.

Open Case

The process begins with notification about a suspected illicit discharge or connection through referral from illicit detection screening (above), discovery through source control inspections (above), or complaint.

The source control specialist will open a case file.

Investigation

Within 21 days, the Clean Water Division source control specialist and a natural resource specialist will attempt to trace a suspected illicit discharge or connection back to its source to identify the problem. If tracing back to the source is not possible, they may elect to follow other protocols established in the IDDE Project Plan.

The source control specialist will confirm the presence or absence of the suspected illicit discharge or connection based on the findings, and, when possible, will specify the source.

Follow-up and Removal

For confirmed illicit discharges or connections, the source control specialist will work with the property owner and, if necessary, other county departments or agencies to eliminate the illicit connection. If relevant, Clark Regional Wastewater District, Public Health, cities, or the Department of Ecology may be requested to assist in areas where they have responsibility.

Addressing illicit discharges will follow standard source control procedures for follow-up actions (e.g. personal contacts) and further enforcement by a Code Enforcement Officer, if necessary.

Removal of illicit connections will be completed within six months of confirmation of an illicit connection through field verification.

Continued Follow-up

Following the IDDE Project Plan, questionable outfalls require continued follow up, which may include effectiveness monitoring at sites where illicit connections or discharges were found, repeat screening where low levels of pollutants were found, or additional visits by the source control specialist to verify that actions leading to an illicit discharge have ceased.

Recordkeeping

The source control specialist will inform the natural resource specialist of the results of the follow-up actions involving illicit discharge or connection abatement. The natural resource specialist will enter information into the IDDE screening database.

If the case is a suspected illicit connection, the date it was first discovered or reported will be used to track the requirement to initiate an investigation with 21 days.

After the illicit connection is confirmed, the requirement to terminate the connection within six-months will apply. If the suspected connection was identified through field observation, source control inspection, or complaint, the discovery date is the date the observation or complaint was made. If the suspected connection was identified through laboratory analysis, the discovery date is the date of the official laboratory report. Discovery dates will be recorded and tracked in the IDDE screening database.

A record is kept for every illicit connection referred to Ecology as a severe threat to human health or the environment.



Outputs

- Removal of illicit connections and reduction of illicit discharges to the MS4
- Entries in the IDDE screening database

SPILL RESPONSE

Clark County responds to spills on surfaces, such as roadways, that discharge to the MS4, surface water or groundwater, and to improper dumping into the MS4.

Purpose

The purpose is to reduce and prevent contamination of surface water, groundwater and stormwater.

Responsibilities Matrix

Task	CCPW Ops Admin.	CCPW Ops Crew Chief	CCPW Ops Road Crews	CCPW Operations OA
Open case	I	A	I	P
Spill response / clean-up	I	A	P	O
Notify Ecology	A	P	S	P
Recordkeeping	A	P	C	S

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Notification

Spill notification can arrive in a variety of ways, including detection by Public Works Operations and Maintenance roads crews or citizen complaint.

Clark County staff receiving notification of a spill will immediately notify Public Works Operations and Maintenance dispatch. Public Works Operation and Maintenance staff will then notify the Clean Water Division senior operations specialist. For spills responded to by Public Works crews, the Crew Chief will call Ecology's spill response team in the Vancouver Field office, if necessary. The Clean Water Division senior operations specialist will also be responsible for ensuring spills are reported to Ecology's 24-hour spill reporting number.

County personnel also will immediately refer significant spills to Department of Ecology

Response

Spill reports received by Public Works generate a Maintenance Management System work order, the appropriate crew responds to work order and, if necessary, they call Ecology or notify the Clean Water Division senior operations specialist who will report the spill to Ecology. For urgent complaints arriving after hours via telephone, the answering service will page the Public Works Operations and Maintenance on-call crew chief, who will determine the level of response following established Public Works guidelines.

Recordkeeping

Records of spill incidents and responses will be kept in the Public Works customer service database. If the Clean Water Division senior operations specialist responds, the spill will be recorded in the IDDE tracking database. The Public Works phone operator enters the

phoned-in spill report into the tracking system. The crew chief enters all follow-up information and closes out the work order.

Outputs

- Spill clean-up
- Records of incidents responses

WATER QUALITY PROBLEM REPORTING

Purpose

Clark County advertises Ecology's spill response hotline as a water quality complaint line. The line gives citizens an opportunity to report spills, dumping and other water quality concerns at any time. The Clark County webpage also includes a web-form to report a spill or environmental problem in the home page "How do I" tab. The webpage includes contacts for non-emergency concerns and has phone numbers for emergencies and spill reporting at: www.clark.wa.gov/public-works/report-stormwater-erosion-or-drainage-concerns.

Responsibilities Matrix

Task	CCPW Ops Admin.	CCPW Ops OA	CCPW Answering Service	CWD Code Enforcement Officer	Public Health	CCPW CWD Source Control Specialist
Take calls during business hours	A	P	O	P	P	P
Take calls after hours	A	I	P	O	O	O
Receive web comment form via email	A	P	I	O	O	P
Referral	A	P	P	P	P	P
Log calls in database	A	P	O	P	O	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Complaint and Referral

Complaints arriving on the Public Works 24-hour line are logged to the Public Works customer service database by Public Works office assistants. Incidents are generally routed to the Public Works source control specialist or Department of Ecology, depending upon the nature of the incident.

Web form comments, at site noted above, are sent via email to the Clean Water Division who directs the report to the appropriate response staff as per phone call protocols.

Water quality complaints are also received by other agencies or county departments including Ecology, Clark County Code Enforcement and Clark County Public Health.

Response to complaints is described under Water Quality Complaint Investigation.

Outputs

- Report of number of calls and emails to the general customer service line
- Water quality complaint response report records

TASK CHECKLIST

STATUS	TASK
ONGOING	Continue implementing on-going program to prevent, identify and respond to illicit connections and illicit discharges
ONGOING	Screen an annual average of 12% of MS4
ONGOING	Procedures for addressing pollutants entering MS4 from interconnected MS4s
ONGOING	Staff training
ONGOING	Implement procedures to respond to spills
ONGOING	Operate a water quality citizen complaint line
ONGOING	Revise program to include new Ecology guideance

For more information on the program to detect and eliminate illicit connections and discharges to the MS4:

Rod Swanson, Clean Water Division NPDES Permit Manager, 564-397-4581
Rod.Swanson@clark.wa.gov

Section 5 – Expanding and Improving the Stormwater Management Infrastructure

As county population and development increase, the primary means of controlling runoff from areas of new growth and for fixing problems caused by uncontrolled runoff from existing developed areas is by expanding and improving the existing stormwater management infrastructure.

In Clark County, stormwater management infrastructure is expanded in two ways:

COUNTY STORMWATER CAPITAL IMPROVEMENT PROJECTS

The county has a program to plan and construct new stormwater infrastructure and improve existing infrastructure to better control and treat runoff from areas where existing development does not include adequate stormwater controls. This addresses the permit requirement to mitigate for stormwater impacts from existing development.

REGULATION OF DEVELOPMENT, REDEVELOPMENT AND CONSTRUCTION PROJECTS

Private entities and government agencies develop the land, and the county regulates the design and construction of stormwater controls on it, many of which eventually become part of the county's own stormwater infrastructure.

The process for each of these types of projects is described below.



Roadway flooding during winter storm, 2007

COUNTY STORMWATER CAPITAL IMPROVEMENTS

Past stormwater management and drainage practices and development regulations have proven inadequate to prevent impacts of runoff on surface water, and thousands of developed acres in Clark County contribute to problems in streams, lakes and rivers. Accordingly, the county has a program to construct stormwater capital improvements primarily to control and treat stormwater from areas of existing development with inadequate stormwater controls. In addition, the county may take opportunities to expand the treatment and flow control capacity of existing facilities when making repairs. These activities all are part of the county's stormwater capital improvement program.



REGULATORY REQUIREMENTS SUMMARY

NPDES Permit – S5.C.7. Structural Stormwater Controls

The NPDES permit requires the county to implement a structural stormwater controls program to prevent or reduce impacts to waters of the state caused by discharges from the MS4. The program considers projects including new flow control facilities, new water quality treatment facilities, retrofits of existing facilities, property acquisition and maintenance with capital construction costs greater than $25,000 to provide water quality or flow control benefits. Other means to reduce impacts are also considered, including riparian habitat acquisition, restoration of forest in upland areas and in riparian buffers, and floodplain reconnection projects. Small-scale projects that are not planned in advance may also be included in meeting this requirement.

The SWMP must include a list of planned individual projects updated in each annual report to the state.

In 2020, Public Works Clean Water Division will update its stormwater capital plan for the 2021 to 2026 period.

The description of the structural stormwater control program in the SWMP must include the program's goals and the planning process, including budget and public involvement. A table describing the 2020-2025 capital projects is included in the 2020-2025 Stormwater Capital Plan. The capital plan will be included in the March 2020 annual report.

It includes a detailed program description and can be found at: https://www.clark.wa.gov/sites/default/files/dept/files/public-works/Stormwater/Capital_Projects/Stormwater%20Capital%20Plan%202019-2024%20FINAL.pdf

Chapter 173-218 WAC – Underground Injection Control (UIC) Program

Pursuant to Chapter 90.48 RCW, the state's requirements for stormwater infiltration wells may result in capital improvements associated with county systems that are found to pose a threat to groundwater.

COUNTY POLICIES, RULES AND REGULATIONS

The Clean Water Division has the following policies for county stormwater capital improvements:

- Meet NPDES Permit requirements for the structural stormwater control program through stormwater capital planning and capital construction.
- County goals for stormwater capital improvements include:
- Protect and enhance streams and wetlands in Clark County through planning and constructing modifications to the stormwater infrastructure.
- Minimize the degradation of receiving waters from impacts attributable to stormwater runoff in existing developed areas.
- Maximize public benefits of county-owned land by providing multiple uses, including recreation, and by leveraging funding from multiple sources.

GUIDING PRINCIPLES

In support of county policies and goals, the capital planning process strives to:

- Prioritize projects with the greatest potential to support multiple county programs and goals, including local and regional fish recovery, habitat enhancement, and water cleanup goals.
- Ensure a reliable scientific and engineering basis for projects.
- Establish that each project in the plan is needed, feasible and cost-effective.
- Focus limited resources on the most pressing concerns and the most cost-beneficial solutions.
- Incorporate environmental benefits into needed infrastructure repair projects.
- Maintain a sufficient list of potential projects to enable replacement of any projects found to be infeasible and to take advantage of funding opportunities.
- Utilize partnerships, where feasible, to meet multiple community goals.

As-Built Plan Preparation

Clark County Public Works follows a management practice for the production of record drawings at the final acceptance of a public capital project.

STORMWATER CAPITAL PLANNING

Purpose

Planning ensures that stormwater capital improvements meet the county's goals.

Capital planning is a process for identifying potential projects, deciding if they are feasible, selecting the best for further development, and tracking their progress from inception through construction. The stormwater capital plan will

list projects scheduled for implementation on a six-year horizon.

- The proposed projects are considered to comply with requirements under Permit Condition S5.C.7.
- Projects reflect what Clark County is best able to implement within its available funding and demands for structural control projects.
- Projects address stormwater impacts not adequately controlled by other permit-required actions, chiefly those caused by uncontrolled or untreated runoff from existing development, and habitat degradation that has already occurred.

By complying with permit condition S5.C.7, together with all of the remaining other permit requirements; Clark County complies with MEP and AKART as set forth in the county's NPDES Municipal Stormwater Permit condition S4.E.

Clark County applied lessons learned from its 2013 permit work on the Whipple Creek watershed-scale plan to its stormwater capital planning program. A key finding was that it is infeasible to restore forested stream hydrology in basins where LID is infeasible. This led to a subwatershed scale review of Vancouver UGA subwatershed to identify areas where detention retrofit projects should be avoided.

Clean Water plans to lead a process in 2020 to develop the next 6-year stormwater capital program covering 2021-2026.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Eng.	CCPW Eng. Program Mgr.	CCPW Eng. Program Staff	Council	CCPW Director
Accept referrals	A/P	P/S	O	O	O	O
ID potential projects	A/P	P/S	O	S	O	O
Database entry & updates	A/P	P/S	O	O	O	O
List of potential projects	A/P	P/S	I	C	O	O
Formulate selection criteria	A	P	I	S	C	C
Apply selection criteria	A	P	C	S	O	C
Scoping and Selection	A	P	O	S	O	I
Six-year capital plan	A	P	C	S	C	C

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Referrals

Project ideas may be referred to the Clean Water Division from several sources, including field work completed by the Assessment and Monitoring Section, CWD engineer review of watershed plans and water quality reports, problems identified by Road Operations crews and projects suggested by the public.

Referrals can arrive continuously throughout the year.

Project Tracking / Capital Planning Database

CWD infrastructure manager will enter potential capital projects selected for further consideration into the *Capital Planning Database* as they are evaluated.

The database tracks stormwater capital projects from inception to construction and close-out, or their status as shelved or dropped, including the following attributes:

- Project category/type.
- Description and basis of the project and the problem being addressed.
- Estimated project benefits including flow control, pollutant load reduction, habitat enhancements and other environmental benefits.
- Status of preliminary engineering and construction.
- Funding summary.
- Types of potential environmental impacts, including wetland, priority habitat, cultural resource, floodplain impacts, etc.

As projects advance and more information is developed, CWD infrastructure manager will update the database with new details on a regular basis.

Project Identification

Stormwater capital projects typically originate from systematic capital planning efforts, routine stormwater facility inspections, observations by maintenance crews, or evaluation of underground injection control wells.

Clean Water completed significant county-wide project identification and screening efforts between 2006 and 2011 under the Stormwater Needs Assessment Program (SNAP). The program identified many potential project opportunities, which formed the basis for much of the stormwater capital plan through 2018. During that time, most priority opportunities identified through the SNAP have either been constructed or were found to be infeasible. The remaining potentially viable projects from the SNAP effort are being re-evaluated in light of updated priorities during sub-basin retrofit studies.

Sub-basin retrofit studies follow up on earlier stream assessments, refining county efforts to plan and build stormwater controls that meet permit requirements and reduce pollutant discharges to receiving waters. The process for sub-basin retrofit studies was developed in 2018 and first applied to Cougar and Suds Creeks in the Salmon Creek watershed. Additional high-priority drainages will be evaluated beginning in 2019.

Studies identify an array of projects that will improve stream conditions, applying consistent objectives and specific project types tailored to the goals for each sub-basin. The process incorporates information from multiple county capital efforts and is intended to promote collaboration between county programs.

The studies apply a series of tools to identify projects, including a series of project area maps depicting existing conditions and needs, long-plots of high traffic roadway corridors, stormwater outfall verification, review of underutilized and county lands, headwater wetland project assessment, right-of-way retrofitting assessment, and channel/floodplain restoration project assessment.

Results are managed in a series of project maps and spreadsheets, and highly-rated projects are promoted to the Capital Planning Database for possible inclusion in the 6-year Stormwater Capital Plan.

A Project Identification Worksheet is first compiled, identifying purpose and level of need (1-5) for each identified project and performing a preliminary high-level verification. The end result is a list of all identified projects shown in three categories: viable; needs more information, or; rejected.

Project Verification

Viable projects from the identification spreadsheet are run through a more detailed verification process in a second spreadsheet called the Project Verification Worksheet.

The primary verification checks are based on detailed Technical Information Report maps automatically generated for each project. These maps inform project verification with current information and also identify whether additional field visits are necessary to perform verification. The end result is a list of projects shown in three categories: verified; additional field information needed, or; rejected.

Verified projects with a need level of 1, 2, or 3 are carried over into the database for consideration in the 6-year plan.

Programming Projects

Programming applies regulatory requirements and available funding to the list of scoped projects to develop a six-year program matrix that can meet Permit requirements and program goals. Permit requirements for structural stormwater controls are stated in the 2019 permit as a number of “retrofit incentive points”.,. Where specific projects have not yet been identified for implementation, placeholder values for projected spending are included in the matrix as ongoing programs.

Funding

The anticipated budget for the 2020-2025 plan is approximately $13.8 million. Completion of these projects is dependent on funding through the Clean Water Fee, Road Fund, Conservation Futures Fund and grants.

Outputs

- Database entries of potential and scoped projects and detailed project attributes for consideration in subsequent years
- Submittal of NPDES permit report Appendix 12
- Six-year capital plan with funding allocation



Construction of the Thomas Wetland East Stormwater Facility

CAPITAL PROJECT CONSTRUCTION PROGRAM

Purpose

The construction program is the engine for designing, permitting and building stormwater capital projects. The Public Works Engineering and Construction Division leads the effort through established project management systems.

The Public Works Engineering and Construction Division designs and oversees construction of all types of capital improvement projects, including county stormwater projects. Their services include project management, survey, property acquisition, engineering and construction management.

The program is responsible for the advancement of stormwater capital projects from the Stormwater Capital Plan to construction. The responsibilities and procedures for this program are briefly reviewed below.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Eng.	CCPW Enhance. and Permitting Mgr.	CCPW Env. Permitting Mgr.	CCPW Eng. Program Mgr.	CCPW Eng. Project Mgmt. Mgr.	CCPW Eng. Project Mgr.	CCPW Eng. Program Engs	CCPW Eng. Construction Mgr.	CCPW Eng. Construction Mgmt. Staff	CCPW Comm. Specialist Sr.
Assign Project Team	I	I	S	S	A	P	S	S	S	S	O
Schedule and Budget	S	S	S	S	A	C	P	S	S	S	I
Preliminary Engineering	I	O	O	O	A	S	S	P	O	O	O
Permitting	I	O	A	P	I	O	I	C	C	O	O
Construction Management	I	I	I	C	I	S	S	C	A	P	O
Public Outreach	S	O	I	I	I	S	I	O	O	O	A/P
Project Close Out	I	S	I	C	A	I	P	C	C	C	I
Update Capital Planning Database	A/P	S	O	O	O	O	O	O	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Team, Schedule and Budget

The manager of the Project Management section will assign a team of professionals, led by a project manager.

The project manager, with the help of the team, will develop a detailed scope, schedule and budget for his/her assigned projects. The project manager will monitor each item closely throughout the life of each project.

Preliminary Engineering and Environmental Permitting

Public Works engineers will create engineering plans, design specifications and cost estimates for each project in the plan. Public Works Permitting Coordinators will guide each project through local, state and federal permitting processes.

As projects near completion of engineering design, the Engineering Program manager, in consultation with the Clean Water Infrastructure manager, will make the final decision to advance selected projects to construction.



Encore Stormwater Facility Retrofit

Bid

The project manager will coordinate with the Clean Water Division Infrastructure Manager and the team to prepare and execute a project bid schedule.

Construction Management

The Public Works Engineering Program Construction Management team will review bids and prepare an award recommendation for the Clark County Council.
Once the contract is awarded, Construction Management will administer it and oversee construction.

As a project reaches completion, the construction manager will send a copy of the letter of physical completion to the Clean Water Division and Public Works Operations and Maintenance program. The Clean Water Division also will be copied on the letter of final acceptance.

Receipt of the physical completion and final acceptance letters by the Clean Water Division will initiate stormwater inventory tasks. Receipt of the final acceptance letter by Operations will initiate maintenance and operations tasks.

Public Outreach

The Public Works Public Information Officer will coordinate outreach about the project including news releases, information on the Public Works website and signage.

Close Out

The project manager and construction manager will coordinate preparation of close out documents, including final expenditures.

CWD engineers will update the Capital Planning Database with metrics from the final report.

Construction Management will oversee the production of record drawings, and Survey staff will notify the Clean Water Division of their location. The receipt of record drawings by Clean Water Division will initiate tasks to verify the stormwater infrastructure inventory.

Outputs

- Project plans, specifications and estimates
- Completed stormwater capital projects
- As-built drawings (record drawings)
- Final expenditures and metrics for each project

TASK CHECKLIST

STATUS	TASK
ONGOING	Implement structural stormwater controls program
ONGOING	Stormwater capital planning
ONGOING	Annual reporting on capital projects
ONGOING	Update structural stormwater controls projects
ONGOING	Update Stormwater Capital Plan
ONGOING	Annual reporting on capital projects

For more information on planning and building county stormwater infrastructure:

Jeff Schnabel, Clean Water Division Infrastructure Manager,
564-397-4583
Jeff.Schnabel@clark.wa.gov

Regulatory Program for Development, Redevelopment and Construction Projects

The county is the local land use regulator. As such, the NPDES Permit requires the county to regulate the discharge of runoff from new development, redevelopment and construction activities in the county.

In 2013, the county began a project to update its regulations in response to the newly issued 2013-2018 NPDES Permit. During 2015, Clark County completed the equivalent code and manual adoption and implementation under the schedule prescribed by the Permit.

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.5.a & b. – Controlling Runoff from New Development, Redevelopment and Construction Sites

The NPDES Permit requires the county to have a program to prevent and control the impacts of runoff from new development, redevelopment and construction activities. The program applies to all development activity, including private-sector development and county projects such as roads and parks. The program enforces development regulations that provide protection equivalent to the minimum requirements, thresholds and definitions in Appendix 1 of the NPDES Phase I stormwater permit and design standards equivalent to the December 2014 version of the *Stormwater Management Manual for Western Washington.* The program also revised code and manuals to make low impact development the standard approach for stormwater management. .

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code 40.386 – Stormwater and Erosion Control

Clark County regulates stormwater runoff and erosion control on development, redevelopment and construction sites primarily in Chapter 40.386 Stormwater and Erosion Control. The purpose of the code is to safeguard public health, safety and welfare by protecting the quality of surface water and groundwater for drinking water supply, recreation, fishing and other beneficial uses through the application of best management practices (BMPs) for stormwater management and erosion control. It was adopted to minimize the degradation of receiving waters from impacts attributable to stormwater runoff, thereby not precluding the preservation of future restoration of beneficial uses.

The regulations generally apply to all development and construction projects, including county roads and parks that

have complete development applications after January 7, 2016, whether or not they discharge to county storm sewers or to waters of the state. A notable exception is construction of buildings and impervious area for agricultural activity, which is only regulated under the stormwater and erosion control code if projects discharge directly or indirectly to the county storm sewer system.

Clark County Code 40.385 40 – Stormwater and Erosion Control

For development, redevelopment and construction sites with a complete application before January 8, 2016, Clark County regulates stormwater runoff and erosion control under Chapter 40.385 Stormwater and Erosion Control (Clark County Code). Although this code has been superseded by Chapter 40.386 it remains in effect for the few projects that remain vested under it.

Clark County Code 13.26A – Water Quality

Clark County regulates the discharge of contaminants to surface water, stormwater and groundwater to protect the county's surface and groundwater quality by providing minimum requirements for reducing and controlling the discharge of contaminants and stormwater flows. It requires certain sites and activities to utilize best management practices to control release of contaminants.

For purposes of regulating development activities, the Chapter applies to those limited projects that only trigger Minimum Requirement 3 of the *Clark County Stormwater Manual 2015*. Source control requirements are *in Book 3 of the Clark County Stormwater Manual 2015*. Stormwater facility maintenance requirements for development and redevelopment projects are in *Clark County Stormwater Manual 2015 Book 4*.

Clark County Code 40.430 – Geologic Hazard Areas

Geohazard code identifies sites where geologic concerns such as excessive erosion and steep slopes are coincident in preparation of erosion control and stormwater site plans.

Clark County Stormwater Manual

The *2015 Clark County Stormwater Manual* is the technical standards that project proponents follow to meet the minimum requirements of the 2013 Permit and meet county stormwater management requirements for development and construction projects in the county. The manual contains county requirements and procedures specific to Clark County and is equivalent to the 2014 SMMWW and is referenced in Permit Appendix 10.

Clark County Code 40.450 and 40.440 – Wetlands and Habitat Protection

Chapters 40.450 Wetland Protection and 40.440 Habitat Conservation regulate some stormwater discharges and the placement of treatment and control facilities in habitat and wetland buffers.

Clark County Code 40.510

Applications for development, redevelopment and construction require different levels of review depending on their impacts to the community, which are defined in Chapter 40.510. The levels of review are ministerial decisions (Type I), administrative decisions (Types II and II-A) and quasi-judicial decisions (Type III).

Stormwater Review and Enforcement of Development and Construction Applications

Purpose

Clark County has a system of ordinances, technical manuals, plan review, inspection and enforcement to apply the NPDES Permit minimum requirements to development, redevelopment and construction projects.

For stormwater, the purpose of the review is to determine:

- Applicability of the stormwater and erosion control minimum requirements.
- Compliance with applicable minimum requirements.
- Compliance with other county-specific stormwater requirements listed in the Clark County Stormwater Manual .

Inspection and enforcement strives to ensure that construction sites correctly and consistently use erosion control BMPs to prevent sediment-laden runoff from leaving the sites, and that permanent stormwater

BMPs for conveyance, LID, treatment and flow control are properly installed, constructed and transferred in good condition to the ultimate owners/operators with a maintenance manual for each facility.

Interdepartmental Responsibilities Summary

Responsibility for implementing the stormwater code is shared by several departments and is guided by interdepartmental MOUs. Public Works will update and maintain these agreements.

Community Development Department – Permit Services
Permit Services will accept development and construction applications and determine if applications include the required submittals. Permit Services staff review residential building permit applications and accept and review stormwater site plans for stormwater compliance and condition building permits for stormwater requirements.

Community Development Department – Building Safety
Building Safety will inspect building construction sites for compliance with erosion control, source control, preservation of natural drainage and onsite stormwater management.

Community Development Department – Development Engineering
Development Engineering staff will provide engineering review of stormwater and erosion control plans on development sites, including residential and non-residential development sites. Development Engineering staff will oversee the issuance of the plat, the final engineering as-built documents (record drawings) and the maintenance warranty, if applicable.

Public Works Department – Construction Management
Construction Management staff will inspect development sites, including county projects, for compliance with stormwater engineering plans and erosion control plans.

Public Works Department – Clean Water Division
Clean Water Division staff will support decision-making regarding interpretation of the code and manuals, providing documentation of their findings.

Public Works Department – Code Enforcement
Code Enforcement will enforce erosion control violations on development and building construction sites as needed.

Responsibilities Matrix

The review and enforcement process varies depending on complexity and scope of the project. For stormwater review purposes, projects generally can be divided into residential development projects (subdivisions), non-residential development projects, residential construction projects (individual home construction) and Public Works projects.

The matrix on next page describes responsibilities at the department and division level.

Overview of Regulatory Review and Enforcement Responsibilities

Task	CD Permit Services	CD Building Safety	CD Building Official	CCPW Code Enforcement Officer	CD Dev. Eng.	CD Dev. Eng. Mgr.	CCPW Construction Mgmt.	CCPW Construction Mgr.	CCPW CWD
Plan Review - residential construction	P/A	I	O	O	O	O	O	O	S
Inspect building construction sites	I	P	A	O	O	O	O	O	I
Engineering review - development	S	O	O	O	P	A	C	O	I
Inspect development sites	O	O	O	O	S	O	P	A	I
Inspect Public Works sites	O	O	O	O	S	O	P	A	I
Enforce erosion control	I	P	A	P	O	O	P	A	I
Maintenance warranty inspection	O	O	O	O	S	O	P	A	I
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted									

Residential Development Project Review

Residential development projects are divisions of land to create individual lots and construction of infrastructure such as roads and storm sewer. Many aspects of residential development project review will not concern stormwater; only aspects concerning stormwater are covered in this plan.

Pre-Application Phase

Applicants typically submit initial information and may meet with a planner, engineer and other pertinent staff in a Pre-application Conference (PAC) before an applicant submits a completed development application. The PAC will help determine options and likely requirements for stormwater control, among many other regulations and requirements.

Preliminary Land Division and Preliminary Engineering Review Phase

The applicant will submit an application for residential land division (subdivision or short plat) to the Permit Center along with a preliminary stormwater plan in accordance with section 1.8.1 of *Clark County Stormwater Manual - Book 1*.

Development Engineering staff will review the preliminary stormwater plan to evaluate whether the proposal for stormwater controls is feasible given existing site conditions and constraints. The engineer's Findings and Conditions of Approval will appear in the Staff Report, which will be forwarded to the applicant.

Findings describe the engineer's determination of whether or not each aspect of the stormwater proposal meets county code. Conditions of Approval list the engineer's requirements for how to meet code, in cases where the proposal does not meet it, and they must be met in the final engineering plan.

Final Engineering Review Phase

The applicant will submit final plans for the residential development, including a final stormwater plan in accordance with section 1.8.2 *of Clark County Stormwater Manual - Book 1*. The final stormwater plan will provide final engineering design (Technical Information Report) and construction drawings for the stormwater aspects of the proposed project and a *construction Stormwater Pollution Prevention Plan (SWPPP*).

Development Review engineers will:

- Ensure that the Conditions of Approval from the preliminary land division have been met.
- Verify that applicable county and NPDES permit requirements have been met.
- Review engineering calculations of stormwater flows, sizing of stormwater facilities, and sizing of conveyances.
- Verify adequacy of erosion control BMPs.
- Perform any other engineering review required for stormwater.

Responsible officials from Public Works, Community Development and Public Health will sign the final plans. The Development Engineering manager will make the final approval. Then the planning technician will return the approved plans to the applicant.

The Development Engineering office assistant will open a development inspection case in Tidemark in preparation for the next phase of the process.

Development Inspection Phase

During development inspection, the applicant will construct the development's infrastructure, including grading, roads and stormwater controls, according to the approved final plans. Public Works development inspectors will inspect the site for conformity with the plans.

The process begins when the applicant submits the final construction plan and application for development inspection.

The assigned development inspector will hold a Preconstruction Conference with the applicant. During the Preconstruction Conference, the inspector will review erosion control requirements, including requirements related to a high potential for sediment to be discharged from the site with the applicant and will receive the name of the Certified Erosion Control and Sediment Lead (CECSL) for the site. The inspector will reiterate storm system requirements and additional inspection-related policies for storm system installation. Department of Ecology state construction stormwater permit enforcement staff are also invited to each Preconstruction Conference. After the conference, the development inspector will give approval to begin constructing the project after completion of a preconstruction inspection to verify proper installation of erosion control BMPs.

During construction of the development, the development inspector will inspect the site to ensure that erosion control measures are operational and effective. The inspector will work with the developer to achieve compliance, using correction notices and stop work orders if necessary. If there is evidence of continued neglect, the inspector will call a code enforcement officer to enforce erosion control measures through citations and penalties. Referral to Ecology for enforcement under the NPDES Construction General Permit is also an option.

The development inspector also will verify that stormwater facilities are constructed as designed.

At the end of construction, the applicant will submit record drawings and a maintenance bond, if applicable, for any public improvements. (Public improvements are roads and stormwater conveyance and facilities that will fall into public ownership upon acceptance of the development.) A Development Engineering engineer will approve the record drawing and then a Development Engineering planning technician will accept the maintenance bond, if applicable.

Development Engineering staff will provide an electronic record drawing file to Public Works, and then send the Mylar plan to the state archives.

After these steps are complete, the planning technician will issue a notice of completion of construction to the applicant and copy it to several departments, including the Clean Water Division and Public Works Maintenance and Operations. The notice signals the start of the stormwater facility maintenance warranty period, if applicable (see below).

The notice of completion of construction constitutes provisional county acceptance of the public infrastructure, including public stormwater facilities. In the case of private facilities, completion of construction is the end of county involvement in construction and the regulated facility operation and maintenance inspection process will begin.

Receipt of the notice of completion of construction will initiate some stormwater mapping tasks (see Mapping the Storm Sewer Infrastructure on page 21) and some maintenance inspection tasks (see Operating and Maintaining the Storm Sewer System, County Property and Roadways on page 33).

Final Land Division Phase

The final land division will begin after the development inspection phase begins but before it ends.

The applicant will submit the final land division application and the draft plat. The plat will contain required information describing facility ownership and maintenance responsibility, stormwater tracts and drainage easements. The plat will be routed to several departments for review and approval. If there are private stormwater facilities, an HOA will be formed.

After approval of the draft plat, the applicant will submit a Mylar version that will be signed by the Planning Director, the County Engineer and the Clark County Council. Development Engineering staff then will record the final plat with the Auditor and issue a plat notification to the developer, copied to several departments, including the Clean Water Division.

Receipt of the plat notification by Clean Water Division may initiate some stormwater mapping tasks (see Mapping the Storm Sewer Infrastructure on page 21).

The final plat must be recorded before building permits for home construction will be issued for lots in the development (see Residential Construction Project Review on page 93).

Maintenance Warranty Period

Most, but not all, residential developments will have public improvements, including public stormwater infrastructure.

For residential developments with public improvements, a two-year maintenance warranty period will begin at completion of construction. During the maintenance warranty period, the developer will be responsible for continued maintenance of the stormwater facilities. During the 22nd month of the maintenance warranty, a development inspector will inspect the public stormwater facilities for compliance with maintenance standards.

If the stormwater facilities are found to be in good condition and properly maintained, the development inspector will recommend release of the maintenance bond. The Development Engineering planning technician will release the bond and notify the Clean Water Division and Public Works Maintenance and Operations.

If the facility has components that fail the maintenance inspection, the planning technician and development inspector will work with the developer to obtain needed repairs. If the developer fails to make repairs, the planning technician will demand the bond from the surety company.

After repairs are made, the Clean Water Division will update stormwater mapping tasks, if necessary (see Mapping the Storm Sewer Infrastructure on page 10), and Public Works Maintenance and Operations will initiate maintenance and operations tasks (see Operating and Maintaining the Storm Sewer System, County Property and Roadways on page 33).

Under the Clark County Stormwater Manual , private stormwater facilities will be maintained by the applicant for two years.

Non-Residential Development Project Review

Non-residential developments include commercial and industrial projects as well as schools, churches and other non-residential land uses. These projects construct infrastructure such as roads and stormwater along with the buildings. Multifamily housing projects also are reviewed using this process. Occasionally, commercial projects may also go through a land division. Many aspects of non-residential development project review will not concern stormwater and are not covered in this plan. Also, many projects do not trigger stormwater requirements because they do not add or replace a sufficient amount of impervious surface; examples include cell tower placement, sign construction and building façade replacement.

Pre-Application Phase

Applicants typically submit initial information and meet with a planner, engineer and other pertinent staff in a Pre-application Conference (PAC) before submitting a completed development application. The PAC will help determine options and tentative requirements for stormwater control, among many other regulations and requirements.

Preliminary Site Plan and Preliminary Engineering Phase

To begin the process, the applicant submits an application for preliminary site review to the Permit Center along with a preliminary stormwater plan in accordance with section 1.81. of the *Clark County Stormwater Manual Book 1*.

The assigned Development Engineering engineer will review the preliminary stormwater plan to evaluate whether the proposal for stormwater controls is feasible given the available information on existing site conditions and constraints. The engineer's Findings and Conditions of Approval will appear in the Staff Report and Decision (or Land Use Hearing Examiner Decision), which will be forwarded to the applicant.

Findings describe the engineer's determination of whether or not each aspect of the stormwater proposal meets county code. Conditions of Approval list the engineer's requirements for how to meet code, in cases where the proposal does not meet it, and they must be met in the final engineering plan.

Final Site Plan and Final Engineering Review Phase

The applicant will submit final plans for the development, including a final stormwater plan in accordance with section 1.8.2 of Clark County Stormwater Manual - Book 1. The final stormwater plan will provide final engineering design and construction drawings for the stormwater aspects of the proposed project and a construction Stormwater Pollution Prevention Plan (SWPPP).

The assigned Development Review engineer will:

- Ensure that the Conditions of Approval from the Final Decision have been met.
- Verify that applicable NPDES permit and county code minimum requirements have been met.
- Review engineering calculations of stormwater flows, sizing of stormwater facilities, and sizing of conveyances.
- Verify adequacy of erosion control BMPs.
- Perform any other engineering review required for stormwater.

Responsible officials from Public Works, Community Development and Public Health will sign the final plans. The Development Engineering manager will make the final approval. The approved plans are returned to the applicant.

Development Engineering will open a development inspection case in Tidemark in preparation for the next phase of the process.

Building Permit Review

The applicant will submit building permit applications to Permit Services. Construction of structures will be concurrent with construction of the development; therefore, most stormwater review will have already occurred.

The building permit must be issued before construction of structures may begin.

Development Inspection Phase

During development inspection, the applicant will construct the development's infrastructure, including grading, roads and stormwater controls. The project's buildings are also erected during this phase.

The process begins when the applicant submits the final construction plans and application for development inspection.



The assigned Public Works development inspector will hold a Preconstruction Conference with the applicant. The inspector will review erosion control requirements with the applicant, including requirements related to a high potential for sediment to be discharged from the site and will receive the name of the Certified Erosion Control and Sediment Lead worker (CECSL) for the site. Department of Ecology state construction stormwater permit enforcement staff are also invited to each Preconstruction Conference. The inspector will reiterate storm system requirements and additional inspection-related policies for storm system installation. After the conference, the development inspector will give approval to begin constructing the project after completion of a preconstruction inspection to verify proper installation of erosion control BMPs.

During construction, the development inspector will inspect the site as needed to ensure that erosion control measures are operational and protective. If necessary, a code enforcement officer will be called to enforce erosion control measures. If the project has a state-issued NPDES construction permit, then violations may be referred to Ecology.

The inspector also will ensure that stormwater facilities are constructed as designed.

At the end of construction, the inspector will verify that the facility was built as shown on approved design plans. The applicant will submit record drawings and, if applicable, a maintenance bond for any public improvements in the right-of-way. A Public Works engineer will review the record drawings for accuracy before approving it. After approval of the completed facilities and record drawings, a Development Engineering planning technician will accept the maintenance bond.

When a record drawing is received, Development Engineering staff will give an electronic file to Public Works and send the Mylar plan to the state archives.

The planning technician will issue the notice of completion of construction to the applicant and copy it to several county agencies, including the Clean Water Division. The notice signals the start of the maintenance warranty period, if applicable.

Receipt of the completion of construction by the Clean Water Division will initiate some stormwater mapping tasks for projects with either public or private stormwater facilities (see Mapping the Storm Sewer Infrastructure on page 21).

Maintenance Warranty Period

The maintenance warranty period is relevant for those few non-residential developments that have public stormwater infrastructure in public right-of-way. However, with increasing use of LID BMPs such as bioretention facilities in county right-of-way, they will become more common.

A two-year maintenance warranty period will begin at completion of construction. During the period, the developer will be responsible for continued maintenance of the stormwater facilities.

During the 22nd month of the warranty, a development inspector will inspect the public stormwater facilities for compliance with maintenance standards.

If the stormwater facilities are found to be in good condition and properly maintained, the development inspector will authorize release of the maintenance bond and will notify the Clean Water Division and Public Works Maintenance and Operations that the bond has been released.

Receipt of the bond release notification will initiate maintenance and operations tasks (see Operating and Maintaining the Storm Sewer System, County Property and Roadways on page 33).

If the facility has components that fail the maintenance inspection, the planning technician and development inspector will require the developer to obtain needed maintenance and repairs. If the developer fails to make repairs, the county will demand the bond from the surety company.

After repairs are made, the Clean Water Division will update stormwater mapping tasks, if necessary (see Mapping the Storm Sewer Infrastructure on page 21), and Public Works Maintenance and Operations will initiate maintenance and operations tasks (see Operating and Maintaining the Storm Sewer System, County Property and Roadways on page 33).

Under the *Clark County Stormwater Manual 2015*, all private stormwater facilities will be maintained by the applicant for two years.

Single Lot Residential Construction Project Review

Single lot residential construction projects include construction or expansion of single-family and duplex homes and their appurtenances, such as decks, garages and driveways, and outbuildings. Many aspects of residential construction project review will not concern stormwater and are not addressed here.

Building Permit Application Review – Stormwater

The applicant will submit a residential building permit application including a stormwater site plan showing proposed building footprint(s), erosion control measures and on-site stormwater control BMPs to the Permit Center. Projects triggering Minimum Requirements 1-9 are referred to Development Engineering for review.

The permit technician will review the residential building permit application to verify applicability of the minimum requirements and selection and use of allowed stormwater BMPs and erosion control BMPs. They will also check for the mapped presence of steep slopes or geo-hazard areas. If they conflict with the proposed stormwater BMPs, the applicant will be required to consult a licensed geotechnical engineer to design stormwater controls.

If the residential construction site is within an existing subdivision with an approved stormwater plan that provides flow control and treatment, then the permit technician will recommend that the applicant consult the development project's engineering plans to determine stormwater requirements, such as roof drain infiltration and amended soils, for the lot. In those cases, the permit technicians also will include requirements from the recorded plat and subdivision engineering drawings and attach them as conditions on the building permit. For projects approved under the Clark County Stormwater Manual 2015, each lot will have an engineered stormwater site plan as part of the final engineering plans.

If the residential construction site is not part of an existing subdivision with an approved stormwater plan, then applicants will follow minimum requirements applicable to their projects. If minimum requirements 1- 5 apply, the applicant can complete the stormwater plan or hire a contractor. If minimum requirements 1-9 apply, the applicant must use an engineer to complete a stormwater plan that complies with county code under an engineering review by Development Engineering.

The Permit Center will issue the building permit before construction may begin.

Construction Inspection

Before construction is allowed to begin on the site, a Building Safety Division inspector will inspect the site as part of a foundation inspection to also verify that the erosion control BMPs are properly installed and that any unusual site conditions that might lead to sediment transport off site are addressed.
All sites are required to maintain an erosion control log with an attached site plan and form that includes the required onsite stormwater management BMPs.

Public Works Project Review

Projects built by the Public Works department, including roads, parks and stormwater facilities will be reviewed by the Public Works Engineering and Design Group independently from the design team for compliance with county stormwater standards. Many Public Works projects will not require land use review, including roadways through existing right-of-way; therefore, the process will frequently begin at the final engineering review phase. Those that require land use review will begin at the preliminary site plan and preliminary engineering phase (above).

Additionally, the development inspection phase is replaced by a construction management phase. Public Works will use its own construction inspectors to oversee the construction of the project to ensure that it is built as designed and bid. Enforcement of erosion control and other measures is through contract management.

Before completion of a project, the construction engineer will invite stakeholders, including the Public Works Maintenance and Operations water quality crew chief, to a walk-through of the new roadways and/or facilities. The construction manager also will copy the Clean Water Division and the Public Works Operations and Maintenance program on the letters of physical completion and final acceptance of the project.

At the final acceptance, Public Works will develop a record drawing according to its *As-Built Plan Preparation Policy*, dated May 7, 2009.



OUTPUTS

General Outputs:

- Stormwater site plans that meet county standards
- Construction site management
- Completed projects include stormwater facilities meeting county standards
- Assigned ownership and maintenance responsibility for stormwater control facilities
- Record drawings are completed
- Completed project notifications to programs

Residential Development Project Review Outputs:

- Final Decision denying, approving, or approving with conditions the proposed development project
- Technical Information Report
- Approved final construction plan
- SWPPP
- Record drawings
- Approved final plat
- Notice of completion of construction
- Maintenance bond release letter, if applicable

Non-Residential Development Project Review Outputs:

- Final Decision denying, approving, or approving with conditions the proposed development project
- Technical Information Report
- Approved Final Site Plan
- Approved final construction plan
- SWPPP
- Record drawings
- Erosion control log
- Building plan
- Notice of completion of construction
- Maintenance bond release letter, if applicable

Residential Construction Project Review Outputs:

- Building Permit including site plan with stormwater requirements
- Erosion control plan
- Erosion control log
- Building Plans

Public Works Project Review Outputs:

- Technical Information Report
- Approved final construction plan
- Record drawings
- Completion of Construction notice
- Physical Completion letter
- Final Acceptance letter

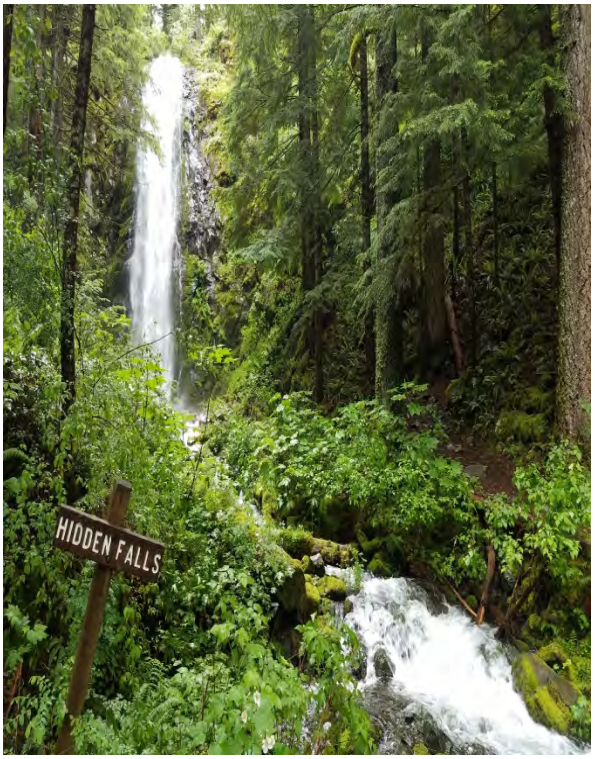
CODE AND MANUAL REVISIONS

Updates to Implement Permit Requirement S5.C.5.b and Clark County Updates The 2019 NPDES permit requires Clark County to update its development code and stormwater manual to include changes listed in permit Appendix 10, Part 2. Clark County also has a list of proposed changes to the manual and code that were developed as the manual was implemented.
Clark County Clean Water will submit the draft manual and code for Ecology review by July 1, 2020.

The adoption and implementation date is July 1, 2021.

Outputs

- Draft updates Stormwater and Erosion Control Chapter 40.386.
- Draft updates to Chapter 13.26A Water Quality.
- Draft updates to the *2015 Clark County Stormwater Manual.*
- Adopted stormwater and Erosion Control Chapter 40.386.
- Adopted Chapter 13.26A Water Quality.
- Adopted updates to the *2015 Clark County Stormwater Manual.*



TASK CHECKLIST

STATUS	TASK
ONGOING	Legal authority to require maintenance of facilities
ONGOING	NOI forms available
ONGOING	Legal authority to require maintenance of facilities
ONGOING	Procedures to implement the SMMWW
ONGOING	Staff training on SMMWW
ONGOING	Enforce stormwater regulations
2022	Complete catchment-scale stormwater plan
2021	Revise stormwater regulations for equivalent of Appendix 10

For more information on how development, redevelopment and construction sites are regulated for stormwater and erosion control:
Rod Swanson, Clean Water Division Permit Manager,
564-397-4581
Rod.Swanson@clark.wa.gov

Stormwater Planning

The 2019 added a new component for stormwater planning. The stormwater planning component has three elements:

- Establish an interdisciplinary team
- Coordination of stormwater activities with other long-range planning
- LID code review
- Stormwater Management Action Planning (SMAP)

Each element is described separately in the following pages.

Regulatory Requirement

NPDES phase I permit requirement S5.C.6. a-d.
Establish an interdisciplinary team
Clark County Clean Water will establish a team consisting of staff from:

- Public Works Engineering and Construction Division
- Public Works Clean Water Division
- Community Planning
- Community Development

Schedule

This task will take place during 2020 and be completed by July 31, 2020.

Outputs

- Meeting records
- List of team members

Long-Range Planning Coordination

Purpose

The long-range planning coordination is intended to create a report describing how stormwater management needs and receiving water health are informing comprehensive land use planning under GMA and any other county long-range land use planning efforts. Other efforts include Regional Transportation Council planning, Clark County transportation planning, Clark County Parks planning and Legacy Lands planning. Stormwater planning efforts include the Whipple Creek study and Stormwater Structural Controls planning under the permit.

Planning Document Review

The NPDES permit manager and Clean Water infrastructure manager will meet with to discuss how their plans consider stormwater. The planning mandates and goals will be listed and their relationship to stormwater management and receiving water protection will be documented.

The required report should address all of the questions in Appendix 3 regarding planning coordination.

Schedule

The planning coordination report can be completed and submitted any time up to the March 31, 2022 annual report submittal for calendar year 2021.

Outputs

- Long-range planning coordination report

Annual LID Barrier Assessment

Purpose

The permit goal is to make LID the preferred approach to site development. This task will annually document any newly discovered barriers to LID development.

LID Barrier Review

The NPDES permit manager in collaboration with staff from CD Development Engineering, CD Building Safety, and Permit Center, and PW

Construction Management will review current status of LID implementation and identify any current barriers. The LID barrier review from the 2013 permit will be reviewed to assess if there are remaining barriers from that code review.

The review should produce a document suitable to address the questions in Appendix 3 with each reporting year after 2019.

Schedule

This effort will be completed each year starting in 2020.

Outputs

- Meeting notes or other documentation from staff review
- Short report to support annual report question response

Stormwater Management Action Planning (SMAP)

The SMAP is a detailed plan considering all options for managing land use and stormwater with a to meet specific objectives for receiving water health. The permit references the August 1, 2019 SMAP guidance document as containing the required SMAP content.

Purpose

The SMAP requirement is intended to be an extension of the stormwater planning required by the 2013 permit. This includes describing the describing how the Whipple Creek plan informs stormwater structural control project selection and a sub-basin catchment for completing the SMAP. At this writing, Clark County is planning to select a catchment in a sub-basin other than Whipple Creek based on the results of that study.

Sub-basin Prioritization and Selection

Clark County is fairly certain that it will select a catchment outside of Whipple Creek for the SMAP. The Whipple Creek study found that the level of existing rural and urban development, coupled with basin geology making LID BMPs largely infeasible suggested the management goal of restoring forested hydrology was unattainable. Also, there is very little salmon habitat or use in Whipple Creek due to poor water quality conditions, lack of gravel channel beds and significant migration barriers in the main stem and tributaries.

Lessons from the Whipple Creek Study

Clark County found that areas where LID was infeasible are impossible to use flow control BMPs to restore healthy, or forested stream flows. Instead the study suggested the much cheaper option of projects to add channel complexity and reconnect flood plains to manage higher storm flows. This led Clean Water to evaluate streams in the urban area for flow control retrofit suitability. The evaluation found that almost none of the Vancouver UGA streams are suitable for flow control retrofits using detention ponds. This led to a focus on water quality retrofits for high traffic areas and promotion of infiltration retrofits where condition permit.

Catchment Selection/Sub-basin Prioritization

If Clean Water selects a Whipple Creek catchment for SMAP work, it will likely be one of a few on the fringes of the Vancouver UGA. The tributary with headwaters in the Clark County Fairgrounds area might be a likely option due to the relatively low traffic and the large amount of county land and effective impervious area on that land.

If Clark County opts to select a sub-basin other than Whipple Creek for the SMAP catchment, the permit referenced SMAP guidance will be used to plan and complete the prioritization steps. Clean Water will mainly use existing data and reports as the principle tools to complete the analysis. Examples include steam health data, the detention facility retrofit suitability report, ESA priorities, inventoried fish use, RTC traffic model vehicle trip density, percent urban and rural area, presence of state highways, and basin hydrogeologic setting. Clean Water will consult with WDFW and the LCFRB.

SMAP

Clean Water will use the SMAP guidance as a tool to create the permit-required report. A project plan is not yet completed.

TASK CHECKLIST

STATUS	TASK
Completed	Describe how Whipple Creek planning is used for SSC planning)
2020	Sub-basin prioritization and catchment selection
2022	Complete SMAP report

For more information on how development, redevelopment and construction sites are regulated for stormwater and erosion control:
Rod Swanson, Clean Water Division Permit Manager, 564-397-4581
Rod.Swanson@clark.wa.gov

Section 6 – Public Involvement, Education and Outreach

Clark County provides ongoing opportunities for the public to review and comment on the stormwater management program through various mechanisms. Public input is one way to tailor policy within the guidelines of the NPDES permit. The county also offers numerous stormwater education opportunities for the public. The education program is aimed at various audiences and is designed to help raise awareness to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts.

