Oak Lodge Water Services District

Oak Grove, Oregon 97267

Total Maximum Daily Load (TMDL) Implementation Plan

Annual Status Report

Fiscal Year 2021

(July 1, 2020 - June 30, 2021)

Submitted to:

Oregon Department of Environmental Quality
October 29, 2021

October 29, 2021

Andrea Matzke, MPH
Lower Willamette Basin Coordinator
Northwest Region – Portland
700 NE Multnomah St. Suite 600
Portland, OR 97232

RE: Oak Lodge Water Services 2020-2021 Annual TMDL Report

Dear Ms. Matzke:

I am pleased to submit the 2020-2021 Total Maximum Daily Load (TMDL) Annual Report for the Oak Lodge Water Services District. This report summarizes progress that the District has made to address nonpoint source pollutants in the Willamette Basin which are not already addressed under the NPDES permits issued to the District for point sources from the District-wide MS4 or the 1200Z for the Water Reclamation Facility.

On June 17, 2014, DEQ approved the updated TMDL Overview and Nonpoint Source TMDL Implementation Plans submitted by the District under the following condition: *"In subsequent Annual Reports, the report should include appropriate milestones and interim targets related to temperature management strategies."*

The attached report (Attachment A) is based on the previously established matrix, and no modifications to the existing plan are currently being proposed.

If you have any questions regarding this report, please contact me at (503) 353-4202.

Sincerely,

Jason Rice
District Engineer
Department of Environmental Services

cc: File

Please find the following notes regarding specific comments made to Oak Lodge Water Services District in DEQ's letter dated May 1, 2017.

(1) *Please note that in DEQ's June 17, 2014 letter conditionally approving the TMDL implementation plan, DEQ indicated that in subsequent annual reports, the reporting matrix should include appropriate milestones and interim targets related to temperature management strategies. OLWSD met this requirement by developing new temperature tracking and performance measures in the 2016 revised annual report matrix received on Mar. 24, 2017. DEQ expects to see more specific milestones and interim targets, where possible, developed for next year's annual report as a condition for acceptance. For example, OLWSD could reference the stream shade GIS analysis that was completed in 2014 as the basis for targeting riparian shade restoration efforts. The District could develop milestones based on private landowner outreach efforts or percent of restoration projects completed in these areas. Similarly, OLWSD could develop other specific milestones for percent reduction of impervious areas that have been identified within the district boundaries, such as the proposed project to reduce impervious surfaces along McLoughlin Boulevard. DEQ encourages continued collaboration with groups, such as the Audubon Society and the North Clackamas Urban Watershed Council to augment and leverage restoration opportunities on both public and private lands. If you have any questions about developing adequate milestones, please contact me.*

To address stream shading beyond scheduled Capital Improvements, the District partners with a number of local non-profits and schools such as North Clackamas Watersheds Council (NCWC), Portland Audubon, Columbia Land Trust, Rex Putnam High School, Ecology in Classrooms and the Outdoors, and the Pacific Northwest Pollution Prevention Resource Center.

Examples of projects

NCWC – The District values its long partnership with the local watershed council, whose Streamside Stewards Program has many longstanding partners (stewards) in a "Maintenance Mode" for properties that have been restored. Keeping up maintenance of restored properties is the best way to maximize shade through plant growth, which supports temperature reduction strategies and water filtration through trapping of sediment. In the SSP there are currently 66 sites, 24.32 acres, and 6,344 linear feet of streambank under revegetation. In the previous year there have been 570 trees and shrubs planted, and there are 34 sites in a "maintenance mode".

BHCP – OLWS continues to support the Backyard Habitat Certification Program (BHCP), which is a partnership program of Portland Audubon and Columbia Land Trust. Through partnering with individual landowners on yard plantings, restoration, and enhancement, BHCP adds shade to both stream sides and yards. The BHCP also provides technical assistance and incentives to residents on lots less than one acre within the cities of Portland, Lake Oswego, Gresham, Fairview, West Linn, Milwaukie, Oak Grove, and Jennings Lodge to restore native wildlife habitat in backyards. There are five program elements: removal of aggressive weeds, naturescaping with native plants, pesticides reduction, stormwater management and wildlife stewardship. This program is a multi-pronged approach to improving not only shade quantity (influencing the temperature TMDL), but also educates our public about healthy maintenance of our local environment.

(2) *To measure effectiveness of stream restoration efforts and reduction of impervious surface within the district boundary, DEQ recommends that OLWSD monitor stream temperature during critical rearing and migration times for salmon and trout. Typically, this is May through October when many streams throughout the Lower Willamette sub basin exceed the state's water quality criteria for temperature. Additionally, the 2006 Willamette Basin TMDL Water Quality Management Plan (pg. 14-34) required designated management agencies to identify potential cold water refugia from river mile 50 of the mainstem Willamette downstream to the confluence with the Columbia River, and provide options for protecting or enhancing such areas. Tributaries to the Willamette River within the District's boundary include, but may not be limited to, Rinearson, Boardman, River Forest, Linden, and Willamette Creeks. These tributaries may provide sources of cold water refugia for salmonids migrating upstream on the Willamette River. DEQ recommends that OLWSD explore opportunities to assess potential for cold water refugia (generally, two degrees colder than the mainstem Willamette River) and include these actions in the next annual report. If you have any questions about the cold water refugia requirement, please contact me.*

Though our partnership with NCWC the District continues to explore options for restoration and stream shading projects. Last year the watershed council received funding to complete a Watershed Action Plan, which has provided a set of potential projects within our District's stretch of river. These projects would enhance habitat along the headwaters of tributaries and contribute to cold water refugia along the Willamette River. Along with the "stream shading" map we have attached the potential projects to this annual report to show what the District is working with in terms of protecting our waterways and shading them as possible (see Attachments B and C). NCWC is applying to OWEB to expand its stakeholder engagement to recruit high priority projects identified in the Shade Analysis project, and other key criteria, into the revegetation program. Since the plans were generated, the watershed council applied for funding for implementation, and has recently secured $239.300 for implementation of the Lower Boardman Project, with construction anticipated in 2023 (see Attachment C). OLWS supports partnering with NCWC on rolling out the projects when sufficient funding has been found.

(3) *The 2015 TMDL Pollutant Load Reduction Evaluation (PLRE) and Waste Load Allocation Attainment Assessment provided excellent analyses of progress to date in meeting MS4 benchmarks and TMDL waste load allocations for bacteria. The PLRE report showed that the District is estimated to be achieving the bacteria load removal benchmark that OLWSD developed in 2013 through implementation of various structural BMPs. The analysis did not include non-structural BMPs, such as education efforts, to estimate bacteria load reductions, so the analysis is likely conservative. Although non-structural BMPs, such as public education efforts, are difficult to quantify in load reduction analyses, DEQ agrees that these programs contribute to a multi-faceted approach for reducing bacteria loadings to impaired waterbodies. OLWSD is not currently estimated to be meeting the TMDL waste load allocation for bacteria established as part of the 2006 Willamette TMDL. According to the report, the PLRE shows a mean pollutant load reduction of 1.5 percent compared with the TMDL waste load allocation of 78 percent. DEQ encourages OLWSD to review and assess bacteria data collected as part of the MS4 permit monitoring requirements. Significant increases in bacteria trends, such as found in Lower Boardman Creek, may lead to more focused efforts in these areas through adaptive management strategies.*

Structural BMPs continue to be the primary line of defense as development occurs within the District.

OLWS continues to invest in a "Scoop the Poop" program in partnership with the North Clackamas Parks and Recreation District (NCPRD) by sponsoring the placement of dog waste removal bags along the "Trolley Trail" (a walking/biking trail) through the District. Each year the parks district installs thousands of bags in signs which also feature public education about pet waste cleanup.

The District itself also continues to pursue capital improvements through its Capital Improvement Plan. In the coming year the District plans on investing $250,000 in another water quality project, the specifics of which are still being finalized.

OLWS in partnership with North Clackamas Parks and Recreation District and Metro, invested in a wetland restoration/park creation project last year. The wetland doubles as a park and has been restored through installment of plants and the re-meandering of the creek. The facility also contains an accessible trail and a nature-based playground in the park.

The park was designed to restore wetland functionality, improve water quality, and create new shade in an area that has been vulnerable to direct sunlight. Installed in the wetland are multiple shade producing native plants including rushes, shrubs including dogwoods and willows, and large trees.

While the impacts of educational efforts regarding reduction in bacterial loading are harder to quantify, they too continue in the District. For example, as part of the sponsorship of the watershed council, NCWC hosted online workshops about nonpoint source pollution, watershed function, and individual actions that contribute to watershed health. NCWC held 8 online workshops with 83 total participants. Of these, 75% rated their learning experience high (4 out of 5 or higher) and 74% reported feeling more motivated to take action to protect watersheds in their daily lives.

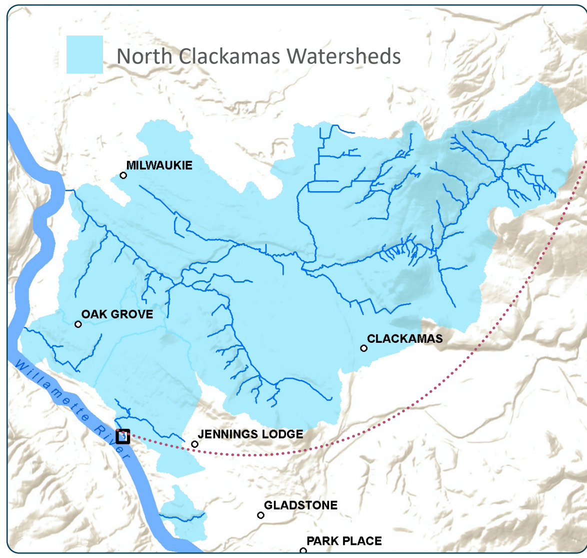
Although in 2020-2021 the public health emergency from the Covid-19 pandemic continued to cause significant challenges to the in-person education programs, stormwater education programming at local elementary and high schools in the area successfully continued through online distance learning platforms. Messaging around bacteria reduction is a significant part of the outreach strategy offered through our education partnerships.

Oregon DEQ: 5-Year TMDL Reporting Matrix
DMA: Oak Lodge Water Services District
Attachment "A"

STRATEGY	ACTIONS	MEASURE	TIMELINE and STATUS	MILESTONE	Addresses: Bacteria TMDL	Addresses: Temperature TMDL	Addresses: Mercury TMDL	5-Year Implementation Plan Status
Source Control	Illicit discharge controls	None required	These events are dealt with immediately upon notice to the District. Dependng on the serverity of the event some are open as long as a few weeks; however, there are no events are currently open.	Ongoing activity with annual report to Oregon DEQ	X	X	X	Yes, implemented per requirements
	Promotion of energy/water efficiency technologies	None required	Currently in place and ongoing	Ongoing activity		X		OLWS pivoted away from a Watershed Protection Levels of Service Study until its role in owning the storm system is established. Currently, OLWS promotes multiple energy/water efficiency technologies such as water conservation (Fish on the Run, Irrigation Done), awareness of efficient sewer pipe protections (Don't Flush Wipes Campaign), and regionally developed campaigns.
	Enforce OLWS and State septic system ban within District	None required	Currently in place and ongoing	When each of the two septic systems are abandoned properly and connected to the public system.	X			Yes, implemented per requirements and included in OLWS code. Currently two functioning septic systems exist in OLWS that meet State Code for structures distance to public mains.
	Require that construction and repair of sanitary facilities meet DEQ, OLWS, and county plumbing codes	Summary of activities in annual report	Currently in place and ongoing	Ongoing activity with annual report to Oregon DEQ	X			Yes, implemented per requirements
	Implement dental BMP program	Plan was delveloped and implemented.	OLWS will re-implement the exisitng outreach if needed in the future.	Ongoing activity			X	Yes, notification completed in 2013 to all dentist businesses in OLWS.
	Implement Industrial Pretreatment Program	Summary of activities in annual report	No current significant users. Program is in place, but not certified by DEQ.	Ongoing activity in compliance with NPDES and MS4 permit	X	X	X	With no current significant users, staff and consultants have been working to finalize the program documents and submit the work to DEQ for approval and certification.
Explore Technical Options	Explore technical options for effluent temperature control, including: 1. Shading/covering of tankage 2. Evaluate secondary treatment process in regards to blower temperatures and biomass caloric demands 3. Evaluate disinfection system for temperature impacts 4. Evaluate hyperbaric cooling for discharge 5. Evaluate heat exchange or subsurface heat discharge 6. Evaluate cooling of recycle flows	Potential options will be studied, designed and implemented as part of the OLWS Capital Improvement Program	Ongoing	Ongoing activity		X		Being continuously implemented. Water Reclamation Facility upgrade completed in 2012.
SSO control in the collection system	Implement infiltration and inflow reduction/control activities	Summary of activities in annual report	Currently in place and ongoing	Ongoing activity with annual report to Oregon DEQ	X			Yes; I&I Assessment initiated for certain collection system lines.
	Collection system maintenance (cleaning, joint repair, etc.)	Summary of activities in annual report	Currently in place and ongoing	Ongoing activity with annual report to Oregon DEQ	X			Yes, implemented per requirements.
	Collection system upgrades	Summary of activities in annual report	Currently in place and ongoing	Ongoing activity with annual report to Oregon DEQ	X			Yes, implemented per requirements.
Biosolids	Provide biosolids stabilization and reuse as required by NPDES permit	Summary of activities in annual report	Currently in place and ongoing	Ongoing activity with annual report to Oregon DEQ	X			Yes; no biosolids applied in District.
NPDES permit	Comply with NPDES permit requirements for temperature monitoring and thermal load WLA	When included in NPDES permit, report in DMR	To be developed	Comply with NPDES permit requirements		X		Complying with current Permit. WLA submitted 11/1/15. New permit to be issued.
	Comply with disinfection permit requirements	Measure and report in DMR	Currently in place and ongoing	Comply with NPDES permit requirements	X			Yes, UV Disinfection.
	Stormwater requirements (1200Z)	Report performance in annual report	Notice of Termination through DEQ in place and ongoing	Comply with NPDES permit requirements	X		X	This year OLWS completed a repiping project at the Wastewater Reclamation Facility and applied for a No Exposure Certification. DEQ certified "No Exposure" and provided a Notice of Termination (NoT) for the Permit. The NoT needs recertification every five years. Document included in Attachment D.
	Overflow controls	Overflows reported to DEQ	Currently in place and ongoing	Comply with NPDES permit requirements	X		X	Implemented per TMDL IP and NPDES Permit.
	Comply with NPDES permit requirements for toxics effluent monitoring	Demonstrate compliance with Mercury water quality criteria at edge of mixing zone	Currently in place and ongoing	Comply with NPDES permit requirements			X	New permit pending, testing to occur per new permit.

TMDL: Attachment B – Overview Stream Shading

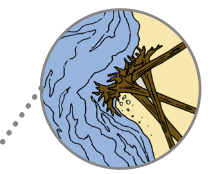
Lower Boardman Creek



Project Description

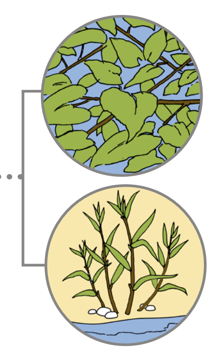
Large wood structures at the confluence of Boardman Creek and the Willamette River are proposed. These are intended to provide cover and high-flow refugia for 11 different populations of juvenile salmon or trout during migration and rearing in the Willamette. In select locations, this will also be paired with enhancement and creation of additional pool habitat to increase channel complexity. Large wood placements would be focused in geomorphically appropriate locations. Large wood near the mouth will be activated at fall through spring flows (coinciding with the primary juvenile fish migration period in the lower Willamette), while large wood upstream of the mouth would interact with streamflows year-round.

Target Performance Measures



Large Wood (LW)

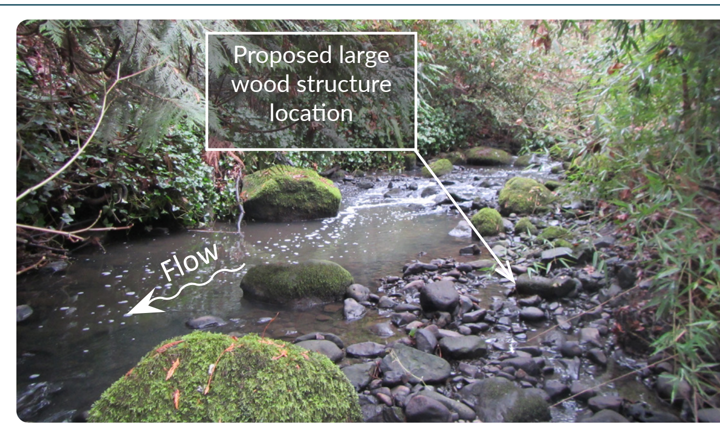
Placement of approximately 14 rootwad "tip in" structures (2 pieces each) and two larger confluence cover habitat structures (5 to 10 pieces each) along 500 linear feet of channel to provide cover and high-flow refugia while creating and maintaining scour pools for rearing and migrating juvenile salmonids. Large wood volume is estimated at approximately 125 cubic yards (not including confluence structure wood volume) per 1000 feet of channel. These structures would be placed strategically to avoid impact to existing mature vegetation and are to be buried or pinned between two anchor points, such as stable trees, boulders or the hillslope. Ballast requirements and final location of habitat structures to be determined in subsequent design phases. Additional placements upstream may also be warranted pending an assessment of juvenile accessibility to these areas.



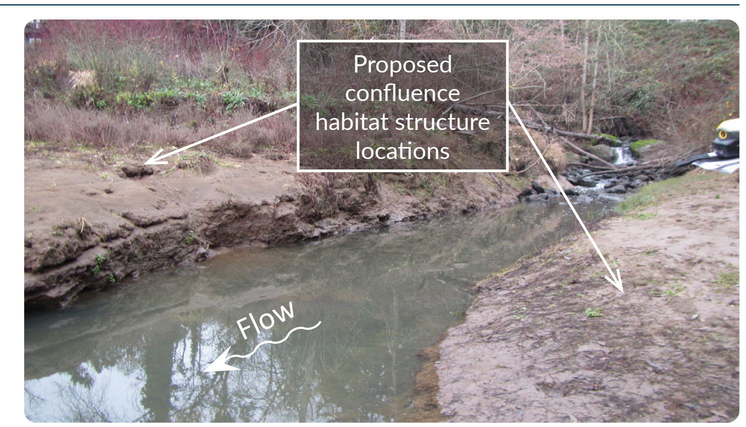
Invasive Species Removal & Riparian Revegetation

Work is anticipated to include 0.67 acres of invasive species removal and revegetation with native species along both banks of lower Boardman Creek. Invasive species removal, particularly of Himalayan blackberry, will promote the recolonization of the riparian zone by native species.

Existing invasive riparian vegetation is present along both banks of Boardman Creek; removal of these invasive species and revegetation with native species along both banks is proposed.



Existing small pool in the upstream project area to be enhanced and large wood added for complexity.

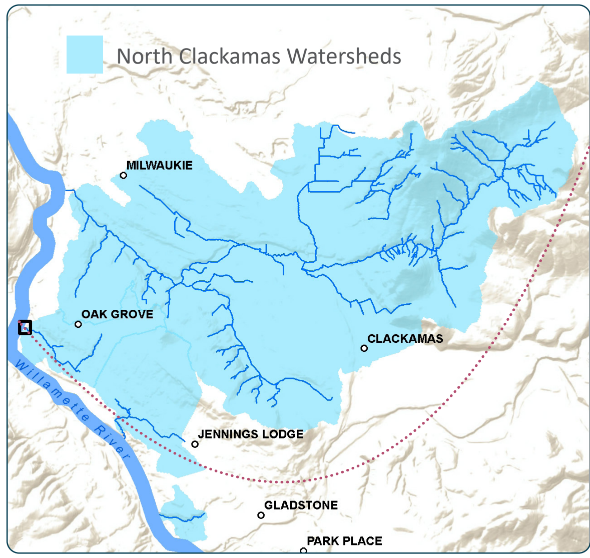


The existing confluence lacks cover habitat and stream shading; large wood placements are proposed on both right and left banks.

Limiting Factors Addressed

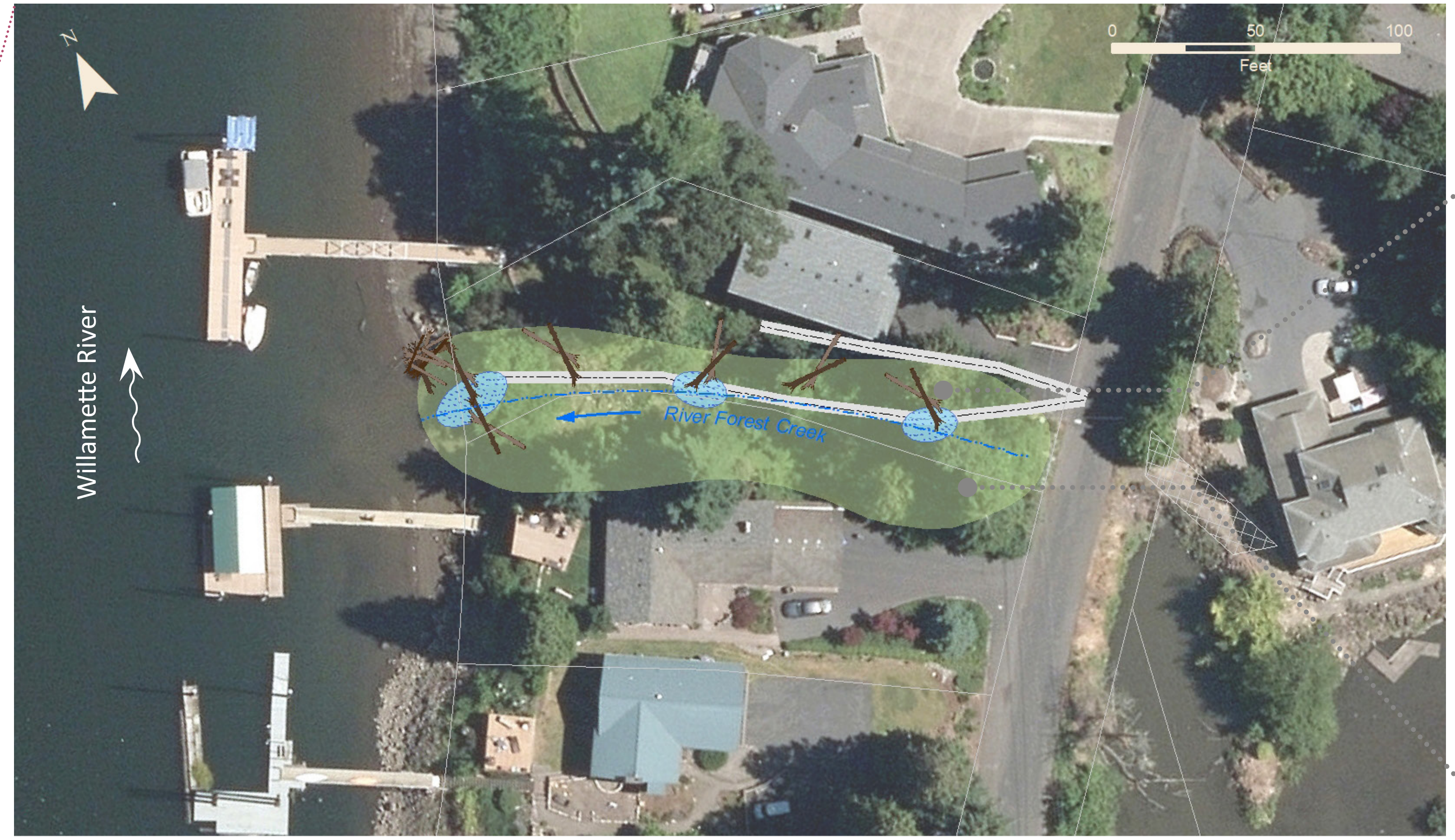
- Hydrograph/water quality (altered hydrology)
- Degraded riparian areas and large wood recruitment
- Degraded channel structure and complexity
- Invasive species
- Water quality (temperature, toxins)

Lower River Forest Creek

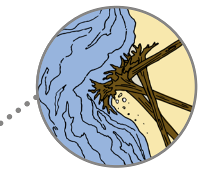


Project Description

Large wood structures at the confluence of River Forest Creek and the Willamette River are proposed. These are intended to provide cover and high-flow refugia for 11 different populations of juvenile salmon or trout during migration and rearing in the Willamette. In select locations this will also be paired with enhancement and creation of additional pool habitat to increase channel complexity. Large wood placements would be focused in geomorphically appropriate locations. Large wood near the mouth will be activated at fall through spring flows (coinciding with the primary juvenile fish migration period in the lower Willamette), while large wood "tip in" structures upstream of the mouth would interact with streamflows year-round.

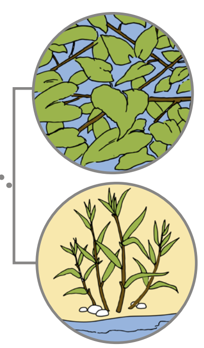


Target Performance Measures



Large Wood (LW)

Placement of approximately six rootwad "tip in" structures (2 pieces each) and two larger confluence cover habitat structures (15 to 20 pieces each) along 230 linear feet of channel to provide cover and high-flow refugia while creating and maintaining scour pools for rearing and migrating juvenile salmonids. Large wood volume is estimated at approximately 550 cubic yards per 1000 feet of channel. These structures would be placed strategically to avoid impact to existing mature vegetation and are to be buried or pinned between two anchor points, such as stable trees, boulders or the hillslope. Ballast requirements and final location of habitat structures to be determined in later design phases. Access to the confluence cover habitat structures is anticipated down the existing channel using a spider hoe to minimize aquatic habitat damage.

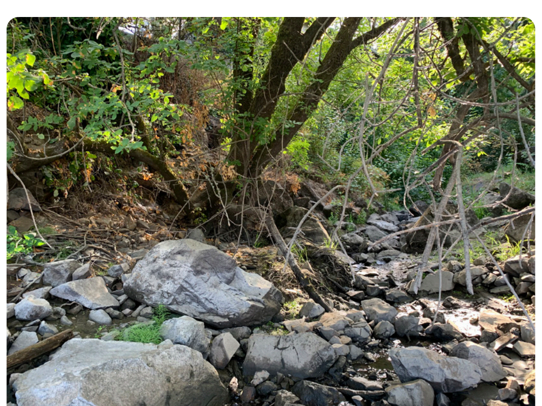


Invasive Species Removal & Riparian Revegetation

Work is anticipated to include 0.24 acres of invasive species removal along both banks of Lower River Forest Creek, focusing particularly on the south bank where English ivy is widespread but also included targeted efforts the north bank, where native species have already been planted under the Streamside Stewards program. Following invasive species removal, revegetation of 0.14 acres with native species on the south bank is anticipated.

Limiting Factors Addressed

- Hydrograph/water quality (altered hydrology)
- Degraded riparian areas and large wood recruitment
- Degraded channel structure and complexity
- Invasive species
- Water quality (temperature, toxins)



The existing confluence lacks cover habitat and includes large, angular substrate; large wood placements are proposed on both right and left banks.

Existing invasive riparian vegetation is present along River Forest Creek, especially on the left bank; removal of these invasive species and revegetation with native species along both banks is proposed.

Rootwad "tip in" wood placements, emulating natural large wood recruitment to a channel, are proposed along the north bank and could incorporate existing trees where feasible.

Existing culverts upstream of project area at the River Forest Drive crossing, currently acting as a full barrier to fish passage.

Rapid Bio-Assessment Report
North Clackamas Watersheds

SUBMITTED TO
North Clackamas Watersheds Council

MAY 2020

FUNDED BY

PGE Salmon Habitat Support Fund

Rapid Bio-Assessment Report

North Clackamas Watersheds

SUBMITTED TO

North Clackamas Watersheds Council
2416 SE Lake Rd.
Milwaukie, Oregon 97222

PREPARED BY

Inter-Fluve, Inc.
501 Portway Ave., Suite 101
Hood River, OR 97031

MAY 2020

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1. Executive Summary

The Four North Clackamas Watersheds Rapid Bio-Assessment intends to document stream habitat conditions and describe reasonably discernable factors limiting native fish (i.e. salmonids, lampreys) persistence within the Kellogg-Mt. Scott, River Forest, Boardman, and Rinearson Creek watersheds (collectively referred to as the 'four watersheds'). This effort is in support of the North Clackamas Watershed Council's (the Council) mission, which is to protect and enhance the four watersheds' water quality, fish, and wildlife habitat. The Council envisions people and nature flourishing in a healthy ecosystem and advocates on behalf of the watershed, engages in prioritized restoration projects, and fosters community stewardship. The entirety of the four watersheds are considered within this rapid bio-assessment framework, with a focused effort to evaluate areas that have already been established as known or assumed refugia for native fish species. The portion of the Willamette River covered by the Council was not included as part of this effort.

The Kellogg-Mt. Scott, Boardman, Rinearson, and River Forest watersheds are known to provide varying degrees of salmonid habitat to winter steelhead (*Oncorhynchus mykiss*), Coho Salmon (*O. kisutch*), fall and spring Chinook Salmon (*O. tshawytscha*) as well as Pacific and brook lamprey (*Entosphenus tridentatus* and *Lampetra richardsonii*), and resident cutthroat trout (*O. clarki clarki*) (Clackamas Partnership, 2018). However, numerous limiting factors exist in these four watersheds, including fish passage barriers, habitat degradation, and water quantity and quality issues. The goal of this assessment was to synthesize existing data and collect additional information to describe fish presence and habitat in the four watersheds, identifying habitat conditions at the reach-scale that may limit the production or perseverance of native fish in these watersheds.

The rapid bio-assessment was completed in two steps: 1) a preliminary desktop-based review of existing reach conditions, and 2) a rapid field-based habitat assessment of priority reaches. Results of the habitat assessments were evaluated against habitat benchmarks (targets) for desirable instream habitat conditions for salmon and trout species. Methods are described in more detail in Section 3 and in the Rapid Bio-Assessment Protocol memorandum (Inter-Fluve, 2019b).

Results of the habitat assessments were evaluated against prior published benchmarks of high-quality salmon and trout aquatic habitat (ODFW 2019). Instream habitat complexity was generally limited among the reaches. Instream large wood quantity and stream shading benchmarks were not met in any of the reaches. Pool habitat area met benchmarks in all reaches except Boardman Creek, but residual depths of these pools frequently did not meet target criteria. Substrate conditions varied substantially across the reaches, with both Mt. Scott Creek reaches achieving desirable conditions in gravel quantities but several reaches with higher than desirable quantities of fine sediments. See Section 3.1.3 for more details on each reach.

Finally, this report concludes with recommended aquatic habitat restoration actions for the four watersheds of the North Clackamas Watersheds Council (NCWC), including Kellogg Creek, Mt.

Scott Creek, River Forest Creek, Rinearson Creek and Boardman Creek. The identified actions are guided by the habitat assessment findings in this Report as well as by other efforts of the Council's partner agencies in the watersheds, including ODFW, Clackamas County WES, and others, which have provided a considerable amount of additional foundational material.

Restoration action types proposed in this report are intended to protect, restore, or enhance aquatic habitats and the ecosystem processes that create and sustain them. In developing restoration actions and identifying potential application areas on the landscape within the prioritized reaches in which field assessments were conducted, our approach strives to apply principles of process-based restoration. The development of restoration actions also took into consideration the urban and suburban nature of landscapes in the four watersheds (industrial, roads, homes, etc.). Seven potential restoration action types are recommended for the four watersheds, and include:

- Riparian management,
- Off-channel habitat enhancement or creation,
- Channel realignment,
- Large wood placements,
- Floodplain enhancement or creation,
- Fish passage improvement, and
- Natural bank treatments

Although these are presented in this report as discrete actions, in many cases, multiple action types can be combined to collectively achieve broader-scale objectives. The application of these restoration action tools in each of the watersheds has been tailored to fit the particular habitat conditions, land uses, and geomorphic context of the site. For more details about these action types, please see Sections 6 and 7.

The potential projects are visually represented on maps and described in detail in the potential project tables for each reach in Section 8. A brief summary of potential projects in each watershed is provided below. Potential projects are generally limited to the reaches visited during the field investigation, since on-the-ground conditions are important to consider prior to any further project design.

Several project types were identified that are recommended across all of the four watersheds, including additional data collection efforts and assessments of water quality and fish passage, education and outreach to landowners on bank and riparian conditions, and watershed-wide riparian management and land acquisitions actions where possible (Table 33).

In Kellogg Creek, potential projects identified included passage improvements to remove small, man-made rock weir features in the channel, bank treatments and riparian management to remove or replace riprap or other bank armor with more natural bank treatments, and in certain locations, wetland and floodplain enhancement, especially in the Upper Kellogg reaches (2 – 4; not visited during this field visit but assessed by Inter-Fluve staff for the Clackamas County WES Upper Kellogg Basin Assessment in 2019). The list of potential projects for Kellogg Creek is presented in Table 34 on page 111.

In Mt. Scott Creek, potential projects identified included passage improvements, riparian management, bank treatments, large wood placement, floodplain and off-channel enhancement or creation, and channel realignment. Passage improvements are largely focused on locations where roads cross the Mt. Scott Creek channel, such as at 84th Avenue. Invasive species removal and replanting with native vegetation is recommended throughout the reaches assessed during the field visit. Floodplain and off-channel projects, recommended throughout the reaches visited during the habitat assessment, would increase hydrology and connection of existing floodplain areas or low surfaces adjacent to the channels to increase fish habitat rearing areas. Large wood placements, ranging from single key pieces to larger structures along the banks and at tributary confluences, would provide cover habitat for fish and encourage scour pool formation and sediment sorting. Channel realignment actions would re-meader the portion of Mt. Scott Creek in lower Reach 5 that had been straightened and simplified to flow alongside the railroad. The list of potential projects for Mt. Scott Creek is presented in Table 35 on page 115.

In River Forest Creek, potential projects identified to improve fish habitat are focused below the River Forest Drive culverts (which currently act as fish passage barriers) and River Forest Lake, and include large wood placements. Adjacent to, and upstream of the Lake, opportunities to improve water quality with wetland enhancement and riparian management have been identified. Should the River Forest Drive crossing become passable for fish in the future, additional potential projects to improve instream fish habitat may be identified throughout River Forest Creek. The list of potential projects for River Forest Creek is presented in Table 36 on page 122.

In Rinearson Creek, potential projects identified included riparian management within the previous restoration project area where invasive vegetation has regrown, and passage assessment (and improvements, if needed) to increase fish access into the previous restoration project areas. Large wood placements in the channel upstream of the previous project were identified as an opportunity following removal of the barrier at rKm 0.7. The list of potential projects for Rinearson Creek is presented in Table 37 on page 124.

The Boardman Creek channel is naturally steep and confined from the confluence with the Willamette to approximately rKm 0.13. Fish accessibility through the steep and confined portion of the channel should be assessed. Potential project opportunities identified upstream include large wood placements to encourage scour pool formation and sediment sorting, and to provide cover habitat for fish if determined to be accessible. The list of potential projects for Boardman Creek is presented in Table 38 on page 126.

2. Introduction & Background

The four watersheds are located within the North Clackamas region, and all drain to the Willamette River (Figure 1). The largest watershed is Kellogg-Mt. Scott Creek, which drains approximately 16.3 square miles, while River Forest, Boardman, and Rinearson drain approximately 1.03, 1.68, and 0.24 square miles, respectively (USGS StreamStats 2019).

Stream and floodplain restoration work has occurred in the past and/or is currently ongoing by other groups including North Clackamas Parks and Recreation District (NCPRD), Clackamas County Water Environment Services (WES) and the Council. This rapid bio-assessment effort will describe and reference where this restoration work has occurred and include it as a consideration during project prioritization. The intention of the rapid bio-assessment is not to re-create work that has already been done, but to support and expand the extent of existing data in the four watersheds.

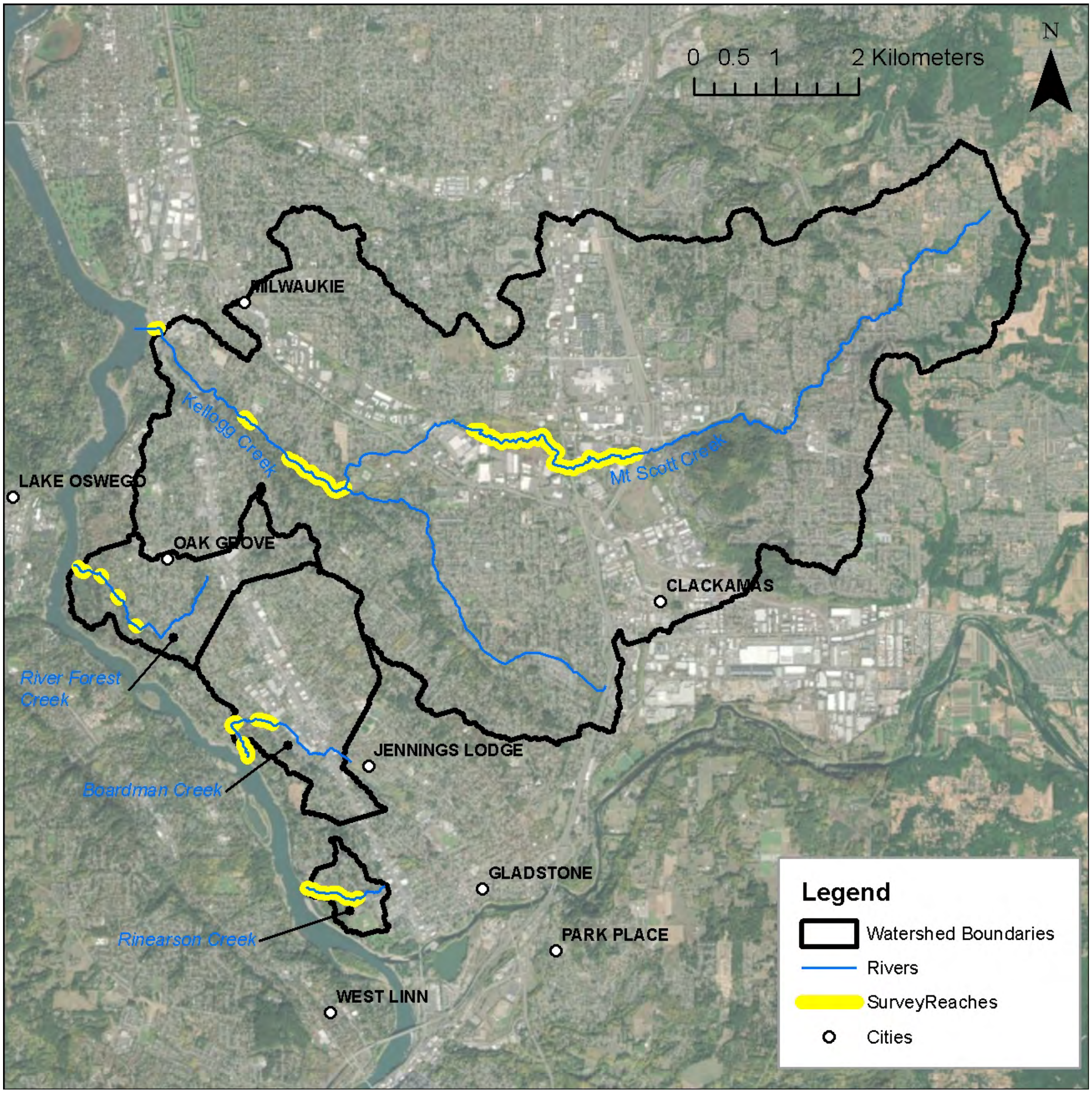


Figure 1. Assessment area for the North Clackamas Four Watersheds, consisting of the Kellogg-Mt. Scott, River Forest, Boardman, and Rinearson Creek watersheds.

