Benthic Macroinvertebrate & Geomorphological Monitoring Report

2024 Monitoring Results

Client: Clackamas Water Environment Services

Date: July 20, 2025

Photos: Trillium Creek in West Linn (left) and Tate Creek in West Linn (right)

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Table of Contents

List of Tables

List of Figures

List of Appendices

1. Introduction

1.1 Background and Purpose

Monitoring watershed health through the collection and analysis of targeted geomorphic and biological data can be a useful tool in understanding watershed processes and evaluating stormwater practices. This is particularly true in urban environments where stream health is intrinsically linked to stormwater management and adopting a process-based perspective of stream health is essential for developing effective treatment strategies and meeting permit requirements.

Clackamas County Water Environment Services (WES), in partnership with the cities of Gladstone, Lake Oswego, Milwaukie, West Linn, Oregon City, Wilsonville, and Oak Lodge Water Services (collectively known as the "Co-Permittees"), conducts periodic stream health assessments to evaluate aquatic resources within their jurisdictions. These assessments help measure the effectiveness of water resource management efforts, the effects of stormwater discharges, inform future actions, and ensure compliance with permit requirements, specifically the National Pollutant Discharge Elimination System (NPDES) Municipal Pollutant Discharge Elimination System (MS4) Permit.

Both WES and the Co-Permittees have previously conducted stream monitoring efforts as described in the following sections of this report. For the 2024 assessment, WES contracted Wolf Water Resources (W2r) and CASM Environmental (CASM) to lead the technical aspects of the study. W2r and CASM respectively focused on evaluating physical and biological stream conditions—two key indicators of overall stream condition—achieved primarily by monitoring geomorphic attributes and macroinvertebrate presence in the study area. Collectively, W2r and CASM surveyed 131 sites across 35 creeks in the monitoring area during the 2024 monitoring period (Table 1).

The purpose of this report is to summarize the main findings from the monitoring effort conducted from September to November 2024. The report focuses on both site-specific and stream-level findings, particularly surrounding current conditions, observable trends, and recommended actions. More detailed methods and results can be found in the appendices.

1.2 Summary of Past Monitoring Efforts

In compliance with the NPDES MS4 permit, both WES and the Co-Permittees have previously conducted macroinvertebrate monitoring. The Co-Permittees conducted monitoring at 22 streams following similar field and analytical methods prior to 2024, which include the following monitoring efforts:

- The City of Wilsonville conducted a biological assessment in 2003 on Boeckman Creek, Coffee Lake Creek, and Mill Creek. A Boeckman Creek site that also serves as a water quality monitoring station was reassessed in 2013. For the 2018 monitoring effort, two sites on Boeckman Creek were added.
- The City of Lake Oswego began biological sampling in 2004 with six perennial stream reaches. In 2007, five additional reaches were added and one site was dropped. These 10 reaches were then re-sampled in 2007, 2009, 2013, 2018, and 2021.
- Oak Lodge began sampling Boardman and River Forest Creek reaches in 2012 and last sampled in 2018.

- The cities of Gladstone, Milwaukie, Oregon City, and West Linn initiated macroinvertebrate sampling in 2013 at six co-located sites with ongoing water quality and pesticide monitoring. The last sampling occurred in 2018.

WES performed macroinvertebrate monitoring in 2002, 2007, 2009, 2011, 2014, 2017, and 2021. As with the Co-Permittees, WES's monitoring methods followed similar field and analytical methods as the 2024 monitoring effort. WES also began physical stream health monitoring in 2009 and continued this monitoring in 2011, 2014, 2017, and 2021. Physical stream health monitoring methods have evolved over the years, from very detailed topographic surveys at fewer sites during 2009–2017 to higher-level observations and measurements at more sites in 2021.

The revised 2021 monitoring protocol, developed by W2r, retained some detailed surveys but prioritized broader spatial coverage of geomorphic data using rapid reconnaissance techniques. This involved collecting more targeted geomorphic measurements, aiming for a sampling frequency of 2–4 sites per mile of stream, although this was adjusted as needed to accommodate access limitations. This approach captured a more extensive and meaningful sample of stream conditions that was found to provide better indicators of regional stream health, development patterns, and potential recovery pathways.

For the 2024 effort, W2r further refined field methods to enhance efficiency and cost-effectiveness while monitoring 35 streams. This included revisiting 110 sites for WES and adding 21 new sites for the Co-Permittees compared to the 2021 effort. In lieu of detailed surveys, standardized measurements were collected consistently across all sites. This approach streamlined both fieldwork coordination and data management processes while retaining data accuracy and their representativeness of overall stream health indicators.

1.3 Hydromodification and Watershed Management

Like many urban stormwater management districts, both WES and the Co-Permittees are facing impacts from hydromodification on both their stormwater systems and the natural landscapes. Hydromodification, as defined by the U.S. Environmental Protection Agency (1993), refers to the "alteration of the hydrologic characteristics of coastal and non-coastal waters, which in turn could cause degradation of water resources." In urban settings, this typically results from the conversion of natural landscapes into impervious surfaces like pavement and rooftops. Gutters, stormwater pipes, and other infrastructure further expedite the movement of water, intensifying hydrologic changes and disrupting natural flow regimes.

Unmitigated hydromodification has cascading impacts on watershed processes. Elevated runoff volumes and altered timing of flows increase the magnitude, frequency, and duration of erosive events (Wolman and Miller, 1960), which often exceed the capacity of natural channels to adapt. Hydromodification accelerates the natural channel evolution process. This can be visualized through the Stream Evolution Model (SEM; Cluer and Thorne, 2014) (Figure 1). In urban watersheds, increased runoff from impervious surfaces initiates a cycle of channel incision and widening represented in the SEM by Stages 3–5. This often results in loss of floodplain connectivity, simplified habitat, and increased erosion. However, targeted restoration actions, such as reconnecting floodplains, installing instream complexity, and improving riparian conditions, can redirect streams toward resilient forms as represented by Stages 0, 1, and 8. These more naturalized, resilient stages are characterized by multi-thread channels, robust vegetation, and hydrologic connectivity, all of which help dissipate energy and support ecological function.

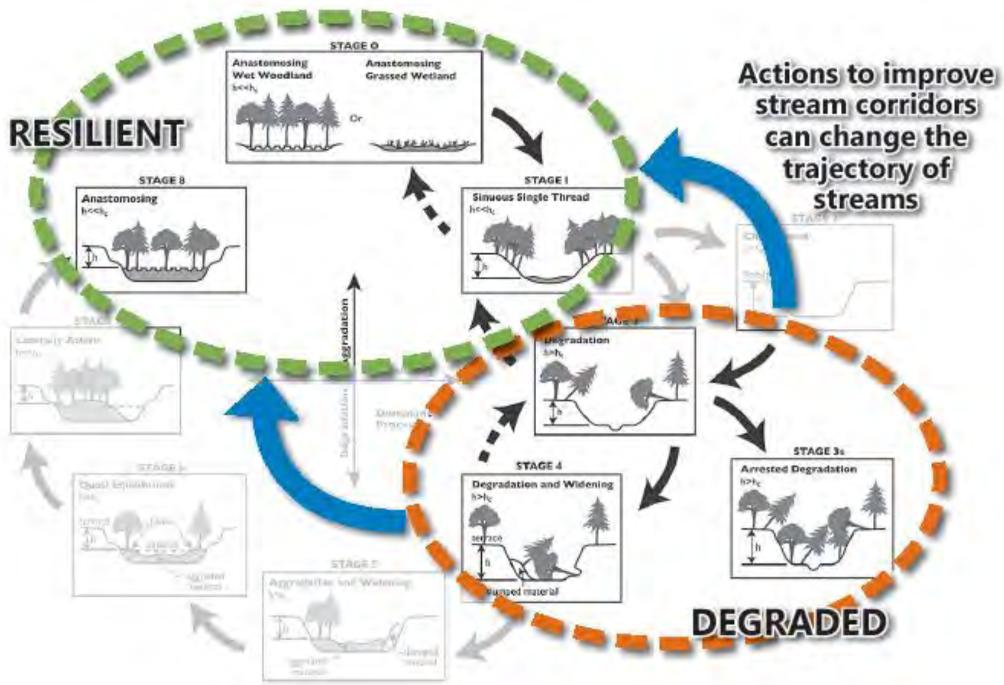


Figure 1: Channel Evolution Model (Cluer and Thorne, 2014) showing recovery pathways associated with stream resiliency.

Hydromodification impacts more than just channel form, it also degrades aquatic habitat and biological integrity. As shown in Figure 2, stream health is shaped by the dynamic balance between hydrology, geology, and biology. In urban streams, altered flow patterns, simplified channels, and impaired riparian zones reduce habitat complexity and water quality, leading to declines in benthic macroinvertebrate communities.

Monitoring physical and biological stream conditions in WES and Co-Permittee jurisdictions not only supports permit compliance but also provides valuable insight into the impacts of hydromodification on local waterways and regional watershed function. Metrics such as stream entrenchment and macroinvertebrate taxa richness can help identify streams most affected by altered flow regimes and clarify the specific stressors at play, guiding appropriate restoration actions.

Effective management of hydromodification requires addressing both the *driving forces* (i.e., altered hydrology) and the *resisting forces* (e.g., stream corridor resilience). Upland stormwater controls, such as infiltration systems and detention basins, can moderate hydrologic inputs and reduce stream power but alone may not be sufficient to restore degraded channels. Over decades, these controls may approximate natural hydrology, but without concurrent instream and riparian restoration, recovery is unlikely.

Therefore, results from this monitoring effort will be used to inform potential stormwater management actions that support both physical and biological recovery. Recommended approaches, as detailed in Section 6 of this report, include adding roughness elements like large wood and vegetation, as well as regrading channels to create inset floodplains or reconnect to historical floodplains. When implemented alongside traditional stormwater practices, these management techniques can help relieve pressure on urban streams and guide them toward a more resilient, biologically driven state consistent with the top of the Stream Evolution Triangle (Figure 2), where natural processes and vegetation structure drive form and function.

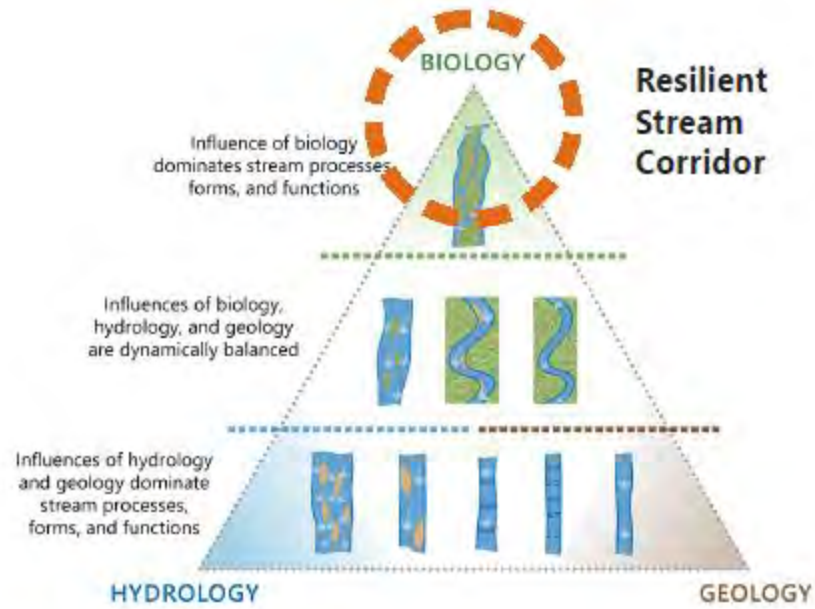


Figure 2: Stream Evolution Triangle (Castro and Thorne, 2019) showing the interplay of geologic, hydrologic, and biological influences on channel-floodplain forms and dominance of biological influences on resilient stream corridors.

2. Study Area Description

This assessment includes 35 tributaries of the Willamette River, as well as two major tributaries of its own: the Clackamas River and the Tualatin River, within northwestern Clackamas County (see Figure 3 and additional maps in Appendix A). The streams of interest include 16 creeks east of the Willamette River ("east-side" streams) and 19 creeks west of the Willamette River ("west-side" streams). The streams range in size and physical characteristics (Table 1) but are all within or near the Portland metropolitan area and are therefore affected by various land uses that include agricultural/rural and urban developments. Most of the study watersheds support urban and semi-urban land uses.

The study area encompasses approximately 126 miles of stream length and 80 square miles of contributing watershed area. Individual stream mainstems range in length from just over 0.5 mile to 12 miles, with watershed areas spanning 0.17 to 14.2 square miles. Impervious cover across these watersheds varies widely, from 5 to 77 percent of the total drainage area. The streams drain relatively low elevation landscapes, generally below 1,000 feet, within the Boring Hills, Tualatin Mountains, and surrounding terrain. The region experiences a Mediterranean climate with cool, wet winters and hot, dry summers. Average annual rainfall ranges from 46.5 to 73 inches, and the 2-year, 24-hour precipitation event ranges from 1.89 to 2.69 (USGS StreamStats, 2025).

Table 1: Summary table of monitored creeks across the WES and Co-Permittee urban stormwater management districts.

Name	Sites on Stream	Co-Permittee	Length (mi.)	Watershed Area (sq. mi.)
Athey Creek	4	WES	3.2	0.8
Ball Creek	1	Lake Oswego	0.8	0.6
Boardman Creek	2	Oak Lodge	1.2	1.8
Boeckman Creek	3	Wilsonville	6.4	2.4
Carli Creek	3	WES	0.6	0.7
Carter Creek	1	Lake Oswego	0.8	0.3
Cedar Creek	3	WES	1.3	0.9
Coffee Creek	1	Oregon City	0.9	0.5
Cow Creek	3	WES	3.1	1.3
Fields Creek	3	WES	2.1	0.4
Kellogg Creek	10	WES	12.2	14.2
Lost Dog Creek	3	Lake Oswego	2.6	0.6
Minthorn Creek	1	Milwaukie	0.5	0.7
Mt Scott Creek	27	WES	9.1	9.6
Nettle Creek	1	Lake Oswego	3.1	0.9
Oswego Creek	1	Lake Oswego	4.4	6.6
Pecan Creek	5	WES	2.3	0.7
Phillips Creek	6	WES	1.8	1.1
Richardson Creek	4	WES	6.9	4.0
Rinearson Creek	1	Gladstone	0.6	0.8
River Forest Creek	1	Oak Lodge	1.4	0.9
Rock Creek	8	WES	11.0	8.5
Saum Creek	7	WES	8.2	4.3
Shipley Creek	3	WES	1.4	0.2
Sieben Creek	5	WES	4.0	2.0
Singer Creek	1	Oregon City	0.8	0.4
Springbrook Creek	2	Lake Oswego	4.4	1.3
Tanner Creek	1	West Linn	1.6	0.9
Tate Creek	4	WES	3.3	0.6
Tributary 2	4	WES	2.3	0.5
Tributary 4	2	WES	2.8	0.6
Trillium Creek	2	WES	3.2	0.9
Trillium (West Linn) Creek	1	West Linn	3.2	0.8
Tryon Creek	1	Lake Oswego	9.0	6.6
Wilson Creek	6	WES	5.5	2.1

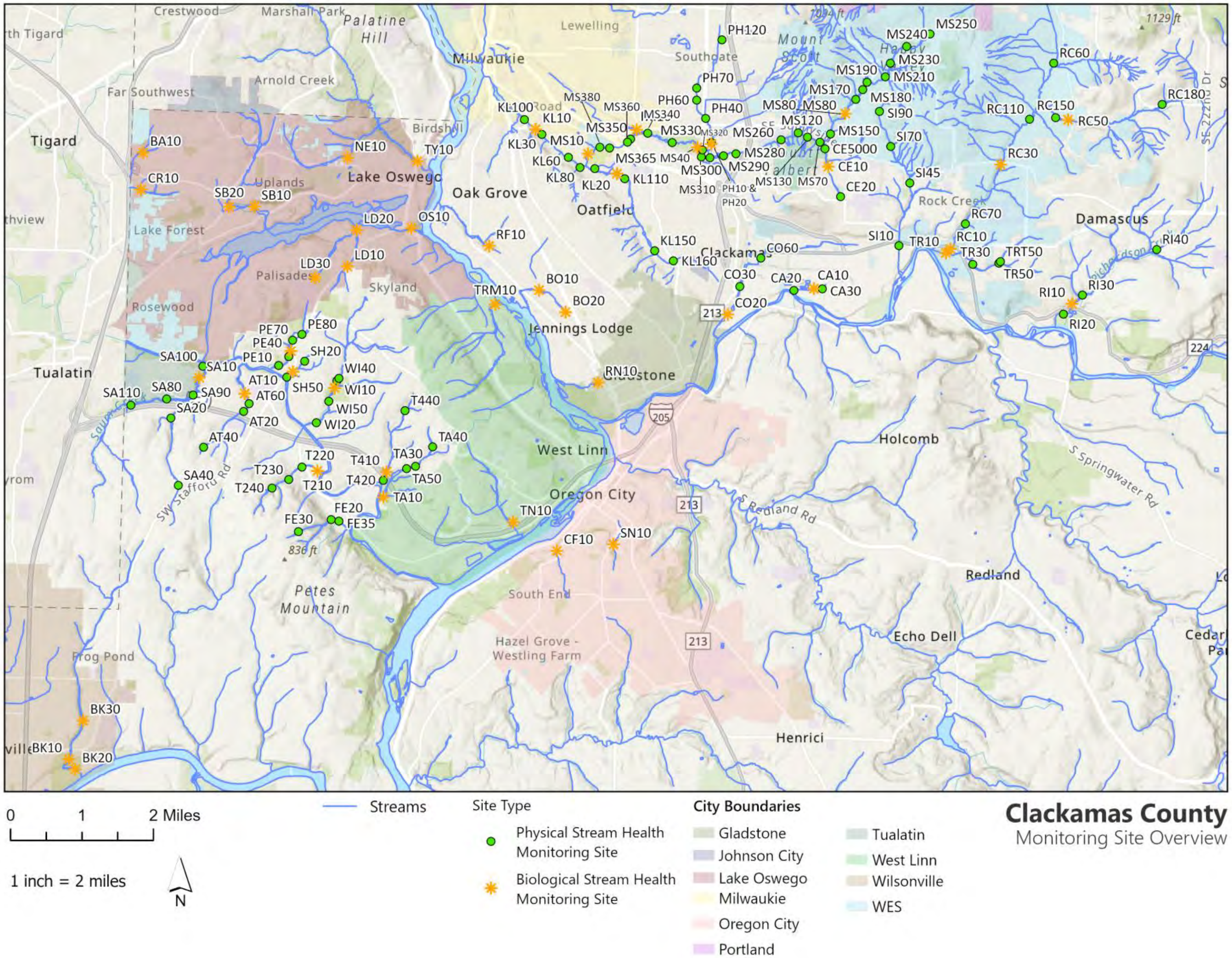


Figure 3: Overview map showing sites visited during 2024 monitoring effort.

2.1 Study Area Geology and Geomorphology

There are three major geological terranes that define this study area: Columbia River Basalts, Boring Volcanoes, and Missoula Flood deposits.

The creeks west of the Willamette River primarily originate on the steep flanks of the Tualatin Mountains and surrounding uplands, underlain by Eocene marine sedimentary units and capped in many locations by Miocene (~16 Ma) Columbia River Basalt flows (Beeson et al., 1989; Madin, 2009). These west-side drainages often follow fault-controlled alignments and descend rapidly through narrow, bedrock-confined channels before entering the broader floodplains of the Tualatin or Willamette Rivers. In the upper and middle reaches, streams encounter resistant basalt or deeply weathered sedimentary units, leading to pronounced channel incision and the presence of coarse, angular bed material. At lower elevations, the channels enter zones of Missoula Flood deposition, where fine-grained silts and sands dominate valley-bottom stratigraphy (O'Connor et al., 2001). These floodplain segments are characterized by low gradient, wider valleys with alluvial features such as inset floodplains, terraces, and backwater wetlands.

The east-side creeks originate within and drain the Boring Volcanic Field, a complex of Quaternary-age (0.5 to 2 Ma) basaltic cones and lava flows interbedded with fine-grained Missoula Flood deposits and volcaniclastic sediments (Conrey et al., 1996; Evarts et al., 2009). The geomorphology of these east-side drainages reflects both their volcanic origin and post-eruption reworking by glacial megafloods. Many creeks exhibit confined upper reaches, incised into coarse volcaniclastics and gravels, with visible accumulations of cobble- and gravel-sized material within the channel bed. As the streams descend, they often transition into broader, unconfined valleys where Missoula Flood scouring has influenced valley form, leaving behind large volumes of sediment fill and broad floodplain deposits (O'Connor et al., 2001; Madin, 2009). Compared to their west-side counterparts, east-side creeks are generally longer, have lower overall gradients, and more consistently incise into gravelly valley fill. They also show more frequent evidence of historical avulsion and meander migration, largely due to the Clackamas River's headwaters originating in the snow-capped Cascades, an area shaped by glacial melt events and historically higher sediment yields.

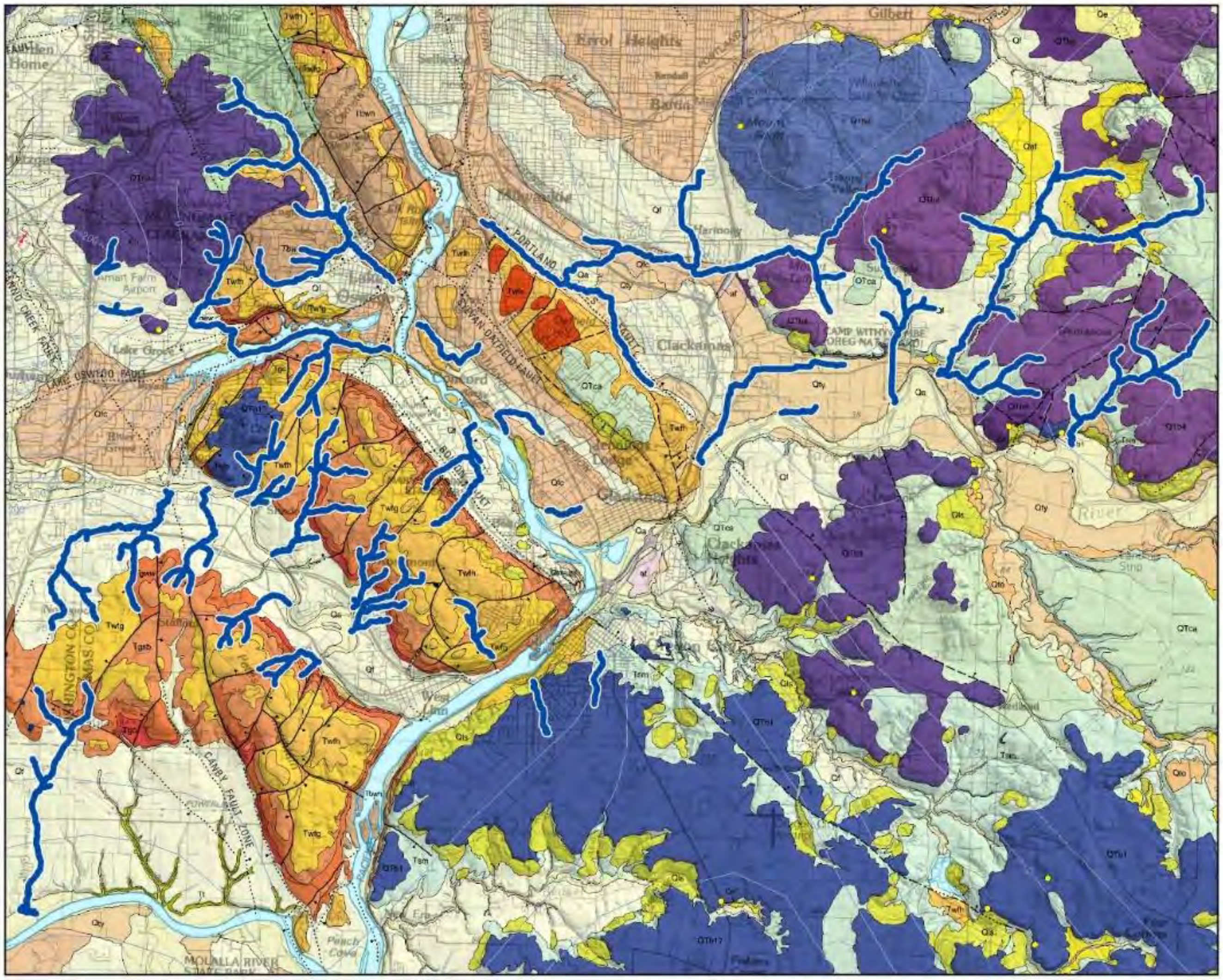


Figure 4: Excerpts from a geologic map of the greater Portland region published by Wells et al. (2020) showing an overlay of the creeks monitored during 2024. Tan colors represent Missoula Flood deposits and more recent alluvium, purple colors are associated with the Boring Hills volcanoes, and the red-orange colors are associated with Columbia River Basalts. The full publication (cited below) contains a more detailed legend describing additional geologic units not relevant here.