Public Information, Involvement and Participation (S5.C.4)

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C. 4 Public Involvement and Participation

The NPDES permit requires the county to provide ongoing opportunities for public involvement in the stormwater management program development and implementation. The public must have opportunities to participate in the development, implementation and update of the *Stormwater Management Plan* and the county must consider public comments on it. The SWMP, annual report and other submittals required by the permit must be posted on the Clean Water Division's website.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 13.30A.040 Clean Water Commission

County Code Chapter 13.30A.040 defines the role of the Clark County Clean Water Commission (CWC), a citizen commission formed to advise the Clark County Council. The CWC will advise the Council on the focus of the SWMP, the effectiveness of the SWMP, program service levels, financing, policies on surface and stormwater issues, and citizen outreach.

PUBLIC INFORMATION

Purpose

The Clean Water Division provides information to the public about the stormwater management program to publicize the program's services to rate payers and keep the community abreast of current stormwater management issues at: www.clark.wa.gov/stormwater.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW CWD Program Coordinator	CCPW CWD Outreach Specialist	CCPW CWD Professional Staff
Provide content	A	I	I	P	P
Web updates	I	C	S	P	S
Write media releases	S	A	S	P	S
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted					

Clean Water Division Website

Clark County Public Works Clean Water Division's website offers an opportunity for the public to review program activities, services and documents, as well as receive educational messages about stormwater. The website address is: www.clark.wa.gov/stormwater. Older technical reports and information formerly on the web are available to the public upon request.



Media Releases

The Clean Water Division releases information on various topics to the media to publicize noteworthy events. The Clean Water Division manager will call for a media release on timely matters. The Outreach Specialist will write the release with the support of the Public Works Public Information Officer. Releases will be reviewed, edited and distributed to the media by the Communications Office.

Outputs

- Content on CWD website
- Media releases

PUBLIC INVOLVEMENT AND PARTICIPATION

Purpose

The purpose of involving the public in the SWMP is to make an effort to tailor the program, while considering the prescriptive nature of the permit, to the local community's priorities. Public feedback about program effectiveness and the public's needs also helps the Clark County Council set policies for stormwater management.

Responsibilities Matrix

Task	Council	CCPW CWD Mgr.	CCPW CWD Outreach Specialist	CCPW CWD NPDES Permit Mgr.	CCPW CWD OA	CCPW CWD Program Asst.	CCPW Enhance. and Permitting Mgr.	CCPW Enviro. Permitting Coordinator
Appoint Clean Water Commission	A / P	I	I	I	I	S	O	O
CWC liaison	C	A	S	S	S	P	O	O
CWC secretary	O	A	S	O	S	P	O	O
Respond to SWMP public comments	I	A	S	P	I	I	O	O
Respond to SEPA comments for stormwater capital projects	I	I	O	O	O	S	A	P
Community presentations	I	A	P	S	S	S	O	O
Other code update coordination	I	A	responsibilities assigned as needed				O	O
Customer service adaptive management	I	A	any CWD staff may be primary in his/her area				O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Clean Water Commission

The Clean Water Commission (CWC) is a nine-member advisory panel appointed by the County Manager and confirmed by the Clark County Council. It provides a forum for public participation in the stormwater management program and also informs the Council about stormwater topics and policy recommendations.

Staff Support

Clean Water Division staff support the CWC in a variety of ways. A program assistant is the primary staff liaison to the CWC. The liaison will attend each meeting to take notes, distribute meeting materials, provide minimal facilitation when required, and respond to requests for information from CWC members. The CWC webpages will be updated with current commission member information and

terms, agendas, meeting summary notes and audio files, as well as any handouts.
Other Clean Water Division staff members may attend meetings, as required, to present updates on program activities or documents.

Member Appointments
Public notice of openings on the CWC will be listed in a news release issued by the Communications Office. Interested applicants, including incumbents seeking another term, must submit a letter of interest and a resume to the Clean Water Division manager. Clean Water Division staff and Clean Water Commissioners will conduct interviews and select candidates to fill vacant positions. Selected candidates are recommended to the County Manager for approval and submitted to the Clark County Council for confirmation.

Public Meetings
The CWC will hold a minimum of six public meetings each year, every other month starting in January. Meetings are held on the first Wednesday of the month at 6:30 pm in the Public Service Center, 1300 Franklin St., Vancouver, Washington. Public notice of meetings are issued in the county paper of record (The Columbian) the Sunday prior to the meeting date, as well in The Camas-Washougal Post-Record (east county) and The Reflector (north county).

Discussion topics will include updates from staff on the stormwater management program, education and outreach activities, surface water / stormwater monitoring, capital project planning and regulatory changes.

At meetings, the CWC will review and discuss major stormwater policy recommendations. All meetings will be documented with a meeting summary (.pdf file) and an audio recording (.mp3 file). The meeting documentation will be available on the CWC webpage.

The CWC will hear public comment at the meeting.

Communications with Clark County Council
Each year, the CWC will provide an annual report to the County Manager and Clark County Council in a public meeting during the first quarter of the year. The annual report should summarize CWC discussions, actions and recommendations from the previous year, as well as include a work plan for the upcoming year.

The CWC may elect to communicate with the Council at any time via letter, memorandum, or during scheduled public comment periods at Council Work Sessions and Hearings.

Stormwater Management Plan Review and Input

Clark County places its *Stormwater Management Plan ea*ch year on the Clean Water Division website for review and comment by the public at: www.clark.wa.gov/public-works/clark-county-stormwater-management-plan.

The Clean Water Division manager or a designee will respond to comments.

Stormwater Capital Projects SEPA

As the Clean Water Division builds stormwater capital projects (see County Stormwater Capital Projects on page 54), each project will be subject to public review and comment under the Washington State Environmental Policy Act (SEPA).

The CCPW Public Works Environmental Permitting coordinator assigned to the project will write and distribute to stakeholders a

Determination of Significance or a Determination of Non-Significance. The required public comment period will be held. The coordinator will respond to any comments received, and if warranted, require changes to the project's design.

Each capital project may also include a package of outreach materials to inform potentially impacted citizens and stakeholders of the project. Typical products include a "Heads-upp" notice to citizens in the immediate project area, a detailed project letter to adjacent property owners (describing project timeline and potential impacts), a project sign at the construction site and informational fliers. Materials may also be posted on the CWD stormwater capital project webpage.

Community Presentations

As requested, Clean Water Division staff will provide information on the program's activities to community, neighborhood and civic groups, at times in concert with the Clean Water Commission, to distribute information about the stormwater management program and get feedback on community priorities. A program power point is available for presentations.

Code Updates

Code revisions for water quality, stormwater and erosion control and Clean Water Fee regulations require extensive public outreach, review and comment, which will be coordinated by the Clean Water Division.

Per the 2013-2019 NPDES Municipal Stormwater Permit, a public outreach plan was developed to inform the public about stormwater code and manual updates. Any code updates utilize a variety of outreach strategies including emails to internal and external stakeholders, as well as website updates.

Customer Service / Adaptive Management

The Clean Water Division and its designees maintain regular contact with the public through daily programmatic activities such as customer service for the Clean Water Fee, source control inspections (Section 4), inspections of regulated stormwater control facilities at businesses and subdivisions (Section 3), information requests, social media and complaint response. Staff receives feedback during these contacts and frequently incorporates suggestions into their daily procedures and processes.

For example, as a result of public feedback, the Clean Water Division provides a program to educate residential subdivision homeowners associations about proper maintenance of their stormwater facilities at: www.stormwaterpartners.com/facilities.

Outputs

- Clean Water Commission notes including public comments
- Clean Water Commission Annual Report to the County Manager and Clark County Council
- Log of public comments on the Stormwater Management Program
- Log of public comments from community presentations
- SEPA file for each stormwater capital project
- Media releases
- Email updates
- Web content

TASK CHECKLIST

STATUS	TASK
ONGOING	Create opportunities to the public, including overburdened communities, to participate in the decision-making process involving the development, implementation and update of the SWMP
ONGOING	Implement processes to involve public in the SWMP
ONGOING	Display SWMP and other NPDES submittals on the website
ONGOING	Continue ongoing outreach programs
2020	Conduct an evaluation of the effectiveness of ongoing behavior change program
2021	Develop behavior change campaign and program evaluation plan
2024	Evaluate and report on behavior change campaign

For more information on efforts to inform and involve the public in the stormwater management program:

Greg Shafer, Interim Clean Water Division Manager
564.397.4064
greg.shafer@clark.wa.gov

Education and Outreach Program (S5.C.10)

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.10 Education and Outreach Program

The NPDES permit requires the county to have an educational program to raise general awareness and effect behavior change to reduce or eliminate stormwater pollution. The Clean Water Division also provides stewardship opportunities to encourage residents to participate in stormwater related activities.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 13.26A.005 Education and Technical Assistance

County Code Section 13.26A.005 describes the use of education and technical assistance to business owners and the general public as a primary means of implementing a successful pollution source control and prevention program.

Clark County Code Chapter 13.30A.050(D) Clean Water Fee Reduction Program for Schools

Section 13.30A.050(D) describes the Clean Water Fee program including the need and uses for the fee. It states that "many of the difficulties in managing of surface and stormwater problems result in part from the general lack of public knowledge about the relationship between human actions and surface and stormwater management. In order to achieve a comprehensive approach to surface and stormwater management, the county should provide general information to the public about land use and human activities that affect surface and stormwater management."

The code identifies schools as playing an important role for achieving this goal, and allows a program for schools to reduce their Clean Water Fees for providing activities that further this effort. Schools meeting four tasks including stormwater BMP training for staff, passing stormwater facility inspections, implementing educational activities related to stormwater, and disseminating stormwater messages to the broader school community, will receive a reduction in their Clean Water Fees.

EDUCATION FOR THE GENERAL PUBLIC

Purpose

The goal of the stormwater education and outreach program is to build general awareness and influence behavior changes that adversely impact stormwater. The support and awareness of the general public is crucial to achieving this goal. Education for the general public will focus on the following topics:

- Importance of clean water for local waterways.
- General impacts of stormwater flows into surface waters, including watershed management.
- Impacts from impervious surfaces.
- How people contribute to the problem through daily activities.
- Each person's ability to help protect and improve the quality of Clark County's water resources through source control BMPs and environmental stewardship.
- Low impact development principles and practices.
- General information about water quality and stream health.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW CWD Program coordinator	CCPW CWD Outreach Specialist	Partner Agencies / Contractors
Coordinate education programs	A	C	P	P	C
Track and measure deliverables	A	C	P	P	S
Create messages, programs and collateral	A	C	P	P	P
Distribute messages and collateral	A	C	P	P	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Canines for Clean Water

The Canines for Clean Water program provides information to dog owners about proper management and disposal of pet waste. The program's webpage provides educational information, directions for properly managing and disposing of pet waste, and a pledge for dog owners to pick up after their dogs.

An outreach specialist will oversee the program and complete the majority of the tasks including receiving pledges, mailing materials, keeping program materials up to date, having a table at events, and coordinating with local partners to share the message.





The program webpage also provides information for community members to work in their neighborhood to support pet waste pick-up. Signs are available to place in yards and common pet walking areas.

Public Works also partners with Community Development to educate the public on the need to pick up pet waste (stormwater protection and solid waste management issues) through the promotion of the Pet Waste Scoop code. Informational fliers are sent out in every pet license update notification.

Green Neighbors Program

Clark County launched the Green Neighbors program in 2012. Promoting sustainable practices (including stormwater pollution prevention) to homeowners via their webpage www.clarkgreenneighbors.org, the program also hosts workshops and other educational events. The program is administered within the Public Health Department, in partnership with Public Works, to provide timely messaging of upcoming events and activities, including a community event calendar.

Website

The Clean Water Division maintains a website at www.clark.wa.gov/stormwater, as well as specific program webpages, that showcases information about stormwater pollution and prevention techniques aimed at all audiences. The site contains information on endangered species at www.clark.wa.gov/public-works/endangered-species-act , with multiple links to additional resources on endangered species.

A webpage dedicated to "What you can do for clean water" includes educational information and stewardship opportunities for home projects, community projects, schools, businesses and property managers.

The website is updated on a monthly basis or as needed by the Public Works Clean Water Division staff.

Publications and Displays

Clean Water Division staff produce displays and publications generally as part of specific program areas, such as pet waste management, natural gardening to prevent toxic runoff, pollution prevention techniques, watershed education and others.

Many displays and publications are in stock and ready for distribution. Staff continues to display and distribute materials at community events, targeted environmental events, Clean Water Division presentations and Clean Water Commission meetings.



Other displays include interpretive signs on county capital projects and park trails. Interpretive / educational messages are tailored to each site. Typical messaging includes information on watersheds, the value of the stormwater project, the value of protecting water quality, and contact information for the Green Neighbors program.

Clean Water Division staff also refer citizens to the 2010 Stream Health report for information about their local watersheds, especially teachers and neighborhoods.

Outreach Events

Public Works Clean Water Division sponsor and staff informational booths at a variety of community events, such as the Earth Day Fest, Klineline Kids Fishing Derby, and Columbia River Watershed Festival. Outreach includes information about water quality, the effects of stormwater pollution, pollution prevention and other targeted environmental protection messages.

Social Media



Public Works utilizes several forms of social media to increase outreach messaging effectiveness including:

- Facebook –Various divisions post messaging including the Clean Water Division at www.facebook.com/Clark-County-WA-Public-Works-1286536668033187/ and by the end of 2019 had 1,710 followers.
- Twitter – The Twitter feed is at www.twitter.com/ClarkCoWa_PW, and as of the end of 2019 has 2,199followers.
- Instagram – Various divisions use the Public Work Instagram account, @clarkcowa_pw, including the Clean Water Division and by the end of 2019 had 1,049 followers.
- Nextdoor.com – The Clean Water Division posts on the Clark County Communications agency account, which had more than 100,000 followers at the end of 2019.

Stormwater Partners of SW Washington

Public Works Clean Water Division is promoting and staffing the Stormwater Partners of SW Washington to include local jurisdictions and other local / regional agencies and organizations which provide stormwater education and outreach. The county coordinates and facilitates quarterly meetings focused on maximizing education and outreach effectiveness through the sharing of resources, collaboration on projects, and the development of consistent messaging.

An updated Stormwater Partners website (www.stormwaterpartners.com) includes resources from previous collaborations on stormwater facility maintenance and LID, in addition to pollution prevention resources pertinent to audiences including businesses, residents, schools and developers.

The partnership collectively applies for grants to fund activities and pools resources where applicable.

Regional Clean Water Campaign

The Clean Rivers Coalition is a group of Oregon and Southwest Washington cities, counties, stormwater utilities and nonprofit organizations committed to water quality and protection. An identified need is development of a strategy connecting regional messaging to local programs to increase the effectiveness of behavior change messages. The Clean Water Division is collaborating with Clean Rivers Coalition partners and KPTV Fox 12 on a regional public awareness media campaign promoting nonpoint stormwater pollution prevention.

Outputs

- Clean Water Division webpages www.clark.wa.gov/stormwater and www.cleanwaterdogs.com
- Public contacts at events
- Fact sheets / brochures / informational signage
- Pledges to pick up pet waste
- Promotional materials such as water bottles, pens, etc.
- Social media outreach
- Stormwater Partners of SW Washington
- Regional clean water campaign

EDUCATION AND TECHNICAL ASSISTANCE FOR BUSINESSES

Purpose

Education for businesses helps meet county goals for assisting commercial, industrial and governmental enterprises in preventing contribution of pollutants to stormwater runoff or to receiving waters.

Outreach and assistance will focus on:

- General stormwater issues
- Information about illicit discharges
- Preventing and controlling the discharge of contaminants through proper use of Best Management Practices (BMPs)
- Equipment maintenance

Responsibilities

Most activities for this requirement are conducted concurrently or in association with procedures described elsewhere in the SWMP to complete source control inspections and follow-up technical assistance. Responsibilities are described in their respective sections.

Clark County Green Business Program

Clark County's Green Business Program (www.clarkgreenbiz.com) recognizes and promotes local businesses that document "green" practices, including stormwater BMPs. The program currently supports 78 local businesses that have completed sustainability assessments and have met the requirements to be a local Green Business. This program is now managed through Clark County Public Health. An integral part of the program is the technical assistance visits and education to promote proper handling and disposal of toxic and hazardous materials and stormwater BMPs.

Targeted Messaging

The Clean Water Division has identified a number of businesses that would benefit from messaging targeted to how their business can modify everyday practices to minimize pollution to stormwater. A series of brochures developed in 2017 are used to educate businesses and assist in finding solutions to their pollution prevention strategy. The brochures include messaging in Spanish and Russian.



Targeted business practices inserts include:

- Dumpster/Compactor management
- Spill kit use
- Landscaping
- Surface cleaning

Staff created English and Spanish language mop bucket management posters for businesses that routinely mop floors, such as restaurants. In the 2015 fuel station assessment program, messaging tools specific to fueling stations were developed.

Local Source Control Pollution Prevention

The Clean Water Division, through a Department of Ecology Pollution Prevention grant, provides targeted outreach to businesses to address pollution source control. There are several aspects to the project, including technical assistance visits, messaging and materials. Available materials include 5-gallon emergency spill kits and drum lid covers, as part of the "Keep a lid on it" program.

In 2020, Clean Water Division staff will develop for business and property managers an oil/water separator user's guide covering function, inspection and maintenance.

Catch Basin Cleanout Program

The Clean Water Division will continue the Catch Basin Cleanout Program aimed at increasing routine maintenance of privately owned catch basins. The program partners with a vendor to provide catch basin cleaning for an agreed upon price of $45 per catch basin. The vendor then performs the catch basin cleaning, properly disposes of waste material, invoices the business, and provides a manifest of proper waste disposal.
Clean Water Division staff created a webpage where owners of private catch basins sign up to have catch basins cleaned for the fixed rate (www.clark.wa.gov/catchbasincleanout). Out of compliance businesses are referred to the county.

In 2018, Clean Water Division staff mailed postcards to nearly 500 high priority businesses with stormwater facilities and catch basins draining to the county storm sewer system that need maintenance. The cards promoted the program and reminded businesses that they can save money and prevent pollution by performing regular maintenance.



The next mailing is planned for the 2020 NPDES permit term.

Outputs

- www.clarkgreenbiz.com
- Other outputs listed in relevant sections
- Targeted business materials, spill response, etc.
- Pollution Prevention Assistance brochures
- Pollution Prevention Assistance oil/water separator user's guide
- Catch Basin Cleanout Program www.clark.wa.gov/catchbasincleanout

EDUCATION FOR HOMEOWNERS, LANDSCAPERS AND PROPERTY MANAGERS

Purpose

Homeowners, landscapers and property managers are caretakers for a large percentage of the county's impervious surfaces, such as roofs and driveways, as well as lawn and landscaped areas that may contribute pollutants to runoff. Education messages will focus on the following topics:

- Impacts of stormwater on surface waters.
- Rural property management techniques.
- Yard care techniques.
- Proper storage and use of pesticides, fertilizers and other chemicals.
- Proper maintenance of stormwater treatment and flow control facilities.
- Low Impact Development principles and practices.
- Proper maintenance of vehicles, equipment and home/buildings.
- Proper techniques for carpet cleaning and auto repair.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW CWD Project Coordinator	CCPW CWD Outreach Specialist	Agencies Providing Services
Coordinate education programs	A	C	P	P	C
Track and measure deliverables	A	C	P	P	S
Create messages, programs and collateral	A	C	P	P	P
Distribute messages and collateral	A	C	P	P	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Small Acreage Education Program

The Small Acreage program, funded by the Clean Water Division in partnership with WSU Clark County Extension, provides educational workshops and other outreach to residents on water quality topics unique to rural properties. Topics include mud and manure management, pasture management, wells and septic maintenance, and fencing for livestock.



The goal of the Small Acreage program is to reduce pollution entering storm and surface water coming from residential and agricultural properties by giving residents the knowledge and skills necessary to manage their land and animals.

WSU Clark County Extension will provide one full-time program coordinator and oversight by the Extension director. The coordinator will facilitate workshops, training sessions and follow-up activities. The coordinator also will attend community events to recruit new trainees.

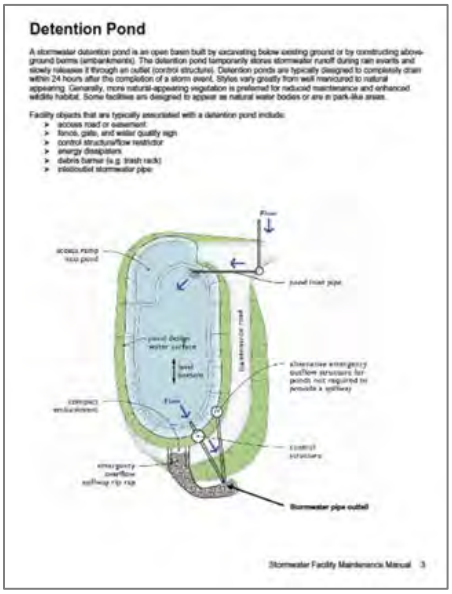
Clark County Public Works staff track deliverables of the program and negotiate the annual scope of work with the Extension director. WSU Clark County Extension submits quarterly and annual reports detailing deliverables.

Targeted Outreach for Agency Partners

Clark County participates in the Local Interagency Networking Cooperative (LINC), an education and outreach partnership between Clark County departments of Public Works and Public Health, City of Vancouver Department of Public Works, Clark Regional Wastewater District, Southwest Washington Clean Air Agency, and the Washington State Departments of Agriculture, Ecology and Labor & Industries.

Regulated Facility Maintenance Inspections

Clark County combines site visits for regulated stormwater facility maintenance inspections with delivery of technical assistance materials such as relevant pages from the Stormwater Facility Maintenance Manual. Refer to the section Operating and Maintaining the Storm Sewer System, County Property, and Roadways on page 21 for a complete description of the process.



Stormwater Facility Assistance & Stormwater Partners

Clark County continues to partner with municipalities and regional partners within the county through Stormwater Partners of SW Washington, a program to provide common stormwater messages, education and guidance to the public on how to properly maintain privately owned stormwater treatment and flow control facilities.

The Stormwater Partners website (www.stormwaterpartners.com) contains how-to videos and user-friendly outreach materials.

The Clean Water Division outreach specialist will continue to work with the Stormwater Partners to develop this program. Quarterly meetings will be ongoing and include partners who have a role in educating the public about stormwater.

Low Impact Development (LID) Training

Clark County staff has several tools for educating the public on LID, including a tour book of LID sites in Clark County. The book is in hard copy, as well as a Google map on the Stormwater Partners webpage.

The Clean Water Division with Stormwater Partners plans to review and update outreach materials related to LID education. The program will create stormwater feature-specific information to share with various audiences including realtors, landscape professionals, contractors, single family residential homeowners and property managers. Some of the materials may be presented in workshops and trainings, including in collaboration with partners such as Community Development.

Homeowner Targeted Messaging

- Grasscycling – Natural yard care to maintain healthy lawns without chemicals.
- Natural Garden Demonstration Site – A demonstration home garden site has been established at a local park (Pacific Community Park) to show how to manage diverse home landscapes while conserving and protecting water. More information is on the project webpage at: clarkgreenneighbors.org.
- Technical Assistance for Natural Gardening – The Naturally Beautiful Backyard program offers technical assistance through a web-based platform to homeowners to improve yards and minimize water use, pesticides and runoff. It also aims to encourage the use of native plants and creation of wildlife habitat.
- Backyard Habitat Certification Program – Provides technical assistance, incentives, resources, and recognition to owners of private property sized up to one acre focusing on habitat enhancements in five key areas including pesticide reduction and stormwater management.

Related Messaging

Other Clean Water Division efforts distribute information about water quality, the effects of stormwater pollution, and pollution prevention techniques as integral parts of their program outreach and education messages to the general public. Many of these messages are with partner agencies, such as Public Health.

- Naturally Beautiful Backyards curriculum delivered through a contract with WSU Clark County Extension's Master Gardeners program – less toxic gardening and yard care
- Master Composter Recyclers – less toxic gardening and yard care
- Hazardous Waste Reduction – proper disposal of household and business hazardous wastes
- Recycling A-Z website at www.recyclinga-z.com – proper disposal of tires, electronics and household hazardous waste
- Clark County Community Development - Building Safety – information for homeowners on erosion and stormwater requirements
- Other local grant programs provide additional messaging about stormwater management and pollution prevention.

Outputs

- Fact sheets
- Workshops
- Videos
- Landowner trainings
- Staff LID training
- LID educational materials
- Homeowner targeted materials
- Collateral materials

EDUCATION FOR DEVELOPMENT AND CONSTRUCTION COMMUNITY, COUNTY PLANNERS AND REVIEWERS

Purpose

The individuals, businesses and agencies involved in development project planning and construction (both regulated communities and the regulators) have great influence on the impacts of stormwater from new development and redevelopment. Education to these communities will focus on the following topics:

- Technical standards for stormwater site and erosion control plans
- Low impact development techniques
- Stormwater treatment and flow control BMPs and facilities

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Program Coordinator	CCPW CWD Permit Mgr.	CCPW CWD Natural Res. Specialist	CD Dev. Services Mgr.	CCPW Dev. Eng.
Code update outreach	A	P	P	O	I	S
Construction Management training	A	O	P	O	O	O
Facility inspection training	A	O	S	P	O	O
WWHM training	A	O	S	O	I	I
CD website	O	O	O	O	A / P	C
Pre-application conference	O	O	O	O	A / P	P
Small Projects BMP handout	A	S	S	O	P	O
DEAB	I	O	O	O	I	P

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

WORKSHOPS AND PRESENTATIONS

Stormwater Facility Inspection Training

Public Works Construction Management has an ongoing stormwater facility inspection program. Training will be provided to new inspectors or when there is a change in procedures or manual requirements. Staff are trained to be certified erosion and sedimentation control leads.

Training on Demand

Clean Water Division staff will provide training, code interpretation, BMP manual interpretation and informational materials to technical, professional and field workers as requested. Clark County departments with employees who work with the development community are trained by CWD staff on topics such as understanding "Pollution by Design" conflicts in development designs (i.e., dumpsters that include covers and separate drain systems).

Education Delivered Through Development Review

Many active development community stakeholders receive educational and outreach messages about water quality, stormwater and erosion control topics as an integral aspect of the regulatory development review process, including individual residential building permits.

For detailed information on the development review process, see Regulatory Program for Development, Redevelopment and Construction Projects on page 77.

Community Development Website

The Clark County department of Community Development hosts a website devoted to compliance with erosion control measures at: www.clark.wa.gov/community-development/erosion-control.

Pre-Application Conference

All Type II and Type III development applications require the applicant to attend a pre-application conference with county planners and engineers where, among other topics, stormwater, erosion control and submittal requirements are reviewed.

Clark County Stormwater Manual

The Clark County Stormwater Manual 2015, which guides applicants for development and new development through stormwater and submittal requirements, contains educational messages about the importance of stormwater management. Training materials are posted on the county stormwater manual webpage at: www.clark.wa.gov/public-works/stormwater-code-and-manual.

Small Project BMP Handouts for Permit Center

Clark County provides BMP packet handouts for small projects that are required to have stormwater site plans, erosion controls and on-site stormwater management BMPs but don't require an engineered design. The target audience is mainly applicants for single family residential building permits and other small building projects.

Development Engineering Advisory Board

The Development Engineering Advisory Board (DEAB) is a technical and policy review body reporting to the Clark County Council. The DEAB also serves as a mechanism for coordinating with the development community and consulting engineers to distribute information and organize training.

Outputs

- Presentations
- Employee training
- Development community training
- Small Project BMP Handout
- Sustainable and affordable development reports
- Educational messages in Clark County Stormwater Manual 2015

EDUCATION FOR STUDENTS

Purpose

Students are the next generation to own property, own or manage businesses, or simply live, work and recreate in Clark County. Education for students will focus on the following topics:

- Raising awareness of the importance of clean water.
- Introducing the idea of pollutants entering water through stormwater.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Program Coordinator	CCPW CWD Outreach Specialist	Agencies Providing Services
Coordinate education programs	A	P	P	C
Track and measure deliverables	A	P	P	S
Create messages, programs and collateral	A	P	P	P
Distribute messages and collateral	A	P	P	P
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted				

Student Watershed Monitoring Network Program

In partnership with the City of Vancouver, Clark County involves students grade K-12 in water quality monitoring of sites near their schools. Teachers and students receive mentoring in water quality and macroinvertebrate monitoring and conduct stream studies. Students share their findings with peers and the community at an annual Student Watershed Congress. About 3,500 students participate each year.

Program activities and outreach will be conducted primarily by City of Vancouver staff. Clark County staff will negotiate the annual scope of work and track deliverables.

County staff may participate in the Student Watershed Congress as facilitators or judges during student presentations.

Student Outreach Program

In 2014, Clark County partnered with the City of Vancouver to receive an Ecology Grant of Regional or Statewide Significance to expand student monitoring and educational outreach, "Connecting Schools and Families to Healthy Stormwater Actions." The grant provided the following additional activities for students in the Clark County school districts. All materials are available to teachers and students on the City's webpage: www.cityofvancouver.us/publicworks/page/watershed-monitoring-network-investigations-and-resources.

- Land-based stormwater impact monitoring investigations (tied to Washington K-12 Learning Standards). The field investigations cover several key topics, such as soils, plants and water quality.
- Hands-on toolkits to build stormwater projects on or near school sites (i.e., rain gardens, etc.).

Washington Green Schools

Clark County Public Health continues to manage the local Washington Green Schools program. A Seattle non-profit organization runs the program full-time, with financial support from Clark County and other entities. The web address is www.wagreenschools.org.

Schools complete assessments in six environmental categories, including water and school grounds. More than 65 schools in Clark County currently participate in the program. An outreach specialist serves as a resource for local participating Green Schools.

The School Grounds Assessment covers stormwater management and use, as well as natural landscaping techniques to reduce chemical use, on school grounds. The Water Assessment covers watershed identification, path of stormwater from the school campus, LID or stormwater facilities, and possible sources of pollution. Outreach staff has created activity sheets related to stormwater to assist schools with completing the forms. Activity sheets are available on the "What You Can Do for Clean Water" webpage. Clean Water Division staff also participate in the annual teacher trainings and student summits to offer advice on their assessments and "make a lasting change" projects.

Experience Vancouver Lake

Clark County partners with the Port of Vancouver and the City of Vancouver to fund the Experience Vancouver Lake project that provides a variety of outreach activities. The student program provides in-classroom lessons about watersheds, invasive plant species, water quality and human-environment connections. The students then participate in a 4-hour field trip to Vancouver Lake for nature hikes, water quality monitoring, stewardship projects and educational messaging about the lake. Community events target residents and their families to visit the lake. Six on-water community paddles will be offered, with a focus on providing opportunities for overburdened community members to get on the lake with no paddling skills required. Past events have included community forums, EcoBlitz (mini BioBlitz) and stewardship opportunities (trash pick-up, invasive species removal, etc.).

Watershed Storytelling

In an effort to support schools that want to provide watershed, stream and water quality educational sessions to large groups, the Clean Water Division has contracted with regional storytelling expert Will Hornyak. He will be available to large school groups, school assemblies and student focused events, such as the annual Columbia River Watershed Festival. He was awarded the Brimstone Grant by the National Storytelling Network for his watershed education assembly "Living Streams: Stories for Healthy Watersheds," which has been performed for over 60,000 students throughout the Northwest. This program will continue in 2020. A new contract will be negotiated to support at least 10 schools with watershed stories.

Enviroscape

The Clean Water Division has an Enviroscape watershed model available for schools to use for watershed and stream health studies. Utilized by both elementary and middle schools, the model includes a variety of

"pollutant" types such as soaps, dirt, oils and pet waste.



Outputs

- Student Watershed Monitoring Network and Watershed Congress
- Washington Green Schools (school grounds and water activity sheets)
- Experience Vancouver Lake student and community outreach activities
- Watershed Storytelling school assemblies
- Enviroscape models for classroom use

STEWARDSHIP OPPORTUNITIES

PURPOSE

Clark County creates stewardship opportunities and/or partners with existing organizations to encourage residents to participate in educational activities. The county offers hands-on activities including the following:

- Storm drain marking – kits are available to citizens, businesses, scouts and community groups to mark drains on private property or local roads with speed limits less than 25 miles per hour (both metal medallions and paint stencil kits). In 2019, seven volunteer groups engaged more than 66 volunteers to mark over 489 drains in high priority neighborhoods.
- River-friendly car wash kit – This kit is available to businesses that host charity car washes for local community groups.
- Build bat boxes at stormwater facilities – A great project for neighborhoods or scouts, the county is encouraging the location of bat boxes in the urban area to promote habitat. Educational signage is then installed at the site.
- Other individual site projects – Other projects are available based on the site, such as informational kiosk construction. Community-led projects build the kiosk and the county provides signage / poster / educational materials about the site, the watershed and key messages.
- Informational sign installations – Scouts are great partners to install watershed specific messaging signs.
- Planting projects are available to citizens through local organizations such as the Watershed Alliance of Southwest Washington, Clark Public Utilities StreamTeam and the Lower Columbia Estuary Partnership along riparian areas and critical habitat zones.
- Clark County Parks - beach clean ups and invasive plant removal events are offered in many county parks.

Other Community Partner Stormwater Outreach

There are numerous agencies and nonprofits that provide stormwater education throughout Clark County, including in the jurisdictional area of Clark County. Many of these programs offer education messaging, raising awareness and stewardship opportunities. Clark County does not partner on funding, but these programs continue to increase awareness of stormwater related issues in our community. Some of the programs anticipated to continue in 2020 include:

- Clark Conservation District – Best Management Practices program (providing technical assistance for agricultural properties to manage pollution sources).
- Clark Conservation District – Watershed Stewards learn about watershed topics and return service hours in the community.
- Clark Public Utilities – StreamTeam (tree plantings, invasive species removal, education/outreach, events).
- Columbia Springs Environmental Education Center – hosts various outreach events and programs including Salmon in the Classroom (raise and release baby salmon) and community events focused on river health.
- Lower Columbia Estuary Partnership – provides restoration projects, outreach and education, including big canoe tours and working with students in classroom education.
- City of Vancouver Water Resources Education Center – hosts a number of programs to schools and the community about water, water quality, fish and other environmental messages.

TASK CHECKLIST

STATUS	TASK
ONGOING	Educate the general public
ONGOING	Educate businesses
ONGOING	Educate residents, landscapers and property managers
ONGOING	Educate the development and land use planning community
ONGOING	Provide and advertise stewardship opportunities
ONGOING	Increase awareness and education of homeowners, landscapers and property managers
ONGOING	Affect behavior through hands on activities, workshops, trainings and stewardship
2020	Evaluation the effectiveness of ongoing program
2021	Apply social marketing practices and methods
2024	Report on changes in adoption of targeted behaviors and changes to make it more effective

For more information on programs providing education and outreach about stormwater and the SWMP:
Greg Shafer, Interim Clean Water Division Manager
564.397.4064
greg.shafer@clark.wa.gov

Section 7 – Coordination

Clark County coordinates internally and with other local governments and agencies on a variety of environmental and planning topics.

Regulatory Requirements Summary

NPDES Permit S5.C.3 – Coordination

The NPDES permit requires the county to coordinate among its own departments and with neighboring jurisdictions to eliminate barriers to permit compliance and to encourage coordinated stormwater policies, programs and projects within a watershed.

COUNTY POLICIES, RULES AND REGULATIONS

The following policies and regulations promote permit implementation by county departments.

Clark County Code Chapter 13.26A – Water Quality

Chapter 13.26A requires inspection and maintenance of all public and private stormwater facilities and stormwater disposal wells in accordance with the Clark County Stormwater Manual that provides source control BMPs for materials handling, landscape management, trash management and building exterior maintenance. This manual is equivalent to maintenance standards in Volume V and source control standards in Volume IV of the SMMWW.

Environmentally Responsible Purchasing Policy

Clark County adopted its Environmentally Responsible Purchasing Policy in 2004. One element addresses purchase of landscaping and vegetation maintenance products, including pesticides. The policy establishes a set of criteria, any of which will disqualify a pesticide from purchase. A waiver process requires further examination of the pesticide by the Environmentally Responsible Purchasing Team to determine if a more environmentally-friendly alternative exists. If no alternative is found, the pesticide can be purchased and used within specific limiting guidelines. The policy promotes a coordinated approach to the pesticide and fertilizer use reduction.

Regional Road Maintenance Program

Clark County has been a member of the ESA Regional Road Maintenance Forum since 2003. The group assisted the county in developing a Regional Road Maintenance Program that is designed to meet the requirements of the Endangered Species Act (ESA). In 2004, NOAA Fisheries approved Clark County's Regional Road Maintenance Program and determined that it was compliant with the ESA. The program seeks to protect salmon and steelhead by relying on the extensive use of pre-approved BMPs for routine maintenance activities. The program promotes systematic adherence to pollution control standards for road operations.

Intra-governmental Coordination

Purpose

Intra-governmental coordination helps ensure cooperation of all Clark County departments in meeting the terms of the NPDES Municipal Stormwater Permit and in protecting local water resources.

Responsibilities

Responsibility for negotiating interdepartmental and programmatic agreements lies with the Clean Water Division manager or a designee and with managers of coordinating programs and departments.

Responsibilities for implementing the agreed upon activities are shown in detail in responsibility matrices and program descriptions in the appropriate sections.

Agreements

The Clean Water Division coordinates the county's NPDES permit compliance efforts. Although the program coordinates with other departments, it is not responsible for all compliance actions. The Clean Water Division maintains memoranda of understanding or other agreement mechanisms with several county departments to support compliance. Agreements include services provided for payment by the CWD and description of permit requirements that must be met by departments.

Public Works Road and Parks Maintenance Divisions

Public Works completed an intra-departmental agreement between the Clean Water Division and the Road and Parks Maintenance Divisions to implement requirements under permit requirements S5.C.9, Operations and Maintenance Program, including:

- Standards and schedules for stormwater facility and catch basin maintenance.
- Practices for operating streets, roads and highways.
- Spill response practices.
- Private facility inspection and enforcement.
- Water quality BMPs for maintaining public land.
- Training.
- Stormwater Pollution Prevention Plans (SWPPs) for heavy equipment yards.
- Recordkeeping.
- Reporting requirements for the NPDES permit annual report.

Public Works Engineering and Construction Division

Public Works provides services to implement permit requirements under S5.C.5, S5.C.6 and S5.C.7.

Public Works provides the following services:

- Project management for stormwater capital improvements.
- Design and construction management for stormwater capital improvements.
- Capital planning assistance.
- Development site inspection.
- Program to inspect stormwater facilities during maintenance warranty.
- Enforce stormwater, erosion control and water quality codes.
- Inspection program recordkeeping.
- County facility annual maintenance inspection.
- Training for staff whose primary job duties include design, construction site inspection and enforcement.

Community Development

Department of Public Works maintains an interdepartmental agreement with Community Development to implement requirements under permit requirement S5.C.5, including:

- Accept development applications.

- Review site plans for residential building projects that do not require engineered designs.
- Review and inspect erosion controls, on-site stormwater controls at residential building sites, primarily single-family residential construction sites.
- Enforce stormwater, erosion control and water quality codes.
- Maintain records of applications, reviews, inspections and enforcement actions.
- Training for staff whose primary job duties include permitting and plan review.
- Referring water quality complaints to the Clean Water Division.

Community Development

Community Development provides development review services for enforcing Clark County Code Chapter 40.386 Stormwater and Erosion Control and its predecessor, Chapter 40.385.
Community Development provides the following services:

- Review and approval of development project applications.
- Administration of development project recordkeeping.
- Training for staff whose primary job duties include permitting and plan review.

Internal Services Facilities

The Clean Water Division has an interdepartmental agreement with General Services that includes operation and maintenance of stormwater facilities, use of source control BMPs, and technical assistance and training from Public Works. In early 2019, the General Services Department was dissolved and the department's facilities management functions were moved into a new facilities division of the newly-formed Internal Services Department. Public Works will update the agreement to reflect the new department structure, while retaining the same performance requirements.

Public Health

The Clean Water Division coordinates with Clark County Public Health on spill responses, illicit discharge investigations and other environmental complaints.
Public Health's agreement includes referring illicit discharges to Clean Water Division when discovered during routine work such as restaurant inspections, swimming pool inspections and other field activities that may discover illicit discharges. Field staff are trained to report spills and refer sites having illicit discharges to the Clean Water Division. Public Health is also responsible for addressing illicit discharges caused by on-site sewage disposal facilities.

GIS Department and Application Services

Department of Public Works maintains an agreement with the GIS Department for various services that support SWMP implementation, including administration of the county's storm sewer infrastructure asset database, StormwaterClk, the stormwater asset Maintenance Management System, stormwater fee database administration, software support, GIS data used for capital planning and monitoring studies, developing Web applications and internet access to program information, and database development.

Other Intra-governmental Coordination

The Clean Water Division also coordinates informally with other county programs and departments on various stormwater-related and environmental efforts and projects such as development code and comprehensive plan updates .

Outputs

- Interdepartmental memoranda of understanding for services and permit requirements performed.

INTERGOVERNMENTAL COORDINATION PURPOSE

Clark County informally coordinates with Phase II permittees and other local organizations to control pollutants between physically interconnected storm sewer systems, to attempt to provide consistent stormwater management for shared water bodies, and to collaborate on permit implementation tools and TMDL implementation.

Responsibilities Matrix

Task	CCPW Director	CCPW CWD Mgr.	CCPW CWD NPDES Permit Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Program Coordinator
Vancouver Lake Partnership	I	A	O	S	P
Provide input to TMDL DIPs	O	A	S	P	O
TMDL advisory committees rep.	O	A	S	P	O
Local permittee coordination	A	I	P	I	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Coordination to Clarify Roles and Responsibilities for Interconnected Systems

The Clean Water Division has identified approximately 500 connection points between the county MS4 and other municipal entities such as cities and WSDOT right of way. Within the urban area, the Clean Water Division assesses the potential for intersystem pollutant discharges using IDDE procedures.

Clark County has informal discussions with NPDES Phase II permittees regarding mapping and illicit discharge screening programs.

General Intergovernmental Coordination

Clark County participates with other local governments and agencies on several joint efforts, including:

- Shared education and outreach programs with the City of Vancouver.
- A regional education program covering facility maintenance to stormwater facility owners within Vancouver, Battle Ground, Camas, Washougal, Ridgefield and La Center.
- Operation of the regional street waste decant facility with WSDOT, Vancouver, Battle Ground, Camas and Washougal.
- Hosting quarterly Southwest Washington permittee meetings to coordinate activities including roles and responsibilities for our interconnected systems.

Coordination for Shared Water Bodies: Vancouver Lake Watershed Partnership

The Vancouver Lake Watershed Partnership (VLWP) is no longer meeting. However, the original funding partners (Clark County, City of Vancouver and Port of Vancouver) continue to provide financial support for community outreach, education and volunteer activities focused on Vancouver Lake under a contract with the Lower Columbia Estuary Partnership (LCEP). The Clean Water Division program coordinator administers the contract with LCEP, and the Clean Water Division manager serves as representative to coordinate with the other funding partners.

TMDL Coordination

Clark County coordinates with other local entities on TMDL implementation. Upon request, the NPDES Permit manager will provide input to Ecology in development and update of Detailed Implementation Plans. The Stormwater Infrastructure manager will continue to participate on the local advisory committees for the following existing or emerging TMDL water bodies:

- Burnt Bridge Creek Watershed
- East Fork Lewis River
- Gibbons Creek
- Salmon Creek
- Lacamas Creek

In 2020, the focus will be on a partnership developing a cleanup plan for bacteria in the East Fork Lewis River in collaboration with Ecology and local stakeholders. Other work includes working with stakeholders to develop a plan in response to the East Fork Lewis River temperature TMDL and continued work at bacteria source identification in 303(d)-listed Whipple Creek watershed.

Clark County complies with TMDL requirements by implementing its Stormwater Management Program.

Outputs

- Various outputs from education and outreach programs (see section 6)
- Notes and summaries from each TMDL's Advisory Committee meetings

For more information on ways the county coordinates with other jurisdictions and permittees:
Greg Shafer, Interim Clean Water Division Manager
564.397.4064
greg.shafer@clark.wa.gov



County staff monitoring water quality at the Jones Creek stream gauge

CHAPTER 3

Assessment and Monitoring

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Assessment and Monitoring

Clark County is a regional leader in natural resource monitoring and assessment. The Assessment and Monitoring section implements a variety of projects to collect scientific data about stormwater, surface waters, stream corridor condition and habitat to support and implement NPDES permit requirements.

The core goal is to provide information leading to successful on-the-ground actions that improve natural resources in Clark County. The program utilizes sound science and data collection practices to inform the county's policy and program management decisions and provide information vital to the success of Clark County programs.

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit – S8 Monitoring

The NPDES permit no longer requires the county to develop and implement a monitoring program.

In 2020, Clean Water will complete the final report and data submittal to Ecology.

TOOLS THAT SUPPORT PERMIT COMPLIANCE

The Assessment and Monitoring section provides the tools and staffing to support completion of permit-required Watershed-Scale Stormwater Planning technical analysis and the permit's S8 stormwater monitoring requirements. These are standard procedures for collecting environmental data, database systems for storing data, quality assurance and quality control procedures, and methods to analyze and present data results.



Stream bed stability testing in the Mill Creek sub-watershed, 2009

Standard Procedures for Monitoring Activities

The Clean Water Division maintains the Standard Procedures for Monitoring Activities for use in guiding field and laboratory work. It details the protocols and means used to generate data.

Water Quality Database

The Water Quality Database (WQDB) is a centralized repository for the Clean Water Division's water quality and benthic macroinvertebrate data. The WQDB is a SQL 2000® database with Access® interfaces for data entry and retrieval. A batch uploading tool enables rapid entry of large datasets.

Quality Assurance Project Plans

Each monitoring project follows a Quality Assurance Project Plan or QAPP to ensure that data are of adequate quality to meet project objectives. Each QAPP follows guidelines published by Ecology.

Hydrology Databases

Data from the county's hydrologic and stormwater monitoring sites (storm flow, stream flow and rainfall gages) is stored in an Aquarius® database.

Outputs

- Annual stormwater data reports and pollutant loads for two sites
- Enter stormwater data into the Ecology EIM database

BMP EFFECTIVENESS MONITORING

Clark County is not conducting Best Management Practice Effectiveness Monitoring as a permit requirement. The project 2013 permit effectiveness project began implementation in late 2015 and was completed under the 2013 permit in 2018.



Crews install weir at a treatment wetland BMP monitoring site

ILLICIT DISCHARGE MONITORING

This activity is described in detail in Illicit Connections and Illicit Discharges Detection and Elimination (IDDE) on page 56.

Monitoring Resource Center

Purpose

The Volunteer Monitoring Resource Center lends monitoring equipment to volunteers who wish to monitor water bodies in Clark County. The program loans sampling equipment and professional-grade field meters. Staff scientists provide limited overview of how to use the equipment for their project.

Method

Staff assemble, calibrate and track equipment on loan to qualified borrowers. Citizens can visit the volunteer website for equipment checklists and resource information to support a successful project. The webpage is: www.clark.wa.gov/environmental-services/volunteer-monitoring-resources.

Outputs during Permit Term

- Log of Monitoring Resource Center borrowers
- Log of data requests
- Equipment checkouts to individuals, agencies and groups

For more information on services provided by the Assessment and Monitoring section:
Jeff Schnabel, Clean Water Division Infrastructure Manager, 564-397-4583
Jeff.Schnabel@clark.wa.gov

Exhibit O

ERTS Incident #737260

Environmental Report Tracking - *Generated 2/28/2025, 8:08 AM*

Primary Initial Report - Reported: 02/25/25 16:58

Reference ID - 229415

Where did it happen?

Location name:	Salmon Creek Ridge HOA
Physical address:	11815 NE 99th St Ste 1200 Vancouver WA 98682 US
County:	Clark
Ecology region:	SWRO
Lat, long:	45.692787 , -122.550272

Directions/Landmarks:

Parcel: 986067638
https://maps.app.goo.gl/cgbLfpa1yeR8p1dW9?g_st=com.google.maps.preview.copy

WRIA Number:

What happened?

Incident date:	02/22/25
Activity:	Surface water diversion
Cause:	
Medium:	Water - Storm drain
Source:	Private property - Residential
Substance:	Water - Water
Substance amount:	

Who might be responsible?

Name:	Jordan Rotschy
Organization:	Rotschy Inc / Hinton M&H Subdivision
Email:	

How was it reported?

Intake type:	Website form
Reported date:	02/25/25 16:58
Entered by:	Joe Thomas
Entered at:	02/27/25 10:53

Who reported it?

Do they want this to be confidential?	No
Reporter type:	Citizen
Name:	Lyle Nielsen
Organization:	
Email:	lyle_nielsen@yahoo.com
Phone number(s):	(971) 409-9858
Mailing address:	16516 NE 37th Ave Vancouver WA 98686 US US
Are they anonymous?	No
Are they self-reporting?	No
External reference number:	

Phone number(s): (360) 921-9296

Mailing address:

Comments/notes

The storm water retention ponds do not fill. The outlet runs to a drainfield, and creates a constant flow of water that runs down a hill and into Mill Creek. The water in the ponds is muddy from dirt that was left in pipes. (inlet water is brown) The ponds have pipes at level, with no riser. Water from streets and houses goes into the ponds, and immediately flows out of the outfall and down the hill on the surface.

Rotschy was the subcontractor for the rough grading.

Incident details

Life cycle status:	Follow-up assignment pending
Incident Date:	02/22/25
Was it self-reported?:	No
Show to public?:	No

Program owners

Becky Parker (Primary)

SWRO - Water Quality

Comments:

Joe Thomas (Primary)

SWRO - External

Comments:

Location

Location name:	Salmon Creek Ridge HOA
Physical Address:	11815 NE 99th St Ste 1200 Vancouver WA 98682 US
County:	Clark
Lat, long:	45.692787 , -122.550272

Directions/Landmarks:

WRIA Number:

Who might be responsible?

Name:	Jordan Rotschy
Organization:	Rotschy Inc / Hinton M&H Subdivision
Email:	
Phone number(s):	(360) 921-9296
Mailing address:	7710 NE 113th Circle Vancouver WA 98662 US US

Follow-ups

Program: Water Quality - Subject: Land Clearing/Excavation/Construction

Reference ID - 248651

What happened?

Primary activity

Activity: Surface water diversion

Action history

Status: Started

Action: Follow-up owner assigned

Date: 02/27/2025 12:43:32

Follow-up owners

Status: Pending acceptance

Organization: WA Ecology

First name: Tullee

Last name: Stanford

Is external?: N

Email: tust461@ecy.wa.gov

Phone number: (360) 624-5741

Comments:

Program: Water Quality - Subject: Other Spill to MS4

Reference ID - 248650

What happened?

Primary activity

Activity: Surface water diversion

Action history

Status: Started

Action: Follow-up owner assigned

Date: 02/27/2025 12:43:11

Status: Accepted

Action: Follow-up ownership accepted

Date: 02/27/2025 14:19:18

Primary detail

Medium:	Water - Storm drain
Source:	Private property - Residential
Substance:	Water - Water
Substance amount:	

Follow-up owners

Status: Accepted

Organization: WA Ecology

First name: Morgan

Last name: Maupin

Is external?: N

Email: MORM461@ecy.wa.gov

Phone number: (360) 798-2906

Comments:

Program: External - Subject: Other Spill to MS4

Reference ID - 248632

What happened?