2.1 LAND USE HISTORY

Changes in land use and landcover, hydromodification, and floodplain encroachment within the four watersheds have all altered watershed processes and functions. Understanding the linkages between these variables can help elucidate a strategy for developing treatments. To do that, it is helpful to review how watershed processes have been modified over time.

While little evidence of pre-disturbance conditions remains in the four watersheds, these and most other streams in the area likely functioned more as forested wetlands (Brown and Caldwell, 2009), rather than a single sinuous or straightened channel. Late successional forest and large, old growth trees would have exerted substantial control over floodplain processes, preventing the formation of long, continuous channels.

In the uplands and lowlands, flood energy would have been diffused throughout a complex, broad forested wetland area (e.g., Pacific Water Resources, Inc. 2008). Topographic complexity created through leaf litter, fallen trees, and tree roots would have slowed overland flow, encouraging soil infiltration. Groundwater storage and infiltration would have been relatively high, reducing stream discharge magnitudes, but extending duration of flow throughout the year.

Stream habitats would have been more diverse and complex. Stream complexity tends to lead to greater resilience to climate fluctuations and disturbance. Given the greater soil infiltration, channels and wetlands would likely have been connected by a high groundwater table, providing a high degree of diverse hydraulic and substrate conditions that cater to a range of organisms, though some ponded areas may have gone dry, seasonally.

The contemporary state of the four watersheds has now been shaped by intensive human disturbance, with landscape evolution strongly controlled by hydrology. Logging activities, followed by land clearing, drainage, and landcover conversion to agriculture, residential neighborhoods, and industrial uses have decreased stormwater infiltration and storage. Flood peaks likely have increased in magnitude, while decreasing in duration (Pacific Water Resources, Inc. 2008). Stream power has increased overall as more runoff became concentrated in stream channels. This has increased sediment production, accelerating erosion rates into readily erodible floodplains that were formed by vertical accretion and offer low lateral erosion resistance to the increases in stream power. Wetlands have been converted to channels to drain lands for urban landuses.

Conversion of agricultural land to residential development (which rapidly accelerated during the 70s and 80s) further exacerbated the hydrologic stress on the watersheds. An increase in impervious surfaces (as detailed in Brown and Caldwell, 2009) further increased the flashiness of runoff events, which subsequently triggered more erosion of the channel bed and banks as in-channel stresses increased. Floodplain encroachment from roads, residential development, and drainage works triggered the need for bank armoring and limited the ability of the channel to adjust to the increased flows. Riparian and aquatic habitats were drastically changed, simplified, and/or eliminated altogether.

2.2 SALMONID USE AND STATUS

Fish species documented in the four watersheds include several salmonid species and other native resident species, but vary by watershed. Currently, native fish known to be present in the Kellogg-Mt. Scott watershed include several anadromous salmonid species listed under the Endangered Species Act: Lower Columbia River fall Chinook Salmon (federally listed as threatened in 1999), Upper Willamette River spring Chinook Salmon (federally listed as threatened in 1999), Lower

Columbia River Coho Salmon (federally listed as threatened in 2005), and Lower Columbia River winter steelhead trout (federally listed as threatened in 1998); these are considered our focal species. In addition, Pacific and brook lamprey and resident cutthroat trout are present in the Kellogg-Mt. Scott watershed as well as other non-listed native species (Clackamas Partnership, 2018). Historical fish population use in Boardman, Rinearson, and River Forest may have included coho and spring Chinook Salmon, cutthroat and steelhead trout, and Pacific lamprey, though current fish use in these watersheds is largely unknown. A description of each species and known habitat preferences by life stage is presented in the following subsections.

2.2.1 Lower Columbia River Coho Salmon

Lower Columbia River Coho Salmon typically enter tributaries of the Columbia River from October through January. Most spawning occurs between November and January, in these warmer, lower basin tributaries. Eggs incubate over late fall and winter and juveniles typically rear in freshwater for more than a year (LCFRB 2010). Juvenile Coho favor pool and slack-water habitats and often congregate in quiet backwaters, side channels, and small creeks with riparian cover and woody debris. Most juvenile Coho migrate seaward as smolts during high spring flows, often between April and June of their second year. Coho salmon typically spend 18 months in the ocean before returning to fresh water at age 3. A small proportion of male Coho may return at age 2 after only 5 to 7 months in the ocean (LCFRB 2010).

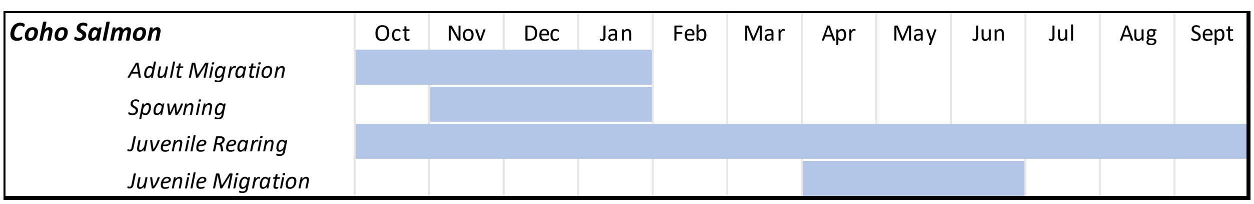


Figure 2. Typical life history timing for Coho salmon in the four watersheds.

Coho historically spawned in all accessible lower Columbia River tributaries but the run now consists of very few wild fish; present Coho populations have been heavily influenced by extensive hatchery releases. The strongest remaining populations occur in Oregon and include the Clackamas River population (LCFRB 2010). Fish surveys in Kellogg Creek (Reaches 1 and 2) and Mt. Scott Creek in 1997-1999 and 2008 indicate Coho are present in both systems in very low numbers (Friesen and Zimmerman, 1999; Neerman and Vogt, 2009). Though Coho particularly favor small, rain-driven, lower elevation streams such as those in the four watersheds, Kellogg Dam may present a barrier for returning Coho and rearing juveniles in the Kellogg-Mt. Scott drainage and other barriers limit the use of Boardman, Rinearson, and River Forest Creeks for Coho. Additionally, stream habitat conditions during spawning and rearing – particularly the lack of instream habitat complexity, suitable spawning substrate, and slower velocity off-channel rearing habitats –contribute to the lack of adult returns to the four watersheds.

2.2.2 Lower Columbia River Steelhead Trout

Lower Columbia River Steelhead trout are the anadromous form of rainbow trout. Anadromous parents can produce resident offspring and resident parents can produce anadromous offspring depending on stream conditions, growth rates and flow conditions. The Clackamas population of Winter steelhead begin entering the Willamette River system between December and January, migrating into tributaries such as Kellogg-Mt. Scott, between January and April as sexually mature individuals that spawn shortly thereafter. Peak spawning occurs in mid-March. Unlike salmon, not all steelhead die after spawning, and some steelhead may return to the ocean following spawning. Juvenile emergence generally occurs from March into July. Steelhead typically spend one to three years rearing in freshwater before migrating to the ocean for the first time. While in freshwater, juvenile steelhead typically favor habitats with moving, though relatively low in velocity, flows such as are found on the channel margins of riffles or in side-channels. In the lower Columbia River, emigration of steelhead smolts generally occurs from March to June in their second year, though freshwater residence of juveniles can vary and has been documented for up to 7 years in the Upper Columbia River basin (Peven, et al., 1994). Steelhead typically spend between 2-3 years in the ocean before returning to spawn (LCFRB, 2010).

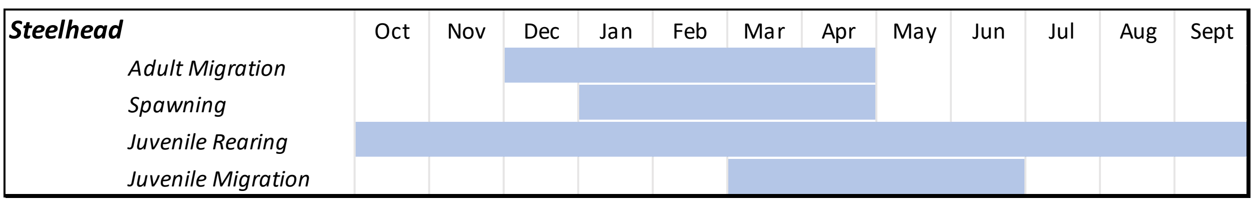


Figure 3. Typical life history timing for steelhead trout in the four watersheds.

Winter steelhead were historically distributed in all lower Columbia River subbasins and tributaries. Steelhead today remain widely distributed throughout lower Columbia River subbasins, though declining long-term trends and habitat reductions have placed this ESU at significant risk of extinction (LCFRB, 2010). Designated Lower Columbia River steelhead critical habitat extends into the Upper portions of Mt. Scott and Kellogg Creeks. Fish surveys in Kellogg and Mt. Scott Creeks in 1997-1999 and 2008 indicate juvenile rainbow trout/steelhead (which cannot be differentiated in the juvenile phase) are present throughout the watershed, with the highest abundance in the upper reaches of Mt. Scott Creek (Friesen and Zimmerman, 1999; Neerman and Vogt, 2009). Kellogg Dam may present a barrier for returning steelhead and rearing juveniles and other barriers limit the use of Boardman, Rinearson, and River Forest Creeks for steelhead. Additionally, stream habitat conditions during spawning and rearing – particularly the lack of instream habitat complexity, suitable spawning substrate, and off-channel rearing habitats – may contribute to the lack of adult returns to the four watersheds.

2.2.3 Upper Willamette River Spring Chinook Salmon

Upper Willamette spring Chinook salmon typically begin entering the Willamette River system in February with the bulk of the run entering in late spring. Some adult spring Chinook continue to enter the Willamette throughout the late spring and into the summer, but often are subject to elevated water temperatures and unsuitable migration conditions that may result in pre-spawn mortality. After migrating into the Willamette and larger tributaries, the adults hold in deep pools until spawning in the fall. Young emerge in the late winter and early spring in these warmer, lower elevation systems. In these freshwater systems, juvenile Chinook prefer low velocity, complex rearing habitats that can range from complex side channels to sandy beaches along the lower Willamette River. Juvenile (sub-yearling) spring Chinook salmon often migrate downstream from the Clackamas River and other upper Willamette tributaries during the spring freshet or in the fall to rear in the lower Willamette River or the lower Columbia River and estuary for 6-12 months prior to ocean migration.

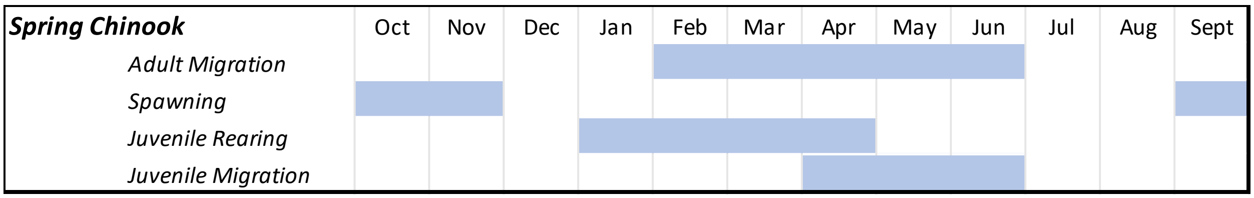


Figure 4. Typical life history timing for spring Chinook salmon in the four watersheds.

Historically, spring Chinook were abundant in the Columbia and Willamette Rivers. Dams and the associated loss of high-quality instream habitats, large hatchery programs, and substantial harvest pressure led to the decline of the wild fish. Fish surveys in Kellogg and Mt. Scott Creeks in 1997-1999 and 2008 recorded no Chinook in Mt. Scott Creek and less than one percent of the catch were Chinook in Kellogg Creek Reach 2 (Friesen and Zimmerman, 1999; Neerman and Vogt, 2009). Access to the small Willamette River tributaries and Clackamas River is important for migrating and holding adults, as they may provide cool-water refuge during the summer and early fall. However, Kellogg Dam likely presents a barrier to adult spring Chinook salmon that may attempt to enter the Kellogg watershed to escape high water temperature in the lower Willamette River. Given the small size of Boardman, Rinearson, and River Forest Creeks, it is unlikely that adult Chinook would utilize these streams unless they provide cool-water refugia during migration, though the barriers may limit even that use. Recent water temperature analysis in the Willamette River indicates Rinearson Creek is within the cold-water plume of the Clackamas River entering the Willamette (ODEQ 2020).

A significant benefit for juvenile Chinook provided by the four watersheds is winter rearing habitat for sub-yearlings (0+) that have migrated out of the Clackamas, Santiam, Molalla, and Mackenzie Rivers in late fall. These juveniles over-winter in the warmer Willamette River off-channel areas and complete their outmigration to the ocean the following spring. While over-wintering in the Willamette, these juveniles may seek refuge in tributary rearing habitats including areas such as Kellogg Lake and lower Kellogg and Mt. Scott Creeks. However, Kellogg Dam restricts upstream migration of juvenile spring Chinook looking for velocity refuge into the Kellogg-Mt. Scott watershed except when Willamette River water levels are high enough to overtop the Dam (ODFW FPB online map, 2020).

2.2.4 Lower Columbia River Fall Chinook Salmon

Lower Columbia River fall-run Chinook Salmon typically enter freshwater in an advanced state of maturation from August to September and spawn from late September to November (LCFRB, 2010). Juvenile Fall Chinook most frequently follow the “ocean type” life history, in which the young emigrate from freshwater as subyearlings at 1 to 4 months of age. Juveniles typically emigrate from natal freshwater habitats in late spring and remain in the estuary for an extended period of time. In the Columbia River estuary, subyearling Chinook salmon may be found in every month of the year. Most fall Chinook salmon remain at sea from 3 to 5 years and return to spawn between 4 and 6 years of age (though some male fish may remain only a single year and return as “jacks”) (LCFRB, 2010). Historically, fall Chinook were found in the mainstem Columbia and its tributaries from the mouth to the Klickitat River at RM 180.5. Though fall Chinook remain widely distributed throughout their historical habitat, current numbers of wild fish are very low (LCFRB, 2010). The number of historical returns to Kellogg Creek is unknown. The current critical habitat designation for fall Chinook in the Kellogg-Mt. Scott watershed only includes Kellogg Lake for rearing juveniles which likely only use the lake seasonally in the spring.

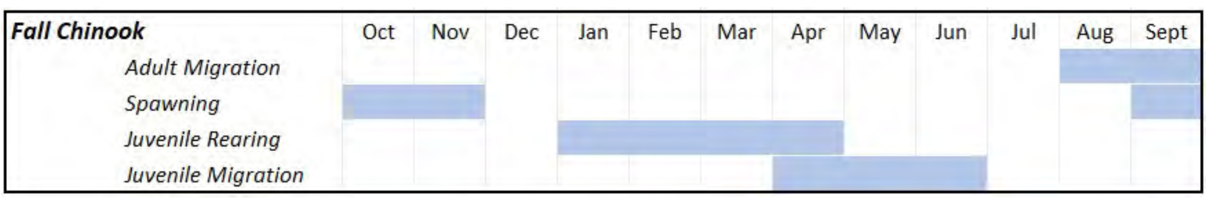


Figure 5. Typical life history timing for fall Chinook salmon in the four watersheds.

Due to the migration timing of both adult and juvenile fall Chinook during periods of lower flow (e.g. during the summer and fall), it is likely that Kellogg Dam acts as a passage barrier for a majority of the population and Chinook found in the Kellogg-Mt. Scott watershed are spring Chinook. Other barriers limit the use of Boardman, Rinearson, and River Forest Creeks for Chinook. Emerging fry and early-rearing juveniles from other nearby spawning and rearing areas may utilize Kellogg Lake for rearing when flows are high enough to overtop Kellogg Dam and provide access to Kellogg Lake.

Climate change and flashy stream runoff in urban streams affects all species of salmonids during migration, spawning, egg incubation, and rearing, but fish that spawn in the lower basin areas, such as fall Chinook, may feel the largest impacts. Late summer and fall spawning may be delayed as a result of later fall precipitation events combined with warmer stream and air temperatures predicted for the Pacific Northwest (Mote and Salanthe, 2010; Isaak, et al., 2017, 2018). Delays in spawning may make redds, and the eggs in the redds, more susceptible to flashy scouring winter flows.

2.2.5 Other Species

Other notable species that may be present in aquatic habitats include Pacific Lamprey, a species of concern for the state of Oregon, brook lamprey, and rainbow and cutthroat trout. Lamprey spawning occurs within approximately the same time period and similar habitats to steelhead spawning. Periodic spawning ground surveys by ODFW record observations of lamprey spawning; no adult lamprey have been observed in Kellogg or Mt. Scott Creeks over the period of 2012 – 2019 (ODFW, 2012-2019). Low numbers (n<5, or less than 3% of the total catch) of juvenile Pacific lampreys were observed in the Kellogg-Mt. Scott watershed during 1997-1999 and 2008 fish surveys (Friesen and Zimmerman, 1999; Neerman and Vogt, 2009). The limiting factors identified for salmon and steelhead (Clackamas Partnership, 2018) also address the primary factors affecting Pacific lamprey: degraded floodplain habitat, changes in stream hydrology, water quality (elevated water temperatures, toxins) and passage barriers. Recent spawning surveys in the lower Clackamas and Abernethy Creek (Todd Alsbury, pers. comm 01/24/20) indicate dense spawning by Pacific lamprey.

Proximity to those streams and the large population known to migrate over Willamette Falls indicate the Kellogg/Mt. Scott watershed may provide substantial rearing potential for native lamprey if passage was improved. The upper reaches of Mt. Scott Creek are noted as a stronghold for coastal cutthroat trout population within the Portland metro area, and fish surveys from 1997-1999 and 2009 indicate the greatest number of cutthroat found in the watershed are present in upper reaches of Mt. Scott (Friesen and Zimmerman, 1999; Neerman and Vogt, 2009). Other fish recorded in fish surveys included speckled dace, redside shiners, brook trout, reticulate sculpin, and bluegill (Friesen and Zimmerman, 1999; Neerman and Vogt, 2009).

2.2.6 Limiting Factors

Habitat limiting factors have been compiled at the basin-scale for Kellogg-Mt. Scott and the Willamette tributaries: Boardman, Rinearson, and River Forest Creeks by the Clackamas Partnership (2018).

Kellogg & Mt. Scott Creeks

In the Kellogg-Mt. Scott watershed, primary and secondary limiting factors include:

- **Habitat access (impaired upstream passage)**: small dams and diversions
- **Hydrograph/Water quantity (altered hydrology):** upslope land uses, including stormwater, flashy flows, and altered groundwater recharge
- **Water quality (elevated water temperature)**: land uses that impair riparian function
- **Physical habitat quality**: degraded floodplain connectivity and function
- **Physical habitat quality**: channelization and hardening of streambanks and channels
- **Water quality (toxins):** urban and industrial practices, including stormwater

Historically, the Kellogg-Mt. Scott watershed provided high-quality habitat to support substantial runs of salmon and trout. Despite the loss of habitat, these urban tributaries still support salmon, steelhead, and Pacific lamprey populations that contribute to the overall diversity, spatial extent, and productivity of the fish populations, as well as supporting migrating adult and juvenile salmon and steelhead derived from other watersheds.

Juveniles from Clackamas and upper Willamette Basin fish populations access the lower portions of these urban streams and associated floodplain habitats to rear during high-flow periods in the winter and spring when the Willamette River occupies the floodplain and lower tributary channels. Rearing juveniles and migrating adults may also seek refuge from high water temperatures in summer and early fall when conditions in the lower Willamette River become unsuitable for salmonid survival.

Side channels, alcoves, and backwater areas are present in some reaches of Kellogg and Mt. Scott Creeks, but extensive bank hardening, channel alterations, and areas where streams have been routed through underground pipes have greatly reduced the number, quality, and accessibility of main channel as well as off-channel habitats (Brown and Caldwell 2009).

Impaired upstream passage is a major limiting factor for all four watersheds. Though a fish ladder is present and was constructed improve fish access over Kellogg Dam, located just upstream of the confluence with the Willamette River, fish passage through the ladder and dam is limited to periods of high water when the Dam is overtopped (ODFW FPB online map, 2020). The Dam limits the ability of anadromous adult fish to access high quality habitat in the upstream portions of the watershed (especially in Mt. Scott Creek) except during high winter and spring flows when the Dam backwaters, and therefore is the primary limiting factor for the Kellogg Creek-Mt. Scott Creek watershed. Kellogg Lake, near the confluence of Kellogg Creek and the Willamette River, is the upstream impoundment formed by Kellogg Dam. In the summer, the Lake itself may present a water temperature issue for native salmonid species when it heats above 65°F, but likely provides adequate rearing habitat for juvenile salmonids during the winter. In addition to Kellogg Dam, the number of smaller fish passage impairments from road crossings and instream modifications combine to create a substantial limiting factor.

Willamette Tributaries

The three small tributaries that connect directly to the Willamette River – River Forest, Rinearson, and Boardman Creeks – show similarly reduced instream habitat conditions as in Kellogg-Mt. Scott, with varying degrees of access for fish.

In the Boardman, Rinearson, and River Forest Creek watersheds, primary and limiting factors identified by the Clackamas Partnership (2018) include:

- **Physical habitat quality**: degraded channel structure and complexity, including lack of large wood
- **Habitat access (impaired upstream passage)**: road crossings
- **Hydrograph/Water quantity (altered hydrology):** upslope land uses, including stormwater, flashy flows, and altered groundwater recharge

- **Physical habitat quality**: degraded channel structure and complexity, including lack of large wood
- **Physical habitat quality**: degraded floodplain connectivity and function
- **Physical habitat quality**: channelization and hardening of streambanks and channels
- **Physical habitat quality**: invasive species (riparian, terrestrial)
- **Physical habitat quality**: degraded riparian areas and large wood recruitment
- **Water quality (toxins):** urban and industrial practices, including stormwater

River Forest Creek. River Forest Creek is almost entirely inaccessible to anadromous fish, with a perched and undersized culvert connecting the downstream 0.1 km of channel through SE River Forest Rd to the Lake. Numerous road crossings upstream of the Lake are similarly unsuitable for fish passage, were access to be restored for anadromous fish upstream of the Lake. The 0.1 km that was connected to the Willamette River appeared relatively steep with little pool or low-velocity habitat areas except at the backwatered confluence. Very little cover, in the form of large wood or riparian vegetation, was present.

Boardman Creek. The confluence of Boardman Creek and the Willamette River produce a backwatered pool that with low water velocities and predominately sand and silt substrates. Very little cover, in the form of large wood or riparian vegetation, was present at the confluence. A boulder step feature that may or may not be natural, as well as natural bedrock cascade upstream from the boulders near approximately rKm 0.2, appear to limit anadromous fish passage into the majority of the Boardman Creek. Upstream of the bedrock, the slope decreases and potentially suitable spawning and rearing habitat is present for 0.15 km until the culverts under SE Walta Vista Road and SE River Road. Numerous road crossings exist in Boardman Creek upstream from SE River Road.

Rinearson Creek. Of the three Willamette tributaries, Rinearson Creek offers the greatest potential for existing anadromous fish habitat. A steep constructed riffle downstream of a beaver dam may provide access issues due to water depths <6 in during low-flow periods, but upstream of the beaver dam are pools. The steep, high-velocity riffle at the downstream-most end of Rinearson Creek is expected to only be passable by some adult salmon or trout. However, the minimal (almost no) spawning habitat observed upstream of the riffle indicates that salmonids are likely not utilizing this as a spawning or rearing (since presumably the only juveniles that would be able to access and be present upstream of the riffle are those that were hatched there). The lower 3 – 5 m of Rinearson Creek is a backwatered pool where it meets with a perennially connected side channel to the Willamette River. This side channel to the Willamette, as well as the backwatered pool, provide low velocities and sand and silt substrates. Very little cover, in the form of large wood or riparian vegetation, was present. Juvenile Coho salmon have been observed in this side channel and in the

Willamette River in the vicinity of the Rinearson Creek confluence (Todd Alsbury, Pers. Comm. 01/20/2020). This area also likely to support rearing spring Chinook.

2.3 PREVIOUS ASSESSMENTS

A number of studies have been conducted by local and state agencies documenting the habitat conditions, water quality, fish use, and other aquatic species presence in the four watersheds. In general, more information is available for the Kellogg-Mt. Scott watershed compared to River Forest, Boardman, and Rinearson. All available data were reviewed; key studies relevant to the rapid bio-assessment effort and referenced in this document include the following:

- Clackamas County, Water Environment Services. 2017. Water temperature monitoring from 2013/2014-2017 at Kellogg Creek, Phillips Creek, and Mt. Scott Creek (at highway 224). Excel spreadsheet.
- Cole, Michael B. and Haxton , Nick. 2013. 2012 Boardman and River Forest Creeks Benthic Macroinvertebrate Assessment. Prepared for Oak Lodge Sanitary District, Oak Grove Oregon by ABR, Inc.
- Falling Springs, LLC. 2018. Rinearson Natural Area Habitat Development Plan. Prepared for Rinearson Natural Area, LLC. Richmond, VA.
- Friesen, Thomas A. and Zimmerman, Mark P. 1999. Distribution of Fish and Crayfish, and Measurement of Available Habitat in Urban Streams of North Clackamas County. Final Report, 1997-1999. Oregon Department of Fish and Wildlife, Clackamas Oregon.
- Mangano, Joseph F., Piatt, David R., Jones, Krista L., and Rounds, Stewart A. 2018. Water Temperature in Tributaries, off-Channel Features, and Main Channel of the Lower Willamette River, Northwestern Oregon, Summers 2016 and 2017. Open File Report 2018-1184. Prepared by the USGS in cooperation with the Cities of Lake Oswego and Wilsonville, Meyer Memorial Trust, and Benton Soil and Water Conservation District.
- Montgomery Watson HARZA . 2001. A Watershed Assessment of Kellogg and Mount Scott Creeks, Final Report. Prepared for Clackamas County Water Environment Services.
- Neerman, Alex and Vogt, Jessica. 2009. Fish Species Distribution and Abundance and Habitat Assessment of Streams in Clackamas County Service District No 1 (CCSD No.1). Oregon Department of Fish and Wildlife North Willamette Watershed District.
- Raymond, Richard S. 2007. River Forest Lake Condition and Functional Values Evaluation. Final Report. E&S Environmental Chemistry, Inc. Submitted to Oak Lodge Sanitary District.
- Tinus, Eric A., Koloszar, James A., and Ward, David L. 2003. Abundance and Distribution of Fish in Clackamas County Urban Streams. Final Report 2002-2003. Oregon Department of Fish and Wildlife. Funded by Water Environment Services Surface Water Management Agency of Clackamas County, Clackamas County Service District No. 1, and Greenspaces Program. Clackamas Oregon.

3. Rapid Bio-Assessment Methods

3.1 FRAMEWORK

The rapid bio-assessment is based on the assumption that an ecosystem approach is required to address salmon and steelhead habitat needs. Inherent in this is an understanding of the controls and process drivers that affect aquatic habitat conditions that salmon and steelhead rely on. These controls and processes, and their relationships to fish and habitat, are displayed conceptually in Figure 6.

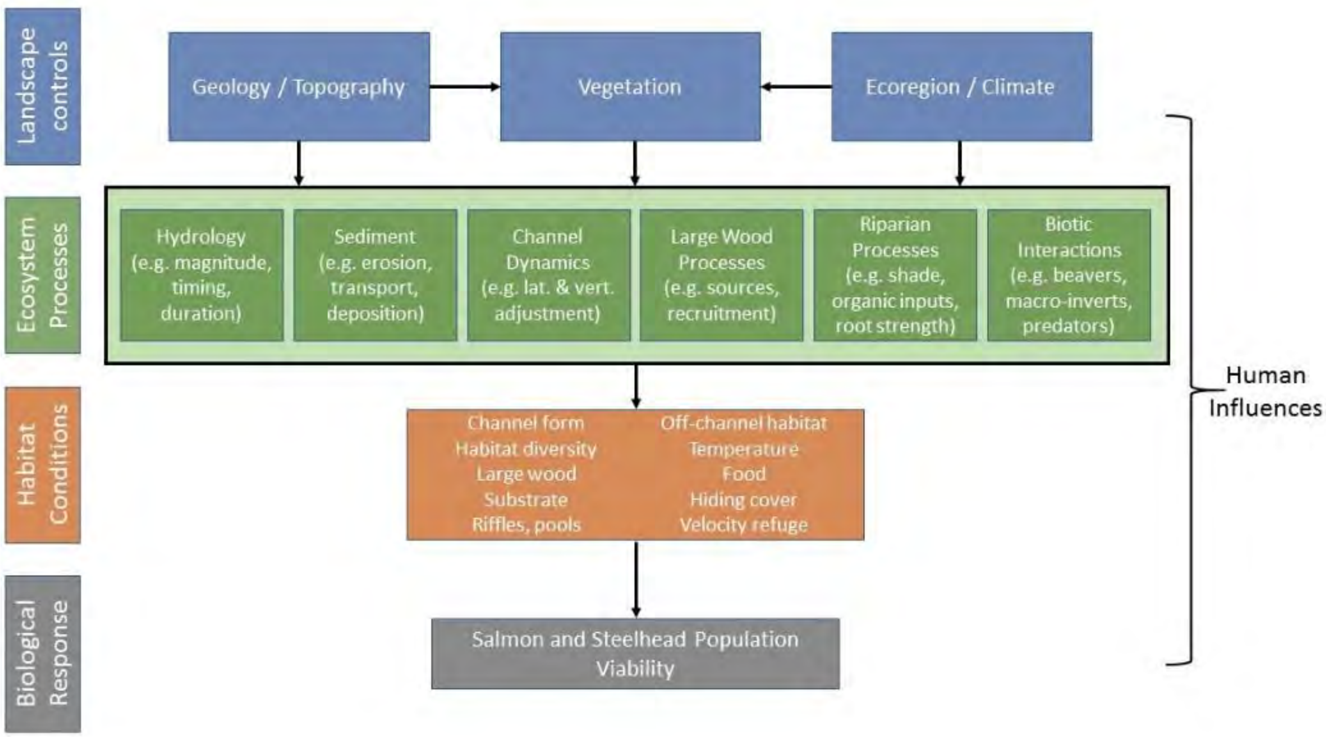


Figure 6. Linkages among landscape controls, ecosystem processes, habitat conditions, and biological response (adapted from Beechie and Bolton 1999, Beechie et al. 2010).

3.1.1 Assessment Methodology Overview

The rapid bio-assessment was completed in two steps: 1) a desktop-based review of existing reach conditions, and 2) a rapid field-based assessment of priority reaches. The desktop review analyzed relevant available studies, surveys, and remote sensing data (e.g., LiDAR and aerial photos). A primary component of this exercise was to characterize key geomorphic characteristics for each reach (e.g., slope, channel/valley form, sinuosity, and confinement) and to compare these variables to trends in habitat and fish use.

These proposed RBA reaches were determined through close coordination and input from members of the North Clackamas Watersheds Council Board and with reference to existing available information. Reach boundaries were based upon existing reach breaks used by ODFW Aquatic Inventories Project surveys (Moore et al. 2019) in Kellogg and Mt. Scott Creeks. Reach delineations in River Forest, Boardman, and Rinearson Creeks were based on office-based geomorphic assessment of slope, confinement, and confining anthropogenic features (e.g., culverts).

Prioritization efforts began with an evaluation of existing research, literature, and data relevant to basin- and reach-scale patterns and processes in the four North Clackamas watersheds. Various elements considered included previous habitat and fish survey data, the importance of the reach for fish, the potential for future restoration actions, and the level of survey accessibility to the reaches. Additional data considered, where available, was hydrologic information, geologic information, disturbance (natural, anthropogenic) regimes, water temperatures, and water quality information.

To determine priority reaches for field investigations, metrics relating to fish use or potential for fish use where no data was available, the level of field accessibility, and geomorphic characteristics were scored individually for each reach. Reaches with the highest overall scores in each watershed were selected for field surveys. More information on reach prioritization and selection of field reaches is available in the Rapid Bio-Assessment Protocol memorandum (Inter-Fluve, 2019b).

The rapid bio-assessment field protocol for the four watersheds is largely based on Oregon Department of Fish and Wildlife's Aquatic Inventories Project (AIP) stream habitat survey protocol (2019; minor modifications for this rapid bio-assessment are described in the subsequent section), which is designed to provide quantitative information on habitat conditions within wadeable streams. As part of this protocol, field assessments documented habitat unit composition (e.g., pool, riffle), riparian conditions within a fixed 30-meter buffer, and geomorphic information such as channel form or hydromodifications. During the field assessment, stream crossings or culverts were recorded and assessed within the survey reaches, to expand the understanding of overall fish passage conditions and opportunities for improvements within the four watersheds.
Informed by the field assessment data, the location of potential project opportunities were also mapped using a GPS. The project type, extent, limiting factors addressed, and access considerations were noted.

3.1.2 Modifications to AIP for the Rapid Bio-Assessment

The unique urban and suburban character of the four watersheds and the nature of the rapid bio-assessment requires minor modification to the AIP methodology.

Several modifications are related to the urban residential landscape covering a large portion of the assessment area. Additional information collected at the reach-scale included the number of outfalls (i.e., from stormwater pipes), and the approximate number of feet of bank armoring and erosion within the reach. Fish passage barriers within the reach were noted and described. At the habitat unit-scale, additional information was collected on the type of land use within the floodprone area (e.g., landscaped lawn, forested). Within the 30-meter riparian area, the approximate percentage of impervious surfaces and types of invasive vegetation species observed was also recorded.

Modifications to the AIP protocol to meet the rapid nature of the bio-assessment additionally prioritized collecting information on pool habitat conditions. All units, including ‘fast water’ and ‘step’ unit types, were enumerated and unit break locations recorded. However, in fast water units, only the average water depth was recorded. Locations where high-quality spawning habitat is present, as determined by professional judgement, were recorded in each reach with a GPS waypoint, photos, and narrative description of the habitat conditions. Side channels, tributary inputs, and seeps/springs were also recorded.

Pool information recorded was similar to that in the AIP protocol, and included max pool depth, pool tail out depth, and pool width and length. Additional information recorded in the rapid bio-assessment includes the approximate percentage of cover over the surface area of the pool, from riparian vegetation, overhanging banks, large wood, etc. Each pool was given a pool complexity rank from 1 (low) – 5 (high). Factors influencing pool complexity included presence of large wood or varied substrate (i.e., boulders) under the water surface and cover above the water surface from vegetation or banks. An ocular estimate of the dominant substrate type within the pool was recorded.

Large wood information was collected using the same size class requirements as the AIP, but was summarized at the reach scale, rather than at the habitat unit scale. Slight simplifications were made to the large wood length categories. Substrate observations in non-pool habitat units were also spaced throughout the reaches. Other modifications, which did not change the type of data collected but rather the method of data collection, included using a GPS to mark and delineate habitat unit break instead of measuring length in the field using a tape. More detailed information about the methods utilized during the RBA are provided in the Protocol (Inter-Fluve, 2019b).

3.1.3 ODFW Benchmarks

Results of the habitat assessments can be evaluated against habitat benchmarks (targets) for desirable instream habitat conditions for salmon and trout species. Benchmarks provide a method for comparing values of key features that are important to quality salmonid habitat. Benchmarks used for this effort were developed by ODFW and are intended to identify specific habitat conditions preferred by native salmon and trout fish species. Though the value of a habitat feature depends to some degree on the natural regime of the stream and the fish species of interest, it can be useful to provide some general guidelines to compare different systems to each other. The components and values in Table 1 provide a starting point for comparing the distribution of habitat features within a watershed and their importance to fish.

It is worth noting that while values for habitat features are listed as desirable or undesirable in Table 1, the values must be viewed on a sliding scale and the natural context of the stream and watershed must be considered (Foster, 2001). For example, the amount of large woody material that would be expected under historical/natural conditions will be very different for a stream in the Cascade Mountains than for a stream in the high desert of Southeast Oregon.

Reaches were evaluated against these ODFW Habitat Benchmarks, and a summary of all reach ratings are provided in Table 2. Reaches with conditions meeting neither the Undesirable or Desirable categories were classified as Neutral. No data was collected in River Forest Creek to support evaluation against habitat benchmarks, and therefore is not included in Table 2.