2.2 Development Patterns in the Study Streams

Hydromodification impacts, and therefore stream health, are closely linked to impervious surface coverage, making it important to evaluate imperviousness across the study area. The National Land Cover Database (NLCD) was used to estimate impervious cover for the years 1985, 2007, 2014, 2019, and 2023. The 2023 dataset (USGS, 2024) was used to represent existing conditions (Figure 5).

All streams in the study area maintain some level of development. Carli Creek has the highest level of development with 76.5% impervious cover, while Fields Creek has the lowest impervious cover at just under 5%. In general, the east side creeks have experienced more development, particularly along major corridors like SR 99E, SR 224, and 82nd Ave.

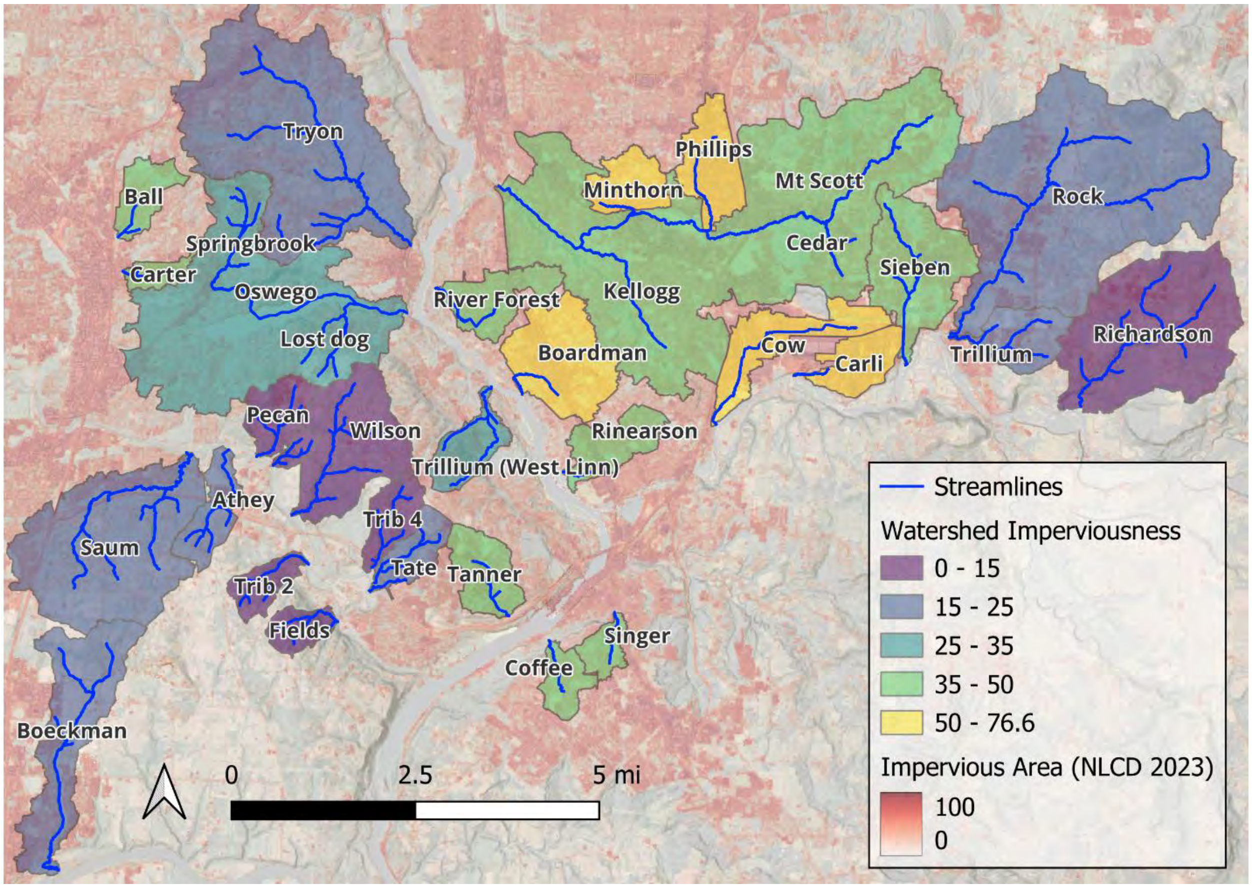


Figure 5: 2023 NLCD impervious area across the study area with watershed averages.

3. General Description of Monitoring Approach

3.1 Framework for Urban Stream Health and Monitoring

Monitoring efforts were specifically designed to capture the impacts of urbanization and inform regulatory compliance, stormwater management, and restoration planning. For the 2024 monitoring, W2r and CASM focused on collecting data and conducting analyses aligned with the four subcategories identified in WES's initial Watershed Health Framework (WES, 2016), which represent key drivers of urban stream health in the region:

- **Physical Stream Health:** This category addresses geomorphic and riparian conditions, including metrics such as channel incision and entrenchment, presence of erosion, floodplain connectivity, substrate composition, and habitat complexity. Riparian health indicators such as canopy cover, invasive species presence, and buffer width are also assessed, along with adjacent land use and nearby infrastructure.
- **Biological Health:** While closely linked to physical conditions, biological health incorporates macroinvertebrate community sampling to evaluate stream biological integrity.

Macroinvertebrate metrics provide a standardized, sensitive measure of biological condition and complement geomorphic and riparian assessments.

- **Water Quality:** This category includes measuring common water quality metrics (e.g., dissolved oxygen, pH, temperature, etc.) to assess how streams are impacted by land use, stormwater runoff, or pollutant loading.
- **Hydrology:** This category evaluates the effects of urban development on streamflow characteristics, with a particular focus on stream power and altered flow regimes due to development.

Understanding the interconnections among these subcategories is critical: changes in one often influence others. A systems-based approach that evaluates all four together provides a more complete understanding of stream conditions and supports more effective watershed management and restoration decision making.

3.2 Application of the Monitoring Framework

W2r and CASM used a combination of fieldwork and desktop methods to apply the monitoring framework. Methodology for each of the different components is briefly explained below and detailed in Appendix B.

3.2.1 Physical Stream Health

Physical stream health data were collected at 131 sites across the study area (see Figure 3) and maps in Appendix A) from September through November 2024 using rapid reconnaissance methods designed to maximize site coverage efficiently. The goal of the physical stream monitoring approach is to take simple, repeatable, and objective measurements with as much spatial coverage as possible to be able to speak about stream conditions at any location within the watershed.

At each site, key physical measurements of stream geometry were recorded along with qualitative observations related to habitat condition, riparian vegetation, and geomorphic features. Measurements were taken at individual transects, while observations were made across broader stream reaches to provide context. All data were recorded in real-time using the ArcGIS Online platform. The main metrics investigated are summarized below and a full list of metrics and observations collected is provided in Appendix B.

- Channel Geometry: Assessing stream geometry is important for understanding the condition of a stream because it provides critical information about channel stability, erosion potential, floodplain connectivity, and habitat quality. Metrics such as channel width, depth, and bank height help inform whether a stream is stable, incised, widening, or aggrading. These measurements can also be used to inform floodplain connectivity, as described below.
- Floodplain Connectivity: Floodplain connectivity is a key indicator of physical stream health, as well-connected floodplains help dissipate stream energy, improve water quality, support habitat complexity, and sustain healthy riparian vegetation. At each site, floodplain connectivity was evaluated using average width-to-depth and confinement ratios (detailed in Appendix B). These metrics were scored on a scale from 1 (least connected) to 5 (most connected), and the scores were then averaged to generate an overall connectivity score for each creek.

- Riparian Habitat: Riparian health is a key component of overall stream health because riparian zones play a critical role in supporting ecological function. Healthy riparian areas help stabilize banks, reduce erosion, and filter pollutants and excess nutrients from runoff before they reach the stream. They also provide shade, which regulates water temperature, a vital factor for aquatic species like fish and macroinvertebrates. At each site, riparian health was assessed based on observations of invasive vegetation prevalence, the presence of infrastructure, and dominant surrounding land use. Scores ranged from 1 (least healthy) to 5 (most healthy).

Following fieldwork, the data were compiled into a refined database derived from the ArcGIS Online entries. This database categorized the field measurements and observations, computed additional summary metrics, and began applying preliminary scoring to assess overall stream condition. The refined database is available in Appendix E.

In addition to field data, desktop analyses were conducted to supplement and contextualize physical stream health findings. This included quantification of slope, valley bottom width, watershed area, and impervious surface coverage using publicly available data and derived digital measurements. Most of these metrics were based on the 2019 Oregon Lidar Consortium (OLC) West Metro 3DEP LiDAR dataset and the NLCD for 2023.

3.2.2 Biological Stream Health

As part of the required biological monitoring for WES and the Co-Permittees, benthic macroinvertebrate communities throughout 45 study sites over 32 streams were collected, identified, and analyzed to relate community composition to pollution, erosion, and water quality. Data from the 2024 monitoring efforts were compared to macroinvertebrate community data from historic monitoring efforts to investigate biological trend implications.

Macroinvertebrate monitoring occurred during September through November 2024. The methodology for macroinvertebrate collection generally followed Level 2 and 3 protocols suggested in the Benthic Macroinvertebrate Monitoring Protocol for Wadeable Rivers and Streams, developed in part by DEQ (EPA et al., 2009). Within each site, eight individual 500-micrometer (μm) D-frame kicknet samples were collected from a 1 square-foot area in each of eight different riffles and combined to create one composite sample. If eight individual riffles did not exist within a study reach, two kicknet samples were collected from different areas within each of four different riffles. If no riffles existed within a study reach, kicknet samples were taken from habitats representative of the general study reach, such as pools or runs. Collected samples were then sent to a lab for analysis through identification to the lowest practical taxonomic level recommended by the Pacific Northwest Aquatic Monitoring Partnership (PNAMP Level II; PNAMP, 2015).

Biological conditions in sample communities were then assessed using several DEQ models, including: (1) a multimetric macroinvertebrate-based index of biotic integrity (M-IBI); (2) a probability-based PREDATOR MWCF regional model (Predictive Assessment Tool for Oregon, Marine Western Coastal Forest; Hubler, 2008); (3) weighted-average inference models developed by DEQ (Huff et al., 2006) for inferring fine sediment or elevated water temperature as potential stressors; and (4) and a Macroinvertebrate Thermal Tolerance Index (MTTI; Hubler et al., 2024). A detailed description of each model is provided in Appendix B. Additional metrics used in the site assessments included the number of total taxa in the sample, which is a measure of habitat quality and heterogeneity, and the number of EPT taxa: Ephemeroptera (mayfly), Plecoptera (stonefly), Trichoptera (caddisfly). These orders are generally considered to contain groups that are the most sensitive to increased temperature and sediment, lower dissolved oxygen, disturbance, and organic enrichment. However, it should be noted that sensitivities vary among families and genera. For example, the net-spinning caddisfly *Cheumatopsyche*, which had high organismal abundance at many sites, is commonly enriched in urban streams with high levels of organic inputs.

3.2.3 Water Quality

A YSI DDS Pro multi-meter was utilized to collect water chemistry measurements at most sites. Measurements were taken at the downstream extent of the study reach before macroinvertebrate sampling or physical stream health assessments began. The following measurements were collected:

- **Temperature** (in degrees Celsius [°C]): Stream temperature is influenced by several factors, including shading, water velocity, pollution, sediment, air temperature, groundwater input, and elevation (Dent et al., 2008). In small Oregon streams, daily temperature fluctuations can reach up to 9°C, with an average diurnal change of about 2°C. Seasonal variation is also significant, with summer stream temperatures averaging 5°C to 10°C higher than in fall (Stratton Garvin et al., 2022). Water quality standards, specifically for temperatures, can vary by season and by waterway based on documented life stage usage of salmonids. Within the study areas, some waterways support spawning habitat for salmon and steelhead, with spawning possible generally between October through May, though this timing can vary slightly by stream (ODEQ, 2025a). During these designated times, the seven-day-average maximum temperature of these waterways may not exceed 13°C (OAR, 2025a). Additionally, many waterways in the study area are designated as core cold water habitat, and some are mapped as specifically providing salmon and trout rearing and migration habitat (ODEQ, 2025b). The core cold water habitats should not exceed an average seven-day maximum temperature of 16°C, while those mapped as supporting rearing and migration should not exceed 18°C.
- **pH**: Cold water biota, including sensitive macroinvertebrates and trout, may become impaired in water that is low on the pH scale (acidic), with damage to skin and gills. Skin damage can increase the risk of fungal infections in fish, and prolonged stress can lead to additional abnormalities, impaired swimming, and reduced biological function.
- **Dissolved Oxygen** (in milligrams per liter [mg/L]): The Oregon Department of Fish and Wildlife and DEQ considers DO levels of 8 mg/L to be the absolute minimum acceptable level to sustain cold water aquatic life (OAR, 2025b). To support trout spawning, absolute minimum DO standards are considered to be 11 mg/L.
- **Specific Conductance** (µS/cm): Conductivity in streams can be influenced by numerous factors, including the presence of dissolved salts, stormwater runoff and pollution inputs. DEQ has no set standards for conductivity of stream waters in Oregon. However, waters with higher conductivity can often have increased amounts of total dissolved solids (TDS), which in high abundance can have negative impacts on trout and salmon. High conductivity/TDS can negatively affect salmonid osmoregulation and reproduction, and high conductivity is also often related to low DO levels, which can further stress cold water biota (Woelfle-Erskine, 2017). Finally, high conductivity can also impact the toxicity of specific dissolved metals, another relevant water quality concern.

3.2.4 Hydrology

Urban development directly and negatively affects water quality and stream health, primarily due to the expansion of impervious surfaces. Impervious area can often be measured with reasonable accuracy using remote sensing and therefore can serve as a useful, though imperfect, proxy for assessing stream health and water quality.

The desktop hydrologic analysis conducted for this effort aimed to characterize current flow conditions, evaluate their influence on physical and biological stream processes, and assess how these conditions may shift under future development scenarios. The full set of equations used for this analysis is provided in Appendix B.

Existing Conditions

At each monitoring site, 2-year and 25-year peak flows were estimated using regional regression equations developed by Cooper (2005). These estimates represent peak discharges under rural or largely undeveloped conditions. From there, an empirical relationship between percent impervious area and peak flow defined by Bledsoe and Watson (2001) was used to adapt the regional regressions for urban areas.

Full Buildout

Development patterns in the area are largely dictated by the Urban Growth Boundary (UGB), set forth by the State of Oregon and managed by Portland Metro. Within the UGB, counties and cities are allowed to set their own zoning regulations.

For future impervious cover, a "full buildout" scenario was considered. Although this scenario may not occur for several decades, it provides insight into the potential increase in impervious area. The Bledsoe and Watson (2001) relationship was used to calculate full buildout hydrology using the City of Portland’s maximum permissible impervious standards.

Stream Power

After estimating hydrology, stream power was calculated. Stream power is a measure of the erosive energy of streamflow acting against the bed, banks, and floodplain (Bagnold 1966). Total stream power is calculated as the total energy exerted on the wetted channel per unit channel length:

$$Total\ Stream\ Power = Specific\ Weight\ of\ Water\ x\ Stream\ Discharge\ x\ Stream\ Slope$$

Dividing stream power by the wetted width yields Specific Stream Power (SSP), which normalizes stream power values across different scales. The SSP metric is well suited to comparing the erosivity of streams of varying size and location in the watershed. This study utilizes SSP to assess patterns of erosion potential throughout the stream network and suggest potential management activities.

To forecast the impact of future development on stream health via hydromodification, SSP estimates were calculated under both existing and full buildout imperviousness scenarios. The SSP values, presented in watts per square meter (W/m^2; equivalent to lb/ft-s), were then grouped into relative high, medium, and low stream channel erosion potential based on published thresholds empirically derived from similar stream systems (Table 2). The sources used to inform these threshold categories are listed in Appendix B.

Table 2: Specific Stream Power thresholds used to identify erosion potential and determine feasibility of different restoration actions.

Relative Stream Channel Erosion Potential	Specific Stream Power Thresholds	
	(W/m^2)	(lb/ft-s)
Low	<10	<0.7
Medium	10–60	0.7–4.1
High	>60	>4.1

4. Stream Sheets

A key deliverable of this report is the creation of "Stream Sheets" for each of the 35 streams monitored across the different urban stormwater management districts. These one-page sheets are designed as a holistic presentation to clearly and efficiently communicate the health and condition of the individual streams. They are intended to be visually appealing, accessible to a broad audience, and focused on the most important indicators of stream condition. Each sheet includes the following elements:

- **Overview Map:** The overview map on each stream sheet includes an inset regional locator map showing the stream's position in a broader context and a zoomed-in watershed map to highlight watershed-specific details. This detailed watershed map includes the location of each monitoring site, with sites color-coded according to their SEM stage (see Figure 1). In addition, the map illustrates the stream's erosion potential, based on SSP (see Table 2), helping to identify stream reaches that may be at risk of channel instability or degradation. The map also depicts "additional allowable impervious area" (AAIA) within the watershed based on the difference between existing impervious area and the maximum allowable impervious area for each tax lot. Areas with 15–60% AAIA are classified as having moderate development pressure, while areas >60% AAIA are classified as high development pressure. Areas with less than 15% AAIA are considered to have low development pressure are not shown for simplification.
- **Qualitative Stream Health Scoring**: The graphic shown on the stream sheets represents condition scores for six key stream health indicators. The different metrics are scored from 1 (worst condition) to 5 (best condition).
    - Macroinvertebrate Health: Based on a composite of IBI, O/E, EPT richness, MTTI, temperature stressor score, and sediment stressor score, and are only shown for streams where macroinvertebrate sampling was done.
    - Water Quality: Based on the measured dissolved oxygen at streams where water quality data was collected. Dissolved oxygen is a key indicator of water quality, particularly in relation to biological health. Higher DO levels are associated with greater taxonomic richness among macroinvertebrates (Croijmans et al., 2021), and

concentrations approaching 10 mg/L are considered optimal for supporting aquatic life, including fish (U.S. EPA, 2021). Only show for streams where water quality measurements were taken.

  - Riparian Condition: Reflects a composite evaluation of invasive species presence and the extent of land use and infrastructure impacts at each site. During field observations, the prevalence of invasive riparian species was qualitatively assessed and categorized as low, medium, or high. This was then combined with a score representing land use and infrastructure, where a score of 1 indicates substantial disturbance, such as culverts, riprap, utilities, or industrial and developed land uses, and a score of 5 represents more natural, undisturbed conditions such as open space or native vegetation.
  - Floodplain Connectivity: Calculated using average width-to-depth and confinement ratios (metrics further explained in Appendix B). Both of these ratios help understand a stream's geomorphic setting, departure from reference condition, and restoration potential.
  - Development Pressure: Incorporates both existing impervious area and AAIA based on tax lot data and zoning allowances.
  - Canopy Cover: Derived from Metro RLIS 2019 canopy raster using NDVI and LiDAR. Higher scores reflect greater vegetation density, which supports thermal regulation, habitat quality, and bank stability.
- **Longitudinal Profile**: Each sheet presents a longitudinal profile of the stream's elevation derived from LiDAR. The profile also includes average slopes and points for each site along the stream classified by their dominant grain size.
- **Narrative**: A brief narrative describes the stream's key characteristics, primary land uses, and, where applicable, observed trends in physical or biological condition based on historical data. Narratives may vary in content, highlighting only the most relevant information for each stream.
- **Representative Photos:** One or two site photos illustrate a range of stream conditions, often highlighting both natural features and anthropogenic impacts.

These Stream Sheets serve as a practical tool for communicating stream health to WES, the Co-permittees, and the public. By summarizing a large amount of data into a concise, standardized format, the sheets allow for easy comparison across watersheds while still capturing meaningful, site-specific information. The Stream Sheets are included in Appendix C of this report and are designed to function as stand-alone documents that can be shared independently of the report to support informed decision-making, help prioritize future monitoring and restoration efforts and foster greater community awareness of local watershed conditions.

5. Results

Results of the 2024 monitoring of the physical stream health, water quality, and hydrology metrics are presented below on a stream basis, as multiple monitoring sites were often located along a single stream. In contrast, biological health results are reported on a site basis, since macroinvertebrate data were typically collected at only one location per stream.

5.1 Physical Stream Health

Comprehensive results of physical stream health are presented in Appendix E in the refined database. The following focuses on some of the key metrics used to assess overall physical stream health and, where possible, notes changes observed between 2021 and 2024. Two years of data collection are not enough to derive statistically significant trends in physical stream health, but continued monitoring and collection of similar data will allow for more detailed trend analyses in the future. However, because WES collected some of the same physical stream health data during earlier monitoring events, some geomorphic metrics could be compared across 2009, 2011, 2014, and 2021. The results of this trend analysis are presented in Appendix F.

5.1.1 Channel Geometry

Channel geometry measurements collected in 2021 and 2024 at 110 paired sites were used to compare changes in channel size and shape. Over a three-year period, major shifts in channel form are not typically expected, as geomorphic changes often occur over longer timescales. However, localized factors such as new development or beaver activity can cause abrupt changes in channel geometry. This comparison also serves as a check on potential observer bias in collecting relative measurements, with generally consistent values expected between 2021 and 2024. Figure 6 supports this expectation, showing little to no change in the distribution of observed channel geometry measurements as the changes in average measured value are within the standard deviations of the populations.

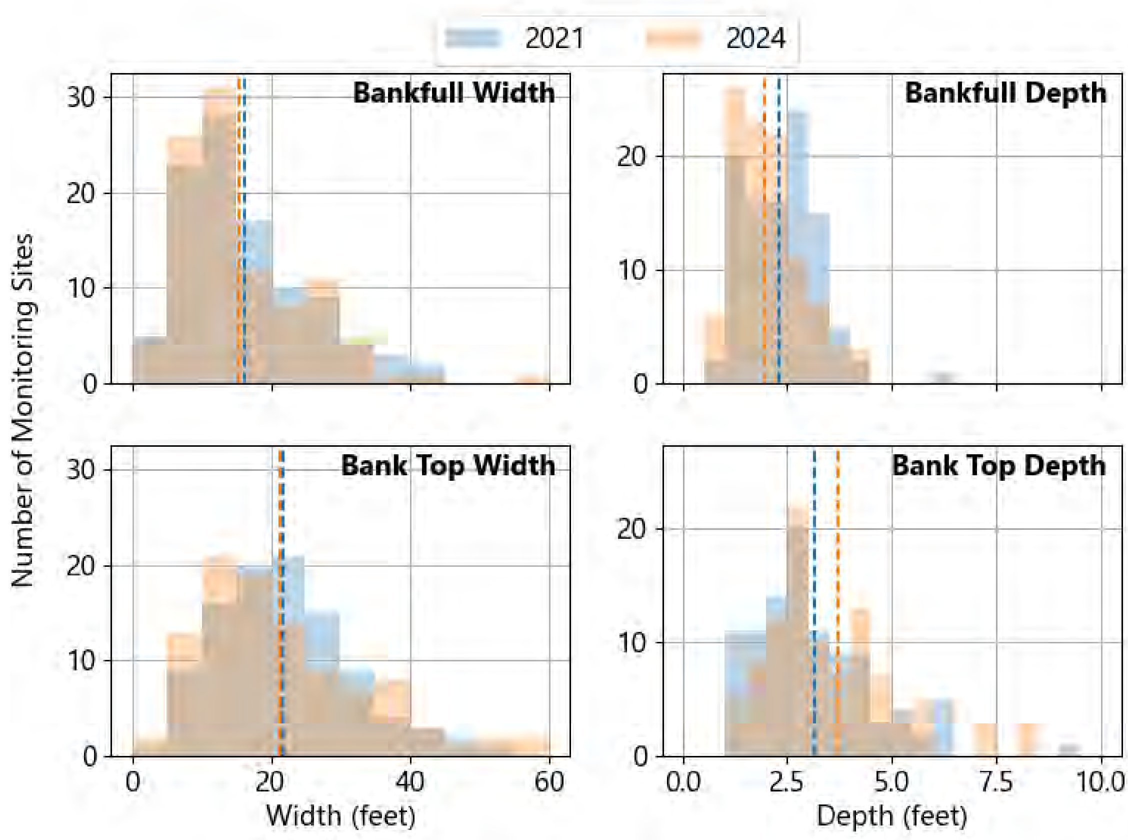


Figure 6: Histograms of measured channel geometry variables, compared between 2021 and 2024. Mean values are indicated with dashed lines.