Primary activity

Activity:	Surface water diversion

Action history

Status: Email not sent

Action: Follow-up owner email not sent

Date: 02/27/2025 10:54:52

Status: Email sent

Action: Follow-up owner email sent

Date: 02/27/2025 10:55:01

Primary detail

Medium:	Water - Storm drain
Source:	Private property - Residential
Substance:	Water - Water
Substance amount:	

Follow-up owners

Status: Email sent

Organization: Clark County Public Works

First name:

Last name:

Is external?: Y

Email: DLCntyCleanWaterERTSAlerts@clark.wa.gov

Phone number:

Comments:

Incident attachments

Contact Ecology if you would like a copy of any of these attachments

File Name: 737260 Report of an environmental issue in Clark county.msg

File Description: Initial report

Section/Reference ID: Initial report - 229415

Date uploaded: 02/27/2025

Exhibit P

CLARK COUNTY

2026 Stormwater Management Plan



2026 Stormwater Management Plan

Updated March 2026

CLARK COUNTY PUBLIC WORKS CLEAN WATER
1300 Franklin Street

Vancouver, WA 98666-9810

www.clark.wa.gov/stormwater



For other formats, contact the Clark County ADA Office
Voice 564.397.2322 / **Relay** 711 or 800.833.6388
Fax 360.397.6165 / **Email** ADA@clark.wa.gov

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S5.C.4	Public Involvement and Participation	Chapter 2, Section 6
S5.C.5	Controlling Runoff from New Development, Redevelopment and Construction Sites	Chapter 2, Section 5
S5.C.6	Stormwater Planning	
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Fishermen sitting by river with poles in the water at sunset



Storm drain medallion used to mark storm drains and catch basins

Acronyms and Glossary

AKART – all known, available and reasonable methods of prevention, control and treatment as the Ecology standard for the effort required to meet wastewater discharge and NPDES permit requirements.

BMP – best management practices (controls for stormwater runoff)

Cartegraph – an asset management system used by the county

Council – Clark County Council

CCPH – Clark County Public Health

CCPW – Clark County Public Works

CCSM – Clark County Stormwater Manual 2021

CCSWMP – Clark County Stormwater Management Plan

CIP – Capital Improvement Program

County Manager – Executive officer for Clark County

CWD – the Clean Water Division of Clark County Public Works

Ecology – Washington State Department of Ecology

EPA – Environmental Protection Agency

GIS – geographic information services

GMS – grounds maintenance specialist

IDDE – illicit discharge detection and elimination

Illicit Discharge – a non-stormwater discharge or illegal connection to the storm sewer

system (e.g. a sanitary sewer line connected to storm sewer system)

LID – low impact development

LMS – Land Management System (replaces Tidemark)

MEP – maximum extent practicable

MS4 – municipal separate storm sewer system

NOAA Fisheries - National Oceanic and Atmospheric Administration, National Marine Fisheries Service

NOI – Notice of Intent

NPDES – National Pollutant Discharge Elimination Systems

PPGS – potential pollutant generating site

RCW – revised code of Washington

SMAP – Stormwater Management Asset Plan

SMED – Stormwater Management for Existing Development also referred to as retrofits.

SNAP – Stormwater Needs Assessment Program

StormwaterClk – a GIS database the county maintains for storm sewer infrastructure

SMMWW – 2019 Stormwater Management Manual for Western Washington, published by Ecology

SWMP – Stormwater Management Program

SWPPP – stormwater pollution prevention plan

TMDL – total maximum daily load

UIC – underground injection control

WAC – Washington Administrative Code

WQDB – Water Quality Database



Hidden Falls located along the Tarbell Trail in east Clark County

Responsibility Index

CCPW = Clark County Public Works

ABBREVIATION	FULL STAFF TITLE	JOB DESCRIPTION
Applicant	(as stated)	Customer who utilizes the municipal code and stormwater manual to guide development projects
CCPW Answering Service	(as stated)	Coordinates after business hours service calls
CCPW PIO	Public Information Officer	Supports the development and delivery of public outreach and educational materials
CCPW Construction Mgmt. Eng.	Construction Management Engineer	Reviews PW construction projects for compliance with approved plans and applicable regulations
CCPW Construction Mgmt. Inspectors	Construction Management Inspectors	Conducts on-site construction inspections to ensure compliance with approved plans and applicable regulations and perform county facility maintenance inspections
CCPW Construction Mgmt. OA	Construction Management Office Assistant	Coordinates document management associated with project approvals
CCPW Construction Mgmt. Supervisor	Construction Management Supervisor	Oversees the compliance with inspections of development construction
CCPW Construction Supervisor	Construction Management	Oversees the compliance of development construction with approved plans and code
CCPW CWD Admin.	Clean Water Division Administration	Supports document control and recordkeeping
CCPW CWD Eng.	Clean Water Division Engineer	Coordinates design and engineering of Clean Water projects
CCPW CWD Infrastructure Mgr.	Clean Water Division Infrastructure Manager	Oversees / manages stormwater capital planning, infrastructure mapping and monitoring activities, coordinates stormwater infrastructure inspection and maintenance
CCPW CWD Mgr.	Clean Water Division Manager	Oversees and manages the Clean Water Division
CCPW CWD Natural Res. Specialist	Clean Water Division Natural Resource Specialist	Performs monitoring and illicit discharge field work and analysis
CCPW CWD NPDES Manager.	Clean Water Division National Pollution Discharge Elimination System Permit Manager	Oversees compliance with the county's Phase I Municipal Stormwater Permit
CCPW CWD NPDES Permit Coordinator	Clean Water Division National Pollution Discharge Elimination System Permit Coordinator	Coordinates Phase I permit reporting requirements with county staff
CCPW CWD OA	Clean Water Division Office Assistant	Coordinates document control and recordkeeping
CCPW Outreach Specialist Sr.	(as stated)	Coordinates, implements and evaluates outreach programs for Clean Water
CCPW CWD Professional Staff	(as stated)	Supports various work projects and products
CCPW CWD Program Asst.	(as stated)	Staffs Clean Water Commission meetings

ABBREVIATION	FULL STAFF TITLE	JOB DESCRIPTION
CCPW Mgmt. Analyst Sr.	Management Analyst Senior	Coordinates specific project tasks and work products, supports outreach / education.
CCPW CWD Source Control Specialist	Clean Water Division Source Control Specialist	Technical assistance with citizens and businesses to comply with facility maintenance and source control regulations
CCPW CWD Sr. Eng. Tech	Clean Water Division Senior Engineering Technician	Inventory and maps the stormwater system
CCPW CWD Sr. Operations Specialist	Clean Water Division Senior Environmental Operations Specialist	Technical assistance with citizens and businesses to comply with private stormwater facility maintenance
CCPW Dev. Inspectors	Development Inspectors	Coordinates inspections and compliance with code
CCPW Director	(as stated)	Designated director for permit compliance
CCPW Eng. Program Mgr.	Engineering Program Manager	Oversees PW engineer activities
CCPW Eng. Program Design	Engineering Program Staff	Develops engineering designs for stormwater retrofits
CCPW Eng. Project Mgr.	Engineering Project Manager	Manages engineering projects
CCPW Eng. Permitting Mgr.	Environmental Permitting Manager	Coordinates environmental permitting for the department
CCPW Land and Vegetation Mgr.	Land and Vegetation Manager	Oversees the operations and maintenance of the vegetation management program
CCPW Noxious Weed Mgmt crews	(as stated)	Perform weed management for county stormwater facilities and control noxious weeds
CCPW Ops Admin.	Operations Administration	Provides support to various tasks, such as spill response and citizen complaints
CCPW Ops Crew Chief	Operations Crew Chief	Leads and coordinates road crew activities
CCPW Ops Mgr.	Operations Manager	Oversees all operation and maintenance responsibilities
CCPW Ops Road Crews	Operations Road Crews	Perform all necessary stormwater facility and road maintenance and operations activities to meet applicable standards and regulations
CCPW Ops Road Super	Operations Road Superintendent	Oversees all elements associated road maintenance and operations
CCPW Parks and Lands Mgr.	Parks and Lands Manager	Oversees administration, customer service, maintenance and operations of parks and other county land management
CCPW Parks Super.	Parks Maintenance and Operations Supervisors	Oversees the maintenance and operations of the parks
CCPW Real Property Services	(as stated)	Coordinates property acquisition and ownership information, such as titles, legal information, etc.
CCPW Survey	(as stated)	Coordinates all necessary survey data required for a project

CD = Community Development

ABBREVIATION	FULL STAFF TITLE	JOB DESCRIPTION
CD Building Official	(as stated)	Oversees customer application for development, all building permits and permit counter
CD Building Safety	(as stated)	Enforces erosion control regulations and stormwater for residential building permits
CD Dev. Eng. Mgr.	Development Engineering Manager	Oversees the engineering review of development applications
CD Dev. Eng. Planning Tech	Development Engineering Planning Technician	Coordinates bonds, compliance and final plat
CD Dev. Eng. Review Eng.	Development Engineering Review Engineer	Conducts the engineering development review and participates in application meetings
CD Dev. Services Mgr.	Development Services Manager	Coordinates a pre-application conference with potential applicants and provides planning approvals
CD Permit Services	(as stated)	Coordinates review of development applications
CD Permit Tech	Permit technician	Processes permit applications
CD Planner	(as stated)	Supports the land use application and approval process
GIS	(as stated)	Supports the county's GIS system including stormwater asset inventory
Internal Services Facilities Crews	(as stated)	Performs all tasks associated with the operations of the program on county properties
Internal Services Facilities Mgr.	Facilities Manager	Oversees the facilities program for county properties
Public Health	(as stated)	Coordinates illicit connection/discharge issues with CCPW staff
Council	Clark County Council	Legal Authority for budget, code revisions and contracts
County Mgr.	County Manager	Executive official for Clark County
CRWWD	Clark Regional Wastewater District	Supports the coordination of illicit discharge protection
Contract Services	Outside firm or agency contracted with Clark County	Hired to meet specific scope of work items per the appropriate fund and need



Yacolt Falls at Big Tree Creek

CHAPTER 1
Introduction and Background

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Clark County Stormwater Management Plan

The Clark County Stormwater Management Plan (CCSWMP) describes the various ways Clark County manages stormwater and related water resources issues in the unincorporated area. It acts as a resource for the public to learn about the county's efforts to reduce pollution in stormwater, an informative guide for staff, and a compliance measure for the county's municipal stormwater permit under permit requirement S5.C.4 and S5.A.

INTRODUCTION

As the county's unincorporated population continues to increase (estimated over 245,000 in 2025 with 175,000 in the unincorporated Vancouver Urban Growth Area according to the Washington State Office of Financial Management data analyzed by Clark County GIS). Clark County is committed to responsible stormwater management to keep our waterways healthy for people, fish and wildlife.

The Clark County Public Works department (CCPW) utilizes the Clean Water Division (CWD) to protect surface water and groundwater resources from polluted stormwater and to coordinate compliance with state and federal water pollution laws.

Primary responsibilities of the overall stormwater program include planning and building stormwater control facilities, stormwater management planning, water quality and habitat monitoring of streams, public education and outreach, development and enforcement of water quality regulations, water quality compliance for businesses and private stormwater facility owners, coordination with other municipalities, and maintenance of the county's stormwater system.

STORMWATER AND NPDES PERMIT

Much of the pollution in Washington State waters comes from many different, hard-to-trace sources with no obvious point of collection and discharge. It is called "nonpoint source pollution" and it travels to streams, lakes and other water bodies through polluted stormwater runoff carried by the county's storm sewer system.

Most U.S. cities and counties that collect stormwater runoff in municipal separate storm sewers and discharge it to surface waters are required to obtain a permit under the federal Clean Water Act. Clark County qualifies under the Environmental Protection Agency (EPA) stormwater regulations for the National Pollutant Discharge Elimination Systems (NPDES) Phase I Municipal Stormwater Permit program. In Washington State, the EPA has delegated to the Washington Department of Ecology (Ecology) the authority to develop and administer the NPDES permitting program. Ecology issued the current NPDES Phase I Municipal Stormwater Permit to Clark County and other larger western Washington jurisdictions in July 2024, with an effective

date of August 1, 2024. This permit is for a five-year period expiring on July 31, 2029.

Phase I municipal permittees are cities and counties that operate large and medium municipal separate storm sewer systems (MS4s). Governmental bodies within their boundaries, such as state universities, public school districts and drainage districts, are also required to meet permit requirements. The permit regulates discharges to waters of Washington State from the permittees' MS4s in compliance with Washington Water Pollution Control Law (Chapter 90.48 RCW) and the federal Clean Water Act (Title 33 USC, Section 1251 et seq.).

PERMIT COMPLIANCE

The NPDES permit prescribes a variety of requirements and actions. It lists 21 general conditions; these include, among others, a requirement to notify Ecology of spills, a duty to avoid bypassing water quality treatment and flow control facilities, and a requirement to notify Ecology of a failure to comply with the permit.

The permit also lists nine special conditions that, among other things, specify permit coverage, list permittee responsibilities, and under Special Condition S5, prescribes an eleven-component stormwater management program (SWMP).

The SWMP consists of actions meeting the eleven required components and any additional actions and activities necessary to reduce pollutant discharges to the federal maximum extent practicable (MEP) standard, meet state requirements for managing stormwater using all known, available and reasonable methods of prevention, control and treatment (AKART), and protect water quality.

The county is required to prepare a stormwater management program plan to inform the public of planned program activities for the upcoming calendar year. The SWMP plan must be updated annually to include program changes or revisions that occur and be submitted in part or in whole with the annual report to the Department of Ecology.

THE CLARK COUNTY STORMWATER MANAGEMENT PLAN AND STORMWATER MANAGEMENT PROGRAM

This Clark County Stormwater Management Plan (CCSWMP or Plan) encompasses efforts by Clark County, primarily in the Public Works and Community Development departments for the protection of water quality and the management of stormwater and related concerns. The Plan includes, as chapter 2, the NPDES stormwater management program required by Ecology.

THE CLEAN WATER DIVISION

The Clean Water Division (CWD) in Clark County's Public Works department is responsible for a majority of the county's NPDES compliance actions and activities, coordination and reporting. The program coordinates and contracts with county departments to achieve and facilitate compliance. The CWD is the primary author of reports and other documents required by Ecology.

In addition to activities addressing NPDES permit compliance and surface water resource management, the CWD manages other important stormwater-related activities, including managing stormwater injection wells regulated under the state's Underground

Injection Control Rules (173-218 WAC) pursuant to the federal Safe Drinking Water Act, and giving engineering advice and support on flooding and drainage problems.

Funding and Budget

The Clean Water Division is funded primarily by an annual stormwater fee charged to developed parcels in the unincorporated area of the county. The county collects approximately $14 million annually from nearly 82,000 properties. Other sources of funding may include grants and the General Fund. The Road Fund provides support for stormwater management associated with county roadways.

Clean Water Fee

Residential and multifamily properties are charged a fee based on each residential dwelling. Commercial properties, roads, churches and schools are assessed a fee based on the number of equivalent residential units (ERUs) of impervious surface measured on the parcel. The fee varies for residents in the Urban Growth Boundary versus rural areas.

Per Clark County Code 13.30A, fee revenues are used to fund stormwater management activities.

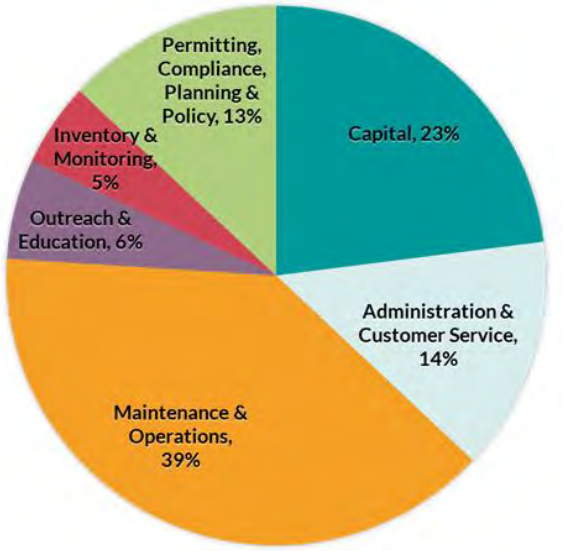
Clean Water Fund

Revenues from the Clean Water Fee, from grants awarded to the Clean Water Division and from fines are deposited into the Clean Water Fund by the Clark County Treasurer. Revenues in excess of annual operating expenses for maintenance, repair, enforcement, assessment, monitoring and education remain in the fund balance for use in constructing new public storm sewer infrastructure and perform large maintenance projects on county facilities.

The Road Fund provides support for stormwater management associated with county roadways.

Budget

Clark County budgets on a one-year cycle. The Clean Water Division budget is set at the beginning of each cycle and modified, if necessary, through requests for additional appropriations from the Clean Water Fund during the year.



2026 Clean Water Adopted Budget

The budget is approved by the elected Clark County Council. The Council sets the Clean Water Division budget in response to state priorities, expressed through the NPDES Municipal Stormwater Permit and local priorities.

Areas of greatest expenditure include stormwater capital construction, maintenance and operation of storm sewer infrastructure, and administration and customer service.

In recent years, a focus on building new stormwater facilities in underserved areas has increased the overall budget and the proportion dedicated to capital construction. The total budget for 2026 is $16 million.

Organization & Staffing

The Clean Water Division employs a staff of scientists, engineers, technical specialists and administrators who perform essential stormwater management functions. The program also coordinates with other Public Works divisions and county departments for additional essential stormwater services that fit within those divisions or departments' core services. This organizational structure allows the Clean Water Division to minimize expenses by engaging technical and professional experts such as design engineers, road maintenance crews and educators employed by other divisions or departments to complement a core staff of stormwater specialists.

The Clean Water Division is directly responsible for storm sewer system inventory; code and manual updates; watershed planning; source control inspections; illicit connection and discharge inspections and abatement; private stormwater facility inspections; stormwater facility maintenance compliance; stormwater capital planning; coordination with other jurisdictions and entities; and surface water and stormwater assessment, planning and monitoring.

The program coordinates with other Public



Works divisions and county departments to collect and process the Clean Water Fee; operate, inspect and maintain the storm sewer system; manage the design and construction of stormwater capital improvements; enforce development and building regulations related to NPDES permit compliance; inform and

educate the public about stormwater problems and solutions; and support the Clean Water Division with database programming and analysis.

County departments are responsible for complying with NPDES permit requirements in their operational activities under the adopted stormwater plan and by interdepartmental agreements.

TASK CHECKLIST

STATUS	TASK
Ongoing	The Clean Water Division administers the NPDES Municipal Phase 1 Stormwater Permit for Clark County

For more information on the county's Clean Water Division, contact:

Devan Rostorfer, Clean Water Division Manager
564.397.4264
devan.rostorfer@clark.wa.gov



Turbid urban runoff from Cougar Creek into Salmon Creek

CHAPTER 2
Stormwater Management Program

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Section 1 – Legal Authority

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.1 Legal Authority	The NPDES permit requires the county to demonstrate that it has the legal authority to control discharges to and from its municipal separate storm sewer system (MS4).

Legal Authority to Regulate

Clark County maintains the legal authority required by the permit to control discharges to and from its MS4.

Clark County Code Chapter 13.26A Water Quality	Chapter 13.26A prohibits illicit discharges and spills into the county's MS4, requires the control of industrial site runoff, and adopts source control requirements in the Clark County Stormwater Manual. It maintains the county's authority to inspect and enforce its provisions.
Clark County Code Title 32 Enforcement	Title 32 permits Clark County to enforce any of its civil codes through inspection, surveillance, monitoring and enforcement actions.

Clark County Code Title 40 Unified Development Code

Title 40 contains a suite of requirements regulating the design, construction and operation of stormwater controls on development and redevelopment sites that will discharge to the MS4 or to waters of the state. Stormwater and erosion control measures are required under Chapter 40.386

Legislative Authority of the Clark County Council

Through the legislative authority of the Clark County Council, Clark County has the ability to enter into contracts and intergovernmental agreements with other permittees and secondary permittees for the purpose of controlling pollutants entering or leaving the county MS4.

TASK CHECKLIST

STATUS	TASK
Ongoing	Maintain legal authority to control discharges to and from the MS4

For more information on the county's Clean Water Division, contact:

Devan Rostorfer, Clean Water Division Manager
564.397.4264
devan.rostorfer@clark.wa.gov

Section 2 – Taking Inventory and Mapping the Stormwater Infrastructure

Clark County operates a municipal separate storm sewer system (MS4) within unincorporated Clark County. This system includes stormwater drainage ditches and pipes in county right-of-way and county-operated conveyances on easements.

An MS4 is a conveyance or system of conveyances that meets all of the following criteria:

1. Owned by a state, city, town, village, or other public entity that discharges to waters of the U.S. (and the state of Washington).
2. Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.).
3. Not a combined sewer.
4. Not part of a publicly owned treatment works (sewage treatment plant).



Stormwater Infrastructure Mapping

A related type of infrastructure used to manage stormwater is a Class V stormwater injection well, which allows stormwater to be disposed directly into the ground instead of to a surface water body.

Clark County inventories and maps its storm sewer infrastructure and Class V injection wells to serve a variety of purposes. The inventory is a primary source of information for inspection, operation and maintenance of the MS4, illicit discharge detection and removal, drainage and source control support, stormwater assessment and monitoring, and capital planning.

Clark County administers a comprehensive program to inventory the storm sewer system in a geographic information system (GIS) database called *StormwaterClk*. All known infrastructure is inventoried and mapped. An ongoing program inventories and maps storm sewer infrastructure built in the course of private development and public capital improvement projects. The inventory includes all stormwater infrastructures inside and outside of the county MS4, including:

- Flow control and water quality treatment facilities
- UIC-regulated Class V injection wells
- County outfall locations
- Conveyances (pipes, ditches and culverts)
- Interconnections with other municipal systems
- Connections to the county MS4

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.2. Municipal Separate Storm Sewer Mapping and Documentation

The NPDES permit requires the county to map and document components of the MS4 including stormwater control facilities, receiving waters and land uses within the MS4.

Chapter 173-218 WAC Underground Injection Control (UIC) Program

Pursuant to Chapter 90.48 RCW, Washington Administrative Code requires owners of Class V injection wells (underground drywells and infiltration trenches with perforated pipes that dispose stormwater into the ground) to comply with regulations designed to protect groundwater quality for use as public water supplies. Clark County owns approximately 1,700 wells that are regulated under this rule.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 40.386 Stormwater and Erosion Control

Chapter 40.386 describes county regulations for ownership of stormwater facilities and the lands on which they are located. Section 40.386.030 sets forth requirements to submit record drawings for completed projects and requirements to document facility ownership.

Section 40.386.030(G) requires developers to submit record drawings to the county prior to 1) the issuance of building permits for single-family/duplex residential subdivisions, 2) the issuance of occupancy permits for site plan reviews, and 3) within sixty days following completion of construction for other types of development.

Clark County Code Chapter 40.540.070 Final Plat

Chapter 40.540.070 describes county regulations for information about dedications and easements for utilities that must be contained on a plat.

Revised Code of Washington Chapter 58.17.165 Plats – subdivisions – dedications

Washington state code prescribes information that must be shown on a plat when land is subdivided, including dedications of roadways and utilities and stormwater easements, tracts, or lots.

TOOLS

StormwaterClk

Clark County Public Works maintains a stormwater database called *StormwaterClk*. The database is administered by the GIS Department, while data is maintained and updated by the Clean Water Division. The GIS data can be accessed in Clark County MapsOnline in the utilities map site.

Land Development Records

Clark County Community Development maintains the *Land Management System*, a database of regulatory and enforcement cases, including permits for land division and development projects.

Annexation Tracker

Annexation Tracker is an application developed by the GIS Department that helps county departments track annexations.

ONGOING INVENTORY AND MAPPING

Purpose

Clark County maps and inventories stormwater treatment and control infrastructure because an accurate and complete inventory is critical to a successful program to inspect, maintain and regulate stormwater conveyances and stormwater treatment and flow control facilities.

As part of the process, new outfalls, Class V injection wells, and connections also are documented.

Background

Most stormwater infrastructure and conveyances in the county are built by the private sector during residential and commercial development. Other facilities are built by the county to retrofit previously developed areas or to handle runoff from new roads, parks and other construction projects. The Clean Water Division builds a limited number of stormwater facilities to retrofit developed areas that lack adequate flow control or treatment. (See County Capital Improvements below.)

After a project is constructed, Clean Water Division staff inventory the new facility and its related conveyance infrastructure including pipes, catch basins and connections in

StormwaterClk.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Infra. Mgr.	CCPW CWD Sr. Eng. Tech	CCCD Dev. Engineering Planning Tech	CCCD Dev. Engineering Mgr.	CCPW Construction Mgmt. Engineer	CCPW Construction Mgmt. OA	CCPW Construction Manager	CCPW Engineering Program Manager	CCPW Survey	CCPW Real Property Services
Notify CWD of new private development completion	O	O	I	P	A	O	O	O	O	O	O
Notify CWD of new county capital improvement project physical completion	O	O	I	O	O	O	P	A	O	I	O
Notify CWD of new county capital improvement project final acceptance	O	O	I	O	O	O	P	A	O	I	O
Gather project information	O	A	P	C	O	C	O	O	A	C	C
Notify CWD of county project As-built location	O	O	I	O	O	S	O	S	O	A/P	O
Make final decision on maintenance owner	O	A	P	O	S	C	O	O	O	C	C
Inventory/ Map infrastructure	O	A	P	O	O	O	O	O	O	O	O
Track progress	O	A	P	O	O	O	O	O	O	O	O
Transfer information to Operations	O	A	P	O	O	O	O	O	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Notification and Tracking

The first step of inventorying is becoming aware that a new development or county project, potentially with stormwater infrastructure, has been completed. The senior engineering technician will regularly query the

LMS for new Development Inspection Numbers (DINs), which are created when engineering plans have been approved for construction.
The senior engineering technician will create a folder for the project on the Clean Water Division's network drive, where copies of relevant documents relating to the project's storm sewer infrastructure will be stored.

Private Sector Projects Notification
The CD Development Engineering planning technician will notify the CCPW CWD senior engineering technician that a new residential or commercial development has been completed by forwarding a copy of the completion of construction letter sent to the developer.

In some cases, the first notification to the Clean Water Division may be a different document, such as notice of a plat recording.

County Projects Notification - Physical Completion
The Public Works Engineering Program Construction Management section will notify the senior engineering technician that new public project is physically complete with a copy of the letter sent to the construction contractor.

Notification of Existing Projects
Infrequently, the senior engineering technician will discover engineering drawings or other evidence of an existing project that does not appear in the inventory. In those cases, the senior engineering technician will begin the mapping process as though it were a new facility by researching information about the project (see below), potentially using legacy data storage systems not discussed here.

Research

The senior engineering technician will research and assemble relevant documentation about the project from various sources, including Development Engineering and the Auditor.
To inventory and map the stormwater infrastructure, the senior engineering technician needs:

- Engineering drawings of the project.
- For private sector projects, the preferred source is a record drawing (sometimes also called an as-built). An acceptable alternate source is an approved construction plan.
- For county projects, the preferred source is a record drawing; however, most projects will be documented initially from the final construction plan with as-built notes from the construction manager.
- Geographic location of the infrastructure.
- Maintenance responsibility for the infrastructure.
- Ownership of tracts or parcels containing the facilities, if any.
- Location of easements containing the facilities and related infrastructure, if any.

Finding documentation may take several steps, outlined below.

Locate and Verify Engineering Drawings
For private sector projects, record drawings are submitted by the private developer to the Development Engineering program in electronic format. The senior engineering technician is then notified of the availability of record drawings.
For county capital improvement projects, Public Works Survey section maintains electronic copies of county projects and places them on the county Olympus server, where they are accessible to the senior engineering technician.

Determine Ownership and Maintenance Responsibility

The senior engineering technician will look for several types of information, including:

- The party responsible for maintaining the stormwater infrastructure.
- The owner of parcel(s) underlying any treatment or flow control facilities.
- The existence of easements for access to stormwater facilities and conveyances.

Responsibility for maintaining facilities may change over time. At this stage, the senior engineering technician will determine the current maintenance responsibility.

The senior engineering technician will evaluate information on legal documents such as the plat map, full plat recordings, covenants and recorded surveys. Ultimately, citing the owner of the land where a facility is located.

Inventory and Map (Digitize)

The senior engineering technician will find the project's location in the GIS. Using the assembled information, the technician will digitize the project's stormwater facilities and related infrastructure, such as conveyance and drywells, in *StormwaterClk*.

The senior engineering technician also will enter attributes of storm system features in the database. Attributes are unique to each feature type. Some of the most important attributes that are common to most types of features include:

- Subwatershed (auto-populated)
- Custodial county department
- Service status
- Installation date
- Elevations
- Dimensions (pipe diameter, length, etc.)
- Facility name (for facility polygons only)
- Serial number of the parcel containing the facility (if relevant)

Transfer Information

Information in *StormwaterClk* is nightly uploaded electronically into the Public Works Cartegraph asset management database which is used to track and schedule inspection and maintenance activities for stormwater infrastructure.

Outputs

- Updates to *StormwaterClk*
- Asset data in Cartegraph

OTHER PERMIT-REQUIRED MAPPING / INVENTORY

Background

The NPDES permit requires both continuation of ongoing inventory/mapping activities (S5.C.2.a) and completion of several additional mapping tasks under (S5.C.2.b).

Specific requirements under permit section S5.C.2.a are addressed through already completed mapping efforts and the ongoing inventory and mapping program includes updates as new development is inventoried.

New mapping requirements under S5.C.2.b are partially addressed through already completed mapping efforts; additional efforts to address specific requirements are described below.

A specific project to complete new mapping will be developed in 2025. The Fee Increase Rate Study will allow Clean Water to complete this mapping.

New mapping requirements are:

- Submitting all outfall locations by March 31, 2026.

- Mapping tree canopy on county property by December 31, 2026.
- Complete outfall catchment mapping for nominal 24-inch outfalls for conveyance systems that contain county-owned treatment and flow control facilities by March 31, 2028.
- Map overburdened communities by December 31, 2028.
- Complete conveyance mapping for nominal 24-inch outfalls by December 31, 2028.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Sr. Eng. Tech	GIS
Map land use	O	O	O	A/P
Map connections to tributary conveyances	O	A	P	O
Map connections between BMPs and tributary conveyances	Completed – updated as needed (CCPW CWD Sr. Eng. Tech)			
Map receiving waters	* Completed for urban area*			
Map areas not draining to outfalls	* Completed for urban area *			
Map outfall catchments	Completed for urban area– updated as needed (CCPW CWD Sr. Eng. Tech)			
Map tributary conveyances	Completed for urban area– updated as needed (CCPW CWD Sr. Eng. Tech)			
Submit all outfall locations	O	A	P	O
Map tree canopy cover on county property	O	A	P	I
Map outfall catchments for 24-inch outfalls	O	A	P	I
Map overburdened communities	O	A	P	O
Map conveyance for 24-inch outfalls	O	A	P	I
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted				

Procedures

Map Tributary Conveyances

Clark County completed an inventory of the conveyance system in early 2010.

Map Connections to Tributary Conveyances

This effort primarily involves mapping private road ditch connections to public road ditches and now applies to areas outside the UGA where the public ditch leads to an outfall with nominal diameter of at least 24 inches. Most county roadside ditches have nominal diameters of 24 inches.

The Clean Water Division is completing an updated inventory of road ditches and stormwater outfalls outside the UGA. Field mapping is accomplished by a driver and GPS operator to record the location of ditches and outfalls. Office post-processing ultimately results in updated ditch and outfall records digitized in the *StormwaterClk* database.

Map Connections between BMPs and Tributary Conveyances

Existing connections, including overflows between BMPs and tributary conveyances are mapped, and new connections will be mapped as part of the ongoing inventory and mapping program.

Map Outfall Catchments
The Clean Water Division completed mapping catchments to most urban area outfalls. This includes nearly 500 outfalls, most of which are smaller than 24 inches of nominal diameter. Catchments to new outfalls will be mapped as outfalls are added.

Map Outfall Land Use
Known outfalls are mapped, and new outfalls will be mapped as part of the ongoing inventory and mapping. As a result of Clark County's function as a land use regulator, the Clark County Assessor maintains land use data at the parcel scale in GIS. To produce a map of land uses for outfalls, Clean Water Division staff or GIS Department staff will overlay land use data with outfall catchments and conveyance systems in the GIS upon request or as needed.

Map Areas Not Draining to Outfalls

In 2010, the CWD and GIS Department mapped areas served by the MS4 that do not drain to surface water within the UGA. For outfalls outside the UGA, areas not mapped as an outfall catchment fulfill this requirement.

Submit all Outfall Locations
Outfall locations are submitted with the NPDES Phase I annual report, due March 31, 2026.

Map Outfall Catchments and Conveyance for 24-inch Outfalls
By 2028, CWD will map catchments and conveyances to outfalls of 24-inch diameter or greater located outside of the previously mapped urban/higher density rural sub-basins.

Map Tree Canopy on County Property
In 2026, CWD will map tree canopy cover to support stormwater management on county-owned or operated properties and develop and follow methodology to identify canopy for stormwater management purposes.

Map Overburdened Communities
By 2028, CWD will use available and existing data to map overburdened communities in relation to stormwater assets and tree canopy cover.

Outputs

- Updated inventory of Stormwater infrastructure in *StormwaterClk*
- Inventory of connections to tributary conveyances in *StormwaterClk*.
- A plan to complete mapping requirements due by March 31, 2026

INVENTORY QUALITY ASSURANCE AND REPORTING

Purpose

To continuously improve accuracy and data completeness in *StormwaterClk* and the Maintenance Management System.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Sr. Eng. Tech	GIS
Ongoing Data Updates	O	A	P	O
Reporting	O	A	P	S
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted				

Ongoing Data Updates

The CWD Infrastructure manager and the senior engineering technician will verify accuracy of stormwater infrastructure in the GIS as annexations occur and as more accurate project plans are produced or discovered.

Annexation Updates

Annually, the Infrastructure manager will check *Annexation Tracker* to determine if stormwater infrastructure has been annexed to a city. The senior engineering technician will change facility ownership attributes and update county MS4 municipal connection points in *StormwaterClk* where infrastructure has been annexed.

Ongoing Corrections

As possible errors in inventory data or needed revisions are discovered, the senior engineering technician will keep a list of possible corrections, then periodically research and, if necessary, correct StormwaterClk. Possible sources of discovery include Public Works Operations and Maintenance personnel, annual stormwater facility inspectors, source control inspections and Clean Water Division engineers. These corrections are addressed in GIS and in updated links to facility assets in the maintenance management system.

Review of Older Paper Plans

The senior engineering technician will review the archive of older paper plan sets to fill gaps in mapping and attributes of existing infrastructure.

Outputs

- Data updates in *StormwaterClk*
- Reports from *StormwaterClk*

UNDERGROUND INJECTION CONTROL (UIC) REGISTRATION

Purpose

Pursuant to the Safe Water Drinking Act and Chapter 90.48 RCW, Washington Administrative Code 173-218 requires new UIC-regulated stormwater disposal wells, also called Class V injection wells and referred to as UIC wells by Ecology, to be registered with the Department of Ecology prior to construction.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Sr. Eng. Tech	CCPW CWD Engineer	CCPW Project Mgr.	CCPW Const. Mgr.	Applicant	CD Dev Eng. Mgr.
Map new Class V injection wells	A	P	O	O	O	O	O
Locate unregistered Class V injection wells	A	P	I	O	O	O	O
Submit private project registrations to Ecology	O	O	O	O	O	P	A
Submit public project registrations to Ecology	O	O	O	P	A	O	O
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted							

UIC Registration for County Projects

The CCPW CWD senior engineering technician will add new UICs to *StormwaterClk* upon project completion as part of ongoing inventory and mapping activities.

UIC Registration for Private Projects Having Public UICs

For privately built projects that include new UICs in the public ROW or that are intended to be turned over to the county, the developer will register the UICs with the Washington Department of Ecology. For all such UICs, Clark County will be designated the owner on the registration form. Registration materials must be submitted to Ecology prior to construction.

When a developer submits plans for review, CD Development Engineering staff will confirm if UIC-regulated systems are included and inform the applicant of registration requirements. Registrations are verified prior to construction by Development Engineering at the pre-construction conference.
The CCPW CWD senior engineering technician will add new UICs to StormwaterClk upon project completion as part of ongoing inventory and mapping activities.

Outputs

- Updates to *StormwaterClk*
- UIC wells registered with Ecology

TASK CHECKLIST

STATUS	TASK
ONGOING	Map all known MS4 outfalls and receiving waters, and structural stormwater treatment and flow control BMPs operated by Clark County
ONGOING	Map connection points between the MS4 and other municipalities
ONGOING	Map existing 8" and greater connections to the MS4
ONGOING	Map tributary conveyances and associated drainage areas
ONGOING	Map geographic areas served by the MS4 that do not drain to surface water
ONGOING	Map connections between BMPs and tributary conveyances
ONGOING	Continue ongoing inventory and mapping
ONGOING	Continue to map connections to tributary conveyances
March 31, 2026	Submit known outfall locations to Ecology
December 31, 2026	Map canopy cover for county properties
March 31, 2028	Map rural outfall catchments with county stormwater facilities
December 31, 2028	Map overburdened communities in relation to stormwater mapping
December 31, 2028	Complete mapping rural conveyance systems

For more information on the county's stormwater infrastructure mapping, contact:

Jeff Schnabel, Clean Water Division Infrastructure and Assessment Services Manager

564.397.4583
jeff.schnabel@clark.wa.gov

Section 3 – Operating and Maintaining the Storm Sewer System, County Property and Roadways

The county inspects and maintains storm sewer infrastructure to maintain its ability to convey, detain, infiltrate and treat stormwater. Clark County also manages its properties and roadways to reduce stormwater impacts from potential pollutant sources such as erosion, fertilizers and pesticides.



County crew replacing filters in a stormwater treatment filter vault system

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit – S5.C.10 Operations and Maintenance

The NPDES permit requires the county to manage its maintenance activities and regulate non-county stormwater facilities to prevent or reduce stormwater impacts. The program must include:

- Maintenance standards and schedules for public and private stormwater facilities including catch basins.
- Street operation and maintenance practices that reduce stormwater impacts.
- Policies and procedures to reduce pollution from pesticides, herbicides and fertilizers used by the county.
- Operational practices that reduce stormwater impacts for equipment yards and storage facilities.
- Staff training.

The 2024 permit adds several new Operations and Maintenance requirements that Clean Water and Road Operations will begin working to implement in 2025. These are:

- Updating county property operation practice to include PCBs in building exteriors by December 31, 2027.
- Implement a street sweeping program by July 1, 2027.
- Begin detailed sweeping program reporting by March 31, 2028.
- Update training to meet more detailed permit requirements.

Stormwater Management Manual for Western Washington

The permit requires the use of source control BMPs equivalent to Volume IV of the *Stormwater Management Manual for Western Washington (SMMWW)* or an approved manual. The Clark County Stormwater Manual, Book 4 contains BMPs equivalent to the SWMMWW and has greater detail than the state guidance.

The permit also requires a stormwater facility maintenance inspection program equivalent to Appendix V-A of Volume V of the SMMWW.

Chapter 173-218 WAC – Underground Injection Control (UIC) Program

Pursuant to Chapter 90.48 RCW, Washington Administrative Code requires the county to comply with regulations controlling the discharge of fluids, such as stormwater, into Class V injection wells. Examples of wells that handle stormwater include drywells and infiltration trenches. The stormwater management program addresses the UIC Program requirement to maintain wells and address pollutant sources.

Endangered Species Act 4(d) Rule

The federal Endangered Species Act prohibits "take" of threatened or endangered salmon. Take is harassment, harm, wounding or killing of an ESA-listed salmon, or harming the critical habitat upon which it depends. The 4(d) rule directly prohibits take without authorization. However, the prohibition is limited under 13 different programs that describe procedures and processes by which an activity may be conducted to contribute to the conservation of the species overall. Road maintenance is an activity that, when conducted according to the Regional Road Maintenance Forum guidelines, is certified by National Marine Fisheries Service to contribute to the conservation of listed salmon.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 40.386 – Stormwater and Erosion Control

Chapter 40.386 requires newly constructed stormwater treatment and flow control facilities to be maintained in accordance with the Clark *County Stormwater Manual, Book 4* – Operations and Maintenance, and it gives the county authority to inspect privately-operated facilities for compliance.

The chapter also requires ownership and maintenance responsibility of private facilities to be noted on subdivision final plats.

The *Clark County Stormwater Manual's Book 3-Source Control* adopts source control and treatment standards for public and private properties equivalent to Volume IV of the SMMWW.

Clark County Code Chapter 13.26A – Water Quality

Chapter 13.26A requires inspection and maintenance of all public and private stormwater facilities and Class V injection wells in accordance with the *Clark County Stormwater Manual*, that provides BMPs for business and public agency activities such as materials handling, landscape management, trash management and building exterior maintenance.

Clark County Environmentally Responsible Purchasing Policy

Clark County adopted its Environmentally Responsible Purchasing Policy in 2004. One element addresses purchase of landscaping and vegetation maintenance products, including pesticides. The policy establishes a set of criteria, any of which will disqualify a

pesticide from purchase, and a waiver system, allowing chemicals with no equivalent that is more environmentally friendly to be used within specific limiting guidelines.

ESA Regional Road Maintenance Forum

Clark County Public Works has been a member of the ESA Regional Road Maintenance Forum since 2003. The group assisted the county in developing a regional road maintenance program designed to meet the requirements of the Endangered Species Act (ESA). In 2004, NOAA Fisheries approved the program and determined that it was compliant with the ESA 4(d) rule. The program seeks to protect salmon and steelhead by relying on the extensive use of pre-approved BMPs for routine maintenance activities. Clark County staff attend the Regional Road Maintenance Forum's Track 3 – Field BMP training on a yearly basis. The training is offered once per year at the WSDOT LTAP Center. This training meets the requirements of Regional Road Maintenance ESA Program Guidelines for Track 3F training.

TOOLS

Cartegraph Asset Management System (Cartegraph)

The *Cartegraph Asset Management System (Cartegraph)* is a database operated by Public Works for tracking infrastructure assets, recording condition, and scheduling inspections and maintenance. Cartegraph was implemented in 2023 and replaced the county's previous Maintenance Management System database in use since 2011. Cartegraph is used to prioritize, schedule and track stormwater infrastructure inspections and maintenance by Public Works crews. It is also used for private facility inspections.

For stormwater facilities and related infrastructure, the inventory in Cartegraph is uploaded directly from *StormwaterClk* (see Inventorying and Mapping the Storm Sewer Infrastructure in Section 2).

INSPECTIONS

Purpose

Clark County inspects both county-owned and regulated non-county stormwater facilities to evaluate condition and function and to determine if maintenance or repairs are warranted. In the case of regulated non-county facilities, follow-up actions include technical support to the BMP owner and, in some cases, enforcement.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Infrastructure Mgr.	CCPW CWD Sr Operations Spec.	CCPW CWD Sr. Eng. Tech	CCPW Construction Mgmt . OA	CCPW Construction Mgmt. Supervisor	CCPW Construction Mgmt. Inspectors	CCPW Ops Road Crews	CCPW Ops Road Supervisor
Inspect Regulated Facilities	A	I	P	S	O	O	S	O	O
Inspect Facilities During Heaviest Home Construction	I	I	O	S	S	A	P	O	O
Inspect County-owned Facilities	I	I	O	S	S	A	P	O	O
Inspect Catch Basins	I	I	O	S	O	O	O	P	A

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Inspect Regulated Facilities

Regulated facilities are treatment and flow control facilities including low impact development BMPs owned and operated by private parties and non-county governmental bodies. Clark County plans to annually inspect 100% of regulated facilities with a permit mandate to inspect at least 80% of regulated facilities connected to the MS4.

County responsibility for inspecting regulated facilities will begin at issuance of the completion of construction letter by CD Development Engineering or the occupancy permit for individual residence projects subject to maintenance requirements. (See Regulatory Program for Development, Redevelopment and Construction Projects in Section 5)

For facilities not in compliance with maintenance standards, the county will follow procedures to compel compliance through follow-up technical assistance and enforcement actions if needed.

Track and Schedule Annual Inspections

Public Works Clean Water Division will use Cartegraph applications on iPad devices to schedule, log and track regulated facility inspections.

Inspection

Inspections will be completed by Public Works Clean Water Division operations specialists. Inspections are also combined with business source control inspections. The inspectors will compare facility condition with maintenance standards from the Clark County Stormwater Manual.



Facility inspection

Contact Owners of Non-Compliant Facilities
If an inspection shows that a facility is out of compliance, the Clean Water Division senior operations specialist will send a mailing to the owner(s) and/or responsible party. In many cases, a meeting with the owner will be sufficient to identify needed maintenance.

Facility ownership or homeowner association leadership may change. In some cases, no viable homeowner association exists. The Clean Water Division senior operations specialist will research and follow up in these cases.

Follow-Up Technical Assistance
The Clean Water inspectors will assist owners who reply to the initial letter by giving advice on maintenance. The assistance may include phone calls, additional correspondence and site visits. The inspector will facilitate compliance and use professional judgment to set deadlines for compliance activities.

Further Enforcement
If the owner or owners of a non-compliant facility are unresponsive, then the Senior Operations Specialist will refer the case to Community Development Code Enforcement Division.

The code enforcement officer will use progressive enforcement methods, terminating with a Notice and Order and issuance of fines and liens in cases where the owner refuses to comply.

Alternate Compliance Strategy
The county retains the option of maintaining the facility and billing the owner at any point after an inspection demonstrates that a facility is out of compliance. This is a costly and time-consuming option, so it is generally avoided.

Compliance Tracking
Public Works Clean Water will update facility records with compliance information on a regular basis, including inspection results, contact information and other relevant facility information. Follow-up and enforcement actions will be tracked by the Clean Water Division senior operations specialist and tracked as case files.

Inspect Facilities During Heaviest Home Construction

Clark County will inspect permanent stormwater treatment and flow control facilities, including catch basins, in new residential developments every six months during the period of heaviest construction. The NPDES permit defines the period of heaviest construction as the time until 90 percent of the lots are built out (see condition S5.C.5.b.vi.d).



Residential development

Maintain Inspection List
Construction Management runs a report from permit tracking software listing the number of lots in the subdivision and the number of lots having active building permits.

Schedule Inspections
The Public Works Construction Management lead inspector will consult the inspection list monthly and schedule project sites requiring inspection for the following month. Any subdivision with less than 90 percent of the

lots built out will be scheduled. The Public Works Construction Management lead inspector will schedule six-month inspections for each project using the inspection list.

Inspection
Public Works Construction Management inspectors will inspect project sites using standards from the *Clark County Stormwater Manual*.

Track Inspections
The Public Works Construction Management inspector or office assistant will enter the inspection results into permit tracking software under the DIN (development inspection number). The electronic field inspection form is attached to the DIN case.

Enforcement
The method used to enforce maintenance compliance of a facility found to be out of compliance will depend on its ownership.

When a private facility or catch basin is out of compliance, the standard process for enforcement on a regulated facility will be followed.

When a county-owned facility or catch basin on maintenance warranty is out of compliance, the inspector will refer the issue to the Public Works development inspector assigned to that development project.

When a county-owned facility or catch basin is out of compliance after the warranty period, the facility will be treated as any other county-owned facility.

Inspecting County-Owned Facilities

The Clark County Public Works Construction Management Program annually will inspect at least 95% of county-owned stormwater treatment and flow control facilities. Facilities with known problems may be spot-checked by Public Works Operations and Maintenance after significant storm events in addition to routine inspections.

- For county capital improvement projects, inspection responsibility will transfer to the county at the issuance of the final acceptance letter to the contractor by Public Works Construction Management.
- For facilities constructed as part of a private-sector development project that did not include a warranty period, maintenance responsibility will transfer to the county two years after issuance of the completion of construction letter to the developer. (See Regulatory Program for Development, Redevelopment and Construction Projects in Section 5.)

Inspection
Public Works Construction Management will inspect facilities using standards from *the Clark County Stormwater Manual*. Crews will note compliance and defects using the same field applications used for regulated facilities.

Tracking
Public Works Construction Management inspection results are collected in Cartegraph using the iPad-based field applications.

Spot Checks
After significant storms, Public Works Road Operations will inspect facilities that have known problems associated with heavy rainfall.

Photo Documentation
The Fee Increase Rate Study will allow Clean Water to complete photo documentation of county stormwater assets.

Inspect Catch Basins

Inspect and Clean Catch Basins
The Clark County Public Works Operations and Maintenance Program will inspect catch basins in road right-of-way annually. Each catch basin is inspected, and those exceeding sediment depth standards are scheduled for cleaning.

Catch basins in parks and other county facilities will be inspected and cleaned as part of routine maintenance by Public Works.

Training
The Fee Increase Rate Study will allow Clean Water to fund a more rigorous training program to meet the requirements of perm component S5.C.10.

Outputs

- Cartegraph records of regulated facility inspections
- Updates to six-month inspection list
- Spot checks of public facilities after severe storms
- Catch basin cleaning
- Cartegraph records of public facility inspections
- Asset photo documentation in Cartegraph

COUNTY STORMWATER FACILITY AND CLASS-V INJECTION WELL MAINTENANCE

Purpose

Maintenance of stormwater facilities and stormwater disposal wells ensures that facilities continue to perform their important environmental and drainage functions. Clark County Public Works is responsible for maintenance of most county stormwater infrastructure when it fails to meet a maintenance standard established by permit and county standards.

County responsibility for maintaining county-owned stormwater treatment and flow control facilities will begin at issuance of the final acceptance letter for those constructed as part of a county capital improvement and at the end of the maintenance warranty period for those built as part of a private-sector development project. (See Regulatory Program for Development, Redevelopment and Construction Projects.)

The county does not maintain private stormwater facilities except in emergency situations or when pursuing an alternate compliance strategy for a non-compliant facility, whereby the county maintains the private facility at the owner's expense.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD NPDES Mgr.	CCPW CWD Sr. Eng. Tech	CCPW Road Ops and Parks Supers	CCPW Ops Roads and Parks Crews	Contract Services
Routine Facility Maintenance	I	I	S	A	P	O
Non-routine Facility Maintenance	C	C	S	A	P	P
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted						

Typical Facility Maintenance

Clark County will perform routine maintenance, such as litter removal, mowing and weed control, on swales, ponds, filter strips and LID BMPs that it owns. Typical maintenance is regular activities that maintain a facility's function that can be accomplished primarily with hand tools, lawn mowers and weed whackers, and do not require engineering evaluation or heavy equipment. It does include cleaning sediment traps using vacuum trucks.

The following procedure applies to stormwater facilities maintained by Public Works, such as those in subdivisions and road right-of-way. Maintenance of county stormwater facilities located in parks and on county campuses is also performed by Road Operations.



Stormwater facility maintenance

Schedule and Prioritize

Most of the typical facility maintenance will occur during the growing season (April to September). The Clark County Public Works water quality crew chief will schedule the work.

Maintenance

Mowing grass, controlling weeds and litter or debris removal are the primary typical maintenance activities. Other maintenance for defects including sediment accumulation in sediment traps, minor erosion, presence of trees in pond or swale bottoms, etc., is also part of typical maintenance.