Table 1. Table of ODFW habitat benchmarks that are applicable to the four watersheds Rapid Bio-Assessment. Modified from ODFW

Habitat Parameter	Undesirable	Desirable
POOL AREA (% Total Stream Area)	<10	>35
RESIDUAL POOL DEPTH (m) SMALL STREAMS (<7m width)	<0.2	>0.5
RESIDUAL POOL DEPTH (m) MEDIUM STREAMS (≥ 7m and < 15m width), LOW GRADIENT (<3%)	<0.3	>0.6
Non-Pool Substrate: GRAVEL (% AREA)	<15	>35
SILT-SAND-ORGANICS (% AREA) VOLCANIC PARENT MATERIAL	>15	<8
SILT-SAND-ORGANICS (% AREA) CHANNEL GRADIENT <1.5%	>25	<12
SHADE (Reach Average, Percent), STREAM WIDTH <12 m, WEST SIDE	<60	>70
PIECES / 100 m STREAM LENGTH	<10	>20
'KEY' PIECES (>60cm dia. & ≥10m long)/100m	<1	>3

Reaches with the most Undesirable conditions observed were Rinearson Creek (with a total of six Undesirable ratings) and Boardman Creek (with a total of five Undesirable ratings). Mt Scott Creek reaches 3 and 5 received the highest number of Desirable ratings (three). Mt Scott Creek reach 3 and Kellogg Creek had the lowest number of Undesirable ratings. All reaches were rated Undesirable in the stream shade, pieces of LW, and key pieces of LW categories.

Table 2. Summary of ODFW reach benchmark ratings for each reach.

Habitat Parameter	Kellogg Reach 1	MSC Reach 3	MSC Reach 5	Boardman Reach 1	Rinearson Reach 1
POOL AREA (% Total Stream Area)	70%	52%	65%	19%	88%
	Desirable	Desirable	Desirable	Neutral	Desirable
RESIDUAL POOL DEPTH (m) SMALL STREAMS	0.26	0.42	0.67	0.21	0.7
	Neutral	Neutral	Desirable	Neutral	Desirable
Non-Pool Substrate: GRAVEL (% AREA)	29.6%	50%	39%	10%	5%
	Neutral	Desirable	Desirable	Undesirable	Undesirable
SILT-SAND-ORGANICS (% AREA) VOLCANIC PARENT MATERIAL	15.5%	10%	21%	5%	100%
	Neutral	Neutral	Undesirable	Desirable	Undesirable
SILT-SAND-ORGANICS (% AREA) CHANNEL GRADIENT <1.5%	15.5%	10%	21%	5%	100%
	Neutral	Desirable	Neutral	Desirable	Undesirable
SHADE, WEST SIDE	50.8%	56.7%	46%	52.5%	15%
	Undesirable	Undesirable	Undesirable	Undesirable	Undesirable
PIECES / 100 m STREAM LENGTH	0.9	2.7	3.8	2.4	1.5
	Undesirable	Undesirable	Undesirable	Undesirable	Undesirable
'KEY' PIECES / 100m STREAM LENGTH	0.1	0.7	0.2	0	0
	Undesirable	Undesirable	Undesirable	Undesirable	Undesirable

4. Rapid Bio-Assessment Results

4.1 KELLOGG CREEK REACH 1

4.1.1 Overall Reach Conditions

Reach 1 of Kellogg Creek is 2.25 kilometers (km) in length, but the surveyed length of Reach 1 consisted of the upstream most 900 meters of channel starting at river kilometer (rKm) 2.77 and ending at the confluence with Mt Scott Creek near rKm 3.65 (covering approximately 40% of the total reach length). Survey in Kellogg Creek Reach 1 was conducted on December 18, 2019. General land use within the reach is Rural Residential, with houses and managed lawns present at the top of bank throughout nearly all of the reach. Flooding was noted as common during a conversation with a landowner in the reach.

The gradient of the channel in this reach is less than 1%. The floodplain and channel banks are substantially armored, with an estimated 75% (or approximately 600 feet of the channel banks with at least some form of armoring). Minor bank erosion where bank armoring was not present was noted, approximately 100 meters in total, throughout the surveyed reach. The floodplain and channel banks consist of residential land uses, with a valley form identified during the survey as predominately constrained by terraces (CT).

Stream flows during the survey were low, with gage measurements at the Clackamas County WES stream gage at Wilbur Rowe Middle School recorded as 3.9 feet. Two stormwater (presumed) outfalls and several small yard or stormwater drains were observed within the surveyed reach. Three bridges were observed crossing Kellogg Creek in this reach. One unnamed tributary enters Kellogg Creek in the reach near rKm 2.89. One location in the reach was identified as a potentially suitable spawning area near rKm 2.91.

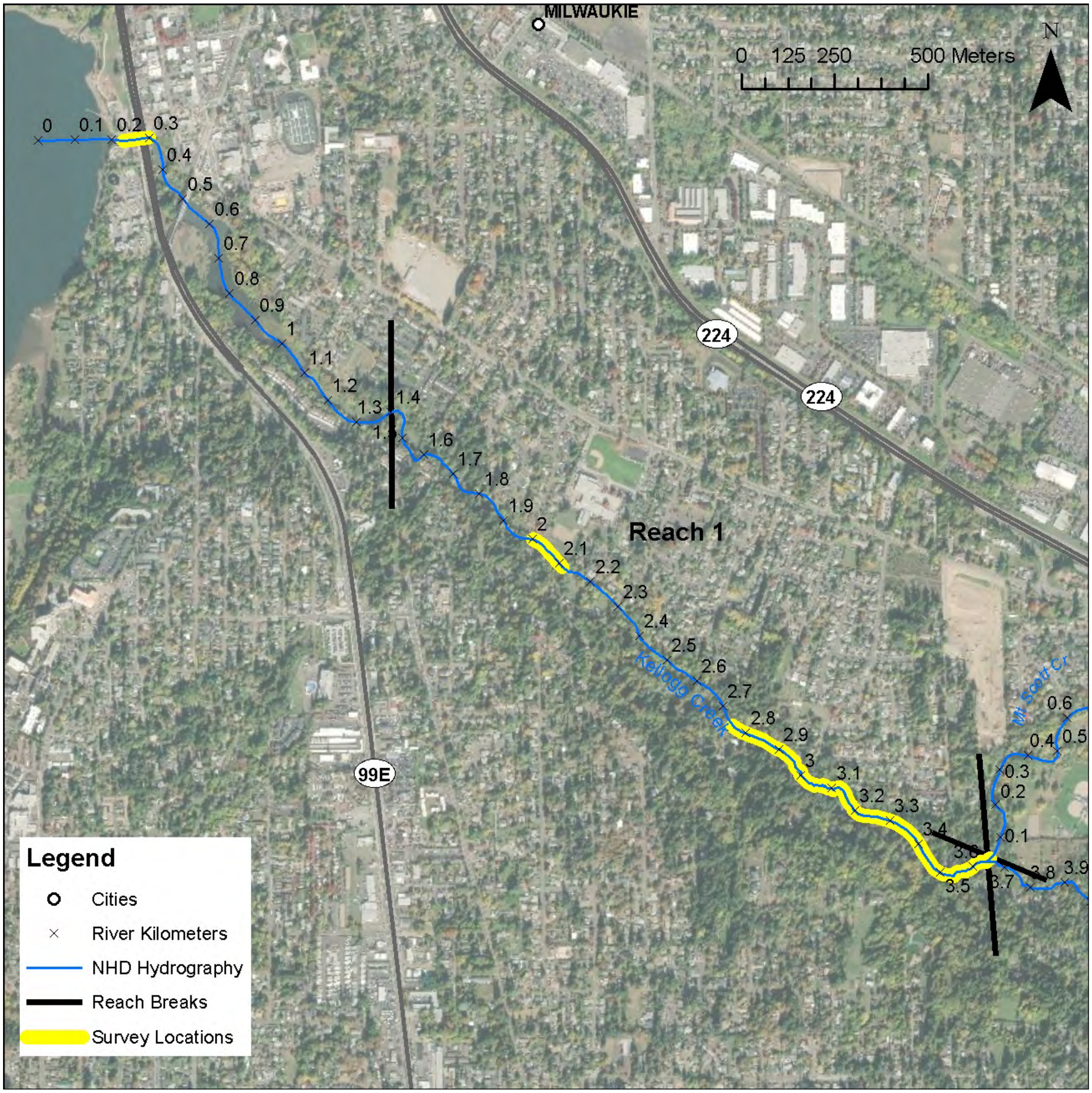


Figure 7. Map showing Kellogg Creek Reach 1 and the portions of the reach visited during the field investigation.

Large woody material was observed in the reach and tallied according to length and diameter of the piece. Large wood was tallied at the reach scale rather than habitat unit scale due to the rapid nature of the Bio-Assessment. Suitable amounts of large wood, and especially key pieces of large wood, is notably lacking from this reach. Six pieces of large wood were recorded in the reach, with most of the wood recorded in the smallest four categories and only a single piece recorded in the DBH > 95 cm category. No jams were observed in the surveyed portion of Kellogg Creek Reach 1.

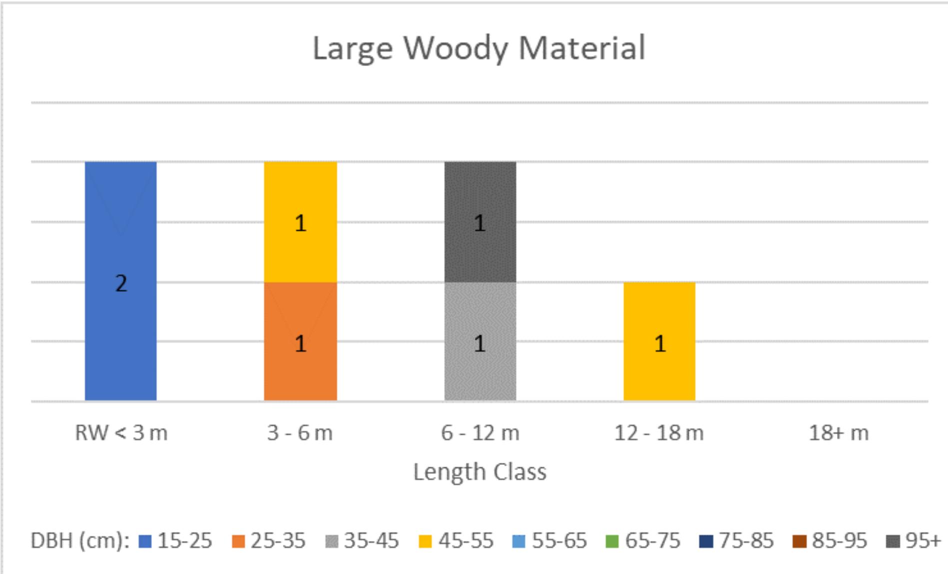


Figure 8. Large woody material by DBH and length classes observed in the surveyed portion of Kellogg Creek Reach 1. The 'RW > 3m' category is for any piece of large wood that had a rootwad and was greater than 3 meters in length.

4.1.2 Habitat Unit Composition

Reach 1 habitat primarily consists of pool habitats (70%, n = 17), while 27% of habitat area was recorded as glides (n = 7). Only 2.9% of the habitat area in Reach 1 were riffles (n = 2) (Table 3; Figure 9). No side channel habitat was observed in the surveyed portion of Kellogg Creek Reach 1. The channel is confined by residential land use, bank armoring, bridges, and, at the upstream end, Keuhn Rd to a minor degree.

Table 3. Amount of habitat type observed during rapid bio-assessment field investigation in Kellogg Creek reach 1 (surveyed portion of reach is from rKm 2.77 - 3.65).

Habitat Unit Type	Percent of Reach Bankfull Habitat
GLIDE	27.2%
POOL	69.9%
RIFFLE	2.9%

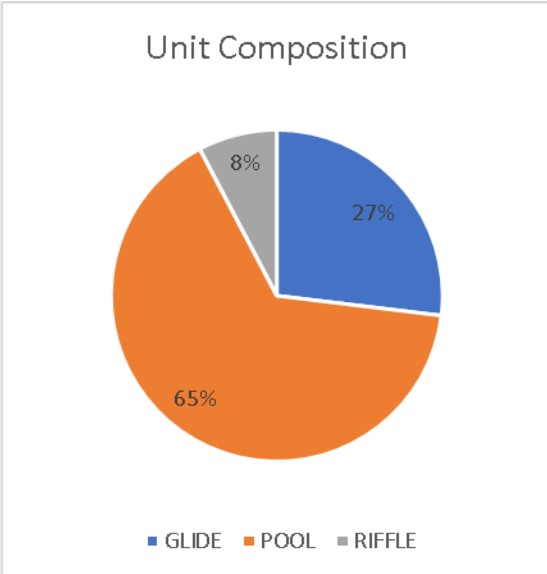


Figure 9. Percent of units recorded in each habitat unit type in Kellogg Creek reach 1 (surveyed portion of reach is from rKm 2.77 - 3.65).

Pools

Pool was the most common habitat type recorded in Kellogg Creek Reach 1 with 70% of the habitat unit area identified as pools. A total of 17 pools (26 total units) were recorded in the reach. The average maximum pool depth was 0.47 meters with a max of 0.88 meters and minimum of 0.18 meters (Figure 10). Mean pool spacing in Kellogg Creek Reach 1 was 3.7 channel widths per pool, compared to an average of 7.4 channel widths per pool for the entire study area. Residual pool depth, defined as the different in bed elevation between the deepest part of a pool and the downstream riffle crest, averaged 0.26 meters (Figure 10). Of the 17 pools identified, only one pool maintained a residual depth of greater than 0.5 meters, six pools maintained residual depths less than 0.2 meters and 10 pools had residual depths between 0.2 and 0.5 meters.

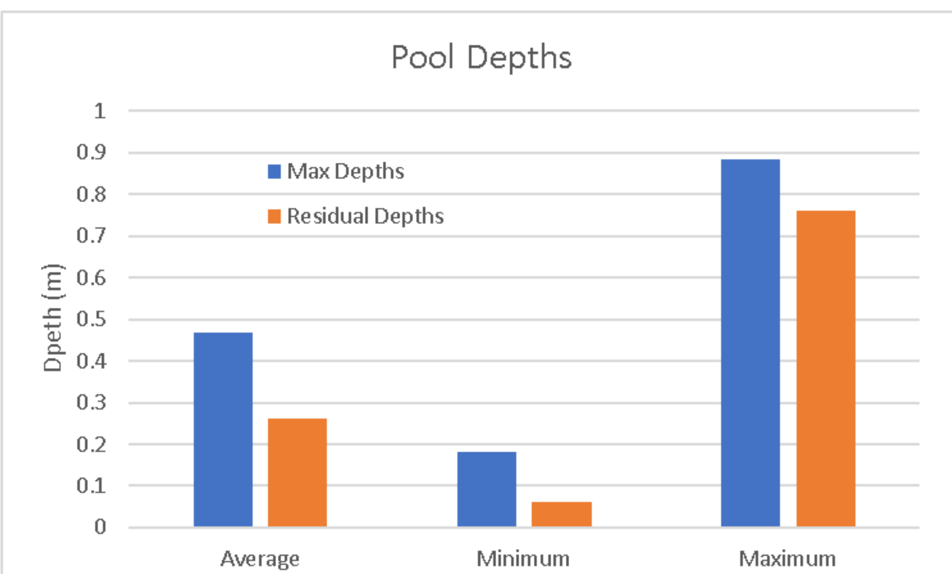


Figure 10. Recorded pool maximum depths and residual depths in Kellogg Creek reach 1.

Pool quality for salmonid habitat was generally low, with an average pool complexity rank of 1.1 (scores may range from 1 to 5). Only one pool received a score of 2, and no pools were ranked higher than 2. Pool cover was low, with an average of only 4.5% cover for the reach and a maximum of only 15% cover in two of the 17 pools.

Figure 11. Pool unit that received the highest complexity rating within the surveyed portion of Kellogg Creek reach 1 (looking upstream). Note presence of minor large wood on river right bank.

Table 4. Number of pool units with residual depths meeting ODFW's habitat benchmarks for Desirable (residual depth > 0.5 m), Undesirable (residual depth < 0.2 m), or in between (residual depth is between 0.2 m and 0.5 m).

Pool residual depths	
Undesirable	6
Neutral	10
Desirable	1

Geomorphic Conditions

Channel form in the reach is predominately in the Broad Valley Floor type (in which the valley width is at least 2.5x greater than the bankfull channel width), either observed during the field survey as constrained by the terrace (CT; n = 10 units) or an Unconstrained predominately single-channel (US; n = 11). Other channel form types were less common: channel constrained by hillslope (CH; n = 3), channel constrained by landscape (CL; n = 1), and unconstrained braided channel (UB; n = 1) (Figure 12).

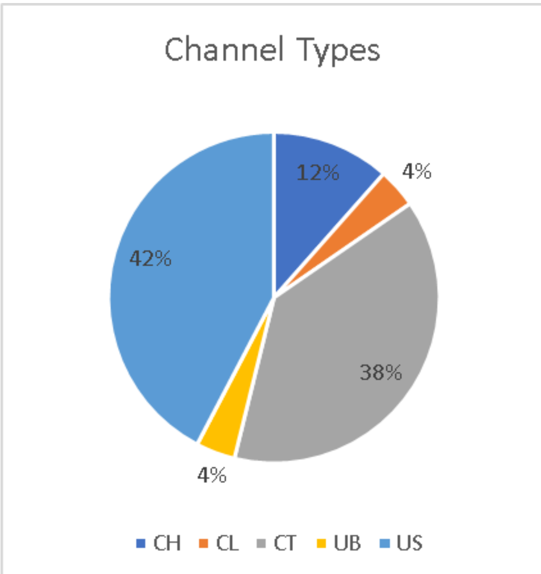


Figure 12. Channel form types within the surveyed portion of Kellogg Creek reach 1.

Bankfull widths (also called active channel widths) in Kellogg Creek Reach 1 were smallest for riffle units, with an average of 6.4 meters (maximum 7.3 m and minimum 5.5 m). Glide and pool units were similar in bankfull widths, with both averaging 8.4 m widths and maintaining a minimum of 6.4 m. Pool maximum bankfull widths were slightly larger (11.6 m) than glides (10.4) (Table 5). Bankfull depths averaged 0.97 m for all units combined, with a minimum recorded bankfull depth of 0.76 and a maximum of 1.5 m. Riffles had a slightly lower average bankfull depth (0.85 m) than either pools (0.99 m) or glides (0.98 m) (Table 6).

Table 5. Bankfull widths summarized by habitat type within the surveyed portion of Kellogg Creek reach 1.

Bankfull Widths	GLIDE	POOL	RIFFLE
Average (m)	8.4	8.4	6.4
Min (m)	6.4	6.4	5.5
Max (m)	10.4	11.6	7.3

Table 6. Bankfull depths summarized by habitat type within the surveyed portion of Kellogg Creek reach 1.

Bankfull Depths	GLIDE	POOL	RIFFLE
Average (m)	0.98	0.99	0.85
Min (m)	0.76	0.80	0.80
Max (m)	1.22	0.76	0.91

Average floodprone widths were similarly smallest for riffle units, with an average of 21.3 meters. Pool and glide units averaged 38.0 and 38.3 meters in floodprone widths, respectively. The smallest floodprone widths were 15.2 meters (recorded in both pool and riffle units) while the largest floodprone width of 61 m was also recorded in a pool unit (Table 7). The average entrenchment ratio for the reach (calculated as floodprone width divided by bankfull width) is 4.1.

Table 7. Floodprone widths summarized by habitat type within the surveyed portion of Kellogg Creek reach 1.

Floodprone widths	GLIDE	POOL	RIFFLE
Average (m)	38.3	38.0	21.3
Minimum (m)	27.4	15.2	15.2
Maximum (m)	54.9	61.0	27.4

Riparian conditions

The average canopy closure, or amount of shade the channel receives from riparian canopy cover, for Kellogg Creek Reach 1 was 50.8%. Units dominated by conifer vegetation types had slightly more canopy cover (54.5%) than those units dominated by deciduous vegetation types (48.6%) (Table 8). Coniferous and deciduous vegetation types were fairly evenly distributed in the reach, with 11 units recording a dominant conifer canopy and 14 units recording a dominant deciduous canopy. One unit was recorded as an open, or no vegetation, for the dominant canopy. Among the habitat units, glides maintained the highest average canopy closure (51.4%), pools maintained on average a 50.5% canopy closure, and riffles maintained the lowest average canopy closure at 50% (Figure 13). Canopy age was primarily large trees, with an average DBH between 30 – 50 cm. Though the floodprone area was largely yards and maintained lawns with tree canopy, very little impervious surfaces were recorded within the 30-m riparian zone. Invasive species, including Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), and bamboo (*Bambusoideae spp.*), were present in all units' riparian zones.

Table 8. The average canopy closure recorded in units, summarized by canopy types, within the surveyed portion of Kellogg Creek reach 1.

Dominant Canopy Type	Average Canopy Closure
Conifer	54.5 %
Deciduous	48.6 %
All	50.8 %

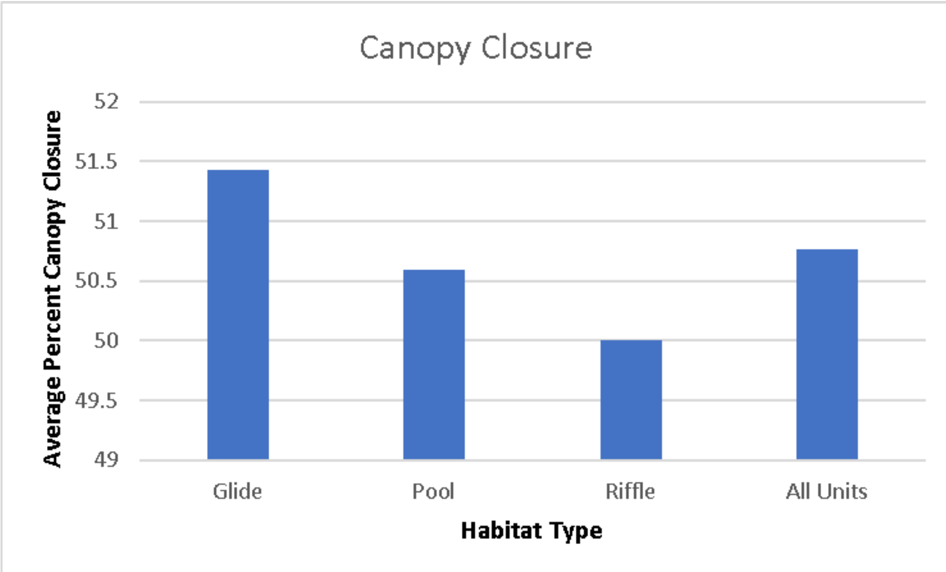


Figure 13. Average canopy closure by habitat unit type in Kellogg Creek reach 1.

Substrate

Ocular estimates of the dominant substrate size class were recorded in all pool units, while ocular estimates of substrate composition were recorded in five representative non-pool units. Non-pool unit substrates primarily consisted of cobble and gravels. Very few fine sediments, such as sand or silt/organic material, were present in non-pool unit substrates (Figure 14). Dominant substrates in pool units were primarily cobbles (n = 12) while gravel pool substrates were only present in four units. An equal mix of gravels/cobbles was present in two pool unit substrates (Figure 15).

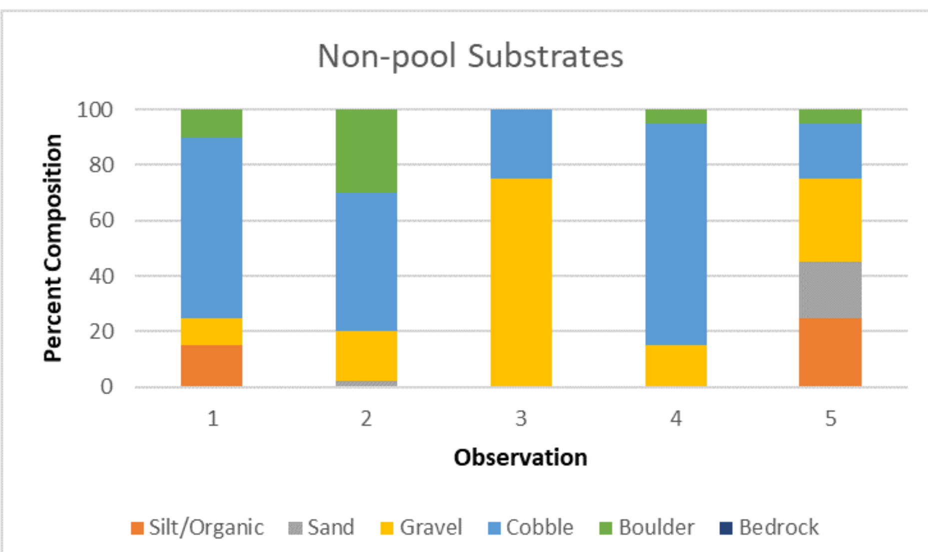


Figure 14. Composition of ocular substrate estimates conducted in non-pool habitat units (e.g., riffle or glide units) within the surveyed portion of Kellogg Creek reach 1.

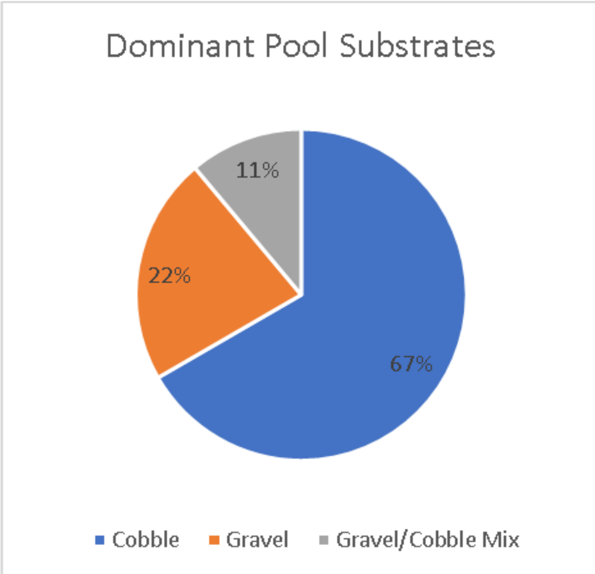


Figure 15. Dominant pool unit substrates recorded within the surveyed portion of Kellogg Creek reach 1.

4.1.3 Channel Infrastructure and Road Crossings

Three bridges cross over Kellogg Creek in the surveyed portion of Reach 1. A bridge appearing to be for pedestrian use only crosses the channel near approximately rKm 2.91 (Figure 16). A driveway bridge provides landowner access to a house near rKm 3.11 (Figure 17), and Keuhn Road crosses the channel near approximately rKm 3.55 (Figure 18). A stormwater outfall (No. 45014) is located on the river right bank near rKm 3.06 (Figure 19, Figure 20) and appears to create a deep scour pool from the flow. Anecdotal information from a landowner received during the field survey indicates fish may use this scour pool as a holding area during migration or prior to/after spawning just downstream.

Stormwater infrastructure was also noted just upstream of the Keuhn Road crossing. At this location, a manhole is present at the edge of the river right channel and a pipe outlet was noted in the middle of the wetted channel (Figure 19). It is unclear the purpose of this pipe outfall. Large angular rock, riprap, appears to have been placed in the channel in this location, likely to protect the pipe infrastructure that may run across the channel. This riprap/pipe is noted as a barrier by ODFW (Barrier No. 34026).

Figure 16. A bridge appearing to be for pedestrian use only crosses the Kellogg Creek channel near approximately rKm 2.91.

Figure 17. A driveway bridge provides landowner access to a house near rKm 3.11.

Figure 18. Keuhn Road bridge crosses the channel near approximately rKm 3.55.

Figure 19. Large angular rock located in the Kellogg Creek channel at rKm 3.55, just upstream of the Keuhn Rd bridge.

Figure 20. Stormwater outfall (No. 45014) located on the river right bank of Kellogg Creek near rKm 3.06.

4.1.4 Summary

Kellogg Creek is highly modified from natural conditions, with a constrained channel and floodplain and minimal complex habitat features that provide fish habitat. Channel banks are armored throughout a majority of the reach, particularly in the lower third. The material armoring the banks is larger, placed stone, river cobbles, or concrete. Bank armoring is varied in age – some locations appear to be recent while others were older. Residential land uses, including homes, outbuildings, and managed landscapes, are present at the top of banks and extend up to edge of the wetted channel in most locations. Large wood is infrequent in the reach and is distributed throughout the surveyed area. Substrate in the channel is variable, though frequently large cobbles with pockets of very fine sand and silt material. Only a single location of generally suitable spawning habitat was noted in the surveyed portion of the reach, adjacent to a small tributary or draw that is coming into the channel. Present throughout the reach are eroding banks with minimal riparian vegetation that would provide bank stability or riparian canopy cover and shading and contribute to large wood and habitat complexity in the channel.

Previous habitat surveys in this reach of Kellogg Creek were conducted in 1997-1998, 2003, and 2008 (Friesen and Zimmerman, 1999; Tinus et al., 2003; Neerman and Vogt, 2009). Glide habitat dominated the reach in 1997-8 with approximately 80% of the surface area and fast water habitat in the remainder, or approximately 20% of the surface area. Surveys of this reach in 2008 indicated nearly half of the reach was a fast water unit (45%), with pools consisting of 25% of the reach habitat area. In 2019, surveys of Kellogg Creek show relatively consistent channel and valley characteristics throughout the surveyed portion of the reach, with the primary habitat units being long, often shallow, pool units (70%). These pool units appear to largely be formed by beaver dams or artificially-created rock weirs (consisting of cobbles and boulders presumably created by landowners). The classification of habitat units as glides or pools by the survey crew may account for the difference in habitat composition over time, as it is unlikely to have changed all that dramatically in the past 20 years.

Figure 21. Example of small, man-made rock weirs within the Kellogg Creek channel in Reach 1. There are numerous of these present throughout the study area (and likely downstream of surveyed portion of reach as well).

4.2 MT. SCOTT CREEK – REACH 3

4.2.1 Overall Reach Conditions

Reach 3 of Mt Scott Creek (MSC) is 1.5 river kilometers (rKm) in length, beginning at rKm 2.2 and ending at rKm 3.7. The field survey in MSC Reach 3 was conducted on December 18, 2019 and covered the entire reach. General land use within the reach is classified as Greenway, with the Reach entirely contained within the Three Creeks Natural Area. Industrial land use is present surrounding the Three Creeks Natural Area. A water control feature is located within the Three Creeks Natural Area and at the downstream extent of the reach. Previous work has been done on portions of this reach to restore functional channel form and riparian conditions.

Stream flows during the survey were low, approximately 5 cubic feet per second (cfs). The gradient of the channel in this reach is generally less than 1%. The floodplain and channel banks are relatively natural, with limited bank armoring recorded during the survey. The floodplain and channel banks consist of natural vegetative land uses, with a broad valley floor form identified during the survey as predominately constrained by terraces or constrained by alternating/multiple terraces. No stormwater outfall infrastructure was observed within the surveyed reach, though stormwater inputs are known to be present in the reach. One single lane bridge not used by vehicle traffic crosses MSC in this reach.

Three locations in the reach were identified as potentially suitable spawning areas, near rKm 2.61, rKm 3.4, and rKm 3.54. A significant portion of suitable spawning substrate appears to be originating from Phillips Creek with the best spawning habitat noted directly below the confluence of Phillips and Mt. Scott creeks. An ODFW survey sign is located at the upstream end of reach 3 indicating the end of a spawning survey reach. No spawning fish have been documented in this reach since surveys began in 2009.

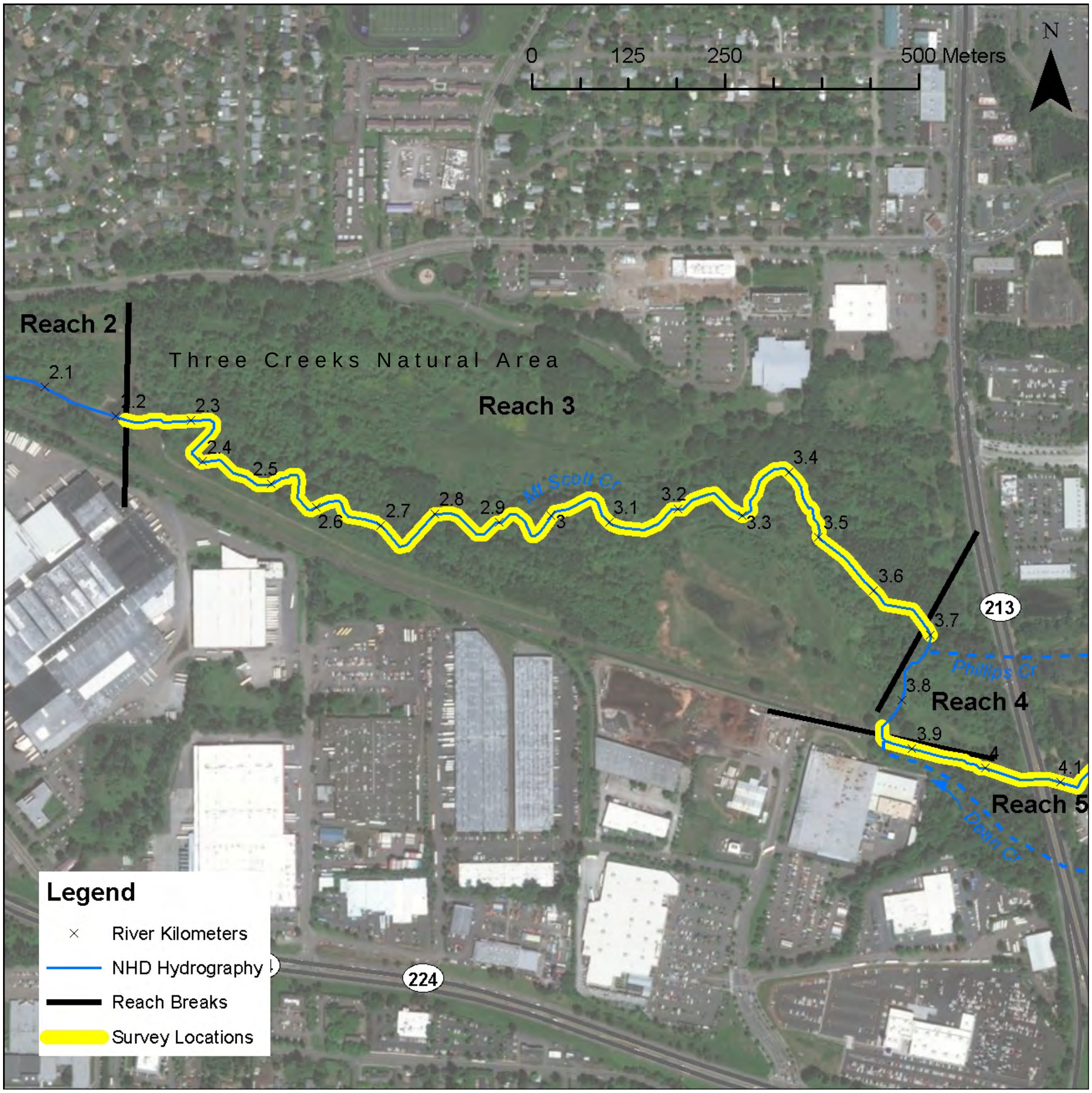


Figure 22. Map showing Mt. Scott Creek Reach 3 and the portions of the reach visited during the field investigation.

Large woody material was observed in the reach and tallied according to length and diameter of the piece. Large wood was tallied at the reach scale rather than habitat unit scale due to the rapid nature of the Bio-Assessment. Pieces of large wood, and especially key pieces of large wood, is relatively low in this reach. A total of 22 individual pieces of large wood were recorded in the reach, with most of the wood recorded in the smallest four categories and only three pieces recorded in the DBH > 65 cm categories (and all three pieces were in the shortest length category of 3 – 6 m) (Figure 23). Four jams (a collection of five or more qualifying pieces of large wood) were noted in this reach, and while the number of pieces per jam were not recorded, a minimum of 20 additional pieces of large wood should be considered for this reach, bringing the total to 42.

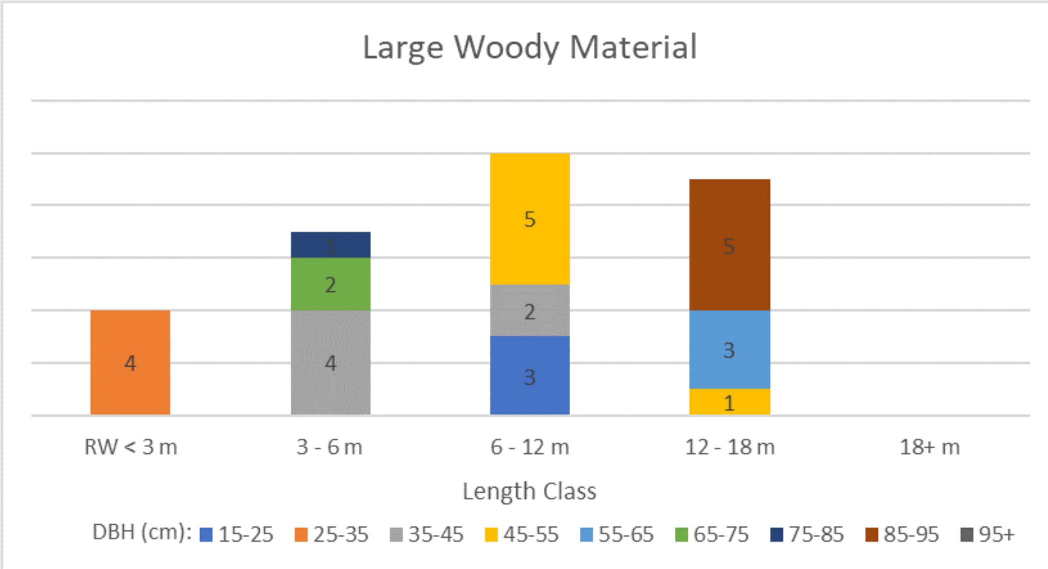


Figure 23. Large woody material by DBH and length classes observed in MSC Reach 3.

4.2.2 Habitat Unit Composition

MSC Reach 3 habitat primarily consists of pool habitats (52%, n = 16), while 29% of habitat area was recorded as riffles (n = 9). Glides consisted of 16% (n = 5) of the total bankfull habitat area. Approximately 3% of the habitat area was alcove (n = 1) (Figure 24). No side channel habitat was observed in MSC Reach 3.