We performed paired t-tests on the datasets to compare intra-site changes between years. Figure 7 shows the 2021-2024 paired data for each site. The results from this analysis also support that there is little-to-no statistical change in channel geometry between 2021 and 2024; additional methods and results for this analysis are in Appendix B.

While the intra-site changes can be significant by themselves, the change is often within the standard deviation of bankfull widths measured at each site. This means that the measured change for most sites can likely be explained by natural variability of channel geometry within each site. There does not appear to be any systemic bias in data collection between different personnel over different years.

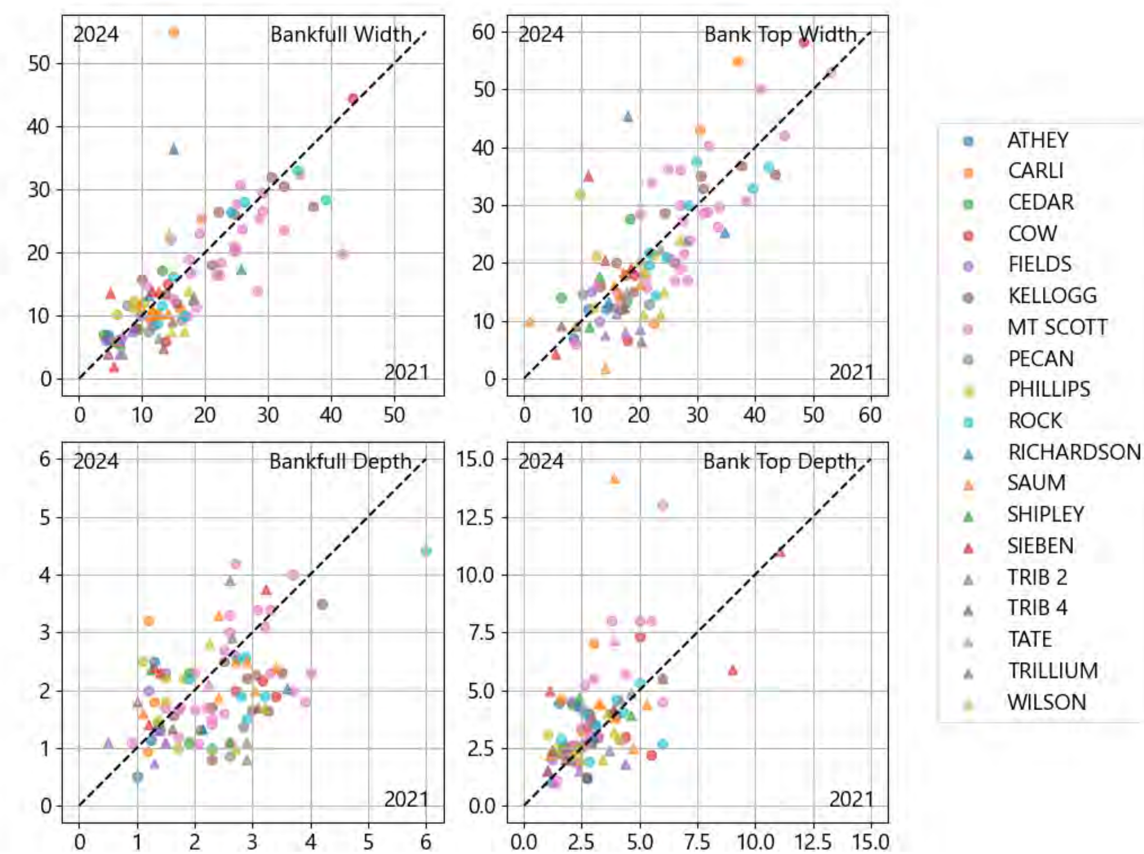


Figure 7: Paired results of channel geometry between 2021 (x-axis) and 2024 (y-axis). Sites with no change will fall along the dashed line, sites where the measurement increased will plot above the dashed line, and sites where the measurement decreased will plot below the dashed line.

5.1.2 Floodplain Connectivity

None of the creeks monitored in 2024 received the highest score of 5, and only two—Tanner Creek and Boardman Creek—received a score of 4. Most creeks scored a 2 or 3, while five creeks received the lowest possible score of 1 (Figure 8).

Of the 35 creeks monitored for physical stream health, 19 were also assessed in 2021. A comparison of floodplain connectivity scores for these streams shows that 9 exhibited improved connectivity, 7 experienced a decline, and 3 showed no change.

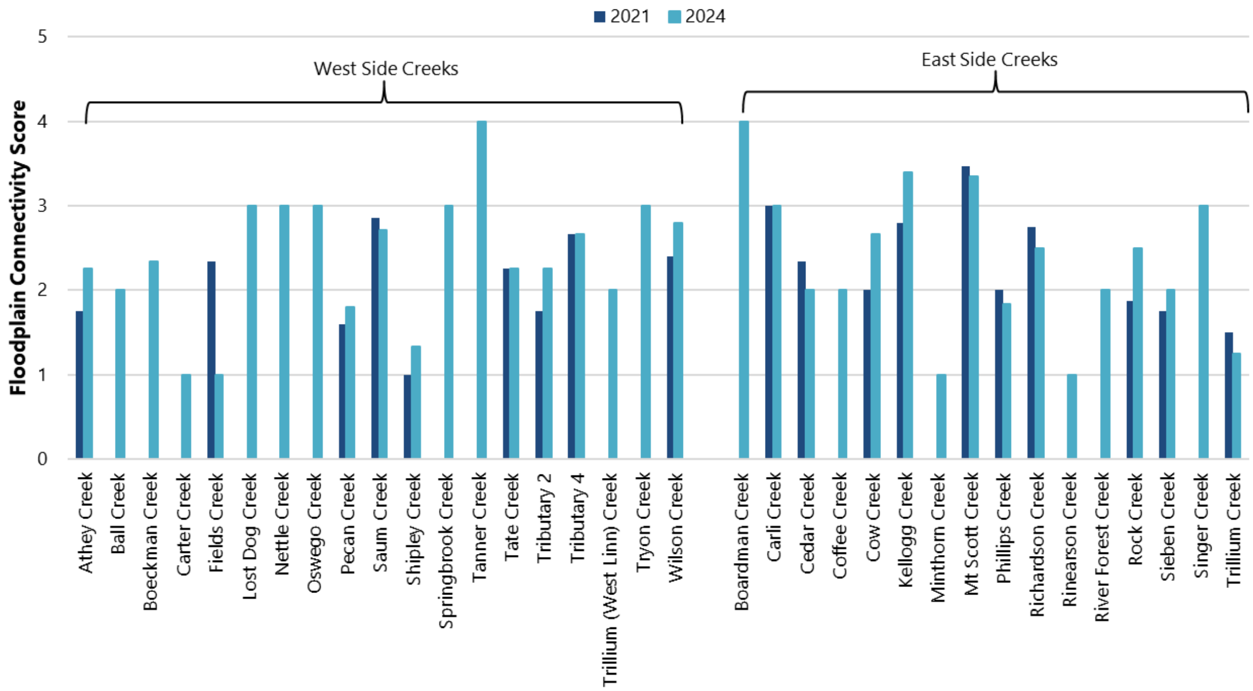


Figure 8: Floodplain connectivity scores for all 35 creeks, based on confinement and width-to-depth ratios. For creeks also monitored in 2021, scores from both years are shown for comparison.

5.1.3 Riparian Habitat and Canopy Cover

Overall, most creeks fall within the moderate range, scoring between 2.0 and 3.5, indicating fair riparian condition with room for improvement. Oswego Creek, Pecan Creek, Boardman Creek, Mt. Scott Creek, and Trillium (WES) Creek achieved relatively higher scores near or above 3.5, suggesting stronger riparian health. Conversely, some creeks such as Boeckman Creek, Coffee Creek, and Springbrook Creek scored below 2.0, indicating degraded riparian zones and likely limited native vegetation (Figure 9). Although riparian health was documented during the 2021 monitoring effort, differences in observation methods between years prevent direct comparison of scores across the two monitoring periods.

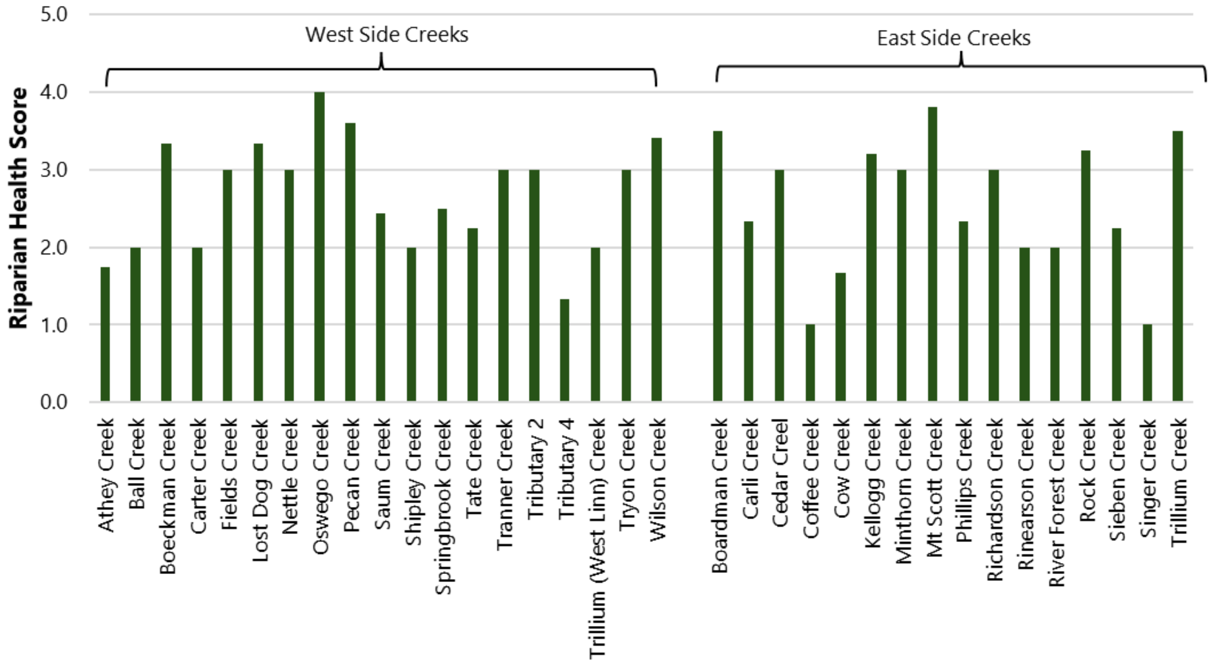


Figure 9: Summary of 2024 riparian health scoring per creek.

Canopy cover results (Figure 10) show wide variability across sites. Fields Creek had the highest observed canopy cover at over 70 percent, followed by several sites including Tate Creek, Tryon Creek, Tributary 4, and Springbrook Creek with values above 50 percent, suggesting relatively intact riparian vegetation. In contrast, sites on Carli Creek, Phillips Creek, and Cow Creek had canopy cover below 20 percent.

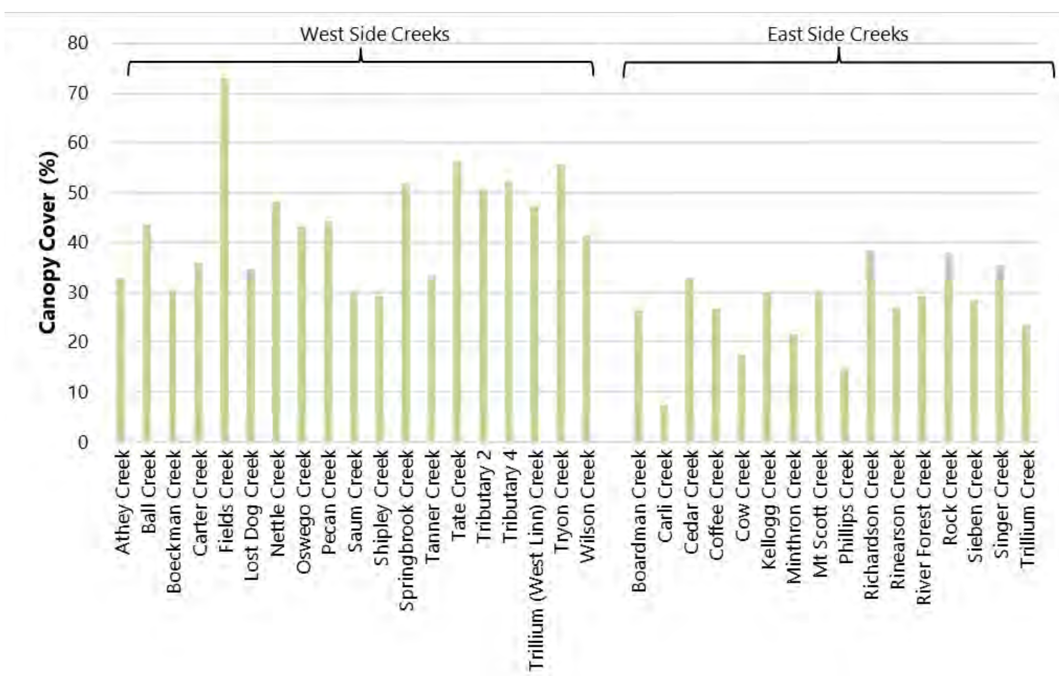


Figure 10: Percent canopy coverage per watershed from the Metro RLIS 2019 canopy raster.

Comparison of the 2007 and 2019 canopy datasets, along with the 2014 intermediate dataset produced by Metro, reveals whether any watersheds have experienced notable increases or decreases in canopy coverage over time (Table 3).

Table 3: Canopy cover trends for watersheds based on Metro's canopy raster datasets from 2007, 2014, and 2019. The table summarizes whether each watershed experienced increasing, decreasing, or stable canopy cover over two time periods: 2007–2014 and 2014–2019.

Stream	2007–2014 Change	2014–2019 Change
Athey Creek	Stable	Stable
Ball Creek	Increasing	Decreasing
Boardman Creek	Stable	Stable
Boeckman Creek	Increasing	Stable
Carli Creek	Increasing	Stable
Carter Creek	Increasing	Stable
Cedar Creek	Increasing	Stable
Coffee Creek	Decreasing	Stable
Cow Creek	Stable	Stable
Fields Creek	Increasing	Stable
Kellogg Creek	Increasing	Stable
Lost Dog Creek	Stable	Stable
Minthorn Creek	Increasing	Stable
Mt Scott Creek	Increasing	Stable
Nettle Creek	Decreasing	Decreasing
Oswego Creek	Stable	Decreasing
Pecan Creek	Stable	Stable
Phillips Creek	Increasing	Stable
Richardson Creek	Increasing	Stable
Rinearson Creek	Decreasing	Stable
River Forest Creek	Decreasing	Decreasing
Rock Creek	Increasing	Decreasing
Saum Creek	Increasing	Decreasing
Shipley Creek	Decreasing	Stable
Sieben Creek	Increasing	Stable
Singer Creek	Decreasing	Stable
Springbrook Creek	Stable	Decreasing
Tanner Creek	Stable	Increasing
Tate Creek	Stable	Increasing
Tributary 2	Increasing	Stable
Tributary 4	Stable	Decreasing
Trillium Creek	Stable	Increasing
Trillium (West Linn) Creek	Decreasing	Stable
Tryon Creek	Stable	Decreasing
Wilson Creek	Decreasing	Stable

5.2 Biological Health

During the 2024 monitoring season, similarities in macroinvertebrate community composition were found to be greatest between each pair of duplicate samples taken for quality assurance (Figure 11), indicating a robust and repeatable sampling technique. Of the 45 reaches sampled, M-IBI scores (Figure 12) reflected severe impairment at 14 sites (31%), moderate impairment at 22 sites (49%), slight impairment at eight sites (18%), and minimal impairment at a single site (2%; PE40). PREDATOR O/E scores (Figure 13) reflected poor biological conditions at 39 sites (87%) and fair conditions at six sites (13%). No site received an O/E score high enough to indicate good conditions.

The total number of unique taxa taken in each sample ranged from 17 (LD30, BO10) to 58 (RC50), with 18 samples scoring in the top scaled range of the M-IBI (>35 taxa) for this metric (Figure 14). Among the more sensitive EPT orders, four sites had no EPT, and 25 sites lacked Plecoptera (stoneflies; Figure 14). RI10 had more stonefly taxa (8) and more EPT taxa (18) than any other site, followed by PE40 which had six stonefly taxa and 17 EPT taxa.

Temperature stressor scores suggest that temperature is a probable stressor at most sites, as 35 sites (78% of total) scored above the 18.4ºC threshold considered to be an indicator of temperature stress (Figure 15). MTTI scores were higher at each site compared to temperature stressor scores (Figure 15), which may be a function of the newly revised temperature tolerance values for OR and WA. Sediment is also a likely stressor at most sites, as only three sites scored below the 19% inferred sediment threshold considered to be an indicator of sediment stress (BA10, RC10, RI10; Figure 16).

There was no significant difference in the mean values of any of the 10 M-IBI metrics between all east side and west side sites. Values of calculated models (M-IBI, O/E, temperature and sediment stressor scores, MTTI) also did not differ significantly between east and west side sites.

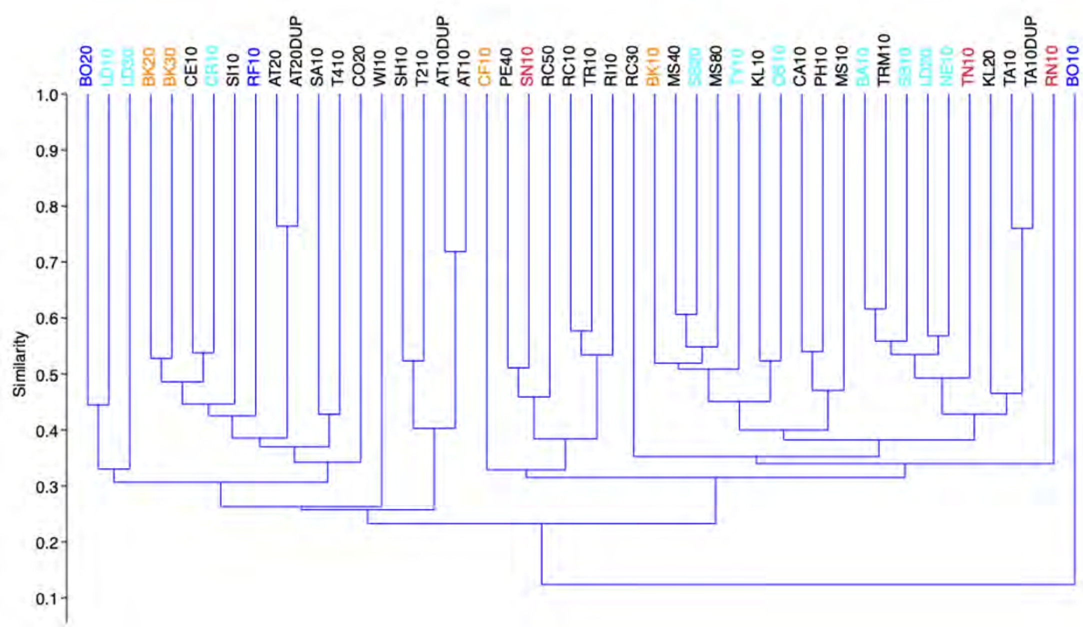


Figure 11: Similarity in macroinvertebrate model community composition across all 2024 sites. Black = WES; aqua = Lake Oswego; orange = Wilsonville; blue = Oak Lodge; red = other co-permittee. DUP = duplicate sample taken for QA purposes.

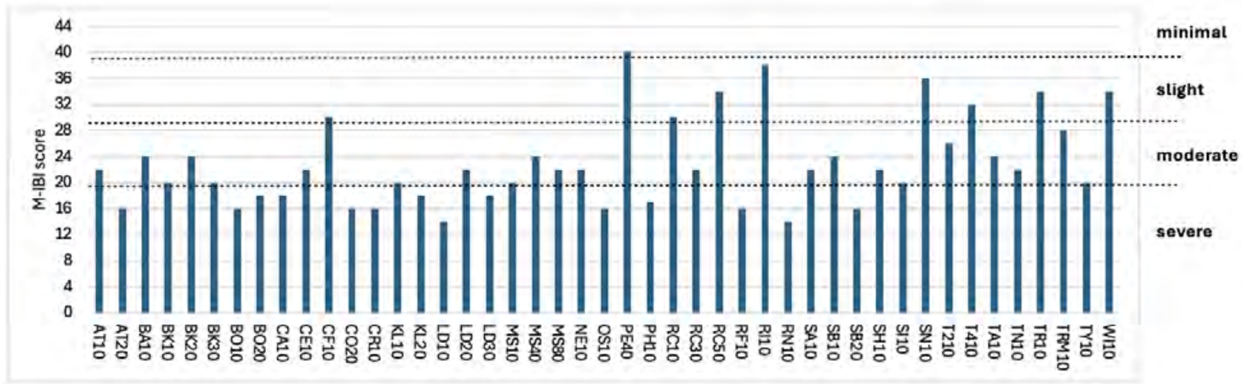


Figure 12: M-IBI scores. Dashed lines show score ranges corresponding to severe, moderate, slight, or minimal disturbance.

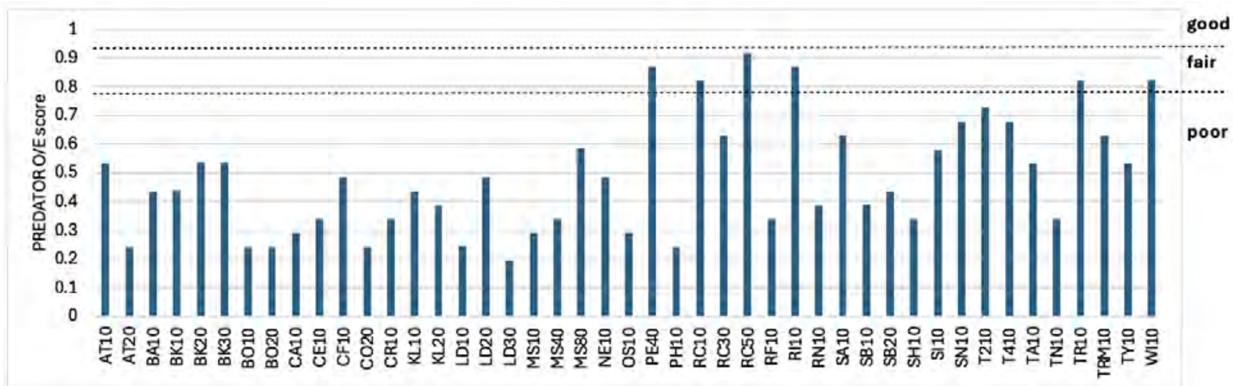


Figure 13: PREDATOR O/E scores. Dashed lines show score ranges corresponding to poor, fair, and good biological conditions.