Capital Construction Facility Maintenance

Prioritization and Budget

The Clean Water Division and Road Operations will develop an annual work plan for maintaining and repairing facilities that require capital construction under $25,000 as indicated by inspection results and repair tasks created in Cartegraph.

Individual maintenance projects estimated to cost more than $25,000 are referred to the Stormwater Capital Program.

The Fee Increase Rate Study will allow Clean Water to improve long term facility repair and replacement.

Inspection Data Review

The Public Works Road Operations Superintendent and crew chief will schedule facility maintenance requiring construction in consultation with the Clean Water Division Infrastructure Manager.



Filter vault cartridges

Implementation

Maintenance requiring construction is accomplished as resources and weather allow within permit timelines.

Pipe Asset Inspections

The Fee Increase Rate Study will allow Clean Water and Public Works to provide prioritized inspections of previously uninspected pipes. This work will be coordinated with pavement preservation.

Switch to Phosphorus Treatment Cartridges

The Fee Increase Rate Study will allow Clean Water to switch from ZPG cartridges to Phosphosorb cartridges which are easier to use and remove phosphorus for drainages to sensitive water bodies.

Permeable Pavement Maintenance

The Fee Increase Rate Study will allow Clean Water and Public Works to increase maintenance of permeable road surfaces.

Drywell Maintenance

Public Works Road Operations maintenance crews will maintain drywells (Class V stormwater injection wells) as necessary based on a visual inspection of defects. Drywells in stormwater facilities will be inspected annually as part of routine facility inspections. Drywells in streets and roads will be inspected at the time catch basins are inspected.

Proactive Drywell Inspection and maintenance

The Fee Increase Rate Study will allow Clark County to perform proactive drywell inspection and maintenance.

Outputs

- Stormwater facilities are maintained and repaired to meet county standards.
- Permeable pavement maintained more frequently.
- List of projects referred to the capital planning program for repairs greater than $25,000.
- Database records of facility maintenance work (Cartegraph.

County Property and Roadways

USE OF WATER QUALITY BMPS DURING ROADWAY AND COUNTY PROPERTY OPERATION AND MAINTENANCE

Purpose

Clark County maintains its properties and roadways in a manner that prevents or reduces stormwater impacts.



Stormwater facility with recently planted vegetation

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Permit Mgr.	CCPW CWD Sr. Operations Specialist	CCPW Ops or Parks Mgrs	CCPW Road Ops Super	CCPW Ops Roads Crews	CCPW Parks Super	CCPW Parks Crews	CCPW Land and Noxious Weeds Mgr.	CCPW Noxious Weeds Mgmt. Crews	Internal Services, Facilities Mgr.	Internal Services, Facilities Crews
Annually inspect and maintain catch basins in parks	I	I	O	A	O	S	A	P	O	O	O	O
Annually inspect and maintain catch basins on campuses	I	I	O	I	O	S	A	P	O	O	A	O
Road maintenance practices	I	I	O	A	C	P	O	O	O	O	O	O
Landscape maintenance on campuses	I	I	C	C	O	O	A	P	O	O	A	O
Landscape maintenance in parks	I	I	C	A	O	O	A	P	O	O	O	O
Noxious weed removal practices	I	I	C	O	O	O	O	S	A	P	O	O
Exterior building and grounds maintenance	I	I	C	O	O	O	O	S	O	O	A	P
Training road maintenance crews	I	S	S	A	P	I	O	O	O	O	O	O
Training parks maintenance crews	I	S	S	A	O	O	P	I	O	O	O	O
Training weed management crews	I	S	S	O	O	O	O	O	A	P	O	O
Training Facilities Maintenance crews	I	S	S	O	O	O	O	O	O	O	A	P
Check SWPPPs	I	S	O	A	O	P	O	O	O	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Maintain Roadways

Road maintenance and operation will be conducted by the Public Works Road Maintenance and Operations Division.

Clark County will maintain roadways and other traveled surfaces using pollution reduction practices defined by the ESA Regional Road Maintenance Program and in Clark County Stormwater Manual.

In 2025, Public Works will begin planning for permit-mandated sweeping in 2026. Currently, Sweeping is performed on a schedule different than the permit mandated program.

The Fee Increase Rate Study will allow Clean Water to support more frequent street sweeping under an enhanced sweeping plan.

Maintain Pervious Sidewalks

The Fee Increase Rate Study will allow Clean Water to fund pervious sidewalk maintenance.

Specific pollution-reduction activities include:

- Periodic removal of litter from conveyances, such as ditches.
- Catch basin cleaning.
- Sweeping curbed roads in priority areas.

This section needs should be under maintaining county property on p[age 43 for county operations under S5.C.10.e. Practices to prevent pollution will be implemented whenever the following maintenance activities are conducted:

- Pipe cleaning
- Ditch maintenance
- Street cleaning
- Road repair and resurfacing, including pavement grinding
- Snow and ice control
- Utility installation
- Maintaining roadside areas, including vegetation management
- Dust control
- Pavement striping maintenance
- Application of fertilizers, pesticides and herbicides according to the instructions of their use, including reducing nutrients and pesticides and using alternatives that minimize environmental impacts
- Sediment and erosion control
- Landscape maintenance and vegetation disposal
- Trash and pet waste management
- Building exterior cleaning and maintenance
- Preparing for building renovation or demolition



Street sweeper with clean water message

Maintain Parks

Parks may contain any or all of the following types of land cover: pavement, landscaped areas, natural areas, structures and stormwater facilities. Parks will be maintained by Public Works Parks and Lands Division.

Clark County will maintain park vegetation and structures according to *Clark County Stormwater Manual*, county policies and procedures, and current pesticide application rules. Pesticides will be purchased according to the county's Environmentally Responsible

Purchasing Policy. Parks maintenance crew members are trained under the ESA Regional Forum and are state licensed pesticide operators.

Parks crews will inspect catch basins within parks during routine park maintenance and will clean them as needed.

Parks crews will mow and remove litter from stormwater facilities within parks during routine park maintenance. Public Works Road Maintenance and Operations will provide the balance of the maintenance.

Maintain County Property

County campuses are managed by the Internal Services department Facilities Division. Facilities personnel maintain pavement and building exteriors; Facilities has an agreement with Public Works Parks and Lands Division for most outdoor vegetation management activities.

Building exteriors are maintained by Internal Services Facilities Division. Facilities will inventory buildings built or renovated from 1950 to 1980 due to concern about PCBs in building materials.



Salmon Creek at Highway 99

Clark County will maintain landscaping and hard surfaces on its campuses according to the *Clark County Stormwater Manual*. Pesticides will be purchased according to the county's Environmentally Responsible Purchasing Policy. Parks maintenance crew members are trained under the ESA Regional Forum and are state licensed pesticide operators.

Parks crews will mow and remove litter from stormwater facilities on county campuses as needed based on visual inspection.

Clark County implements a Stormwater Pollution Prevention Plan (SWPPP) for each of its heavy equipment and materials storage yards, operated by Public Works. Copies of the SWPPPs are kept at each site. Areas of maintenance facilities covered by the Ecology Sand and Gravel General Permit will operate under that permit.

Control Weeds on County Property

State regulated noxious weed control on county properties is provided by Public Works County Lands Management Division.

Clark County will control weeds according to current pesticide application rules. Pesticides will be purchased and used according to the county's Environmentally Responsible Purchasing Policy.

Noxious Weed Management field crews are state licensed pesticide operators.

For some areas, such as mitigated wetlands and properties with Legacy Lands designation, Noxious Weed Management may take additional measures to ensure compliance with all environmental regulatory requirements, including NPDES permit requirements, will be achieved.

Employee Training

Crews from Public Works Operations and Maintenance, Parks and Nature, and County Lands Management Divisions are trained at the Regional Road Maintenance Forum's Track 3 – Field BMP training. Track 3 provides crew chiefs and crew members with maintenance guidelines and procedures to protect endangered species during maintenance work.

In addition to task specific training, county personnel who as part of their field work may encounter a spill or non-stormwater discharge are trained on how to respond.

Train New Personnel

Clark County Public Works will provide ESA Regional Road Maintenance training using an approved vendor for new or promoted staff, as necessary.

Outputs

- Maintenance of county property using proper BMP manuals
- Employee training
- Stormwater Pollution Prevention Plan at each heavy equipment and storage yard.

TASK CHECKLIST

STATUS	TASK
ONGOING	Spot check facilities with known problems after significant storms
ONGOING	Annually inspect and clean, if needed, county-owned catch basins
ONGOING	Implement established practices to reduce stormwater impacts from property and landscape maintenance activities
COMPLETED	Document practices to reduce stormwater impacts from property and landscape maintenance activities for county property
ONGOING	Employee training
ONGOING	Update SWPPPs for county equipment yards
ONGOING	Adopt and implement maintenance standards equivalent to the SMMWW
ONGOING	Require maintenance of regulated facilities to the SMWW
July 1, 2027	Begin mandated road sweeping in curbed priority areas
ONGOING	Implement program to annually inspect all regulated facilities
ONGOING	Inspect all new facilities in new residential developments every 6 months during the period of heaviest construction
ONGOING	Inspect all county-owned facilities annually

Stormwater Pipe Inspection Program

In 2026, CWD will develop a stormwater pipe inspection program, with initial implementation targeting high priority pipe segments.

For more information on county operation and maintenance of the MS4:

Jeff Schnabel, Clean Water Division Infrastructure and Assessment Services Manager
564-397-4583
Jeff.Schnabel@clark.wa.gov

Section 4 – Detecting and Reducing Pollutants and Contamination

Contaminants may enter the MS4 through improper connections and through discharge of contaminants from sites with private storm systems that are connected to the MS4. Eliminating illicit (non-stormwater) connections and discharges of contaminants is an important part of the county's Stormwater Management Program.

> *Improper non-stormwater connections may be discovered through routine screening of the system, site inspections or by complaint. When an improper connection is discovered, removal and disconnection is a high priority.*

Regular and wide-spread inspections of business and multi-family sites helps ensure that sites are properly managing potential contaminants, maintaining catch basins and conveyance systems, and preventing non-stormwater discharges into their private systems that discharge to the MS4. Along with meeting NPDES permit requirements, the program also addresses sources that do not discharge to the Permit-regulated MS4, including discharges to Class V injection wells, non-county storm drains and other conveyances to surface water and groundwater.

Source Control Program

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.8 – Source Control Program for Existing Development	The NPDES permit requires the county to reduce pollutants in runoff from areas that discharge to the MS4 by applying operational, structural source control and treatment Best Management Practices (BMPs); enforcing proper BMPs on commercial, industrial and multifamily properties; enforcing water quality ordinances; and reducing pollutants from pesticides, herbicides and fertilizers entering the MS4.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 40.386 – Stormwater and Erosion Control

Chapter 40.386 adopts the *Clark County Stormwater Manual* as the technical manual for meeting the Minimum Requirements of the Permit, including Minimum Requirement 3, Pollution Source Controls.

Clark County Code Chapter 13.26A – Water Quality

Clark County prohibits non-stormwater discharges to the MS4 and regulates the discharge of contaminants to surface water, stormwater and groundwater to protect the county's surface and groundwater quality. The code and stormwater manual provide requirements for reducing and controlling the discharge of contaminants by requiring all sites and activities to utilize source control Best Management Practices (BMPs) to control release of contaminants.

Chapter 13.26A adopts the *Clark County Stormwater Manual* that provides BMPs for materials handling, landscape management, trash management and building exterior maintenance.

Clark County Stormwater Manual

The *Clark County Stormwater Manual* contains technical requirements for meeting Minimum Requirement #3, Source Control of Pollution under county code Chapter 40.386 for development projects The manual also applies to existing land uses under Chapter 13.26A.



Sunset reflecting off the water at Vancouver Lake

INVENTORY POTENTIAL POLLUTANT GENERATING SITES

Purpose

The Potential Pollutant Generating Site inventory helps target education and enforcement of source control requirements on commercial, industrial and multifamily sites. The site inventory also meets a requirement of the NPDES permit.

Responsibilities Matrix

Task	CCPW CWD Source Control Specialist	GIS	CCPW CWD NPDES Mgr.
Update inventory of sites	S	P	A
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted			

Inventory Maintenance

The Clean Water Division uses several sources to identify commercial, industrial and multifamily sites in the county that have impervious surfaces.

The database is derived from the Clark County Assessor personal property tax database and fire marshal inspection data. As inspections progress to include most permanent business sites, the site information such as contact information updated based on site-specific information. The inventory will be updated once during the permit term.

Outputs

- Inventory of business and multifamily sites.

SOURCE CONTROL AT BUSINESS AND MULTIFAMILY SITES

Purpose

Clark County inspects business sites and many multifamily sites for compliance with source control requirements to ensure pollutants are not discharged to the MS4 or groundwater via Class V stormwater infiltration wells.



Typical residential catch basin

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Source Control Specialist	CCCD Code Enforcement Officer	CCPW CWD Outreach Specialist Sr.	CCPW CWD OA
Site selection	A	P	O	O	O
Inspection / education	A	P	S	S	O
Follow-up for compliance	A	P	S	O	O
Referral	A	P	S	O	O
Recordkeeping	A	P	S	O	P
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted					

Site Selection

Each year, a group of sites are selected for inspection based on land use risk and results from past inspections.

Inspection and Education

Inspections are conducted by qualified county staff. Clean Water Division source control specialists inspect sites.



Grease trap in need of maintenance

At each business site, county staff will approach the owner, manager, or other employees to obtain access to the storm system on the site and to ask questions about source control practices, drainage plumbing, materials storage, and, if relevant, structural source control BMPs.

Staff will note inspection findings using the i-pad field form and enter results into the Pollution Prevention Assistance database in Secure Access Washington (SAW).

During the visit, county staff will provide education and technical assistance as judged necessary or beneficial. Education or assistance could include brochures, BMP handouts, general information on stormwater pollution topics, information about managing hazardous materials, and referrals to a maintenance company for catch basin cleaning.
Materials such as spill kits and barrel lids are also provided.

Follow-up Actions for Compliance

If a business is not in compliance, the source control specialist will work with the manager or owner to reach compliance. Follow-up actions may include phone calls, additional site visits and letters. County staff may give additional technical assistance such as locating engineering drawings, providing handouts from the *Clark County Stormwater Manual* or Ecology and recommending new source control BMPs.

The source control specialist will set deadlines as necessary for compliance actions (e.g. cleaning catch basins).

Follow-up actions will also be recorded using the iPad field form.

Catch Basin Cleaning Assistance

In late 2018, a new program was implemented to provide catch basin cleaning services for a rate that is currently about $50 per catch basin. Out of compliance businesses are referred to the county webpage where businesses can register for the service. The contractor then performs the catch basin cleaning, properly disposes of waste material, invoices the business and provides a manifest of proper waste disposal. Mailers promoting the program were sent to all business sites draining to the county storm sewer system.

Referral

If necessary to gain compliance, the source control specialist will refer the case to another agency such as Clark County Public Health, Ecology or the Clark Regional Wastewater District. The source control specialist will continue to follow the case to conclusion.

Further Enforcement Actions

Further enforcement will be provided by the Community Development Code Enforcement Division or by referral to Ecology in cases of continued inaction.

Recordkeeping

Information status is stored in a database linked to the iPad Survey 123 and Collector applications. Non-stormwater discharges are logged in the county IDDE database and site visit information is logged in the state SAW database under the Pollution Prevention Assistance program. The SAW PPA database is used to create a report to include in the permit annual report.

Training

All county employees who conduct field work need to be aware of spill response procedures and protocols. A training program is established using the county's Workday online training program. Field personnel from multiple departments will be required to complete the training annually to ensure they are familiar with illicit discharge, illicit connections, use of spill kits, and what to look for in the field.

Outputs

- Records of inspections and follow-up cases
- Report of numbers of inspections and referrals
- Case files



A typical emergency spill kit

WATER QUALITY COMPLAINT INVESTIGATIONS

Purpose

Clark County investigates all legitimate complaints about water quality problems to reduce contamination of stormwater, surface water and groundwater as well as to comply with its NPDES Permit.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD Source Control Specialist	CCPW CWD OA	CCPW CWD Natural Res. Specialist	CCCD Code Enforcement Officer
Open case	A	P	O	O	S
Investigation	A	P	O	S	S
Education and compliance	A	P	O	O	S
Recordkeeping	A	P	S	S	S
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted					

Open Case

Water quality complaints may arrive in a variety of ways, including the 24-hour water quality complaint line, referral from other agencies, referrals from Community Development Code Enforcement Officers, e-mail to the Clean Water Division general address, and phone calls to the Clean Water Division. Complaints may be made by the general public or agency staff.

Complaints will be referred or forwarded to the Public Works Clean Water Division source control specialist.

Investigation

The source control specialist will investigate every legitimate complaint beginning with a phone call and site visit.

The source control specialist will fill out the information in the IDDE database. and begin a case file as appropriate.

Education and Compliance

If a water quality or source control violation is found, the source control specialist will work with the property owner or property manager on compliance or refer the case to another agency. The source control specialist generally follows the procedures for source control follow-up (above), and, if necessary, further enforcement actions.

Recordkeeping

A Public Works Clean Water Division source control specialist will enter the data into the IDDE tracking database and maintain a case file.

Outputs

- Records of complaints, investigations and follow-up
- Case files

Training

Clean Water Division personnel have been performing source control inspections, technical assistance and enforcement since 2000. When applicable, new staff will be trained on enforcing the Water Quality Ordinance, including legal basis, BMPs, inspection procedures, enforcement process and recordkeeping. When changes to manuals or procedures are made, all appropriate staff will be trained.

A new employee training program was established in 2025, when a senior environmental operations specialist position was added.

TASK CHECKLIST

STATUS	TASK
ONGOING	Source control inspections and enforcement
ONGOING	Staff training for source control
ONGOING	Update inventory of pollution-generating sites
ONGOING	Inspect sites, enforce and respond to complaints
Completed	Update county municipal code per permit requirements
Completed	Update county stormwater manual per permit requirements

For more information on the Source Control program:

Rod Swanson, Clean Water Division NPDES Permit Manager
564-397-4581
Rod.Swanson@clark.wa.gov

Illicit Connections and Illicit Discharges Detection and Elimination (IDDE)

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.9 – Illicit Connections and Illicit Discharges Detection and Elimination (IDDE)

The NPDES permit requires the county to have a program to detect, remove and prevent illicit connections and illicit discharges, including spills, into the MS4. Illicit connections are man-made conveyances connected to the MS4 without a permit, such as sanitary sewers and floor drains that can carry materials other than stormwater. Illicit discharges are discharges to the MS4 not composed entirely of storm water, except where allowed by a state waste discharge permit.

The Permit designates timelines for beginning an investigation of a suspected illicit connection and for terminating a confirmed illicit connection.

Revised Code of Washington Chapter 90.48 – State Water Pollution Control Act

The State Water Pollution Control Act prohibits the discharge of contaminants to waters of the state.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 13.26A – Water Quality

Chapter 13.26A prohibits the discharge of contaminants into surface water, stormwater or groundwater, and it defines contaminants and illicit connections. It gives inspection and enforcement authority to authorized representatives of the County Manager to enforce that chapter.

Clark County Code Chapter 13.10 – Use of Sewer

Chapter 13.10 requires the use of sewers to dispose of liquid wastes and water carrying waste materials.

Clark County NPDES Illicit Discharge Detection and Elimination Screening Quality Assurance Project Plan

The Project Plan addresses project design, schedule, methods of data collection and management, quality assurance and control requirements, data analysis, thresholds for further investigation, and reporting for the county's program to screen the MS4 for illicit connections.

ILLICIT DISCHARGE AND CONNECTION SCREENING

Purpose

Screening for evidence of illicit discharges and connections helps county staff identify outfalls or points in the MS4 that appear to convey something other than stormwater, as well as meeting Permit requirements for ongoing screening.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW CWD NPDES Mgr.	CCPW CWD Natural Res. Specialist
Screening area selection	A	S	P
Outfall selection	A	I	P
Site visits / screening	A	I	P
Sampling / evaluation	A	I	P
Recordkeeping	A	I	P
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted			

Ongoing Work

Clark County carries out an extensive screening program and has screened the entire urban area and several rural subwatersheds at least once.

Public Works Clean Water Division natural resource specialists will continue effectiveness monitoring on illicit connections discovered during previous field screening operations (see Illicit Connection and Discharge Response and Removal). In addition, a natural resource specialist or source control specialist will respond to any complaints and referrals.

Source control inspections are an important element of illicit discharge detection (see Source Control Program).

Screening Site Selection

In 2026, a Clean Water Division natural resource specialist will select subwatersheds for screening based on professional judgment.

Rural ditch sites are selected to ultimately screen all roadside ditch conveyance systems.

Outfall Selection and Scheduling
A Clean Water Division natural resource specialist will use the county stormwater infrastructure inventory GIS database, *StormwaterClk*, to locate and map all outfalls within chosen screening area. Staff will schedule site visits using this information.

Site Visits
During the summer season, a natural resource specialist will screen outfalls for indicators of illicit connections, such as flow or deposits.

Rural ditch conveyance systems are screened for possible non-stormwater discharges from businesses and farms. Screening is performed through a windshield survey using a driver and an observer concurrently with ditch and outfall mapping efforts (see Other Permit-required Mapping/Inventory in Section 2)

Potential illicit discharges are documented by the observer and referred to the source control specialist to schedule a site visit.

Sampling and Evaluation
The natural resource specialist will take samples at flowing outfalls, use field tests and send them for laboratory analysis, and then evaluate the results using defined protocols to determine if an investigation is warranted. In cases where an investigation is warranted, the discharge is called a suspected illicit discharge or connection.

Investigations and follow-ups are part of the Illicit Connections and Discharge Response program (below).

Recordkeeping
The natural resource specialist will track all information regarding screening, illicit connection investigations and response to illicit discharges if applicable, in the IDDE screening iPad application. Database fields are based on those described in the 2024 permit Appendix 14.

Reporting
Each year, the source control specialist will compile Appendix 14 data and stored in Clean Water project folders. In addition, database information is reported to ecology in the annual report.


Stormwater outfall

Awareness Training
A training program was established using the county's Workday training online program. Field personnel from multiple departments will be required to complete the training annually to ensure they are familiar with illicit discharge, illicit connections, use of spill kits, and what to look for in the field. Clean Water also provides in person training to restaurant inspectors and at the annual all staff Public Works meeting.

Outputs

- Records in the IDDE screening database
- Annual written summary of screening activities, investigations and results
- Report of data from the Permit Appendix 14 database

- Laboratory data and field measurements entered in the Water Quality Database

ILLICIT CONNECTION AND DISCHARGE RESPONSE AND REMOVAL

Purpose

Clark County responds to all suspected illicit discharges and connections to the MS4 that it identifies through screening or other methods. Response is designed to eliminate the source of the discharge or the connection.

Responsibilities Matrix

Task	CCPW CWD NPDES Mgr.	CCPW CWD Natural Res. Specialist	CCPW CWD Source Control Specialist	Public Health	CRWWD	Ecology
Open case	A	I	P	O	O	O
Investigation	A	S	P	S	S	S
Follow-up / removal	A	I	P	S	S	S
Continued follow-up	A	S	P	S	S	S
Recordkeeping	A	P	S	O	O	O
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted						

Suspected Illicit Connection and Discharge Response

The CCPW Clean Water Division and Public Works Operations Division will receive and respond to reports of suspected illicit discharges; however, some illicit connections or discharges due to on-site sewage treatment systems are discovered and terminated by Clark County Public Health. The process described here is that used by the Clean Water Division and Public Works.

Notify Ecology

The county immediately will notify Ecology if an illicit discharge or connection poses a threat to human health or the environment. Notifications are often used by using ERTS.

Open Case

The process begins with notification about a suspected illicit discharge or connection through referral from illicit detection screening (above), discovery through source control inspections (above), or complaint.

The source control specialist will open a case file.

Investigation

Within 21 days, the Clean Water Division source control specialist and a natural resource specialist will attempt to trace a suspected illicit discharge or connection back to its source to identify the problem. If tracing back to the source is not possible, they may elect to follow other protocols established in the IDDE Project Plan.

The source control specialist will confirm the presence or absence of the suspected illicit discharge or connection based on the findings, and, when possible, will specify the source.

Follow-up and Removal

For confirmed illicit discharges or connections, the source control specialist will work with the property owner and, if necessary, other county departments or agencies to eliminate the illicit connection. If relevant, Clark Regional Wastewater District, Public Health, cities, or the Department of Ecology may be requested to assist in areas where they have responsibility.

Addressing illicit discharges will follow standard source control procedures for follow-up actions (e.g. personal contacts) and further enforcement by a Code Enforcement Officer, if necessary.

Removal of illicit connections will be completed within six months of confirmation of an illicit connection through field verification.

Continued Follow-up

Following the IDDE Project Plan, questionable outfalls require continued follow up, which may include effectiveness monitoring at sites where illicit connections or discharges were found, repeat screening where low levels of pollutants were found, or additional visits by the source control specialist to verify that actions leading to an illicit discharge have ceased.



Culvert under a road

Recordkeeping

The source control specialist will inform the natural resource specialist of the results of the follow-up actions involving illicit discharge or connection abatement. The natural resource specialist will enter information into the IDDE screening database.

If the case is a suspected illicit connection, the date it was first discovered or reported will be used to track the requirement to initiate an investigation with 21 days.

After the illicit connection is confirmed, the requirement to terminate the connection within six-months will apply. If the suspected connection was identified through field observation, source control inspection, or complaint, the discovery date is the date the observation or complaint was made. If the suspected connection was identified through laboratory analysis, the discovery date is the date of the official laboratory report. Discovery dates will be recorded and tracked in the IDDE database. A record is kept for every illicit connection referred to Ecology as a severe threat to human health or the environment. These are entered into the IDDE database.

Outputs

- Removal of illicit connections and reduction of illicit discharges to the MS4.
- Entries in the IDDE database.

SPILL RESPONSE

Clark County responds to spills on surfaces, such as roadways, that discharge to the MS4, surface water or groundwater, and to improper dumping into the MS4.

Purpose

The purpose is to reduce and prevent contamination of surface water, groundwater and stormwater.

Responsibilities Matrix

Task	CCPW Ops Admin.	CCPW Ops Crew Chief	CCPW Ops Road Crews	CCPW Operations OA
Open case	I	A	I	P
Spill response / clean-up	I	A	P	O
Notify Ecology	A	P	S	P
Recordkeeping	A	P	C	S
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted				

Notification

Spill notification can arrive in a variety of ways, including detection by Public Works Operations and Maintenance roads crews, Ecology ERTS reports or citizen complaint to Clark County or Ecology.

Clark County staff receiving notification of a spill will immediately notify Public Works Operations and Maintenance dispatch. Public Works Operation and Maintenance staff will then notify the Clean Water Division senior operations specialist. For spills responded to by Public Works crews, the Crew Chief will call Ecology's spill response team in the Vancouver Field office, if necessary. Clean Water Division senior operations specialists will also be responsible for ensuring spills are reported to Ecology's 24-hour spill reporting number.

County personnel also will immediately refer significant spills to Department of Ecology

Response

Spill reports received by Public Works generate a Cartegraph service request, the appropriate crew responds to work order and, if necessary, they call Ecology or notify the Clean Water Division senior operations specialists who will report the spill to Ecology. For urgent complaints arriving after hours via telephone, the answering service will page the Public Works Operations and Maintenance on-call crew chief, who will determine the

level of response following established Public Works guidelines.

Recordkeeping

Records of spill incidents and responses will be kept in the Public Works customer service database. If there is a discharge is to the MS4, the Clean Water Division senior operations specialist responds, the spill will be recorded in the IDDE database. The Public Works phone operator enters the phoned-in spill report into the tracking system. The crew chief enters all follow-up information and closes out the work order.

Outputs

- Spill clean-up
- Records of incidents responses

WATER QUALITY PROBLEM REPORTING

Purpose

Clark County advertises Ecology's spill response hotline as a water quality complaint line. The line gives citizens an opportunity to report spills, dumping and other water quality concerns at any time. The Clark County webpage also includes a web-form to report a spill or environmental problem in the home page "How do I" tab. The webpage includes contacts for non-emergency concerns and has phone numbers for reporting at: clark.wa.gov/public-works/report-stormwater-erosion-or-drainage-concerns.

Responsibilities Matrix

Task	CCPW Ops Admin.	CCPW Ops OA	CCPW Answering Service	CWD Code Enforcement Officer	Public Health	CCPW CWD Source Control Specialist
Take calls during business hours	A	P	O	P	P	P
Take calls after hours	A	I	P	O	O	O
Receive web comment form via email	A	P	I	O	O	P
Referral	A	P	P	P	P	P
Log calls in database	A	P	O	P	O	P
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted						

Complaint and Referral

Complaints arriving on the Public Works 24-hour line are logged to the Public Works customer service database by Public Works office assistants. Incidents are generally routed to the Public Works source control specialist

or Department of Ecology, depending upon the nature of the incident.

Web form comments, at the site noted above, are sent via email to the Clean Water Division who directs the report to the appropriate response staff as per phone call protocols. Water quality complaints are also received by other agencies or county departments including Ecology, Clark County Code Enforcement and Clark County Public Health.

Response to complaints is described under Water Quality Complaint Investigation.

Outputs

- Report of number of calls and emails to the general customer service line.
- Water quality complaint response report records in the IDDE database.

TASK CHECKLIST

STATUS	TASK
ONGOING	Continue implementing on-going program to prevent, identify and respond to illicit connections and illicit discharges
ONGOING	Screen an annual average of 12% of MS4
ONGOING	Procedures for addressing pollutants entering MS4 from interconnected MS4s
ONGOING	Staff training
ONGOING	Implement procedures to respond to spills
ONGOING	Operate a water quality citizen complaint line

For more information on the program to detect and eliminate illicit connections and discharges to the MS4:

Rod Swanson, Clean Water Division NPDES Permit Manager

564-397-4581
Rod.Swanson@clark.wa.gov

Section 5 – Expanding and Improving the Stormwater Management Infrastructure

As county population and development increase, the primary means of controlling runoff from areas of new growth and for fixing problems caused by uncontrolled runoff from existing developed areas is by expanding and improving the existing stormwater management infrastructure.

In Clark County, stormwater management infrastructure is expanded in two ways:

County Stormwater Capital Improvement Projects
The county has a program to plan and construct new stormwater infrastructure and improve existing infrastructure to better control and treat runoff from areas where existing development does not include adequate stormwater controls. This addresses the permit requirement to mitigate for stormwater impacts from existing development.

Regulation of Development, Redevelopment and Construction Projects
As private entities and government agencies develop land, the county regulates the design and construction of stormwater controls constructed. Many of these eventually become part of the county's own stormwater infrastructure.

The process for each of these types of projects is described in this section.



Roadway flooding during winter storm, 2007

County Stormwater Capital Improvements

Past stormwater management and drainage practices and development regulations have proven inadequate to prevent impacts of runoff on surface water, and thousands of developed acres in Clark County contribute to problems in streams, lakes and rivers. Accordingly, the county has a program to construct stormwater capital improvements primarily to control and treat stormwater from areas of existing development with inadequate stormwater controls. In addition, the county may take opportunities to expand the treatment and flow control capacity of existing facilities when making repairs. These activities all are part of the county's stormwater capital improvement program.



Recently reseeded stormwater facility biofiltration swale

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit – S5.C.7. Stormwater Management for Existing Development (Formerly Structural Stormwater Controls)

The NPDES permit requires the county to implement a program to reduce impacts to waters of the state caused by discharges from existing development. The program considers projects including new flow control facilities, new water quality treatment facilities, retrofits of existing facilities, property acquisition, and facility maintenance capital construction having costs greater than $25,000. Other means to reduce impacts are also considered, including riparian habitat acquisition, restoration of forest in upland areas and in riparian buffers, and floodplain reconnection projects. Small-scale projects that are not planned in advance may also be included in meeting this requirement.

Clark County must include a list of planned individual projects updated in each annual report to Ecology.

In 2026, Public Works Clean Water Division will update its stormwater capital plan for the 2027 to 20333 period.

The description of the structural stormwater control program in the SWMP must include the program's goals and the planning process, including budget and public involvement, and a table describing the capital projects.

The Stormwater Capital Plan includes a table and detailed program description and can be found at: clark.wa.gov/public-works/clean-water-projects

Chapter 173-218 WAC – Underground Injection Control (UIC) Program

Pursuant to Chapter 90.48 RCW, the state's requirements for stormwater infiltration wells may result in capital improvements associated with county systems that are found to pose a threat to groundwater.

COUNTY POLICIES, RULES AND REGULATIONS

The Clean Water Division has the following policies for county stormwater capital improvements:

- Meet NPDES Permit requirements for the structural stormwater control program through stormwater capital planning and capital construction.

County goals for stormwater capital improvements include:

- Protect and enhance streams and wetlands in Clark County through planning and constructing modifications to the stormwater infrastructure.
- Minimize the degradation of receiving waters caused by stormwater runoff in urban areas.
- Maximize public benefits of county-owned land by providing multiple uses, including recreation, and by leveraging funding from multiple sources.

GUIDING PRINCIPLES

In support of county policies and goals, the capital planning process strives to:

- Prioritize projects with the greatest potential to support multiple county programs and goals, including local and regional fish recovery, habitat enhancement, and pollution prevention goals.
- Ensure a reliable scientific and engineering basis for projects.
- Establish that each project in the plan is needed, feasible and cost-effective.
- Focus limited resources on cost-beneficial solutions to the most pressing concerns.
- Incorporate environmental benefits into needed infrastructure repair projects.
- Maintain a list of potential projects to take advantage of funding opportunities.

As-Built Plan Preparation

Clark County Public Works follows a management practice for the production of record drawings at the final acceptance of a public capital project.

STORMWATER CAPITAL PLANNING

Clean Water plans to lead a process in 2026 to develop the next 6-year stormwater capital program.

Purpose

Planning ensures that stormwater capital improvements meet the county's goals.

Capital planning is a process for identifying potential projects, deciding if they are feasible, selecting the best for further development, and tracking their progress from inception through construction. The stormwater capital plan will list projects scheduled for implementation on a six-year horizon.

- The proposed projects are considered to comply with requirements under Permit Condition S5.C.7.
- Projects reflect what Clark County is best able to implement within its available funding and demands for projects.

- Projects address stormwater impacts not adequately controlled by other permit-required actions, chiefly those caused by uncontrolled or untreated runoff from existing development, and habitat degradation that has already occurred.

By complying with permit condition S5.C.7, together with all other permit requirements, Clark County complies with MEP and AKART as set forth in the county's NPDES Municipal Stormwater Permit condition S4.D.

REPAIR AND REPLACEMENT OF AGING PIPE SYSTEMS

The Fee Increase Rate Study will allow Clean Water and Public Works to begin systematically addressing repair, refurbishment and replacement of aging county stormwater pipes. The goal is to begin replacing one percent of the pipes each year, beginning in 2028.

ENHANCED CAPITAL PLANNING FROM RATE INCREASE EXPAND

The Fee Increase Rate Study will allow Clean Water to expand implementation of capital projects to improve water quality, in excess of projects needed to meet Phase 1 stormwater permit requirements. It will allow Clark County to Implement watershed projects to support lake management initiatives.

NEIGHBORHOOD DRAINAGE PROJECTS

The Fee Increase Rate Study will allow Clean Water to expand implementation of capital projects to begin planning and design of large-scale neighborhood drainage improvements and flood reduction projects

LARGE COLLABORATIVE PROJECTS

The Fee Increase Rate Study will allow Clean Water to expand implementation of capital projects that leverage other county projects for road and park improvements.

WATERSHED AND NATURE-BASED CAPITAL PROJEXCTS

The Fee Increase Rate Study will allow Clean Water to increase delivery of nature-based planning such as wetland, flood planning and reforestation projects. It will also lead to canopy restoration and coordinate with Legacy Lands.

DEVELOP A 20-YEAR CAPITAL PLAN

The Fee Increase Rate Study will allow Clean Water to develop a 20-Year Capital Plan.

Lessons from the 2013 permit stormwater planning effort

Clark County applied lessons learned from its 2013 permit work on the Whipple Creek watershed-scale plan to inform its stormwater capital planning program. A key finding was that it is infeasible to restore forested stream hydrology in basins where LID is infeasible. This led to a subwatershed-scale review of Vancouver UGA subwatersheds to identify areas where detention retrofit projects should be avoided.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Eng.	CCPW Eng. Program Mgr.	CCPW Eng. Program Staff	Council	CCPW Director
Accept referrals	A/P	P/S	O	O	O	O
ID potential projects	A/P	P/S	O	S	O	O
Database entry & updates	A/P	P/S	O	O	O	O
List of potential projects	A/P	P/S	I	C	O	O
Formulate selection criteria	A	P	I	S	C	C
Apply selection criteria	A/P	P/S	C	S	O	C
Scoping and Selection	A/P	P/S	O	S	O	I
Six-year capital plan	A/P	S	C	S	C	C
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted						

Referrals

Project ideas may be referred to the Clean Water Division from several sources, including field work completed by the Assessment and Monitoring Section, CWD engineer review of watershed plans and water quality reports, problems identified by Road Operations crews and projects suggested by the public.

Referrals can arrive throughout the year.

Project Tracking / Capital Planning Database

CWD infrastructure manager will enter potential capital projects selected for further consideration into the *Capital Planning Database* as they are evaluated.

The database tracks stormwater capital projects from inception to construction and close-out, or their status as shelved or dropped, including the following attributes:

- Project category/type.
- Description and basis of the project and the problem being addressed.
- Estimated project benefits including flow control, pollutant load reduction, habitat enhancements and other environmental benefits.
- Status of preliminary engineering and construction.
- Funding summary.
- Types of potential environmental impacts, including wetland, priority habitat, cultural resource, floodplain impacts, etc.

As projects advance and more information is developed, CWD infrastructure manager will update the database with new details on a regular basis.

Project Identification

Stormwater capital projects typically originate from systematic capital planning efforts, routine stormwater facility inspections, observations by maintenance crews, or evaluation of underground injection control wells.

Clean Water completed significant county-wide project identification and screening efforts between 2006 and 2011 under the Stormwater

Needs Assessment Program (SNAP). The program identified many potential project opportunities, which formed the basis for much of the stormwater capital plan through 2018. During that time, most priority opportunities identified through the SNAP have either been constructed or were found to be infeasible. The remaining potentially viable projects from the SNAP effort are being re-evaluated in light of updated priorities during sub-basin retrofit studies.

Urban area sub-basin retrofit studies follow up on earlier stream assessments, refining county efforts to plan and build stormwater controls that meet permit requirements and reduce pollutant discharges to receiving waters. The process for sub-basin retrofit studies was developed in 2018 and first applied to Cougar and Suds Creeks in the Salmon Creek watershed. Additional studies in the Tenny Creek and 114th Street Tributary sub-basins in the Salmon Creek watershed were completed in 2022. The LaLonde Creek sub-basin was studied in 2024, and additional high-priority drainages will be evaluated beginning in 2025 or 2026 as needs and resources dictate. Capital planning will target Curtin Creek and Mill Creek in 2026 as part of the SMAP work.

Studies identify an array of projects that will improve stream conditions, applying consistent objectives and specific project types tailored to practical goals for each sub-basin. The process incorporates information from multiple county capital efforts and is intended to promote collaboration between county programs.
The studies apply a series of tools to identify projects, including making a series of project area maps depicting existing conditions and needs, long-plot maps of high traffic roadway corridors, stormwater outfall verification, review of underutilized and county lands, headwater wetland project assessment, right-of-way retrofitting assessment, and channel/floodplain restoration project assessment.

Results are managed in a series of project maps and spreadsheets. Highly rated projects are promoted to the Capital Planning Database for possible inclusion in the Stormwater Capital Plan.

A Project Identification Worksheet is first compiled, identifying purpose and level of need (1-5) for each identified project and performing a preliminary high-level verification. The end result is a list of all identified projects shown in three categories: viable; needs more information or rejected.

Project Verification

Viable projects from the identification spreadsheet are run through a more detailed verification process in a second spreadsheet called the Project Verification Worksheet.

The primary verification checks are based on detailed Technical Information Report maps automatically generated for each project. These maps inform project verification with current information and also identify whether additional field visits are necessary to perform verification. The end result is a list of projects shown in three categories: verified, additional field information needed or rejected.

Verified projects with a need level of 1, 2, or 3 are carried over into the database for consideration in the Stormwater Capital Plan.

Programming Projects

Programming applies regulatory requirements and available funding to the list of scoped projects to develop a six-year program matrix that can meet Permit requirements and program goals. Permit requirements for SMED are stated in the 2024 permit as a number of “SMED Program Points ”.

Funding

The anticipated budget for the 2025-2030 plan is approximately $17.9 million. Completion of these projects is dependent on funding through the Clean Water Fee, Road Fund, Clark County Conservation Futures Fund and grants.

Outputs

- Database entries of potential and scoped projects and detailed project attributes for consideration in subsequent years.
- Submittal of NPDES permit report Appendix 12.
- Meet permit required SMED points by March 2028.
- Stormwater Capital Plan with funding allocation
    - Enhanced water quality project planning beyond permit requirements
    - Neighborhood drainage projects in Plan
    - Large Collaborative projects
    - Nature-based projects
    - Plan to replace aging pipes
    - 20-year capital plan

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Construction of the Thomas Wetland East Stormwater Facility

CAPITAL PROJECT CONSTRUCTION PROGRAM

Purpose

The construction program is the engine for designing, permitting and building stormwater capital projects. The Public Works Engineering and Construction Division leads the effort through established project management systems.

The Public Works Engineering and Construction Division designs and oversees construction of all types of capital improvement projects, including county stormwater projects. Their services include project management, survey, property acquisition, engineering and construction management.

The program is responsible for the advancement of most stormwater capital projects from the Stormwater Capital Plan to construction. The responsibilities and procedures for this program are briefly reviewed below.

Responsibilities Matrix

Task	CCPW CWD Infrastructure Mgr.	CCPW CWD Eng.	CCPW Enhance. and Permitting Mgr.	CCPW Env. Permitting Mgr.	CCPW Eng. Program Mgr.	CCPW Eng. Project Mgmt. Mgr.	CCPW Eng. Project Mgr.	CCPW Eng. Program Design	CCPW Eng. Construction Mgmt. Supervisor.	CCPW Eng. Construction Mgmt. Inspectors	CCPW Outreach Specialist Sr.
Assign Project Team	I	I	S	S	A	P	S	S	S	S	O
Schedule and Budget	S	S	S	S	A	C	P	S	S	S	I
Preliminary Engineering	C	O	O	O	A	S	S	P	O	O	O
Permitting	C	O	A	P	I	O	I	C	C	O	O
Construction Management	C	I	I	C	I	S	S	C	A	P	O
Public Outreach	C	O	I	I	I	S	I	O	O	O	A/P
Project Close Out	I	S	I	C	A	I	P	C	C	C	I
Update Capital Planning Database	A/P	S	O	O	O	O	O	O	O	O	O

A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted

Team, Schedule and Budget

The Project Management section manager will assign a team of professionals, led by a project manager.

The project manager, with the help of the team, will develop a detailed scope, schedule and budget for his/her assigned projects. The project manager will monitor each item closely throughout the life of each project.

Preliminary Engineering and Environmental Permitting

Public Works engineers will create engineering plans, design specifications and cost estimates for each project in the plan. Public Works Permitting Coordinators will guide each project through local, state and federal permitting processes.

As projects near engineering design completion, the Engineering Program manager, in consultation with the Clean Water Infrastructure manager, will make the final decision to advance selected projects to construction.



Encore stormwater facility retrofit

Bid

The project manager will coordinate with the Clean Water Division Infrastructure Manager and the team to prepare and execute a project bid schedule.

Construction Management

The Public Works Engineering and Construction Division Construction Management team will review bids and prepare an award recommendation for the Clark County Council. Once the contract is awarded, Construction Management will administer it and oversee construction.

As a project reaches completion, the construction manager will send a copy of the letter of physical completion to the Clean Water Division and Public Works Road Operations Division . The Clean Water Division also will be copied on the letter of final acceptance.

Receipt of the physical completion and final acceptance letters by the Clean Water Division will initiate stormwater inventory tasks. Receipt of the final acceptance letter by Operations will initiate maintenance and operations tasks.

Public Outreach

The Public Works Community Engagement and Inclusion team will coordinate outreach about the project including news releases, information on the Public Works website and signage.

Close Out

The project manager and construction manager will coordinate preparation of close out documents, including final expenditures.

CWD engineers will update the Capital Planning Database with metrics from the final report.

Construction Management will oversee the production of record drawings, and Survey staff will notify the Clean Water Division of their location. The receipt of record drawings by Clean Water Division will initiate tasks to verify the stormwater infrastructure inventory.

Outputs

- Project plans, specifications and estimates
- Completed stormwater capital projects
- As-built drawings (record drawings)
- Final expenditures and metrics for each project

TASK CHECKLIST

STATUS	TASK
ONGOING	Implement structural stormwater controls program
ONGOING	Stormwater capital planning
ONGOING	Annual reporting on capital projects
ONGOING	Update structural stormwater controls projects
ONGOING	Update Stormwater Capital Plan
ONGOING	Annual reporting on capital projects
March 31, 2028	Acquire 1000 SMED points
2027	Water quality projects beyond permit requirements
2027	Neighborhood drainage projects
2028	Begin replacing aging pipes
2027	20-year capital plan

For more information on planning and building county stormwater infrastructure:

Marlena Milosevich, Clean Water Division Capital Program Manager
564.397.4282
Marlena.Milosevich@clark.wa.gov

Regulatory Program for Development, Redevelopment and Construction Projects

The county is the local land use regulator in unincorporated Clark County. As such, the NPDES Permit requires the county to regulate the discharge of runoff from new development, redevelopment and construction activities in the county.

In 2013, the county began a project to update its regulations in response to the newly issued 2013-2018 NPDES Permit. During 2015, Clark County completed the equivalent code and manual adoption and implementation under the schedule prescribed by the Permit. The 2015 manual was updated in 2021 to include permit-mandated changes and other changes proposed by manual users.

The Clark County Stormwater Manual will be updated again by July 2026 to include mandated changes and revisions based on user input.

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.5.a & b. – Controlling Runoff from New Development, Redevelopment and Construction Sites

The NPDES Permit requires the county to have a program to prevent and control the impacts of runoff from new development, redevelopment and construction activities. The program applies to all development activity, including private-sector development and county projects such as roads and parks. The program enforces development regulations that provide protection equivalent to the minimum requirements, thresholds and definitions in Appendix 1 of the NPDES Phase I stormwater permit and design standards equivalent to the 2024 version of the *Stormwater Management Manual for Western Washington.* The program also revised code and manuals to make low impact development a standard approach for stormwater management.

The 2024 Permit requires specific updates set forth in Appendix 10 and for the county to document significant changes. Both of these were submitted to Ecology for approval in 2025 and will be adopted by Clark County Council in June 2026 to become effective on July 1, 2026.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code 40.386 – Stormwater and Erosion Control

Clark County regulates stormwater runoff and erosion control on development, redevelopment and construction sites primarily in Chapter 40.386 Stormwater and Erosion Control. The purpose of the code is to safeguard public health, safety and welfare by protecting the quality of surface water and groundwater for drinking water supply, recreation, fishing and other beneficial uses through the application of best management practices (BMPs) for stormwater management and erosion control by following the requirements of the Clark County Stormwater Manual.

The regulations generally apply to all development and construction projects, including county roads and parks whether or not they discharge to county storm sewers or to waters of the state.

Clark County Code 40.430 – Geologic Hazard Areas

Geohazard code regulates development at sites where geologic concerns such as high soil erosion risk, potential landslides and steep slopes will influence preparation of erosion control and stormwater site plans.

Clark County Stormwater Manual

The *Clark County Stormwater Manual* is adopted under Chapter 40.386 and contains the technical and administrative standards that project proponents follow to meet the Permit minimum requirements and county stormwater management requirements for development and construction projects in the county. The manual contains county requirements and procedures specific to Clark County, is equivalent to the Ecology SMMWW, and is referenced in Permit Appendix 10.

Clark County Code 40.445 – Wetlands and Habitat Protection

Chapters 40.445 Wetland and Fish and Wildlife Conservation Areas regulates some stormwater discharges and the placement of treatment and control facilities in habitat and wetland buffers.

Clark County Code 40.510 – Application and Review Requirements

Applications for development, redevelopment and construction require different levels of review depending on their impacts to the community, which are defined in Chapter 40.510. The levels of review are ministerial decisions (Type I), administrative decisions (Types II and II-A) and quasi-judicial decisions (Type III).

STORMWATER REVIEW AND ENFORCEMENT OF DEVELOPMENT AND CONSTRUCTION APPLICATIONS

Purpose

Clark County has a system of ordinances, technical manuals, plan review, inspection and enforcement to apply the NPDES Permit minimum requirements to development, redevelopment and construction projects.

For stormwater, the purpose of the review is to determine**:**

- Applicability of the stormwater and erosion control minimum requirements.
- Compliance with applicable minimum requirements.
- Compliance with other county-specific stormwater requirements listed in the Clark County Stormwater Manual.

Inspection and enforcement strive to ensure that construction sites correctly and consistently use erosion control BMPs to prevent sediment-laden runoff from leaving the sites, and that permanent stormwater conveyance systems and BMPs for LID, treatment and flow control are properly installed, constructed and transferred in good condition to the ultimate owners/operators with a maintenance manual for each facility.

Interdepartmental Responsibilities Summary

Responsibility for implementing the stormwater code is shared by Public Works and the Community Development departments.

Community Development Department – Permit Services

Permit Services will accept development and construction applications and determine if applications include the required submittals. Permit Services staff review residential building permit applications and accept and review stormwater small project site plans for building sites in new residential subdivisions for stormwater compliance and condition building permits for stormwater requirements.

Community Development Department – Building Safety

Building Safety will inspect building construction sites for compliance with erosion control, source control, preservation of natural drainage and post-construction stormwater management BMPs.

Community Development Department – Development Engineering

Development Engineering staff will provide engineering review of stormwater and erosion control plans on development sites, including residential subdivision and non-residential development sites. Residential building permit projects outside of new subdivision are also

reviewed. Development Engineering staff will oversee the issuance of the plat, the final engineering as-built documents (record drawings) and the maintenance warranty, if applicable.

Public Works Department – Construction Management
Construction Management staff will inspect development sites, including county projects, for compliance with stormwater engineering plans and erosion control plans. Construction Management also inspects residential subdivisions for facility maintenance during the period of new home construction.

Public Works Department – Clean Water Division
Clean Water Division staff will support decision-making regarding interpretation of the code and manuals, providing documentation of their findings.

Community Development Department – Code Enforcement
Code Enforcement will enforce erosion control violations on development and building construction sites as needed.

Responsibilities Matrix

The review and enforcement process varies depending on complexity and scope of the project. For stormwater review purposes, projects generally can be divided into residential development projects (subdivisions), non-residential development projects, residential construction projects (individual home construction) and Public Works projects.

The matrix on next page describes responsibilities at the department and division level.

Overview of Regulatory Review and Enforcement Responsibilities

Task	CD Permit Services	CD Building Safety	CD Building Official	CCPW Code Enforcement Officer	CD Dev. Eng.	CD Dev. Eng. Mgr.	CCPW Construction Mgmt.	CCPW Construction Mgr.	CCPW CWD
Plan Review - residential construction	P/A	I	O	O	P/A	A	O	O	S
Inspect building construction sites	I	P	A	O	O	O	O	O	I
Engineering review – development	S	O	O	O	P	A	C	O	I
Inspect development sites	O	O	O	O	S	O	P	A	I
Inspect Public Works sites	O	O	O	O	S	O	P	A	I
Enforce erosion control	I	P	A	P	O	O	P	A	I
Maintenance warranty inspection	O	O	O	O	S	O	P	A	I
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted									

Residential Subdivision Development Project Review

Residential development projects are divisions of land to create individual lots and construction of infrastructure such as roads and storm sewer. Many aspects of residential development project review will not concern stormwater; only aspects concerning stormwater are covered in this plan.