Table 9. Amount of habitat type observed during rapid bio-assessment field investigation of MSC Reach 3.

Unit Class	Percentage of Habitat
ALCOVE	3%
GLIDE	16%
POOL	52%
RIFFLE	29%

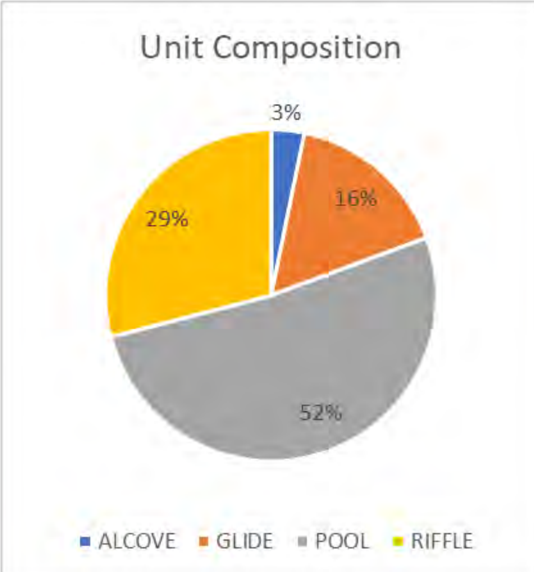


Figure 24. Number of units recorded in each habitat unit type in MSC Reach 3.

Pools

Pool was the most common habitat type recorded in MSC Reach 3 with 52% of the habitat unit area identified as pools. A total of 16 pools (out of 31 total units) were recorded in the reach. The average maximum pool depth was 0.66 meters with a max of 0.91 meters and minimum of 0.34 meters (Figure 25). Mean pool spacing in the reach was 6.9 channel widths per pool, compared to an average of 7.4 channel widths per pool for the entire study area. Residual pool depth averaged 0.42 meters. Of the 17 pools identified, six pools maintained a residual depth of greater than 0.5 meters, seven pools maintained residual depths between 0.2 and 0.5 meters, and only two pools maintained residual depths less than 0.2 meters (Table 10).

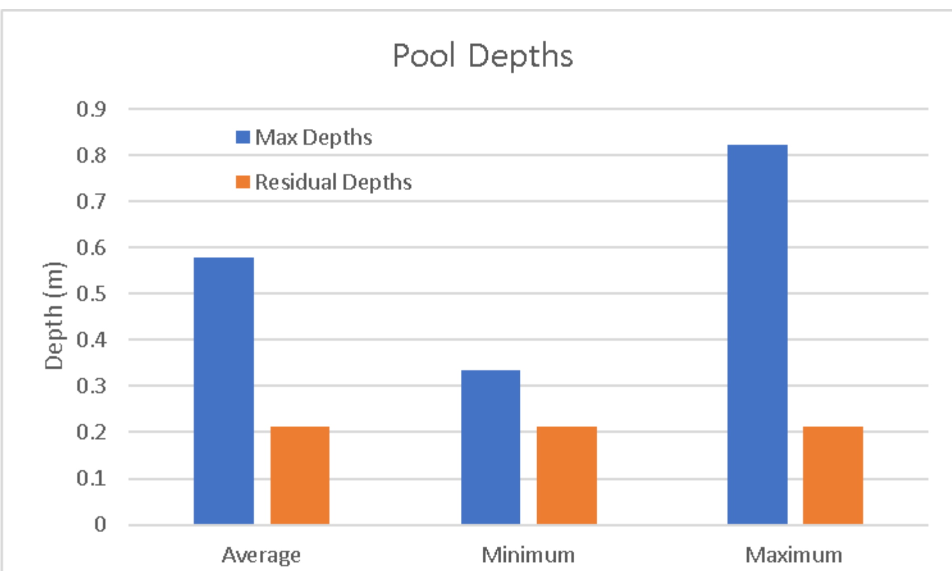


Figure 25. Recorded pool maximum depths and residual depths in Mt Scott Creek reach 3.

Pool quality for salmonid habitat was generally low, with an average pool complexity rank of 1.3, while the overall average pool complexity rank among all streams surveyed was 1.4. Only four pools received a score of 2, and no pools were ranked higher than 2. Pool cover was low, with an average of only 15% cover for the reach and a maximum of 40% cover in one of the pools.

Table 10. Number of pool units with residual depths meeting ODFW's habitat benchmarks for Desirable (residual depth > 0.5 m), Undesirable (residual depth < 0.2 m), or in between (residual depth is between 0.2 m and 0.5 m).

Pool residual depths	
Undesirable	2
Neutral	7
Desirable	6

Geomorphic Conditions

Channel form in the reach is predominately in the Broad Valley Floor type (in which the valley width is at least 2.5x greater than the bankfull channel width), either observed during the field survey as unconstrained predominately single-channel (US; n = 19 units) or constrained by the terrace (CT; n = 10 units) (Figure 26).

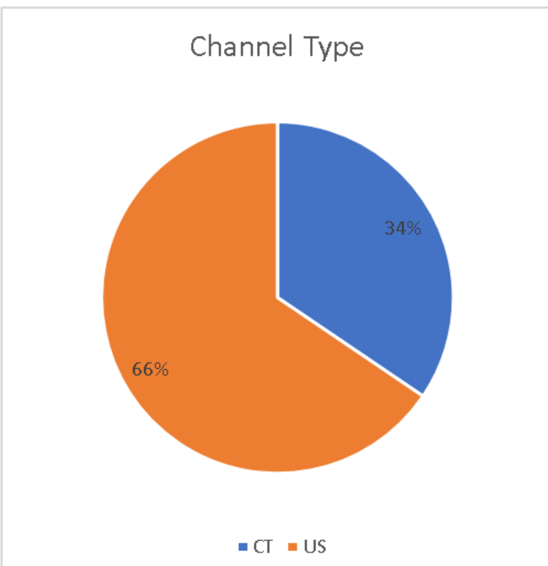


Figure 26. Channel form types within MSC Reach 3.

Bankfull widths (also called active channel widths) in MSC Reach 3 were relatively consistent among the different unit types. Average bankfull widths were smallest for pool units, with a mean of 5.3 meters (maximum 6.7 m and minimum 3.7 m). Glide and riffle units were similar in bankfull widths, averaging 5.9 m and 5.6 m widths respectively and maintaining minimums of 3.1 m and maximums of 7.9 m (Table 11). Bankfull depths averaged 1.2 m for all units combined, with a minimum recorded bankfull depth of 0.9 m and a maximum of 1.6 m. Riffles had a slightly lower average bankfull depth (1.2 m) than either pools (1.3 m) or glides (1.4 m) (Table 12).

Table 11. Bankfull widths summarized by habitat type within MSC Reach 3.

Bankfull Widths	Glide	Pool	Riffle	All
Average (m)	5.9	5.3	5.6	5.4
Minimum (m)	3.1	3.7	3.1	3.1
Maximum (m)	7.9	6.7	7.9	7.9

Table 12. Bankfull depths summarized by habitat type within MCS Reach 3.

Bankfull Depths	Glide	Pool	Riffle	All
Average (m)	1.4	1.3	1.2	1.2
Minimum (m)	1.2	0.9	0.9	0.9
Maximum (m)	1.6	1.8	1.6	1.6

Average floodprone widths were also very similar among the unit types, with an average of 61.0 m for both riffles and glides and an average of 61.3 m for pools. The smallest floodprone width was 36.6 meters (recorded in pool unit) while the largest floodprone width of 91.4 m was also recorded in a pool unit (Table 13). The average entrenchment ratio for this reach was 11.3.

Table 13. Floodprone widths summarized by habitat type within MSC Reach 3.

Floodprone Widths	Glide	Pool	Riffle	All
Average (m)	61.0	61.3	61.0	61.2
Minimum (m)	61.0	36.6	61.0	36.6
Maximum (m)	61.0	91.4	61.0	91.4

Riparian conditions

The average canopy closure, or amount of shade the channel receives from riparian canopy cover, for MSC Reach 3 was 56.7%. A majority of the units were dominated by deciduous vegetation types (n = 19), while mixed coniferous and deciduous canopy was recorded in 8 units and only a single unit was recorded as predominately coniferous canopy vegetation. Average canopy closure for mixed coniferous and deciduous vegetation was 48.3%, while average deciduous canopy closure was 60% (Figure 27). One unit did not specify the dominant canopy vegetation type.

Among the habitat units, pools maintained the highest average canopy closure (58.1%), riffles maintained on average a 57.1% canopy closure, and glides maintained an average canopy closure of 53.3% (Table 14). One alcove was recorded with 40% canopy closure. Canopy age was primarily large trees, with an average DBH between 30 – 50 cm. Given the floodprone area was natural park greenway consisting of vegetated trees, very little impervious surfaces were recorded within the 30-m riparian zone. Invasive species, including Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), garlic mustard (*Alliaria petiolata*) and holly (*Ilex spp.*), were present in all units' riparian zones.

Table 14. The average canopy closure, summarized by canopy vegetation types, within MSC Reach 3.

Vegetation Type	Average Canopy Closure
Coniferous	60 %
Deciduous	60 %
Mixed Conf/Dec	48.3 %
All	56.7 %

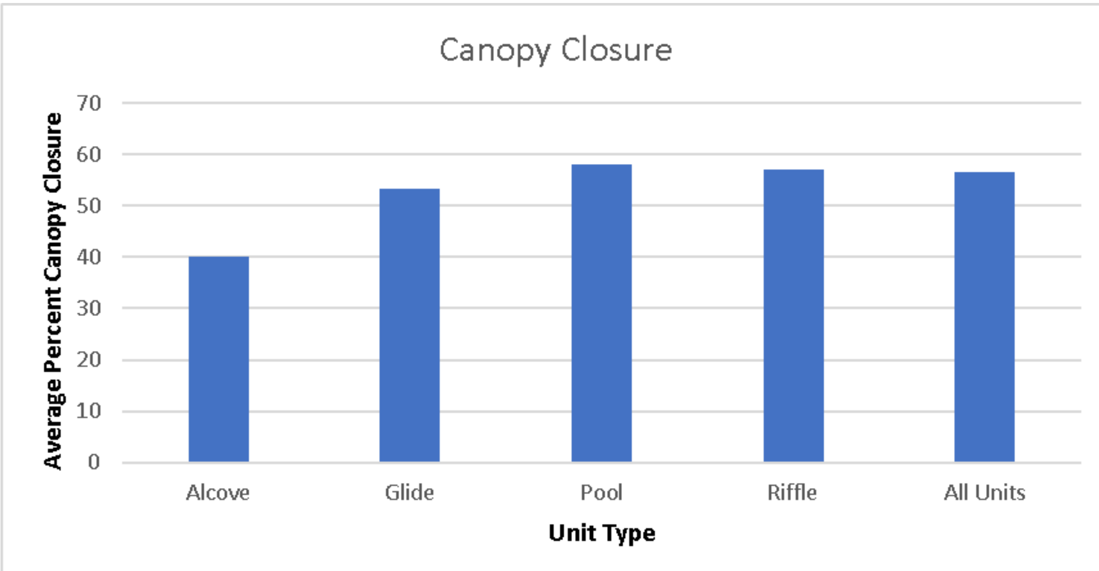


Figure 27. Average canopy closure by habitat unit type in Mt Scott Creek reach 3.

Substrate

Ocular estimates of the dominant substrate size class were recorded in all pool units, while ocular estimates of substrate composition were recorded in five representative non-pool units. Non-pool unit substrates primarily consisted of gravels. Fine sediments, such as sand or silt/organic material, were present in all of the non-pool unit substrates (Figure 28). Dominant substrates in pool units were primarily cobbles (n = 12) while gravel pool substrates were only present in a single unit. Sand was the dominant substrate in three of the pools (Figure 29).

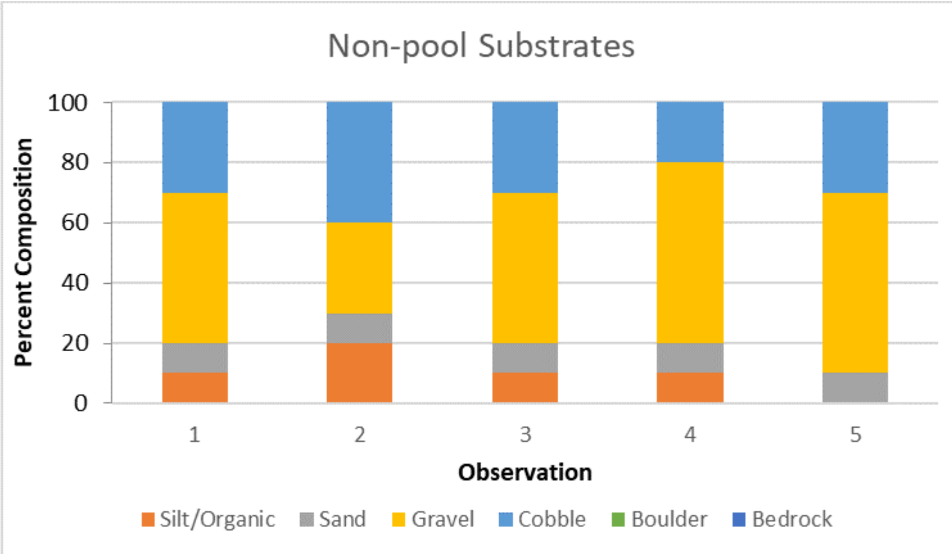


Figure 28. Composition of ocular substrate estimates conducted in non-pool habitat units (e.g., riffle or glide units) within MSC Reach 3.

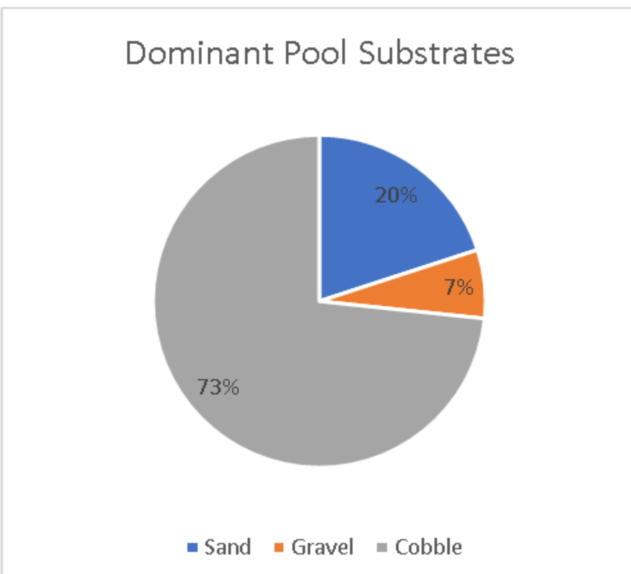


Figure 29. Dominant pool unit substrates recorded within MSC Reach 3.

4.2.3 Channel Infrastructure and Road Crossings

Infrastructure within or adjacent to MSC in Reach 3 includes the County's water control structure (Figure 30) at rKm 2.2, a bridge that crosses over the channel, appearing to act as a flow constriction, near approximately rKm 2.5 (Figure 31), and an historical concrete bridge abutment near rKm 3.6 (Figure 32).

Figure 30. Water control structure gates at rKm 2.2 in MSC Reach 3.

Figure 31. Bridge that crosses over the MSC channel in Reach 3, appearing to constrict flow, near approximately rKm 2.5.

Figure 32. Historic bridge abutment in channel constricting flow near rKm 3.6.

4.2.4 Summary

Reach 3 of Mt. Scott Creek is moderately modified from current or historical infrastructure, and lacking complex habitats in the channel and floodplain that provide fish habitat. The reach begins at a water control structure that impounds the first pool of the survey. Pools in the lower third of the reach are very long (60'-180'). Banks are very steep in this section. A moderate amount of wood is found in the lower third of the reach where 2 jams accumulate approximately 13 pieces of large wood (>6" x 15'). There is some evidence of active restoration in the lower portion of the reach compared to the upper, in which no previous restoration is apparent. There is very little gravel and few riffles in this section of the reach with cobble being the dominate substrate in glides, runs, and pools. However, despite the limited number of riffles in this section of the reach, few fine sediments were observed.

The reach transitions to a more unconstrained channel as it moves away from the constraining levee (essentially a hillslope constraining the floodplain) that runs east-west parallel to the reach. In-channel wood is limited to 2 wood jams, individual logs embedded into the bank (presumed to be a part of previous restoration efforts) and scattered pieces of large wood. A bridge constrains the channel in unit 27, just downstream of an upstream "v" log formation (similarly assumed to be from past restoration work). Spawning gravels become more prevalent in the upper portion of the reach, but coarseness of material may limit success by smaller adult salmonids incapable of moving larger sized substrate. Depth of spawning type substrate is also of concern as depth over mudstone does not appear to be >18" in many units of the reach. Spawning gravel appears to be supplemented with a substantial amount coming in to the reach from Phillips Creek. Undercut banks are evident in the upper two-thirds of the reach with mature riparian trees (oak, cottonwood) providing root mass that maintains bank integrity and critical high-quality rearing habitat not found in the lower end of the reach. An abandoned bridge fell into the channel and constricts the channel as the old deck remains in the center of the stream. The abutments are left in place and erosion beneath will eventually cause them to fall into the channel, likely creating a more significant channel constriction.

Previous habitat surveys in Mt Scott Creek were conducted in 1997-1998, 2003, and 2008 (Friesen and Zimmerman, 1999; Tinus et al., 2003; Neerman and Vogt, 2009). Glide habitat dominated the reach in 1997-8 with approximately 85% of the area in Reach 1 (which started at the mouth and extended up to the confluence with Dean Creek, encompassing Reaches 1 – 4 as delineated in this report). and 100% of the habitat area in Reach 2, and few or no pool units were recorded. Surveys in 2008 show Reach 1 as nearly evenly split among pools and fast water units. The change in habitat types between 1997-1998 and 2008 surveys may be primarily as a result of changes in protocol or survey crew judgement of unit type than physical habitat changes. The 2019 surveys of MSC Reach 3 show nearly equal percentages of pool and riffle/glide habitats, consistent with the 2008 surveys.

4.3 MT. SCOTT CREEK – REACH 5

4.3.1 Overall Reach Conditions

Reach 5 of Mt Scott Creek (MSC) is 1.2 kilometers (rKm) in length, beginning at rKm 3.85 and ending at rKm 5.05 (Figure 34). The field survey in MSC Reach 5 was conducted on December 18, 2019 and covered the entire reach. General land use within the reach is classified as predominately industrial outside of the riparian zone.

Stream flows during the survey were low, estimated at approximately 5 cubic feet per second (cfs). The gradient of the channel in this reach is generally low as well and less than 1%. The floodplain and channel banks are relatively natural, with some bank armoring (approximately 300 meters, mostly in the downstream portion of the reach) recorded during the survey. Minor bank erosion was observed, though vegetation (e.g., Himalayan blackberry) overhanging the banks made bank erosion difficult to discern in some locations. The floodplain and channel banks consist of natural vegetative land uses within an urban/industrial landscape, with a broad valley floor form that is constrained by hillslopes (CH = 2), terraces (CT = 15) or land uses (CL = 9). Six presumably stormwater-related pipes with debris racks were observed within the reach floodplains. Three roads cross MSC in this reach, either via bridges or culverts.

Three locations in the reach were identified as potentially suitable spawning areas, near rKm 4.63, rKm 4.69, and rKm 4.8 (Two of the sites identified are shown in Figure 33).

Figure 33. Examples of locatons identified as potentially suitable spawning areas due to appropriate channel conditions, substrates, etc.

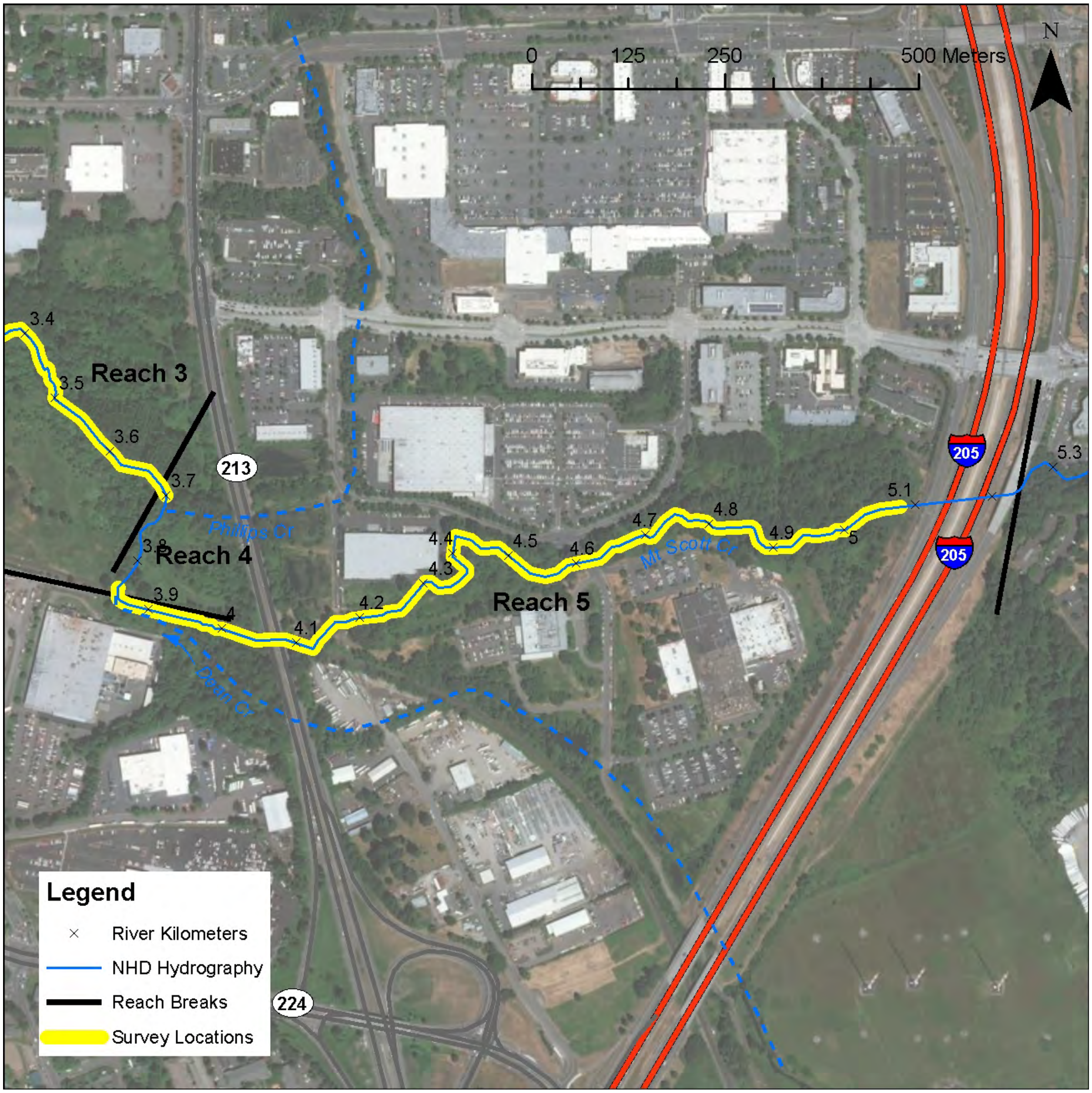


Figure 34. Map showing Mt. Scott Creek Reach 5 and the portions of the reach visited during the field investigation.

Large woody material was observed in the reach and tallied according to length and diameter of the piece. Large wood was tallied at the reach scale rather than habitat unit scale due to the rapid nature of the Bio-Assessment. Of all the reaches surveyed, this reach had the largest number of large wood pieces (n = 47). However, key pieces of large wood are relatively uncommon. Most of the large wood pieces were recorded in the smallest four categories and only five pieces were recorded in the DBH > 55 cm categories (Figure 35). One jam (a collection of five or more qualifying pieces of large wood) was noted in this reach, bringing the total wood count to at least 52 pieces.

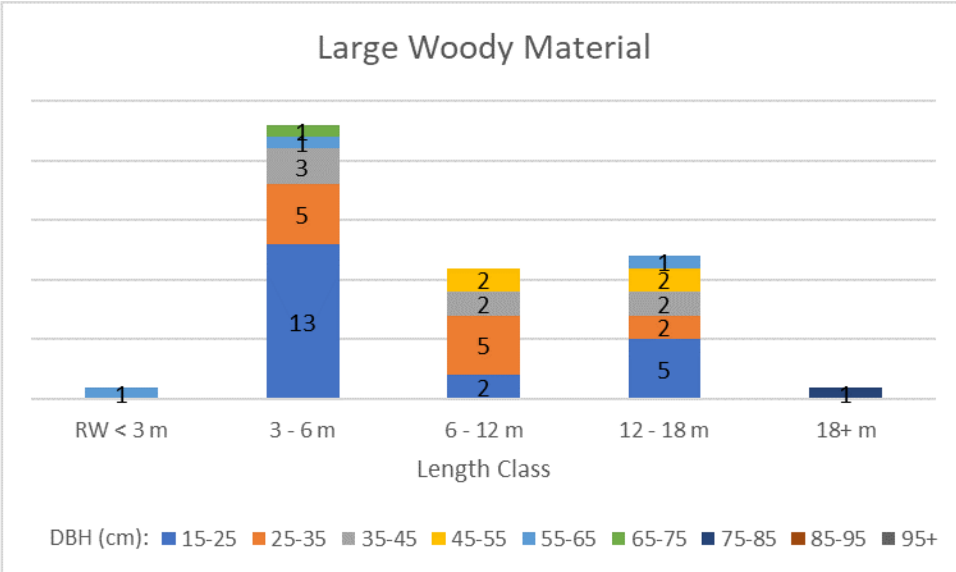


Figure 35. Large woody material by DBH and length classes observed in MSC Reach 5.

4.3.2 Habitat Unit Composition

MSC Reach 5 habitat primarily consists of pool habitats (65%, n = 16), while 19% of habitat area was recorded as glide (n = 5). Riffles consisted of 16% (n = 5) of the total bankfull habitat area (Table 15; Figure 36). No side channel habitat was observed in MSC Reach 5.

Table 15. Amount of habitat type observed during rapid bio-assessment field investigation in MSC Reach 5.

Unit Class	Percentage of Habitat
GLIDE	16%
POOL	65%
RIFFLE	19%

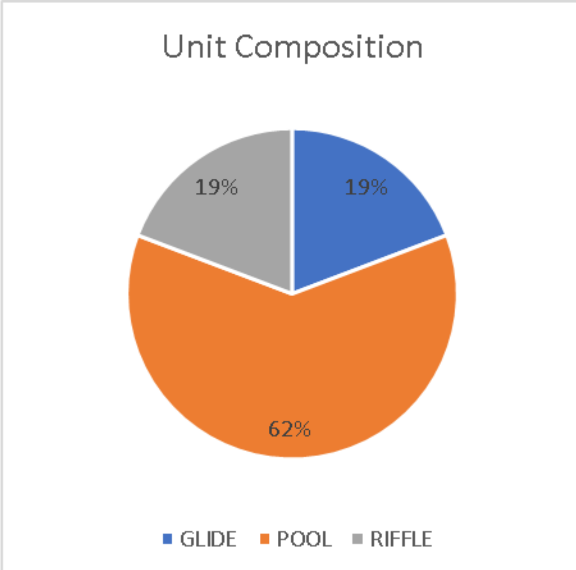


Figure 36. Number of units recorded in each habitat unit type in MSC Reach 5.

Pools

Pool was the most common habitat type recorded in MSC Reach 5 with 65% of the habitat unit area identified as pools. A total of 16 pools (out of 26 total units) were recorded in the reach. The average maximum pool depth was 0.77 meters with a max of 1.5 meters and minimum of 0.46 meters (Figure 37). Mean pool spacing in the reach was 7.7 channel widths per pool, compared to an average of 7.4 channel widths per pool for the entire study area. Residual pool depth averaged 0.67 meters, with one pool having the largest residual depth found in the study area (1.5 m). Of the 16 pools identified, nine pools maintained a residual depth of greater than 0.5 meters and the remaining seven pools maintained residual depths between 0.2 and 0.5 meters.

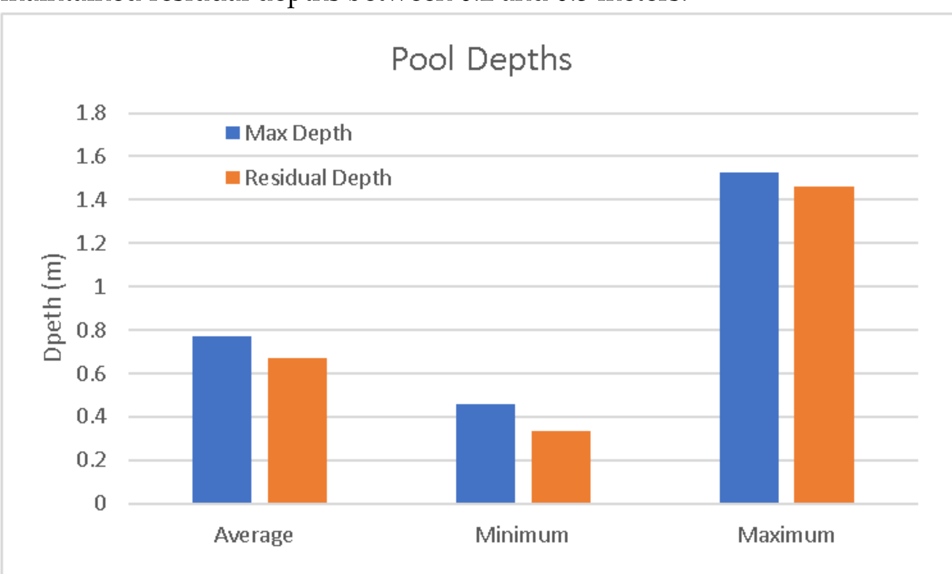


Figure 37. Max and residual pool depths in Mt Scott Creek Reach 5.

Pool quality for salmonid habitat was relatively higher than the other reaches surveyed, with an average pool complexity rank of 1.6 (scores may range from 1 to 5), while the overall average pool complexity rank among all streams surveyed was 1.4. Two pools received a score of 4, and another two pools received a score of 3. These pools with high complexity rankings were the pools with some of the highest residual depths. Pool cover averaged 20.6% for the reach, with a maximum of 50% cover in one of the pools.

Figure 38. Photo from rapid bio-assessment field investigation, of pool with one of the highest complexity ratings.

Table 16. Number of pool units with residual depths meeting ODFW's habitat benchmarks for Desirable (residual depth > 0.5 m), Undesirable (residual depth < 0.2 m), or in between (residual depth is between 0.2 m and 0.5 m).

Pool residual depths	
Undesirable	0
Neutral	7
Desirable	9

Geomorphic Conditions

Channel form in the reach is predominately in the Broad Valley Floor type (in which the valley width is at least 2.5x greater than the bankfull channel width), observed during the field survey as constrained by terraces (CT; n = 15) or landuses (CL; n = 9). Two units in the upper portion of the reach were noted as constrained by the hillslopes (Figure 39).

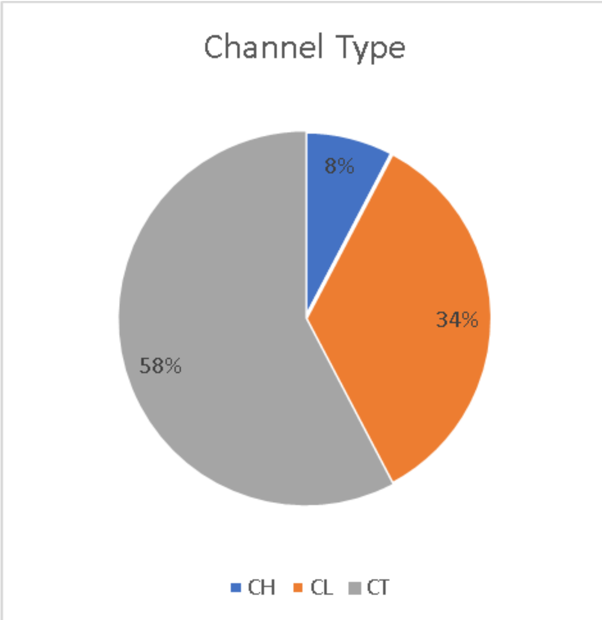


Figure 39. Channel form types within MSC Reach 5.

Bankfull widths (also called active channel widths) in MSC Reach 5 showed the greatest variability among pool units. Average bankfull widths were smallest for pool units, with a mean of 6.0 meters (and a maximum of 11.6 m and minimum of 4.9 m). Glide and riffle units averaged 7.3 m and 6.6 m widths respectively (Table 17). Bankfull depths averaged 1.0 m for all units combined, with a minimum recorded bankfull depth of 0.3 m and a maximum of 2.0 m. Riffles had a slightly lower average bankfull depth (0.7 m) than either pools (1.1 m) or glides (1.0 m) (Table 18).

Table 17. Bankfull widths summarized by habitat type within MSC Reach 5.

Bankfull Widths	Glide	Pool	Riffle	All
Average (m)	7.3	6.0	6.6	6.4
Minimum (m)	4.9	4.9	4.9	4.9
Maximum (m)	8.5	11.6	9.1	11.5

Table 18. Bankfull depths summarized by habitat type within MSC Reach 5.

Bankfull Depths	Glide	Pool	Riffle	All
Average (m)	1.0	1.1	0.7	1.0
Minimum (m)	0.7	0.8	0.3	0.3
Maximum (m)	1.3	2.0	0.9	2.0

Average floodprone widths were also very similar among the unit types, with a mean of 29.9 m for riffles, 32.0 m for glides, and 32.1 m for pools. The smallest floodprone width in the reach was 12.2 meters (recorded in pool unit) while the largest floodprone width was 61 m (Table 13). Floodprone condition was noted as primarily industrial land uses and tree vegetation land cover. The average entrenchment ratio for the reach was 4.9.

Table 19. Floodprone widths summarized by habitat type within MSC Reach 5.

Floodprone Widths	Glide	Pool	Riffle	All
Average (m)	32.0	32.1	29.9	31.7
Minimum (m)	19.8	12.2	13.7	12.2
Maximum (m)	45.7	61.0	61.0	60.1

Riparian Conditions

The average canopy closure, or amount of shade the channel receives from riparian canopy cover, for MSC Reach 3 was 52.5%. A majority of the units were dominated by deciduous vegetation types (n = 24), while no vegetation was recorded in one unit and only a single unit was recorded as predominately shrub vegetation in the 30-mriparian zone. Average canopy closure for deciduous vegetation was 54.8%, while the single unit with shrub vegetation had 50% canopy closure (Table 20).

Among the habitat units, glides maintained the highest average canopy closure (58%), while riffles maintained the lowest on average (41% canopy closure). Pool units maintained an average canopy closure of 54.4% (Figure 40). Canopy age was primarily small – medium sized trees, with an average DBH between 15 – 30 cm. Approximately 22.5% of the riparian area was determined to be impervious surfaces, primarily relating to road and railroad infrastructure adjacent to the channel. Invasive species, including Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), and reed canarygrass (*Phalaris arundinacea*), were present in all units' riparian zones.

Table 20. The average canopy closure recorded, summarized by canopy types, within MSC Reach 5.

Unit Type	Average Canopy Closure
Deciduous	54.8 %
Shrub	50 %
No vegetation	0 %
All	52.5 %

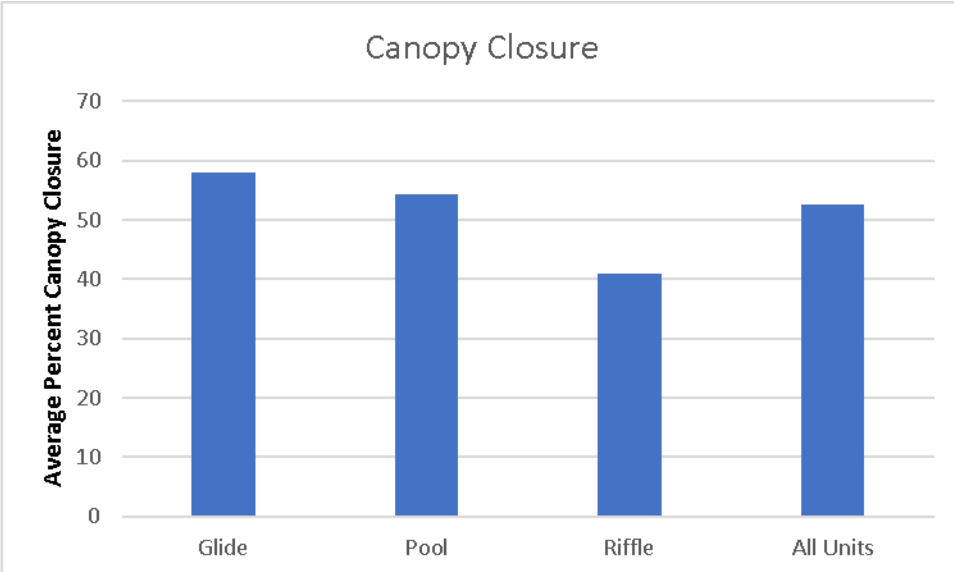


Figure 40. Canopy closure summarized by habitat unit types in Mt Scott Creek reach 5.

Substrate

Ocular estimates of the dominant substrate size class were recorded in all pool units, while ocular estimates of substrate composition were recorded in five representative non-pool units. Non-pool unit substrates primarily consisted of cobble and gravels. Fine sediments, such as sand or silt/organic material, were a relatively high proportion of two non-pool unit substrates (Figure 41). Substrate tended to increase in size moving upstream through the reach. Dominant substrates in pool units were primarily gravels (n = 10) while silt was the next most common substrate recorded in pool units (n = 2) (Figure 42).