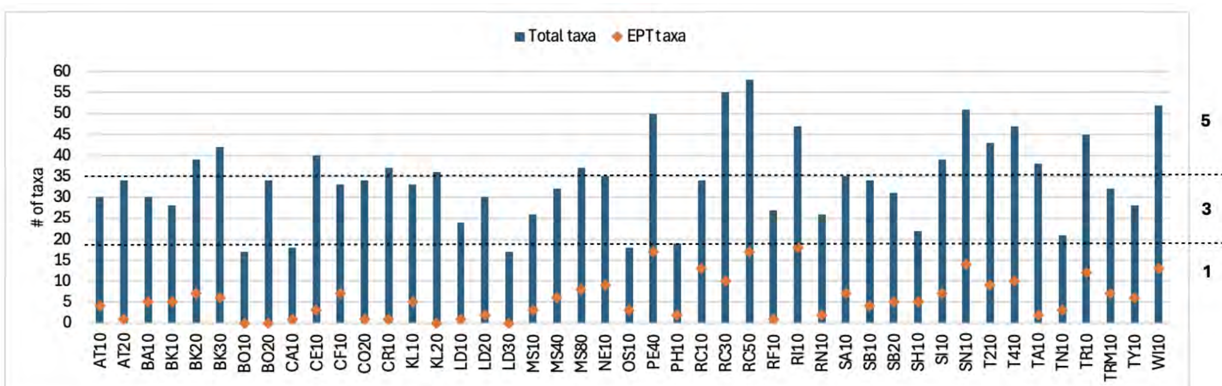


Figure 14: Total sample and EPT (Ephemeroptera [mayfly], Plecoptera [stonefly], Trichoptera [caddisfly]) taxa. Dashed lines show corresponding scaled values for total sample taxa in the M-IBI.

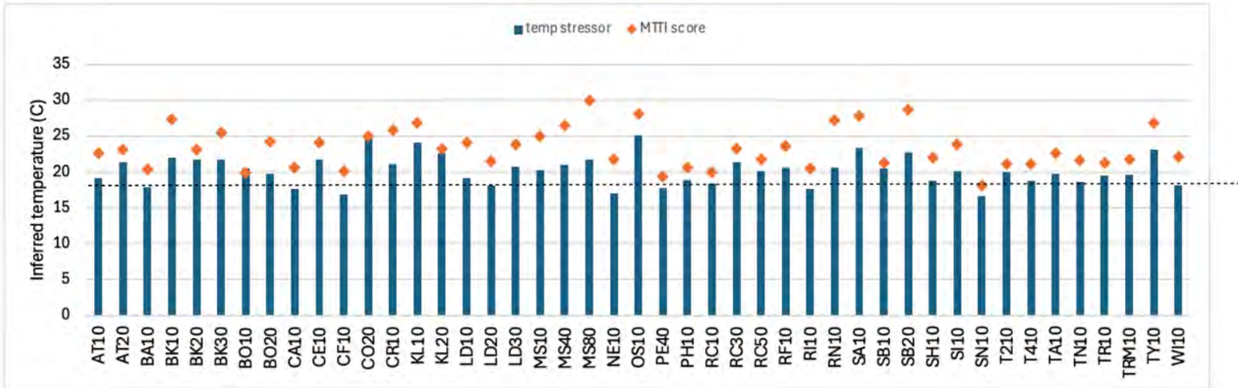


Figure 15: ODEQ temperature stressor and MTTI model score values. Dashed line indicates threshold value above which temperature may be a stressor (18.4°C).

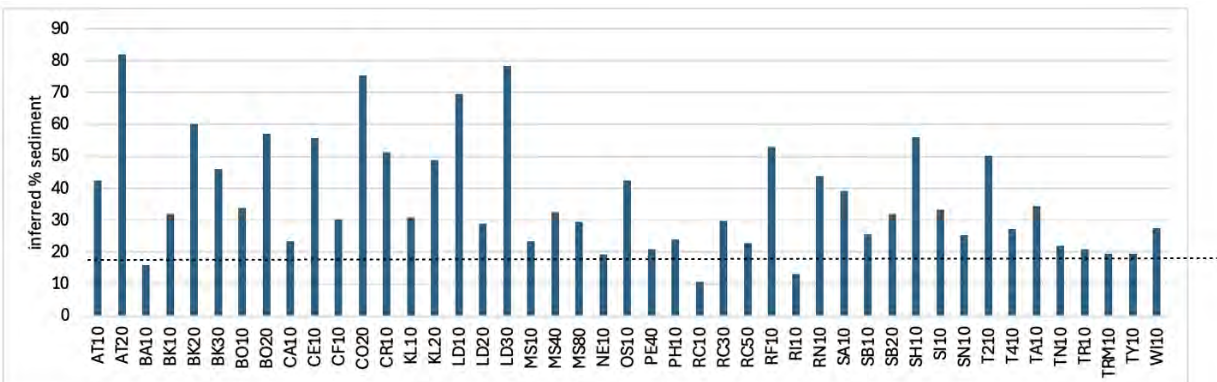


Figure 16: ODEQ sediment stressor model score values. Dashed line indicates threshold value above which sediment may be a stressor (19%).

5.2.1 WES Sites

M-IBI scores generally indicated better biological conditions compared to the O/E score for the same site. PE40 had the highest score for both models, indicating minimal impairment (M-IBI) and good biological condition (O/E). Overall, M-IBI scores indicated slight or minimal impairment at eight sites, while O/E scores indicated good biological condition at a single site and fair biological condition at five sites.

Despite this, M-IBI scores were higher in 2024 compared to 2021 at 16 sites, with the change in score corresponding to an improved category of impairment at nine of these. O/E scores were higher in 2024 compared to 2021 at 14 sites, but the magnitude of the change was smaller and resulted in an improved category of biological condition at just three of these.

Temperature stressor scores at five sites in 2024 were below the threshold value at which temperature is considered a potential stressor (18.4°C); three sites scored below this threshold in 2021. More sites had sediment stressor scores below the 19% threshold in 2021 (6 sites) compared to 2024 (two sites).

Significant unidirectional trends over time were seen for M-IBI score (five sites), O/E score (two sites), number of total taxa (10 sites), number of EPT taxa (four sites), and temperature stressor model score (two sites); no significant unidirectional trend in sediment stressor score was seen at any WES site. Significant trends in all metrics except temperature stressor score suggested improving habitat conditions; in contrast, both significant trends in temperature stressor score suggested declining habitat conditions. Twelve sites had significant unidirectional trends in at least one metric, while 11 sites had no significant trends.

There was no significant difference in the mean values of any of the 10 M-IBI metrics or model scores between east side and west side sites. Values of calculated models (M-IBI, O/E, temperature and sediment stressor scores, MTTI) also did not differ significantly between east and west side sites.

Tables with trends analysis results can be found in Appendix D.

5.2.2 Lake Oswego sites

M-IBI scores indicated better biological conditions compared to the O/E score for the same site at four of the 10 sites sampled. BA10 had the highest M-IBI score in 2024, while TY10 had the highest O/E score. All 2024 sampling sites received O/E scores indicating poor biological condition, while six sites received M-IBI scores indicating severe impairment. Comparison of 2021 and 2024 model scores showed little change. M-IBI scores were higher in 2024 at three sites, but only one site (NE10) moved from severely impaired to moderately impaired as a result. In addition, M-IBI scores were the same in 2021 and 2024 at four sites. O/E scores were the same in both years at three sites, and the small magnitude of difference in O/E scores at the remaining sites suggests little change in habitat.

Temperature stressor scores at three sites in 2024 were below the threshold value at which temperature is considered a potential stressor (18.4ºC); two sites scored below this threshold in 2021. Two sites had sediment stressor scores below the 19% threshold in 2021; in 2024, no sites scored below this threshold.

Significant unidirectional trends over time were seen for M-IBI score (one site), O/E score (one site), number of EPT taxa (two sites), and sediment stressor model score (one site); no significant unidirectional trend in number of total taxa or temperature stressor score was seen at any Lake Oswego site. Only four sites had significant trends in any metric, with no more than two metrics changing significantly over time at any site.

Tables with trends analysis results can be found in Appendix D.

5.2.3 Additional co-permittee sites

Additional sites among the co-permittees Wilsonville, Oregon City, West Linn, Oak Lodge, and Gladstone included Boeckman Creek (BK10, BK20, BK30), Tanner Creek (TN10), Coffee Creek (CF10), Singer Creek (SN10), Boardman Creek (BO10, BO20), River Forest Creek (RF10), Trillium Creek (West Linn) (TRWL10), and Rinearson Creek (RN10). M-IBI scores indicated severely impaired conditions at four sites, moderately impaired at five sites, and slightly impaired conditions at two sites (CF10, SN10). No site scored as minimally impaired. In contrast, all sites received O/E scores indicating poor biological conditions, although the site with the highest M-IBI score (SN10; 36) also received the highest O/E score (0.678).

Only CF10 and SN10 had temperature stressor scores below the 18.4ºC threshold at which temperature is considered a potential stressor. All 11 sites had sediment stressor scores above the 19% fine sediment threshold at which sediment is considered a potential stressor.

There was a single significant difference between east and west side sites among all individual metrics and model scores, with significantly more Trichoptera (caddisfly) taxa in west side sites (mean = 3, SD = 0.8) compared to east side (mean = 0.8, SD = 1.2).

There was insufficient data to conduct correlation analysis of metrics and model scores, but comparisons of 2018 vs. 2024 M-IBI scores, numbers of total and EPT taxa, and MTTI scores revealed little change at most sites. Changes in M-IBI scores were greatest at SN10 (6 points lower in 2024) and BO20 (8 points higher in 2024). Differences in M-IBI scores resulted in a corresponding change in biological condition at just two sites, with SN10 moving from minimal to slight impairment, and TN10 moving from severe to moderate impairment.

The number of total taxa was lower in 2024 at only two sites (BO10, BK10) and unchanged at two sites (TN10, CF10). The remaining sites had anywhere from two to 12 more total taxa in 2024 than in 2018, with RF10 experiencing the greatest increase. The magnitude of change in the number of EPT taxa was much smaller, with two sites experiencing no change in EPT (BO20, RN10), three sites losing one to two EPT taxa in 2024 (BO10, CF10, SN10), and the remaining six sites having one to two more EPT taxa in 2024.

SN10 was the only site with an MTTI score below the 18.4ºC threshold at which temperature is considered a potential stressor; this site scored as 18.2ºC in both 2018 and 2024. Of the remaining 10 sites, five had MTTI scores that were 0.4 to 5.1ºC lower in 2024 compared to 2018 (BK20, BO20, BO10, CF10, TRM10), with the largest decrease occurring at BO10. Five sites had MTTI scores that were 0.5 to 4.4ºC higher in 2024, with the largest increase occurring at BK30.

5.3 Water Quality

Water quality results for 2024 are presented below by metric. While some streams in the study area were monitored in previous years, differences in metrics and methods prevent direct comparisons with historical data.

5.3.1 Temperature

Stream temperatures in the study area ranged from 9.4°C to 17.5°C, with measurements taken between 7:30 a.m. and 3:00 p.m. from mid-September to early November. This variation largely reflects natural daily temperature fluctuations common in Oregon streams. While the time of day likely influence individual temperature readings, the effect is assumed to be minor and not substantial enough to affect overall trends.

Oregon's water quality standard for cold-water biota, such as salmon and trout, is 18°C (DEQ, 2008), with lower thresholds for spawning habitats. Assuming a conservative 5°C increase in summer, at least 10 of the 26 streams sampled in 2024 (38%) may exceed this threshold during peak temperatures (Figure 17).

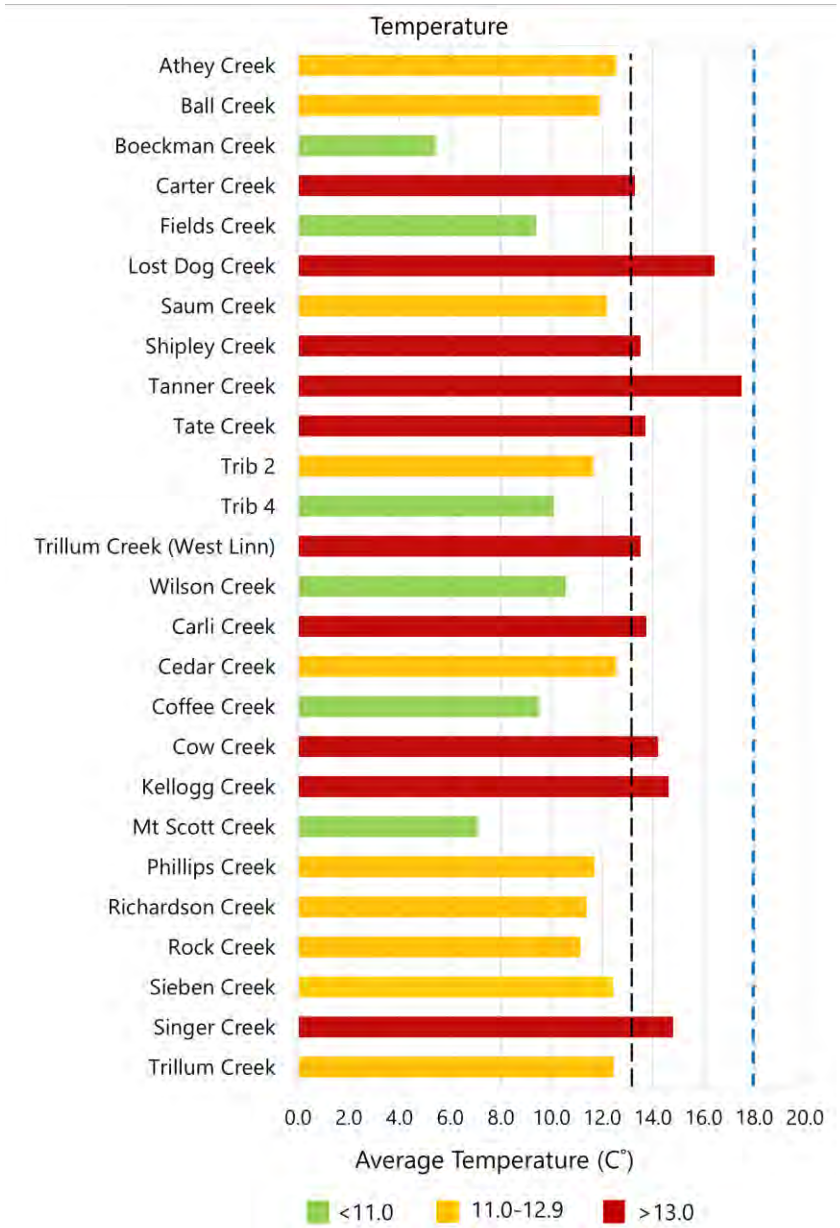


Figure 17: Temperature results for all water quality documented streams in 2024; color scheme assumes summer temperatures that may be 5°C warmer than recorded fall temperatures. The dashed black line indicates streams that could potentially exceed the 18°C water quality standard (shown by the dashed blue line) for cold-water biota during warmer months.

5.3.2 Dissolved Oxygen

Dissolved Oxygen (DO) was generally considered low throughout the majority of sites, with 5 of the 26 sites being below the threshold for providing sufficient DO for cold water biota (Figure 18). Only one study stream (Fields Creek) met this standard.

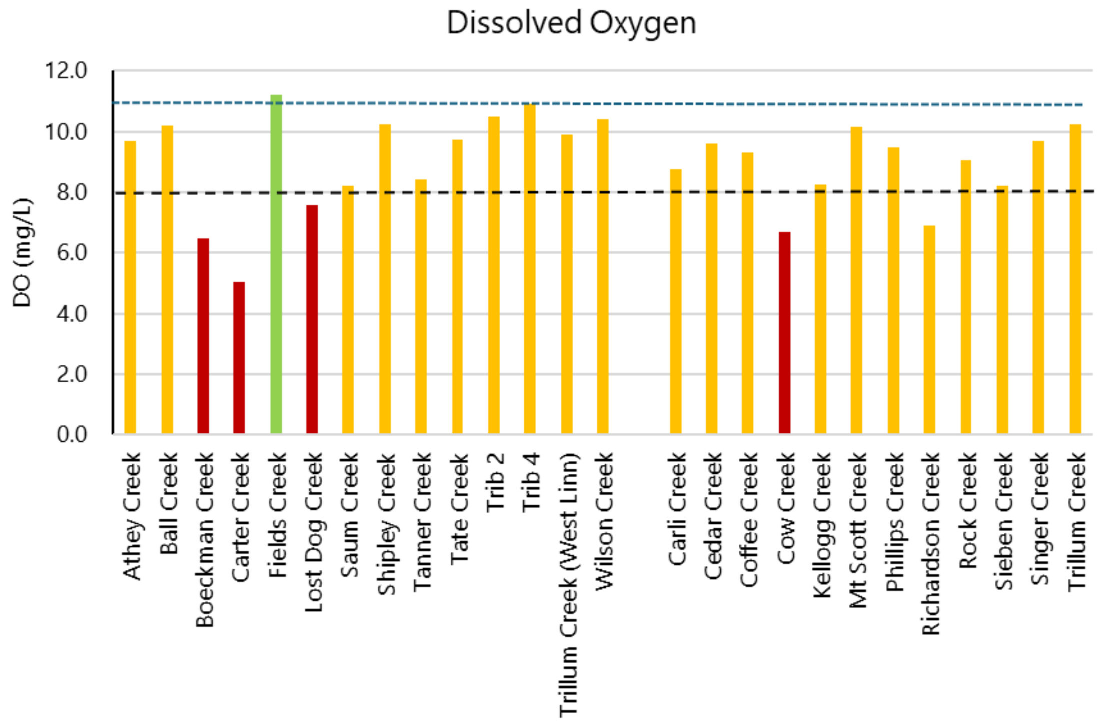


Figure 18: Dissolved oxygen results for all water quality documented streams; black dashed line represents minimum threshold for supporting cold water biota (8 mg/L), and blue dashed line represents minimum threshold for supporting trout spawning (11 mg/L).

5.3.3 pH

The pH findings ranged from 6.6 to 7.8 throughout the sampled streams. The state of Oregon has set standards for stream pH that range from 6.5 to 8.5 (OAR, 2025c). All study streams were within this threshold at the time of water quality sampling and are therefore not plotted here.

5.3.4 Conductivity

Conductivity in the sampled streams generally ranged from 86 μS/m to 252 μS/m, with one stream (Carli Creek) having conductivity levels of 414 μS/m, which is considered relatively high for a freshwater stream (Figure 15). DEQ does not establish a specific numeric water quality standard for conductivity in streams. Instead, conductivity is monitored as a general indicator of water quality, reflecting the presence of dissolved solids such as salts and minerals. Elevated conductivity levels can signal potential pollution sources, including urban runoff, agricultural discharges, or industrial effluents.

In general, conductivity values between 50 and 150 μS/cm are typical for streams in minimally impacted watersheds. Values above 150 μS/cm may indicate underlying geologic conditions or minor human influence, while those exceeding 500 μS/cm are often associated with more substantial pollution sources. None of the sampled streams exceeded 500 μS/cm, though Carli Creek's measurement suggests some level of anthropogenic impact.

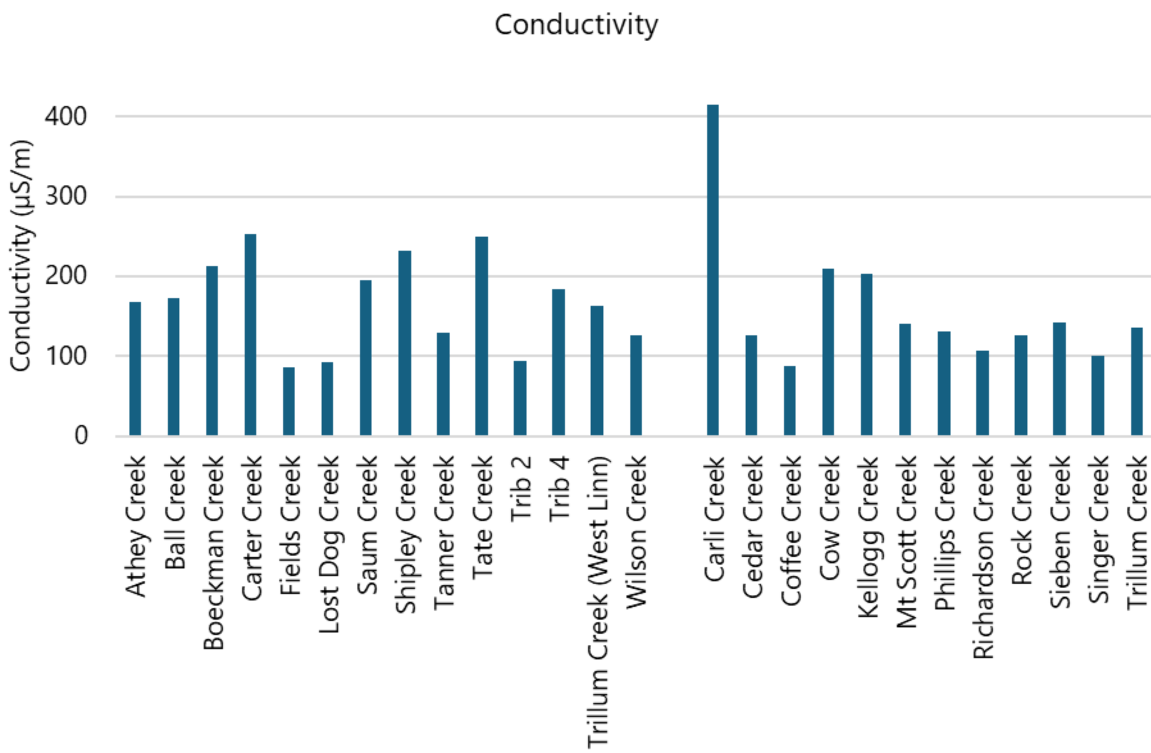


Figure 19: Conductivity results for all water quality documented streams.

5.4 Hydrology

In general, the most development in the study area has occurred in east side streams (Figure 5). The most developed watersheds are near the Town of Clackamas, such as Phillips, Cow, and Carli creeks, which all have heavily industrialized zoning within their watersheds. The least developed watersheds are west side streams outside of the UGB like Wilson, Shipley, Tributary 2, and Fields creeks.

Watersheds at risk of exceeding 70 percent impervious cover include Cow Creek, and Phillips Creek, which are already two of the most developed watersheds today. Among watersheds that are already more than 5 percent impervious, several are projected to experience substantial increases between existing and full buildout conditions, including Trillium Creek with a 120 percent increase, Boeckman Creek with a 128 percent increase, Wilson Creek with a 146 percent increase, and Rock Creek with a 170 percent increase.

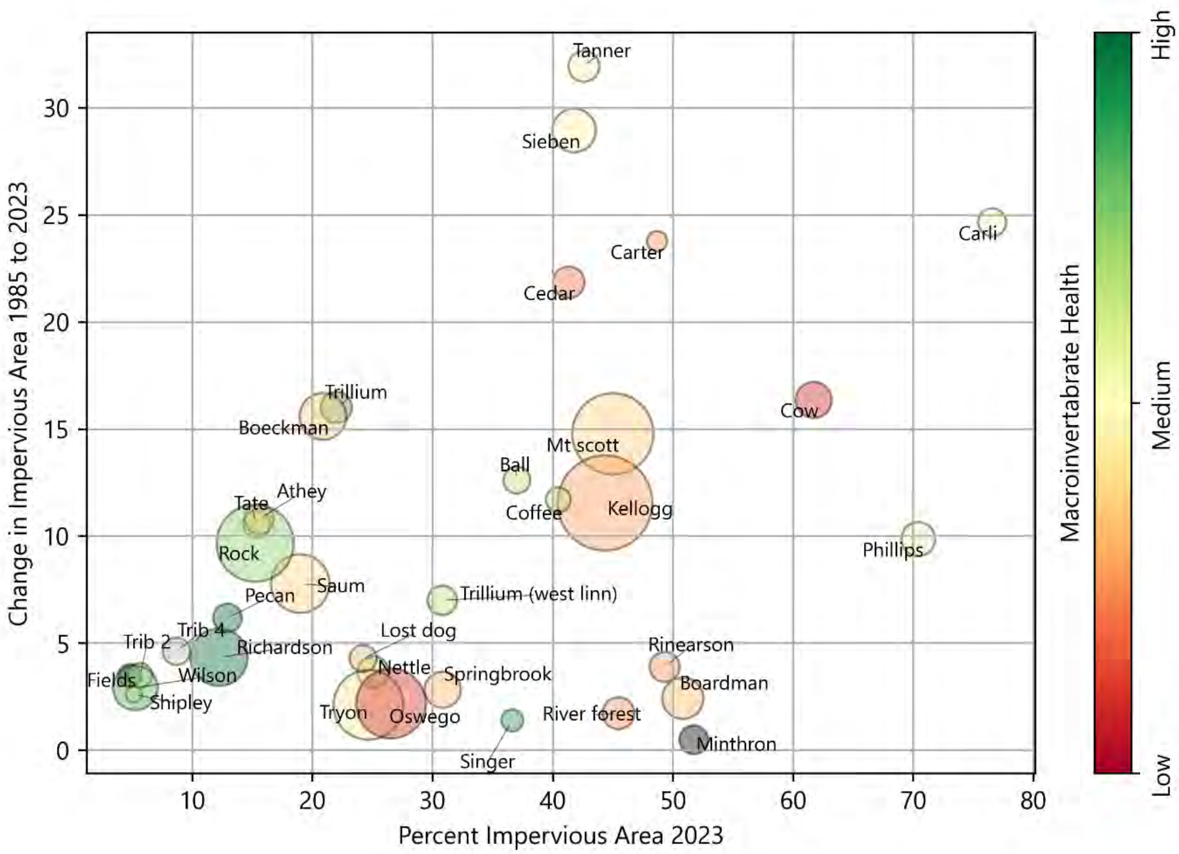


Figure 20: Development patterns related to macroinvertebrate health. Macroinvertebrate health is based on the watershed average 2024 macroinvertebrate score (see Scoring section). Marker size is scaled relative to watershed drainage area. Impervious area determined from 1985 and 2023 NLCD datasets.