Pre-Application Phase

Applicants typically submit initial information and may meet with a planner, engineer and other pertinent staff in a Pre-application Conference (PAC) before an applicant submits a completed development application. The PAC will help determine options and likely requirements for stormwater control, among many other regulations and requirements.

Preliminary Land Division and Preliminary Engineering Review Phase

The applicant will submit an application for residential land division (subdivision or short plat) to the Permit Center along with a preliminary stormwater plan in accordance with section 1.8.1 of *Clark County Stormwater Manual - Book 1*.

Development Engineering staff will review the preliminary stormwater plan to evaluate whether the proposal for stormwater controls is feasible given existing site conditions and constraints. The engineer's Findings and Conditions of Approval will appear in the Staff Report, which will be forwarded to the applicant.

Findings describe the engineer's determination of whether or not each aspect of the stormwater proposal meets county code. Conditions of Approval list the engineer's requirements for how to meet code, in cases where the proposal does not meet it, and they must be met in the final engineering plan.

Final Engineering Review Phase

The applicant will submit final plans for the residential development, including a final stormwater plan in accordance with section 1.8.2 *of Clark County Stormwater Manual - Book 1*. The final stormwater plan will provide final engineering design (Technical Information Report) and construction drawings for the stormwater aspects of the proposed project and a *construction Stormwater Pollution Prevention Plan (SWPPP)*.

Development Review engineers will:

- Ensure that the Conditions of Approval from the preliminary land division have been met.
- Verify that applicable county and NPDES permit requirements have been met.
- Review engineering calculations of stormwater flows, sizing of stormwater facilities, and sizing of conveyances.
- Verify adequacy of erosion control BMPs before preconstruction conference.
- Perform any other engineering review required for stormwater.

Responsible officials from Public Works, Community Development and Public Health will sign the final plans. The Development Engineering manager will make the final approval. Then the planning technician will return the approved plans to the applicant.

The Development Engineering office assistant will open a development inspection case in LMS in preparation for the next phase of the process.

Development Inspection Phase

During development inspection, the applicant will construct the development's infrastructure, including grading, roads and stormwater controls, according to the approved final plans. Public Works development inspectors will inspect the site for conformity with the plans.

The process begins when the applicant submits the final construction plan and application for development inspection. They also submit the final erosion and sediment control plan.

The assigned development inspector will hold a Preconstruction Conference with the applicant. During the Preconstruction Conference, the inspector will review erosion control requirements, including requirements related to a high potential for sediment to be discharged from the site with the applicant and will receive the name of the Certified Erosion Control and Sediment Lead (CECSL) for the site. The inspector will reiterate storm system requirements and additional inspection-related policies for storm system installation. Department of Ecology state construction stormwater permit enforcement staff are also invited to each Preconstruction Conference. After the conference, the development inspector will give approval to begin constructing the project after completion of a preconstruction inspection to verify proper installation of erosion control BMPs.

During construction, the development inspector will inspect the site to ensure that erosion control measures are operational and effective. The inspector will work with the developer to achieve compliance, using technical assistance, correction notices and stop work orders if necessary. If there is evidence of continued neglect, the inspector will call a code enforcement officer to enforce erosion control measures through citations and penalties. Referral to Ecology for enforcement under the NPDES Construction Stormwater General Permit is also an option.

The development inspector also will verify that stormwater facilities are constructed as designed.

At the end of construction, the applicant will submit record drawings and a maintenance bond, if applicable, for any public improvements. (Public improvements are roads and stormwater drainage facilities that will fall into public ownership upon acceptance of the development.) A Development Engineering engineer will approve the record drawing and then a Development Engineering planning technician will accept the maintenance bond, if applicable.

Development Engineering staff will provide an electronic record drawing file to Public Works and then send the Mylar plan to the state archives.

After these steps are complete, the planning technician will issue a notice of completion of construction to the applicant and copy it to several departments, including the Clean Water Division and Public Works Maintenance and Operations. The notice signals the start of the stormwater facility maintenance warranty period, if applicable (see below).

The notice of completion of construction constitutes provisional county acceptance of the public infrastructure, including public stormwater facilities. In the case of private facilities, completion of construction is the end of county involvement in construction and the

regulated facility operation and maintenance inspection process will begin.
Receipt of the notice of completion of construction will initiate some stormwater mapping tasks (see Section 2) and some maintenance inspection tasks (see Operating and Maintaining the Storm Sewer System, County Property and Roadways in Section 3).

Final Land Division Phase
The final land division will begin after the development inspection phase begins but before it ends.

The applicant will submit the final land division application and the draft plat. The plat will contain required information describing facility ownership and maintenance responsibility, stormwater tracts and drainage easements. The plat will be routed to several departments for review and approval. If there are private stormwater facilities, an HOA will be formed before plat approval.

After approval of the draft plat, the applicant will submit a Mylar version that will be signed by the Planning Director, the County Engineer and the Clark County Council. Development Engineering staff then will record the final plat with the Auditor and issue a plat notification to the developer, copied to several departments, including the Clean Water Division.

Receipt of the plat notification by Clean Water Division may initiate some stormwater mapping tasks.

The final plat must be recorded before building permits for home construction will be issued for lots in the development.

Maintenance Warranty Period
Most, but not all, residential developments will have public improvements, including public stormwater infrastructure.

For residential developments with public improvements, a two-year maintenance warranty period will begin at completion of construction. During the maintenance warranty period, the developer will be responsible for continued maintenance of the stormwater facilities. During the 22nd month of the maintenance warranty, a development inspector will inspect the public stormwater facilities for compliance with maintenance standards.

If the stormwater facilities are found to be in good condition and properly maintained, the development inspector will recommend release of the maintenance bond. The Development Engineering planning technician will release the bond and notify the Clean Water Division and Public Works Maintenance and Operations.

If the facility has components that fail the maintenance inspection, the planning technician and development inspector will work with the developer to obtain needed repairs. If the developer fails to make repairs, the planning technician will demand the bond from the surety company.

After repairs are made, the Clean Water Division will update stormwater mapping tasks, if necessary (see Mapping the Storm Sewer Infrastructure on page 10), and Public Works Maintenance and Operations will initiate maintenance and operations tasks.

Under the Clark County Stormwater Manual, private stormwater facilities will be maintained

by the applicant for two years after completion of construction.

MAINTENANCE WARRENTY BOND STUDY

The Fee Increase Rate Study will allow Clean Water to evaluate the current maintenance bond approach for stormwater facilities donated to Clark County. It will develop appraise bond rates and methods to ensure donated infrastructure is fully established and in proper repair when transferred to county ownership.

Non-Residential Development Project Review

Non-residential developments include commercial and industrial projects as well as schools, churches and other non-residential land uses. These projects construct infrastructure such as roads and stormwater drainage along with the buildings. Multifamily housing projects also are reviewed using this process. Occasionally, commercial projects may also go through a land division. Many aspects of non-residential development project review will not concern stormwater and are not covered in this plan. Also, many projects do not trigger stormwater requirements because they do not add or replace a sufficient amount of impervious surface; examples include cell tower placement, sign construction and building façade replacement.

Pre-Application Phase

Applicants typically submit initial information and meet with a planner, engineer and other pertinent staff in a Pre-application Conference (PAC) before submitting a completed development application. The PAC will help determine options and tentative requirements for stormwater control, among many other regulations and requirements.

Preliminary Site Plan and Preliminary Engineering Phase

To begin the process, the applicant submits an application for preliminary site review to the Permit Center along with a preliminary stormwater plan in accordance with section 1.8.1. of the *Clark County Stormwater Manual Book 1*.

The assigned Development Engineering engineer will review the preliminary stormwater plan to evaluate whether the proposal for stormwater controls is feasible given the available information on existing site conditions and constraints. The engineer's Findings and Conditions of Approval will appear in the Staff Report and Decision (or Land Use Hearing Examiner Decision), which will be forwarded to the applicant.

Findings describe the engineer's determination of whether or not each aspect of the stormwater proposal meets county code. Conditions of Approval list the engineer's requirements for how to meet code, in cases where the proposal does not meet it, and they must be met in the final engineering plan.

Final Site Plan and Final Engineering Review Phase

The applicant will submit final plans for the development, including a final stormwater plan in accordance with section 1.8.2 of Clark County Stormwater Manual - Book 1. The final stormwater plan will provide final engineering design and construction drawings for the stormwater aspects of the proposed project. A construction Stormwater Pollution Prevention Plan (SWPPP) is required before the Preconstruction Conference.

The assigned Development Review engineer will:

- Ensure that the Conditions of Approval from the Final Decision have been met.
- Verify that applicable NPDES permit, and county code minimum requirements have been met.
- Review engineering calculations of stormwater flows, sizing of stormwater facilities, and sizing of conveyances.
- Verify adequacy of erosion control BMPs before the preconstruction conference.
- Perform any other engineering review required for stormwater.

Responsible officials from Public Works, Community Development and Public Health will sign the final plans. The Development Engineering manager will make the final approval. The approved plans are returned to the applicant.

Development Engineering will open a development inspection case in LMS in preparation for the next phase of the process.

Building Permit Review

The applicant will submit building permit applications to Permit Services. Construction of structures will be concurrent with construction of the development; therefore, most stormwater review will have already occurred.

The building permit must be issued before construction of structures may begin.

Development Inspection Phase

During development inspection, the applicant will construct the development's infrastructure, including grading, roads and stormwater controls. The project's buildings are also erected during this phase.



A recently constructed stormwater facility

The process begins when the applicant submits the final construction plans and application for development inspection.

The assigned Public Works development inspector will hold a preconstruction conference with the applicant. The inspector will review erosion control requirements with the applicant, including requirements related to a high potential for sediment to be discharged from the site and will receive the name of the Certified Erosion Control and Sediment Lead worker (CECSL) for the site. Department of Ecology state construction stormwater permit enforcement staff are also invited to each Preconstruction Conference. The inspector will reiterate storm system requirements and additional inspection-related policies for storm system installation. After the conference, the development inspector will give approval to begin constructing the project after completion of a preconstruction inspection to verify proper installation of erosion control BMPs.

During construction, the development inspector will inspect the site as needed to ensure that erosion control measures are operational and protective. If necessary, a code enforcement officer will be called to enforce erosion control measures. If the project has a state-issued NPDES construction

permit, then violations may be referred to Ecology.
The inspector also will ensure that stormwater facilities are constructed as designed.

At the end of construction, the inspector will verify that the facility was built as shown on approved design plans. The applicant will submit record drawings and, if applicable, a maintenance bond for any public improvements in the right-of-way. A Public Works engineer will review the record drawing set for accuracy before approving it. After approval of the completed facilities and record drawings, a Development Engineering planning technician will accept the maintenance bond.

When a record drawing is received, Development Engineering staff will give an electronic file to Public Works and send the Mylar plan to the state archives.

The planning technician will issue the notice of completion of construction to the applicant and copy it to several county agencies, including the Clean Water Division. The notice signals the start of the maintenance warranty period, if applicable.

Receipt of the completion of construction by the Clean Water Division will initiate some stormwater mapping tasks for projects with either public or private stormwater facilities.

Maintenance Warranty Period
The maintenance warranty period is relevant for those few non-residential developments that have public stormwater infrastructure in public right-of-way.

A two-year maintenance warranty period will begin at completion of construction. During the period, the developer will be responsible for continued maintenance of the stormwater facilities.

During the 22nd month of the warranty, a development inspector will inspect the public stormwater facilities for compliance with maintenance standards.

If the stormwater facilities are found to be in good condition and properly maintained, the development inspector will authorize release of the maintenance bond and will notify the Clean Water Division and Public Works Maintenance and Operations that the bond has been released.

Receipt of the bond release notification will initiate maintenance and operations tasks (see Operating and Maintaining the Storm Sewer System, County Property and Roadways.

If the facility has components that fail the maintenance inspection, the planning technician and development inspector will require the developer to obtain needed maintenance and repairs. If the developer fails to make repairs, the county will demand the bond from the surety company.

After repairs are made, the Clean Water Division will update stormwater mapping tasks, if necessary, and Public Works Maintenance and Operations will initiate maintenance and operations tasks.

Under the *Clark County Stormwater Manual*, all private stormwater facilities will be maintained by the applicant for two years.

Single Lot Residential Construction Project Review

Single lot residential construction projects include construction or expansion of single-family and duplex homes and their

appurtenances, such as decks, garages and driveways, and outbuildings. Many aspects of residential construction project review will not concern stormwater and are not addressed here.

Building Permit Application Review – Stormwater

The applicant will submit a residential building permit application including a stormwater site plan showing proposed building footprint(s), erosion control measures and on-site stormwater control BMPs to the Permit Center. Projects triggering Minimum Requirements 1-9 require and engineered application and are referred to Development Engineering for review. Smaller projects on lots that are not part of a new subdivision are also forwarded to Development Engineering for review.

The engineering review staff will review the residential building permit application to verify applicability of the minimum requirements and selection and use of allowed stormwater BMPs and erosion control BMPs. They will also check for the mapped presence of steep slopes or geo-hazard areas. If they conflict with the proposed stormwater BMPs, the applicant will be required to consult a licensed geotechnical engineer to design stormwater controls.

If the residential construction site is within an existing subdivision with an approved stormwater plan that provides flow control and treatment, then the reviewer will recommend that the applicant consult the development project's engineering plans to determine stormwater requirements, such as roof drain infiltration and amended soils, for the lot. In those cases, the reviewer also will include requirements from the recorded plat and design requirements from the subdivision engineering drawings and attach them as conditions on the building permit.

If the residential construction site is not part of an existing subdivision with an approved stormwater plan, then applicants will follow minimum requirements applicable to their projects. If minimum requirements 1- 5 apply, the applicant can complete the stormwater plan or hire a contractor. If minimum requirements 1-9 apply, the applicant must use an engineer to complete a stormwater plan that complies with county code under an engineering review by Development Engineering.

The Permit Center will issue the building permit with stormwater plan approval before construction may begin.



Excavator preparing land for a development.

Construction Inspection

Before construction is allowed to begin on the site, a Building Safety Division inspector will inspect the site as part of a foundation inspection to also verify that the erosion control BMPs are properly installed and that any unusual site conditions that might lead to sediment transport off site are addressed. All sites are required to maintain an erosion control log with an attached site plan and form that includes the required onsite stormwater management BMPs. Erosion control inspections are made at the time of each building inspection.

Post Construction BMP Inspection
Stormwater BMPs on individual lots are inspected by Community Development Building Inspectors to verify the BMP was built to the standards of the Clark County Stormwater Manual.

Public Works Project Review

Projects built by the Public Works department, including roads, parks and stormwater facilities will be reviewed by the Public Works Engineering and Design section independently from the design team for compliance with county stormwater standards. Many Public Works projects will not require land use review, including roadways through existing right-of-way; therefore, the process will frequently begin at the final engineering review phase. Those that require land use review will begin at the preliminary site plan and preliminary engineering phase (above).

Additionally, the development inspection phase is replaced by a construction management phase. Public Works will use its own construction inspectors to oversee the construction of the project to ensure that it is built as designed and bid. Enforcement of erosion control and other measures is through contract management.

Before completion of a project, the construction engineer will invite stakeholders, including the Public Works Maintenance and Operations water quality crew chief, to a walk-through of the new roadways and/or facilities. The construction manager also will copy the Clean Water Division and the Public Works Operations and Maintenance Division on the letters of physical completion and final acceptance of the project.

At the final acceptance, Public Works will develop a record drawing according to its *As-Built Plan Preparation Policy*, dated May 7, 2009.

Training for Regulators

The Fee Increase Rate Study will allow Clean Water to develop a training program for county staff who review stormwater plans, inspect construction sites, approve completed projects and understand maintenance requirements.



Hidden Falls in east Clark County

OUTPUTS

General Outputs:

- Stormwater site plans that meet county standards
- Construction site management
- Completed projects include stormwater facilities meeting county standards
- Assigned ownership and maintenance responsibility for stormwater control facilities
- Record drawings are completed
- Completed project notifications to programs

Residential Development Project Review Outputs:

- Final Decision denying, approving, or approving with conditions the proposed development project
- Technical Information Report
- Approved final construction plan
- SWPPP
- Record drawings
- Approved final plat
- Notice of completion of construction
- Maintenance bond release letter, if applicable

Non-Residential Development Project Review Outputs:

- Final Decision denying, approving, or approving with conditions the proposed development project
- Technical Information Report
- Approved Final Site Plan
- Approved final construction plan
- SWPPP
- Record drawings
- Erosion control log
- Building plan
- Notice of completion of construction
- Maintenance bond release letter, if applicable

Residential Construction Project Review Outputs:

- Building Permit including site plan with stormwater requirements and stormwater plan
- Erosion control plan
- Erosion control log

Public Works Project Review Outputs:

- Technical Information Report
- Approved final construction plan
- Record drawings
- Completion of Construction notice
- Physical Completion letter
- Final Acceptance letter

TASK CHECKLIST

STATUS	TASK
ONGOING	Legal authority to require maintenance of facilities
ONGOING	NOI forms available
ONGOING	Legal authority to require maintenance of facilities
ONGOING	Procedures to implement the SMMWW
ONGOING	Staff training on SMMWW
ONGOING	Enforce stormwater regulations
Due by July 1, 2026	Revise stormwater regulations for equivalence to Permit Appendix 10
2027	Maintenance warranty bond study

For more information on how development, redevelopment and construction sites are regulated for stormwater and erosion control:

Rod Swanson, Clean Water Division NPDES Permit Manager
564-397-4581
Rod.Swanson@clark.wa.gov

Stormwater Planning

The 2024 permit continues stormwater planning. The stormwater planning component has these elements:

- Have an interdisciplinary team.
- Coordination of stormwater activities with other long-range planning.
- LID code review for barriers.
- Stormwater Management Action Planning (SMAP).

Each element is described separately in the following pages.

REGULATORY REQUIREMENT

NPDES phase I permit requirement S5.C.6. a-d.

CONTINUE AN INTERDISCIPLINARY TEAM

Clark County Clean Water established a team consisting of staff from:

- Public Works Engineering and Construction Division.
- Public Works Clean Water Division
- Community Planning.
- Community Development Planning and Development Engineering divisions.

Outputs

- List of team members.
- Correspondence and meeting records.

LONG-RANGE PLANNING COORDINATION

Purpose

The long-range planning coordination is intended to create a report describing how stormwater management needs and receiving water health are informing comprehensive land use planning under GMA and any other county long-range land use planning efforts. Other efforts include Regional Transportation Council planning, Clark County transportation planning, Clark County Parks planning and Legacy Lands planning. Stormwater planning efforts include the 2017 Whipple Creek study, the 2022 Mill Creek tributary study and Stormwater Structural Controls planning under the permit.

Planning Document Review

The planning mandates and goals were listed and their relationship to stormwater management and receiving water protection will be documented.

The required reporting will address the annual report questions in Permit Appendix 3 regarding planning coordination.

Schedule

The planning coordination report was submitted with the March 31, 2027 annual report submittal for calendar year 2026.

Outputs

- Long-range planning coordination reporting in the annual report.

ANNUAL LID BARRIER ASSESSMENT

Purpose

The permit goal is to make LID the preferred approach to site development. This task will annually document any newly discovered barriers to LID development.

LID Barrier Review

The NPDES permit manager in collaboration with staff from CD Development Engineering and CD Planning will review current status of LID implementation and identify any current barriers.

Adopt Tree Canopy Goals and Policies

The LID section includes a requirement to adopt and implement tree canopy goals and policies intended to maintain or increase canopy in overburdened communities and maintain existing mature canopy.

Schedule

LID barrier review is annual .
Tree canopy goals and policies are due by December 31, 2028.

Outputs

- Documentation from staff review.
- Short report to support annual report question response.
- Tree canopy goals and policies.

STORMWATER MANAGEMENT ACTION PLANNING (SMAP)

The SMAP is a plan considering options for managing land use and stormwater to meet specific objectives for receiving water health. The permit references the most recent SMAP guidance document as identifying SMAP content.

Purpose

The SMAP requirement is intended to be an extension of the stormwater planning required by the 2013 permit. This includes describing how the Whipple Creek plan informs stormwater structural control project selection. The current work is developing a plan for the urban growth area of lower Salmon Creek.

Lessons from the Whipple Creek Study

Clark County found that areas where LID was infeasible are impossible to restore forested stream hydrology using the standard SWMMWW flow control BMPs. Instead, the study suggested the much cheaper option of projects to add channel complexity and reconnect flood plains to manage higher storm flows. This led Clean Water to evaluate streams in the urban area for flow control retrofit suitability. The evaluation found that almost none of the Vancouver UGA streams are suitable for flow control retrofits using detention ponds. This led to a focus on water quality retrofits for high traffic areas and promotion of infiltration retrofits where conditions permit.

Catchment Selection/Sub-basin Prioritization

Clean Water used existing data and reports as the principal tools to complete the analysis. Examples include steam health data, the detention facility retrofit suitability report, ESA priorities, inventoried fish use, Regional Transportation Council traffic model vehicle trip density, and percent urban and rural area to evaluate sub-basins. Clean Water consulted with WDFW and the LCFRB.

SMAP for Mill Creek Tributary MIL2 Catchment

In 2022 Clark County completed the watershed inventory, sub-basin prioritization, catchment selection, and SMAP plan for MIL2 Catchment.

2024 Permit SMAP

Clark County is using the SMAP program to produce a larger project in the urban and

urbanizing area of Salmon Creek watershed. The project began in early 2024 and is using consultants to complete by spring 2027.

The project includes stormwater capital planning, enhance sweeping, enhanced pipe maintenance, outreach to overburdened communities and materials and other operational actions.

Outputs

- Lower Salmon Creek Plan

TASK CHECKLIST

STATUS	TASK
Due March 31, 2027	Complete lower Salmon Creek SMAP report

For more information on how development, redevelopment and construction sites are regulated for stormwater and erosion control:

Rod Swanson, Clean Water Division NPDES Permit Manager,
564-397-4581
Rod.Swanson@clark.wa.gov

Section 6 – Public Involvement, Education and Outreach

Clark County provides ongoing opportunities for the public to review and comment on the stormwater management program activities through various mechanisms. Public input is one way to tailor policy within the NPDES permit requirements. The county also offers numerous stormwater education opportunities for the public. The education program is aimed at various audiences and is designed to help raise awareness to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts.

Public Information, Involvement and Participation (S5.C.4)

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.4 Public Involvement and Participation

The NPDES permit requires the county to provide ongoing opportunities for public involvement in the stormwater management program development and implementation. The public, including overburdened communities, must have opportunities to participate in the development, implementation and update of the *Stormwater Management Plan* and the county must consider public comments on it. The county must annually document specific public involvement and participation opportunities provided to overburdened communities and specifically, highly impacted communities, and document methods used to identify overburdened communities. The SWMP, annual report and other submittals required by the permit must be posted on the Clean Water Division's website.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 13.30A.040 Clean Water Commission

County Code Chapter 13.30A.040 defines the role of the Clark County Clean Water Commission (CWC), a citizen commission formed to advise the Clark County Council. The CWC will advise the Council on policies on surface and stormwater issues, and citizen outreach.

PUBLIC INFORMATION

Purpose

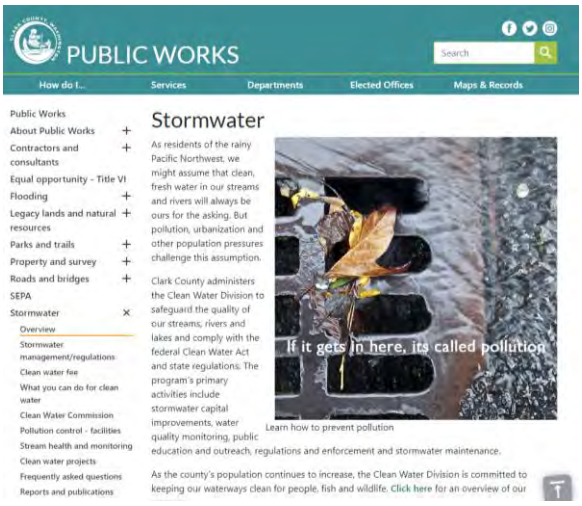
The Clean Water Division provides information to the public about the stormwater management program to publicize the program's services to rate payers and keep the community abreast of current stormwater management issues at: www.clark.wa.gov/stormwater.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW Outreach Mgr.	CCPW Outreach Specialist Sr.	CCPW CWD Professional Staff
Provide content	A	I	P	P	P
Web updates	I	C	S	P	S
Write media releases	S	A	P	S	S
	A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted				

Clean Water Division Website

Clark County Public Works Clean Water Division's website offers an opportunity for the public to review program activities, services and documents, as well as receive educational messages about stormwater. The website address is: clark.wa.gov/stormwater. It can be viewed in more than 100 languages. Older technical reports and information formerly on the web are available to the public upon request.



Clean Water website

Media Releases

The Clean Water Division releases information on various topics to the media to publicize noteworthy events. The Clean Water Division manager will call for a media release on timely matters. The outreach manager will write the press release with the support of the Public Works public information officer. Releases will be reviewed, edited and distributed to the media by the public information officer.

Outputs

- Content on CWD website
- Media releases

PUBLIC INVOLVEMENT AND PARTICIPATION

Purpose

The purpose of involving the public in the SWMP is to try to tailor the program, while considering the prescriptive nature of the permit. Public feedback about program effectiveness and the public's needs also helps the Clark County Council set policies for stormwater management.

Responsibilities Matrix

Task	Council	CCPW CWD Mgr.	CCPW Outreach Mgr.	CCPW Outreach Specialist Sr.	CCPW CWD NPDES Permit Mgr.	CCPW CWD OA	CCPW CWD Program Asst.	CCPW Enhance. and Permitting Mgr.	CCPW Eng. Permitting Mgr.
Appoint Clean Water Commission	A / P	I	I	I	I	I	S	O	O
CWC liaison	C	A	S	O	S	S	P	O	O
CWC secretary	O	A	S	O	O	S	P	O	O
Respond to SWMP public comments	I	A	S	O	P	I	I	O	O
Respond to SEPA comments for stormwater capital projects	I	I	O	O	O	O	S	A	P
Community presentations	I	A	S	P	S	S	S	O	O
Other code update coordination	I	A	responsibilities assigned as needed					O	O
Customer service adaptive management	I	A	any CWD staff may be primary in his/her area					O	O
	A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted								

Clean Water Commission

The Clean Water Commission (CWC) is a nine-member advisory panel appointed by the County Manager and confirmed by the Clark County Council. It provides a forum for public participation in the stormwater management program and also informs the Council about stormwater topics and policy recommendations.

Staff Support

Clean Water Division staff support the CWC in a variety of ways. A program assistant is the primary staff liaison to the CWC. The liaison will attend each meeting to take notes, distribute meeting materials, provide minimal facilitation when required, and respond to requests for information from CWC members. The CWC webpages will be updated with current commission member information and

terms, agendas, meeting summary notes and audio/video files, as well as any handouts. Other Clean Water Division staff members may attend meetings, as required, to present updates on program activities or documents.

Member Appointments
Public notice of openings on the CWC will be listed in a news release issued by the public information officer and sent directly to local organizations representing overburdened communities. Interested applicants, including incumbents seeking another term, must submit a letter of interest and a resume to the Clean Water Division manager. Clean Water Division staff and Clean Water Commissioners will conduct interviews and select candidates to fill vacant positions. Selected candidates are recommended to the county manager for approval and submitted to the Clark County Council for confirmation.

Public Meetings
The CWC will hold a minimum of six public meetings each year, every other month starting in February. Meetings are held in a hybrid format allowing for both virtual and in-person participation on the first Wednesday of every other month at 6:00 pm. Public notice of meetings are issued in the county paper of record (The Columbian) prior to the meeting date.

Discussion topics will include updates from staff on the stormwater management program, education and outreach activities, surface water/stormwater monitoring, capital project planning and regulatory changes.

At meetings, the CWC will review and discuss major stormwater policy recommendations. All meetings will be documented with a meeting summary (.pdf file) and an audio recording (.mp3 file) or link to a video recording. The meeting documentation will be available on the CWC webpage.

The CWC will hear public comment at the meeting.

Communications with Clark County Council
Each year, the CWC will provide an annual report to the County Manager and Clark County Council in a public meeting during the first half of the year. The annual report should summarize CWC discussions, actions and recommendations from the previous year, as well as include a work plan for the upcoming year.

The CWC may elect to communicate with the Council at any time via letter, memorandum, or during scheduled public comment periods at Council Work Sessions and Hearings.

Stormwater Management Plan Review and Input

Clark County places its *Stormwater Management Plan* each year on the Clean Water Division website for review and comment by the public. A one-page summary of the *Stormwater Management Plan* sections and instructions on how to provide input is also used to solicit feedback at in-person events and on social media. The summary is translated in Spanish, Russian and other languages upon request. All documents are available at: clark.wa.gov/public-works/clark-county-stormwater-management-plan.

The Clean Water Division manager or a designee will respond to comments.

Stormwater Capital Projects SEPA

As the Clean Water Division builds stormwater capital projects (see County Stormwater Capital Projects in Section 5), each project will be subject to public review and comment under the Washington State Environmental Policy Act (SEPA).

Along with the individual projects, the annual Stormwater Capital Plan is subject to public review and comment under SEPA.

The CCPW Public Works Environmental Permitting coordinator assigned to the project will write and distribute to stakeholders a Determination of Significance or a Determination of Non-Significance. The required public comment period will be held. The coordinator will respond to any comments received, and if warranted, require changes to the project's design.

Each capital project may also include a package of outreach materials to inform potentially impacted citizens and stakeholders of the project. Typical products include a "Heads-up" notice to citizens in the immediate project area in multiple languages, a detailed project letter to adjacent property owners (describing project timeline and potential impacts), a project sign at the construction site and informational fliers. Materials may also be posted on the CWD stormwater capital project webpage.

Development Engineering Advisory Board

The Development Engineering Advisory Board (DEAB) is a technical and policy review body reporting to the Clark County Council. The DEAB also serves as a mechanism for coordinating with the development community and consulting engineers to distribute information and organize training.

Community Presentations

As requested, Clean Water Division staff will provide information on the program's activities to community, neighborhood and civic groups, at times in concert with the Clean Water Commission, to distribute information about the stormwater management program and get feedback on community priorities. A program slideshow is available for presentations.

INCREASED COMMUNITY INVOLVEMENT

The Fee Increase Rate Study will allow Clean Water Increase administrative support for the Community Engagement & Inclusion team and provide resources to support additional public involvement, open houses, surveys, educational materials, and website updates.

Code Updates

Code revisions for water quality, stormwater and erosion control and Clean Water Fee regulations require extensive public outreach, review and comment, which will be coordinated by the Clean Water Division.

Per the 2024 NPDES Municipal Stormwater Permit, a public outreach plan was developed to inform the public and solicit input on stormwater code and manual updates. Any code updates utilize a variety of outreach strategies including emails to internal and external stakeholders, as well as website updates.

Customer Service / Adaptive Management

The Clean Water Division and its designees maintain regular contact with the public through daily programmatic activities such as customer service for the Clean Water Fee, source control inspections (Section 4),

inspections of regulated stormwater control facilities at businesses and subdivisions (Section 3), information requests, social media and complaint response. Staff receive feedback during these contacts and often incorporate suggestions into their daily procedures and processes.

For example, as a result of public feedback, the Clean Water Division provides a program to educate residential subdivision homeowners associations about proper maintenance of their stormwater facilities at: stormwaterpartners.com/facilities.

Outputs

- Clean Water Commission notes including public comments.
- Clean Water Commission Annual Report to the County Manager and Clark County Council.
- Log of public comments on the stormwater code and manual updates.
- Log of public comments from community presentations.
- SEPA file for each stormwater capital project and annual Stormwater Capital Plan update.
- Media releases.
- Email updates.
- Web content.

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TASK CHECKLIST

STATUS	TASK
ONGOING	Create opportunities to the public, including overburdened communities, to participate in the decision-making process involving the development, implementation and update of the SWMP
ONGOING	Implement processes to involve public in the SWMP
ONGOING	Display SWMP and other NPDES submittals on the website

For more information on efforts to inform and involve the public in the stormwater management program:

Devan Rostorfer, Clean Water Division Manager
564.397.4345
cleanwater@clark.wa.gov

Education and Outreach Program (S5.C.11)

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.11 Education and Outreach Program

The NPDES permit requires the county to have an educational program to build general awareness about methods to address and reduce impacts from stormwater runoff and effect behavior change to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts. The permit also requires the county to create stewardship opportunities that encourage community engagement in addressing the impacts from stormwater runoff.

COUNTY POLICIES, RULES AND REGULATIONS

Clark County Code Chapter 13.26A.010 Education and Technical Assistance

County Code Section 13.26A.010 describes the use of education and technical assistance to business owners and the general public as a primary means of implementing a successful pollution source control and prevention program.

EDUCATION FOR THE GENERAL PUBLIC

Purpose

The goal of the stormwater education and outreach program is to build general awareness and influence behavior changes to reduce or eliminate activities with adverse stormwater impacts. The support and awareness of the general public is crucial to achieving this goal, including options to deliver selected messages to target audiences in languages other than English. Education for the general public will focus on the following topics:

- Importance of clean water for local waterways
- General impacts of stormwater on surface waters, including watershed management
- Impacts from impervious surfaces
- How people contribute to the problem through daily activities including illicit discharges and improper disposal of waste
- Each person's ability to help protect and improve the quality of Clark County's water resources through source control BMPs and environmental stewardship
- Low impact development principles and BMPs
- Information about water quality and stream health

The Fee Increase Rate Study will allow Clean Water to increase education and outreach under the stormwater permit program

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW Outreach Mgr.	CCPW Outreach Specialist Sr.	Partner Agencies / Contractors
Coordinate education programs	A	C	P	S	C
Track and measure deliverables	A	C	P	S	S
Create messages, programs and collateral	A	C	S	P	P
Distribute messages and collateral	A	C	S	P	P
	A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted				

Canines for Clean Water

The Canines for Clean Water program is a behavior change campaign to encourage dog owners to properly manage and dispose of pet waste. The program's webpage (cleanwaterdogs.com) provides educational information in multiple languages, directions for properly managing and disposing of pet waste, free resources to help residents overcome barriers, and a pledge for owners to pick up after their dogs. The program uses social marketing strategies such as prompts and public and durable commitments that normalize desired pet waste disposal practices.

A senior outreach specialist will oversee the program and coordinate most of the tasks including receiving pledges, mailing materials, keeping program materials up to date, having a table at events, and coordinating with local partners to share the message.



Canines for Clean Water Brochures

The program webpage also provides information in multiple languages for community members to work in their neighborhood to support pet waste pick-up. Signs are available to place in yards and common pet walking areas.

Public Works also partners with Community Development to educate the public on the need to pick up pet waste (stormwater protection and solid waste management issues) through the promotion of Canines for Clean Water. Informational fliers are sent out in pet license renewal notifications informing dog owner of the harms pet waste poses and encouraging them to take the pledge.

Green Neighbors Program

Clark County launched the Green Neighbors program in 2012. Promoting sustainable practices (including stormwater pollution prevention) to homeowners via their webpage clarkgreenneighbors.org, the program also hosts workshops and other educational events. The program is administered within the Public Health Department and provides timely messaging about proper disposal of waste, educational opportunities and stewardship activities through a community event calendar.

Website

Public Works maintains a website at clark.wa.gov/stormwater, as well as specific program webpages, that showcase information about stormwater pollution prevention practices aimed at priority audiences. The site also contains information on endangered species at clark.wa.gov/public-works/endangered-species-act, with multiple links to additional resources on endangered species.

A webpage dedicated to "What you can do for clean water" includes educational information and stewardship opportunities for home, community, schools, businesses and property managers.

The website is updated as needed by the Public Works staff.

Clark County Stream Health Report

In 2025, Public Works and GIS staff updated the Clark County Stream Health Report StoryMap with data from water year 2023 and incorporated a section for hydrology data. The report is part of the existing Explore Your Watershed story map at www.clarkwatersheds.org. The report: presents data from 51 stream sites using water quality and biological health indicators to compare 2010 conditions to 2023; evaluates water quality parameters based on the Washington State water quality standards; evaluates stream flow and rainfall; and explores water quality trends at nine long-term index stream sites.

Publications and Displays

Public Works staff produce displays and publications generally as part of specific program areas, such as pet waste management, natural gardening to reduce pesticide use, pollution prevention techniques, watershed education and others.

Many displays and publications are in stock and ready for distribution. Staff continues to display and distribute materials at community events, targeted environmental events, Clean Water Division presentations and Clean Water Commission meetings.



Cougar Creek Interpretive Sign

Other displays include interpretive signs on county capital projects and park trails. Interpretive / educational messages are tailored to each site. Typical messaging includes information on watersheds, the value of the stormwater project, the value of protecting water quality, actions residents can take to protect water quality and contact information for the Green Neighbors program or Stormwater Partners of SW Washington.

Public Works staff also refer residents to the Clark County Stream Health Report for information about their local watersheds.

Outreach Events

Public Works Clean Water Division staffs informational booths at a variety of community events, such as the Klineline Kids Fishing Derby, Multicultural Resource Fair and Home and Garden Idea Fair. Outreach includes information about water quality, the effects of stormwater pollution, pollution prevention and other targeted environmental protection messages.

Social Media

Public Works utilizes several forms of social media to increase outreach messaging effectiveness including:

- Facebook – Clean Water messages are included in content posted through the Public Works department profile at facebook.com/clarkcowa.pw
- X (formerly known as Twitter)– The X handle is @ClarkCoWa_
- Instagram – Clean Water messages are included in content posted through the Public Works department profile, @clarkcowa_pw, including the Clean Water Division.
- Nextdoor.com – The Clean Water Division posts on the Clark County Communications agency account.

Stormwater Partners of SW Washington

Clark County participates is a member of Stormwater Partners of SW Washington, a regional group of NPDES permittees across the county who collaborate to meet education and outreach requirements. Each partner contributes financially and in-kind to develop and implement an annual workplan. Stormwater Partners meet monthly and hold an annual symposium that includes the

broader water outreach and education community.

In 2024 Stormwater Partners will fund the Watershed Alliance to conduct outreach to college, university and trade students, the Clark Conservation District to hold a watershed stewardship course, collaborate on a behavior change campaign focused on dumpster maintenance and hold a Students for Clean Water Video Contest.

The Stormwater Partners of SW Washington website (stormwaterpartners.com) includes resources on stormwater facility maintenance and LID BMPs, in addition to pollution prevention resources pertinent to audiences including businesses, residents, schools, property managers, contractors and developers.

Regional Clean Water Campaigns

The Clean Rivers Coalition is a group of Oregon and Southwest Washington cities, counties, stormwater utilities and nonprofit organizations committed to water quality and protection. The coalition supports an identified need for a regional public awareness campaign and development of strategies connecting behavior change messaging to local programs. Public Works clean water outreach specialist senior sits on the steering committee of the coalition.

In 2023, the Clean River Coalition launched the Follow the Water (followthewater.info), an awareness campaign aimed at connecting people to water, their behaviors to water and providing resources for behavior change. They also launched a What's Your Lawn Style pesticide and nutrient reduction behavior change campaign.

Public Works is collaborating with regional partners and KPTV - Fox 12 on a media campaign promoting stormwater pollution prevention for residents.

Outputs

- Clean Water Division webpages clark.wa.gov/stormwater and cleanwaterdogs.com
- Public contacts at events
- Fact sheets / brochures / informational signage
- Pledges to pick up pet waste
- Promotional materials such as water bottles, pens, etc.
- Social media outreach
- Stormwater Partners of SW Washington
- Regional clean water campaigns
- Clark County Stream Health Report

EDUCATION AND TECHNICAL ASSISTANCE FOR BUSINESSES

Purpose

Education for businesses helps meet county goals for assisting commercial, industrial and governmental enterprises in preventing contribution of pollutants to stormwater runoff or to receiving waters.

Outreach and assistance will focus on:

- General stormwater issues
- Information about illicit discharges
- Preventing and controlling the discharge of contaminants through proper use of Best Management Practices (BMPs)
- Equipment maintenance

Responsibilities

Most activities for this requirement are conducted concurrently or in association with procedures described elsewhere in the SWMP to complete source control inspections and

follow-up technical assistance. Responsibilities are described in their respective sections.

Clark County Green Business Program

Clark County's Green Business Program (clarkgreenbiz.com) recognizes and promotes local businesses that document "green" practices, including stormwater BMPs. The program currently supports local businesses that have completed sustainability assessments and have met the requirements to be a Clark County Green Business. The program is managed through Clark County Public Health. An integral part of the program is the technical assistance visits and education to promote proper handling and disposal of toxic and hazardous materials and stormwater BMPs.

Targeted Messaging

The Clean Water Division has identified a number of businesses that will benefit from targeted messaging on how their business can modify everyday practices to minimize pollution to stormwater. A series of brochures developed in 2017 are used to educate businesses and assist in finding solutions for their pollution prevention strategy. The brochures include messaging in Spanish and Russian.



Pollution Prevention Assistance Flyer

Targeted business practices inserts include:

- Dumpster/Compactor management
- Spill kit / drum lid use
- Landscaping
- Surface cleaning

Staff created English and Spanish language mop bucket management posters for businesses that routinely mop floors, such as restaurants. In the 2015 fuel station assessment program, Clean Water Division staff developed messaging tools specific to fueling stations.

Pollution Prevention Assistance Program

The Clean Water Division, through a Department of Ecology Pollution Prevention Assistance (PPA) contract, provides targeted outreach to businesses to address pollution source control. There are several aspects to the project, including technical assistance visits, messaging and materials. Available materials include 5-gallon emergency spill kits and drum lid covers, as part of the "Keep a lid on it" program.

In 2026, Clean Water Division staff will continue meeting with businesses and support pollution prevention efforts for business and property managers.

Clean Water Division staff also lead a regional PPA workgroup. PPA specialists from the region meet bi-monthly to discuss challenges, share resources and collaborate on strategies for supporting pollution prevention outreach to businesses.

Catch Basin Cleanout Program

The Clean Water Division will continue the Catch Basin Cleanout Program aimed at increasing routine maintenance of privately owned catch basins. The program partners

with a vendor to provide catch basin cleaning for an agreed upon price of $50 per catch basin. The vendor then performs the catch basin cleaning, properly disposes of waste material, invoices the business, and provides a manifest of appropriate waste disposal.

Clean Water Division staff created a webpage where owners of private catch basins sign up to have catch basins cleaned for the fixed rate (clark.wa.gov/catchbasincleanout).

Clean Water Division staff promote the program to businesses with stormwater facilities and catch basins draining to the county storm sewer system.



Catch Basin Cleanout Flyer

Carpet Cleaner Notices

Public Works, in partnership with regional cities and counties, mails a notice to local carpet cleaners informing them of proper waste disposal options, illicit discharges, and enforceable stormwater pollution laws. Approximately 40 Washington carpet cleaning business receive English and Spanish versions of the notices. Oregon carpet cleaners who may work in Washington also receive the notices.

Outputs

- Clark County Green Business Program clarkgreenbiz.com
- Targeted business materials, spill response, etc.
- Pollution Prevention Assistance brochures
- Pollution Prevention Assistance oil/water separator user's guide
- Catch Basin Cleanout Program clark.wa.gov/catchbasincleanout
- Carpet cleaner notices mailed

EDUCATION FOR HOMEOWNERS, LANDSCAPERS AND PROPERTY MANAGERS

Purpose

Homeowners, landscapers and property managers are caretakers for a large percentage of the county's impervious surfaces, such as roofs and driveways, as well as lawn and landscaped areas that may contribute pollutants to runoff. Education messages will focus on the following topics:

- Impacts of stormwater on surface waters
- Rural property management techniques
- Yard care techniques
- Proper storage and use of pesticides, fertilizers and other chemicals
- Proper maintenance of stormwater treatment and flow control facilities
- Low Impact Development principles and practices
- Proper maintenance of vehicles, equipment and home/buildings
- Proper techniques for carpet cleaning and auto repair
- Street and sidewalk wash water discharge reduction

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW Outreach Specialist Sr.	Agencies Providing Services
Coordinate education programs	A	C	P	C
Track and measure deliverables	A	C	P	S
Create messages, programs and collateral	A	C	P	P
Distribute messages and collateral	A	C	P	P
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted				

Small Acreage Education Program

The Small Acreage program, funded by the Clean Water Division in partnership with WSU Clark County Extension, provides educational workshops and other outreach to residents on water quality topics unique to rural properties. Topics include mud and manure management, pasture management, well and septic maintenance, and fencing for livestock.

The goal of the Small Acreage program is to reduce pollution entering storm and surface water from residential and agricultural properties by giving residents the knowledge and skills necessary to manage their land and animals.



Ways to Reduce Agricultural Stormwater

WSU Clark County Extension will provide one full-time program coordinator and oversight by an Extension faculty member. The coordinator will facilitate workshops, model property tours and follow-up activities. The coordinator also will attend community events to recruit new participants.

Clark County Public Works staff track deliverables of the program and negotiate the annual scope of work with the Extension director. WSU Clark County Extension submits quarterly and annual reports detailing deliverables.

What's Your Lawn Style

Clark County received an Ecology grant to implement the Clean Rivers Coalition's (CRC) pesticide and fertilizer reduction behavior change campaign, What's Your Lawn Style. . The social marketing campaign aims to reduce weed'n'feed products commonly used on residential lawns. The campaign is informed by prior research with the priority audience and Latino community members and includes short videos in multiple languages and websites hosted on the Oregon State University Master Gardeners (whatsyourlawnstyle.org) and Follow the Water (followthewater.info)

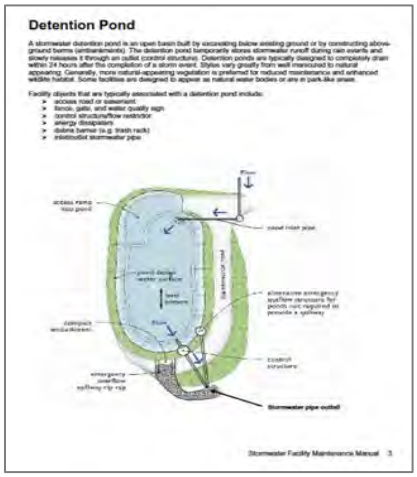
websites. The campaign will utilize paid media and work with WSU Master Gardeners to engage county residents through in-person outreach and activities about reducing pesticides and fertilizer use.

Targeted Outreach for Agency Partners

Clark County participates in the Local Interagency Networking Cooperative (LINC), a regulatory-focused education and outreach partnership between Clark County departments of Public Works and Public Health, City of Vancouver Department of Public Works, Clark Regional Wastewater District, Southwest Washington Clean Air Agency, the Washington State Departments of Agriculture, Ecology and Labor & Industries and others.

Regulated Facility Maintenance Inspections

Clark County combines site visits for regulated stormwater facility maintenance inspections with delivery of technical assistance materials such as relevant pages from the Stormwater Facility Maintenance Manual. Refer to Section 3 – Operating and Maintaining the Storm Sewer System, County Property, and Roadways for a complete description of the process.



Parts of a Detention Pond

Stormwater Facility Assistance & Stormwater Partners

Clark County continues to partner with municipalities and regional partners within the county through Stormwater Partners of SW Washington, a program to provide common stormwater messages, education and guidance to the public on how to properly maintain privately owned stormwater treatment and flow control facilities.

The Stormwater Partners website (stormwaterpartners.com/facilities) contains how-to videos and user-friendly outreach materials.



Stormwater Facility Maintenance brochures

The Public Works senior outreach specialist will continue to work with the Stormwater Partners to develop this program as needs are identified. Quarterly meetings and an annual symposium will be ongoing and include partners who have a role in educating the public about stormwater.

Low Impact Development (LID) Training

Clark County staff have several tools for educating the public on LID, including a tour book of LID sites in Clark County. The book is in hard copy, as well as a Google map on the Stormwater Partners webpage (tinyurl.com/bddfj5tp).

In 2021, Stormwater Partners added new materials on specific stormwater features and LID. Public Works staff share these resources with various audiences including realtors, landscape professionals, contractors, single family residential homeowners and property managers. Some of the materials may be presented in workshops and trainings, including in collaboration with partners such as Community Development.

Homeowner Targeted Messaging

The Clark County Green Neighbors program (clarkgreenneighbors.org) offers residents tips and resources to maintain their homes and yards while minimizing adverse stormwater impacts including:

- Natural Garden Demonstration Site – A demonstration home garden site has been established at a local park (Pacific Community Park) to show how to manage diverse home landscapes while conserving and protecting water.
- Technical Assistance for Natural Gardening – Green Neighbors offers technical assistance through a web-based platform to homeowners to improve yards and minimize water use, pesticides and runoff. It also aims to encourage the use of native plants and creation of wildlife habitat.

Backyard Habitat Certification Program

The Clean Water Division provides funding for the Backyard Habitat Certification Program, a collaboration of Columbia Land Trust, Portland Audubon and Watershed Alliance of SW Washington. The program provides stewardship opportunities to owners of private property sized up to one acre in unincorporated Clark County. Participants receive technical assistance, incentives and recognition to restore native wildlife habitat, control noxious weeds, reduce pesticide use and manage stormwater on-site.



Certified Backyard Habitat Participant

Related Messaging

Other Clean Water Division efforts distribute information about water quality, the effects of stormwater pollution, and pollution prevention techniques as integral parts of their program outreach and education messages to the general public. Many of these messages are with partner agencies, such as Public Health.

- WSU Clark County Extension's Master Gardeners program – Public Health contracts for natural gardening workshops
- Composter Recyclers – less toxic gardening and yard care
- Hazardous Waste Reduction – proper disposal of household and business hazardous wastes
- Recycling A-Z website at www.recyclinga-z.com – proper disposal of tires, electronics and household hazardous waste
- Poop Smart Clark – pollution identification and control program focused on reducing bacteria pollution sources
- Clark County Community Development - Building Safety – information for

homeowners on erosion and stormwater requirements
- Green Apartment Living – pollution prevention assistance webinar series for multifamily property managers
- Other local grant programs provide additional messaging about stormwater management and pollution prevention.

Outputs

- Rural land manager fact sheets and videos
- Rural land manager workshops and trainings
- LID educational materials
- Lawncare BMP materials
- Waste disposal materials

EDUCATION FOR DEVELOPMENT AND CONSTRUCTION COMMUNITY, COUNTY PLANNERS AND REVIEWERS

Purpose

The individuals, businesses and agencies involved in development project planning and construction (both regulated communities and the regulators) have great influence on the impacts of stormwater from new development and redevelopment. Education to these communities will focus on the following topics:

- Technical standards for stormwater site and erosion control plans
- Low impact development techniques
- Stormwater treatment and flow control BMPs and facilities

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW Outreach Specialist Sr.	CCPW CWD Permit Mgr.	CCPW CWD Operations Specialist	CD Dev. Services Mgr.	CCPW Dev. Eng.
Code update outreach	A	S	P	O	I	S
Construction Management training	A	O	P	O	O	O
Facility inspection training	A	O	S	P	O	O
WWHM training	A	O	S	O	I	I
CD website	O	O	O	O	A / P	C
Pre-application conference	O	O	O	O	A / P	P
Small Projects BMP handout	A	S	S	O	P	O
DEAB	I	O	O	O	I	P
A = Accountable, P = Primary (doer), S = Supports, C = Consulted, I = Informed, O = Omitted						

WORKSHOPS AND PRESENTATIONS

Stormwater Facility Inspection Training

Public Works Construction Management has an ongoing stormwater facility inspection program. Training will be provided to new inspectors and when there is a change in procedures or manual requirements. Staff are trained to be certified erosion and sedimentation control leads.