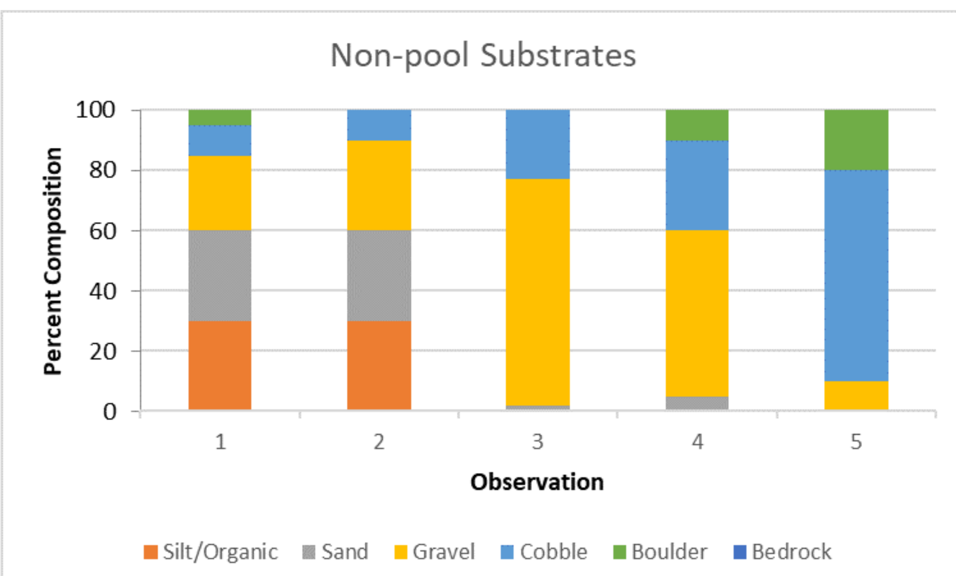


Figure 41. Composition of ocular substrate estimates conducted in non-pool habitat units (e.g., riffle or glide units) within MSC Reach 5.

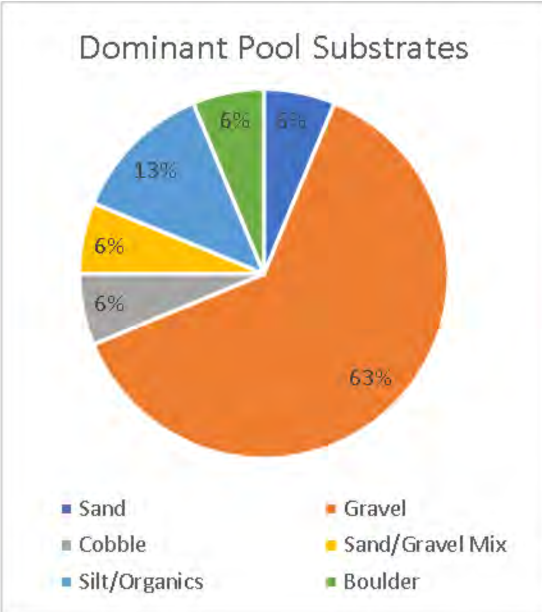


Figure 42. Dominant pool unit substrates recorded within MSC Reach 5.

4.3.3 Channel Infrastructure and Road Crossings

Numerous bridges cross over MSC in Reach 5. At the downstream end, MSC crosses under a railroad bridge near approximately rKm 3.82 (Figure 43). Immediately upstream of this railroad bridge are culverts connecting Dean Creek to MSC (Figure 44). The channel crosses under a very large bridge at 82nd Avenue (state highway 213) (Figure 46) and then again under the railroad near approximately rKm 4.09 (Figure 45). At 84th Avenue (rKm 4.58), MSC passes through a set of three large corrugated metal pipe culverts (Figure 47). These culverts are substantially filled in with fine sediments, effectively minimizing the flow area for MSC. The reach terminates at the Highway 205 culvert (Figure 48). At least six stormwater-related pipes, some with debris racks, were observed within the floodplain in this reach (Figure 49).

Figure 43. Downstream railroad bridge crossing MSC at the start of Reach 5 (rKm 3.82).

Figure 44. Culverts connecting Dean Creek to MSC near rKm 3.82.

Figure 45. Upstream railroad bridge crossing MSC at the rKm 4.09.

Figure 46. MSC adjacent to railroad, under the large 82nd Ave/Hwy 213 bridge.

Figure 47. Series of 3 culverts under 84th Ave near rKm 4.58 in MSC Reach 5.

Figure 48. I-205 culvert outlet; the upstream extent of MSC Reach 5.

Figure 49. Example stormwater outlet/inlet (?) with a debris rack (left) and two stormwater outfall culverts in MSC Reach 5.

4.3.4 Summary

Reach 5 of Mt Scott Creek begins at the confluence with Dean Creek and runs in a straightened channel immediately south and parallel to railroad tracks, for approximately 300 meters. This channel is narrow and confined, largely disconnected from the natural floodplain. After crossing back under the railroad, the channel is less confined and some floodplain and riparian areas appear to be more frequently connected to the main channel. Large wood is dispersed throughout the reach, with one small jam present in the central portion of the reach.

The gradient of the channel in this reach is less than 1%. The floodplain and channel banks are relatively natural, with some bank armoring (approximately 300 meters, mostly in the downstream portion of the reach near the railroad prism) recorded during the survey. Bank erosion was observed throughout the reach, though vegetation (e.g., Himalayan blackberry) overhanging the banks made bank erosion difficult to discern in some locations. The floodplain and channel banks consist of natural vegetative land uses within an urban/industrial landscape. Three roads cross MSC in this reach, either via bridges or culverts, with substantial constrictions in the channel at the 84th Ave culverts. The channel is also constricted by two railroad bridges that cross the channel in the downstream portion of the reach.

Three locations in the reach were identified as potentially suitable spawning areas. Substrates in this reach differed between the lower and upper portions of the reach. Further downstream in the reach consists of more fine sediments such as sand and organic material, while upstream bed substrates are predominately cobbles and gravels.

Previous habitat surveys in Mt Scott Creek were conducted in 1997-1998, 2003, and 2008 (Friesen and Zimmerman, 1999; Tinus et al., 2003; Neerman and Vogt, 2009). The entirety of Reach 2 (which began at the confluence of Dean Creek and extended up through approximately this report's reach 8) was recorded as glide habitat in the 1997-8 surveys. By 2008, surveys recorded 95% of the reach as pool habitat. The change in habitat types between 1997-1998 and 2008 surveys may be primarily as a result of changes in protocol or survey crew judgement of unit type than physical habitat changes. In 2019, surveys of MSC Reach 5 show a majority of the habitat is pool (62%) and the remainder is split relatively evenly between riffle and glide fast water units.

4.4 BOARDMAN CREEK – REACH 1

4.4.1 Overall Reach Conditions

The surveyed portion of Boardman Creek Reach 1is 0.21 kilometers (km) in length, beginning at rKm 0 and ending at rKm 0.21, covering approximately 70% of the reach). Survey was terminated at rKm 0.21 due to lack of landowner permission. The field survey in Boardman Creek was conducted on December 27, 2019. Land use within the reach is predominately classified as rural residential.

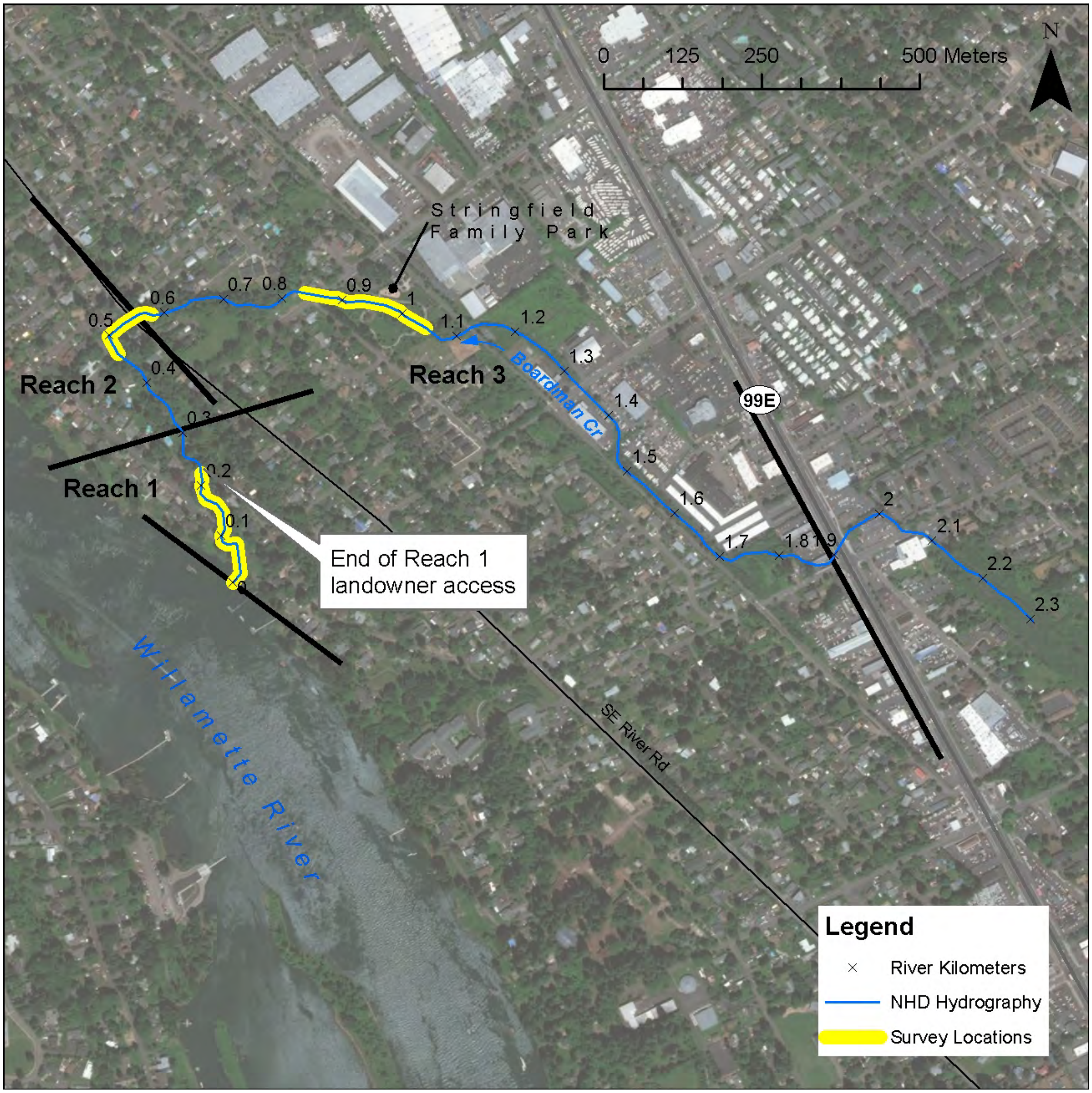


Figure 50. Map showing Boardman Creek and the areas visited during the field investigation.

Stream flows during the survey were low. The gradient of the channel in this reach is relatively steep in the downstream portion of the reach where there is a bedrock outcropping before the confluence with the Willamette River, while above the bedrock the gradient is closer to 1-2%. The floodplain is narrow and channel banks are moderately steep slopes, vegetated with trees. Residential buildings and yards were present at the tops of the banks. No bank armoring was observed during the survey. Minor bank erosion was present, though not widespread through the reach (Figure 51). Valley form was considered primarily moderately v-shaped (MV; side slopes >30° and <60°). Channel infrastructure in this reach is related to a large water control structure and manhole located in the wetted channel near rKm 0.1.

Figure 51. Minor bank erosion (and plastic sheeting along bank, presumably to limit additional erosion) noted along river left bank of Boardman Creek within the reach.

No locations in the reach were identified as a potentially suitable for spawning.

Large woody material was observed in the reach and tallied according to length and diameter of the piece. Large wood was tallied at the reach scale rather than habitat unit scale due to the rapid nature of the Bio-Assessment. Large wood quantities were low in this reach, with only five pieces recorded. No key pieces of large wood are were present. All of the large wood pieces were recorded in the smallest two DBH categories and most pieces were less than 12 m in length (Figure 52). No jams (collections of five or more qualifying pieces of large wood) were noted in this reach.

Figure 52. Large woody material by DBH and length classes observed in Boardman Creek Reach 1.

4.4.2 Habitat Unit Composition

Habitat units in Boardman Creek primarily consist of fast, turbulent habitats such as cascade (42%) or riffle (39%). Only 19% of habitat area was recorded as pool (n = 2). No glides were observed in the surveyed portion of this reach (Table 21; Figure 53). No side channel habitat was observed in Boardman Creek.

Table 21. Amount of habitat type observed during rapid bio-assessment field investigation in Boardman Creek Reach 1.

Unit Class	Percentage of Habitat
Cascade	42%
Glide	0%
Pool	19%
Riffle	39%

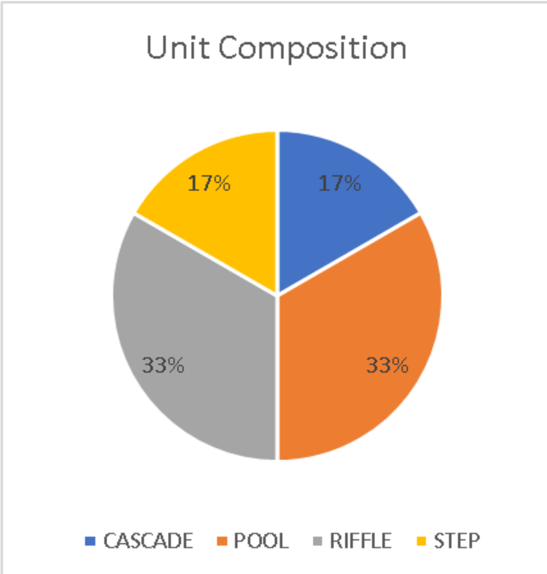


Figure 53. Number of units recorded in each habitat unit type in Boardman Creek Reach 1.

Pools

Pool was the least common habitat type recorded in Boardman Creek, with only 19% of the habitat unit bankfull area identified as pool. A total of 2 pools (out of 6 total units) were recorded in the reach. The average maximum pool depth was 0.58 meters with a max of 0.82 meters and minimum of 0.34 meters (Figure 54). Mean pool spacing in the reach was 4.4 channel widths per pool, compared to an average of 7.4 channel widths per pool for the entire study area. Residual pool depth averaged 0.21 meters. Of the two pools identified, one pool was formed by the Willamette River backwater at the confluence with Boardman Creek (therefore did not have a residual depth) and the other maintained a residual depth of 0.21 meters.

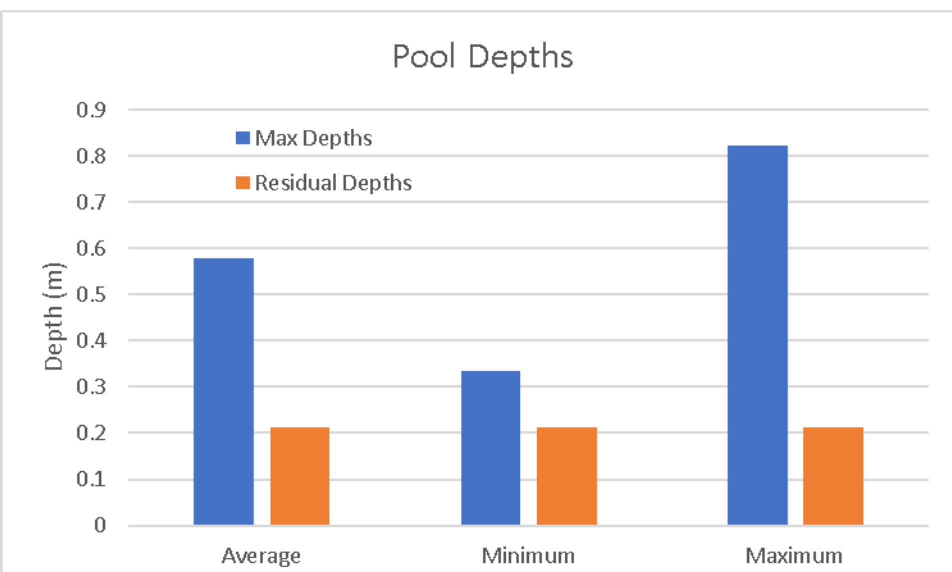


Figure 54. Max and residual pool depths in Boardman Creek reach 1.

Pool quality for salmonid habitat was low, with an average pool complexity rank of 1.0 (scores may range from 1 to 5), while the overall average pool complexity rank among all streams surveyed was 1.4. Both pools received a score of 1. Pool cover averaged 37.5% for the reach, though there was substantial variability between the two pools (one had 75% cover, the other had 0% cover).

Figure 55. Pool habitat in Boardman Creek (looking downstream at pool in mid-ground of photo).

Table 22. Number of pool units with residual depths meeting ODFW's habitat benchmarks for Desirable (residual depth > 0.5 m), Undesirable (residual depth < 0.2 m), or in between (residual depth is between 0.2 m and 0.5 m).

Pool residual depths	
Undesirable (<0.2)	1
Neutral (0.2 – 0.5)	0
Desirable (>0.5)	0

Geomorphic Conditions

Channel form in the reach is predominately in the Narrow Valley Floor type (in which the valley width is less than 2.5x the bankfull channel width), and observed during the field survey as constrained by bedrock (CB; n = 3 units) or terraces (CT; n = 2 units). A single unit was noted as constrained by the hillslopes (CH; n = 1) (Figure 56).

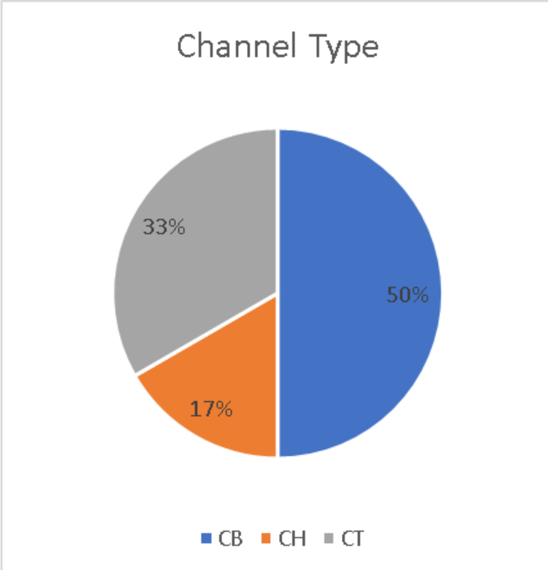


Figure 56. Channel form types within Boardman Creek Reach 1.

Bankfull widths (also called active channel widths) in Boardman Creek were similar among the different habitat unit types. Average bankfull widths were 8.1 m for pool units and 7.62 m for all other units. Maximum bankfull widths were 9.1 m for riffles, 8.5 m for pools, and 7.62 m for the cascade unit, while minimums were 6.1 for riffles, 8 m for pools, and 7.62 m for the cascade unit (Table 23). Bankfull depths averaged 1.1 m for all units combined, with a minimum recorded bankfull depth of 0.9 m and a maximum of 1.3 m. The fast-water units (riffle and cascade) had slightly lower average bankfull depths (0.9 m) than the pool (1.3 m) (Table 24).

Table 23. Bankfull widths summarized by habitat type within Boardman Creek Reach 1.

Bankfull Widths	Cascade	Pool	Riffle	All
Average (m)	7.6	8.1	7.6	7.8
Minimum (m)	7.6	7.6	6.1	6.1
Maximum (m)	7.6	8.5	9.1	9.1

Table 24. Bankfull depths summarized by habitat type within Boardman Creek Reach 1.

Bankfull Depths	Cascade	Pool	Riffle	All
Average (m)	0.9	1.3	0.9	1.1
Minimum (m)	0.9	1.3	0.9	0.9
Maximum (m)	0.9	1.3	0.9	1.3

Floodprone widths in the reach were generally lower than other reaches surveyed, with an average of 10.4 m. The smallest floodprone width in the reach was 9.1 meters while the largest floodprone width was 13.7 m (Table 25). Floodprone condition was noted as primarily vegetated trees and rural residential land uses. The average entrenchment ratio in this reach was 1.3.

Table 25. Floodprone widths summarized by habitat type within Boardman Creek Reach 1.

Floodprone Widths	Cascade	Pool	Riffle	All
Average (m)	9.1	13.7	11.4	10.4
Minimum (m)	9.1	13.7	9.1	9.1
Maximum (m)	9.1	13.7	13.7	13.7

Riparian conditions

The average canopy closure, or amount of shade the channel receives from riparian canopy cover, for Boardman Creek within the surveyed reach was 46%. A majority of the units were dominated by coniferous vegetation types (n = 4), while grassy vegetation was recorded in one unit and no canopy type was recorded in one unit. Average canopy closure for coniferous vegetation was 57.5%, while the single unit with grassy vegetation had 0% canopy closure (Table 26).

Among the habitat units, riffles maintained the highest average canopy closure (62.5%), while the cascade unit had the lowest (30% canopy closure). Pool units maintained an average canopy closure of 37.5% (Figure 57). Canopy age was primarily small – medium sized trees, with an average DBH between 15 – 30 cm. Approximately 16.7% of the riparian area was determined to be impervious surfaces, primarily relating to road and residential buildings and infrastructure adjacent to the channel. Invasive species, including Himalayan blackberry (*Rubus armeniacus*), reed canarygrass (*Phalaris arundinacea*), and bamboo (*Bambusoideae spp.*) were present in all units' riparian zones.

Table 26. The average canopy closure recorded in units, summarized by canopy types, within the surveyed portion of Boardman Creek Reach 1.

Vegetation Type	Average Canopy Closure
Coniferous	57.5 %
Grass	0 %
No Vegetation	0 %
All	46 %

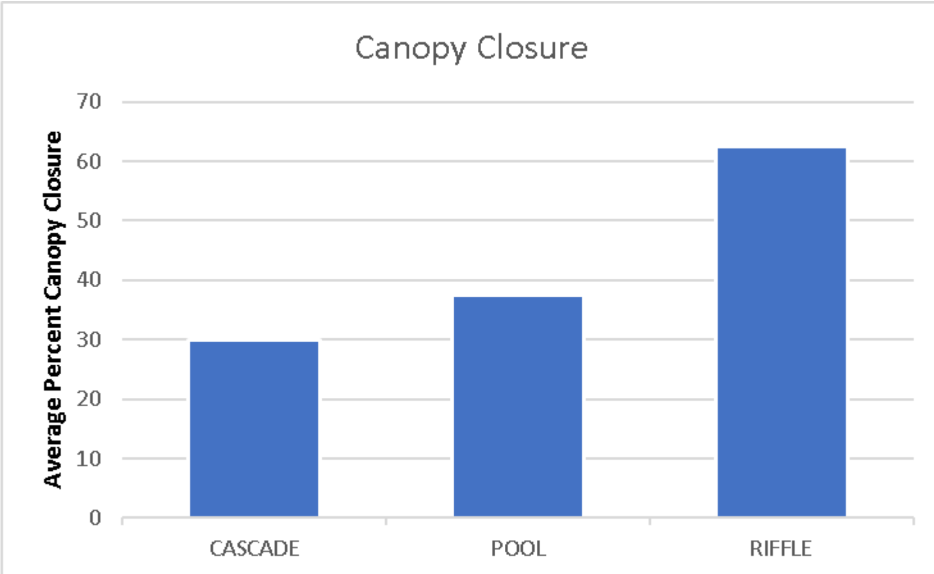


Figure 57. Average canopy closure summarized by habitat unit type in Boardman Creek.

Substrate

Ocular estimates of the dominant substrate size class were recorded in all pool units, while ocular estimates of substrate composition were recorded in five other representative non-pool locations. Non-pool unit substrates primarily consisted of cobble and boulders. Fine sediments, such as sand or silt/organic material, were absent in this reach except in one estimate (Figure 58). Substrate was generally large from the steeper gradient in this reach or was bedrock. Dominant substrates in pool units were either gravels (n = 1) or a mix of sand/silt (n = 1) (Figure 59).

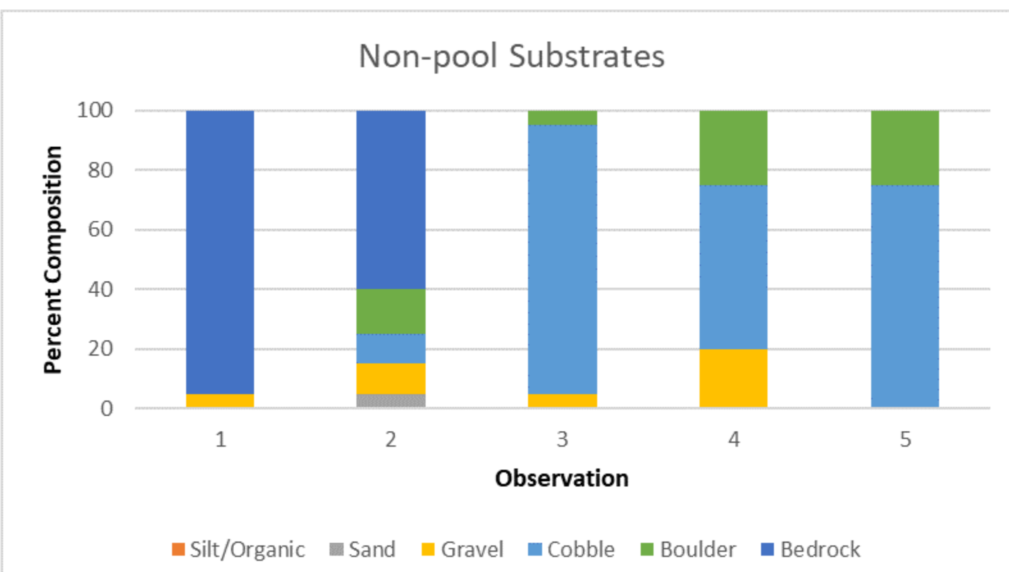


Figure 58. Composition of ocular substrate estimates conducted in non-pool habitat units (e.g., riffle or glide units) within the surveyed portion of Boardman Creek Reach 1.

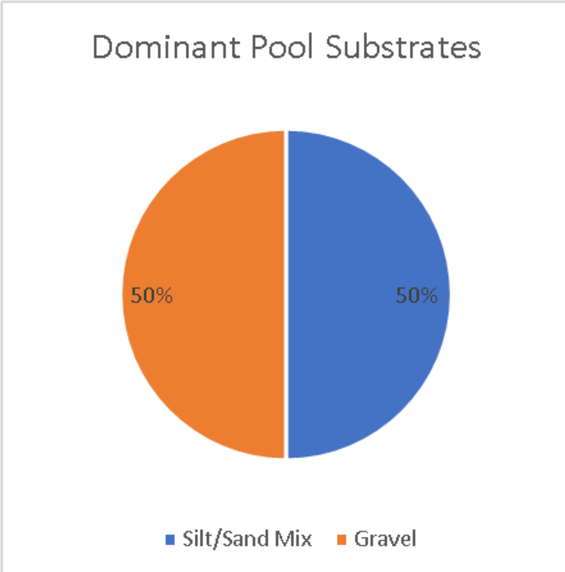


Figure 59. Dominant pool unit substrates recorded within the surveyed portion of Boardman Creek reach 1.

4.4.3 Channel Infrastructure and Road Crossings

The primary infrastructure present in this reach was the stormwater tank located on river right and the manhole located in the middle of the wetted channel near rKm 0.1 in Boardman Creek (Figure 60, Figure 61). Another stormwater manhole was located on the river right floodplain near rKm 0.07 (Figure 62).

No roads cross the Boardman Creek channel within the surveyed portion of the reach. There are numerous road crossings upstream of this reach, however.

Figure 60. Standing in Boardman Creek and looking upstream at the bedrock cascade habitat unit and the manhole located in the center of the wetted channel at approximately rKm 0.1.

Figure 61. Standing in Boardman Creek and looking downstream at the large stormwater/sewerline infrastructure located on the river right bank near approximately rKm 0.1.

Figure 62. Stormwater manhole located in the river right floodplain near rKm 0.07 of Boardman Creek.

4.4.4 Summary

The gradient of the channel in this reach is relatively steep in the downstream portion of the reach where there is a bedrock outcropping before the confluence with the Willamette River, while above the bedrock the gradient is lower and substrates include cobbles and minor amounts of gravel atop bedrock. No suitable spawning areas were recorded in this reach, however, observations from the upstream extent of the surveyed reach and the channel downstream of SE Walta Vista Rd may provide more rearing or spawning habitat potential. However, access to these areas by salmonids due to the natural bedrock steps in the channel at the mouth is unknown. Very little pool habitat was observed in the surveyed channel length.

The floodplain is narrow and channel banks are moderately steep slopes, vegetated with coniferous trees and providing shade to the stream channel. Residential buildings and yards were present at the tops of the banks. No bank armoring was observed during the survey. Minor bank erosion was present, though not widespread. Channel infrastructure in this reach is significant, consisting of a large water control structure and manhole located in the wetted channel near rKm 0.1.

Habitat assessments in Boardman Creek in 2012 recorded 100% glide habitat in both the lower and upper surveyed reaches, which were upstream of the study area surveyed in 2019. Water quality and macroinvertebrate sampling in Boardman Creek in 2012 showed low dissolved oxygen in the water column, low macroinvertebrate species diversity and a high proportion of species that are tolerant of poor aquatic conditions (Cole and Haxton, 2013).

Figure 63. Boardman Creek, looking upstream from upper extent of field survey.

Figure 64. Boardman Creek from SE Walta Vista Rd (looking downstream at reach). Potential fish habitat is present in this reach, if it is accessible to fish. Upstream of this road culvert is inaccessible.

Figure 65. Culvert upstream of SE Walta Vista Rd that is presumed impassable for fish (culvert extends upstream through SE River Road in background of photo, culvert length is an estimated 80 or more meters).

4.5 RINEARSON CREEK – REACHES 1 & 2

4.5.1 Overall Reach Conditions

The field investigation of Rinearson Creek revealed Reach 1 was predominately influenced by the Willamette River, functioning as a side channel to the Willamette, and was therefore inappropriate to include in the assessment of Rinearson Creek. Therefore, the rapid bio-assessment was conducted beginning at the start of Reach 2, or rKm 0.19, and extending up through the entirety of Reach 2. The portion of Reach 3 that fell on public land within the boundaries of Meldrum Bar Park was also investigated, extending up to a large man-made step in the channel at approximately rKm 0.7. The survey was terminated where the channel extends into privately-owned land and out of Meldrum Bar Park. The field survey in Rinearson Creek was conducted on December 27, 2019 and covered the entire reach. Land use within the reach is predominately classified as greenway/park due to the reach being largely contained by Meldrum Bar Park. The majority of this reach was included in the Rinearson Natural Area restoration project constructed in 2017.

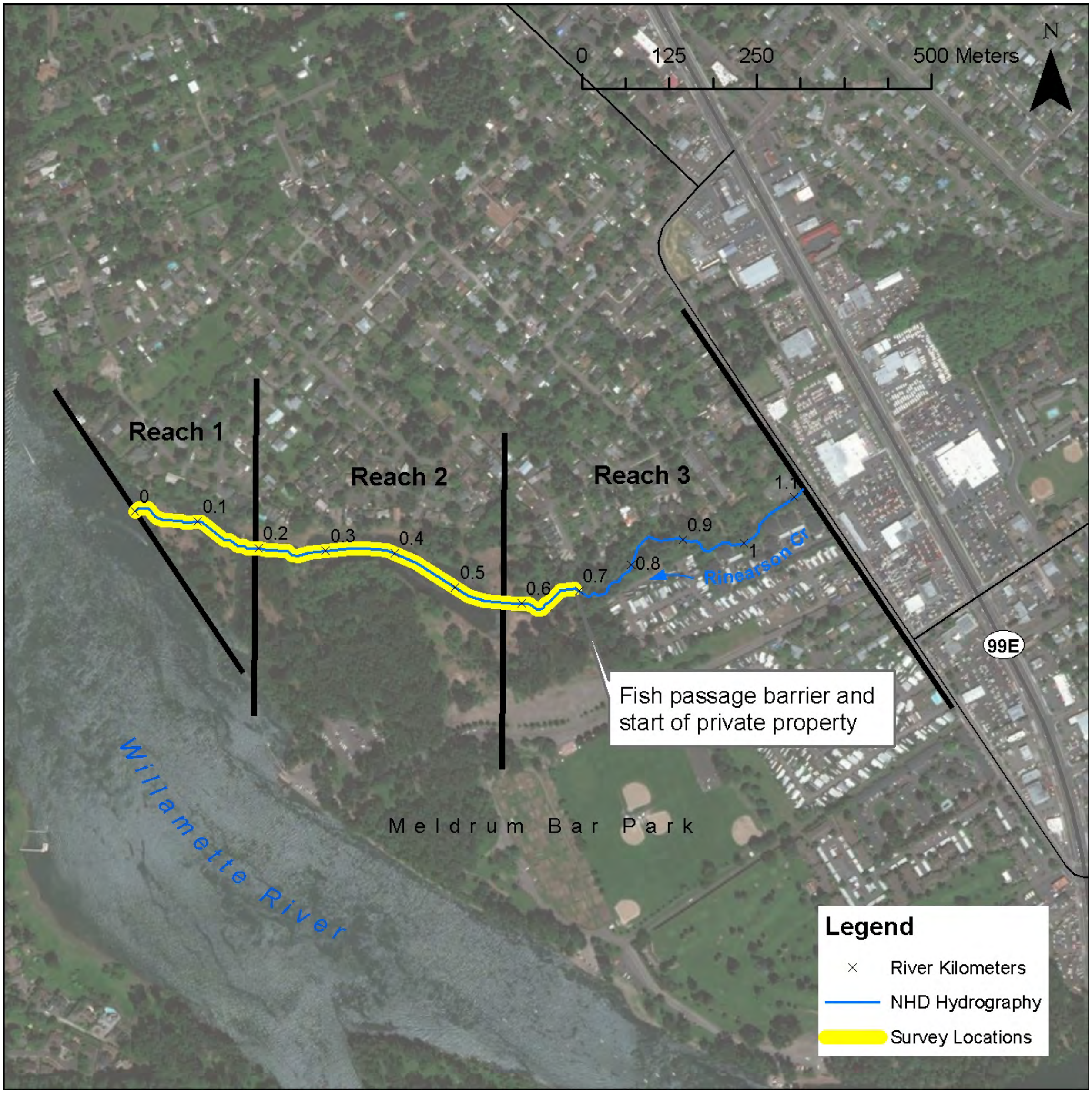


Figure 66. Map showing Rinearson Creek and the areas visited during the field investigation.

Stream flows during the survey were low. The gradient of the channel in this reach is relatively steep in the downstream portion of the reach from the confluence with the Willamette River up to a beaver dam, while above the beaver dam the gradient is very low (<1%). The floodplain is relatively broad, primarily designated as a wide-active floodplain (WF). Some residential buildings and park infrastructure (roads) were present at the tops of the floodplain banks. Channel banks were vegetated with grasses and shrubs.

The channel form varied widely throughout the reach, from the steep riffle at the mouth of Rinearson where the channel was largely constrained by hillslopes, to the unconstrained predominately single channel (US) and large beaver pond in the middle of the reach, to the braided, multi-threaded channel and wetland complex in the upper portion of the reach which then transitioned back into a channel constrained by hillslopes (CH) at the upstream terminus of the reach. No bank armoring was observed during the survey, however, the substrate used in the restored channel and on the channel banks in the downstream portion of the reach was large and angular. Minor bank erosion was present, largely appears to be natural erosion due to the fine sediments in the low slope or braided channels. No locations in the reach were identified as a potentially suitable for spawning.

Large woody material was observed in the reach and tallied according to length and diameter of the piece. Large wood was tallied at the reach scale rather than habitat unit scale due to the rapid nature of the Bio-Assessment. Large wood quantities were low in this reach, with only eight pieces recorded. No key pieces of large wood were present. All of the large wood pieces were recorded in the 25-35 and 35-45 DBH categories and most pieces were less than 12 m in length (Figure 67). It should be noted that woody material, including rootwads, appear to have been placed during the restoration project in this reach. However, the pieces were short (~2 m in length) and therefore did not meet the minimum size criteria. No jams were observed.

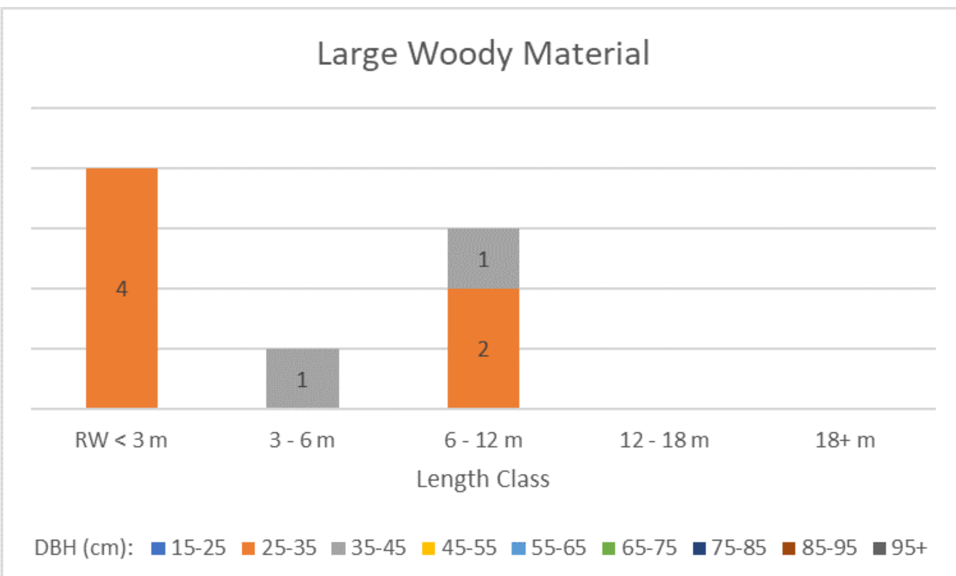


Figure 67. Large woody material by DBH and length classes observed in the surveyed portion of Rinearson Creek.

4.5.2 Habitat Unit Composition

Habitat units in Rinearson Creek were primarily pools (88%). Only 11.5% of habitat area was recorded as riffle (n = 1). One glide was observed in the reach (0.4%) (Table 27; Figure 68). One side channel unit was observed in Rinearson Creek and consisted of 0.5% of the total bankfull habitat area.