This increase in impervious area will potentially influence peak flows in the study creeks. Figure 21 shows the predicted change in peak flows across the study area with the increased impervious areas. Other than the already most developed streams, Boardman Creek, Rinearson Creek, Carter Creek, and Minthorn Creek are predicted to experience the largest increases in peak flows.

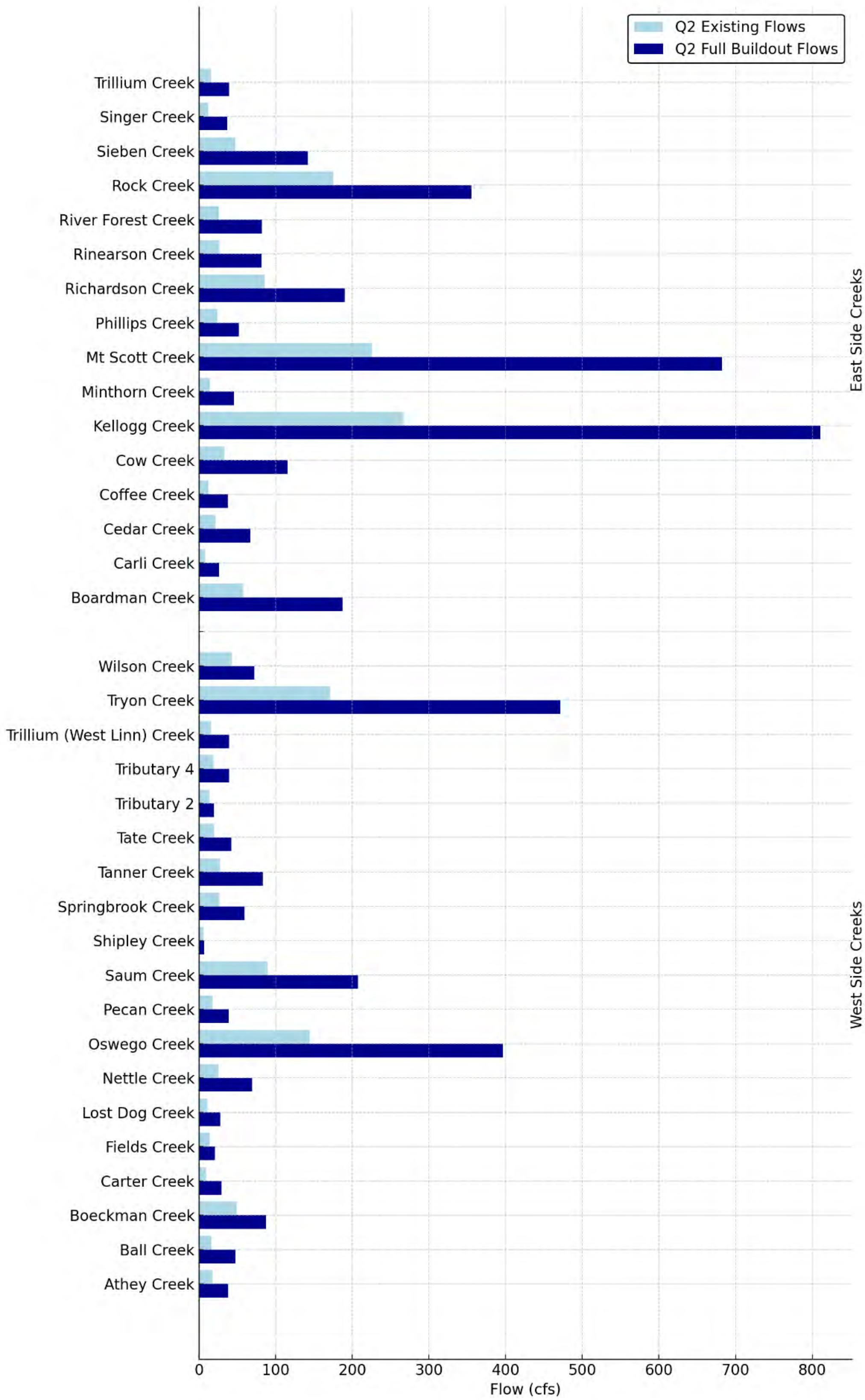


Figure 21: Summary of predicted increase in peak flows across the study area.

Specific stream power values, calculated using the hydrology described above, were used to assess erosion potential across the study area. Under existing conditions, only four streams (Carli Creek, Carter Creek, Minthorn Creek, and Cow Creek) fall within the low erosion potential category (Figure 22). Thirteen streams fall into the medium category and another eighteen fall into the high category. Tryon Creek exhibits the highest specific stream power under current conditions, with Richardson and Seiben Creeks not far behind.

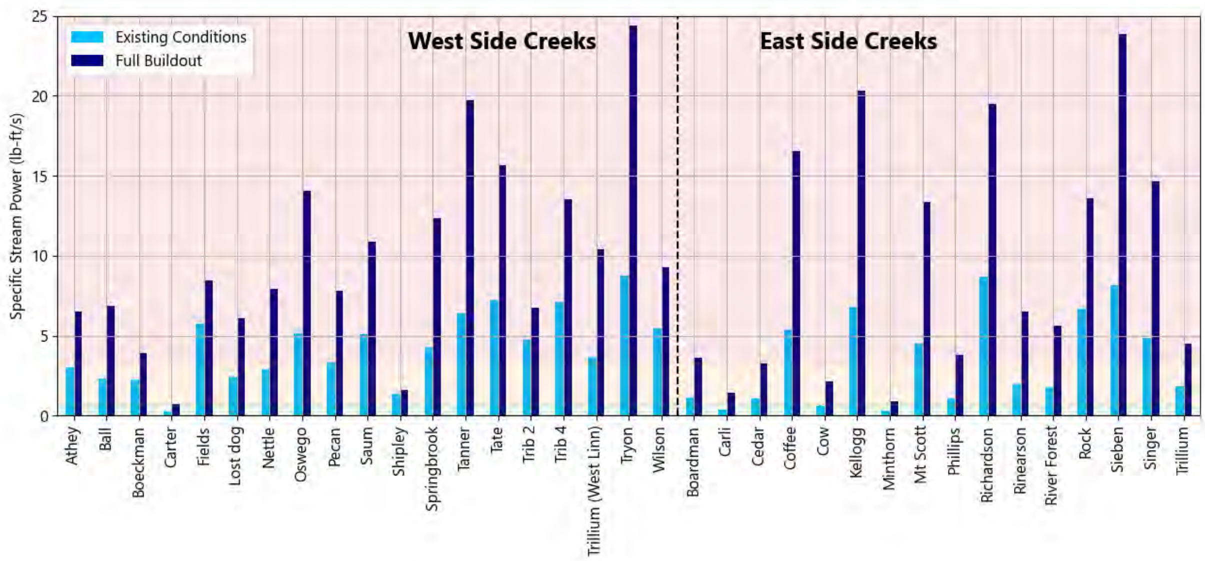


Figure 22: Stream power results for each stream under existing conditions and full buildout conditions. Green represents low erosion potential, yellow represents medium erosion potential, and red represents high erosion potential.

Under full buildout conditions, only Carter Creek remains in the low erosion potential category. Seven streams fall into the medium category, while 27 streams (over 75% of the streams in this study) are classified as high, illustrating the substantial increase in stream energy and erosion potential associated with expanded impervious cover.

These specific stream power results also inform the stream treatment analysis, which is further discussed in the Implications and Results section of this report.

Accuracy Assessment

To evaluate the accuracy of the rapid, desktop-based hydrology approach, estimated 2-year peak flows were compared to estimates derived from gage data using standard methodologies. Over a decade of high temporal resolution gage data was available for four streams in the study area: Mt Scott, Rock, Kellogg, and Phillips, provided by WES. Peak flow hydrology was estimated using PeakFQ software with weighted regional skew. A comparison of these hydrologic methods is presented in Table 4.

Table 4: Comparison of 2-year peak flows estimated from over a decade of gage data in PeakFQ to the desktop-based regional regression approach. PeakFQ flows show the likely median and high/low 90% confidence intervals.

		Mt Scott	Rock	Kellogg	Phillips
PeakFQ Estimates Using Measured Peak Flows	Low	349	306	358	154
	Median	440	427	489	175
	High	564	600	358	194
Regression-Estimated Peak	Existing	380	331	468	36
	Full Buildout	1110	741	1466	130
Regression Estimates as Percent	Existing	86%	78%	96%	21%
	Full Buildout	197%	124%	409%	67%

The regional regression method underestimated the 2-year peak flow for all streams by 5-20% except for Phillips, a highly developed watershed with complex stormwater networks, where the regional regression approach severely underestimated flows. Excluding Phillips, all the regional regression estimates are within PeakFQ's 90% upper and lower confidence intervals.

This systemic underprediction is likely resulting from both a poor delineation of drainage area in such an urbanized watershed and industrial development practices that are not reflected in the 0.3 impervious area multiplier. The impervious area multiplier developed in Bledsoe and Watson (2001) is based on residential developments, not commercial and industrial developments. Small errors in drainage delineation are also more likely to have a larger influence on smaller watersheds.

This analysis indicated that hydrology is likely significantly underestimated for creeks with predominantly industrial and commercial development, including Phillips, Carli, Cow, Boardman, and Minthorn Creeks. River Forest and Rinearson Creeks may also fall into this category, but to a lesser extent.

Drainage delineation in this study was based on topographic data, with obvious stormwater features manually burned into the DEM before delineating stream networks. Future analyses could incorporate stormwater network GIS layers to override flow direction and stream delineation, improving the accuracy of watershed boundaries and flow routing.

5.5 Overall Stream Health

Physical stream health, biological health, and water quality are all interconnected components that influence overall stream condition in urban watersheds. These categories do not operate independently; each one affects and is affected by the others, making it difficult to isolate a single factor as the most important or impactful. Depending on specific restoration or management goals, one aspect may be prioritized over others, but a comprehensive understanding of stream health requires consideration of all.

To support data interpretation, the scoring of six key metrics was compared across monitored creeks: riparian health, water quality, floodplain connectivity, development pressure, canopy cover, and macroinvertebrate health. Because all metrics were evaluated on a consistent 1 to 5 scale, the lowest scoring metric for each stream was identified. A low score does not necessarily indicate the primary stressor, but it may represent a limiting factor to stream health based on field observations and desktop analysis. This method provides a practical snapshot of where conditions may be most impaired and where targeted improvements could be most effective. Primary stressors for each of the macroinvertebrate sites are included in Appendix D.

5.5.1 Low-Scoring Metrics

Some streams had a clearly identifiable lowest scoring metric, while others exhibited similarly low scores across multiple categories, without a single dominant limiting factor. Figure 23 provides a snapshot of these results and serves as a quick reference for identifying potential constraints on stream condition and comparing overall patterns across the districts.

As shown in Figure 23, floodplain connectivity is a common limiting factor, with over one-third of the streams having it as their lowest scoring metric. This is consistent with expectations for urban streams, where hydromodification increases stream energy and alters flow regimes, resulting in more frequent and intense erosive events that degrade channel and floodplain connections. Water quality is the next most frequently identified low-scoring metric, suggesting possible pollution concerns across the study area, likely influenced by stormwater runoff and other impacts associated with urbanization.

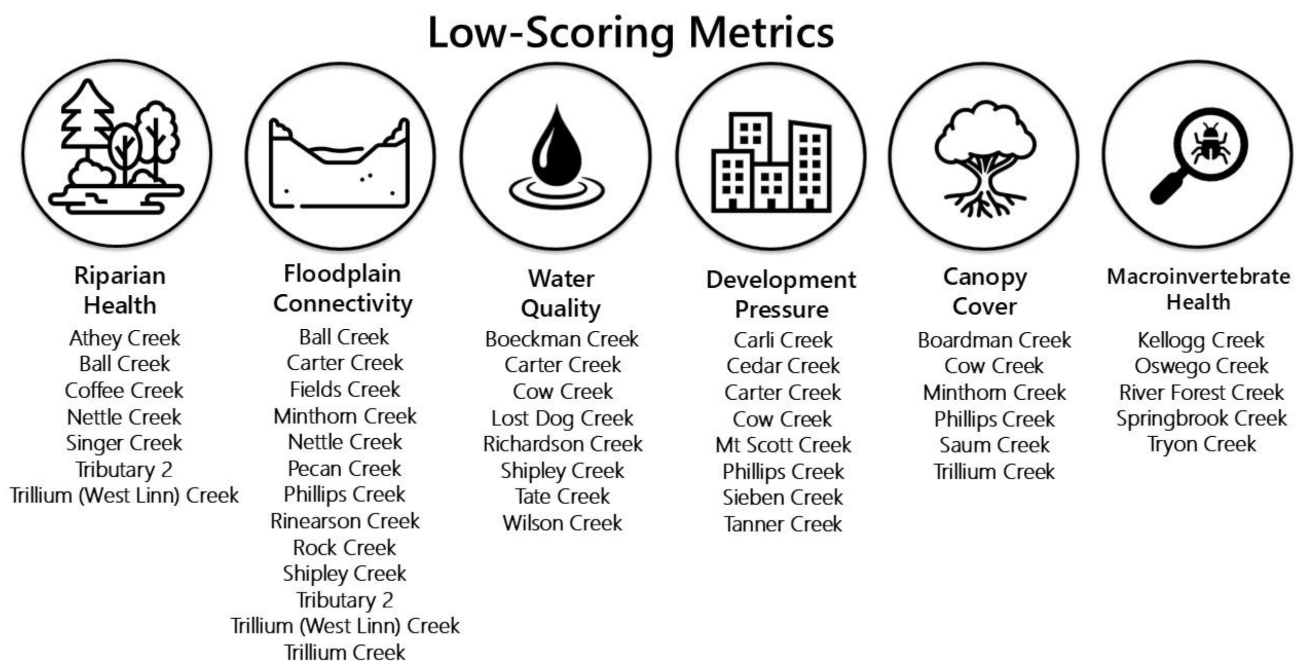


Figure 23: Graphic listing lowest scoring metric for each creek. Some creeks are listed for more than one metric.

5.5.1 East versus West Streams

To explore spatial patterns in stream condition, streams were grouped based on their location relative to the Willamette River and compared across five scoring metrics. Because some streams had more sampling points and represented watersheds of varying sizes, scores were first averaged at the watershed level and then area-weighted based on total watershed area (Table 5). In this section we speak generally about the East and West side streams knowing that there are exceptions and outliers within each group.

It was initially expected that West-side streams would have higher average scores due to generally lower development pressure. However, the results showed slightly higher average macroinvertebrate scores among East-side streams. These differences, however, fall within the standard deviations of the sample sets, suggesting no statistically meaningful distinction in macroinvertebrate condition between East and West side streams.

Table 5: Watershed-area weighted average scores for each stream summarized by East- and West-side streams.

		Riparian Health	Water Quality	Floodplain Connectivity	Development Pressure	Canopy Cover	Macro-invertebrate
Average Score	**East**	3.5	4.0	3.1	2.4	2.7	2.8
	West	3.0	2.0	2.9	3.3	3.2	2.5

Both East and West side streams have comparable macroinvertebrate scores, but possibly for different reasons. While the West-side streams generally have better canopy cover (Figure 10) and less development pressure (Figure 21), these factors alone do not appear sufficient to support healthy macroinvertebrate communities. Differences in underlying geology between East and West (Troutdale Formation/Boring Hill volcanics versus Tualatin Mountain basalt, respectively) may be an important driver of water quality and macroinvertebrate health.

The East-side streams have ample available gravel as they cut into coarse Missoula Flood deposits and the ancient gravels of the Troutdale formation. East-side streams have developed well-graded profiles (gradients usually <4%) that provide better continuity of gravel from headwaters to the mouth as well as lateral connection with the floodplain.

Meanwhile, many West-side streams cascade down the Tualatin Mountains with very high gradients (>10%) before abruptly transitioning to the very low gradient (<0.1%) Tualatin River valley; the basalt hills of the West-side creeks is more erosion resistant and yields less gravel and coarse stream material than the East-side geologic units.

The difference in geology and, consequently, stream slope between East and West streams is visualized in Figure 24; the average West-side stream is twice as steep (~4%) as the average East-side stream (~2%). Lower gradient streams, but not slack water, yields more hyporheic mixing, gravel substrate, and floodplain connectivity – which all benefit macroinvertebrate communities.

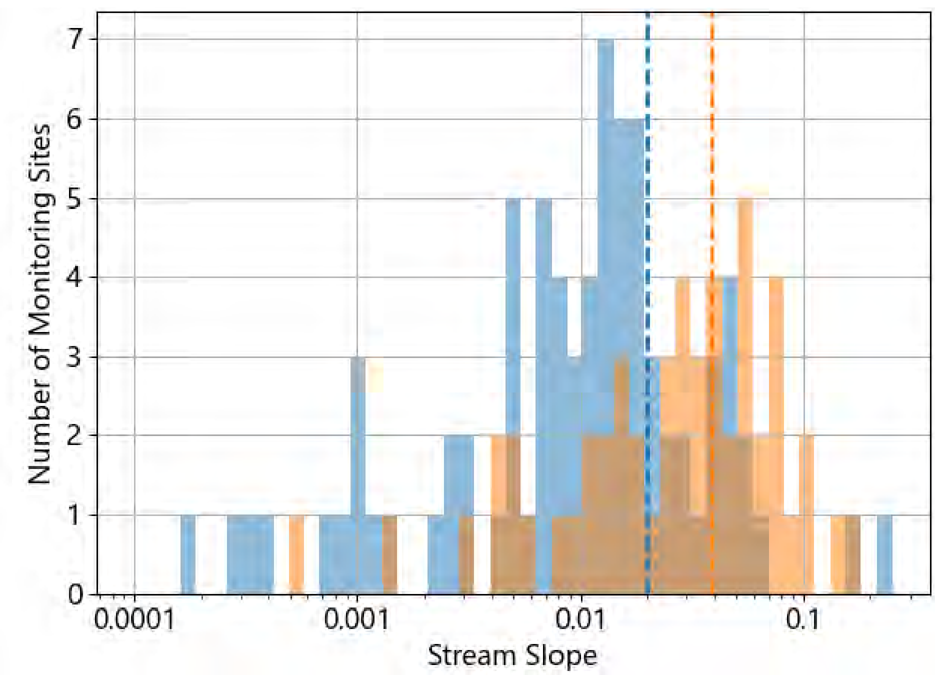


Figure 24: Histograms comparing water surface slope (ft/ft) of monitoring sites between East and West sites. Dashed lines represent the sample means.

A possible explanation of the East vs. West results is that the West side streams benefit from less development pressure and better canopy but suffer unfavorable geologic/geomorphic conditions that would form well-connected, gravel-bedded riparian systems; while the East side streams benefit from favorable geologic conditions yielding healthy sediment supply and floodplain connectivity but suffer from higher development pressure and less canopy cover. It is important to note that the possible linkages discussed here are still hypothesis and this data alone is not concrete proof of direct correlation between geology and macroinvertebrate health.

6. Recommendations

6.1 Permit Requirements

The 2024 monitoring effort fulfills WES and Co-Permittee NPDES MS4 permit requirements by following generally accepted methodologies, as documented in this report. The exception to this is Minthorn Creek, which will be revisited in fall 2025 to collect a macroinvertebrate sample for analysis. To maintain compliance, similar monitoring of all streams should be conducted again in 2027.

6.2 Management Recommendations for WES and Co-Permittees

The results of the 2024 data collection effort and associated analysis reveal a wide range of stream conditions across the study area. While some streams are functioning well, many others show signs of degradation and would benefit from restoration. Key issues identified include floodplain disconnection, water quality concerns, and impaired macroinvertebrate communities. These problems are commonly associated with urban development and altered hydrology, and they highlight the need for focused management and restoration efforts.

To address these challenges, the following presents a variety of strategies aimed at improving stream conditions. Recommendations are provided for both the Co-Permittees and private landowners, recognizing that effective watershed management depends on collaboration across public and private sectors. As previously discussed, understanding and addressing the impacts of hydromodification is a critical component of watershed management for urban streams. There are different approaches, or best management practices (BMPs) to hydromodification solutions, with upland flow control and stream enhancement being the two fundamental categories. Each of these has multiple subcategories that further define the possible goals and solutions within a hydromodification strategy (Figure 25). An integrated strategy will utilize multiple of these solutions depending on local and system scale needs.

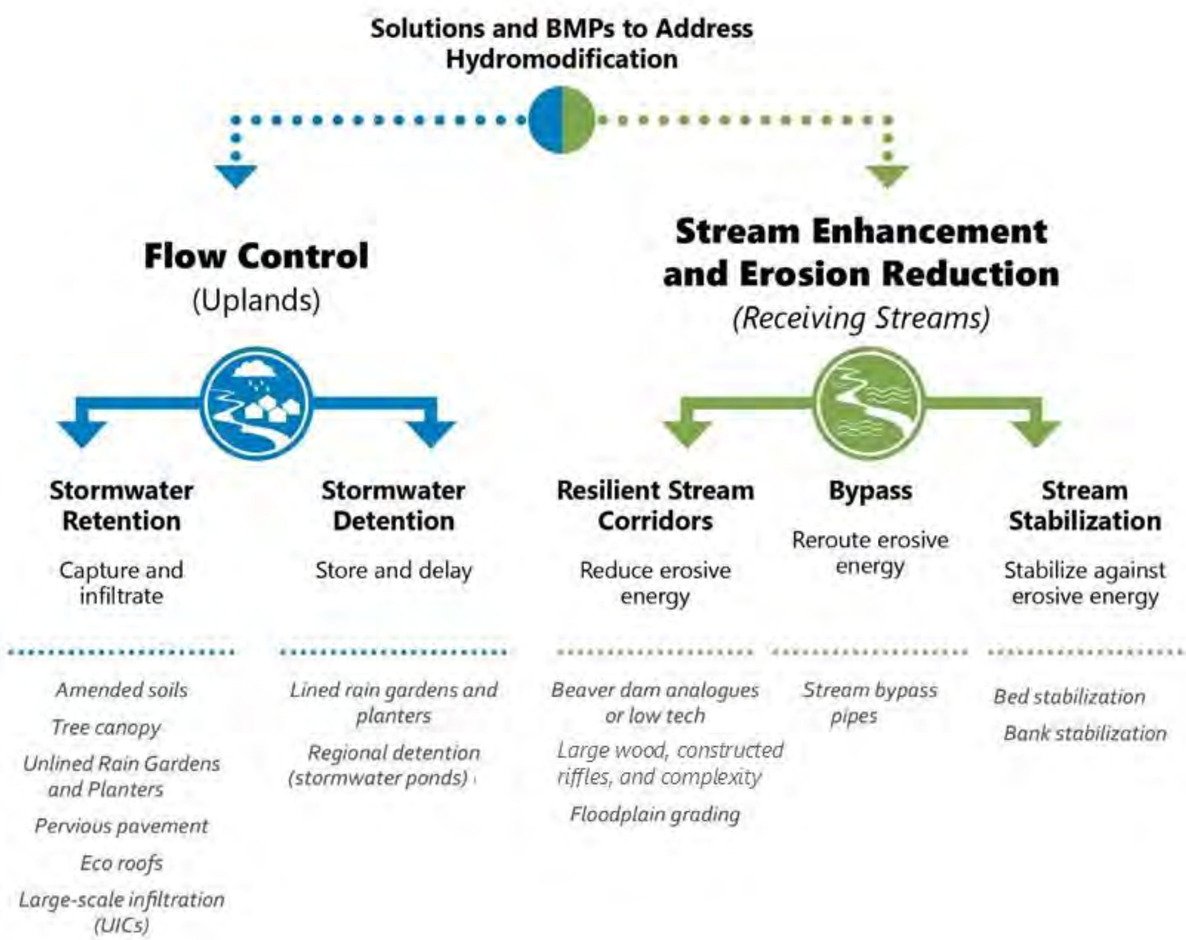


Figure 25: Classification of solutions and BMPs commonly used to address hydromodification and its impacts.