Training on Demand

Clean Water Division staff will provide training, code interpretation, BMP manual interpretation and informational materials to technical, professional, and field workers as requested. Clark County departments with employees who work with the development community are trained by CWD staff on topics such as understanding "Pollution by Design" conflicts in development designs (e.g., dumpsters that include covers and separate drain systems).

Education Delivered Through Development Review

Many active development community stakeholders receive educational and outreach messages about water quality, stormwater, and erosion control topics as an integral aspect of the regulatory development review process, including individual residential building permits.

For detailed information on the development review process, see Section 5 – Regulatory Program for Development, Redevelopment and Construction Projects.

Community Development Website

The Clark County department of Community Development hosts a website devoted to compliance with erosion control measures at: clark.wa.gov/community-development/erosion-control.

Pre-Application Conference

All Type II and Type III development applications require the applicant to attend a pre-application conference with county planners and engineers where, among other topics, stormwater, erosion control and submittal requirements are reviewed.

Clark County Stormwater Manual

The Clark County Stormwater Manual, which guides applicants for development and new development through stormwater and submittal requirements, contains educational messages about the importance of stormwater management. Training materials are posted on the county stormwater manual webpage at: clark.wa.gov/public-works/stormwater-code-and-manual.

Small Project BMP Handouts for Permit Center

Clark County provides BMP packet handouts for small projects that are required to have stormwater site plans, erosion controls and on-site stormwater management BMPs, but don't require an engineered design. The target audience is mainly applicants for single family residential building permits and other small building projects.

Development Engineering Advisory Board

The Development Engineering Advisory Board (DEAB) is a technical and policy review body reporting to the Clark County Council. The DEAB also serves as a mechanism for coordinating with the development community and consulting engineers to distribute information and organize training.

Outputs

- Presentations
- Employee training
- Development community training
- Small Project BMP handout
- Sustainable and affordable development reports
- Educational messages in Clark County Stormwater Manual

EDUCATION FOR STUDENTS

Purpose

Students are the next generation to manage property, own or manage businesses, or simply live, work and recreate in Clark County. Education for students will focus on the following topics:

- Raising awareness of the importance of clean water.
- Introducing the idea of pollutants entering water through stormwater.
- Introducing LID principles and BMPs.
- Impacts from impervious surfaces and improper disposal of waste.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW Mgmt. Analyst Sr.	CCPW Outreach Specialist	Agencies Providing Services
Coordinate education programs	A	P	P	C
Track and measure deliverables	A	P	P	S
Create messages, programs and collateral	A	S	P	P
Distribute messages and collateral	A	S	P	P
A = Accountable, **P** = Primary (doer), **S** = Supports, **C** = Consulted, **I** = Informed, **O** = Omitted				

Student Watershed Monitoring Network Program

In partnership with the City of Vancouver, Clark County involves students grade K-12 in water quality monitoring of sites near their schools. Teachers and students receive mentoring in water quality and macroinvertebrate monitoring and conduct stream studies. Students share their findings with peers and the community with an annual culminating activity in late spring.

Program activities and outreach will be conducted primarily by City of Vancouver staff. Clark County staff will negotiate the annual scope of work and track deliverables. County staff may participate in the annual culminating activity where needed.

Student Video Contest

Stormwater Partners of SW Washington will hold the Students for Clean Water Video Contest (stormwaterpartners.com/video-contest). Open to Clark County middle and high school students, contest submissions

include short videos on topics related to pollution prevention, stewardship, and cultural connections to local water. Prizes are awarded for five categories, and winning videos are promoted on social media and recognized at movies in the park events during the summer.

Experience Vancouver Lake

Clark County partners with the Port of Vancouver and City of Vancouver to fund the Lower Columbia Estuary Partnership (LCEP) to implement the Experience Vancouver Lake program. The program provides a variety of educational activities related to Vancouver Lake including in-class instruction and hands-on educational science kits. LCEP educators conduct Vancouver Lake field trips that include water quality monitoring, stewardship projects and educational messaging about the lake. To engage community and encourage residents and their families to visit the lake LCEP educators lead on-water community paddles and family nature hikes. LCEP focuses on providing opportunities for overburdened community members to get on the lake with no paddling skills required. LCEP also provides a highly visual, illustrated trail map available as a community and school resource in English and Spanish.

College, University and Trade Students

Through Stormwater Partners of SW Washington, the county contracts with the Watershed Alliance of SW Washington to conduct outreach and education to local colleges, universities and trade students. The Watershed Alliance seeks on-campus outreach opportunities and organizes class presentations for Stormwater Partners to share information about impacts of stormwater, hazards associated with illicit discharges and improper waste disposal, LID principles and BMPs and careers in the stormwater field.

Enviroscape

The Clean Water Division has an Enviroscape watershed model available for schools to use for watershed and stream health lessons. Utilized by classes K-12, the model helps illustrate how a variety of “pollutant” types such as soaps, dirt, oils and pet waste, can reach waterways.



Enviroscape watershed model

Outputs

- Student Watershed Monitoring Network
- Students for Clean Water Video Contest
- Experience Vancouver Lake student and community outreach activities
- College, university and trade student outreach
- Enviroscape models for classroom use

STEWARDSHIP OPPORTUNITIES

Purpose

Clark County creates stewardship opportunities and/or partners with existing organizations to encourage residents to participate in stewardship activities. The county offers hands-on activities including the following:

- Storm drain marking – Kits are available to residents, businesses, scouts, and

community groups to mark drains on private property or local roads with speed limits 25 miles per hour or less (both metal medallions and paint stencil kits).
- Adopt a Drain – Residents can adopt neighborhood storm drains by sweeping up around the drain each month on roads with speed limits 25 miles per hour or less.
- Planting projects are available to residents through local organizations such as the Watershed Alliance of Southwest Washington, Clark Public Utilities StreamTeam and the Lower Columbia Estuary Partnership along riparian areas and critical habitat zones.
- Clark County Parks – Beach clean ups and invasive plant removal events are offered in many county parks.
- Backyard Habitat Certification Program – Technical assistance for property owners to restore native wildlife habitat, control noxious weeds, reduce pesticide use and manage on-site stormwater.
- Students for Clean Water Video Contest – Students create short videos about pollution prevention practices that are shared at community events and on social media.
- River-friendly car wash kit – This kit is available to businesses that host charity car washes for local community groups.
- Watershed Stewardship – Clark Conservation District offers a six-week course on watershed topics and volunteer opportunities. Participants share knowledge and volunteer in their community.
- Other individual site projects – Other projects are available based on the site, such as informational kiosk construction. Community-led projects build the kiosk, and the county provides signage / poster / educational materials about the site, the watershed and key messages.
- Informational sign installations – Community groups, such as scouts, can install watershed specific messaging signs.
- Experience Vancouver Lake – Lower Columbia Estuary Partnership provides service-learning opportunities at Vancouver Lake.

Other Community Partner Stewardship Opportunities

There are numerous agencies and nonprofits that provide stewardship opportunities throughout Clark County, including in the jurisdictional area of Clark County. Many of these partners offer educational and stewardship opportunities. Clark County does not partner on funding, but these programs continue to increase awareness of stormwater related issues in our community. Some of the programs anticipated to continue in 2026 include:

- Clark Conservation District – Best Management Practices program (providing technical assistance for agricultural properties to manage pollution sources).
- Clark Public Utilities – StreamTeam (tree plantings, invasive species removal, education/outreach, events).
- Columbia Springs Environmental Education Center – hosts various outreach events and programs including Salmon in the Classroom (raise and release baby salmon) and community events focused on river health.
- Lower Columbia Estuary Partnership – provides restoration projects, outreach and education, including big canoe tours and working with students in classroom education.
- City of Vancouver Water Resources Education Center – hosts a number of programs to schools and the community about water, water quality, fish and other environmental messages.

BEHAVIOR CHANGE PROGRAM

Purpose

Develop a behavior change program based on local water quality information to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts for at least one target audience and one best management practice (BMP). Regional collaboration on a behavior change program enables development and promotion of consistent messaging and leverages resources.

Responsibilities Matrix

Task	CCPW CWD Mgr.	CCPW PIO	CCPW Outreach Specialist	Agencies Providing Services
New evaluation of ongoing behavior change program	A	O	P	C
Develop campaign strategy, schedule and evaluation plan	A	I	P	S
Implement campaign strategy	A	C	P	P
Evaluate and report	A	O	P	S
A = Accountable, P = Primary (doer), S = Supports, C = Consulted, I = Informed, O = Omitted				

Develop a Behavior Change Campaign

In collaboration with Stormwater Partners of SW Washington, Clark County will develop a behavior change campaign to address dumpster maintenance. The campaign, including an evaluation plan will follow social marketing practices and be completed by July 1, 2025. The behavior is to close and keep dumpster lids shut. Commercial businesses are the priority audience.

Implement Behavior Change Campaign

Clark County and Stormwater Partners of SW Washington will implement the dumpster lid behavior change campaign by September 1, 2025.

Outputs

- Develop behavior change campaign and evaluation plan.
- Implement behavior change campaign.

TASK CHECKLIST

STATUS	TASK
ONGOING	Educate the general public
ONGOING	Educate businesses
ONGOING	Educate residents, landscapers and property managers
ONGOING	Educate the development and land use planning community
ONGOING	Provide and advertise stewardship opportunities
ONGOING	Increase awareness and education of homeowners, landscapers and property managers
ONGOING	Affect behavior through hands on activities, workshops, trainings and stewardship
ONGOING	Apply social marketing practices and methods
IN PROGRESS	Develop behavior change campaign and program evaluation plan
IN PROGRESS	Implement behavior change campaign
BY MARCH 31, 2029	Evaluate and report on behavior change campaign

For more information on programs providing education and outreach about stormwater and the SWMP:

Devan Rostorfer, Clean Water Division Manager
564.397.4345
cleanwater@clark.wa.gov

Section 7 – Coordination

Clark County coordinates internally and with other local governments and agencies on a variety of environmental and planning topics.

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit S5.C.3 – Coordination

The NPDES permit requires the county to coordinate among its own departments and with neighboring jurisdictions to eliminate barriers to permit compliance and to encourage coordinated stormwater policies, programs and projects within a watershed.

COUNTY POLICIES, RULES AND REGULATIONS

The following policies and regulations promote permit implementation by county departments.

Clark County Code Chapter 13.26A – Water Quality

Chapter 13.26A requires inspection and maintenance of all public and private stormwater facilities and stormwater disposal wells in accordance with the Clark County Stormwater Manual that provides source control BMPs for materials handling, landscape management, trash management and building exterior maintenance. This manual is equivalent to maintenance standards in Volume V and source control standards in Volume IV of the SMMWW.

Environmentally Responsible Purchasing Policy

Clark County adopted its Environmentally Responsible Purchasing Policy in 2004. One element addresses purchase of landscaping and vegetation maintenance products, including pesticides. The policy establishes a set of criteria, any of which will disqualify a pesticide from purchase. A waiver process requires further examination of the pesticide by the Environmentally Responsible Purchasing Team to determine if a more environmentally friendly alternative exists. If no alternative is found, the pesticide can be purchased and used within specific limiting guidelines. The policy promotes a coordinated approach to the pesticide and fertilizer use reduction.

WSDOT Regional Road Maintenance Program

https://wsdot.wa.gov/construction-planning/protecting-environment/regional-roadside-maintenance

Clark County has been a member of the ESA Regional Road Maintenance Forum since 2003. The group assisted the county in developing a Regional Road Maintenance Program that is designed to meet the requirements of the Endangered Species Act (ESA). In 2004, NOAA Fisheries approved Clark County's Regional Road Maintenance Program and determined that it was compliant with the ESA. The program seeks to protect salmon and steelhead by relying on the extensive use of pre-approved BMPs for routine maintenance activities. The program promotes systematic adherence to pollution control standards for road operations.

INTRA-GOVERNMENTAL COORDINATION

Purpose

Intra-governmental coordination helps ensure cooperation of all Clark County departments in meeting the terms of the NPDES Municipal Stormwater Permit and in protecting local water resources.

Responsibilities

Responsibility for negotiating interdepartmental and programmatic agreements lies with the Clean Water Division manager or a designee and with managers of coordinating programs and departments.

Responsibilities for implementing the agreed upon activities are shown in detail in responsibility matrices and program descriptions in the appropriate SWMP sections.

Agreements

The Clean Water Division coordinates the county's NPDES permit compliance efforts. Although the program coordinates with other departments, it is not responsible for all compliance actions. The Clean Water Division maintains interdepartmental agreements or other agreement mechanisms with several county departments to support compliance. Agreements include services provided for payment by the CWD and description of permit requirements that must be met by departments.

Public Works Road Operations, Parks, and County Land Management Divisions

Public Works completed an intra-departmental agreement between the Clean Water, Road Operations and Maintenance, Parks, and County Lands Management Divisions to implement requirements under permit requirements S5.C.10, Operations and Maintenance Program, including:

- Standards and schedules for stormwater facility and catch basin maintenance
- Practices for operating streets, roads and highways
- Street sweeping
- Spill response practices
- Stormwater facility inspection and Maintenance
- Water quality BMPs for maintaining public land
- Training
- Stormwater Pollution Prevention Plans (SWPPPs) for heavy equipment yards
- Recordkeeping
- Reporting requirements for the NPDES permit annual report

Public Works Engineering and Construction Division

Public Works provides services to implement permit requirements under S5.C.5, S5.C.6 and S5.C.7.

Public Works provides the following services:

- Project management for stormwater capital improvements.
- Design and construction management for stormwater capital improvements.
- Capital planning assistance.
- Development site inspection.
- Program to inspect stormwater facilities during maintenance warranty.
- Enforce stormwater, erosion control and water quality codes.
- Inspection program recordkeeping.
- County stormwater facility annual maintenance inspection.
- Training for staff whose primary job duties include design, construction site inspection and enforcement.

Community Development Building Safety and Permit Services

Department of Public Works maintains an interdepartmental agreement with Community Development to implement requirements under permit requirement S5.C.5, including:

- Accept development applications.
- Review site plans for residential building projects that do not require engineered designs.
- Review and inspect erosion controls, on-site stormwater controls at residential building sites, primarily single-family residential construction sites.
- Enforce stormwater, erosion control and water quality codes.
- Maintain records of applications, reviews, inspections and enforcement actions.
- Train staff whose primary job duties include permitting, plan review and BMP compliance.
- Referring water quality complaints to the Clean Water Division.

Community Development Planning and Development Engineering

Community Development provides development review services for enforcing Clark County Code Chapter 40.386 Stormwater and Erosion Control. Community Development provides the following services:

- Review and approval of development project applications.
- Administration of development project recordkeeping.
- Train for staff whose primary job duties include permitting and plan review.

Internal Services Facilities

The Clean Water Division has an interdepartmental agreement with Internal Services that includes operation and maintenance of stormwater facilities, use of source control BMPs, and technical assistance and training from Public Works.

Public Health

The Clean Water Division coordinates with Clark County Public Health on spill responses, illicit discharge investigations and other environmental complaints.

Public Health's agreement includes referring illicit discharges to Clean Water Division when discovered during routine work such as restaurant inspections, swimming pool inspections and other field activities that may discover illicit discharges. Field staff are trained to report spills and refer sites having illicit discharges to the Clean Water Division. Public Health is also responsible for addressing illicit discharges caused by on-site sewage disposal facilities.

GIS Department and Application Services

Department of Public Works maintains an agreement with the GIS Department for various services that support SWMP implementation, including administration of the county's storm sewer infrastructure asset database, StormwaterClk, the Cartegraph asset management system, stormwater fee database administration, software support, GIS data used for capital planning and monitoring studies, developing Web applications and internet access to program information, and database development.

Other Intragovernmental Coordination

The Clean Water Division also coordinates informally with other county programs and departments on various stormwater-related and environmental efforts and projects such as development code and comprehensive plan updates.

Outputs

- Interdepartmental memoranda of understanding for services and permit requirements performed.

INTERGOVERNMENTAL COORDINATION PURPOSE

Clark County informally coordinates with Phase II permittees and other local organizations to control pollutants between physically interconnected storm sewer systems, to attempt to provide consistent stormwater management for shared water bodies, and to collaborate on permit implementation tools and TMDL implementation.

Coordination to Clarify Roles and Responsibilities for Interconnected Systems

The Clean Water Division has identified approximately 500 connection points between the county MS4 and other municipal entities such as cities and WSDOT right of way. Within the urban area, the Clean Water Division assesses the potential for intersystem pollutant discharges using IDDE procedures.

Clark County has informal discussions with local NPDES Phase II permittees regarding mapping and illicit discharge screening programs.

The regional Stormwater Partners web page has a list of contacts for local municipalities.

General Intergovernmental Coordination

Clark County participates with other local governments and agencies on several joint efforts, including:

- Shared education and outreach programs with the City of Vancouver.
- Operation of the regional street waste decant facility with WSDOT, Vancouver, Battle Ground, Camas and Washougal.
- Pet waste behavior change campaign with Battle Ground, Camas and Washougal.
- Regional media buy for stormwater education and outreach messaging with Battle Ground, Camas, Washougal.
- Stormwater Partners of SW Washington to produce shared education and outreach products.
- Clean Rivers Coalition collaborates regionally, including Oregon jurisdictions, on education, outreach and behavior change programs.
- Hosting quarterly Southwest Washington permittee meetings to coordinate activities including roles and responsibilities for our interconnected systems.

Stormwater Partners of SW Washington

Clark County coordinates Stormwater Partners of SW Washington to collaborate with other local governments and agencies on outreach and education efforts. Stormwater Partners is led by a steering committee consisting of staff representing Clark County, the cities of Battle Ground, Camas, Ridgefield, Vancouver and Washougal and the Port of Vancouver. In 2024, the partners entered into a formal ILA to continue joint efforts, including:

- Watershed Stewardship course with Clark Conservation District.
- College, university and trade student outreach.
- Dumpster lid behavior change campaign.
- A regional education program covering facility maintenance to stormwater facility owners within Vancouver, Battle Ground, Camas, Washougal, Ridgefield and La Center.

- The Students for Clean Water Video Contest.
- Canines for Clean Water pet waste program.
- Mobile carpet cleaner outreach.

Pollution Prevention Assistance Program Coordination for Source Control Work

Clark County Public Works, Clark County Public Health, Vancouver and Longview are all member agencies in Ecology's Pollution Prevention Assistance Program. Clark County is leading an effort to coordinate our efforts and outreach materials. Non-PPA jurisdictions are invited to attend coordination meetings.

Coordination for Shared Water Bodies

Vancouver Lake Watershed Partnership

The Vancouver Lake Watershed Partnership (VLWP) steering committee meets periodically. The original funding partners (Clark County, City of Vancouver and Port of Vancouver) continue to provide financial support for community outreach, education and volunteer activities such as Experience Vancouver Lake under a contract with the Lower Columbia Estuary Partnership (LCEP). The Clean Water Division manager administers the contract with LCEP and serves as representative to coordinate with the other funding partners.

Vancouver Lake Legislative Proviso

The Washington State Legislature allocated $330,000 to Department of Ecology in the 2023-2025 budget bill to provide a grant to Clark County for the purpose of developing and implementing a lake management plan for Vancouver Lake. In 2025, Clark County will complete an RFP process and hire a consultant team to work on several aspects of plan development and implementation, including:

- Framework for a Vancouver Lake Management Special District and Governance Structure.
- Beach Algaecide Treatment Implementation Plan.
- Flushing Channel Enhancement – conceptual designs and alternatives analysis.

Clark County will also implement additional monitoring and watershed activities funded by the Proviso.

Lacamas Lake Interlocal Agreement

Clark County worked with the City of Camas in 2024 to finalize and adopt an Interlocal Agreement for cooperative efforts managing Lacamas, Round, and Fallen Leaf Lakes and their associated watersheds.

TMDL Coordination

Clark County coordinates with Ecology and local entities on TMDL implementation. Upon request, the NPDES Permit manager and Stormwater Infrastructure manager will provide input to Ecology in development and update of Detailed Implementation Plans. The Stormwater Infrastructure manager and Natural Resource Specialists will continue to participate on the local advisory committees for the following existing or upcoming cleanup plan water bodies:

- Burnt Bridge Creek TMDL
- East Fork Lewis River alternative restoration Plan
- Gibbons Creek TMDL
- Salmon Creek TMDLs
- Lacamas Creek

In 2024, the focus will be on implementing the cleanup plan for bacteria in the East Fork Lewis River and the multi-parameter Salmon Creek cleanup plans in collaboration with Ecology and local stakeholders. Other work

includes ongoing development of multi-parameter TMDLs in Burnt Bridge Creek and Lacamas Creek.

Clark County complies with TMDL requirements by implementing its Stormwater Management Program.

Coordinated Lake Treatment

The Fee Increase Rate Study will allow Clean Water to financially support in-lake treatment activities in Vancouver and Lacamas Lakes to implement Lacamas Interlocal Agreement & Vancouver Lake Management Plan.

Outputs

- Various outputs from education and outreach programs (see section 6)

Environmental benefits

For more information on ways the county coordinates with other jurisdictions and permittees:

Devan Rostorfer, Clean Water Division Manager
564.397.4345
cleanwater@clark.wa.gov

CHAPTER 3
Assessment and Monitoring

Assessment and Monitoring 117



County staff monitoring water quality at the Whipple Creek stream gauge

Assessment and Monitoring

Clark County is a regional leader in natural resource monitoring and assessment. The Assessment and Monitoring section implements a variety of projects to collect scientific data about stormwater, surface waters, stream corridor condition and habitat to support and implement NPDES permit requirements.

The core goal is to provide information leading to successful on-the-ground actions that improve natural resources in Clark County. The program utilizes sound science and data collection practices to inform the county's policy and program management decisions and provide information vital to the success of Clark County programs.

REGULATORY REQUIREMENTS SUMMARY

NPDES Permit – S8 Monitoring

Clark County meets requirements S8.A Regional Status and Trends Monitoring and S8.B Stormwater Management Effectiveness and Source Identification Studies by using the pay-in option.

Standard Procedures for Monitoring Activities

The Clean Water Division maintains the Standard Procedures for Monitoring Activities for use in guiding field and laboratory work. It details the protocols and means used to generate data.

Water Quality Database

The Water Quality Database (WQDB) is a centralized repository for the Clean Water Division's water quality and benthic macroinvertebrate data. The WQDB is a SQL 2000® database with Access® interfaces for data entry and retrieval. A batch uploading tool enables rapid entry of large datasets.

TOOLS THAT SUPPORT PERMIT COMPLIANCE

The Assessment and Monitoring section provides tools and staff to support completion of permit-required stormwater planning technical analysis. These are standard procedures for collecting environmental data, database systems for storing data, quality assurance and quality control procedures, and methods to analyze and present data results.

Quality Assurance Project Plans

Each monitoring project follows a Quality Assurance Project Plan or QAPP to ensure that data are of adequate quality to meet project objectives. Each QAPP follows guidelines published by Ecology.

Hydrology Databases

Data from the county's hydrologic and stormwater monitoring sites (storm flow, stream flow and rainfall gages) is stored in an Aquarius® database.

ILLICIT DISCHARGE MONITORING

This activity is described in detail in Illicit Connections and Illicit Discharges Detection and Elimination (IDDE) in Chapter 2.

For more information on services provided by the Assessment and Monitoring section:

Chad Hoxeng, Clean Water Division Monitoring Manager
564-397-4018
Chad.Hoxeng@clark.wa.gov

Exhibit Q

URBAN TREE CANOPY

ASSESSMENT



CLARK COUNTY, WASHINGTON
URBAN GROWTH AREAS

MAY | 2025

PlanIT Geo
developers of TreePlotter

CLARK CONSERVATION DISTRICT

Funding for this project was provided through an Urban & Community Forestry Grant to the Clark Conservation District, in cooperation with Clark County Public Works and the Washington Department of Natural Resources.



CLARK COUNTY URBAN GROWTH AREAS

URBAN TREE CANOPY ASSESSMENT

> **There are priceless benefits that trees provide across the urban landscape - cooling shade, cleansing our water and air, and moderating the impacts of extreme weather. On a human level, trees give us an immediate connection to the natural world as we note the changing seasons, smile at the return of our avian friends and feel a sense of hope for the future.**
>
> **- SUE MARSHALL, CLARK COUNTY COUNCILOR**

PREPARED BY

PlanIT Geo, Inc., Arvada, Colorado

PREPARED FOR

Clark Conservation District and Clark County Public Works

COMPLETED

May 2025

Cover photo caption: Recreationalists enjoy the benefits of urban tree canopy as they ride their bikes along under mature tree canopies, providing shade on a sunny day. Photo taken by Beth Conyers.

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ASSESSMENT

INTRODUCTION

INTRODUCTION

Clark County is one of the fastest-growing regions in Washington State. It is located on the banks of the Columbia River, just north of the Portland metropolitan area in Oregon. As Clark County's population continues to grow, the region remains rich in natural resources that support fish and wildlife. Among these resources are healthy tree canopies, which provide essential shade for rivers. This shade helps maintain cool water temperatures, benefiting up to five populations of Endangered Species Act-listed salmonids. The environmental resources in Clark County have made this area of Washington State a high priority for salmon recovery, water quality, and water quantity management, ensuring these important natural resources are available for future generations. This includes efforts to protect and restore the urban tree canopy, which provides a multitude of environmental, social, and economic benefits.

PURPOSE

The purpose of this Urban Tree Canopy Assessment is to evaluate the status of the tree canopy in Clark County, Washington, as of 2023, and to assess changes in the tree canopy since 2011. This study also identifies possible planting areas for future plantings to help replenish and to establish the urban tree canopy in areas with the greatest need. This Urban Tree Canopy Assessment serves as the initial step in establishing goals, priorities, policies, and implementation programs to preserve and restore Clark County's tree canopy for the future. This assessment was completed through a partnership between Clark County Public Works and the Clark Conservation District, funded by the Washington State Department of Natural Resources' Urban and Community Forestry Program.

STUDY AREA

The study area includes the eight (8) unincorporated urban growth areas (UGAs) of Vancouver, Camas, Battle Ground, Washougal, Ridgefield, La Center, Yacolt, and Woodland as of May 2025. These unincorporated UGAs are managed by Clark County until they are annexed by the cities. Urban growth areas are zones in Clark County's Comprehensive Plan where denser development and infrastructure can be built over the next 20 years to support population growth. Land outside the UGAs is mostly rural, with larger lots, more open space, farms, and natural areas like forests.

This assessment summarizes the status of urban tree canopy within Clark County UGAs using multiple assessment boundaries including:

1. Watersheds
2. Stream buffers
3. Public and private land ownership
4. Municipal jurisdictions
5. Zoning classifications
6. Census Blocks
7. Census Block Groups

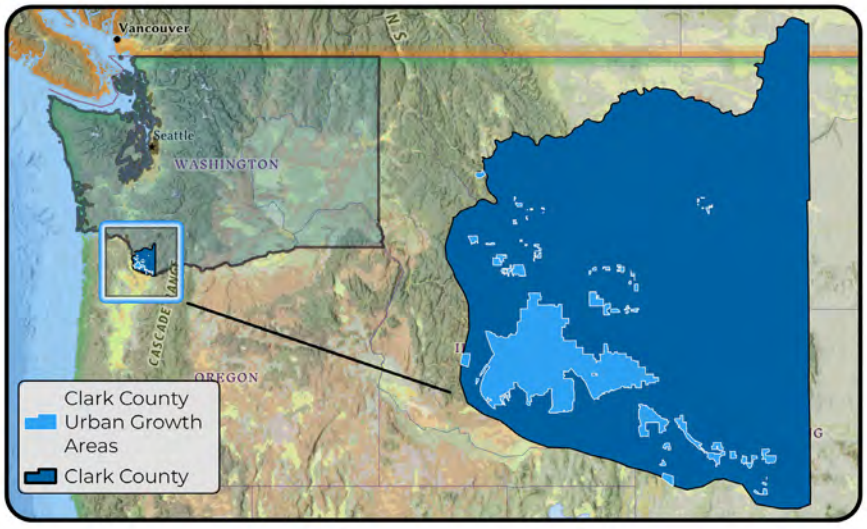


Figure 1. Clark County is in the southwestern part of Washington state, just north of Portland, Oregon, along the Columbia River. This assessment focused on the urban growth areas, covering 61 square miles, which includes 38,972 acres of both surface water and land. The study area is highlighted in light blue.

ASSESSMENT OVERVIEW

Results of this assessment were divided into chapters based on different assessment boundaries. Each chapter presents data on the current tree canopy as of 2023, as well as the changes in tree canopy from 2011 to 2023 for each assessment boundary. The boundaries are listed in order from largest to smallest, starting with the county and concluding with census blocks as defined by the U.S. Census Bureau (2024) on page 23.

This assessment examined the distribution of urban tree canopy within the unincorporated urban growth areas by analyzing several different boundaries. The primary goal was to identify areas with the lowest tree canopy coverage and, therefore, the greatest opportunities for new tree planting. To enhance this analysis, data from the American Community Survey (ACS) were incorporated. This allowed for a comparison of tree canopy opportunities with socioeconomic factors at the census block group level, helping to direct resources to communities with the most need and promote both environmental and social equity. By understanding these patterns, the assessment supported the development of targeted programs and outreach efforts, ensuring that tree planting resources were focused on the highest priority locations.

This assessment utilized i-Tree tools (USDA Forest Service), a tree benefits calculator, to evaluate the benefits and functions of existing canopy incorporating the latest research. **The analysis estimated that Clark County UGAs' current canopy provides approximately $6.98 million annually in avoided infrastructure costs and stores $75.1 million in carbon.**

The Minnehaha neighborhood, located in southwestern Clark County directly north of central Vancouver, was selected as a case study due to its lower urban tree canopy coverage and greater socioeconomic needs compared to other unincorporated neighborhoods in Clark County. Over 250 Minnehaha residents participated in a free tree giveaway program. Additionally, 650 trees were planted in parks, county rights-of-way, and across the neighborhood. The goal of this pilot program was to plant up to 1,000 trees in Minnehaha by 2025. For more information about Minnehaha, see page 28.



Clark County volunteers work with partner organizations to plant new street trees to help increase urban tree canopy.

METHODS OVERVIEW

Urban tree canopies (UTC) are constantly changing. New plantings and natural vegetation growth increases canopy cover, while development, disasters, disease, and pests can diminish tree canopy. Climate change exacerbates these issues by resulting in more frequent and intense natural disasters, altering environmental conditions, and creating new habitats that favor invasive plants, pests, and diseases. This further threatens trees that are already weakened by stress related to climate change.

Canopy assessments using aerial imagery can measure changes in tree canopy with high accuracy. This assessment follows industry-approved land cover definitions and utilizes a proven approach. The study employed imagery from the USDA's National Agriculture Imagery Program (NAIP) and applied US Forest Service standards, along with machine learning techniques, to analyze land cover in Clark County from 2011 to 2023. The assessment included various land cover types: tree canopy, shrubs, other vegetation, bare soil and dry vegetation, impervious surfaces, and water.

Within these land cover categories, the analysis identified potential planting sites that are suitable for future tree planting. Additionally, the assessment outlined areas that are deemed unsuitable for planting due to ecological or logistical concerns. These unsuitable areas include wetlands, which are crucial for biodiversity and water filtration; recreational fields, which serve community needs for sports and leisure; utility corridors, where infrastructure may hinder tree growth; and stormwater facilities, designed to manage runoff and prevent flooding.

Completion of this assessment enables Clark County stakeholders to develop new programs and priorities for protecting and expanding the urban forest. The key objectives of this Urban Tree Canopy Assessment include:

- Quantify the amount and location of tree canopy and other land cover types.
- Analyze the change in canopy cover from 2011 to 2023.
- Describe the ecosystem services tree canopy provides to the community, the environment, and the local economy.
- Identify areas where tree canopy can be expanded through an assessment of possible planting areas.
- Determine priority areas for tree preservation and planting initiatives based on socioeconomic, environmental, and climate-related factors.
- Provide data to inform future planning and to establish canopy coverage goals.

For more information about the methodology used to complete this assessment, see Appendix A.



Baseball fields and other recreational areas used for sports are examples of land uses that are unsuitable for future tree plantings.



9,866

ACRES OF TREE CANOPY IN UNINCORPORATED URBAN GROWTH AREAS

28%

OF THE TERRESTRIAL LAND AREA WAS COVERED WITH CANOPY IN 2023

Public parks with available open space provide opportunities to plant more trees to increase urban canopy. This also helps reduce maintenance costs by decreasing lawn areas that need regular mowing.

RESULTS OVERVIEW

The unincorporated urban growth areas (UGAs) in Clark County cover a total of 38,972 acres. According to the US Forest Service's UTC assessment protocols, it is best practice to exclude surface water to ensure a more accurate and actionable assessment of urban forest resources and planting opportunities. In line with these guidelines, 3,261 acres of surface water were excluded from the analysis. As a result, the total terrestrial area within the unincorporated urban growth regions of Clark County is 35,711 acres.

As of 2023, tree canopy covers 28% of this terrestrial study area when viewed from above. The remaining 72% of the study area, has been categorized based on its suitability for tree planting. Of this area, 39% is considered unsuitable for planting, including wetlands and recreational fields, while 33% have been identified as suitable for potential future tree planting efforts. For more information on land cover classification, please refer to the Tree Canopy Cover and Potential Planting Areas in County UGAs chapter.

Tree canopy cover in the unincorporated UGAs was evaluated using aerial imagery from 2011 and 2023. Over this twelve-year period, total canopy cover in the UGAs declined by 401 acres, representing a 1.1% net decrease. The assessment provides a snapshot of canopy percent change based on the imagery collected in those years, acknowledging that actual canopy coverage may have fluctuated during the interval. Throughout this report, tree canopy change is expressed as percent net change, calculated by dividing the change in urban tree canopy acres by the total land area.

Tree canopy levels varied across the UGAs, with some areas experiencing gains and others experiencing losses. Increases in urban tree canopy typically resulted from the maturation of existing trees, reforestation of previously vacant land, and community-driven tree planting initiatives. In contrast, areas with significant canopy loss saw removals, likely due to development activities or storm-related impacts. The precise causes of tree canopy loss remain uncertain, highlighting the need for additional site-level investigation and ground-truthing to identify the underlying factors driving these changes within the UGAs in Clark County. Regular reassessment of canopy cover is essential to effectively track changes over time and to inform adjustments to urban forestry strategies and programs.

28%
URBAN TREE CANOPY

33%
POSSIBLE PLANTING AREA

-1.1%
TREE CANOPY CHANGE

Figure 2. Based on an analysis of 2023 and 2011 high-resolution imagery.

PROJECT

METHODOLOGY

MAPPING LAND COVER IN WASHINGTON

This assessment used high-resolution (60-centimeter) multi-spectral imagery from the USDA's National Agriculture Imagery Program (NAIP) collected in 2023 to classify six land cover types: tree canopy, shrubs, bare soil and dry vegetation, water, impervious surfaces, and other vegetation. EarthDefine applied advanced machine learning techniques to extract these land cover features from the imagery.

For historical comparison, 1-meter NAIP imagery from 2011 was used to map tree canopy and assess changes over time. For more details on methodology, see Appendix A.



TREE CANOPY
leaves, branches, and stems generally greater than 10-15' tall



SHRUBS
woody plants with multiple stems arising from the base, generally less than 10' tall



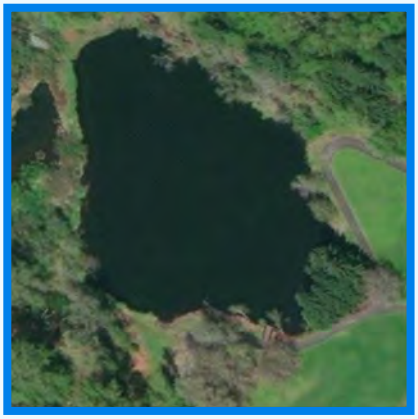
OTHER VEGETATION
healthy grasses, herbaceous plants, open pastures and turf grass



BARE SOIL AND DRY VEGETATION
exposed earth, sand, or dead/ dormant grasses



IMPERVIOUS SURFACES
roads, sidewalks, parking lots, buildings, and other paved areas



WATER
rivers, lakes, ponds, reservoirs, and wetlands

Figure 3. This study identified six (6) unique land cover classes within the 2023 assessment imagery: tree canopy, shrubs, other vegetation, bare soil and dry vegetation, impervious surfaces, and water.

IDENTIFYING POSSIBLE PLANTING AREAS

In addition to quantifying current tree canopy cover, areas suitable for planting trees (referred to as possible planting area or plantable space) were identified as opportunities to increase tree canopy cover. These areas absent from tree canopy cover were classified as either suitable for planting or unsuitable for planting. Unsuitable areas for tree planting, such as recreation fields, utility corridors, wetlands, etc., were manually delineated from the possible planting assessment and identified as Unsuitable Impervious, Unsuitable Vegetation, Unsuitable Wetland, Unsuitable Soil and Water.

Areas suitable for planting have been identified, but planting trees in Clark County require careful planning to consider existing infrastructure and specific site conditions. Conducting thorough site assessments is vital for evaluating the feasibility of planting and ensuring long-term success. It is important to follow the "right tree, right place" principle, which emphasizes selecting the appropriate species, sizes, and locations. This approach ultimately increases the success rate of the trees and helps reduce maintenance demands for the program and its partners.



Figure 4. The study identified vegetated areas where tree plantings would be feasible but are undesirable based on their current usage. An example includes recreational areas, such as this baseball field (left), which is delineated as “Unsuitable,” highlighted in yellow (right).



Tree planting events help bring community members and neighbors together for a great cause.

STATE OF THE CANOPY AND KEY FINDINGS

CLARK COUNTY'S LAND COVER

The US Forest Service's Urban Tree Canopy (UTC) assessment protocols are widely recognized for recommending the exclusion of water bodies to provide an accurate and actionable evaluation of urban forest resources and planting potential. Water bodies are excluded from the land area calculations because they are typically unsuitable for planting new trees without significant modifications. However, the total land cover findings and percentages presented below include water bodies to illustrate the distribution of all land cover classes—both aquatic and terrestrial—throughout the study area.

When examining all land cover types in the Urban Growth Areas (UGAs):

- Non-canopy vegetation, like grass and small bushes, covers the largest portion at 32% of the area.
- Impervious surfaces—such as buildings, roads, and parking lots—make up 30%.
- The tree canopy overhanging pervious surfaces covers 24% of the area, plus an additional 1% where trees overhang paved surfaces. Altogether, tree canopies cover 25% (9,866 acres) of the total area.
- Bare soil and shrub/scrub vegetation each cover 2% of the area.

Table 1. Land cover classes in the urban growth areas of Clark County (percentages based on the total area including water bodies).

Land Cover Class	Acres	% of Total
Non-Canopy Vegetation (Grass/Small Bushes)	12,619	32%
Impervious Surfaces	11,621	30%
Tree Canopy Over Pervious Surfaces	9,427	24%
Water	3,261	8%
Bare Soil/Dry Vegetation	944	2%
Shrubs	659	2%
Tree Canopy Over Impervious Surfaces	439	1%

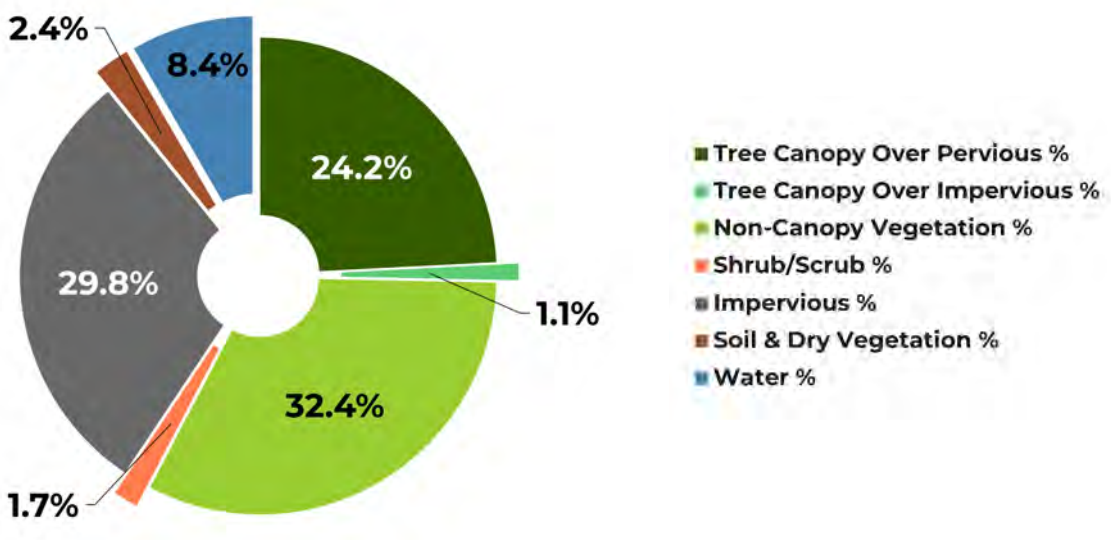


Figure 5. Distribution of land cover classes in the urban growth areas of Clark County, Washington (percentages based on the total area including water bodies).

LAND COVER CLASSIFICATIONS IN THE URBAN GROWTH AREAS OF CLARK COUNTY

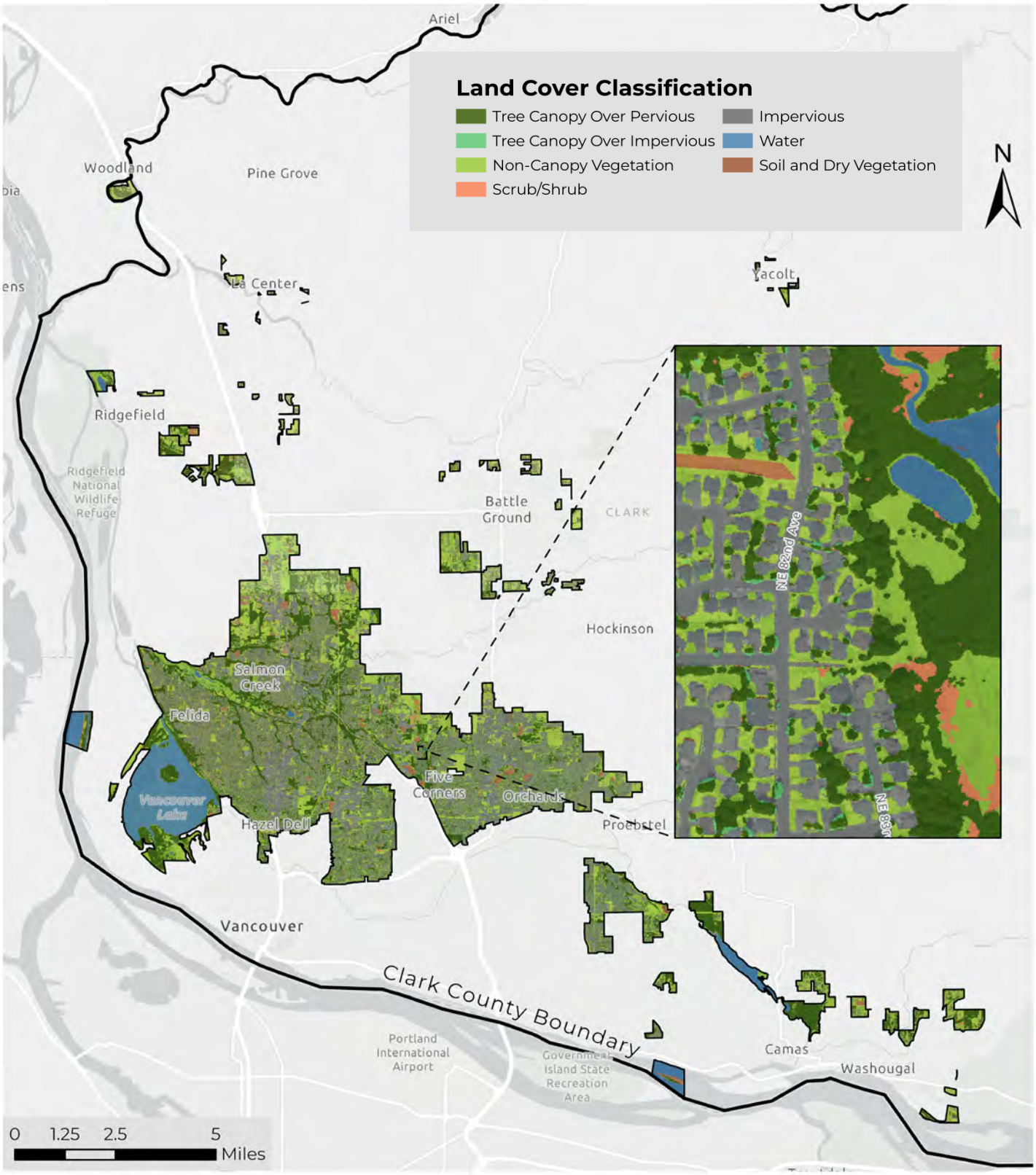
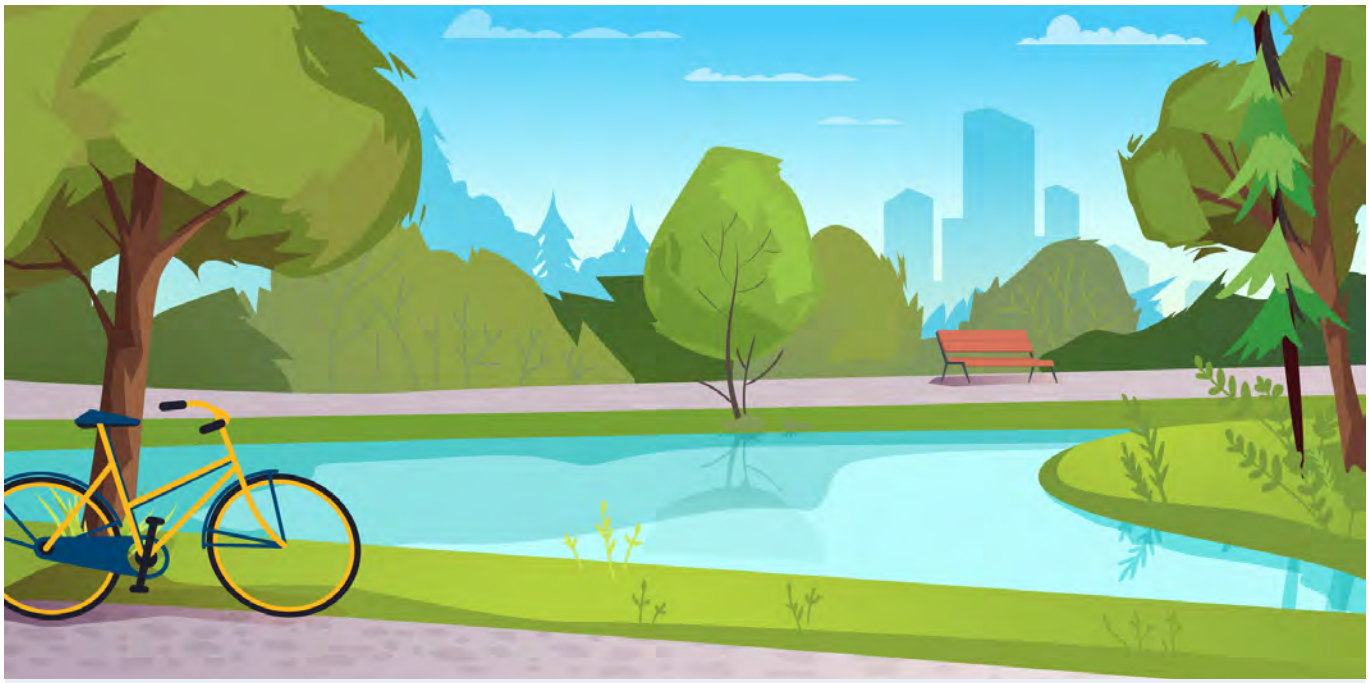


Figure 6. Land cover classification results.



TREE CANOPY AND IMPERVIOUS SURFACES

Tree canopy covers 28% of the unincorporated urban growth areas (UGAs), which is equal to 9,866 acres. This assessment divided tree canopy into subcategories based on whether the canopy overhangs pervious or impervious surfaces. Tree canopy over impervious surfaces provides many advantages in urban areas, including localized cooling and increased interception of rainfall to reduce stormwater runoff.

Most of the tree canopy (96% of the 9,866 canopy acres) overhangs pervious surfaces, while the remaining 4% overhangs impervious surfaces. Increasing tree canopy over paved areas like streets, sidewalks, and parking lots helps reduce urban heat, stormwater runoff, and pollution. It also protects hardscapes from deteriorating, lowering maintenance costs. Strengthening ordinances to require tree planting in and around these areas can enhance these benefits. Targeted canopy expansion supports environmental resilience while balancing priorities like safety, accessibility, and infrastructure needs.

TREE CANOPY CHANGE

In 2011, the UGAs had 10,267 acres of tree canopy, which covered 29% of the total area. However, by 2023, this amount had decreased to 9,866 acres. This represents a loss of 401 acres and a reduction in tree cover to 28% over the twelve-year period.

This loss can be quantified in two ways:

- **Net change:** The net change shows that there were 401 fewer acres of canopy in 2023, representing a 1.1% decrease in tree cover relative to the total land area.
- **Relative change:** Relative change compares the amount of canopy lost to the amount present in 2011. Losing 401 acres out of 10,267 acres indicates that the tree canopy decreased by approximately 4% from its initial level.

This documents reports the net change percentages to align with the metrics presented in Clark County's TreePlotter CANOPY tool (https://pg-cloud.com/clarkcountywashington/). While these figures provide a general overview of canopy trends in the region, they do not capture variations at the neighborhood level. Local factors, such as urban development, changes in land use, and environmental policies, can lead to significant differences in tree canopy coverage from one area to another. This highlights the importance of conducting more localized assessments to fully understand the ecological impacts and conservation needs.

TREE CANOPY COVER AND POTENTIAL PLANTING AREAS IN COUNTY UGAS

After excluding 3,261 acres of surface water, the terrestrial areas in the unincorporated urban growth regions of Clark County total 35,711 acres. In 2023, 28% of this land was covered by tree canopy. An additional 33%, or 11,741 acres, was available for tree planting. The remaining 39% of the land was considered unsuitable for tree planting. This includes 11,621 acres of impervious surfaces and 2,482 acres that cannot support tree growth due to poor soil, recreational fields, utility corridors, or wetlands.

Note that the 28% urban tree canopy metric is different from the earlier 25% metric discussed in the Clark County Land Cover chapter (page 7). The initial 25% figure was calculated using the total area, which includes surface water. It was determined by dividing 9,866 canopy acres by 38,972 total acres (9,866 / 38,972 = 25%). **The remainder of this assessment will focus specifically on tree canopy as a percentage of terrestrial land areas only, excluding water. This method aligns with the US Forest Service standards for tree canopy assessments**. For the entire study area, the percentage of UTC was calculated by dividing 9,866 canopy acres by 35,711 land acres, resulting in 28%.