Table 27. Amount of habitat type observed during rapid bio-assessment field investigation in the surveyed portion of Rinearson Creek.

Unit Class	Percentage of Habitat
Glide	0.4%
Pool	87.6%
Riffle	11.5%
Side	0.5%

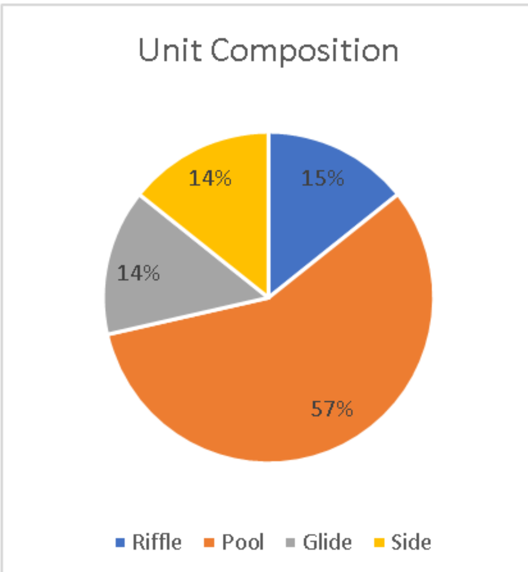


Figure 68. Number of units recorded in each habitat unit type in the surveyed portion of Rinearson Creek.

Pools

Pool was the most common habitat type recorded in Rinearson Creek, with 88% of the habitat unit bankfull area identified as pool. A total of 4 pools (out of 7 total units) were recorded in the reach. The average maximum pool depth was 0.91 meters with a max of 1.2 meters and minimum of 0.8 meters (Figure 69). Mean pool spacing in the reach was 14.4 channel widths per pool, compared to an average of 7.4 channel widths per pool for the entire study area. Residual pool depth averaged 0.7 meters, and most of the pools had residual depths >0.5 m, with only one pool with a residual depth <0.2 m (Table 28).

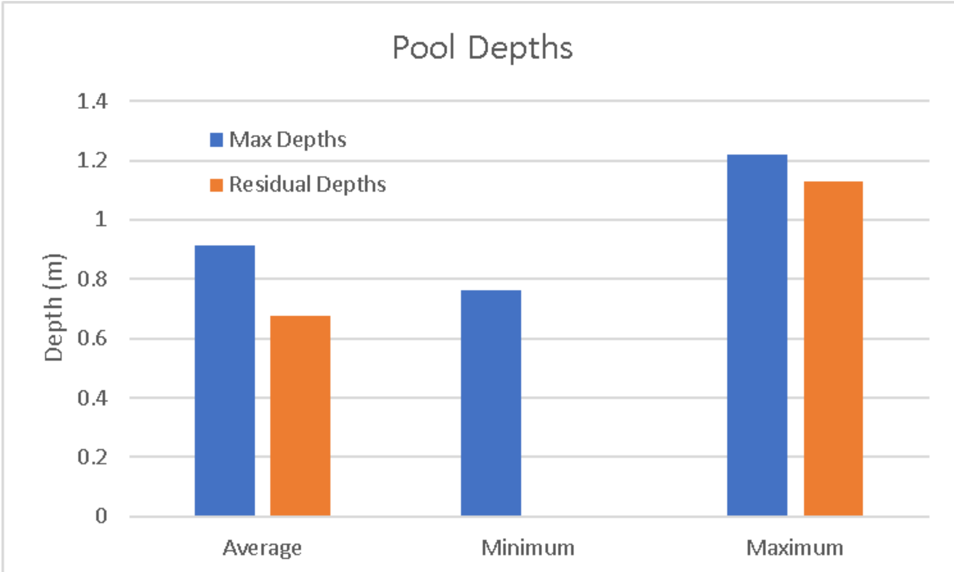


Figure 69. Max and residual pool depths recorded in Rinearson Creek.

Pool quality for salmonid habitat was relatively high, with an average pool complexity rank of 2.0 (scores may range from 1 to 5), while the overall average pool complexity rank among all streams surveyed was 1.4. All four pools received a score of 2. Pool cover averaged 20% for the reach, with all pools having at least 10% cover. Cover was provided by large wood or overhanging grassy vegetation, which covered a large portion of the narrow channel in some units.

Figure 70. The large beaver pond pool unit recorded in Rinearson Creek, standing at the beaver dam and looking upstream.

Figure 71. Pool habitat unit in Rinearson Creek.

Table 28. Number of pool units with residual depths meeting ODFW's habitat benchmarks for Desirable (residual depth > 0.5 m), Undesirable (residual depth < 0.2 m), or in between (residual depth is between 0.2 m and 0.5 m).

Pool residual depths	
Undesirable (<0.2)	1
Neither (0.2 – 0.5)	0
Desirable (>0.5)	3

Geomorphic Conditions

Channel form in the reach is predominately in the Broad Valley Floor and unconstrained channel types (in which the valley width is greater than 2.5x the bankfull channel width), and observed during the field survey as unconstrained predominately single channel (US; n = 3 units), unconstrained braided channels (UB; n = 3 units), and two units at the downstream and upstream ends of the reach that are constrained by hillslopes (CH; n = 2) (Figure 72).

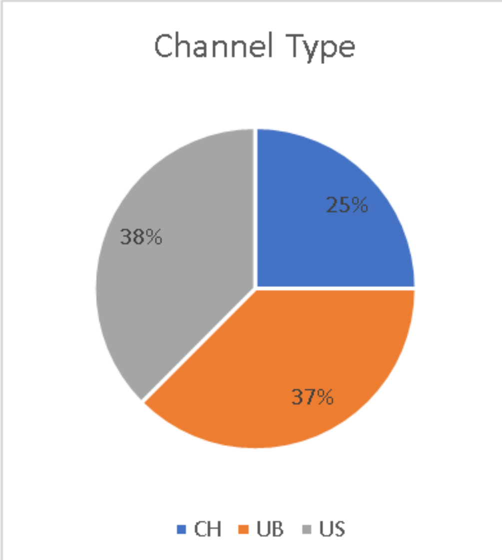


Figure 72. Channel form types within the surveyed portion of Rinearson Creek.

Bankfull widths (also called active channel widths) in Rinearson Creek averaged 7.5 m for pool units, with a minimum of 1.2 m and a maximum of 22.9 m. Average, minimum and maximum bankfull widths all equal for each of the other unit types, which all had only a single unit recorded, and are provided in Table 29. Bankfull depths averaged 0.9 m for all units combined, with a minimum recorded bankfull depth of 0.3 m and a maximum of 1.8 m (Table 30).

Table 29. Bankfull widths summarized by habitat type within the surveyed portion of Rinearson Creek.

Bankfull Widths	Glide	Pool	Riffle	Side	All
Average (m)	0.9	7.5	7.0	0.3	5.4
Minimum (m)	0.9	1.2	7.0	0.3	0.3
Maximum (m)	0.9	22.9	7.0	0.3	22.9

Table 30. Bankfull depths summarized by habitat type within the surveyed portion of Rinearson Creek.

Bankfull Depths	Glide	Pool	Riffle	Side	All
Average (m)	0.5	1.0	1.3	0.3	0.9
Minimum (m)	0.5	0.7	1.3	0.3	0.3
Maximum (m)	0.5	1.8	1.3	0.3	1.8

Floodprone widths in the reach ranged from 13.7 m to 45.7 m. The riffle unit had the smallest floodprone width at 13.7 m, while both the side channel and glide floodprone widths were 30.5 m. The pool units had an average floodprone width of 36.6 m, a minimum of 30.5 m, and a maximum of 45.7 (Table 31). Floodprone condition was noted as primarily vegetated grasses. The average entrenchment ratio for the reach was 5.5.

Table 31. Floodprone widths summarized by habitat type within the surveyed portion of Rinearson Creek.

Floodprone Widths	Glide	Pool	Riffle	Side	All
Average (m)	30.5	36.6	13.7	30.5	29.9
Minimum (m)	30.5	30.5	13.7	30.5	13.7
Maximum (m)	30.5	45.7	13.7	30.5	45.7

Riparian Conditions

The average canopy closure, or amount of shade the channel receives from riparian canopy cover, for Rinearson Creek within the surveyed reach was 15%. A majority of the units were dominated by grass and small shrub vegetation types (n = 5), with deciduous vegetation was recorded in two units. Average canopy closure for units with deciduous canopy in the riparian zone was 0%, owing to the distance between the channel and the large deciduous trees (immediately adjacent to the channel are small trees and shrubs, planted following the restoration project and providing no canopy cover). Units with grassy vegetation as the dominant riparian vegetation type had an average of 21% canopy closure, owing to the very narrow channel which was covered substantially by overhanging grass vegetation in some units.

Among the habitat units, the glide and side channel units had the highest estimated canopy closure (30%), while the pool units averaged 11.3% canopy closure (Table 32). The riffle unit had no canopy closure. Canopy age was primarily grasses and small woody-stemmed shrubs, with an average DBH less than 3 cm. Approximately 8% of the riparian area was determined to be impervious surfaces, primarily relating to residential buildings and infrastructure at the top of the channel banks in the downstream portion of the reach. Invasive species, including Himalayan blackberry (*Rubus armeniacus*), reed canarygrass (*Phalaris arundinacea*), and English ivy (*Hedera helix.*) were present throughout the reach's riparian zones.

Table 32. The average canopy closure recorded, summarized by habitat unit types, within the surveyed portion of Rinearson Creek.

Unit Type	Average Canopy Closure
GLIDE	30 %
POOL	11.3 %
RIFFLE	0 %
SIDE	30 %
All	15 %

Substrate

Ocular estimates of the dominant substrate size class were recorded in all pool units, while ocular estimates of substrate composition were recorded in three other representative non-pool locations. Non-pool unit substrates were variable depending on the location within the reach; in the riffle near the mouth, the substrate is large cobbles and boulders. Fine sediments, such as sand or silt/organic material made up the entirety of the two other substrate estimates in the middle and upper portions of the reach (Figure 73). Dominant substrates in pool units were entirely silt/organic materials (n = 4) (Figure 74).

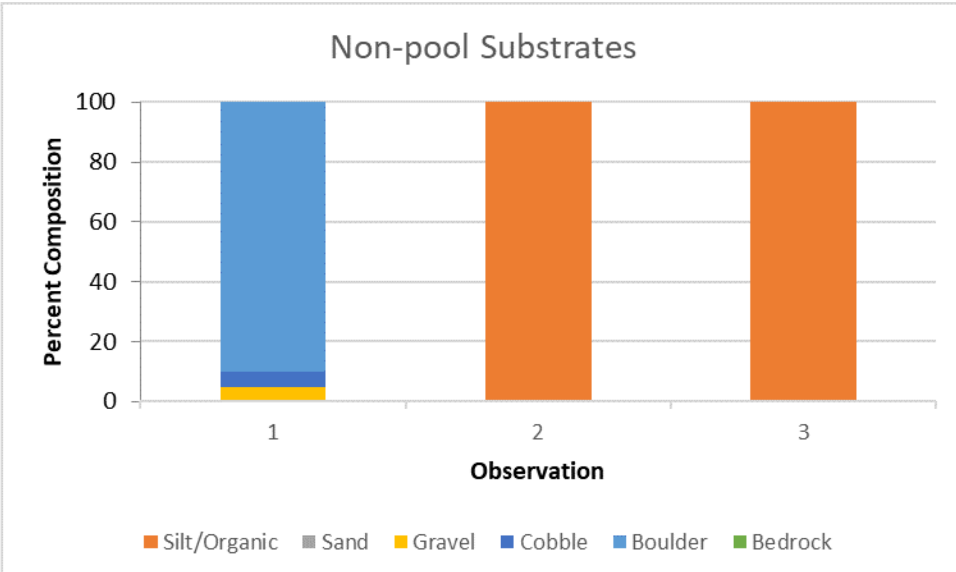


Figure 73. Composition of ocular substrate estimates conducted in non-pool habitat units (e.g., riffle or glide units) within the surveyed portion of Rinearson Creek. Only three substrate estimates were recorded due to the limited number and extent of non-pool units.

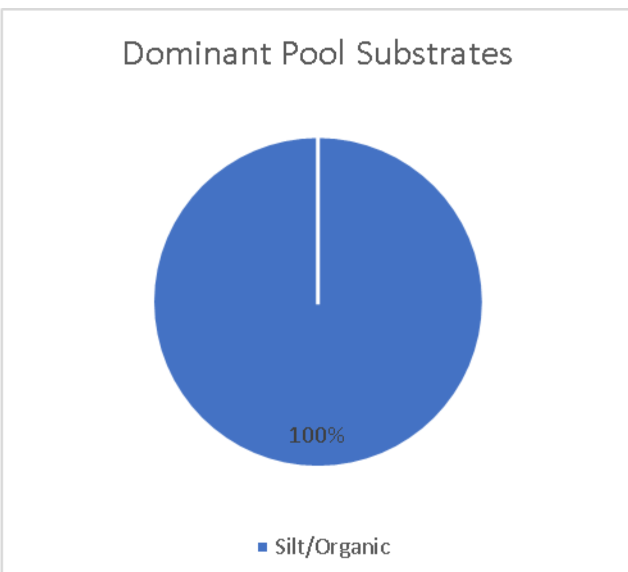


Figure 74. Dominant pool unit substrates recorded within the surveyed portion of Rinearson Creek.

4.5.3 Channel Infrastructure and Road Crossings

The primary infrastructure present in this reach was the man-made dam/step barrier that was the upstream terminus of the survey near rKm 0.7 (Figure 75).

No roads cross the Rinearson Creek channel within Reach 1. There are numerous road crossings upstream of this reach, however.

Figure 75. Manmade fish passage barrier in Rinearson Creek at rKm 0.7 (the upstream extent of the survey area).

4.5.4 Summary

The lower portion of Rinearson Creek flows through Meldrum Bar Park, and much of Reach 1 was a part of a 2017 restoration project. The gradient of the channel in this reach is relatively steep in the downstream portion of the reach from the confluence with the Willamette River up to a beaver dam, while above the beaver dam the gradient is very low. Some residential buildings and park infrastructure (roads) were present at the tops of the floodplain banks, though channel banks were entirely vegetated with grasses and shrubs. The channel form varied widely throughout the reach, from the steep riffle at the mouth of Rinearson to the unconstrained predominately single channel and large beaver pond in the middle of the reach, to the braided, multi-threaded channel and wetland complex in the upper portion of the reach which then transitioned back into a channel constrained by hillslopes at the upstream terminus of the reach.

Cold-water springs, plus stormwater runoff, are the source of Rinearson Creek (Falling Springs, 2018). Temperature monitoring in 2009 indicated that water temperatures upstream of the man-made dam remain cool and mostly below thermal limits for salmonids throughout the summer but warm substantially once flows reach the pond (Falling Springs, 2018). Furthermore, the confluence of Rinearson Creek is within the cold-water plume of the Clackamas River entering the Willamette, a location important to salmonids migrating and rearing in the Willamette (ODEQ 2020).

No bank armoring was observed during the survey, however, the gradient of and the substrate in the riffle below the beaver dam (which is large and angular) may restrict salmonid passage (Figure 76). The pool-dominated habitat units upstream of the beaver dam provide essentially no spawning areas for adult salmonids. Juvenile salmonids rearing in the mainstem Willamette River may be unable to access the deep pools with large wood and vegetative cover upstream of the beaver dam in Rinearson Creek; fish passage should be assessed at various streamflows. It should be noted, however, that resident salmonids such as cutthroat trout that are present in Rinearson Creek (Falling Springs, 2018) likely benefit from these habitats.

Figure 76. Steep riffle in Rinearson Creek extending from the confluence with the Willamette River side channel up to the beaver dam, and part of previous restoration project in Rinearson Creek. Riffle substrates consist of relatively large, angular rock.

4.6 RIVER FOREST CREEK – REACH 1

4.6.1 Reach conditions

River Forest Creek was not surveyed due to limited, discontinuous landowner access permission. Where publicly accessible (e.g., road crossings, Parks) the Creek was visited and observations recorded in this section. Generally, the channel is small and the land use immediately adjacent the Creek channel is residential – buildings, yards, roads – confining the channel.

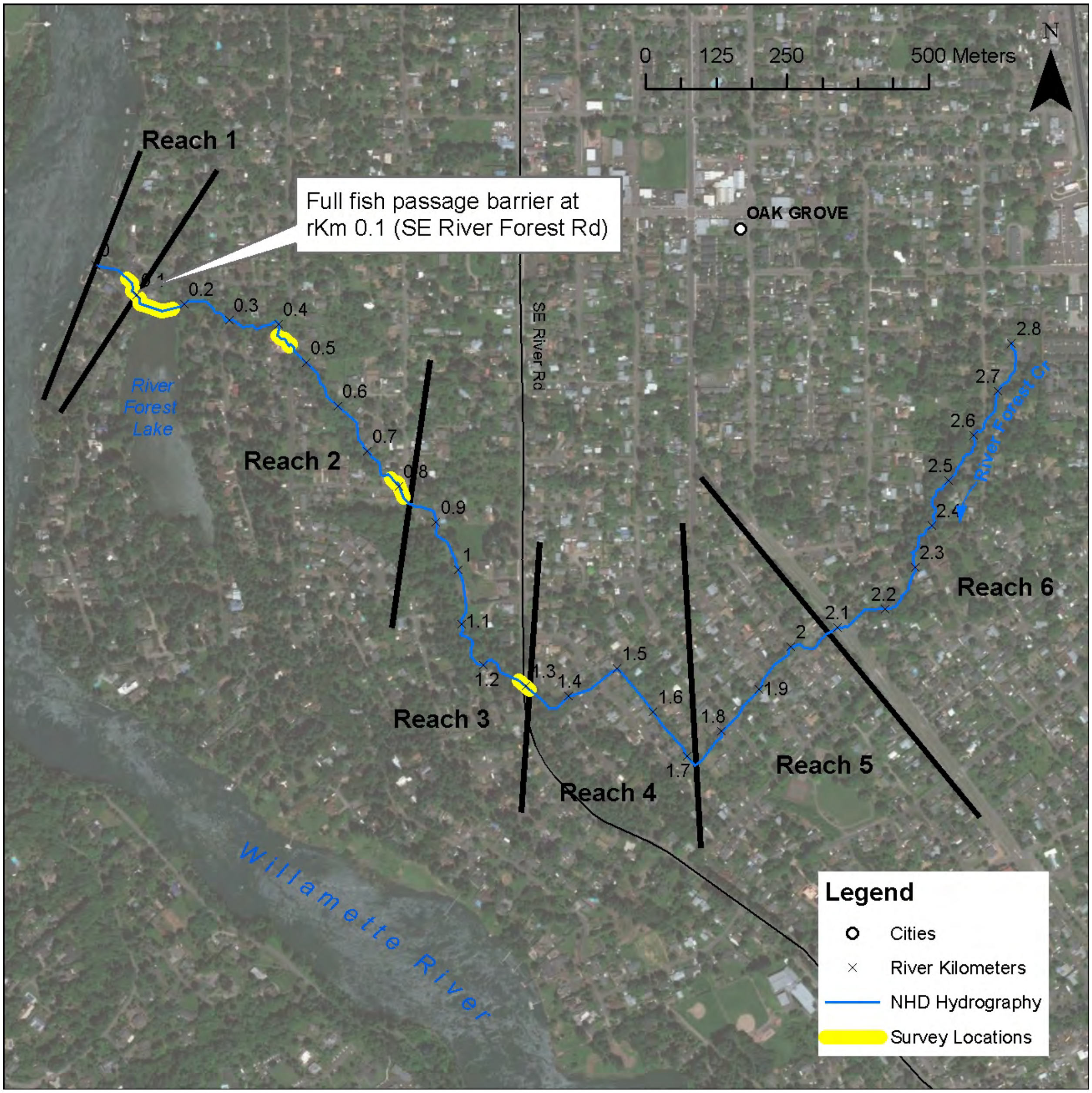


Figure 77. Map showing River Forest Creek and the areas visited during the field investigation. Note investigation areas were limited to road crossings due to limited landowner access.

Figure 78. Standing on SE River Forest Drive, looking downstream at River Forest Creek channel out to confluence with Willamette River.

Figure 79. View of outlet of culvert through SE River Forest Drive from river left bank.

Figure 80. Upstream culvert inlet for SE River Forest Drive crossing, with debris rack and overflow culvert, substantial bank armoring, and debris accumulation. This culvert maintains River Forest Lake water surface levels.

Figure 81. River Forest Lake. In foreground Himalayan blackberry invasive vegetation can be observed. In background, can see example of bank armoring along lake frontage and unvegetated, managed lawns.

Figure 82. River Forest Creek at SE Fairoaks Ave crossing (looking downstream).

Figure 83. River Forest Creek at corner of SE Laurie Ave and SE Anspach St. (looking upstream).

Figure 84. River Forest Creek at SE River Rd crossing (looking downstream)

Figure 85. River Forest Creek at SE Fairoaks Ave crossing (looking upstream).

4.6.2 Channel Infrastructure and Road Crossings

The culvert located at rKm 0.1 under SE River Forest Drive is a full fish passage barrier (Figure 79, Figure 80). Numerous other road crossings and channel modifications are present throughout the watershed.

4.6.3 Summary

No fish passage is possible above rKm 0.1 and SE River Forest Road crossing. All restoration recommendations are focused on water quality and wetland enhancement (overall fluvial riverine processes restoration) and vegetation enhancement within riparian areas or along the Lake banks as well as invasive species control. However, it is important to note that if the River Forest Road crossing is removed or replaced with a fish-passable crossing structure, additional restoration action types would become more appropriate, or prioritization of restoration actions may shift, in River Forest Creek upstream of the road and lake.

Water quality and macroinvertebrate sampling in River Forest Creek show that at the outlet of River Forest Lake, water is turbid, high in phosphorus, organically enriched, low in dissolved oxygen, and has warm water temperatures. River Forest Lake contributes to excessive warming of water temperatures leaving the Lake and entering the Willamette River (Raymond, 2007). More recent water quality testing in 2012 continued to show low dissolved oxygen in River Forest Creek (even upstream of the Lake) and macroinvertebrate sampling during the same period observed low macroinvertebrate species diversity and high proportion of species that are tolerant of poor aquatic conditions (Cole and Haxton, 2013). The Clackamas Partnership Strategic Plan (2018, p. 16) recommends an emphasis on efforts that improve water quality and hydrology issues for these small urban tributaries that flow into the Willamette River, which did not historically support salmon and steelhead spawning but provided important rearing habitat and cool water inputs.

4.7 ADDITIONAL REACHES NOT SURVEYED

4.7.1 Upper Kellogg Creek

Upper Kellogg Creek, covering approximately reaches 2 – 4, was visited by Inter-Fluve staff in 2018 and early 2019 as part of the Upper Kellogg Basin Assessment (Inter-Fluve, 2019a). Habitat units were not explicitly surveyed at the time of the field visits, however, habitat conditions were observed and compared to documented surveys by ODFW from the 1990s and 2000s. Field conditions in 2018 and 2019 did not appear to differ substantially from those observed during the ODFW surveys.

Upper Kellogg displays many of the same degraded aquatic habitat conditions that are found in other urban stream systems in the region. Within the Upper Kellogg Creek reach, much of the channel has been simplified from historical conditions, and disconnected from or lacking floodplain habitats and riparian areas. In the Upper Kellogg reach the majority (~80%) of the instream habitat was glide habitat (ODFW & WES 2003). Only approximately 2% of the units surveyed were pools (defined as habitats with residual depth as flows diminish). In 2019, surveys of Kellogg Creek show relatively consistent channel and valley characteristics throughout the surveyed portion of the reach, with the primary habitat units being long, often shallow, pool units (70%). These pool units appear to largely be formed by beaver dams or artificially-created rock weirs (consisting of cobbles and boulders presumably created by landowners). The classification of habitat units as glides or pools by the survey crew may account for the difference in habitat composition over time, as it is unlikely to have changed all that dramatically in the past 20 years. Surveys differed little among the years in the quantity of large wood present in Kellogg Creek, however. Little to no large woody material was recorded during this habitat assessment. Available instream cover for salmonids was primarily from undercut banks. A relatively high proportion of fine sediments was also recorded in the upper portions of the creek, while approximately 20% of the habitat units contained actively eroding banks. These habitat surveys indicated little stream shading was provided by the riparian areas (ODFW & WES 2003).

Much of the former wetland and floodplain areas associated with Kellogg Creek have been converted to residential uses, with roads, driveways, landscaped yards and parks located in the historical floodplains of Upper Kellogg Creek. As a result of these land uses, the riparian vegetation is heavily altered from the historical conditions as well as the surrounding vegetation communities. There are few large trees along the channel banks, and invasive vegetation species, including blackberry, are common within the Upper Kellogg reach. A lack of riparian shading increases solar radiation reaching the water surface of Kellogg Creek. Invasive species, such as English ivy and blackberry, may be contributing to increased erosion in some portions of the Upper Kellogg reach as these plants have limited root structures providing less structure for the stream banks.

Furthermore, flooding and nuisance sedimentation have been noted by residents and agencies living and working in the Upper Kellogg Creek subbasin (Clackamas County WES, 2019). Many of the eighteen roads and driveways that cross the creek within the Upper Kellogg reaches are associated with the flooding or sedimentation issues. Additional concerns within the Upper Kellogg Creek subbasin include loss of infiltration of rainwater and efficient delivery of runoff to streams due to impervious surfaces and the piped storm drainage system, loss of tree canopy in riparian corridors and uplands, untreated runoff from impervious surfaces, floodplain development, and land management practices (Brown and Caldwell 2009; Wolf Water Resources 2017).

4.7.2 Upper Mt. Scott Creek

Reaches 6 – 8

Reach 6 of Mt. Scott Creek begins at the upstream end of the I-205 culvert and reach 8 terminates at the downstream end of the Sunnyside Road crossing. These reaches are grouped due to geomorphic similarities, with reaches 6 – 8 situated in a relatively narrow valley constrained by Mt. Talbert to the south and Sunnybrook Rd. to the north. Reaches 6-8 of Mt. Scott Creek were not included in physical habitat surveys due to the relatively high channel confinement, moderate stream slopes, and a high number of instream crossing structures downstream. In addition, recent habitat inventories and general knowledge of the reaches indicate significantly better instream habitat condition than are found in any other portion of the Kellogg/Mt. Scott Creek watershed.

The Mt. Scott Creek channel in reaches 6 through 8 is moderately confined by the narrow valley walls and has a channel slope often exceeding 2%. These channel conditions indicate habitat in these reaches is more suited to steelhead and cutthroat trout than other salmonid species, and fish sampling by ODFW has documented steelhead spawning in reach 6 and cutthroat trout distributed widely throughout the watershed upstream of I-205 (ODFW 2006, 2007, 2011, 2015, 2016; Friesen and Zimmerman, 1999). Based on ODFW habitat surveys, these reaches contain more complex habitat in the form of pools with wood and substrate consisting of more suitable gravel, cobble, and boulder than any reach downstream. The number of pools meets benchmarks described in this report, but a majority of pool depths are relatively shallow. Substrate is indicative of a high energy reach of stream with cobble and boulder more prevalent that gravel and sand (ODFW 2006, 2007, 2011, 2015, 2016).

Riparian habitat in reaches 6 through 8 consists of a dominant overstory of deciduous trees with increasing numbers of conifers (Western red cedar) as one moves upstream. Adequate riparian cover combined with shading from Mt. Talbert likely reduces influence from afternoon sun and maintains temperatures suitable for rearing salmonids. Corresponding with the improving condition of the riparian area, there is substantial instream wood in reaches 6-8 with wood loading approaching target benchmarks. In spite of high wood loading, there are few key pieces of large wood that are critical to maintaining channel structure and stability (ODFW 2006, 2007, 2011, 2015, 2016).

There are no potential barriers to upstream migration within these reaches, except for the I-205 crossing at the downstream end of reach 6. ODFW surveys documented steelhead upstream of this crossing in 2018 (Ben Walczak, ODFW, pers. comm. 2020) but there is no other indication that migratory fish (salmonids or lampreys) can pass through the 408-foot-long culvert (ODFW 2006, 2007, 2011, 2015, 2016; ODFW FHB Online Viewer, 2020).

Reaches 9 – 12

Reaches 9 through 12 of Mt. Scott Creek were not included in the physical habitat surveys for similar reasons as reaches 6-8. Like Mt. Scott Creek's reaches 6-8, recent habitat inventories and general knowledge of the reaches indicate significantly better instream habitat condition than are found in any other portion of the Kellogg/Mt. Scott Creek watershed.

Mt. Scott Creek reach 9 begins just upstream of the Sunnyside Road crossing over Mt. Scott Creek and Reach 12 ends at the presumed end of migratory fish use at SE 129th Ave in Happy Valley. In these reaches, the valley floor widens out as the stream moves away from the influence of Mt. Talbert, but gradient remains moderate (2-3%) with substrate consisting of a mix of gravels, cobbles, and boulders, though the proportion of gravel and fines increases as one moves upstream. Pool habitat is present in this reach but pool depths are shallow, corresponding to the higher fine sediment loads (ODFW 2006, 2007, 2011, 2015, 2016).

Riparian habitat in reaches 9 through 12 consists of a dominant overstory of conifer trees with an understory consisting of alder and big leaf maple. Similar to what is found in reaches 6 – 8, there is adequate large wood in the stream channel. However, much of the wood is smaller pieces and not considered key pieces that create and maintain channel structure over time (ODFW 2006, 2007, 2011, 2015, 2016).

There are no known potential barriers to fish migration within reaches 9 through 12 but further assessment is needed to determine if any other private road crossings exist that may impact fish passage. Several homes are found along the stream channel in these reaches, two of which were involved in fish passage restoration actions in the past (e.g., instream dam removal by Clackamas County WES and culvert replacement with a small bridge by SOLV).

5. Conclusions

The Rapid Bio-Assessment surveys in the prioritized reaches intended to update, or in some cases, supplement, existing historical data collected about stream aquatic habitat, water quality, and fish or macroinvertebrate species assemblages. In combination, these efforts indicate relatively low habitat quality among the four watersheds. In general, data support the idea that Mt. Scott Creek, particularly the upper reaches, supported higher quality habitat which in turn supports larger numbers of native fishes. As evidenced by the reaches visited during the Rapid Bio-Assessment and data from previous survey efforts, high-quality habitat is limited and sparsely distributed throughout the watersheds. Pool habitat, where present, was frequently shallow and lacking cover, while riffle habitat was minimal and often spawning gravels were lacking. Almost all of the historical floodplain habitats have been disconnected due to incision of the main channel or bank armoring/human infrastructure, leaving few areas for native species rearing and refugia. Water quality may exacerbate these habitat issues. For instance, summer water temperatures likely exceed the lethal limits for salmonids in some locations, and may affect the ability or desire of cold-water native species to migrate into, spawn, and rear in the four watersheds. Springs and seeps are known to exist, particularly in Kellogg and Mt. Scott Creeks, providing cool water inputs but the limited numbers of deep pools with cover and the challenging access to the watershed during a large portion of the year may mean these refuges are not fully utilized.

These urban streams therefore provide ample ecological uplift potential. Restoration and enhancement actions should aim to improve habitat quality for all life stages, address the nearly-universal water quality and passage issues, and support reconnection of floodplain, wetland, and other off-channel habitats. A strategic restoration plan that prioritizes and focuses efforts where the greatest benefit relative to cost may be realized will be important, given the complex land ownership and infrastructure present throughout the four watersheds. The following section provides a brief discussion on the various restoration actions that may be implemented within the North Clackamas watersheds, including the anticipated ecological benefits from the different types of actions as well as feasibility considerations.

6. Restoration Strategy

6.1 OVERVIEW

This report describes recommended aquatic habitat restoration actions for the four watersheds of the North Clackamas Watersheds Council (NCWC), including Kellogg Creek, Mt. Scott Creek, River Forest Creek, Rinearson Creek and Boardman Creek. The identified actions are guided in large part by the findings of the Four Watersheds Rapid Bio-Assessment (results described in this Report) and by other efforts performed by NCWC's partner agencies in the watersheds, including ODFW, Clackamas County WES, and others, which have provided a considerable amount of additional foundational material.

What are Restoration Actions?

Restoration Actions are on-the-ground activities that improve aquatic habitat conditions or the physical and ecological processes that support them. They may include planting vegetation along streams, adding large wood to the channel, removing features that constrain the channel, or reconnecting (or creating) habitat such as side-channels. They are tailored to specific settings and habitat enhancement objectives, while honoring the social, economic, and cultural values of the landowners in the four watersheds.

The purpose of this section is to present a suite of restoration action types that are tailored to the four watersheds and are intended to protect, restore, or enhance aquatic habitats and the ecosystem processes that create and sustain them. The development of restoration actions also takes into consideration the urban and suburban nature of landscapes in the four watersheds (industrial, roads, homes, etc.). The suite of potential restoration actions provides a toolbox for use in subsequent conceptual project design development phases. The toolbox describes each action's objectives, ecological functions, and desired aquatic species habitat benefits.

Following the description of this suite of potential restoration action types, specific locations identified during the field assessment as restoration opportunities within the reaches of the four watersheds are identified in Sections 8.1 - 8.5. This pre-conceptual level mapping of potential restoration actions areas may be refined in subsequent project phases based on 1) additional information that will be collected and analyzed, 2) ongoing discussions with the landowners, and 3) feedback from the NCWC Restoration Council and their agency partners.

Our overall approach has been to base the identification of potential restoration actions on an understanding of how changes to ecosystem processes have affected habitats and how those habitat conditions, in turn, have affected aquatic species. Our approach to restoration also involves addressing the drivers of degradation where possible. We further consider the opportunities and constraints imposed by landownership, land use, and other social and economic factors. In this way, we can develop actions that improve habitats and the ecosystem processes that create and sustain them, but that are also set within an appropriate social context.

Reach-Based Aquatic Habitat Restoration Strategy

The restoration strategy establishes the framework for identifying, prioritizing, and selecting restoration actions and combining them into a comprehensive reach scale approach to address habitat impairment.

In developing restoration actions and identifying potential application areas on the landscape within the prioritized reaches in which field assessments were conducted, our approach strives to apply principles of process-based restoration. This includes, to the extent practicable, addressing root causes of problems, performing actions within the appropriate human and bio-physical context, performing actions at appropriate scales, and being explicit about expected outcomes. These principles are generally based on those outlined in Beechie et al. (2010). Furthermore, there are limitations in the ability to fully apply the principles of process-based restoration within the confines of an urban setting and there are ecosystem and geomorphic processes operating at larger scales that affect reach-scale conditions. Our objective is nevertheless to apply process-based principles to the extent practicable, and to acknowledge the influence of broader process drivers and the constraints imposed by past and on-going land uses.

6.2 RESTORATION ELEMENTS

Working with natural channel processes is often the most effective strategy for restoring and maintaining aquatic species habitat (Beechie 2008, Beechie et al. 2010, Krueger 2017). As such, the strategy described here follows the guidelines of 1) protection, 2) reconnection and restoration, and 3) enhance and create. These priorities have been tailored to the reach as described in the following sections.

6.2.1 Protection

Protection strategies for restoration focus on preserving properly functioning or naturally recovering areas. They generally provide the opportunity for continuation of natural processes to maintain aquatic habitat. They can include actions such as:

- Land use acquisition; and
- Education and outreach efforts (e.g., guidelines and informative booklets to empower landowners to become streamside steward)

Protection strategies should be monitored for performance over time as conditions in the reach and watershed change. Adaptive management may be needed to address new risks to the protected areas or new opportunities become available in the watersheds.

6.2.2 Reconnect and Restore

Reconnection and restoration strategies focus on actions that remove impairments to natural processes and establish conditions for sustaining those processes in the long run. These actions focus on opening up and reconnecting habitats that are already present in the system but unusable by fish or other aquatic species under existing conditions and can include actions such as:

- Floodplain reconnection (e.g., reconnecting existing low floodplain surfaces that are cut off from surface water flows via unnatural blockages or uplifting the bed elevation of an incised channel to reactivate existing floodplains);
- Off-channel reactivation (e.g., removing an unnatural blockage from the inlet of a side channel);
- Riparian vegetation management and planting (e.g., removal of invasive species and replanting with native species); and
- Fish passage improvements (e.g., removal of full or partial barriers to upstream habitats, or the modification of instream channel conditions to improve likelihood of fish passage)

Given the urban/suburban nature of the four watersheds and the land uses immediately adjacent to the reaches, projects within the four watersheds cannot impact the landowners (for example, in most cases there can be no increase to water surface elevations as a result of restoration projects since flooding is already a known issue in the region). For this reason, projects that simply reconnect floodplain or reactive off-channel habitats are assumed to be limited and have not be presented at this point.

Reconnection and restoration strategies should be monitored for performance over time as conditions in the reach and watershed change. Adaptive management may be needed to address new risks to the reconnected and restored areas to improve their long-term potential for supporting aquatic species restoration.

6.2.3 Enhance and Create

Enhancement and creation strategies focus on actions that provide immediate habitat benefits while applying the process-based principles to improve their suitability, function, and persistence (Beechie et al. 2010). This can include actions such as:

- Off-channel habitats (e.g., a side channel or alcove excavation that emulates the conditions left following a channel avulsion or progressive migration);
- Floodplain & wetland habitats (e.g., a floodplain bench excavation that emulates the conditions left by lateral channel migration and bar growth);
- Large wood structures (e.g., a large wood structure that emulates the accumulation of large wood on the outside of a meander bend or at the apex of a bar); and
- Bank treatments (e.g., removal of bank armoring and replacing with a bank treatment that reestablishes more natural bank form and provides a base for riparian vegetation regrowth).

- Natural channel re-alignment (e.g., return existing channel that has been straightened and modified to more natural, sinuous, and appropriately-sized planform)

Enhancement and creation strategies should be monitored for performance over time as conditions in the reach and watershed change and as the design life of created structural elements is approached. Adaptive management may be needed to address the long-term limitations of structural enhancements and support the reestablishment of natural processes (e.g. vegetation growth monitoring and replanting) in order to support aquatic species restoration.