Using stream enhancement techniques, such as resilient stream corridors (RSCs), as an alternative stormwater strategy consistent with options provided by the MS4 permit presents an opportunity to both uplift the streams from a degraded condition and build in-stream resilience that is adapted to an altered watershed (hydromodification) and anticipated changes in climate. An RSC has sufficient frequently inundated width and contains natural materials such as downed wood and dense vegetation that effectively dissipate stream power to resist incision. The RSCs use natural processes to dissipate stream flow energy through channel and floodplain roughening and by maximizing floodplain engagement. In addition, peak flows are attenuated by dense vegetation, dispersed flows, and floodplain storage. This aids in maintaining and restoring functional stream corridors while also protecting co-located community infrastructure such as trails, road crossings, and sanitary sewers.

The results from the 2024 monitoring effort supports the identification of targeted restoration and mitigation actions to address hydromodification and improve both physical and biological stream conditions. The effectiveness of specific techniques depends on stream characteristics such as slope, channel size, and watershed location. To guide the selection of appropriate strategies, Figure 26 presents a decision tree that evaluates restoration feasibility based on geomorphic and hydraulic conditions. All recommended actions incorporate riparian planting as a foundational component.

Figure 27 expands on the decision tree showing predicted outcomes of each restoration action and examples in the Portland Metro Area.

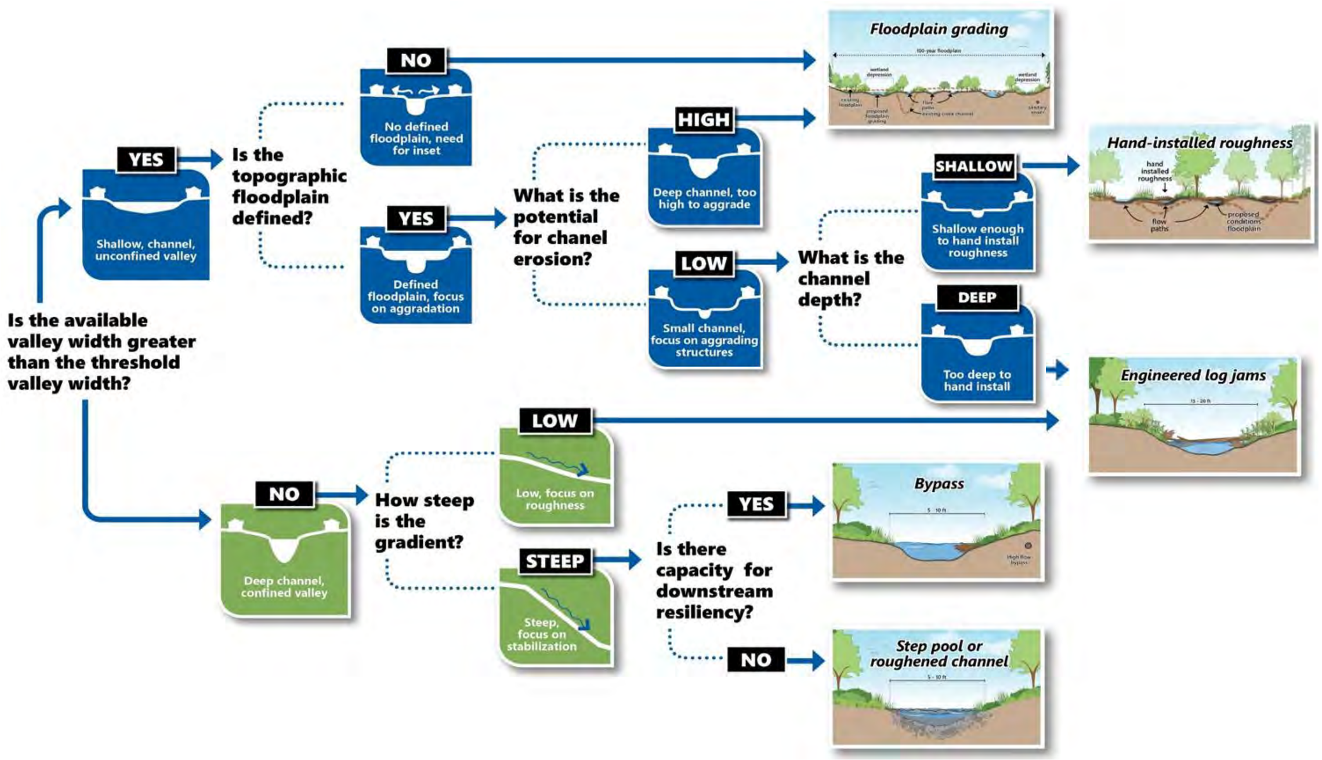


Figure 26: Decision tree for determining feasible restoration actions.

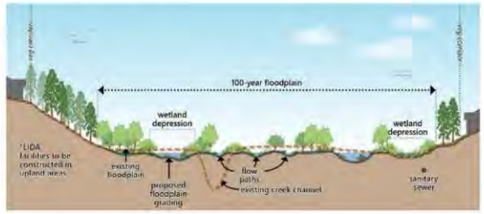
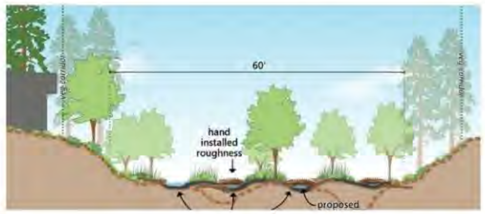
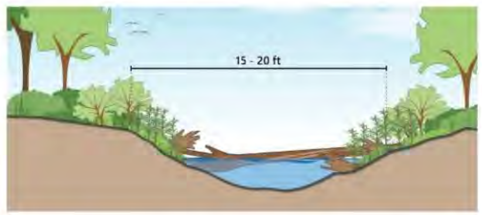
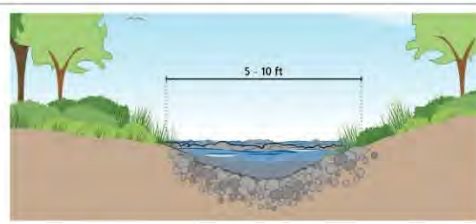
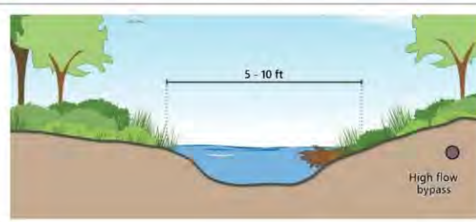
Action Type	Target Reach	Action Concept	Actions	Outcome
1 **Floodplain Grading**	• Unconfined floodplain • Low valley slope • Large Q2		Floodplain grading, large wood placement, and revegetation.	Biologically-driven stream reach that frequently connects with its adjacent floodplain or maintains a perennial network of anabranching channels. **EXAMPLE:** Lower Derry Dell Creek
2 **Hand Installed Roughness**	• Unconfined to moderately confined floodplain • Low to moderate valley slope • Moderate to low Q2		Hand installed roughness placement and revegetation	Biologically-driven stream reach that frequently connects with its adjacent floodplain or maintains a perennial network of anabranching channels. **EXAMPLE:** Bronson Creek
3 **Large Woody Debris**	• Unconfined to moderately confined floodplain • Low to moderate valley slope • Moderate to low Q2		LWD placement and revegetation	Biologically driven stream reach that maintains a primary channel may be a sinuous single thread channel that frequently connects with its floodplain. **EXAMPLE:** Cedar Mill Creek
4 **Channel Roughening**	• Confined floodplain • Steep valley slope • Moderate to low Q2		Channel grading/ fill with coarse streambed material (boulders/cobbles) and revegetation	Geologically-stabilized stream reach that is generally confined to a defined channel and maintains a single thread channel. **EXAMPLE:** Roshak Ridge
5 **High Flow Bypass**	• Confined floodplain • Steep valley slope • Moderate to low Q2		Construct stormwater pipe to bypass sensitive reach and revegetation. Outfall bypass flows to low gradient RSC reach	Stormwater flows bypass sensitive headwater reaches or highly urban reaches and outfall to a downstream, low gradient RSC. **EXAMPLE:** Morgan Farms

Figure 27: RSC approaches, outcomes, and examples.

Previously calculated hydrology and stream power, along with channel geometry measurements, can be used to support this process. Hydrology and stream power were calculated for a "full buildout" scenario that maximizes impervious area within city and county regulations. These results were used with the decision tree to identify the most effective restoration techniques across the study area, particularly in the context of future development (Figure 28).

The results from this analysis highlight the geologic difference between east and west, with the West side streams requiring more intensive, and expensive, mitigation to address the steep slopes. Portions of streams such as Trillium Creek, Tate Creek, Tributary 4, Coffee Creek, Fields Creek, Pecan Creek, and Tributary 2 exhibit extremely high stream power and erosive force. In these areas, bypass piping may need to be used alongside resilient stream corridor (RSC) techniques to effectively improve stream condition. In contrast, streams with gentler slopes and greater floodplain availability are more likely to benefit from lighter interventions, such as large wood placement or hand-installed structures designed to enhance floodplain connectivity.

Improved floodplain connection not only reduces stream energy during high flows, helping to limit erosion and promote sediment deposition, but also supports more stable channel morphology. These physical changes increase habitat complexity, which is essential for supporting diverse and healthy biological communities.

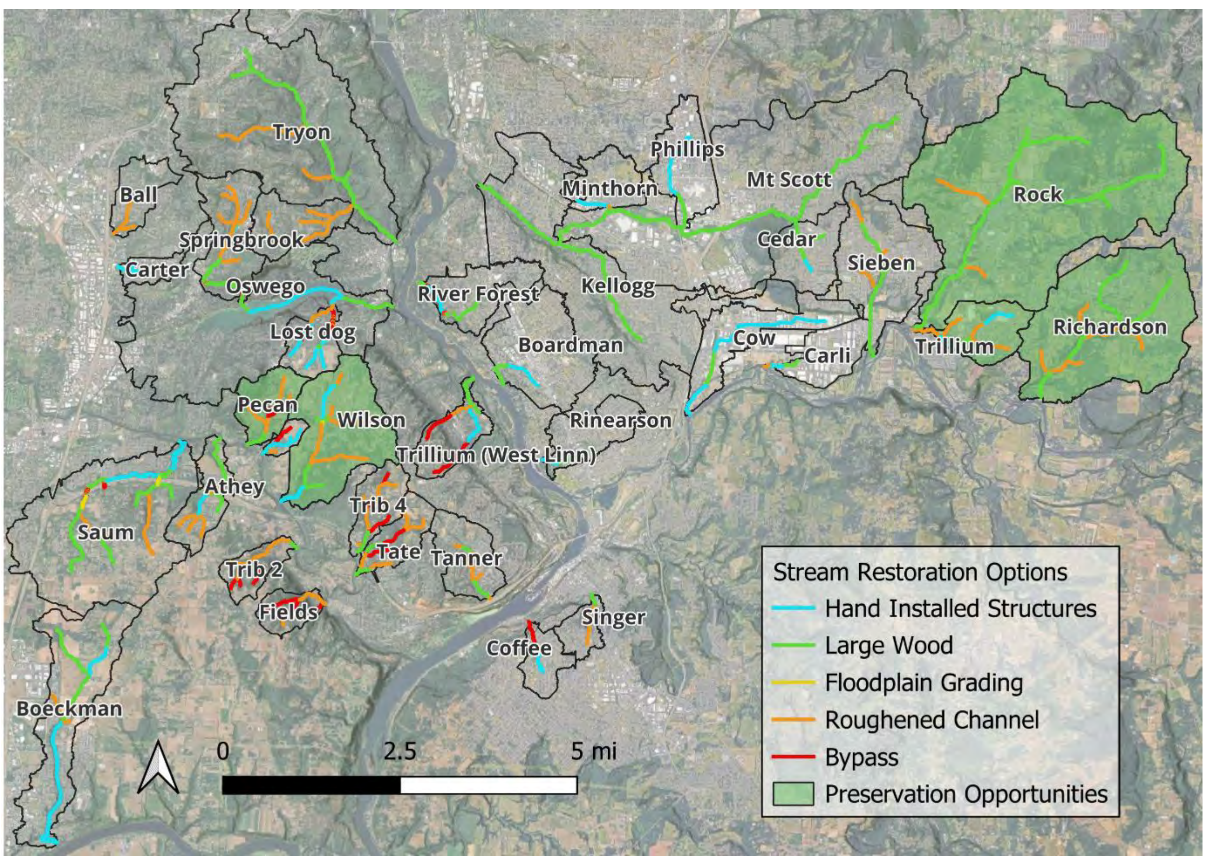


Figure 28: Potential stream restoration options based on feasibility.

Figure 28 also highlights watersheds that should be prioritized for preservation (see in green). These watersheds represent important opportunities to protect and sustain existing biological integrity by maintaining conditions that support healthy macroinvertebrate communities.

On the west side, Pecan Creek and Wilson Creek stand out as larger watersheds with healthy riparian systems and relatively low development pressure. Wilson Creek, in particular, includes extensive floodplain areas within public land, much of which is currently inaccessible to the public and undisturbed. This makes it one of the most intact and ecologically valuable watersheds in urban Clackamas County. Wilson Creek received the highest overall score in the assessment, only slightly below Tributary 2, which, although highly rated, is a smaller watershed with more limited preservation potential.

On the east side, the priority is less about preservation and more about proactively managing the impacts of anticipated development and therefore, hydromodification. Watersheds such as Rock Creek, Trillium Creek, and Richardson Creek all ranked within the top six for macroinvertebrate scores, yet they are also among the most likely to face substantial development pressure in the coming decades. Strategies such as maintaining setbacks or stream buffers, requiring canopy cover minimums, promoting low impact development practices, and addressing hydromodification through early restoration efforts and effective stormwater management approaches can help mitigate the long-term impacts of urbanization in these areas.

In contrast, watersheds that scored lower for macroinvertebrate condition, including but not limited to, Kellogg Creek, Oswego Creek, Carter Creek, Rinearson Creek, and Tryon Creek, will require targeted restoration efforts both in-stream and across the landscape to address legacy impacts and improve biological condition.

The restoration actions mapped in Figure 28 are intended to support improvements in physical stream health, but they will also aid in improving biological health. Table 6 lists potential macroinvertebrate responses to these actions, along with additional strategies that have been shown to produce positive biological outcomes.

Table 6: Potential restoration actions applicable within the study area and their anticipated macroinvertebrate responses.

Restoration action	Potential habitat impacts	Potential macroinvertebrate responses
Logjam / large wood addition	build alluvial streambed, govern channel migration; increase pool units	more xylophilic/xylophage taxa; more shredders, collector-gatherers, and/or predators
Riparian planting	increased riparian vegetation, improved water quality, increased stream shading	more shredder organisms; more terrestrial taxa; more cool/cold-associated taxa
Fencing / livestock enclosure	increased riparian vegetation, improved water quality, increased bank stability	increased total and EPT taxa richness; more shredder and/or scraper organisms, fewer collector-filterer; more sensitive and/or sediment-sensitive organisms
Dam removal	flow restoration, increased mobilization of fine sediment, more habitat heterogeneity	increased total and EPT richness; more sensitive and/or sediment-sensitive organisms
Channel reconfiguration	increased habitat and flow heterogeneity, decreased sedimentation	increased total and EPT taxa richness; more sensitive and/or sediment-sensitive organisms
Floodplain reconnection	increased lateral connectivity, slower flows, decreased channel incision	increased taxa richness, fewer sediment-tolerant organisms
Riparian management	increased riparian vegetation, improved water quality	increased total and EPT taxa richness; more shredder and/or scraper organisms, fewer collector-filterers; more sensitive and/or sediment-sensitive organisms
Bank stabilization through riparian planting	decreased sedimentation, incision	more sensitive and/or sediment-sensitive organisms
Side channel creation	increased habitat and flow heterogeneity	increased total taxa richness; more taxa and organisms tolerant of a range of flow types, sediment conditions, and temperatures
Instream habitat improvement	increased habitat heterogeneity, improved water quality	increased total and EPT taxa richness; more sensitive and/or sediment-sensitive organisms

6.3 Recommendations for Landowners

Private landowners play an important role in the health and restoration of local streams, particularly in areas where a significant portion of the watershed is privately owned, as is the case across this study area. Many of the stressors that impact stream condition, such as degraded riparian areas, increased stormwater runoff, and barriers to aquatic species movement, are directly influenced by how land is managed. While large-scale restoration projects are often led by public agencies or conservation groups, the day-to-day decisions of individual landowners can have a meaningful impact on stream health.

One of the most effective ways landowners can support healthier streams is by protecting and enhancing riparian vegetation. Allowing native trees, shrubs, and groundcover to grow along streambanks helps stabilize soils, reduce erosion, filter pollutants, and provide shade that regulates water temperature. Landowners can also remove invasive species, avoid vegetation clearing near the stream, and limit activities like mowing or dumping yard waste in riparian zones.

Managing stormwater runoff is another critical way landowners can contribute. Redirecting roof drainage to vegetated areas, using rain gardens or vegetated swales, and minimizing paved or compacted surfaces can reduce the volume and speed of runoff entering the stream. These practices help slow the flow of water, filter out pollutants, and lessen the likelihood of erosion or flooding during storms. Additionally, responsible pesticide use can improve water quality in urban streams, and many resources are available to guide best practices.

It is also important for landowners to avoid activities that alter the natural flow of streams or interfere with habitat. Removing large wood, straightening channels, or installing structures like culverts without proper design can degrade stream function and create barriers for fish and wildlife. Preserving natural stream features, maintaining access to floodplains, and allowing streams to meander can support more resilient and ecologically healthy systems.

Landowners interested in doing more can reach out to local watershed councils, soil and water conservation districts, restoration organizations, or stormwater management staff in their local cities to learn about cost-share programs, technical assistance, or opportunities to participate in coordinated restoration efforts. For example, WES's RiverHealth Stewardship Program offers grants to support community groups, businesses, and property owners who want to improve watershed health by funding plantings, invasive species removal, and education projects. Even modest changes on private property can contribute to broader improvements across the watershed when adopted at a community scale.

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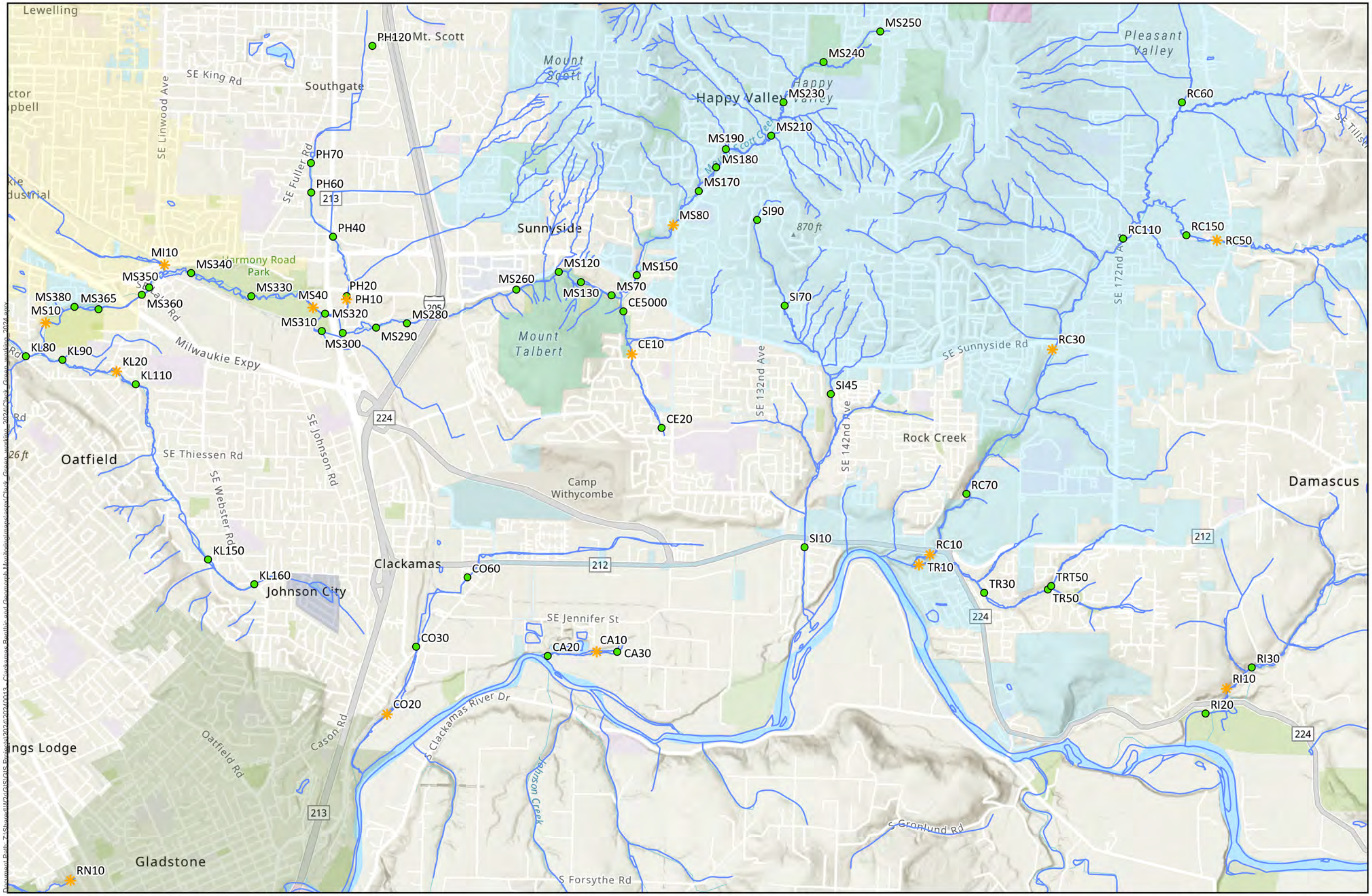
Appendix A – Site Maps and Table



0	0.4	0.8	1.6 Miles

1 inch = 1 mile

N

Streams

Site Type

- Physical Stream Health Monitoring Site
- Biological Stream Health Monitoring Site