Table 2. Tree canopy potential (existing, possible, and unsuitable) in the urban growth areas of Clark County (percentages based on the land area excluding water bodies).

UTC Potential Class	Acres	% of Total
Existing Canopy	9,866	28%
Possible Planting Area	11,741	33%
Total Unsuitable (Impervious, Soil, Wetlands, and Vegetation)	14,103	39%

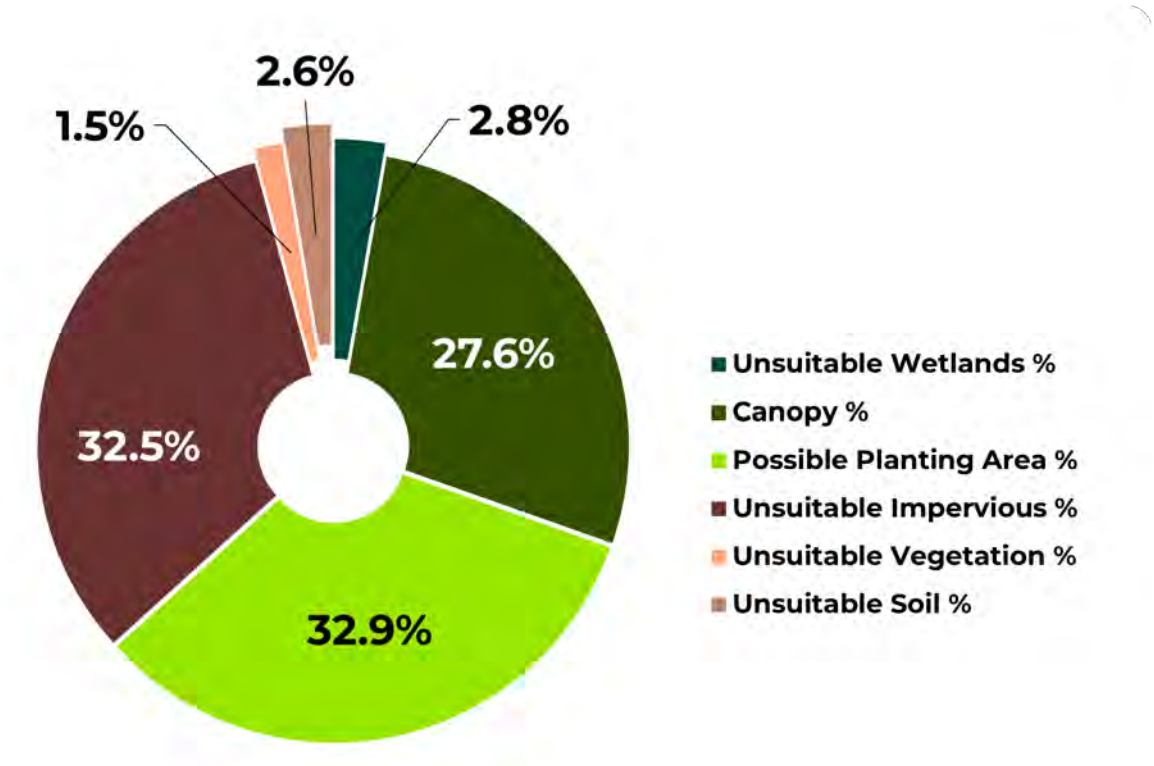


Figure 7. Distribution of UTC, possible planting area, and unsuitable areas in the unincorporated urban growth areas (percentages based on the land area excluding water bodies).

URBAN GROWTH AREA TREE CANOPY POTENTIAL CLASSIFICATION

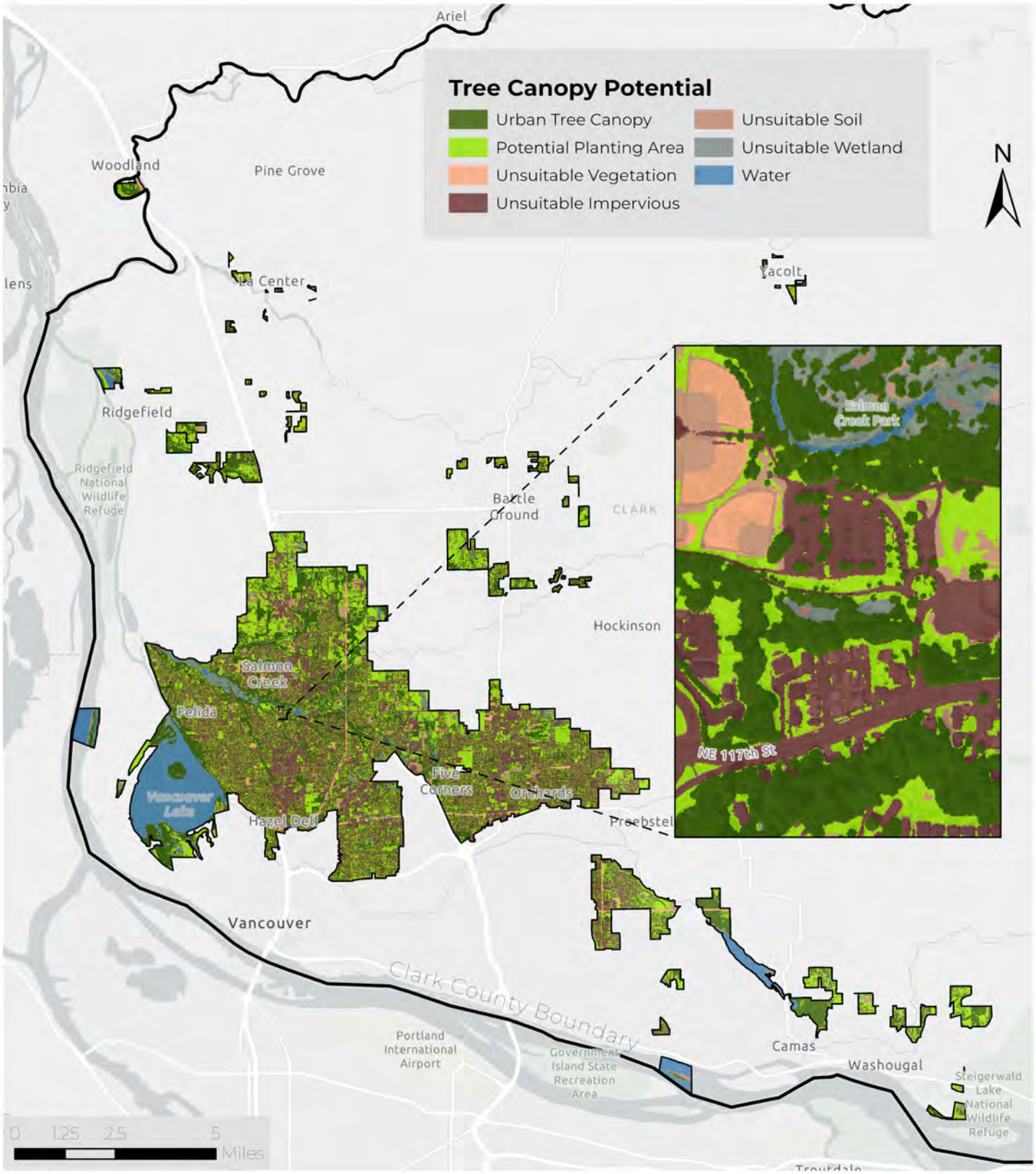


Figure 8. Classification of urban tree canopy, possible planting area, and areas unsuitable for canopy expansion within the unincorporated urban growth areas.

TREE CANOPY COVER IN

WATERSHEDS & STREAM BUFFERS

To provide a more detailed understanding of how tree canopy cover differs across the UGAs, the following section examines canopy distribution at the watershed level, with special attention to areas within 200 feet of streams, known as shoreline riparian zones. These zones are a high priority for protection and restoration because trees in these areas help manage stormwater runoff, filter pollutants and sediments, reduce flooding, and improve local water quality. Land cover metrics were evaluated within five primary watersheds intersecting the UGAs, as well as within the 200-foot buffer along rivers and streams. The assessment used the HUC-12 watershed scale and excluded watersheds covering less than 1% of the total UGA land area to focus on those with the most significant land area and planting opportunities.

After removing the five smallest watersheds from the total, Lower Salmon Creek is the largest watershed in the UGAs, making up 50% of the total land area and supporting 45% of the urban tree canopy across the study area. Lake River, which drains into the Columbia River, is the next largest, representing 19% of the total area and 23% of the total tree canopy. Lacamas Creek and Burnt Bridge Creek comprised 12% and 11% of the land area, respectively, with tree canopy percentages of 29% and 21%. Burnt Bridge Creek had the lowest canopy cover among the major watersheds, at 6% below the UGA-wide average of 28%. In contrast, Gee Creek, which covers 5% of the total land area, has a relatively high canopy cover of 35%.

Lower Salmon Creek has the greatest potential for new plantings, with over 5,500 acres (32%) of its area identified as possible planting space. Lacamas Creek and Burnt Bridge Creek also offer substantial opportunities, with 35% and 31% of their areas available for planting respectively. Both had lower-than-average canopy cover compared to other watersheds, presenting significant opportunities for canopy enhancement. Burnt Bridge Creek has the highest impervious surface coverage (43%) among all watersheds, making it a key area for targeted planting to address stormwater runoff and urban heat island effects.

The 200-foot stream buffer covers 6% of the total UGA land area and contains a dense tree canopy. On average, tree canopy covers 56% of these buffer zones, which is much higher than the average for entire watersheds. Only 20% of stream buffer areas are available for new planting, underscoring the importance of conserving existing canopy in riparian zones rather than focusing solely on restoration.

Table 3. Distribution of land area, urban tree canopy, potential planting areas, changes in tree canopy, and impervious surfaces for watersheds and stream buffers. *The five major watersheds comprise 97% of the total land area. The remaining 3% is found in watersheds that each cover less than 1% of the total UGA land area. This emphasis highlights the watersheds with the largest land area and the best opportunities for planting.

Watersheds & 200-ft Stream Buffers	Land Area Distribution %	Land Area (Acres)	Urban Tree Canopy %	Possible Planting Area %	UTC Change % (2011 - 2023)	Impervious Surface %
Lower Salmon Creek	50%	17,513	24%	32%	-1.1%	37%
Lake River	19%	6,596	34%	30%	-0.6%	21%
Lacamas Creek	12%	4,118	29%	35%	-2.5%	29%
Burnt Bridge Creek	11%	3,873	21%	31%	-1.4%	43%
Gee Creek	5%	1,590	35%	44%	1.1%	12%
Watersheds Totals & Averages	**97%***	33,691	**27%**	**32%**	-1.1%	**31%**
Stream Buffer	**6%**	2,218	**56%**	**20%**	1.9%	**6%**

TREE CANOPY COVER BY WATERSHED

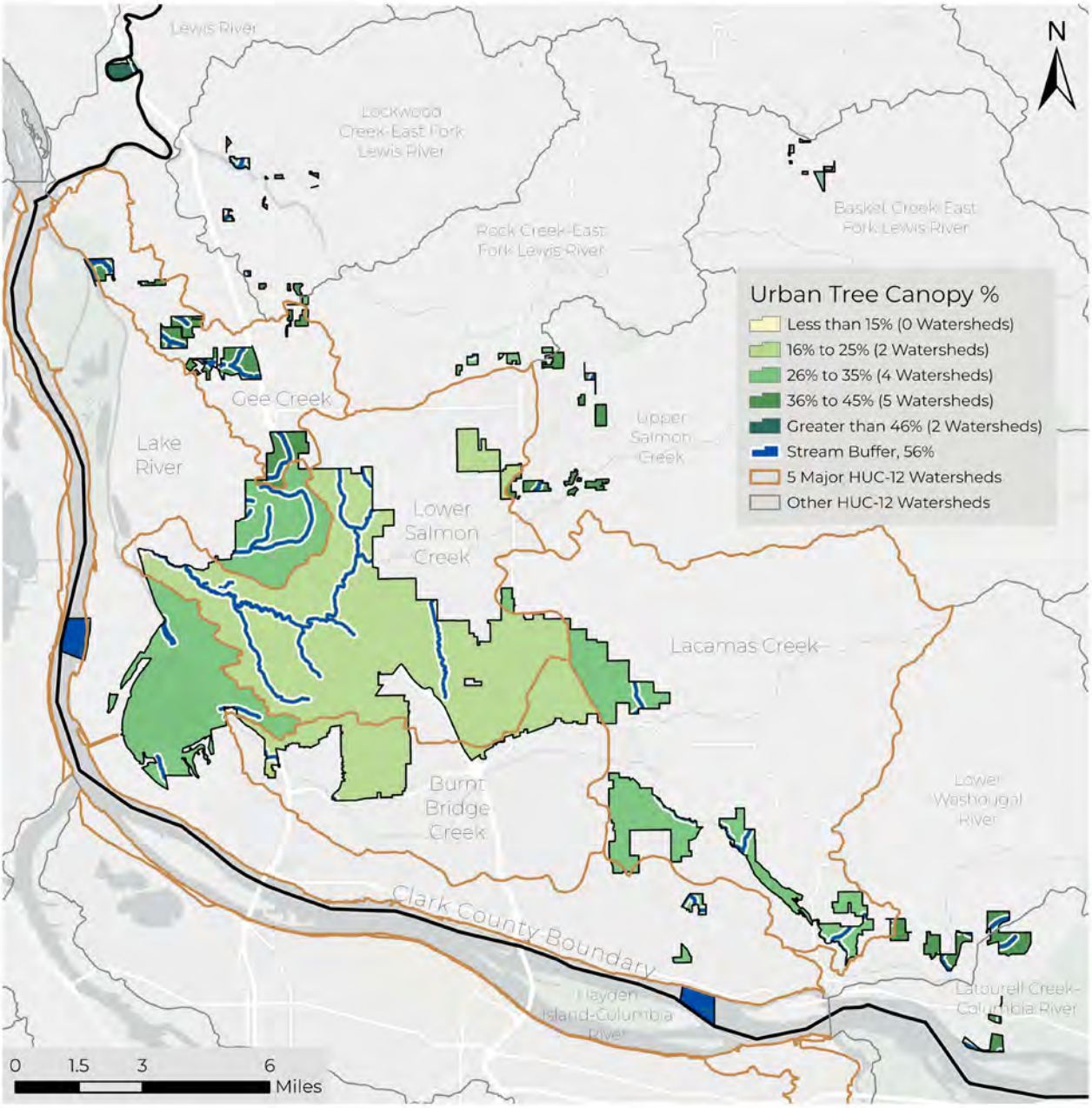


Figure 10. The percentage of canopy cover in the watershed is displayed, along with a UGA-wide stream buffer highlighted in blue.

The largest watershed, Lower Salmon Creek, covers 50% of the total land area and 45% of the tree canopy across all watersheds. Planting trees in these headwaters, with over 5,500 acres available for tree planting, presents a significant opportunity to support salmon recovery and stream health.

TREE CANOPY CHANGE IN WATERSHEDS AND STREAM BUFFERS

Between 2011 and 2023, four of the five major watersheds in the study area experienced a net decline in tree canopy. Lower Salmon Creek recorded the largest loss, with a reduction of 187 acres of tree canopy, followed by Lacamas Creek with a loss of 105 acres. Burnt Bridge Creek and Lake River also showed declines, losing 54 acres and 40 acres, respectively.

Gee Creek was the only major watershed to gain tree canopy, adding 17 acres over the twelve-year period, which reflects a 1.1% net increase. Overall, these five major watersheds experienced a collective net loss of 368 acres.

In contrast to the general watershed trend, the 200-foot stream buffer showed a positive change, with canopy cover increasing from 54% in 2011 to 56% in 2023—a net gain of 42 acres, or a 1.9% increase. This improvement is likely due to natural regeneration, the growth of existing trees, and the effectiveness of local restoration efforts and regulatory protections in riparian zones. The continued protection and restoration of mature trees in these stream buffers are critical for maintaining water quality, regulating stream temperatures, and supporting vital aquatic and terrestrial habitats.

Enhancing stormwater management and improving water quality in the UGAs will have positive impacts on the native species inhabiting local streams and the Columbia River.



Volunteers celebrate planting trees together. Trees often provide social benefits by improving community wellbeing.

TREE CANOPY COVER BY

PROPERTY OWNERSHIP

Private and public properties in Clark County present distinct opportunities and require different approaches for tree planting and maintenance. This assessment focuses on two types of property ownership: private properties—mainly residential parcels within the urban growth area—and public properties, which include rights-of-way, county-owned parcels, city-owned parcels, parks, schools, and federal or state properties. Since the study area excludes incorporated areas, there are relatively few city-owned properties.

Private properties comprise most of the land in unincorporated urban growth areas (UGAs), covering a total of 7,504 acres of urban tree canopy. Three-quarters (76%) of the tree canopy across the UGAs is found on private land (represented in light green in Figure 11).

In contrast, public parcels contribute 2,362 acres of tree canopy, which represents about a quarter of the total tree canopy in the UGAs, as shown in dark green in Figure 11. While private properties cover a larger area of tree canopy due to their greater overall land size, public lands tend to have a higher density of tree canopy. This is because public lands often include larger tracts of undeveloped forested areas. As of 2023, 45% of public land was covered by tree canopy, compared to only 25% on private properties. This difference highlights the effects of conservation, preservation, and restoration efforts on public lands.

Private properties account for most potential planting areas, representing 87% (10,164 acres) of all possible planting sites within the UGAs, as indicated in light green in Figure 12. This opportunity emphasizes the importance of engaging private landowners in tree-planting and preservation initiatives. Approximately 33% of private land is suitable for tree canopy planting, although these properties also have a higher impervious surface coverage of 33%. Strategic plantings near homes, sidewalks, and driveways can enhance urban green space, especially when residents are actively involved.

In contrast, public property makes up only 13% of the total plantable space in the study area. Nevertheless, utilizing the 1,578 acres of public land available for tree planting can offer numerous benefits creating inviting public spaces that encourage outdoor activity and foster social interaction in the community.

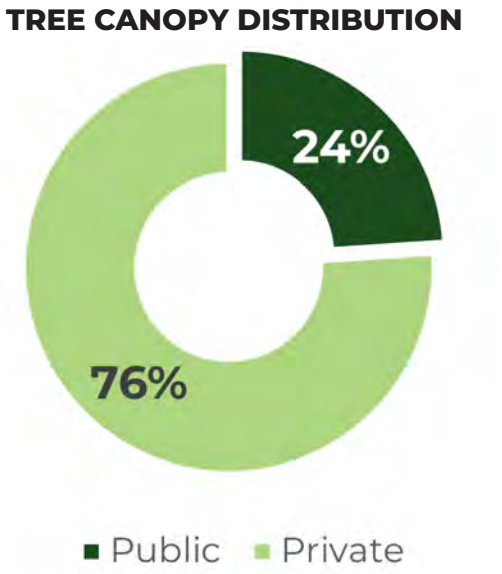


Figure 11. This graphic shows how tree canopy is split between public and private properties. Dark green represents public land, and light green shows private land.

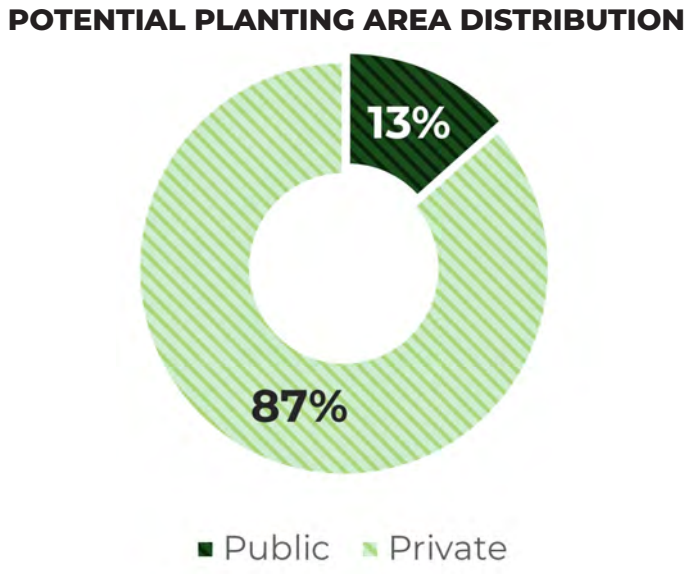


Figure 12. This graphic shows how plantable space is distributed between public and private properties. Dark green represents public land, and light green shows private land.

PROPERTY OWNERSHIP IN THE UGAS OF CLARK COUNTY

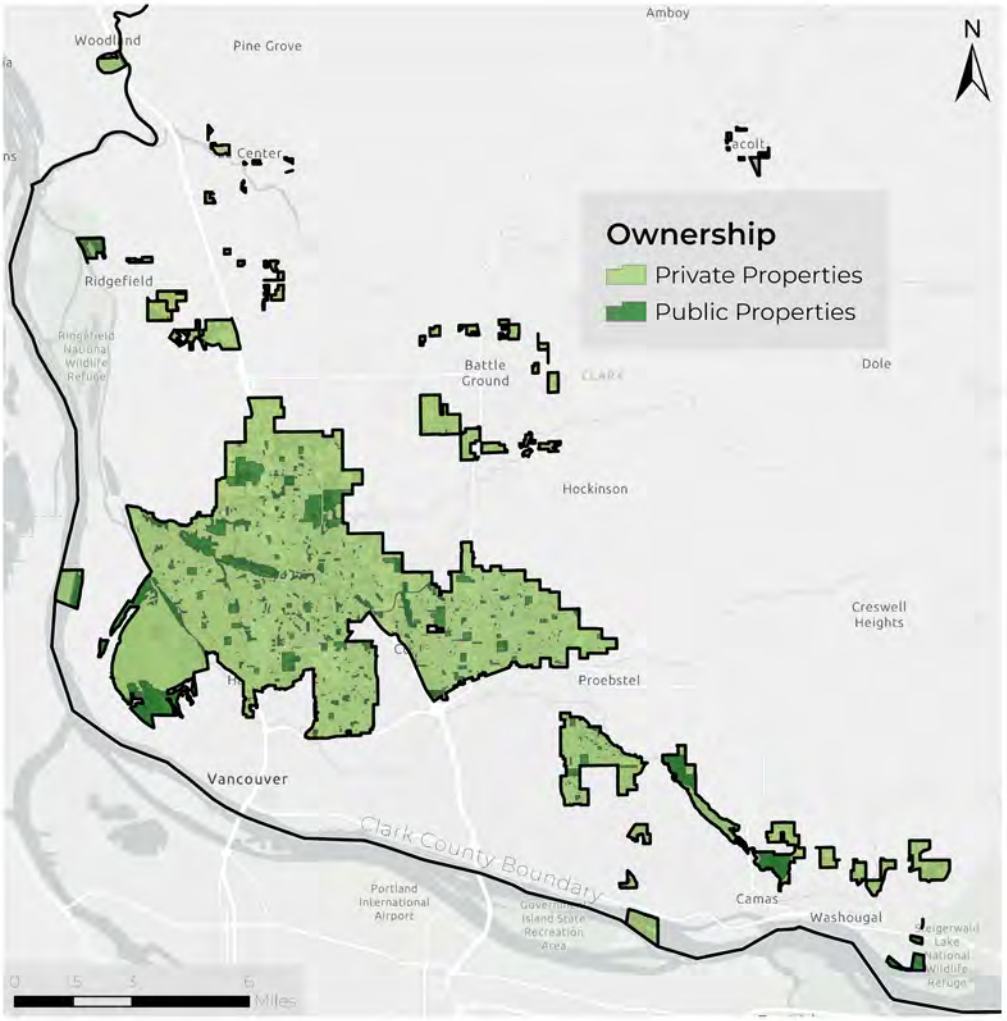


Figure 13. Depiction of private and public properties in the unincorporated UGAs of Clark County. Private properties are marked in light green, and public properties are marked in dark green.

Public Properties

Represents 15% of total land area (5,299 acres)

Canopy covers 45% of public land (2,362 acres), accounting for 24% of the total canopy in the unincorporated UGAs of Clark County

Plantable areas make up 30% of public land (1,578 acres), representing 13% of total PPA seen within the study area

10% of public land is covered with impervious surfaces (562 acres)

Private Properties

Represents 85% of total land area (30,412 acres)

Canopy covers 25% of private land (7,504 acres), accounting for 76% of the total canopy in the unincorporated UGAs of Clark County

Plantable areas make up 33% of private land (10,164 acres), representing 87% of total PPA

33% of private land is covered with impervious surfaces (11,060 acres)

TREE CANOPY CHANGE BY PROPERTY OWNERSHIP

Over the twelve-year assessment period from 2011 to 2023, changes in tree canopy coverage were observed on both public and private lands. Private properties, which encompass a substantial proportion of the UGAs, experienced a notable loss of 569 acres of tree canopy. This decline resulted in a decrease in their overall tree canopy cover from 27% to 25%. This reduction may be attributed to various factors, including urban development.

In contrast, public properties saw an increase in their tree canopy coverage. Over the same period, the canopy cover on public lands increased from 41% to 45%, reflecting an addition of 168 acres of trees. This growth could be linked to intentional reforestation efforts, improved urban forestry programs, and community initiatives aimed at enhancing green spaces within public domains.

TREE CANOPY CHANGE (2011 - 2023)

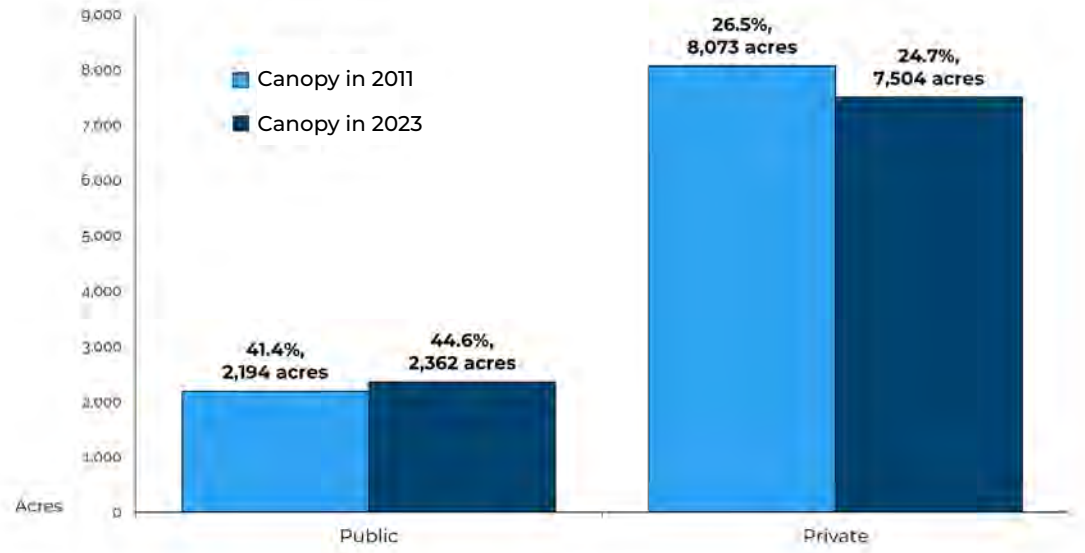


Figure 14. Canopy area in acres by property ownership for 2023 and 2011. The figure compares total canopy coverage on public and private lands for each year, highlighting changes in UTC distribution over time.

Most of the UGAs consists of private property, which currently has a lower-than-average tree cover of 24.7%.

There has been a noticeable decline of trees on private property, but there's good news—over 10,000 acres of land that could be planted with new trees is available. This presents a great opportunity to help increase tree cover in the areas where residents live and play.

TREE CANOPY COVER BY

MUNICIPAL URBAN GROWTH AREAS

Tree canopy was assessed for the urban growth areas of eight municipalities that overlap with unincorporated Clark County: Battle Ground, Camas, La Center, Ridgefield, Vancouver, Washougal, Woodland, and Yacolt. It is important to note that this assessment focused solely on the unincorporated county portion of the UGAs, rather than the entire jurisdictions of the cities. Rural areas outside of the UGAs were not assessed.

The Vancouver UGA makes up the largest share of all UGAs in the county, covering 87% of their total land area. It also contains the majority of tree canopy across UGAs, contributing 79% of the total canopy cover. However, within the Vancouver UGA itself, only 25% of the land area is covered by tree canopy. This urban growth area was the only one that had tree canopy coverage below the UGA-wide average of 28%. However, 83% of the possible planting areas in the UGAs are located within Vancouver's UGA

Ridgefield, La Center, Woodland, and Camas all had tree canopy cover exceeding 40% within their respective unincorporated urban growth areas. The Camas UGA had the densest tree canopy, with 62% of its area covered. Although the Camas UGA represented only 3% of the total study area, it contributed to 7% of the overall canopy distribution within the County UGAs, totaling 666 acres. This makes Camas the second-largest contributor to tree canopy cover in the urban growth areas, following Vancouver.

Camas and Vancouver have the highest tree canopy acreage among the areas studied; however, both cities, along with Woodland, have less plantable space compared to the UGA-wide average of 33%. Although Camas significantly contributes to the overall canopy, it offers limited opportunities for planting. Vancouver faces challenges due to 11,143 acres of impervious surfaces, making it the only UGA where these surfaces exceed the tree canopy cover.

For increasing canopy cover, Yacolt had the highest percentage of land available for planting, with 55% of its UGA accessible for new trees, though this represents only 55 acres. The Battle Ground UGA also had over 50% of its land available, providing more than 600 acres of plantable space. However, the most significant opportunity for expanding the canopy lies within Vancouver's UGA, which has nearly 10,000 acres available for planting.



The Vancouver urban growth area is a great place to target tree maintenance and preservation efforts due to its large land area, lower-than-average canopy cover, and higher-than-average impervious surface.

TREE CANOPY COVER BY MUNICIPAL URBAN GROWTH AREAS

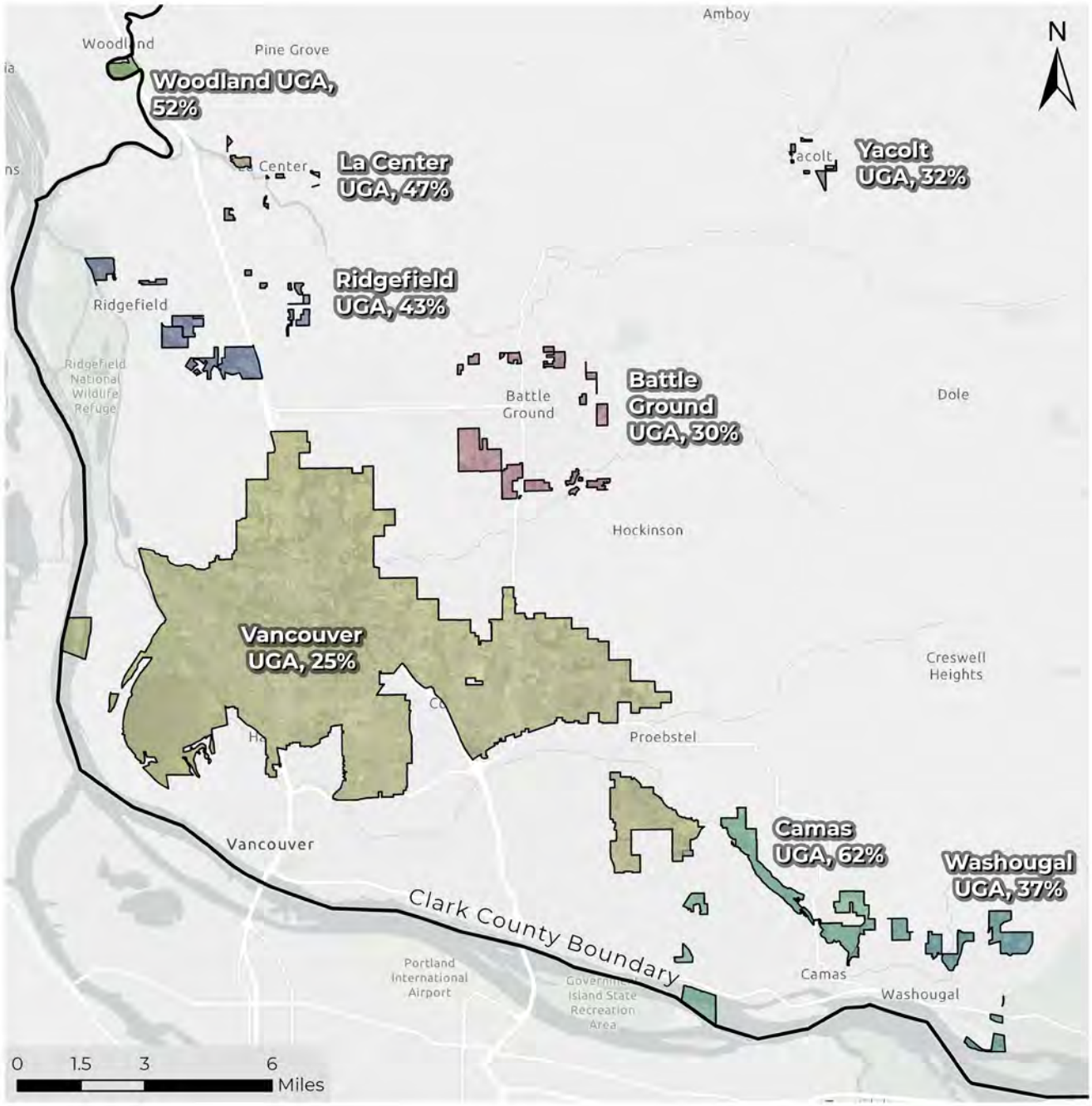


Figure 15. Depiction of Clark County's eight unincorporated urban growth areas.

TREE CANOPY CHANGE BY MUNICIPAL URBAN GROWTH AREAS

Over the twelve-year assessment period, tree canopy gains surpassed losses in some urban growth areas (UGAs). However, four UGAs experienced a net loss of tree canopy, totaling over 400 acres of decline within Clark County UGAs. Particularly affected was Vancouver's UGA, which lost 400 acres of canopy between 2011 and 2023. The UGAs of Camas, Washougal, and Yacolt also faced losses, with reductions of 19 acres, 38 acres, and 5 acres, respectively. The Yacolt UGA experienced the largest percentage loss, with a 6% decrease in canopy coverage.

In contrast, three UGAs (Battle Ground, Ridgefield, and Woodland) gained canopy cover, mitigating some, but not all, of the total tree canopy losses observed throughout the study area. Among these, Battle Ground recorded the most significant gain, increasing its canopy by 35 acres, which represents a 3% increase across its urban growth areas.

Table 4. Land area distribution, urban tree canopy, potential planting area, urban tree canopy change, and impervious surface coverage by UGA.

Planning Area	Land Area Distribution %	Urban Tree Canopy %	Possible Planting Area %	UTC Net Change % (2011 - 2023)	Impervious Surface %
Vancouver	87%	25%	32%	-1.3%	33%
Battle Ground	3%	30%	51%	2.9%	16%
Ridgefield	3%	43%	41%	2.2%	9%
Camas	3%	62%	22%	-1.8%	4%
Washougal	3%	37%	48%	-3.8%	7%
Woodland	0.4%	52%	26%	1.6%	8%
La Center	0.4%	47%	40%	-0.2%	7%
Yacolt	0.2%	32%	55%	-6.2%	7%



Planting trees adjacent to natural areas with established canopy helps increase connectivity of forested habitat in Clark County.

TREE CANOPY COVER BY
ZONING CLASSIFICATIONS

Tree canopy changes were evaluated across 30 zoning classes, which were grouped into nine general zoning categories: Agriculture, Business, Commercial, Industrial, Mixed-Use, Parks/Open Space, Public Facilities, Residential, and University. This approach helps identify how zoning relates to tree canopy coverage and supports targeted strategies for sustainable urban development.

Residential areas occupy 71% of the total land area within Clark County UGAs and account for 67% of the total tree canopy within the study boundary. Agriculture, Parks/Open Space, Public Facilities, and Business zoning categories all had higher tree canopy cover than the UGA-wide average of 28%. Agricultural zones have the highest percentage of canopy (61%), with most located near Vancouver Lake and used for agriculture, wildlife habitat, and recreation. Parks/Open Spaces follow closely, boasting a canopy cover of 53%. Public facilities also contributed significantly to canopy coverage, with over 600 acres of tree canopy.

Commercial and Industrial zones have the lowest canopy cover, at 14% and 16%, respectively. Commercial areas also have the highest impervious surface coverage, with over 50% of these zones covered by paved surfaces. Industrial and Residential areas follow, with 38% and 36% impervious cover.

Residential areas offer the greatest potential for expanding the canopy with 8,329 acres (about 13 square miles) available for planting. These areas represent 71% of all plantable space in the UGAs. Industrial, Business, and Commercial zones each provide 500 acres or more of potential planting space, totaling over 2,000 acres and representing 7%, 6%, and 5% of the UGAs' plantable area, respectively.

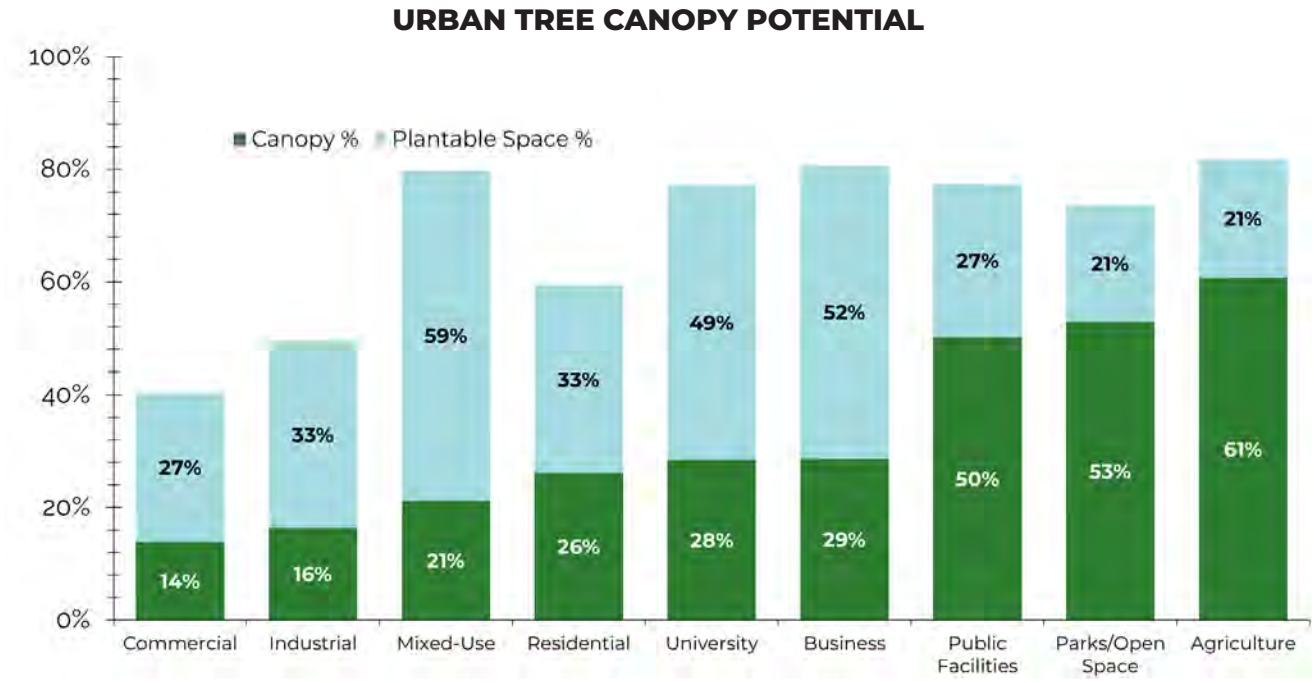


Figure 16. Urban tree canopy potential by general zoning classes.

Commercial areas had less than average canopy cover, greater than average impervious cover, and over 500 acres of plantable space.

TREE CANOPY CHANGE BY ZONING CLASSIFICATIONS

Between 2011 and 2023, tree canopy changes varied across the nine general zoning categories. Five categories experienced gains in tree canopy: University, Agriculture, Public Facilities, Parks/Open Space, and Mixed-Use University zones had the largest percentage increase at 4%, but this represented only a 13-acre gain due to the zone's small size of 379 acres.

Agriculture-zoned areas saw the most significant total increase in canopy, likely due to favorable growing conditions within the UGA. Public Facilities added 32 acres of tree canopy, a 3% increase on these properties.

Despite these gains, the overall tree canopy in the UGAs declined. The largest reduction of tree canopy occurred in Residential areas, where there was a loss of 385 acres, equivalent to about 300 football fields, or a 2% net decrease in total across residential properties. Commercial and Industrial zones also experienced similar losses, with reductions of 38 acres and 41 acres, respectively, each representing a 2% net decrease in canopy cover. These losses outweighed the gains in other zoning categories.



Friends of Trees volunteers planted street trees in unincorporated neighborhoods of the Vancouver UGA from 2017 to 2019 with grant funding Clark County received from the Lower Columbia Fish Recovery Board.

TREE CANOPY COVER BY CENSUS BLOCKS

An analysis was conducted at the UGA's census block scale to reveal detailed patterns in tree canopy coverage. A census block is a division of census block groups (refer to page 26 for a detailed understanding of census block groups). These blocks are the smallest geographic unit defined by the United States Census Bureau for collecting and tabulating complete census data. In urban settings, a census block often aligns with a city block bounded by streets, while in suburban or rural regions, its boundaries may be formed by roads, rivers, or other visible or legal features. The population within a census block can vary widely, and some blocks may have no residents at all.

In Clark County's UGAs, 80% of the 1,922 census blocks (CBs) have tree canopy cover below the average of 28% for the entire UGA. Meanwhile, 91 blocks, representing 5% of the total, had urban tree canopy coverage of 50% or greater.

TREE CANOPY COVER BY CENSUS BLOCKS

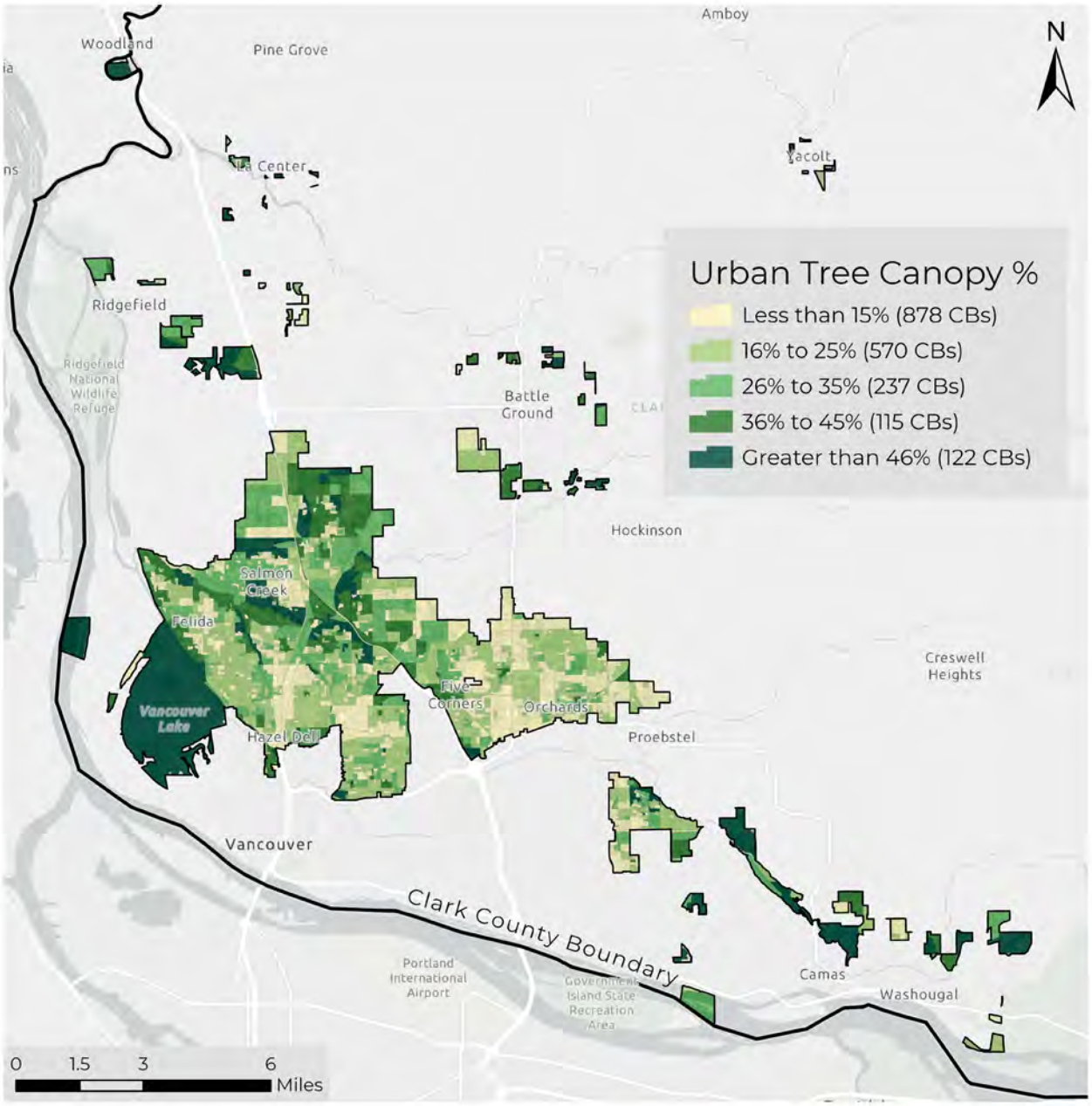


Figure 17. Urban tree canopy cover percent by census blocks (CBs).

PLANTABLE SPACE BY CENSUS BLOCKS

Nearly three-quarters (74%) of census blocks in the unincorporated urban growth areas have less than 33% of their land classified as potential planting area. The lowest percentages of plantable space are concentrated in the urban core of Vancouver and nearby neighborhoods, where development density is highest. In contrast, blocks with the greatest planting potential (those exceeding the UGA-wide average of 33%) are more commonly found on the urban fringe and in outlying areas such as near Ridgefield, Battle Ground, Camas, and Washougal. This pattern suggests that opportunities for expanding tree canopy are more limited in the established urban center, while suburban and peripheral zones retain larger areas suitable for new tree planting.

PLANTABLE SPACE PERCENT BY CENSUS BLOCKS

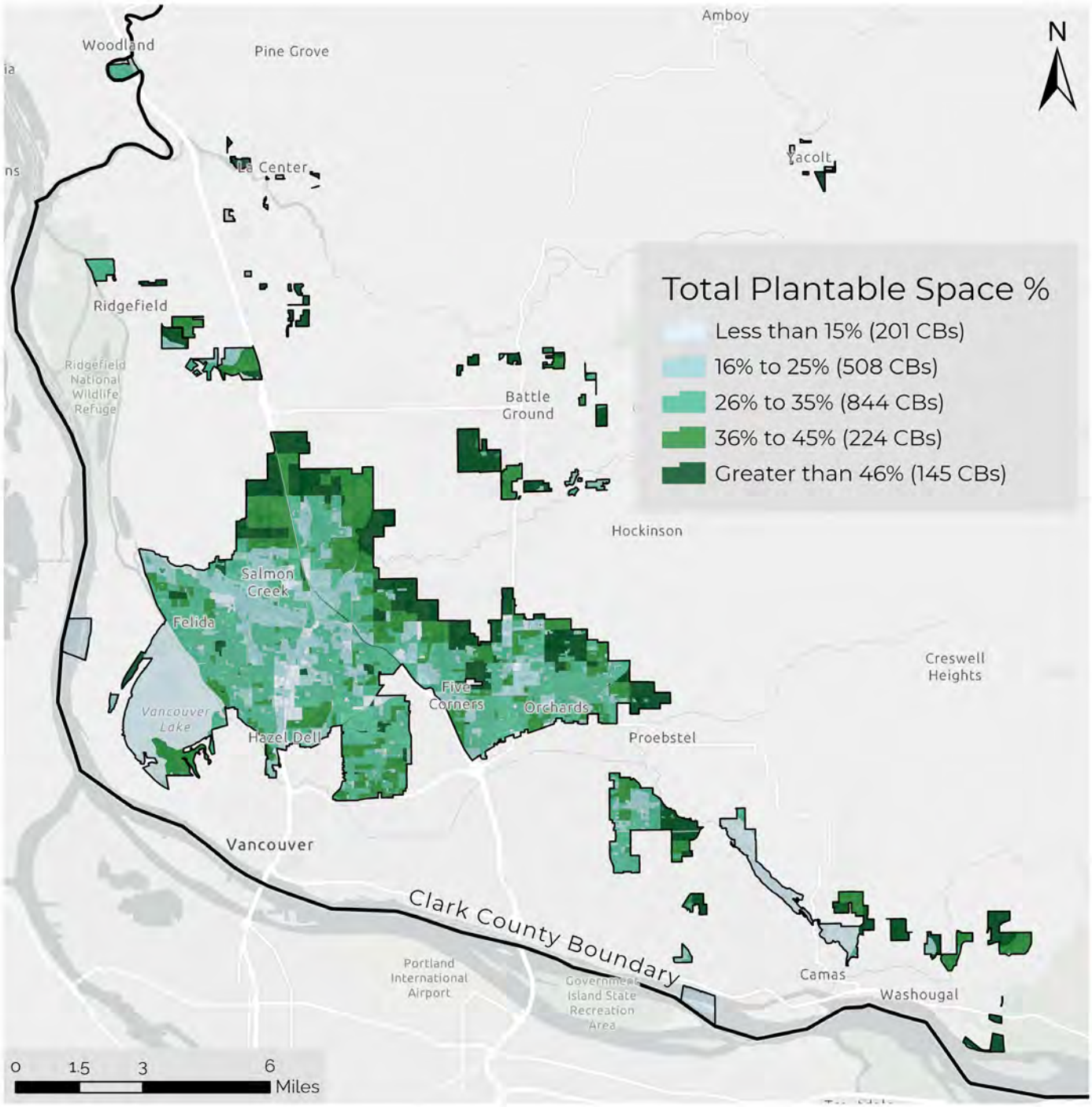


Figure 18. Potential planting area percentage by census blocks (CBs).

TREE CANOPY CHANGE BY CENSUS BLOCKS

The spatial distribution of urban tree canopy changes in census blocks across Clark County UGAs highlight several key trends. The most substantial canopy losses are concentrated in clusters within Vancouver's more densely developed neighborhoods and in select areas near Camas and Washougal. In contrast, significant canopy gains are relatively uncommon and are primarily located along the urban fringe, particularly in outlying blocks near Camas, Washougal, and the northern edges of the UGA. Most census blocks experienced only minor changes, with small increases or decreases in canopy, reflecting a balance between ongoing development and incremental tree planting or removal. Overall, while blocks that gained tree canopy between 2011 and 2023 experienced a total increase of 486 acres, this was outweighed by losses in blocks that lost canopy, which amounted to 887 acres of canopy lost during the same period (amounting to the net decrease of 400 acres of tree canopy across the UGAs).