6.3 STRATEGY CONSTRAINTS

The restoration strategy within the reach is constrained by a number of factors both at the reach and watershed scale. Project extents are limited to the reach, which restricts the ability to change watershed conditions such as land use or impact channel and floodplain processes outside the project reach. Furthermore, potential projects may be limited by physical site constraints, for example, locations where there is practical construction access or where existing structures or roads are to be maintained.

Additional constraints that may impact subsequent project design include landowner willingness and interest in a project, regulatory conditions, such as the County's FEMA no-rise code, extent of work below ordinary high water, and regulations on conversion of wetlands to waters, public safety, including things like recreation uses (swimming, boating, fishing), and cost effectiveness relative to likely available implementation funding.

7. The Restoration-Actions Toolbox

Why a Restoration-Action Toolbox?

Restoration actions provide a wide selection of tools to choose from and combine to suit the specific needs, opportunities, and constraints of the project. The tools presented are designed to partially restore processes that have been altered or modified, recreate previously limited habitat, and encourage a trajectory towards full recovery of the ecosystem and the processes that sustain it.

The study reaches within the four watersheds reflect a dynamic human and natural history. Residential and industrial development, extraction of natural resources, and flashy urban hydrology has resulted in deterioration of habitat, disconnection between floodplain and channel, and degraded water quality. Addressing the existing conditions of the study reach requires an integrated and holistic understanding of how issues manifest locally and the large-scale processes driving them. The term 'restoration' is used as a broad catch-all when referring to recommended actions; however, it's acknowledged that many of the actions are not restoration in the true sense of the word and would be more appropriately labeled as enhancement or creation (Beechie et al. 2010).

Seven potential restoration action types are presented below for the four watersheds (Figure 86). Although these are presented here in the toolbox as discrete actions, in many cases, multiple action types can be combined to collectively achieve broader-scale objectives. The application of these restoration action tools in each of the watersheds has been tailored to fit the particular habitat conditions, land uses, and geomorphic context of the site.

Figure 86. Restoration Actions Toolbox: restoration action types applicable to the four watersheds.

7.1 RIPARIAN MANAGEMENT

The reaches have been residentially or industrially developed almost up to the channel in many locations, drastically reducing or modifying the available riparian zone. In general, the vegetation within the project area, where it does exist, does not display the range of different successional classes or variety of vegetation communities indicative of a dynamic, properly functioning riparian system. Dense non-native vegetation (e.g. Himalayan blackberry and Reed canary grass) has proliferated in these frequently disturbed urban stream systems.

Riparian management restoration projects would be located in areas where native riparian vegetation communities have been significantly impacted by anthropogenic activities such that riparian functions and connections with the stream are compromised. The locations of riparian restoration projects will be prioritized in areas where there is very little existing vegetation adjacent to the channel, where there are high concentrations of invasive or non-native plant types, or where the existing vegetation is likely to be disturbed by other restoration actions or temporary construction impacts such as within access and staging areas. Even though it is not always explicitly stated, riparian restoration is a recommended component of most restoration projects, particularly within the disturbance limits of the project.

7.2 FLOODPLAIN & WETLAND ENHANCEMENT

Channel and floodplain modifications (e.g., straightening, bank armoring, and hydrologic disconnection due to roads and infrastructure) have resulted in decreased floodplain function throughout many of the study reaches. This means that in many locations, floodplains are inundated infrequently and only at very high flows rather than at seasonal high flows. This loss of floodplain connection also limits the availability of low-velocity areas providing refuge habitat for juvenile salmonids rearing and flood water dissipation and infiltration during higher flows.

Similarly, channel and floodplain modifications have limited the extent of wetlands located in the floodplain areas and within the four watersheds. The benefits of wetland reconnection generally include floodwater and sediment attenuation and storage, and improvements to water quality and aquatic habitat. Wetland reconnection with the main channel, regrading of the slopes, planting of native vegetation and addition of roughness features such as large wood could provide important off-channel velocity refuge habitats for rearing salmonids, allow increased stormwater and streamflow infiltration into the ground, and attenuate sediment and floodwater. The greatest habitat and floodwater storage benefits are attained when wetlands can be fully inundated with water during higher flows and native vegetation is supported. However, even more moderate actions with native plantings may provide benefits relative to existing conditions. Floodplain reconnection is proposed in areas that have the potential for increased habitat quality and re-establishment of dynamic fluvial processes. The creation of refuge habitats through floodplain reconnection likely entails excavation to achieve desired grades relative to targeted flow event water surface elevations.

7.3 OFF-CHANNEL HABITAT

Channel and floodplain modifications (e.g., straightening, bank armoring, and hydrologic disconnection due to roads and infrastructure) have also resulted in the loss of off-channel habitats, such as side channels or backwater alcoves. Natural re-development of off-channel habitat is likely to be a slow or impossible process, as many channel banks have been armored, are heavily entrenched, or the channel is locked in by surrounding land uses. This disconnection and lack of off-channel habitats limits the availability of suitable habitat for juvenile fish rearing or adult spawning, particularly during higher flows, and flood water dissipation during high flows.

Off-channel habitat features will be prioritized in areas which currently exhibit low channel complexity and where there is sufficient area to allow for the off-channel feature. Given the substantial land uses constraining the channels throughout much of the watersheds, the limited locations where these features may be feasibly constructed should be utilized. Construction of these areas likely entails excavation to achieve desired grades for the particular activation flow, and includes placement of large wood at appropriate locations, planting of aquatic and riparian vegetation, and management of existing surrounding vegetation.

7.4 LARGE WOOD

These watersheds have a long history of anthropogenic modifications—including early agricultural development and subsequent residential clearing and development – both adjacent to the channel and within the contributing hillslopes. This history has resulted in the loss of old growth forest adjacent to the channel, which in turn limits the number, size and volume of large wood that can be naturally recruited by the stream. This decline in large wood recruitment has been detrimental to ecological and morphological processes and the establishment of suitable aquatic habitat. It is also likely, based on similar practices known to have occurred throughout the Pacific Northwest, that large wood was removed from the channels in the four watersheds.

Large wood projects can span a broad range of form- versus function-based approaches. For example, a single log placement might be used in an existing pool or a large wood structure may be placed at a confluence of two stream to simply provide salmonid hiding cover, which would be primarily a form-based approach. In contrast, a large wood structure might be used as a more function-based element that is intended to create split-flow conditions and help maintain side channel flows, create a bar/island complex, and to create or maintain scour pools. Smaller wood features, such as those called Beaver Dam Analogues (BDAs) may be utilized in certain portions of the watersheds where increasing pool habitat, wetland creation, or riparian management would benefit from increased water inundation extents/duration.

Large wood would be placed in areas where it would naturally accumulate. For example, accumulation frequently occurs along the outside of bends, at the apex of bars, or at the upstream end of riffles. Large wood placements are most sustainable in areas with appropriately matched hydraulic conditions. Locations would be selected where the large wood would be maintained by the existing stream hydrology and geomorphology.

7.5 BANK TREATMENTS

Bank erosion and armoring with riprap or concrete are common within the study reaches. The loss of bank vegetation and floodplain roughness that would have served to diffuse flood energy has resulted in increased localized stream power and scouring of the channel bed and banks. Increased stormwater runoff and storm flow flashiness as a result of the urban nature of these watersheds has likely also contributed to increased erosion of the banks and the landowner desire to protect those banks. Bank treatment actions would, in many cases, remove existing armor and replace with a more gradually sloped bank (where feasible) and bio-engineered bank approaches such as Fabric Encapsulated Soil (FES) lifts.

Bank treatments that lay back the bank and incorporate natural native vegetation and large wood provide a number of benefits to aquatic species, and provide many of the same benefits as riparian revegetation and management, habitat wood, side channel habitat, and floodplain roughness and reconnection. Bank treatments would be prioritized in areas experiencing accelerated channel migration where the existing riparian vegetation is limited or not mature. These bio-engineered bank treatments may also be valuable in areas where channel migration may threaten structures or roadways, to prevent emergency actions that are detrimental to fish habitat conditions (e.g., placement of riprap or levees). Following construction, the areas would be treated with planting of native species, and possibly integrated with use of biodegradable erosion control fabrics for near-term erosion protection.

7.6 CHANNEL RE-ALIGNMENT

The river corridor in some locations has been modified – straightened, simplified, and/or armored – limiting the availability of complex instream habitat features and discouraging natural re-development of these habitats. Additionally, straightening and armoring the channel has minimized surface water connections to historical floodplain areas.

Channel re-alignment actions will be prioritized in areas where channel straightening, disconnection, and channelization have occurred in the past and has decreased instream or floodplain habitat complexity. Construction of these areas will entail excavation to achieve necessary elevations to tie into the existing channel points, and include placement of large wood at appropriate locations, planting of aquatic and riparian vegetation, and management of existing surrounding vegetation. Channel re-alignment is only possible in areas where residential and urban infrastructure is set back away from the stream and riparian zones to allow enough space to re-meander and increase channel sinuosity, allow channel banks to be sloped back, and provide room for construction access. The re-meandered channel features should be appropriately matched to the local hydraulic conditions.

7.7 FISH PASSAGE IMPROVEMENTS

Barriers to anadromous fish passage, whether full barriers or only partial barriers depending on the flow or season, are present throughout the four watersheds. Road crossings with undersized culverts or bridges make up a majority of the passage issues in these basins, though there are also more minor channel alternations (such as small manmade rock weirs altering flow dynamics throughout much of the surveyed reach of Kellogg Creek), historic small dams, and channel drops due to instream riprap substrate that likely influence native fish species' movement in the watersheds.

Bridges and road prisms that constrict the channel and limit the dynamic movement of the stream channel may act as velocity barriers to migrating fish during higher flow events. Old bridges or remnant bridge components, roads, or other infrastructure that is no longer used and which interacts with the stream channel and floodplain areas should be removed to encourage natural geomorphic channel processes.

Undersized culverts, or culverts that have filled in with sediments and no longer provide an appropriate cross-sectional area for the volume of stream flow, may similarly act as velocity barrier to migrating salmonids during higher flows. At baseflows, the culverts may completely disconnect the upstream and downstream channels (e.g., perched culverts) or create shallow water depths that prevent salmonid movement through the culvert. At higher flows, undersized culverts and bridge openings may limit volitional salmonid movements throughout the watersheds due to high water velocities.

Passage improvement actions will be prioritized in areas where passage is most impaired and where, by improving passage, the greatest amount of habitat would be made available spatially or temporally (i.e., more physical habitat would be available or the duration of time during the year that the habitat is available is increased). Re-evaluation of potential projects in a system may be warranted following passage improvement projects. Opportunities to pair passage improvement actions with other infrastructure projects, such as public works improvements, may be possible.

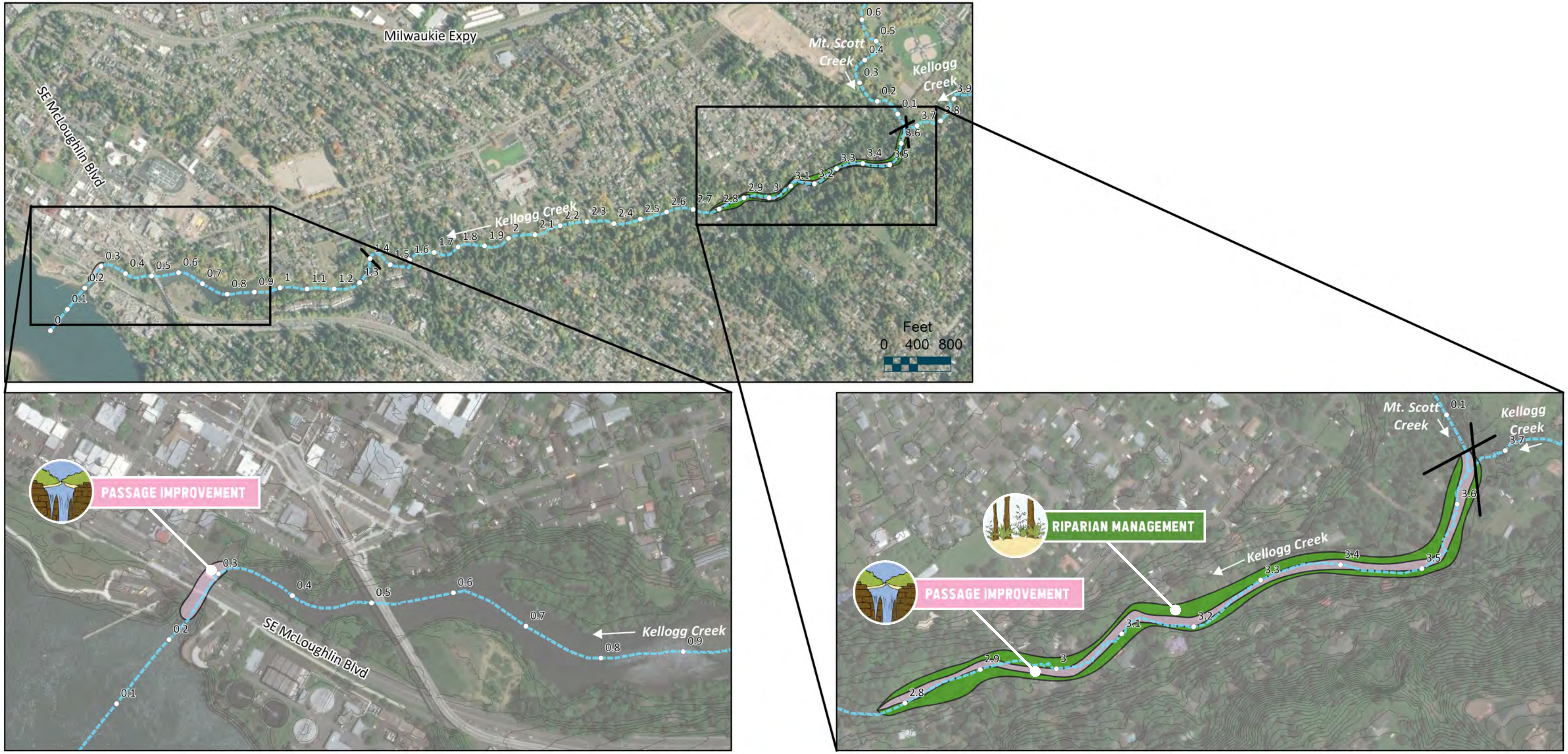
8. Potential Project Identification

Restoration action types identified in the Toolbox are applied to appropriate locations within each of the watersheds throughout the following sub-sections. These potential projects are visually represented on maps and described in more detail in the potential project tables for each reach (Table 33 - Table 38). Potential projects are generally limited to the reaches visited during the field investigation, since on-the-ground conditions are important to consider prior to any further project design. Furthermore, these reaches were identified during the reach prioritization process (see the Rapid Bio-Assessment Protocol, Inter-Fluve 2019b for a complete description of reach prioritization methods) as the reaches with the greatest potential to support fish and other aquatic species or suitable geomorphic conditions to make restoration feasible.

Several project types were identified that are recommended across all of the four watersheds, including additional data collection efforts and assessments, education and outreach to landowners, riparian management and opportunistic land acquisition (Table 33).

Table 33. Project types that are applicable across all watersheds.

Project Name	Project Description	Considerations
Comprehensive Barrier Assessment	Document and assess degree of passage barriers throughout watersheds to prioritize access improvement projects in future.	Require large landowner access outreach effort. Potential to partner with other organizations.
Water Quality Assessment	Document and assess degree of water quality impairments within the four watersheds, to prioritize water quality improvement projects.	Require large landowner access outreach effort.
Streamside Stewards Education & Outreach	Develop landowner handbook on best Streamside Stewards practices, including riparian vegetation management recommendations and stream bank management and armoring alternatives.	Relatively low cost – can create a single document that applies to all landowners in the four watersheds.
Invasive Vegetation Management & Native Species Revegetation	Actively control invasive species spread and replace with native plant species.	Low cost but a long-term, ongoing project (has no end).
Land acquisition	Acquire properties as they become available and as funding allows. Selectively target properties adjacent to channel where potential projects exist or where infrastructure could be removed to increase room for river channel and floodplain areas.	Work with project partners (e.g., Clackamas County WES). Riparian easements may also be an option in the short-term or for willing landowners.



inter·fluve

Projection: NAD 1983
State Plane Oregon North FIPS 3601

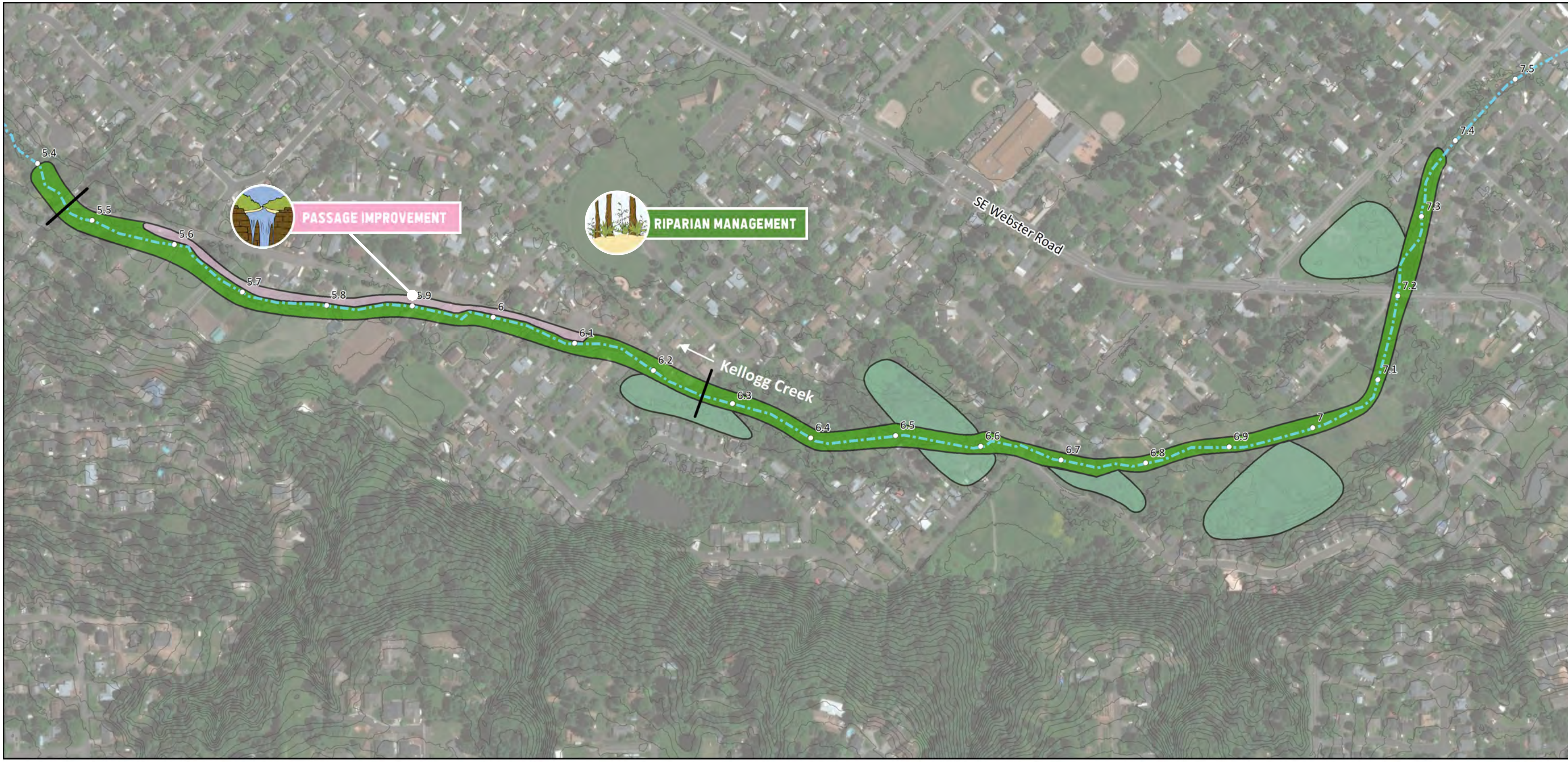
Feet
0 400 800

River kilometers
Channel centerline
Reach breaks

Restoration actions
Passage improvement
Riparian management

Note: Rest of reach not surveyed due to access limitations, however, passage improvement and riparian management actions likely applicable to entire reach.

Kellogg Creek, Reach 1
North Clackamas Watersheds Council
Project Identification



Projection: NAD 1983
State Plane Oregon North FIPS 3601

Feet
0 400 800

Contours (5ft)
Channel centerline
River kilometers
Reach breaks

Restoration actions
Floodplain enhancement
Passage improvement
Riparian management

Kellogg Creek, Reach 2

North Clackamas Watersheds Council
Project Identification

Table 34. Potential restoration actions in the Kellogg Creek watershed. Please reference maps for more detailed location of potential actions.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
1	0.04 - 0.25	Passage Improvement	Kellogg Dam Passage Improvement	Remove Kellogg Dam or improve passage through fish ladder at mouth of Kellogg Creek and restore naturalized channel. May include stabilization of Kellogg Creek channel and other infrastructure.	Project could also include improvements to fish ladder to provide interim access while dam removal designs are developed. Long-term, large, and high-cost project. Recreational value of Kellogg Lake, stability of infrastructure, and contamination of impounded sediments all potential issues. However, extremely high value project due to potential for increased access to higher-quality available habitat in Mt Scott, especially.
All	All	Bank Treatment & Riparian Management	Kellogg Creek riparian & bank enhancement	Work with landowners to replace bank and (in some locations) bed armoring with more natural bank conditions (FES lifts, bank slope backs, large wood bank stabilization, etc.) and to control the spread of invasive vegetation like Himalayan blackberry & English ivy, replanting with native species. (NOTE: applicable to entire Creek length, however, entire length is not shown on maps)	The proximity of houses and residential land uses to the active channel precludes any substantial habitat improvement efforts in this reach (to avoid any adverse impact to landowners).
All	All	Passage Improvement	Kellogg Creek Instream Passage Improvements	Work with landowners to remove man-made rock weirs placed throughout the channel in Kellogg Creek Reach 1 to return channel to more natural habitat patterns.	The proximity of houses and residential land uses to the active channel precludes any substantial habitat improvement efforts in this reach (to avoid any adverse impact to landowners). However, allowing natural habitat patterns in the stream bed may provide low cost, small benefits.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
4	5.93	Floodplain Enhancement	Upper Kellogg floodplain wetland enhancement	Address flooding issues and improve water quality in Kellogg Creek by reconnecting wetland and floodplain habitats. Help attenuate flood flows /decrease flashy flood flows, retain water in Kellogg longer.	Project location identified in Upper Kellogg Basin Assessment (Inter-Fluve, 2019b). See Basin Assessment for more details.
4	6.18 – 6.25	Floodplain Enhancement	Upper Kellogg floodplain wetland enhancement	Address flooding issues and improve water quality in Kellogg Creek by reconnecting wetland and floodplain habitats. Help attenuate flood flows /decrease flashy flood flows, retain water in Kellogg longer.	Project location identified in Upper Kellogg Basin Assessment (Inter-Fluve , 2019b). See Basin Assessment for more details.
5	6.5 – 6.6	Floodplain Enhancement	Upper Kellogg floodplain wetland enhancement	Address flooding issues and improve water quality in Kellogg Creek by reconnecting wetland and floodplain habitats on both river right and left banks. Help attenuate flood flows /decrease flashy flood flows, retain water in Kellogg longer.	Project location identified in Upper Kellogg Basin Assessment (Inter-Fluve, 2019b). See Basin Assessment for more details.
5	6.65 – 6.75	Floodplain Enhancement	Upper Kellogg floodplain wetland enhancement	Address flooding issues and improve water quality in Kellogg Creek by reconnecting wetland and floodplain habitats. Help attenuate flood flows /decrease flashy flood flows, retain water in Kellogg longer.	Project location identified in Upper Kellogg Basin Assessment (Inter-Fluve 2019b). See Basin Assessment for more details.
5	6.95	Floodplain Enhancement	Upper Kellogg floodplain wetland enhancement	Address flooding issues and improve water quality in Kellogg Creek by reconnecting wetland and floodplain habitats. Help attenuate flood flows /decrease flashy flood flows, retain water in Kellogg longer.	Project location identified in Upper Kellogg Basin Assessment (Inter-Fluve, 2019b). See Basin Assessment for more details.
5	7.2	Floodplain Enhancement	Upper Kellogg floodplain wetland enhancement	Address flooding issues and improve water quality in Kellogg Creek by reconnecting wetland and floodplain habitats. Help attenuate flood flows /decrease flashy flood flows, retain water in Kellogg longer.	Project location identified in Upper Kellogg Creek Floodplain Restoration Assessment (2017).

Projection: NAD 1983
State Plane Oregon North FIPS 3601
Feet
0 400 800

Contours (5ft)
Railroad
Channel centerline
River kilometers
Reach breaks

Restoration actions
Bank treatment
Floodplain enhancement
Large wood
Off-channel habitat
Passage improvement

Mt Scott Creek, Reaches 3-4

North Clackamas Watersheds Council
Project Identification

inter·fluve

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Projection: NAD 1983
State Plane Oregon North FIPS 3601
Feet
0 400 800

Contours (5ft)
Railroad
Channel centerline
River kilometers
Reach breaks

Restoration actions
Bank treatment
Channel realignment
Floodplain enhancement
Large wood
Off-channel habitat
Passage improvement

Mt Scott Creek, Reach 5
North Clackamas Watersheds Council
Project Identification

Table 35. Potential restoration actions in the Mt Scott Creek watershed. Please reference maps for more detailed location of potential actions.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
3	2.2	Passage Improvement	Reach 3 fish passage assessment & improvement	Assess fish passage at WES Water Control structure & improve passage if necessary	Evaluate function and necessity of WC structure first.
3	2.2 - 3.67	Bank Treatment & Large Wood	Reach 3 mainstem large wood and bank enhancement	Improve fish habitat by adding large wood pieces to channel to enhance or encourage scour pools, sediment sorting, and provide cover/refuge habitat, and slope back banks.	Large wood types include key piece placements as well as habitat complexity jams along banks.
3	2.2 - 3.67 (Entire reach)	Riparian Management	Reach 3 riparian enhancement	Control spread of invasive species such as Himalayan blackberry and English ivy, and replant with native vegetation species.	
3	3.5	Passage Improvement	Reach 3 infrastructure removal	Remove bridge crossing channel and creating a constriction.	If access is necessary via this crossing location, potentially replace bridge with a larger spanning bridge to eliminate artificial constriction to channel.
3	2.5 - 2.77	Floodplain Enhancement & Off-Channel Habitat	Reach 3 off-channel and floodplain	Add side channel or off-channel (e.g., alcove) habitat, or create low floodplain/wetland surfaces that are frequently hydrologically connected to the Creek to provide fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Type of off-channel or wetland enhancement to be determined following more detailed site investigation.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
3	2.72 - 2.82	Floodplain Enhancement	Reach 3 floodplain wetland enhancement	Add side channel or off-channel (e.g., alcove) habitat, or create low floodplain/wetland surfaces that are frequently hydrologically connected to the Creek to provide fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Type of off-channel or wetland enhancement to be determined following more detailed site investigation.
3	2.8 - 2.9	Floodplain Enhancement & Off-Channel Habitat	Reach 3 off-channel and floodplain	Add side channel or off-channel (e.g., alcove) habitat, or create low floodplain/wetland surfaces that are frequently hydrologically connected to the Creek to provide fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Type of off-channel or wetland enhancement to be determined following more detailed site investigation.
3	2.95 - 3.1	Floodplain Enhancement & Off-Channel Habitat	Reach 3 off-channel and floodplain	Add side channel or off-channel (e.g., alcove) habitat, or create low floodplain/wetland surfaces that are frequently hydrologically connected to the Creek to provide fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Type of off-channel or wetland enhancement to be determined following more detailed site investigation.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
3	3.03 - 3.2	Floodplain Enhancement & Off-Channel Habitat	Reach 3 off-channel and floodplain	Add side channel or off-channel (e.g., alcove) habitat, or create low floodplain/wetland surfaces that are frequently hydrologically connected to the Creek to provide fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Type of off-channel or wetland enhancement to be determined following more detailed site investigation.
3	3.17 - 3.27	Floodplain Enhancement & Off-Channel Habitat	Reach 3 off-channel and floodplain	Add side channel or off-channel (e.g., alcove) habitat, or create low floodplain/wetland surfaces that are frequently hydrologically connected to the Creek to provide fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Type of off-channel or wetland enhancement to be determined following more detailed site investigation.
3	3.28 - 3.47	Floodplain Enhancement & Off-Channel Habitat	Reach 3 off-channel and floodplain	Add side channel or off-channel (e.g., alcove) habitat, or create low floodplain/wetland surfaces that are frequently hydrologically connected to the Creek to provide fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Type of off-channel or wetland enhancement to be determined following more detailed site investigation.
3	3.4 - 3.63	Floodplain Enhancement & Off-Channel Habitat	Reach 3 off-channel and floodplain	Add side channel or off-channel (e.g., alcove) habitat to create better fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Type of off-channel or wetland enhancement to be determined following more detailed site investigation. May even be possible to re-meander main MSC channel.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
3	3.67	Large Wood	Philips Creek confluence enhancement	Add large wood structure to encourage scour pool formation and to provide fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Place a large wood structure at the confluence where a deep pool is already present, to enhance rearing and holding habitat.
4	3.7 - 3.78	Floodplain Enhancement & Off-Channel Habitat	Reach 4 off-channel and floodplain	Add side channel or off-channel (e.g., alcove) habitat, or re-meander main channel to create better fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Type of off-channel or wetland enhancement to be determined following more detailed site investigation.
5	3.82 - 4.09	Channel Realignment	Mt Scott Creek mainstem re-meander	Add side channel or off-channel (e.g., alcove) habitat to create better fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Type of off-channel or wetland enhancement to be determined following more detailed site investigation. May even be possible to re-meander main MSC channel.
5	3.82 - 3.94	Large Wood	Dean Creek confluence enhancement	Add large wood structure to encourage scour pool formation and to provide fish rearing and refugia habitat, especially during high flows (refuge from high main stem velocities and cover habitat from predators)	Place a large wood structure at the confluence where a deep pool is already present, to enhance rearing and holding habitat.
5	4.1	Passage Improvement	Reach 5 stormwater pond assessment	Evaluate potential for fish stranding in these ponds when high flows overtop banks and send main channel surface flow into these ponds, then as water levels drop, ponds become disconnected potentially stranding fish (and then temperatures increase, potentially causing fish mortality)	Anecdotal information that stranding and mortality does occur.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
5	4.16 - 4.23	Off-Channel Habitat	Reach 5 channel habitat	Route flows either perennially (split flow) or during high flows (side channel) into existing low depression on river right floodplain	Type of hydrologic connection to be determined following more detailed site investigation.
5	4.1 - 4.33	Large Wood & Bank Treatments	Reach 5 large wood and bank enhancement	Improve fish habitat by adding large wood (key pieces and small LW structures) to channel to enhance or encourage scour pools, sediment sorting, and provide cover/refuge habitat. Possibly create riffle/pool sequences in channel.	Large wood types include key piece placements as well as habitat complexity jams along banks.
5	4.23 - 4.3	Floodplain Enhancement	Wetland Enhancement	increase hydrology and connection of an existing wetted floodplain area to the mainstem MSC channel.	
5	4.58	Passage Improvement	84th Ave culvert replacement	Replace series of three filled in culverts at 84th Ave crossing with a bridge.	
5	4.58 - 5.05	Large Wood & Bank Treatments	Reach 5 large wood and bank enhancement	Improve fish habitat by adding large wood pieces to channel to enhance or encourage scour pools, sediment sorting, and provide cover/refuge habitat. Possibly create riffle/pool sequences in channel.	Large wood types include key piece placements as well as habitat complexity jams along banks.
5	5.05	Passage Improvement	I-205 fish passage improvement	Create roughened channel downstream of existing large riprap apron out of I-205 culvert to increase fish passage through culvert	Add cobble/gravel to existing riprap apron and add roughened channel downstream of existing culvert riprap apron to decrease slope of and increase passability by native fish.
5	4.92 - 5	Off-Channel Habitat	Reach 5 channel habitat	Route flows either perennially (split flow) or during high flows (side channel) into existing low depression on river right floodplain	Type of hydrologic connection to be determined following more detailed site investigation.
5	4.74	Floodplain Enhancement	Wetland Enhancement	River right wetlands at toe of hillslope (capturing stormwater, likely) have a small connection to the main channel but could be more connected. Utilize wetlands to improve stormwater water quality before entering Mt Scott.	May also provide water quality benefits by filtering stormwater prior to reaching MSC channel.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
5	4.74	Floodplain Enhancement	Bike path wetland reconnection	Bike path disconnecting wetland/stormwater area at toe of hillslope from main channel. Create bridge/connection through the bike path	Increase connectivity between floodplain wetland areas and main channel.
5	3.82 – 5.05 (Entire reach)	Riparian Management	Reach 5 riparian enhancement	Control spread of invasive species such as Himalayan blackberry and English ivy, and replant with native vegetation species.	

inter·fluve

Projection: NAD 1983
State Plane Oregon North FIPS 3601
Feet
0 400 800

Contours (5ft)
Channel centerline
River kilometers
Reach breaks

Restoration actions
Floodplain enhancement
Large wood
Passage improvement
Riparian management

River Forest Creek, Reaches 1-3
North Clackamas Watersheds Council
Project Identification

Table 36. Potential restoration actions in the River Forest Creek watershed. Please reference map for more detailed location of potential actions.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
1	0 - 0.1	Large Wood	River Forest confluence enhancement	Add key LW pieces, create or enhance scour pools, provide cover & refuge habitat. Riparian revegetation and invasive vegetation management also likely needed.	Upstream is completely disconnected for fish; focus efforts below road barrier.
2	0.1 - 0.2	Riparian Management	River Forest Lake Riparian Enhancement	Encourage replacement of riprap along Lake edges with more "natural" alternatives: revegetation with natural species and bank slope backs.	Objective is to improve water quality coming out of River Forest and into Willamette.
	0.2	Passage Improvement	River Forest Drive culvert replacement	Remove or replace River Forest Drive culvert to provide fish passage into River Forest Creek.	If this barrier was removed or replaced with a fish-passable culvert, additional projects upstream of this location may become higher priority/provide increased value for native species. Different project types, including channel habitat projects, may also be recommended as a result.
2	0.2 - 1.3	Large Wood	River Forest BDAs and Water Quality Enhancement	Place beaver dam analogue structures (BDAs) throughout River Forest Creek where feasible to attenuate flood flows, encourage water infiltration and water quality improvements to watershed.	Objective is to improve water quality coming out of River Forest and into Willamette through low-cost, straightforward methods.
3	0.8 - 1.06	Floodplain Enhancement	Wetland Enhancement	Increase wetland floodplain connection to main channel in existing open forested area.	Objective is to improve water quality coming out of River Forest and into Willamette.

inter·fluve

Projection: NAD 1983
State Plane Oregon North FIPS 3601
Feet
0 400 800

Contours (5ft)
Channel centerline
River kilometers
Reach breaks

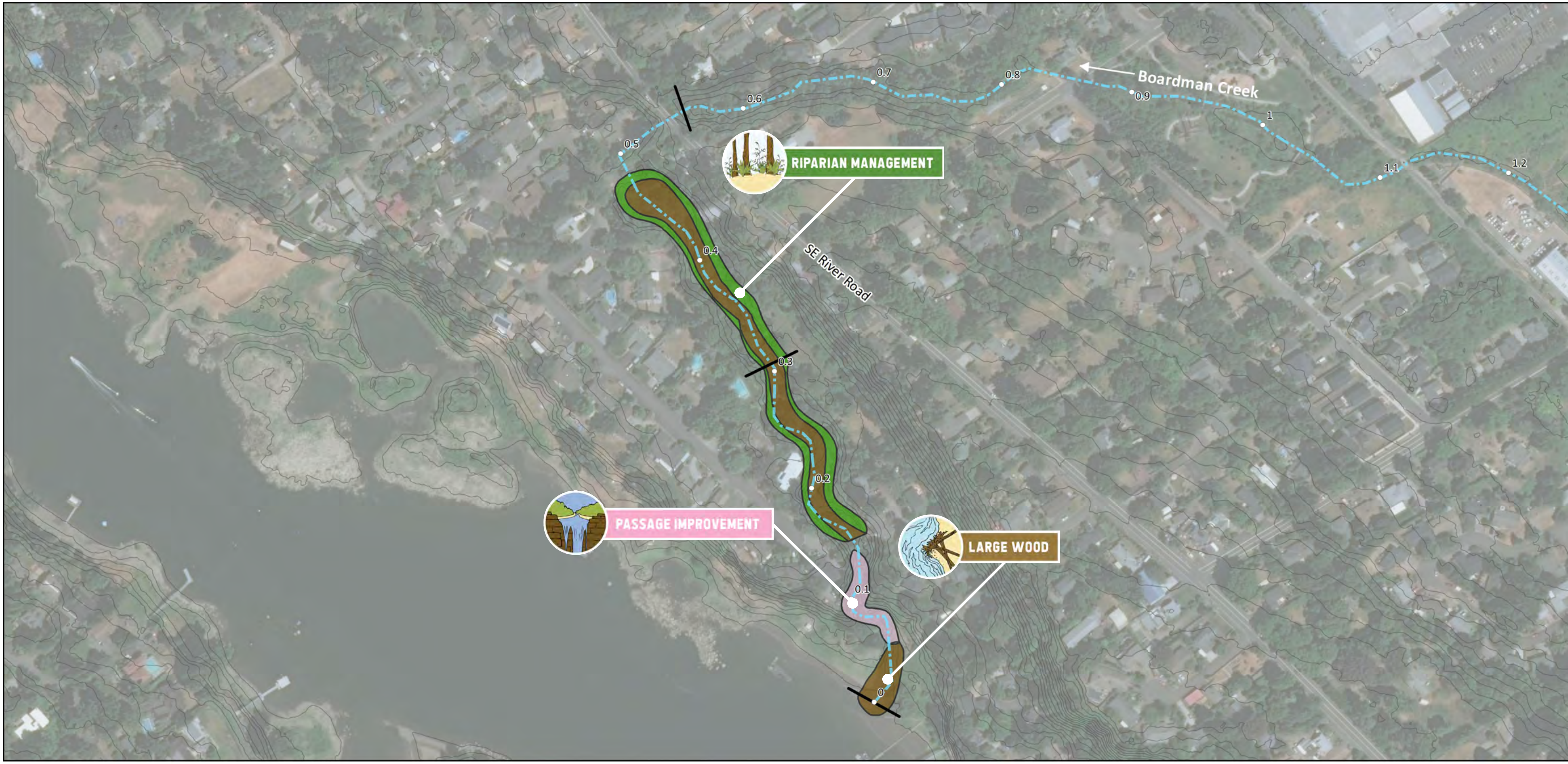
Restoration actions
Large wood
Passage improvement
Riparian management

Rinearson Creek, Reaches 2-3

North Clackamas Watersheds Council
Project Identification

Table 37. Potential restoration actions in the Rinearson Creek watershed. Please reference map for more detailed location of potential actions.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
2	0.19 - 0.26	Passage Assessment / Improvement	Rinearson Spawning Gravel Supplementation	Add spawning sized gravels and smaller rounded streambed material to existing angular rock present in this riffle from the restoration project done here previously	Location of previous project. Fish passage/use of Rinearson Creek important to understand first. A bed mobility assessment to determine gravel size class would also be recommended.
2	0.19 - 0.64	Riparian Management	Riparian Revegetation Supplementation & Invasive Control	Increase density of (or replace plants that didn't survive) revegetation efforts from previous restoration project, and control spread of invasive species	Plants in wetland area above beaver pond appear to be doing well. This project would focus on downstream of the beaver dam along the banks in the short and steep riffle at the mouth.
3	0.7	Passage Improvement	Rinearson barrier removal	Remove historical barrier to provide additional potential fish passage upstream into cool water refugia.	Temperature monitoring indicates cool water is present upstream of barrier, could provide refugia. However, unknown what physical habitat conditions are upstream of barrier and recommend site visit to evaluate.
3	0.64 - 1.13	Large Wood	Rinearson large wood	Improve fish habitat by adding key large wood pieces to channel to enhance or encourage scour pools, sediment sorting, and provide cover/refuge habitat.	Didn't walk this section; would need to in order to determine LW placement locations. Recommend implementation concurrently or after passage improvement at rKm 0.7.