City Boundaries

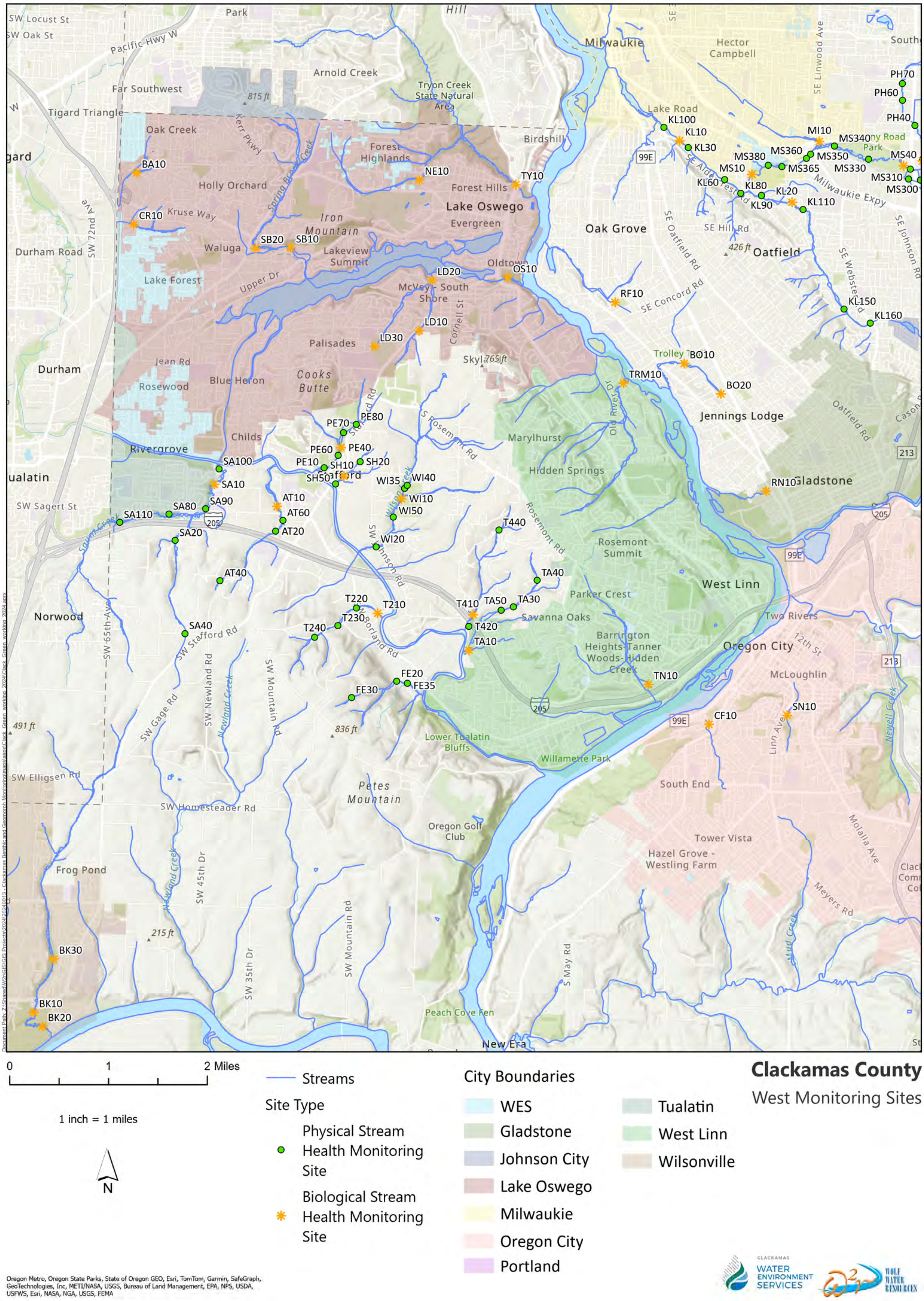
- WES
- Gladstone
- Johnson City
- Milwaukie
- Oregon City
- Portland

Clackamas County

East Monitoring Sites

CLACKAMAS WATER ENVIRONMENT SERVICES

WOLF WATER RESOURCES



Clackamas County
West Monitoring Sites
Streams
Site Type
Physical Stream Health Monitoring Site
Biological Stream Health Monitoring Site
City Boundaries
WES
Gladstone
Johnson City
Lake Oswego
Milwaukie
Oregon City
Portland
Tualatin
West Linn
Wilsonville
0
1
2 Miles
1 inch = 1 miles
N
PH70
PH60
PH40
KL100
KL10
KL30
MI10
MS340
MS360
MS350
MS380
MS365
MS330
MS40
MS10
MS310
MS300
KL60
KL80
KL20
KL90
KL110
KL150
KL160
BA10
CR10
NE10
TY10
SB20
SB10
LD20
OS10
RF10
LD10
LD30
BO10
BO20
TRM10
PE70
PE80
PE60
PE40
PE10
SH10
SH20
SH50
WI35
WI40
WI10
WI50
WI20
SA100
SA10
SA90
SA80
SA110
SA20
AT10
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AT40
SA40
RN10
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TA40
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T230
T240
T410
TA50
TA30
T420
TA10
FE20
FE35
FE30
TN10
CF10
SN10
BK30
BK10
BK20
Milwaukie
Lake Oswego
Oak Grove
Oatfield
Gladstone
Jennings Lodge
West Linn
Oregon City
Tualatin
Durham
Norwood
Rivergrove
Oregon Metro, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS, Esri, NASA, NGA, USGS, FEMA
CLACKAMAS WATER ENVIRONMENT SERVICES
WOLF WATER RESOURCES

Site Monitoring Data - 2021 & 2024									
Site Code	Stream Name	Sites on Stream	Permittee/District	Physical Stream Health 2021	Physical Stream Health 2021	Water Chemistry 2021	Water Chemistry 2024	Biological Health 2021	Biological Health 2021
AT10	Athey Creek	4	WES	X	X	X	X		X
AT20	Athey Creek	4	WES	X	X		X		X
AT40	Athey Creek	4	WES	X					
AT60	Athey Creek	4	WES	X	X		X		
BA10	Ball Creek	1	Lake Oswego		X		X	X	X
BO10	Boardman Creek	2	Oak Lodge		X				X
BO20	Boardman Creek	2	Oak Lodge		X				X
BK10	Boeckman Creek	3	Wilsonville		X		X		X
BK20	Boeckman Creek	3	Wilsonville		X		X		X
BK30	Boeckman Creek	3	Wilsonville		X		X		X
CA10	Carli Creek	3	WES	X	X	X	X		X
CA20	Carli Creek	3	WES	X	X		X		
CA30	Carli Creek	3	WES	X	X		X		
CR10	Carter Creek	1	Lake Oswego		X		X	X	X
CE10	Cedar Creek	3	WES	X	X	X	X		X
CE20	Cedar Creek	3	WES	X	X		X		
CE5000	Cedar Creek	3	WES	X	X		X		
CF10	Coffee Creek	1	Oregon City		X		X		X
CO20	Cow Creek	3	WES	X	X	X	X		X
CO30	Cow Creek	3	WES	X	X		X		
CO60	Cow Creek	3	WES	X	X				
FE20	Fields Creek	3	WES	X	X		X		
FE30	Fields Creek	3	WES	X					
FE35	Fields Creek	3	WES	X	X				
KL10	Kellogg Creek	10	WES	X	X	X	X		X
KL100	Kellogg Creek	10	WES	X	X		X		
KL110	Kellogg Creek	10	WES	X	X		X		
KL150	Kellogg Creek	10	WES	X	X		X		
KL160	Kellogg Creek	10	WES	X	X		X		
KL20	Kellogg Creek	10	WES	X	X	X	X		X
KL30	Kellogg Creek	10	WES	X	X		X		
KL60	Kellogg Creek	10	WES	X	X		X		
KL80	Kellogg Creek	10	WES	X	X		X		
KL90	Kellogg Creek	10	WES	X	X		X		
LD10	Lost Dog Creek	3	Lake Oswego		X		X	X	X
LD20	Lost Dog Creek	3	Lake Oswego		X		X	X	X
LD30	Lost Dog Creek	3	Lake Oswego		X		X	X	X
MI10	Minthorn	1	Milwaukie		X				
MS10	Mt Scott Creek	27	WES	X	X	X	X		X
MS120	Mt Scott Creek	27	WES	X	X		X		
MS130	Mt Scott Creek	27	WES	X	X		X		
MS150	Mt Scott Creek	27	WES	X	X		X		
MS170	Mt Scott Creek	27	WES	X	X		X		
MS180	Mt Scott Creek	27	WES	X	X		X		
MS190	Mt Scott Creek	27	WES	X	X		X		
MS210	Mt Scott Creek	27	WES	X	X		X		
MS230	Mt Scott Creek	27	WES	X	X		X		
MS240	Mt Scott Creek	27	WES	X	X		X		
MS250	Mt Scott Creek	27	WES	X	X		X		
MS260	Mt Scott Creek	27	WES	X	X		X		
MS280	Mt Scott Creek	27	WES	X	X		X		
MS290	Mt Scott Creek	27	WES	X	X		X		
MS300	Mt Scott Creek	27	WES	X	X		X		
MS310	Mt Scott Creek	27	WES	X	X		X		
MS320	Mt Scott Creek	27	WES	X	X				
MS330	Mt Scott Creek	27	WES	X	X		X		

Site Monitoring Data - 2021 & 2024									
Site Code	Stream Name	Sites on Stream	Permittee/District	Physical Stream Health 2021	Physical Stream Health 2021	Water Chemistry 2021	Water Chemistry 2024	Biological Health 2021	Biological Health 2021
MS340	Mt Scott Creek	27	WES	X	X		X		
MS350	Mt Scott Creek	27	WES	X	X		X		
MS360	Mt Scott Creek	27	WES	X	X		X		
MS365	Mt Scott Creek	27	WES	X	X				
MS380	Mt Scott Creek	27	WES	X	X				
MS40	Mt Scott Creek	27	WES	X	X	X	X		X
MS70	Mt Scott Creek	27	WES	X	X		X		
MS80	Mt Scott Creek	27	WES	X	X	X	X		X
NE10	Nettle Creek	1	Lake Oswego		X			X	X
OS10	Oswego Creek	1	Lake Oswego		X			X	X
PE10	Pecan Creek	5	WES	X					
PE40	Pecan Creek	5	WES	X	X	X			X
PE60	Pecan Creek	5	WES	X	X				
PE70	Pecan Creek	5	WES	X	X				
PE80	Pecan Creek	5	WES	X	X				
PH10	Phillips Creek	6	WES	X	X	X	X		X
PH120	Phillips Creek	6	WES	X	X		X		
PH20	Phillips Creek	6	WES	X	X				
PH40	Phillips Creek	6	WES	X	X		X		
PH60	Phillips Creek	6	WES	X	X		X		
PH70	Phillips Creek	6	WES	X	X		X		
RI10	Richardson Creek	4	WES	X	X	X	X		X
RI20	Richardson Creek	4	WES	X	X		X		
RI30	Richardson Creek	4	WES	X					
RI40	Richardson Creek	4	WES	X	X				
RN10	Rinearson Creek	1	Gladstone		X				X
RF10	River Forest Creek	1	Oak Lodge		X				X
RC10	Rock Creek	8	WES	X	X	X	X		X
RC110	Rock Creek	8	WES	X	X		X		
RC150	Rock Creek	8	WES	X	X		X		
RC180	Rock Creek	8	WES	X	X		X		
RC30	Rock Creek	8	WES	X	X	X	X		X
RC50	Rock Creek	8	WES	X	X	X	X		X
RC60	Rock Creek	8	WES		X		X		
RC70	Rock Creek	8	WES	X			X		
SA10	Saum Creek	7	WES	X	X	X	X		X
SA20	Saum Creek	7	WES				X		
SA40	Saum Creek	7	WES				X		
SA100	Saum Creek	7	WES	X	X		X		
SA110	Saum Creek	7	WES	X	X		X		
SA80	Saum Creek	7	WES	X	X		X		
SA90	Saum Creek	7	WES	X	X		X		
SH10	Shipley Creek	3	WES	X	X	X	X		X
SH20	Shipley Creek	3	WES	X					
SH50	Shipley Creek	3	WES	X	X				
SI10	Sieben Creek	4	WES	X	X	X	X		X
SI45	Sieben Creek	4	WES	X	X		X		
SI70	Sieben Creek	4	WES	X	X				
SI90	Sieben Creek	4	WES	X	X		X		
SN10	Singer Creek	1	Oregon City		X				X
SB10	Springbrook Creek	2	Lake Oswego		X			X	X
SB20	Springbrook Creek	2	Lake Oswego		X			X	X
TN10	Tanner Creek	1	West Linn		X		X		X
TA10	Tate Creek	4	WES	X	X	X	X		X
TA30	Tate Creek	4	WES	X					
TA40	Tate Creek	4	WES	X					
TA50	Tate Creek	4	WES	X	X				
T210	Trib 2	4	WES	X	X		X		X

Site Monitoring Data - 2021 & 2024									
Site Code	Stream Name	Sites on Stream	Permittee/District	Physical Stream Health 2021	Physical Stream Health 2021	Water Chemistry 2021	Water Chemistry 2024	Biological Health 2021	Biological Health 2021
T220	Trib 2	4	WES	X	X		X		
T230	Trib 2	4	WES	X	X		X		
T240	Trib 2	4	WES	X	X		X		
T410	Trib 4	3	WES	X	X				X
T420	Trib 4	3	WES	X	X		X		
T440	Trib 4	3	WES	X	X		X		
TR10	Trillum Creek	4	WES	X	X	X			X
TR30	Trillum Creek	4	WES	X	X				
TR50	Trillum Creek	4	WES	X	X		X		
TRT50	Trillum Creek	4	WES	X	X		X		
TRWL10	Trillum Creek (West Linn)	1	WES		X		X		
TY10	Tryon Creek	1	Lake Oswego		X			X	X
WI10	Wilson Creek	5	WES	X	X	X			X
WI20	Wilson Creek	5	WES	X	X		X		
WI35	Wilson Creek	5	WES	X	X		X		
WI40	Wilson Creek	5	WES	X					
WI50	Wilson Creek	5	WES	X	X				

Appendix B – Detailed Methodology

Appendix B – Methods and Definitions

B.1 Physical Stream Health

B.1.1 Sampling Sites

Physical stream health measurements were collected at 131 sites across the study area. Site selection prioritized locations that had been previously monitored, including those with historical macroinvertebrate data and over 100 sites assessed by W2r in 2021 for physical stream condition. Whenever possible, sites were located on public land or properties owned by public entities such as parks departments. For sites on private property, coordination with landowners was necessary to secure access and permission to conduct monitoring.

In some cases, sites identified for data collection during the 2024 campaign were inaccessible due to access limitations or site conditions. Where feasible, nearby alternative locations were selected to maintain continuity and data quality. However, the following sites, which were visited in previous monitoring years, could not be accessed in 2024:

- AT 40 (Athey Creek)
- FE 30 (Fields Creek)
- PE 10 (Pecan Creek)
- RI 30 (Richardson Creek)
- TA 30 (Tate Creek)
- TA 50 (Tate Creek)
- WI 40 (Wilson Creek)

For the 2017 monitoring effort and earlier, sites were named based on their relative longitudinal position along the stream. When numerous additional sites were added in 2021, maintaining this naming convention became difficult without renaming existing sites. For future monitoring efforts, it may be possible to adopt a revised naming convention that follows a more logical and consistent structure.

B.1.2 Field Measurements

Field measurements focused on capturing channel geometry, riparian condition, land use pressures, and substrate characteristics at each site. Table 1 details the field measurements collected at each site and Figure 1 depicts a schematic of some of the important channel geometry metrics. All field measurements were recorded using a tablet that automatically uploaded data to the ArcGIS Online platform.

B.1.3 Derived/Desktop Metrics

Field work measurements were supplemented by additional calculated physical health metrics and desktop analyses. Table 2 details these metrics and how they were calculated.

Table 1: Definitions of measured field parameters to assess physical stream health.

Metric	Definition/Method
Bankfull Width	Width of channel between banks at bankfull stage as indicated by vegetation and scour features (bare areas).
Bankfull Depth	Channel depth measured from stream thalweg to bankfull stage.
Banktop Width	Channel width measured from top of bank or edge of first terrace.
Banktop Depth	Height from toe of bank to top of bank or edge of first terrace.
Riffle Depth	Depth of water at deepest point on the riffle along the transect.
Pool Depth	Depth of deepest pool found immediately upstream of measured riffle.
Wetted Width	Width of wetted channel at current flow, measured from water's edge to water's edge.
% Riffle, Run, Pool	Visual estimate of the percent of each habitat type (riffle, run, pool) within the reach surrounding the transect, totaling 100%.
Dominant Substrate	Visual observation of the substrate type (e.g. coarse gravel, fines, etc.) composing the greatest proportion of the channel bed.
Presence of Bedrock	Observed presence or absence of bedrock within the channel within 100 ft upstream and downstream of the transect location.
Presence of Embeddedness	The degree to which fine sediments surround coarse substrates on the surface of a streambed. A percentage of embeddedness was observed during pebble counts by counting the number of pebbles that were more than 50% embedded.
Presence of Wood	The observed presence or absence of large woody debris (<6" DBH) within the active (bankfull) channel at a given site.
Presence of Bank Erosion	True or false designation indicating the presence of active erosion, based on observations of both banks within 100 feet upstream and downstream of the transect location.
Presence of Overhanging Banks	True or false designation indicating the presence of overhanging banks, based on observations of both banks within 100 feet upstream and downstream of the transect location.
Presence of Beavers	True or false designation indicating the presence of beavers, based on signs such as dams, lodges, chewed vegetation, or tracks observed within 100 feet upstream and downstream of the transect location.
Dominant Invasive Vegetation	If invasive vegetation is observed, documentation of dominant species observed
Prevalence of Invasive Vegetation	Categorized (high, medium, low) prevalence of common invasive plant species.
Dominant Vegetation Type	Observation of dominant structural vegetation type within the riparian zone (e.g., herbaceous, canopy, shrub).
Dominant Landuse	Land use type (e.g., residential, industrial, open space) observed within the surrounding area, based on visual assessment.
Type of Infrastructure Present	Identification of human-made structures (e.g., culverts, bridges, pipes) present within or adjacent to the stream channel.
SEM Stage	Based on the stage of stream evolution (according to Cluer and Thorne, 2014), as identified through visual observations.

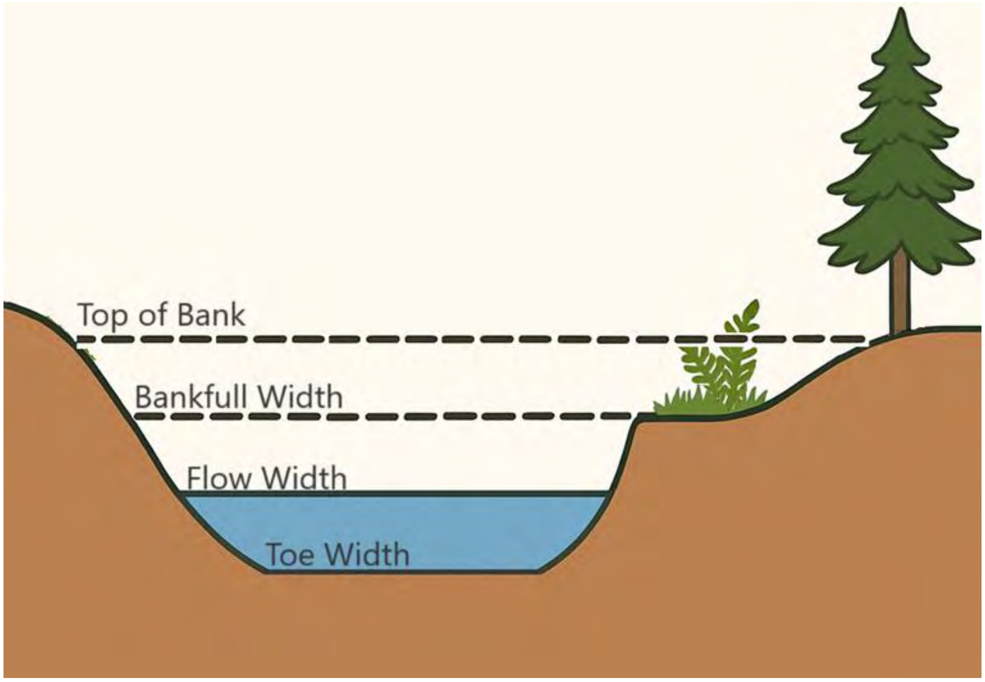

Figure 1: Schematic of channel geometry measurements taken in the field.

Table 2: Definitions of calculated or desktop-derived metrics to assess physical stream health.

Metric	Definition/Method
Drainage Area	Total area that drains rainfall and runoff into each stream, measured in square miles using Metro (2019) LiDAR.
Valley Width	Distance across valley floor, measured perpendicular to the channel using Metro (2019) LiDAR.
Mean Basin Slope	Average steepness of the land surface within the drainage area derived from Metro (2019) LiDAR.
Slope	Average rate of elevation change along the length of the stream derived from Metro (2019) LiDAR.
Width to Depth Ratio	Bankfull width divided by bankfull height (from field measurements).
Confinement Ratio	Valley width divided by banktop width.
Residual Depth	The difference between the measured pool depth and the riffle depth.
Canopy Coverage	Percentage of canopy coverage measured from Metro (2019) canopy mapping data with each watershed.
Impervious Coverage	Percentage of area covered by impervious area derived from National Land Cover Database (2023).

B.1.4 Physical Stream Health Analysis/Scoring

All of the data described above was compiled into two database:

1. Raw Field Data: This database is a direct export from the ArcGIS Online data collection platform and includes all field-collected measurements and observations for each site. It can be provided as a geospatial shapefile as needed. While comprehensive, this dataset is most

useful for quality assurance/quality control of derived metrics or for comparing specific raw measurements across and within sites. On its own, it is not well-suited for assessing overall stream condition.

2. Refined Database: This database integrates cleaned and standardized field data for key metrics, along with desktop-derived metrics as outlined in Table 2. It also incorporates available data from the 2021 field effort and includes final stream health scores (described below). This streamlined and analysis-ready dataset was used to assess stream health conditions and will be the most useful resource for understanding site-based metrics and overall findings. This database is in Appendix E.

Once the refined database was compiled scoring for key physical stream health was calculated. The key physical health metrics are as follows:

- Riparian Condition: Reflects a composite evaluation of invasive species presence and the extent of land use and infrastructure impacts at each site. During field observations, the prevalence of invasive riparian species was qualitatively assessed and categorized as low, medium, or high. This was then combined with a score representing land use and infrastructure, where a score of 1 indicates substantial disturbance—such as culverts, riprap, utilities, or industrial and developed land uses—and a score of 5 represents more natural, undisturbed conditions such as open space or native vegetation.
- Floodplain Connectivity: Calculated using average width-to-depth and confinement ratios. (Table 1). Both of these metrics help understand a stream's geomorphic setting, departure from reference condition, and restoration potential.
- Development Pressure: Incorporates both existing and potential impervious surface coverage based on tax lot data and zoning allowances.
- Canopy Cover: Derived from Metro RLIS 2019 canopy raster using NDVI and LiDAR. Higher scores reflect greater vegetation density, which supports thermal regulation, habitat quality, and bank stability.

The different metrics are scored from 1 (worst condition) to 5 (best condition) and were calculated for each individual site and then averaged to obtain a score for each creek.

B.1.4 Channel Geometry T-testing

To quantitatively compare channel geometry between 2021 and 2024 we used a paired t-test over 101 sites for bankfull and bank top depth/width measurements (Table 3). The t-test compares paired data points (2021 and 2024 data for each monitoring point) and yields two parameters: the t-statistic and p-value. The t-statistics indicate the direction of the trend (negative or positive), with numbers closer to zero representing no change and numbers further from zero representing more change. The p-values represent the level of confidence in a meaningful difference between the two datasets, where lower values ($p<0.05$) indicate statistical significance in the detected change.

The p-values suggest there is no detected change in channel width and the measured intra-site change is well within the standard deviation of widths measured at the site. The p-values suggest there was a detectable trend of shallowing bankfull depth while the bank top depth is increasing. While these trends seem contradictory, it is possible these opposite trends represent a degraded and widening system where the bankfull channel is widening within its inset floodplain. However, given the changes in depth are within the intra-site standard deviation (~0.4 feet) it is also very possible that these changes are simply due to human bias or different hydrology – the summer leading up to data collection in 2021 was much hotter, drier, and lower flow than the summer of 2024.

Table 3: T-test results of channel geometry measurements at 101 monitoring sites between 2021 and 2024.

	2021 Mean	2024 Mean	t-statistic	p-value
Bankfull Width	16.2	15.3	-1.2	0.22
Bank Top Width	21.8	21.3	-0.7	0.52
Bankfull Depth	2.3	2.0	-3.9	0.0002
Bank Top Depth	3.2	3.7	3.1	0.003

B.2 Biological Health - Macroinvertebrate Monitoring

B.2.1 Sampling Sites

45 sites were sampled throughout the Co-Permittee's jurisdictions, including 23 sites that were sampled in 2021 and 22 new sites in Clackamas County. Sites were located within the jurisdictional city boundaries of Lake Oswego, Milwaukie, Happy Valley, Oregon City, West Linn, Gladstone, and Wilsonville, with 17 sites falling within unincorporated Clackamas County, outside of city boundaries. 44 sites were sampled for all instream biological monitoring data (macroinvertebrates, instream and riparian habitat, and water quality). Macroinvertebrate collection took place between September and November 2025, generally between 8:00 am and 5:00 pm.