CANOPY CHANGE PERCENT BY CENSUS BLOCKS

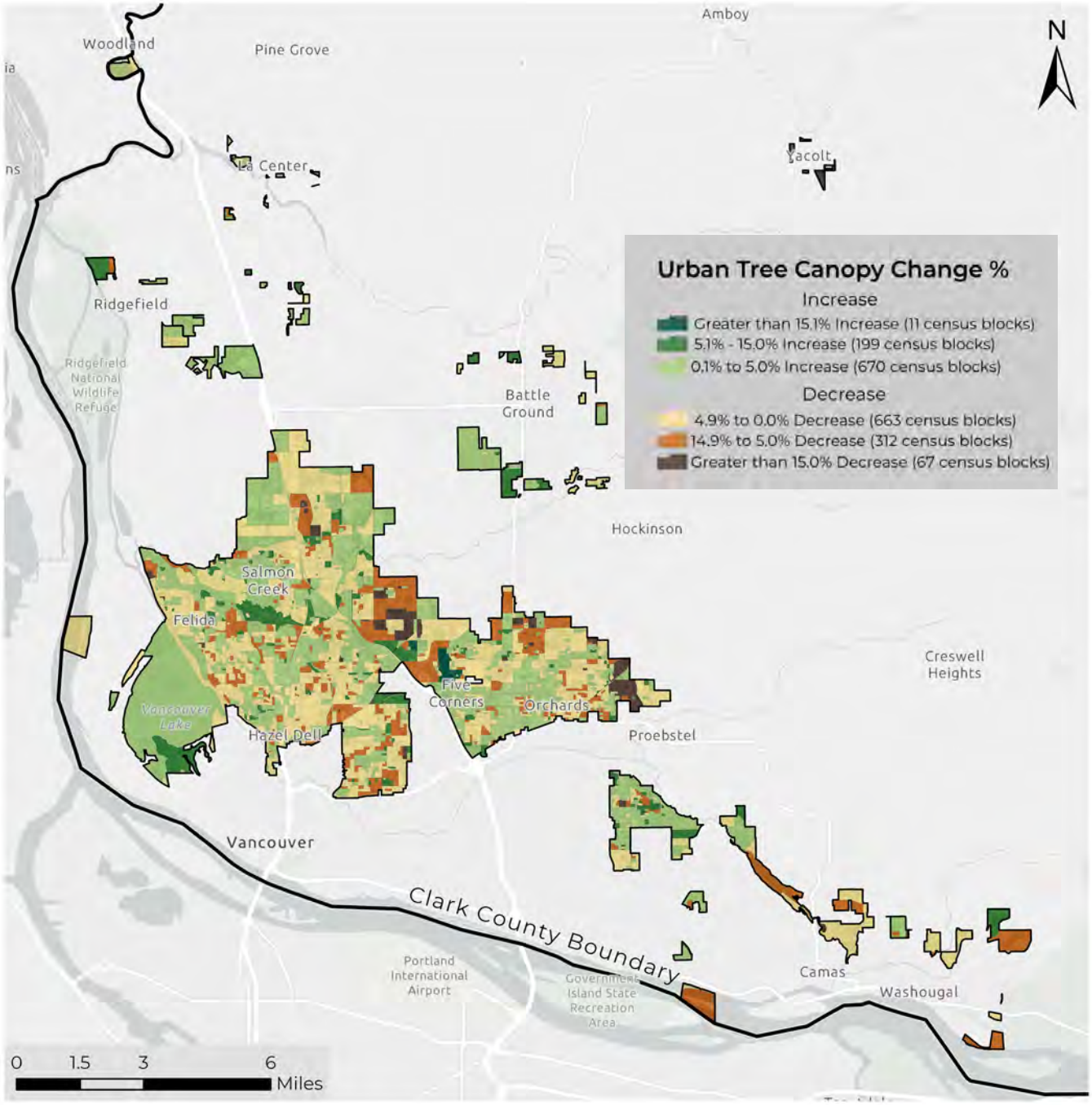


Figure 19. Tree canopy change percent (2011 - 2023) by census blocks.

PLANTING PRIORITIZATION BY

CENSUS BLOCK GROUPS

CONSIDERING SOCIOECONOMIC FACTORS

Clark County urban growth areas comprise 147 census block groups (CBGs), which are clusters of census block boundaries designed to create even population distributions. These areas are essential for analyzing the equitable distribution of tree canopy across the UGAs and can be linked to demographic and socio-economic data from the American Community Survey (ACS).

Of the 147 CBGs in the study area, 94 had a tree canopy percentage below the UGA-wide average of 28%. The remaining 53 block groups (about one-third of the total) exceeded this average with tree canopy density of over 28%. Notably, two-thirds of the census block groups had between 20% and 40% of their land available for tree planting. However, available space is not the only factor to consider when focusing on plans for opportunities to expand the tree canopy.

Increasing tree canopy cover can offer numerous benefits for local communities and visitors. Eight variables representing a range of socioeconomic, demographic, and accessibility factors were analyzed at the census block group level to prioritize areas for future planting. Efforts to target plantings in areas with the lowest tree canopy and the greatest socioeconomic need often result in improved social, economic, and community outcomes, in addition to the inherent environmental benefits produced by tree planting.

The five socioeconomic variables incorporated into this assessment were sourced from the 2022 U.S. Census American Community Survey 5-year summaries, and urban heat island information was derived from surface temperature data captured on July 9, 2024, during a heatwave event. Each variable was normalized and assigned equal weight in the prioritization criteria, and the final score for each CBG was calculated by summing the normalized values. The rankings range from high priority (dark blue) to low priority (light yellow) and were calculated for each criterion, as well as overall, to highlight where multiple needs overlap**. The top 15 priority census block groups are in Vancouver's UGA.**



Areas with Low Existing Tree Canopy: Census block groups with lower tree canopy cover percentages and higher non-canopy land are prioritized for planting.



Possible Tree Canopy: Census block groups with greater plantable areas are prioritized for expanding urban tree canopy.



Urban Heat Island Effect: Census block groups with higher surface temperatures are prioritized for planting to mitigate heat effects.



Poverty Rate: Census block groups with higher percentages of residents below the poverty level are prioritized for planting to enhance benefits designated poverty level.



Unemployment Rate: Census block groups with higher unemployment rates are prioritized for planting opportunities.



Vulnerable Population: Census block groups with larger ratios of residents under 18 or over 65 are prioritized for planting to support vulnerable populations.



Median Household Income: Census block groups with lower median household incomes are prioritized for planting to address environmental inequality.



Educational Attainment: Census block groups with lower percentages of residents with a high school diploma or GED are prioritized for planting to improve outcomes.

OVERALL PRIORITIZATION BY CENSUS BLOCK GROUPS (CBGS)

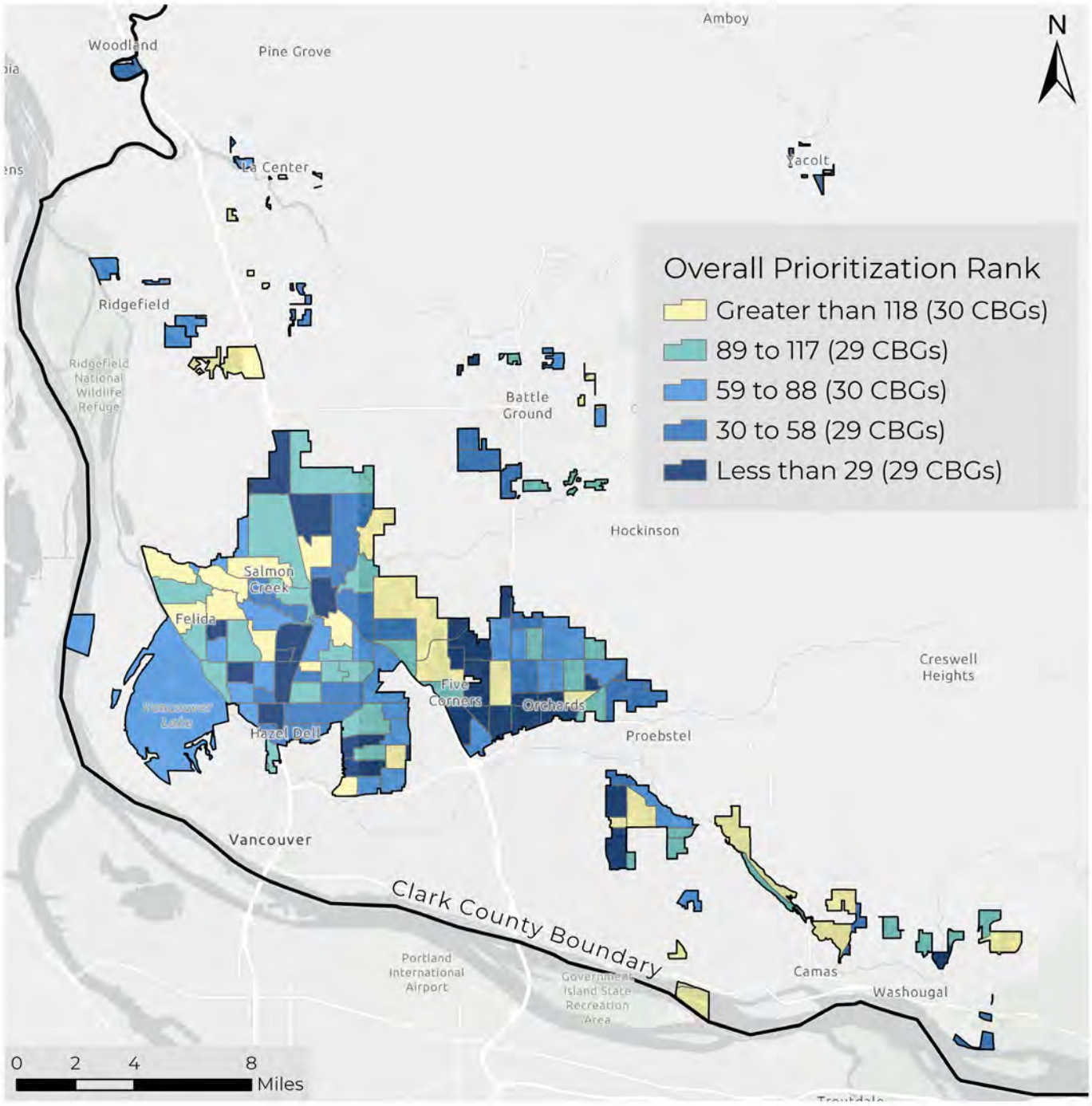


Figure 20. Overall prioritization rankings for the census block groups (CBGs) based on the eight prioritization criteria. Lower rankings (darker colors) indicate an overall higher priority for tree plantings. The top 15 priority census block groups are in Vancouver's UGA. All but two census block groups that make up the highest priority class (darkest blue) reside in Vancouver's UGA.

TREE CANOPY PRIORITIZATION PILOT STUDY

MINNEHAHA NEIGHBORHOOD

TREE CANOPY IN THE MINNEHAHA NEIGHBORHOOD

Minnehaha is a small neighborhood near the southern boundary of Clark County's unincorporated Vancouver urban growth area, adjacent to the City of Vancouver. Its name comes from the Dakota language, meaning "waterfall" or "curling water." This neighborhood was selected as a pilot area for urban tree canopy implementation because it has both a lower percentage of tree canopy compared to other neighborhoods in Clark County and a higher level of socioeconomic need.

As of 2023, tree canopy covered 252 acres (23%) of Minnehaha, which is 5% below the UGA-wide baseline average of 28%. Between 2011 and 2023, Minnehaha experienced a net canopy decrease of 2%, resulting in a loss of 25 acres of tree canopy.

Impervious surfaces constitute 40% of Minnehaha, which is 10% higher than the average for the surrounding urban growth areas. This significant level of impervious cover contributes to increased heat and reduces the absorption of stormwater. Therefore, adding more trees is essential for mitigating heat and improving environmental quality.

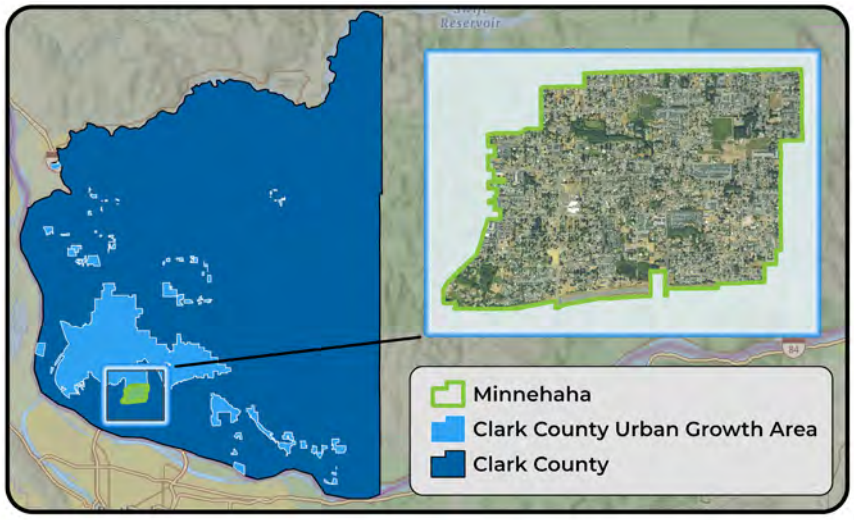


Figure 21. The Minnehaha neighborhood encompasses 1,092 acres in the southwestern part of the County urban growth areas.

One third (34%) of Minnehaha, or about 368 acres, has been identified as suitable for planting trees. These areas, which are located along road rights-of-way, on private properties, near bus stops, and within parks, represent key opportunities to expand the tree canopy. Increasing tree cover in these locations would provide much-needed shade for walkways, sidewalks, and park benches. Planting large stature trees in these areas would help counteract the heat effects associated with high impervious surface coverage and offer further benefits such as improved air quality, better stormwater management, and enhanced livability in the neighborhood. The following page describes an approach to prioritizing areas based on these factors and others including sociodemographic data.

Canopy Metrics in Minnehaha:

277 Acres (25%)
UTC 2011

252 Acres (23%)
UTC 2023

-25 Acres
UTC Change 2011-2023

-2%
Net Change

-9%
Relative Change

Net change is the absolute change in tree canopy as a percentage of total land area. It tells you how much the canopy has changed relative to the entire land area.
Relative change is the change in tree canopy as a percentage of the previous 2011 canopy. It tells you how much the canopy has changed relative to what it was before.

Table 5. Land cover and census data for the census block groups in Minnehaha. The top 3 priority census block groups are in bold and were selected based on their overall prioritization ranks. For more information on methodology, see Page 26. The average surface temperature is derived from temperature data captured on July 9, 2024, during a heat-wave event.

Census Block Groups in Minnehaha	% of Population in Poverty	% of Working Class Unemployed	Median Income	Avg. Surface Temp.	Impervious Surface %	UTC %	Possible Planting Area %	UTC Change % (2011 - 2023)
53-011-041110-1	15	27	$132,792	118	38	25	29	**0%**
53-011-041110-2	**35**	**34**	**$67,763**	**122**	**46**	**21**	**32**	-3%
53-011-041110-3	3	17	$175,456	117	35	29	31	-1%
53-011-041110-4	**13**	**15**	**$80,179**	**120**	**35**	**20**	**40**	-3%
53-011-041112-1	10	20	$93,672	121	39	22	38	-4%
53-011-041112-2	1	35	$104,208	122	40	24	35	-3%
53-011-041112-3	**28**	**48**	**$45,625**	**125**	**53**	**22**	**23**	2%



The Minnehaha area had a 23% tree canopy cover, which was 5% below the UGA-wide average of 28%.

This area also had above-average impervious cover (40%) and experienced a loss of canopy cover over the 12-year study period.

PRIORITY CENSUS BLOCK GROUPS WITHIN THE MINNEHAHA NEIGHBORHOOD

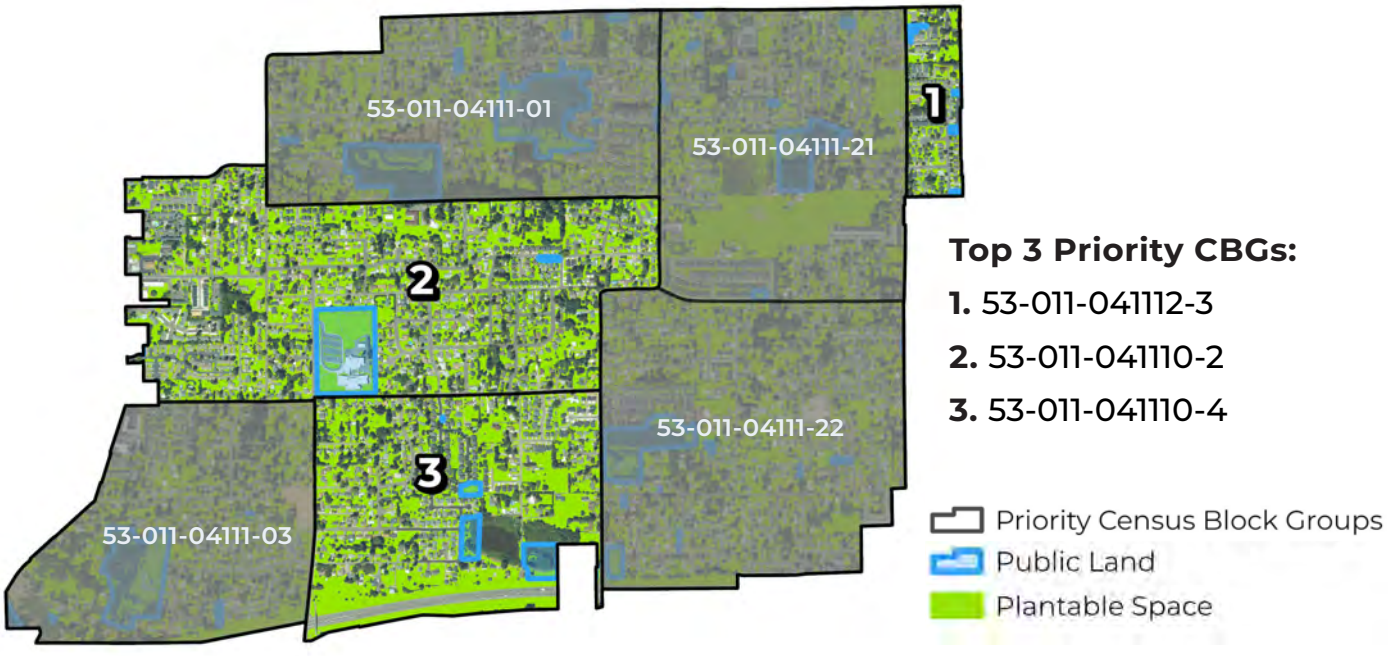


Figure 22. Plantable space in Minnehaha's top three priority census block groups. The highest priority is designated as 1, with subsequent priorities arranged in descending order.

TREE PLANTING EFFORTS IN THE MINNEHAHA NEIGHBORHOOD

To address Minnehaha's lower-than-average tree canopy and high socioeconomic need, Clark County Public Works launched a collaborative effort with the Clark Conservation District, local partners, and state agencies to expand tree planting in the neighborhood. The project focuses on planting trees along county roads, in parks, and in front of homes, with at least 250 residents participating in a free tree giveaway. To further engage the community, three volunteer tree planting events were held in January 2025 at Road's End Neighborhood Park, Bosco Farm Neighborhood Park, and Douglas Carter Fisher Neighborhood Park, where residents and volunteers helped plant 650 trees throughout Minnehaha. The goal is to plant up to 1,000 new trees in the neighborhood by the end of 2025. This initiative is supported by the Clean Water, Roads Maintenance and Operations, and Parks and Nature divisions of Public Works, with funding from the Washington State Department of Natural Resources Urban and Community Forestry Program.

Increasing Minnehaha's tree canopy will help reduce urban heat, improve air quality, manage stormwater, and offer economic, health, and social benefits-such as higher property values, improved mental health, and stronger neighborhood connections. This project also serves as a model for expanding urban tree canopy programs in other neighborhoods across urban growth areas.



Clark County volunteers water new street trees planted in the road right-of-way.

ECOSYSTEM

BENEFITS

I-Tree tools were used to calculate the benefits and functions of the canopy throughout Clark County UGAs, utilizing the latest available research. Trees produce oxygen, indirectly reduce pollution by lowering air temperature, and improve public health by reducing air pollutants that can cause illness and death. Likewise, canopy coverage has been shown to mitigate stormwater runoff, minimizing flood risk, stabilizing soil, reducing sedimentation in streams and riparian areas, and absorbing pollutants, thus improving water quality and habitats. Trees play a critical role in sequestering carbon from the atmosphere through photosynthesis and storing it long-term in their biomass. **Clark County UGAs' existing canopy provides an estimated $6,987,027 annually in avoided infrastructure costs and an additional $75,116,030 in stored carbon.**

THE VALUE OF THE URBAN FOREST IN THE URBAN GROWTH AREA OF CLARK COUNTY



Figure 23. Ecosystem service benefits of canopy cover in the urban growth area. Data sourced from I-Tree, the US Forest Service, the Arbor Day Foundation, and the U.S. Environmental Protection Agency.

CONCLUSIONS AND RECOMMENDATIONS

Clark County UGAs' forests provide the community with essential resilience-boosting services, such as reducing air temperatures, improving public health, and enhancing endemic wildlife habitats such as the multiple salmon species that rely on the Clark County Watersheds that feed into the Lower Columbia River. However, forests in the Pacific Northwest United States face numerous challenges. Drought, forest fires, extreme storms, pests, diseases, and ongoing development pose significant threats to the UGAs' tree canopy.

Regular assessments of Clark County's tree canopy serve multiple purposes: establishing a baseline, acting as a report card, and supporting strategic guidance for maintaining the UGAs' long-term canopy health. The findings from these assessments help inform planning, investment, and management strategies, ensuring that the communities most in need of forest benefits receive targeted support and access to critical resources. The following recommendations are based on results from this Urban Tree Canopy Assessment.

RECOMMENDATIONS

1. **Implement tree canopy requirements in the County's Municipal Stormwater Permit**
   By no later than December 2026, the County must use available, existing data to map tree canopy in support of stormwater management on Permittee-owned or operated properties. Additionally, by December 2028, Clark County must adopt and implement tree canopy goals and policies to enhance stormwater management. This includes establishing objectives for how the existing or future tree canopy can contribute to stormwater management and improve water quality in receiving waters. It also includes efforts to maintain the existing mature tree canopy, focusing on overburdened communities. Prioritizing efforts to increase tree canopy in these communities is a key aspect of the County's Stormwater Permit.

2. **Integrate Tree Canopy Goals into Regional Planning**
   As parts of Clark County continue to grow and urbanize, it is essential to preserve the existing tree canopy. Since it can take decades for newly planted trees to mature and have a significant impact, protecting the current canopy is the best way to maintain stable coverage until future increases can be achieved. Use the data from this assessment to establish both short-term and long-term goals:

   - Set annual tree planting targets.
   - Implement regularly scheduled maintenance programs.
   - Increase tree diversity by planting a wider variety of large stature tree species.
   - Establish specific canopy coverage goals for designated target years.
   - Review long-term land-use and development plans to include policies that protect mature trees and create canopy ordinances for new developments.

3. **Once finalized and adopted, implement tree-related climate goals and associated policies outlined in Clark County's Comprehensive Climate Element as required by Washington State's Growth Management Act. Draft policy concepts include, but are not limited to:**

   - Protect and plant more trees in both rural and urban areas, with targeted efforts to equitably increase tree canopy cover and provide ongoing maintenance support.
   - Increase, enhance, and protect county-owned plantings and greenspaces, while identifying, preserving, and rewilding critical areas such as riparian zones, wetlands, prairies, forests, and open spaces.
   - Develop and implement a comprehensive plan for trees and greenspaces that advances climate resilience, ecosystem health, and equity, in alignment with relevant laws and best practices.

- Expand funding, policies, and community partnerships for tree planting, invasive species removal, restoration, and sustainable forestry, prioritizing native and climate-resilient species.
- Promote inclusive education, engagement, and volunteer opportunities around tree stewardship and natural areas, and advocate for long-term protection of forests and critical habitats.

4. Use this Urban Tree Canopy Assessment as a platform and framework to establish future Urban Forestry Programs in Clark County

This includes the completion of an official Urban Forestry Management Plan to serve as the backbone for all urban forestry efforts. It encompasses initiatives to continue mapping and inventorying tree canopy, complete assessments and planning, and develop programs. It also involves building resources for private landowners and working lands, as well as establishing technical and financial assistance and incentives for forest landowners. Additionally, identifying essential funding for long-term maintenance and stewardship is crucial to sustaining urban tree canopy programs. Efforts to build regulatory backstops are also critical in ensuring that forest practice requirements are met, that critical riparian and shoreline areas are protected, and that impacts on tree canopy are mitigated. The protection of essential riparian and shoreline areas remains crucial, along with creating new requirements to mitigate impacts on the tree canopy. Furthermore, enhancing staff capacity, expertise, and resources to develop new tree canopy programs is vital, as are efforts to foster new partnerships with local organizations dedicated to protecting and restoring the urban tree canopy in Clark County.

5. Establish partners and resources to engage the Community and Partner with Private Landowners

Since much of Clark County's plantable space is on private land, community involvement is key to increasing canopy and mitigating canopy losses. Develop outreach programs to engage residents, schools, and local businesses in tree planting and care. Initiatives like Arbor Day celebrations, workshops, and volunteer planting events can educate the public about the benefits of trees and encourage participation. Pairing these programs with tree giveaways, private property planting initiatives, and tree maintenance events to boost canopy growth on private land. Building financial and technical assistance resources to implement urban tree canopy programs on private property is an essential first step.

6. Expand and Protect Canopy in Underserved Areas

Direct tree-planting efforts toward neighborhoods identified in the planting prioritization analysis, especially those with high levels of impervious surfaces, low canopy cover, or significant concentrations of residents dealing with socioeconomic inequity. Planting new trees and/or preserving existing mature canopies in these areas can help reduce urban heat islands, lower energy costs, and create calming spaces that alleviate stress and promote community engagement. By prioritizing these underserved areas, we can maximize the impact of forest management resources and ensure a fair distribution of green infrastructure.

7. Promote a Resilient Urban Forest

The findings of this assessment offer valuable information that can help develop a more resilient urban forest in Clark County UGAs. This data can support state, county, and local budget requests, as well as grant applications aimed at enhancing the county's resilience. Urban forests play a crucial role in addressing regional challenges by managing stormwater to reduce the burden on infrastructure during heavy rains and improving water quality by filtering pollutants before they reach rivers in Clark County. Additionally, they provide shade that helps lower urban heat island effects and protect buildings and residences by acting as a buffer against high winds. Together, these efforts contribute to creating a more sustainable and livable community for both residents and visitors.

8. Monitor Progress and Adapt Strategies

To track progress, revise strategies, and stay informed about areas of canopy growth and loss, it is essential to conduct recurring canopy assessments using updated imagery every 2-3 years using imagery data, such as the NAIP Imagery used in this assessment. The 2025 NAIP Imagery data will be available sometime in 2026. Continuous monitoring will ensure that management efforts remain effective, aligned with Clark County Conservation District's goals, and maintain a thriving, resilient urban forest.

REPORT

APPENDIX

A. EXPANDED METHODOLOGY

1. Data Acquisition and Preparation

PlanIT Geo utilized 2023 EarthDefine US Tree Map data (derived from 60-centimeter multispectral NAIP imagery and LiDAR) and 1-meter resolution NAIP imagery from 2011 to map tree canopy and land cover. The tested accuracy of the US Tree Map in Washington is 98.8% according to EarthDefine's accuracy assessment using 1,000 random points throughout the state.

2. Land Cover Classification

Training labels for seven land cover classes—tree canopy (including overhanging impervious surfaces), shrub vegetation, herbaceous/grass, bare soil/dry vegetation, impervious surfaces, open water, and tree canopy over impervious—were developed using NAIP imagery, LiDAR, and external datasets. Identical Deep Convolutional Neural Network (DCNN) workflows were applied to both the 2011 and 2023 imagery for consistency, with hyperparameter-optimized models performing semantic segmentation. Post-classification refinements included knowledge-based rules (e.g., masking water bodies using NDWI) and manual QA/QC.

3. Possible Planting Areas Delineation

All areas lacking tree canopy were further classified as either suitable or unsuitable for planting. Unsuitable areas for canopy expansion (e.g., airports, sports fields, utility corridors, wetlands) were excluded by manually digitizing these features. These areas, while vegetated and potentially suitable for tree planting from a biophysical perspective, are considered unsuitable due to land use constraints. The original seven-class land cover data was then converted into Urban Tree Canopy potential classes, resulting in the following final classifications: Possible Planting Area, Unsuitable Impervious, Unsuitable Vegetation, Unsuitable Wetland, Unsuitable Soil, and Water. This refined classification provides a detailed spatial framework for prioritizing tree planting efforts.

4. Historical Canopy Change Analysis

The 2011 and 2023 tree canopy classifications were compared using GIS overlay analysis to quantify changes in canopy extent over the 12-year period. This approach enabled the identification of areas where tree canopy was lost, gained, or remained stable, providing essential baseline data for evaluating the effectiveness of urban forestry initiatives. It should be noted that the 2011 historical tree canopy data is a single-class dataset; therefore, land cover change analysis was limited to the tree canopy class only. This methodology enables precise tracking of canopy changes since 2011 while maintaining methodological consistency across time periods, ensuring comparable results for long-term urban forest management planning.

5. Multi-Scale Spatial Analysis

Land cover metrics (area and percent cover) were calculated for the entire Area of Interest (Urban Growth Area) and for each assessment geography. Raster and vector outputs supported both fine-grained analysis and regional planning.

GLOSSARY/KEY TERMS

Land Acres: Total land area, in acres, of the assessment boundary (excludes water).

Non-Canopy Vegetation: Areas of grass and open space where tree canopy does not exist.

Possible Planting Area - Vegetation: Areas of grass and open space where tree canopy does not exist, and it is biophysically possible to plant trees.

Shrub: Areas of shrub or other leafy and woody vegetation (smaller than 6ft tall) that are not classified as tree canopy.

Soil/Dry Vegetation: Areas of bare soil and/or dried, dead vegetation.

Total Acres: Total area, in acres, of the assessment boundary (includes water).

Unsuitable Impervious: Areas of impervious surfaces that are not suitable for tree planting. These include buildings and roads and all other types of impervious surfaces.

Unsuitable Planting Area: Areas where it is not feasible to plant trees. Airports, ball fields, golf courses, etc. were manually defined as unsuitable planting areas.

Unsuitable Soil: Areas of soil/dry vegetation considered unsuitable for tree planting. Irrigation and other modifiers may be required to keep a tree alive in these areas.

Unsuitable Vegetation: Areas of non-canopy vegetation that are not suitable for tree planting due to their land use.

Urban Tree Canopy (UTC): The “layer of leaves, branches and stems that cover the ground” (Raciti et al., 2006) when viewed from above; the metric used to quantify the extent, function, and value of the urban forest. Tree canopy was generally taller than 10-15 feet tall.

Water: Areas of open, surface water not including swimming pools.



Partner organizations host tree potting events to prepare trees for future planting events.

MAY | 2025

TREE CANOPY COVER

ASSESSMENT

CLARK COUNTY, WASHINGTON
URBAN GROWTH AREAS

Funding for this project was provided through an Urban & Community Forestry Grant to the Clark Conservation District, in cooperation with Clark County Public Works and the Washington Department of Natural Resources.

Exhibit R

Water Quality Program

Permit Submittal Electronic Certification

Permittee: CLARK COUNTY

Permit Number: WAR044001 **Site Address:** 1300 FRANKLIN ST
VANCOUVER, WA 98660

Submittal Name: MS4 Annual Report Phase I City County

Version: 1 **Due Date:** 3/31/2026

Questionnaire

Number	Permit Section	Question	Answer
1	S9.D.6.	Attach a map of any annexations, incorporations or jurisdictional boundary changes resulting in an increase or decrease in the Permittee's geographic area of permit coverage during the reporting period per S9.D.6.	Q01 Annexation mapping_1_ 03182026110540 Comment: https://gis.clark.wa.gov/gishome/AnnexationTracker/
2	S9.D.1, S5.A.1	Attach updated annual Stormwater Management Program Plan (SWMP Plan). (S9.D.1, S5.A.1)	2026 SWMP Final_2_032320260910 10
3	S5.A.2.	No later than March 31, 2027, implemented an ongoing program to gather, track, and maintain information per S5.A.2, including costs or estimated costs of developing and implementing the SWMP?	Not Applicable
4	S9.D4	If applicable, identify other entities relied on to satisfy any of the obligations under the Permit. (S9.D4).	Not Applicable
5	S5.C.2.a	Maintained electronic mapping data for the features listed in S5.C.2.a?	Yes
6	S5.C.2.a.i.	Attach file that lists the known outfall locations, size, and materials no later than March 31, 2026 in accordance with S5.C.2.a.i. The data shall be in one of the following formats: a. ESRI file geodatabase template (feature class in a .gdb): https://fortress.wa.gov/ecy/ezshare/wq/permits/MS4GP.Mapoutfall.prelim.gdb.zip • Shapefile template: https://fortress.wa.gov/ecy/ezshare/wq/permits/MS4GP.Mapoutfall.prelim.shape.zip • ArcGIS Online template (sharing template a or b via ArcGIS Online). • Excel template: https://fortress.wa.gov/ecy/ezshare/wq/permits/MS4GP.Mapoutfall.prelim.excel.xlsx	Q06 MS4_Outfalls_WAR 044001_260_6_ 03182026074124 Comment: Mapped outfalls within the Urban Growth Area (UGA) are accurate based on current GIS data in the StormwaterClk database. Outfalls outside the UGA are undergoing field verification and review as part of our ongoing mapping improvement efforts and will not be completed before the annual report is submitted. Once completed, we will resubmit the revised outfall information.

7	S5.C.2.b.ii	No later than December 31, 2026, mapped tree canopy, using available, existing data, to support stormwater management on Permittee-owned or operated properties. (S5.C.2.b.ii)	Not Applicable
12	S5.C.3.b.i	Implemented coordination mechanisms clarifying roles and responsibilities for control of pollutants between physically interconnected MS4s per S5.C.3.b.i?	Yes Comment: Informal coordination with phase II cities in Clark County takes place at the operational staff level. Periodic permittee meetings are held by Southwest Washington permittees. Clark County organized SW Partners and SW WA PPA coordination.
13	S5.C.3.b.ii	Coordinated stormwater management activities for shared waterbodies among Permittees and Secondary Permittees, as necessary to avoid conflicting plans, policies and regulations? (S5.C.3.b.ii)	Yes Comment: Clark County continued as the financial manager for the Vancouver Lake Watershed Partnership. Clark County continued to coordinate outreach and education activities. Clark County operates a regional street waste management facility shared with numerous permittees including WSDOT. Clark County participates in TMDL work led by Ecology. Clark County entered into an interagency agreement with the city of Camas to improve water quality in Lacamas Lake and its watershed.
14	S5.C.4.a	Describe in Comments field opportunities created for the public, including overburdened communities, to participate in the decision making processes involving the development, implementation and updates of the SWMP and SMAP (SMAP applies to Counties). (S5.C.4.a).	See attachment: "Q14 NPDES permit 14.a public participation OBC 2.11.26"

14a	S5.C.4.a.i	Annually document specific public involvement and participation opportunities provided to overburdened communities, including highly impacted communities (e.g., federally recognized tribes). (S5.C.4.a.i)	Attachment "Q14 NPDES permit 14.a public participation OBC 2.11.26" contains a table in the appendix documenting specific public involvement and participation opportunities provided to overburdened and highly impacted communities. The attached SWMP also describes public involvement actions and Public Works Community Engagement and Inclusion Division documents specific actions.
15	S5.C.4.b	Posted the updated SWMP Plan and latest annual report on your website no later than May 31? (S5.C.4.b)	Yes
15a	S5.C.4.b	List website address in Comments field.	https://clark.wa.gov/public-works/clark-county-stormwater-management-plan
16	S5.C.5.b.iii	Submitted draft enforceable requirements, technical standards and manual to meet site and subdivision-scale requirements of S5.C.5.a to Ecology no later than July 1, 2025. (S5.C.5.b.iii)	Yes
18	S5.C.5.b.i	Number of adjustments granted to the minimum requirements in Appendix 1? (S5.C.5.b.i, and Section 5 of Appendix 1)	1 Comment: DIN-2025-00110
18a	S5.C.5.b.i	Number of adjustments granted to minimum requirement #5?	0
19	S5.C.5.b.i	Number of exceptions granted to the minimum requirements in Appendix 1? (S5.C.5.b.i, and Section 6 of Appendix 1)	0
20	S5.C.5.b.vi.(a)	Reviewed Stormwater Site Plans per S5.C.5.b.vi.(a).	Yes
20a	S5.C.5.b.vi(a)	Number of stormwater site plans reviewed during the reporting period? S5.C.5.b.vi(a)	1701
21	S5.C.5.b.vi.(b)	Inspected, prior to clearing and construction, permitted development sites per S5.C.5.b.vi.(b)?	Yes
22	S5.C.5.b.vi.(c)	Inspected permitted development sites during construction to verify proper installation and maintenance of required erosion and sediment controls per S5.C.5.b.vi.(c)?	Yes
23	S5.C.5.b.vi.(d)	Inspected stormwater treatment and flow control BMPs/facilities and catch basins in new residential developments twice per 12-month period, with no less than four months between inspections, per S5.C.5.b.vi.(d)?	Yes

24	S5.C.5.b.vi(e)	Inspected permitted development sites upon completion of construction and prior to final approval or occupancy to ensure proper installation of stormwater facilities per S5.C.5.b.vi(e)?	Yes
25	S5.C.5.b.vi(e)	Verified that a maintenance plan is completed and responsibility for maintenance is assigned for stormwater treatment and flow control BMPs/facilities prior to final approval and occupancy being granted? (S5.C.5.b.vi(e))	Yes
26	S5.C.5.b.vi(e)	Number of enforcement actions taken during the reporting period? (Based on all construction and post-construction phase inspections at new development and redevelopment projects.) (S5.C.5.b.vi(b)- (e))	1528
27	S5.C.5.b.vi.(f)	Achieved at least 80% of required construction-related inspections? (S5.C.5.b.vi.(f))	Yes
28	S5.C.5.b.vii	Made online links to Ecology's Construction Stormwater General Permit Notice of Intent, the Industrial Stormwater General Permit Notice of Intent, and the registration requirements for Underground Injection Control (UIC) wells available to representatives of proposed new development and redevelopment? (S5.C.5.b.vii)	Yes
29	S5.C.5.b.viii	All staff whose primary job duties are implementing the program to control stormwater runoff from new development, redevelopment, and construction sites are trained to conduct these activities? (S5.C.5.b.viii)	Yes
30	S5.C.6.a	Continued to convene an interdisciplinary team to inform and assist in the development, progress, and influence of the stormwater planning program? (S5.C.6.a)	Yes
36	S5.C.6.c.i	Continue to design and implement local development-related codes, rules, standards, or other enforceable documents to minimize impervious surfaces, native vegetation loss, and stormwater runoff, where feasible? See S5.C.6.c.i. (Required annually)	Yes
37	S5.C.6.c.i.(a)	From the assessment described in S5.C.6.c.i. (a), did you identify any administrative or regulatory barriers to implementation of LID Principles or LID BMPs? (Required annually)	No
39	S.5.C.6.d.i	Counties Only: Described in your SWMP how the watershed-scale stormwater plans (developed in the 2013-2019 Permit) are being used to inform S5.C.7 project prioritization and selection? (S.5.C.6.d.i)	Yes
42	S5.C.7.c	Attach a list of planned, individual projects scheduled for implementation during this permit term for the purpose of meeting S5.C.7.d, with the information and formatting specified in Appendix 12? (S5.C.7.c)	Q42 Appendix 12 Table_42_03042026114451
44	S5.C.8.b	Updated inventory to identify commercial and industrial properties which have the potential to generate pollutants to the Permittee's MS4 per S5.C.8.b? (Required once every five years.)	Yes

44a	S5.C.8.a	Number of total sites identified for inventory?	598
45	S5.C.8.a-d	Attach a summary of actions taken to implement the source control program per S5.C.8.a.-d.	Q45 Summary actions to impleme_45_03132026104700
46	S5.C.8.b., c.	Attach a list of inspections per S5.C.8.b, organized by the business groups, noting the number of times each business was inspected, and if enforcement actions were taken, per S5.C.8.c.i.-v.	Q46 Source Control Inspections_46_03132026104700
47	S5.C.8.e.	Implemented an ongoing source control training program per S5.C.8.e?	Yes
48	S5.C.9.b	Continued to implement the regulatory mechanisms to effectively prohibit illicit discharges into the MS4 per S5.C.9.b.	Yes
50	S5.C.9.c.i	Implemented procedures for conducting illicit discharge investigations in accordance with S5.C.9.c.i?	Yes
50a	S5.C.9.c.i	Cite field screening methodology used in the Comments field.	Clark County follows a QAPP developed based on the Herrera guidance and the Center for Watershed Protection guidance. Clark County also uses source control visits in the urban area and rural ditch mapping for the large area outside the urban area.
51	S5.C.9.c.i(a)	Provide the percentage of MS4 screened in reporting year per S5.C.9.c.i(a). (Required to screen 12% each year.)	23
51a	S5.C.9.c.i(a)	Cite field screening techniques used to determine percent of MS4 screened.	Clark County used the total number of outfalls and the outfalls screened to arrive at the percentage of the MS4 screened.

52	S5.C.9.c.ii	Describe how you publicized a hotline telephone number for public reporting of spills and other illicit discharges in the Comments field (S5.C.9.c.ii).	The general Public Works complaint line is always available at 564-397-2446. The county web pages also refer the public to the department of Ecology spill reporting number. There are also tools to report problems on the Co. web pages, including reporting water quality problems on the PW Clean Water Division web page and Clark County Code Enforcement Division. The majority of complaints are via email and ERTS reports from Ecology.
53	S5.C.9.c.iii	Implemented an ongoing illicit discharge training program for all municipal field staff per S5.C.9.c.iii?	Yes
54	S5.C.9.d	Updated an ongoing program to address illicit discharges, including spills, and illicit connections into the MS4 per S5.C.9.d?	Not Applicable
55	S5.C.9.e	Implemented an ongoing illicit discharge training program for all staff responsible for the procedures and program, per S5.C.9.e?	Yes Comment: Staff continued from previous years.
56	S5.C.9.f	Participated in a regional emergency response program, or implemented procedures to investigate and respond to spills and improper disposal? (S5.C.9.f)	Yes
57	S5.C.9.g	Attach a report with data describing the actions taken to characterize, trace, and eliminate each illicit discharge reported to, or investigated by, the permittee as described in S5.C.9.g. The submittal must include all of the applicable information and must follow the format described in Appendix 14.	WAR044001-2025-ImportedIDDEs_03232026141428
58	S5.C.10.a	Implemented maintenance standards that are as protective, or more protective, of facility function than those specified in the Stormwater Management Manual for Western Washington, or a Phase I program approved by Ecology? (S5.C.10.a)	Yes

60	S5.C.10.a	Applied a maintenance standard for a facility or facilities which do not have maintenance standards specified? If so, note in the Comments field what kinds of facilities are covered by this alternative standard. (S5.C.10.a)	Yes Comment: Clark County Storm Water Manual Book 4 includes several stormwater facilities not included in the Ecology manual: Hydrodynamic Separator Systems, Treatment Wetland, Modular Detention Systems, Treatment Soil Media Planter Boxes Vegetated Roof, Drywell, Downspout Infiltration, Downspout Dispersion, Sheet Flow Dispersion, Compost Amended Soil, and Rain Garden.
61	S5.C.10.a.ii	Verified that maintenance was performed, per the schedule in S5.C.10.a.ii, when an inspection identified an exceedance of the maintenance standard.	Yes
61a	S5.C.10.a.ii	Attach documentation of maintenance time frame exceedances that were beyond the Permittee's control.	Not Applicable
63	S5.C.10.b.ii	Implemented an ongoing inspection program for stormwater facilities regulated by the Permittee per S5.C.10.b.ii.	Yes
63a	S5.C.10.b.iii	Are you using a reduced inspection frequency? (S5.C.10.b.iii)	No
63b	S5.C.10.b.iii	If using a reduced inspection frequency on stormwater facilities regulated by the Permittee for the first time during this permit cycle, attach documentation per S5.C.10.b.iii.	Not Applicable
64	S5.C.10.b.iv	Achieved at least 80% of inspections required? (S5.C.10.b.iv)	Yes Comment: Achieved 92% of required inspections
65	S5.C.10.c.i	Number of known stormwater treatment and flow control BMPs/facilities owned or operated by the Permittee? (S5.C.10.c.i)	2169
65a	S5.C.10.c.i	Number of these BMPs/facilities inspected during the reporting period?? (S5.C.10.c.i)	2160
65b	S5.C.10.c.i	Number of these BMPs/facilities for which maintenance was performed during the reporting period?? (S5.C.10.c.i)	2179
66	S5.C.10.c.ii	If using reduced inspection frequency for municipally owned or operated stormwater treatment and flow control BMPs/facilities for the first time during this permit cycle, attach documentation per S5.C.10.c.ii.	Not Applicable
67	S5.C.10.c.iii	Conducted spot checks and inspections of potentially damaged stormwater treatment and flow control BMPs/facilities after major storm events? (S5.C.10.c.iii)	Yes
68	S5.C.10.c.iv	Achieved at least 95% of required inspections per S5.C.10.c.iv?	Yes

69	(S5.C.10.d.i	Inspected catch basins owned or operated by the Permittee every year or used an alternative approach? (S5.C.10.d.i)	Yes
69a	(S5.C.10.d.i	Number of known catch basins and inlets?	13293
69b	(S5.C.10.d.i	Number of catch basins and inlets inspected during the reporting period?	13142
69c	(S5.C.10.d.i	Number of catch basins and inlets cleaned during the reporting period?	3838
70	(S5.C.10.d.i	Attach documentation of alternative catch basin inspection approach, if used. (S5.C.10.d.i.)	Not Applicable
71	S5.C.10.d.ii	Disposed of decant water in accordance with the requirements in Appendix 6 – Street Waste Disposal. (S5.C.10.d.ii)	Yes
72	S5.C.10.e	Implemented practices, policies, and procedures to reduce stormwater impacts associated with runoff from all lands owned or maintained by the Permittee, and road maintenance activities under the functional control of the Permittee per S5.C.10.e.	Yes
78	S5.C.10.g	Implemented a Stormwater Pollution Prevention Plan for all heavy equipment maintenance or storage yards, and material storage facilities, owned or operated by the Permittee in areas subject to this Permit that are not required to have coverage under an NPDES permit that authorizes stormwater discharges associated with the activity per S5.C.10.g?	Yes
79	S5.C.10.h	Implemented an ongoing training program for employees of the Permittee whose primary construction, operations or maintenance job functions may impact stormwater quality per S5.C.10.h?	Yes
80	S5.C.11	Did you choose to adopt one or more elements of a regional program? (S5.C.11)	Yes
80a	S5.C.11	If yes, list the elements, and the regional program.	Use 80a attachment - E&O memo
81	S5.C.11.a.i	Attach description of public education and outreach general awareness efforts conducted, including your priority audiences and subject areas, per S5.C.11.a.i.	Q81 NPDES permit 81_85a_EandO _81_03042026120350
82	S5.C.11.a.ii(b)	Developed a behavior change campaign that is tailored to the community, in accordance with S5.C.11.a.ii(b)? (Required no later than July 1, 2025)	Yes
82a	S5.C.11.a.ii(b)	Attach the strategy and schedule developed in accordance with S5.C.11.a.ii.(b).	Q82a NPDES permit 82a_behavior_82a_030 42026120350
83	S.5.C.11.a.ii.(c)	Began implementing strategy outlined in S.5.C.11.a.ii.(b). (Required by September 1, 2025 – S.5.C.11.a.ii.(c))	Yes
85	S5.C.11.a.iii	Provided, partnered, or promoted stewardship opportunities to encourage resident or business participation in activities such as those described in S5.C.11.a.iii?	Yes

85a	S5.C.11.a.iii	Attach a list of stewardship opportunities.	Q81 NPDES permit 81_85a_EandO _85a_03042026120351 Comment: Both Q81 and Q85a addressed in this attachment
86	S7.A	Complied with the Total Maximum Daily Load (TMDL)-specific requirements identified in Appendix 2? (S7.A)	Not Applicable
86a	S7.A	List any requirements that were not met.	Not Applicable
87	S7.A	For TMDL listed in Appendix 2, attach a summary of relevant SWMP and Appendix 2 activities to address the applicable TMDL parameter(s). (S7.A)	Not Applicable
88	S8.A	Submitted payment for cost-sharing for Stormwater Action Monitoring (SAM) status and trends monitoring no later than December 1, 2024 (S8.A.1); and no later than August 15 of each subsequent year? (S8.A.2.a)	Yes
90	S8.B.2	Submitted payment for cost-sharing for SAM effectiveness and source identification studies no later than December 1, 2024 (S8.B.1); and no later than August 15 of each subsequent year? (S8.B.2.a or S8.B.2.c)	Yes
92	S.8.B.2.c	If conducting a study per S.8.B.2.c, submitted a detailed effectiveness study proposal to Ecology no later than February 2, 2025? (S8.B.2.c.ii(a))	Not Applicable
93	S8.B.2.c.ii.(b)	If conducting a study per S.8.B.2.c, submitted a QAPP to Ecology within 120 days of Ecology's approval of the detailed effectiveness study proposal? (S8.B.2.c.ii.(b))	Not Applicable
94	S8.B.2.c.ii.(c)	If conducting a study per S.8.B.2.c, began full implementation of the effectiveness in accordance with the schedule in the approved QAPP, and submitted required reports? (S8.B.2.c.ii.(c))	Not Applicable
95	S8.C.1	City of Tacoma: Submitted data and final report on stormwater discharge monitoring conducted pursuant to S8.B Effectiveness Studies Option b. in the Phase I Municipal Stormwater Permit August 1, 2019 – July 31, 2024? (S8.C.1- Due June 30, 2025)	Not Applicable
96	S8.C.2.c	If conducting stormwater discharge monitoring in accordance with S8.C.2, submitted a QAPP to Ecology no later than February 1, 2025? (S8.C.2.c and Appendix 9)	Not Applicable
97	S8.C.2.d.	If conducting stormwater discharge monitoring in accordance with S8.C.2, attach a data and analysis report per S8.C.2.d. and Appendix 9. (Due annually beginning March 31, 2026.)	Not Applicable
98	G3	Notified Ecology in accordance with G3 of any discharge into or from the Permittee's MS4 which could constitute a threat to human health, welfare or the environment? (G3)	Yes
99	G3.A	Took appropriate action to correct or minimize the threat to human health, welfare, and/or the environment per G3.A?	Yes

100	S4.F.1	Notified Ecology within 30 days of becoming aware that a discharge from the Permittee's MS4 caused or contributed to a known or likely violation of water quality standards in the receiving water? (S4.F.1)	Not Applicable
101	S4.F.3.a	If requested, submitted an Adaptive Management Response report in accordance with S4.F.3.a?	Not Applicable Comment: Adaptive management plan requested in 2025 by Ecology and submitting in 2026.
102	S4.F.3.d	Attach a summary of the status of implementation of any actions taken pursuant to S4.F.3 and the status of any monitoring, assessment, or evaluation efforts conducted during the reporting period? (S4.F.3.d)	Not Applicable Comment: Work done for adaptive management plan. Submittal in 2026.
103	G20	Notified Ecology of the failure to comply with the permit terms and conditions within 30 days of becoming aware of the non-compliance? (G20)	Yes
104	G20	Number of non-compliance notifications (G20) provided in reporting year? List permit conditions described in non-compliance notification(s) in Comments field.	1 Comment: S5.C.5.v(e).

I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Kathleen Otto — **Signature**

3/25/2026 8:38:17 AM — **Date**