Projection: NAD 1983
State Plane Oregon North FIPS 3601
Feet
0 400 800

Contours (5ft)
Channel centerline
River kilometers
Reach breaks

Restoration actions
Large wood
Passage improvement
Riparian management

Boardman Creek, Reaches 1-2

North Clackamas Watersheds Council
Project Identification

Table 38. Potential restoration actions in the Boardman Creek watershed. Please reference map for more detailed location of potential actions.

Reach	Project rKm	Restoration Action Toolbox Type	Project Name	Project Description	Considerations
1	0 - 0.13	Passage Improvement	Lower Boardman fish passage assessment	Evaluate fish passage potential over bedrock step and cascade (Willamette River water surface elevations compared to topographic survey elevations).	Use existing topographic survey that has possibly occurred here already (rebar control observed in two locations in this reach) in combination with gage data/existing hydraulic models of the Willamette River. Can be relatively low-cost assessment.
1	0 - 0.13	Passage Improvement	Lower Boardman fish passage improvement	If determined to be not passable, create step pools through the bedrock section to provide passage for steelhead at very least.	Expensive, complex due to residential uses at tops of banks.
1	0 - 0.05	Large Wood	Boardman confluence enhancement	Create refugia habitat off of mainstem Willamette River in Boardman Creek channel below the bedrock step.	Construction access from landowner roads.
2-3	0.16 - 0.48	Large Wood	Boardman large wood	Improve fish habitat by adding key large wood pieces to channel to enhance or encourage scour pools, sediment sorting, and provide cover/refuge habitat.	Existing habitat has potential, if fish can access for even a part of the year. If had more wood and gravel / sediment retention could be decent spawning habitat. Upstream of Rkm 0.48 are series of impassable culverts (especially River Road crossing).

9. Next Steps

This report provides the foundational material to move forward with the more detailed restoration designs for selected projects. The understanding developed from these efforts of the physical and biological conditions within the watersheds and reaches will help advance the ideas presented in this report into conceptual designs and provide a baseline for evaluating those proposed designs.

The potential restoration actions presented in this report will be prioritized in subsequent phases of this effort, with selected projects moving forward to be refined during the conceptual design phase. The efforts in these future phases will take into consideration a number of factors including: 1) consistency with natural process, 2) landowner willingness, 3) biological limiting factors, 4) physical opportunities and constraints, 5) regulatory conditions, 6) public safety, and 7) cost effectiveness.

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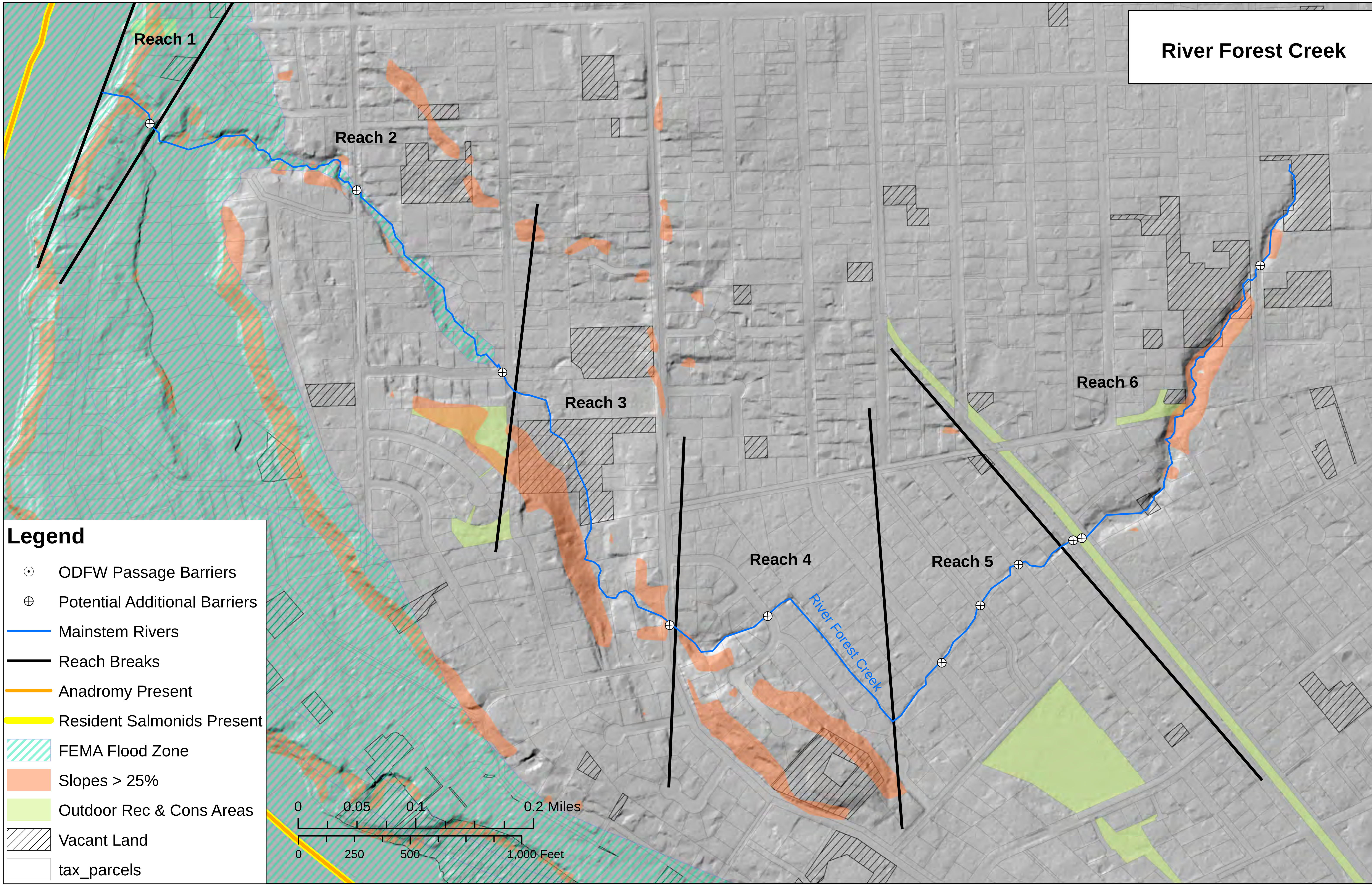
River Forest Creek
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
River Forest Creek
Legend
ODFW Passage Barriers
Potential Additional Barriers
Mainstem Rivers
Reach Breaks
Anadromy Present
Resident Salmonids Present
FEMA Flood Zone
Slopes > 25%
Outdoor Rec & Cons Areas
Vacant Land
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0.05
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0.2 Miles
0
250
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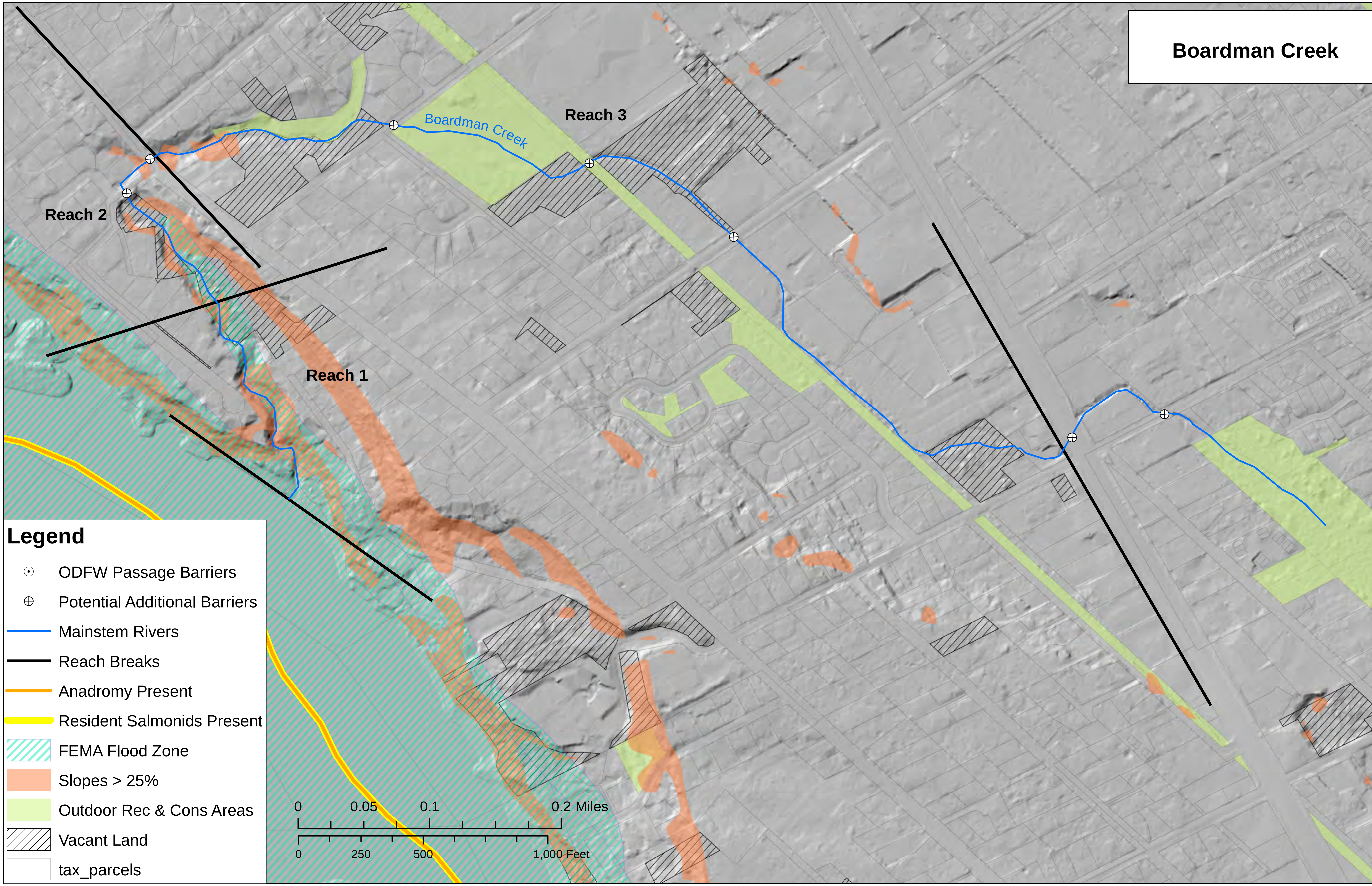
1,000 Feet


Boardman Creek
Boardman Creek
Reach 3
Reach 2
Reach 1
Legend
ODFW Passage Barriers
Potential Additional Barriers
Mainstem Rivers
Reach Breaks
Anadromy Present
Resident Salmonids Present
FEMA Flood Zone
Slopes > 25%
Outdoor Rec & Cons Areas
Vacant Land
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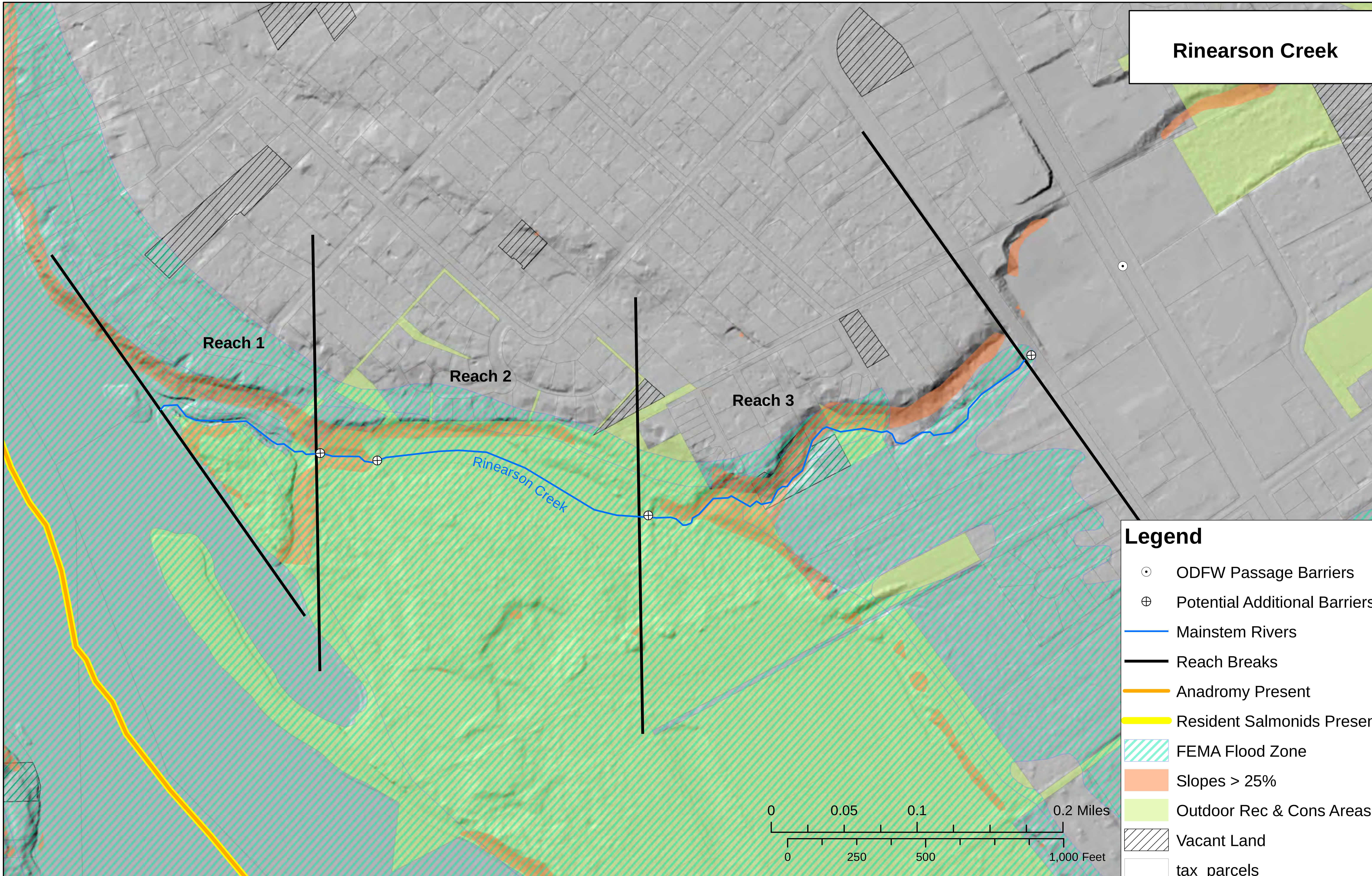
Rinearson Creek
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Reach 3
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ODFW Passage Barriers
Potential Additional Barriers
Mainstem Rivers
Reach Breaks
Anadromy Present
Resident Salmonids Present
FEMA Flood Zone
Slopes > 25%
Outdoor Rec & Cons Areas
Vacant Land
tax_parcels


Lower Kellogg Creek
Reach 1
Reach 2
Kellogg Creek
Mt Scott Creek
Legend
ODFW Passage Barriers
Potential Additional Barriers
Mainstem Rivers
Reach Breaks
Anadromy Present
Resident Salmonids Present
FEMA Flood Zone
Slopes > 25%
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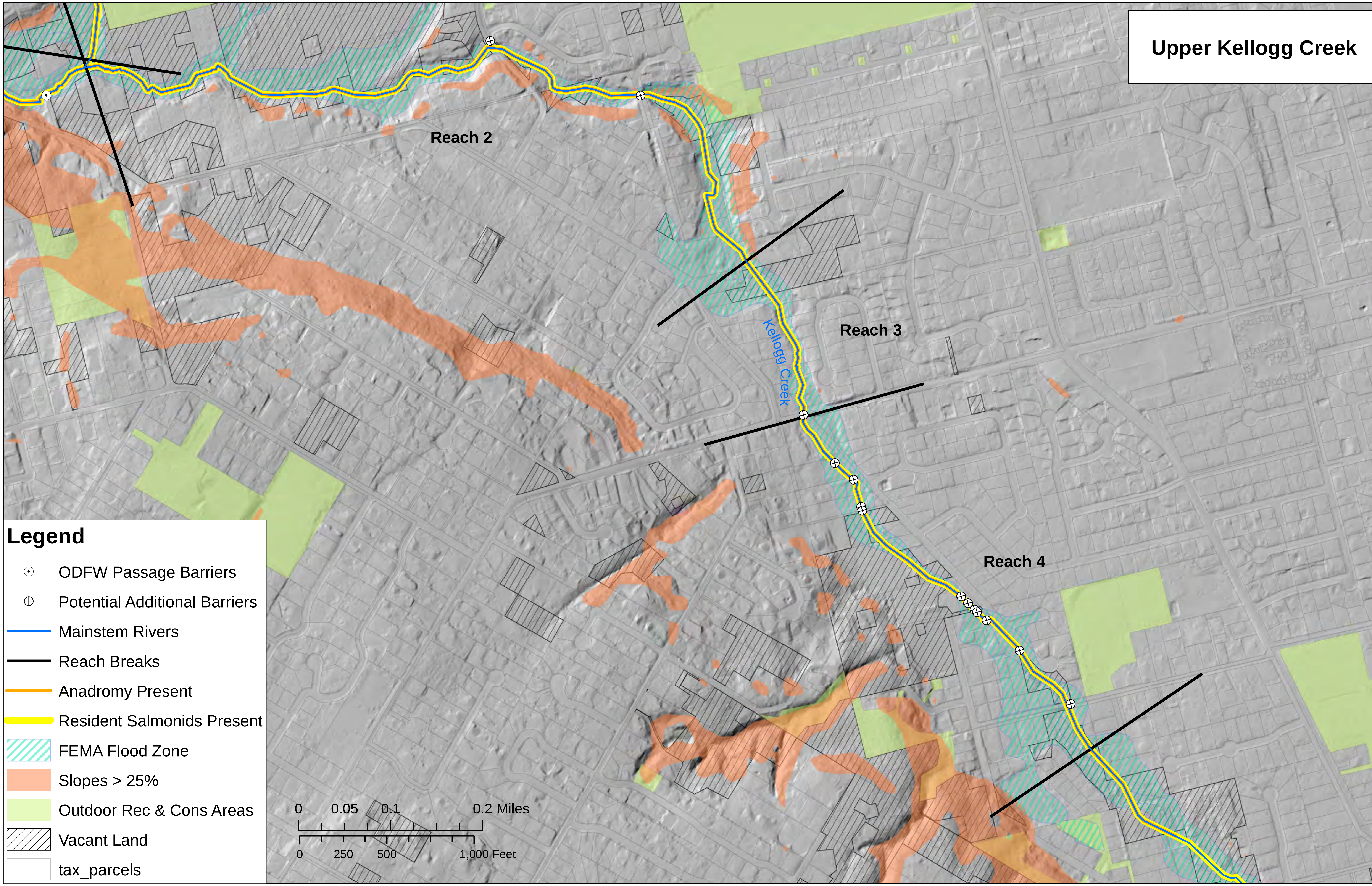
Upper Kellogg Creek
Reach 2
Reach 3
Reach 4
Kellogg Creek
Legend
ODFW Passage Barriers
Potential Additional Barriers
Mainstem Rivers
Reach Breaks
Anadromy Present
Resident Salmonids Present
FEMA Flood Zone
Slopes > 25%
Outdoor Rec & Cons Areas
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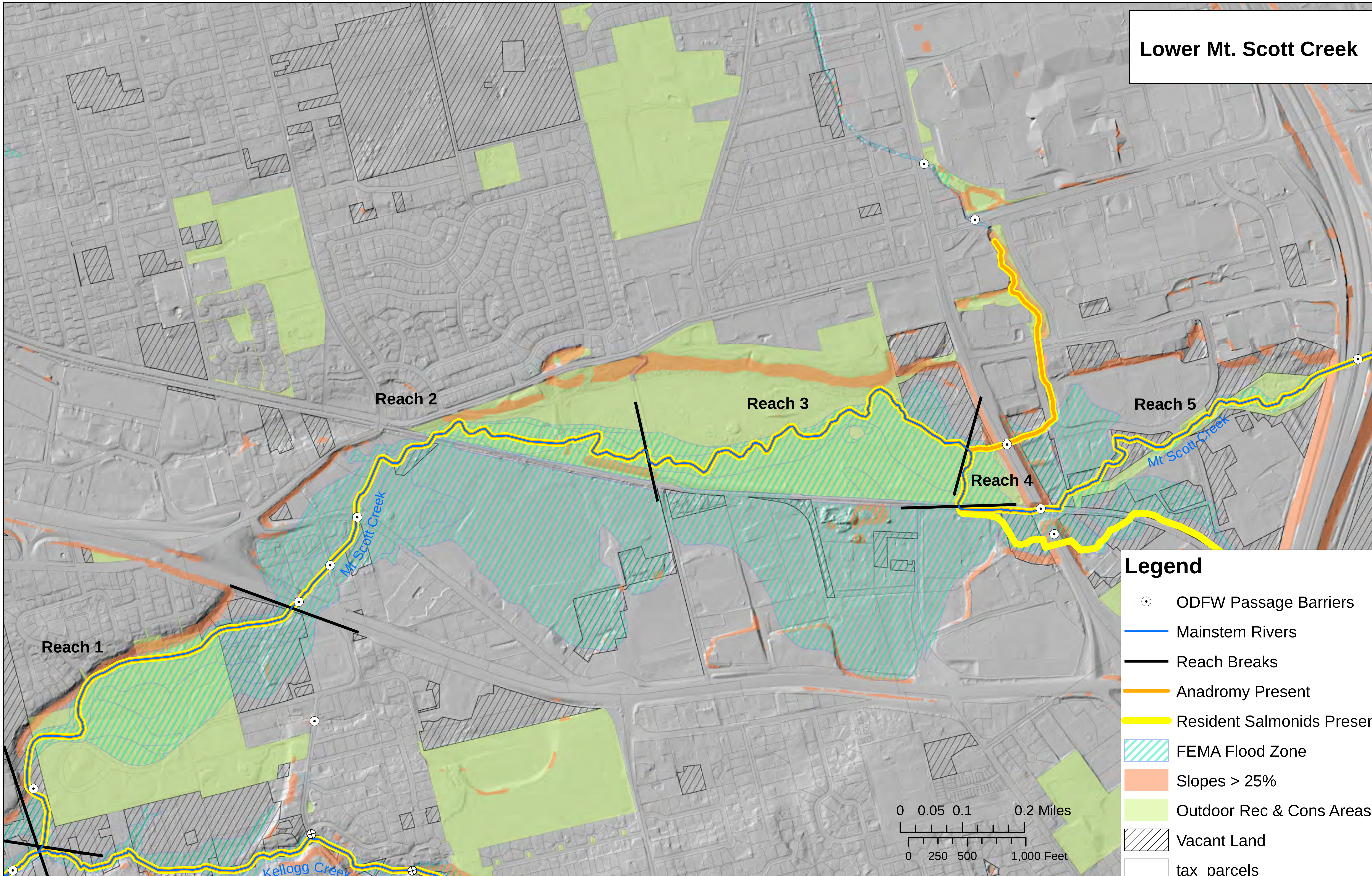
Lower Mt. Scott Creek
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Mt Scott Creek
Mt Scott Creek
Kellogg Creek
Legend
ODFW Passage Barriers
Mainstem Rivers
Reach Breaks
Anadromy Present
Resident Salmonids Present
FEMA Flood Zone
Slopes > 25%
Outdoor Rec & Cons Areas
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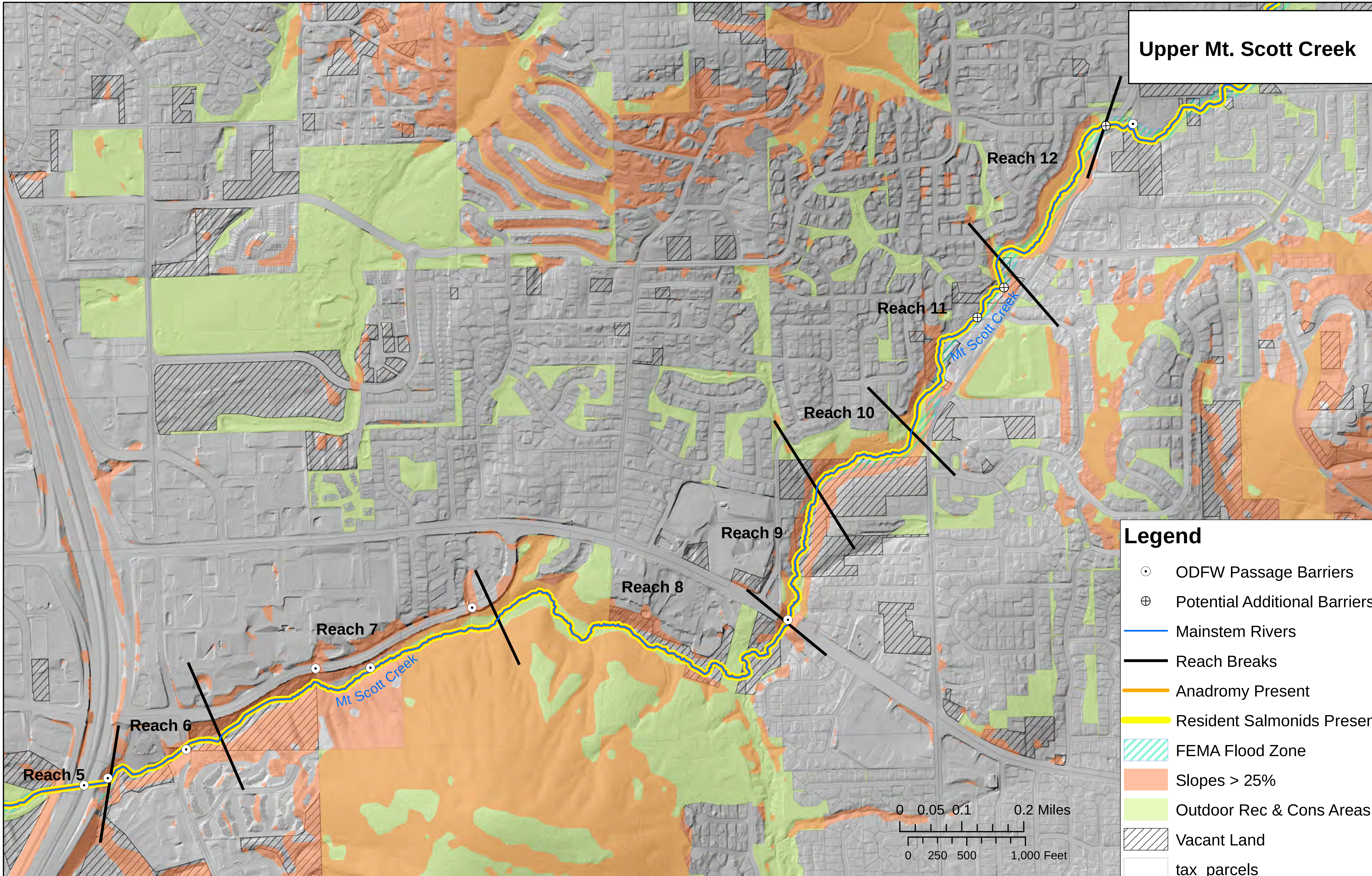
Upper Mt. Scott Creek
Reach 5
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Reach 10
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Reach 12
Mt Scott Creek
Mt Scott Creek
Mt Scott Creek
Legend
ODFW Passage Barriers
Potential Additional Barriers
Mainstem Rivers
Reach Breaks
Anadromy Present
Resident Salmonids Present
FEMA Flood Zone
Slopes > 25%
Outdoor Rec & Cons Areas
Vacant Land
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Stream	Reach	Sub-Reach (Habitat or Sub-Reach for Fish Surveys)	Length (mi)	Fish Presence?	IBI Scores (mean) & IBI Trajectory	Known or Potential Downstream Fish Barriers? (not incl. barriers w/in reach)	Fish Score	Public Ownership for Access?	# of Private Parcels (non-park, etc.)?	Vacant Parcels / Public Land Adjacent?	Access Score	Avg Channel Confinement	Avg Channel Slope	Geomorph Score	Total Points	Weighted Rank (60% fish, 20% access, 20% geomorph)	FIELD INVESTIGATION?	Rationale
Point Scoring:				Yes = 2 Unk = 1 No = 0	Yes (IBI>75) = 3 Yes (IBI = 51-74) = 2 Unk = 1 No or IBI<50 = 0 +1 for increasing IBI trend	0 - 1 = 2 1 - 5 = 1 >5 = 0		Yes = 2 Partial = 1 No = 0	< 5 = 2 5-15 = 1 >15 = 0	Yes = 2 Partial = 1 No = 0		< 1% = 2 1-3% = 1 > 3% = 0	low = 2 mod = 1 high = 0					
Kellogg	1	1	1.4	Yes	52.4 (decreasing)	1	6	Partial	73	Partial	2	6.1	0.4%	2	10	4.4	Y	First priority based on ranking. Fewer barriers to fish passage in this reach as compared to upstream reaches. May be challenging to gain access due to number of private landowners. Highest priority area of Reach is upstream: 1000 feet just below confluence w/ MSC
	2	2	0.9	Yes	58.1 (stable)	3	5	Partial	40	Partial	2	7.1	0.5%	4	11	4.2	N	Second priority for field investigation.
		3	0.2	Yes		5	5	No	17	Partial	1	5.6	1.2%	1	7	3.4	N	Not a priority for field investigation.
		4	0.5	Yes		5	5	Partial	15	Partial	3	5.0	0.5%	2	10	4	N	Not a priority for field investigation.
Mt Scott	1	1	0.7	Yes	45.4 (increasing)	3	4	Yes	9	Yes	5	21.8	0.3%	3	12	4	N	Despite lower rank than other reaches, majority of Reach 1 is contained in North Clackamas Park , allowing for easy site access. Second priority for field investigation.
		2	0.8	Yes		4	4	Partial	10	Partial	3	5.8	0.3%	2	9	3.4	N	Not a priority for field investigation.
		3	0.7	Yes		9	3	Yes	1	Yes	6	15.9	0.3%	3	12	3.6	N	Despite lower rank than other reaches, majority of Reach 3 is contained in Three Creeks Natural Area , allowing for easy site access. Second priority for field investigation.
	2	4	0.1	Yes	43.0 (increasing)	9	3	Yes	1	Partial	6	23.1	0.2%	3	12	3.6	N	Not a priority for field investigation.
	3	5	0.8	Yes	54.7 (increasing)	10	5	Partial	7	Yes	4	11.2	0.4%	4	13	4.6	Y	Second highest rank after Reach 8. First priority for field investigation efforts since fewer downstream barriers.
		6	0.2	Yes		13	5	Partial	3	Partial	4	5.8	2.7%	1	10	4	N	Not a priority for field investigation.
		7	0.5	Yes		15	5	Yes	4	Yes	6	3.9	2.3%	1	12	4.4	N	Not a priority for field investigation.
		8	0.7	Yes		16	5	Yes	1	Yes	6	7.7	1.3%	3	14	4.8	N	Ranked highly but number of fish passage barriers or potential barriers (from road crossings) downstream of reach eliminates this reach from the field investigation priority.
	4	9	0.25*	Yes	52.6 (increasing)	16	5	No	6	Yes	3	7.2	2.1%	3	11	4.2	N	Not a priority for field investigation.
		10	0.2*	Yes		17	5	Partial	2	Yes	5	6.8	4.4%	2	12	4.4	N	Not a priority for field investigation.
		11	0.4*	Yes		17	5	Partial	9	Partial	3	4.3	1.9%	1	9	3.8	N	Not a priority for field investigation.
		12	0.3*	Yes		19	5	Yes	1	Yes	6	4.7	2.7%	1	12	4.4	N	Not a priority for field investigation.
Rinearson	1		0.12	Unk	Unk	0	4	Yes	1	Yes	6	28.5	1.8%	2	12	4	Y	Short reach, will be combined with Reach 2 for assessment.
	2		0.24	Unk	Unk	2	3	Yes	0	Yes	6	5.7	0.1%	2	11	3.4	Y	Second priority, will be included in the field investigation since Reach 1 is short.
	3		0.34	Unk	Unk	3	3	Partial	8	Partial	3	4.0	1.9%	1	7	2.6	N	Not included, assuming no fish access to channel above the large ponds and dams based on longitudinal profile.
Boardman	1		0.18	Yes	Unk	0	6	No	10	Yes	3	8.9	3.8%	2	11	4.6	N	Though ranked highest, will not be surveyed since restoration has already occurred here.
	2		0.15	Unk	Unk	0	4	Partial	8	Partial	3	4.2	1.6%	1	8	3.2	Y	Ranked second highest and will be the priority reach for field investigations since restoration has already occurred in Reach 1.
	3		0.83	Unk	Unk	2	3	Partial	11	Partial	3	14.9	0.3%	3	9	3	N	Not a priority for field investigation.
River Forest	1		0.05	Unk	Unk	0	4	No	5	No	1		2.7%	3	8	3.2	Y	Very short reach. To be combined with Reach 3 for site investigation.
	2		0.45	Unk	Unk	1	4	No	22	No	0	8.2	1.1%	3	7	3	N	Tied with Reach 3 for second priority, but will not be investigated due to the lack of public access or vacant parcels adjacent to the channel limiting future restoration potential.
	3		0.3	Unk	Unk	3	3	No	14	Partial	2	10.5	0.9%	4	9	3	Y	Tied with Reach 2 for second priority. Selected as field investigation priority reach due to the suitable geomorphic conditions for future restoration potential.
	4		0.26	Unk	Unk	4	3	No	25	No	0	2.2	0.1%	2	5	2.2	N	Not a priority for field investigation.
	5		0.22	Unk	Unk	5	3	No	12	No	1	1.3	2.6%	1	5	2.2	N	Not a priority for field investigation.
	6		0.45	Unk	Unk	8	2	No	19	Partial	1	7.0	3.5%	2	5	1.8	N	Not a priority for field investigation.
Sources:				Tinus et al 2003 Neerman & Vogt 2009 Friesen and Zimmerman 1999 (Boardman Creek Reach 1 fish salvage information documenting salmonid presence from Todd Alsbury personal communications)		Bing Aerial Imagery in ArcGIS, digitization of road crossings, & ODFW Fish Passage Barriers shapefile, dated Sept. 2019. From https://nrimp.dfw.state.or.us/DataClearinghouse/		Outdoor Recreation & Conservation Areas (2019), Taxlots (2019), and Vacant Land shapefiles (2018). From http://rlisdiscovery.oregonmetro.gov				Defined based on 2014 LiDAR from Oregon METRO and the National Hydrological Database (NHD) channel alignments.						

Oregon
Kate Brown, Governor

Department of Environmental Quality
Northwest Region Portland Office/Water Quality
700 NE Multnomah St Suite 600
Portland, OR 97232
(503) 229-5263
FAX (503) 229-6957
TTY (800) 736-2900

October 28, 2020

Sarah Jo Chaplen
Oak Lodge Water Services District
14496 SE River Rd
Oak Grove, OR 97267

RE: PERMIT TERMINATION
Site: OAK LODGE WATER SERVICES WATER RECLAMATION FACILITY
File Number: 62795
County: CLACKAMAS

Dear Permit Registrant:

We have received your Notice of Termination form, which requests termination of the National Pollutant Discharge Elimination System 1200-Z industrial stormwater permit coverage for the above-referenced site. Thank you for providing this update.

DEQ has granted your termination request. This letter serves as notification that the NPDES permit referenced above has been terminated effective October 28, 2020

DEQ is processing the cancellation of annual compliance invoice WQ21STM-0809.

Should you have any questions or concerns, please contact Jenni Seven, Permit Coordinator, at 503-229-5886. Questions regarding your invoice should be directed to Water Quality Invoicing at 503-229-5437.

Sincerely,

Christine Svetkovich, Water Quality Manager
Stormwater & Underground Injection Control
Northwest Region, Oregon Department of Environmental Quality

ecc:
DEQ File
WQ Invoicing Staff
DEQ Revenue Accountant 1