B.2.1 Macroinvertebrate Sampling and Identification

Macroinvertebrate collection methods were consistent with previous sampling events conducted by WES and the Co-Permittees. The sampling generally followed Level 2 and Level 3 protocols outlined in the *Oregon Plan for Salmon and Watersheds Water Quality Monitoring Guidebook* (EPA et al., 1999). Sample reach length was determined by measuring the bankfull width (BFW) and multiplying the BFW by 40. Minimum reach lengths were 500-feet and maximum reach lengths were 1,000-feet. Within each study reach, eight individual kicknet samples were collected from eight different riffles. If eight individual riffles did not exist within a study reach, two kicknet samples were collected from different areas within a singular riffle. If no riffles existed within a study reach, kicknet samples were taken from habitats representative of the general study reach (i.e. pools and/or runs). Duplicate samples were collected at three sites (AT10, AT20, TA10) for QA purposes.

Samples were collected by disturbing a 1ft^2 area of substrate and allowing debris and macro-organisms to flow back into a metal-framed D-net. Netting of the D-net consisted of 500 um Nitrex mesh, allowing small macroinvertebrates such as Chironomidae to be collected. To disturb the sample substrate, medium to large cobble and any woody debris was cleaned off by hand in the stream (in front of the net), and smaller sediments were disturbed to a depth of 5- to 10-centimeter with either the foot or hands. This process was altered for soft sediment bottomed streams. After thoroughly disturbing the substrate, the contents of the D-net were transferred to a sieve lined with 500 µm mesh to drain water. Sides of the D-net were sprayed with water to direct any clinging organisms in the sieve. Any large organics or debris like sticks, leaves, or gravels were rinsed and removed. Once a sample was adequately drained and organics were removed, the sample was placed in a 1,000 mL high-density polyethylene Nalgene bottle and inundated with 80% ethanol. This process was repeated for the other 7 samples within the study reach, with all samples being combined into one composite sample inside of one or more Nalgene bottles.

Sample identification was done by Cole Ecological, Inc. Each composited sample was first randomly sub-sampled to 500 individuals using a Caton gridded tray (Caton, 1991); if samples lacked 500 organisms, the entire sample was sorted for identification. Sorted organisms were identified to the lowest practical taxonomic level recommended by the Pacific Northwest Aquatic Monitoring Partnership (PNAMP Level II; PNAMP, 2015).

B.2.3 Macroinvertebrate Community Analysis/Soring

Biological conditions in sample communities were assessed using several ORDEQ models, including: a multimetric macroinvertebrate-based index of biotic integrity (M-IBI); a probability-based PREDATOR model (Predictive Assessment Tool for Oregon; Hubler, 2008); weighted-average inference models developed by ORDEQ (Huff et al., 2006) for inferring fine sediment and/or elevated water temperature are potential stressors; and a Macroinvertebrate Thermal Tolerance Index (MTTI; Hubler et al., 2024). A more detailed description of each model is provided below.

The M-IBI consists of 10 taxonomic and ecological metrics, each of which is assigned a scaled score (5, 3, or 1) based on the metric's raw value. Scaled scores of individual metrics are then summed to give a total site score corresponding to a level of biological impairement (Table 4). The I-IBI score provides an easily understood "report card" for a stream, and changes in the score over time can be assessed and compared to known management or restoration activities to investigate potential correlations. However, the IBI has unavoidable constraints; urban streams experience a multitude of broad-scale stressors that may override the impacts of reach-level practices and limit the extent of macroinvertebrate community change, especially in more degraded systems where sensitive colonizers (i.e., stoneflies, caddisflies) are not abundant and/or lack intact riparian corridors for efficient dispersal. Additionally, the IBI was developed specifically for riffle habitats, and streams that lack riffles can be artificially downgraded by the model.

Table 4: Metrics and scoring for the ORDEQ M-IBI.

Metric	5	3	1
# total taxa	>35	19-35	<19
# Ephemeroptera (mayfly) taxa	>8	4-8	<4
# Plecoptera (stonefly) taxa	>5	3-5	<3
# Trichoptera (caddisfly) taxa	>8	4-8	<4
# sensitive taxa	>4	2-4	<2
# sediment-sensitive taxa	≥2	1	0
% abundance of dominant taxon	<20	20-40	>40
% abundance tolerant organisms [a]	<15	15-45	>45
% abundance sediment-tolerant organisms	<10	10-25	>25
Community BI (biotic index)[b]	<4	4-5	>5
Summed score and corresponding biological condition			
<20 severely impaired; **20-29** moderately impaired; **30-39 s**lightly impaired; **>39** minimally impaired			

[a] tolerant to disturbance, high sediment, organic enrichment
[b] reflects tolerance to organic enrichment, ranging from 1 (low tolerance) to 10 (high tolerance; calculated as weighted average of individual sample taxon BI values

The PREDATOR model calculates the ratio of taxa observed at a site to the taxa expected if the site is not impaired (O/E), based on established reference stream communities selected by the model. O/E scores correspond to condition categories of poor (most disturbed; <0.78); fair (moderately disturbed; 0.79-0.92); good (least disturbed; 0.93-1.23); or enriched (>1.23). Like the M-IBI, PREDATOR was developed specifically for riffle habitats and streams that lack riffles can be artificially downgraded by the model.

MTTI indices were calculated using an RShiny app developed by TetraTech (https://tetratech-wtr-wne.shinyapps.io/BCGcalc/). The MTTI was developed for wadeable streams in Oregon and Washington. It generates maximum weekly maximum temperature (MWMT) values for each sample based on relative abundances of different taxa and MWMT weighted average optima values of the taxa in the sample. MWMT is the metric that Oregon and Washington use for numeric water temperature standards to protect salmonid habitat. It is available from the NorWeST modeled stream temperature database (https://tinyurl.com/2c7kypbf) and has been shown to have high predictive accuracy when compared to field-measured temperatures (Isaak et al., 2017). The MTTI is not a direct temperature measure but rather a stressor index that represents a macroinvertebrate assemblage-level thermal preference for a given stream reach. This is the first year this new model was applied to

WES data; MTTI indices were also calculated for all 2021 samples to allow for comparisons to be made.

Additional analyses to detect changes in community composition and metric values over time were done using PAST 4.0 (Hammer et al., 2001) statistical software. CLUSTER dendrograms were run on a Bray-Curtis similarity matrix of square-root transformed taxa abundances to assess similarity in macroinvertebrate community composition. At sites with sufficient years of data available, statistically significant unidirectional long-term trends in community metrics were investigated by running Pearson Product-Moment Correlation between each of the community metrics and sampling years, with results reported at alpha = 0.05. Sites with multiple significant trends were further examined to determine whether trends consistently indicated improving or declining conditions, as such directionally consistent results can be construed as several lines of evidence of either improving or declining community conditions at individual sites.

Individual stream ratings for each site were determined based on six different elements: M-IBI score; O/E score; MTTI index; temperature and fine sediment stressor scores; and number of EPT (mayfly, caddisfly, stonefly) taxa. For each element, all individual sample values within a single year were plotted on a histogram and divided into five bins. Raw values were then assigned a rating from 1-5 for each element in each sample, and the mean value for each sample was calculated as the final stream score. Samples from 2021 and 2024 were ranked separately and between-year changes were assessed.

B.3 Water Quality

chemistry data should be collected at all monitoring sites; however, in 2024, sampling was limited by equipment availability. A YSI DDS Pro multi-meter was utilized to collect water temperature (°C), pH, dissolved oxygen (mg/L), dissolved oxygen saturation (%), conductivity (µS/cm), and specific conductance (µS/cm). The dissolved oxygen probe was calibrated for dissolved oxygen at the start of each field day whereas the remaining parameters were calibrated weekly. Calibration methods and standards were taken from Xylem's ProDSS Calibration Guide (W89).

Water quality measurements were collected at the downstream extent of each study reach, before macroinvertebrate sampling or instream habitat and riparian assessments began. Water quality sampling occurred between 7:30 am and 3:00 pm.

B.4 Hydrology

B.4.1 Existing Conditions

At each monitoring site, 2-year and 25-year peak flows were estimated using regional regression equations developed by Cooper (2005). These estimates represent peak discharges under rural or largely undeveloped conditions. This regional regression uses drainage area (DA, sq mi), mean basin slope (MBS, dimensionless) and a 2-year, 24-hour intensity precipitation (I2).

$$Q2_{rur} = 9.136 * DA^{0.9004} * MBS^{0.4695} * I2^{0.8481}$$

An empirical relationship between percent impervious area (IA) and peak flow defined by Watson and Bledsoe (2001) was used to adapt the regional regressions for urban areas. This simple power law was derived from residential developments in Pierce and King Counties with construction dates from the 1960s to 1990s. The climate, ecology, and development practices in the Puget Sound region and the Willamette Valley are similar, making this empirical relationship particularly applicable. Existing impervious cover was estimated using the 2023 National Land Cover Database (NLCD).

$$Q2_{urb} = Q2_{rur} * IA^{0.3}$$

B.4.2 Full Buildout conditions

Development patterns in the area are largely dictated by the Urban Growth Boundary (UGB), set forth by the State of Oregon and managed by Portland Metro. Within the UGB, counties and cities are allowed to set their own zoning regulations.

For future impervious cover, a "full buildout" scenario was developed using Oregon Metro's generalized zoning classifications. Although Metro does not provide maximum impervious surface values for each zone, the City of Portland's maximum permissible imperviousness standards were used as a proxy.

Given the possible increases in impervious area and the current rate of development, it seems unlikely they expect to reach such a capacity by the end of the current 2040 regional growth plan. Therefore, this full buildout scenario likely represents conditions decades out, at least past 2040. However, observed changes in impervious area seem to indicate that more sprawl is occurring than originally intended/expected in the ambitious regional growth plan, which emphasized denser town centers and main corridors.

It is important to note that even though this scenario is projected to be decades out, the developments that are reflected in this scenario are already being built today.

Table 5: City of Portland's zoning codes and corresponding maximum permissible impervious standards.

Zoning	CODE	Max Impervious %
Rural	RUR	10
Future Urban Development	FUD	85
Public Facilities	PF	85
Commercial	COM	85
Multi-Use Residential	MUR	75
Single Family	SFR	36
Industrial	IND	85
Multi Family	MFR	75
Public Open Space	POS	0

To forecast the impact of future development on stream health via hydromodification we calculated stream power under existing and full buildout imperviousness scenarios. We then binned the stream power thresholds into categories of high, medium, and low based on the existing body of literature around stream power (Table 6). The papers used to inform these thresholds can be found in Table 7.

Table 6: Specific Stream Power thresholds used to identify erosion potential and determine feasibility of different restoration actions.

Relative Stream Channel Erosion Potential	Specific Stream Power Thresholds	
	(W/m^2)	(lb/ft-s)
Low	<10	<0.7
Medium	10–60	0.7–4.1
High	>60	>4.1

Table 7: Literature used to inform stream power (ω) thresholds for erosion potential and feasibility of different restoration actions.

Publication	Specific Stream Power Deposition-Erosion Threshold		Description of Applicability to the Tualatin Basin
	(W/m^2)	(lb/ft-s)	
Nanson and Croke (1992)	10	0.7	Genetic classification of floodplain types based on bankfull hydraulic conditions, with the most relevant to the Tualatin River and its valley tributaries being low to medium-energy, cohesive to low-cohesive, meandering, single-channel floodplains with mostly fine-grained sediments.
	60	4.1	
Brookes (1987)	25	1.7	Incising streams eventually enter a non-erosion phase when they have enlarged to a point with ω <35 W/m^2; a related deposition-to-erosion threshold in altered streams equates to ω =25 W/m^2.
Orr et al. (2008)	30–35	2.1–2.4	Found the deposition-erosion threshold occurs between ω =30 and 35 W/m^2.
Wallerstein et al. (2016)	35	2.4	Applied a common threshold in their stream power screening tool.
Papangelakis et al. (2022)	50	3.4	Categorized rural and urban reaches by specific stream power, with "low rural stream power conditions" having ω <50 W/m^2, "high rural stream power conditions" having ω >50 W/m^2, and urban areas having ω >100 W/m^2.
Yochum et al. (2017)	230	16	Characterized large flood influence on semi-arid streams: for channel slopes ω <3%, substantial widening with ω >230 W/m^2, wholesale channel repositioning with ω >480 W/m^2, and major geomorphic change with ω >700 W/m^2.
Miller (1990)	300	21	Found that a major flood caused severe erosion when ω >300 W/m^2, but did not find a strong link between specific stream power and geomorphic change due to the size and rarity of the flood event.

Magilligan (1992)	300	21	Evaluated variation in stream power associated with the 2-year to 500-year flood events, for which it was found the threshold for causing major morphological adjustments in low gradient, alluvial channels in humid to sub-humid environments corresponds to ω >300 W/m^2.

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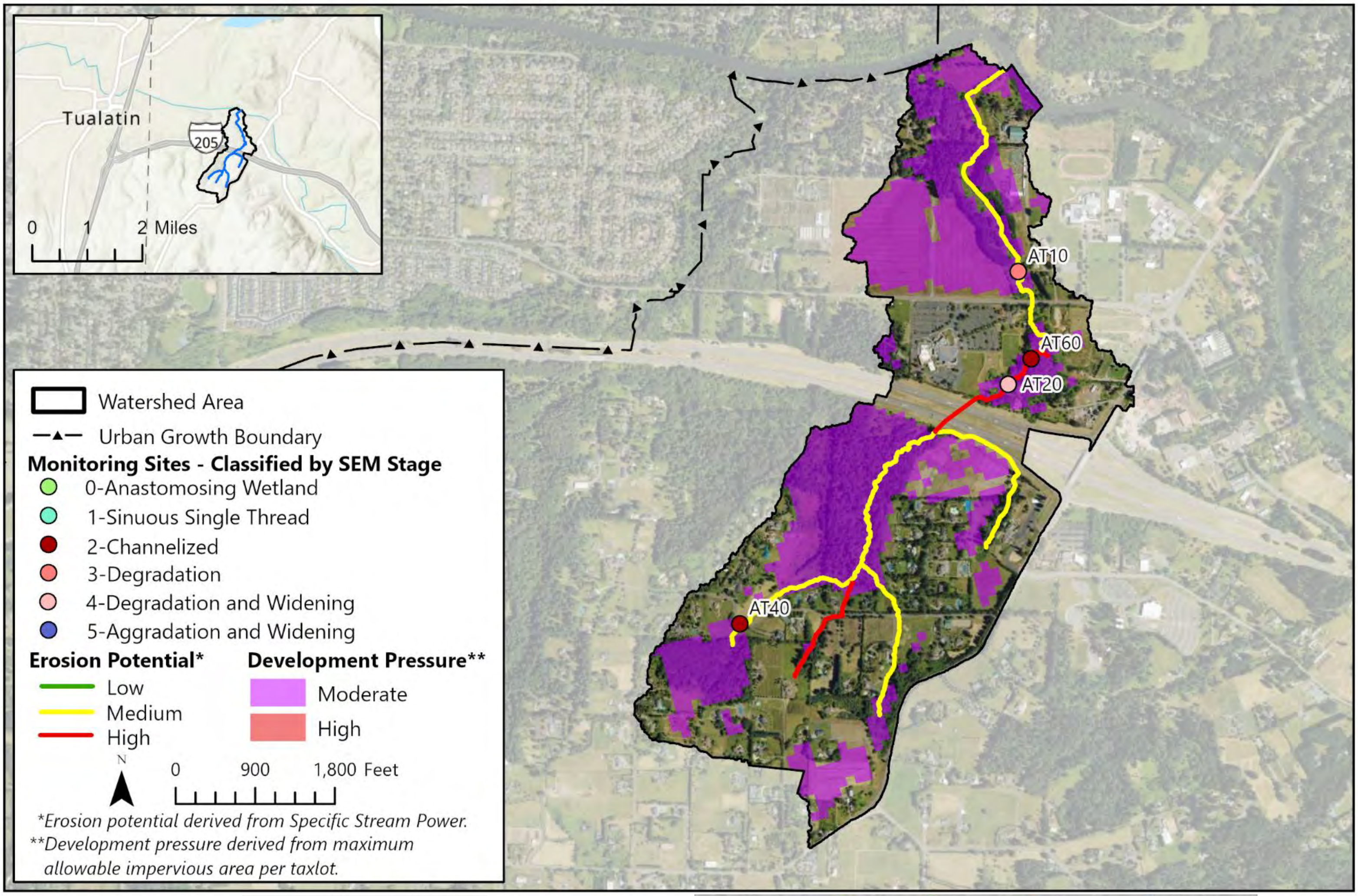
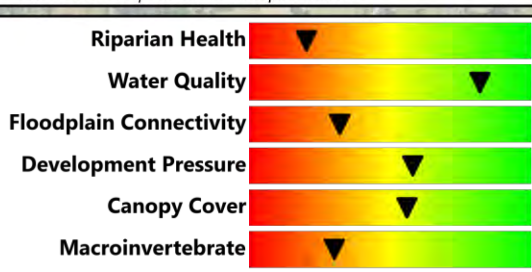
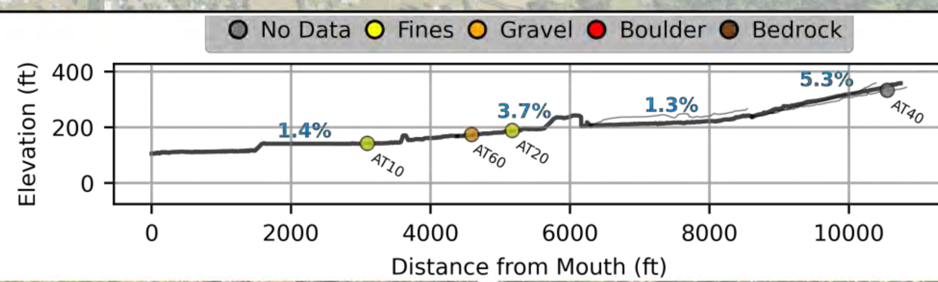
Appendix C – Stream Sheets



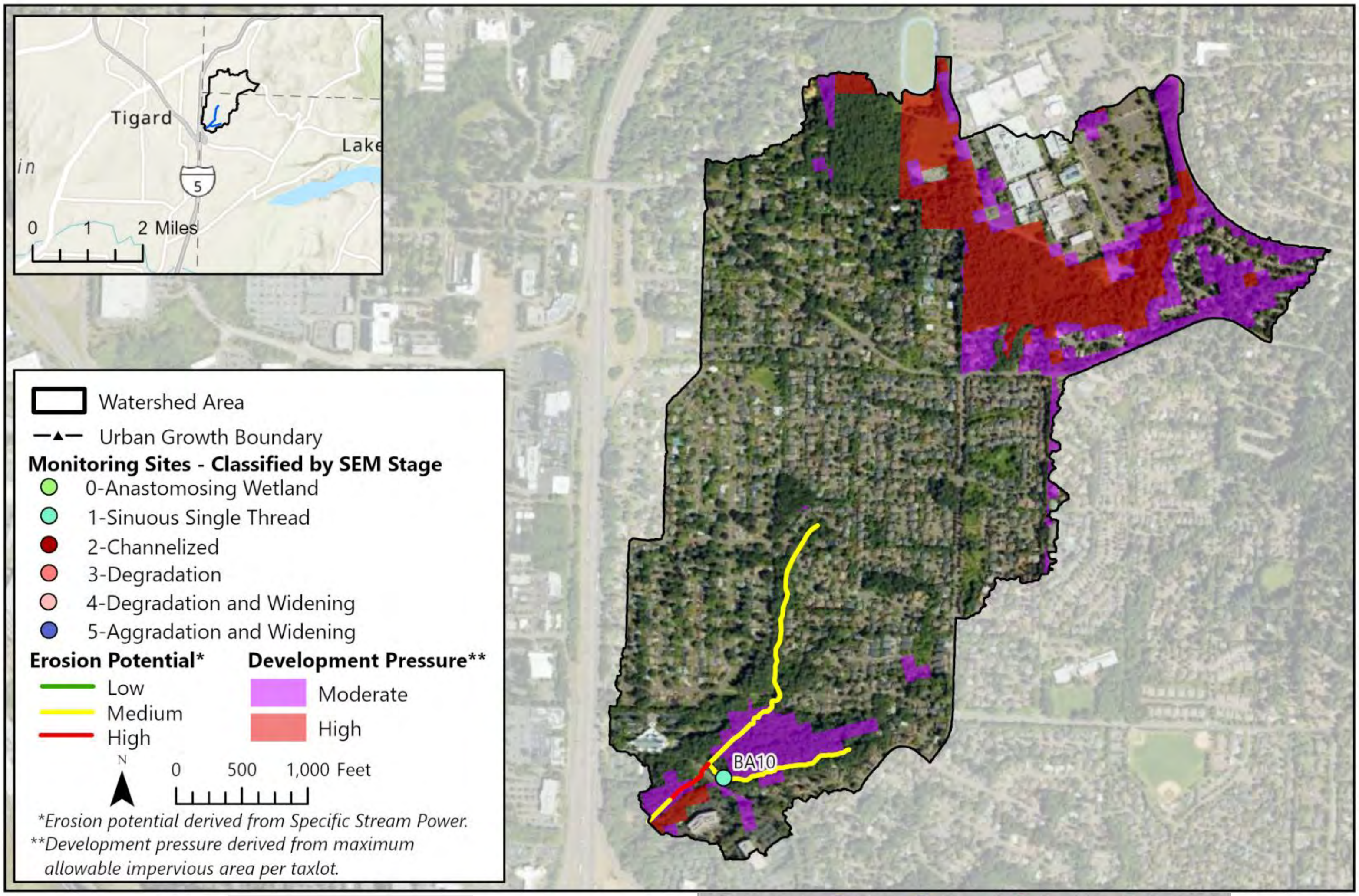


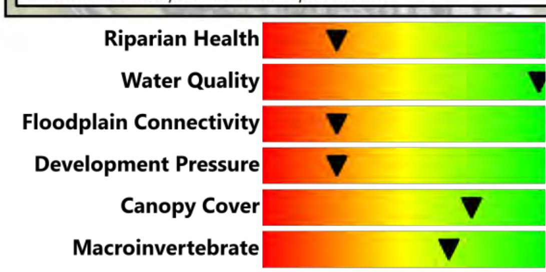


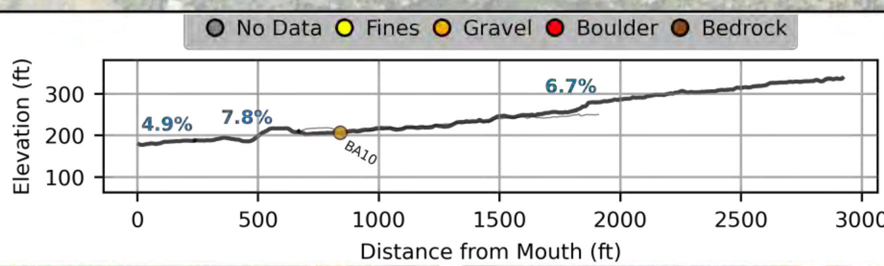
Athey Creek flows northward from steep bluffs into the Tualatin River. Its channel substrate varies between bedrock, gravel, and fines, and it primarily flows through rural properties outside the urban growth boundary, with minimal risk of future development. The watershed is approximately 99.2% private and 0.8% public land.

The creek has good canopy cover, but the riparian zone is largely dominated by invasive vegetation. Trend analysis shows slight improvement in both macroinvertebrate health and degree of floodplain connectivity.

Athey Creek



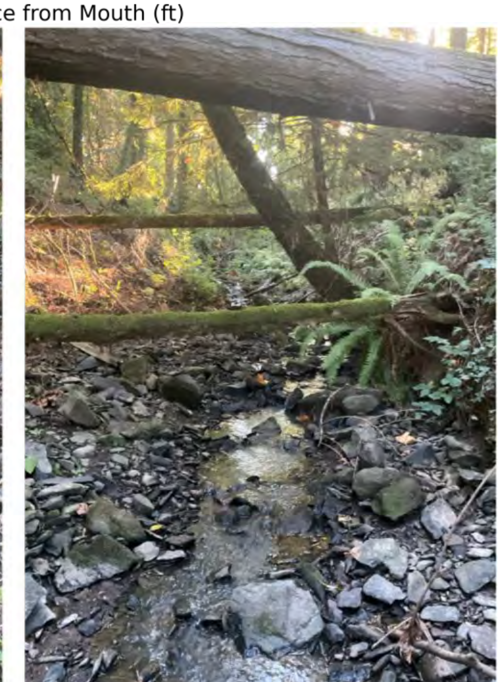




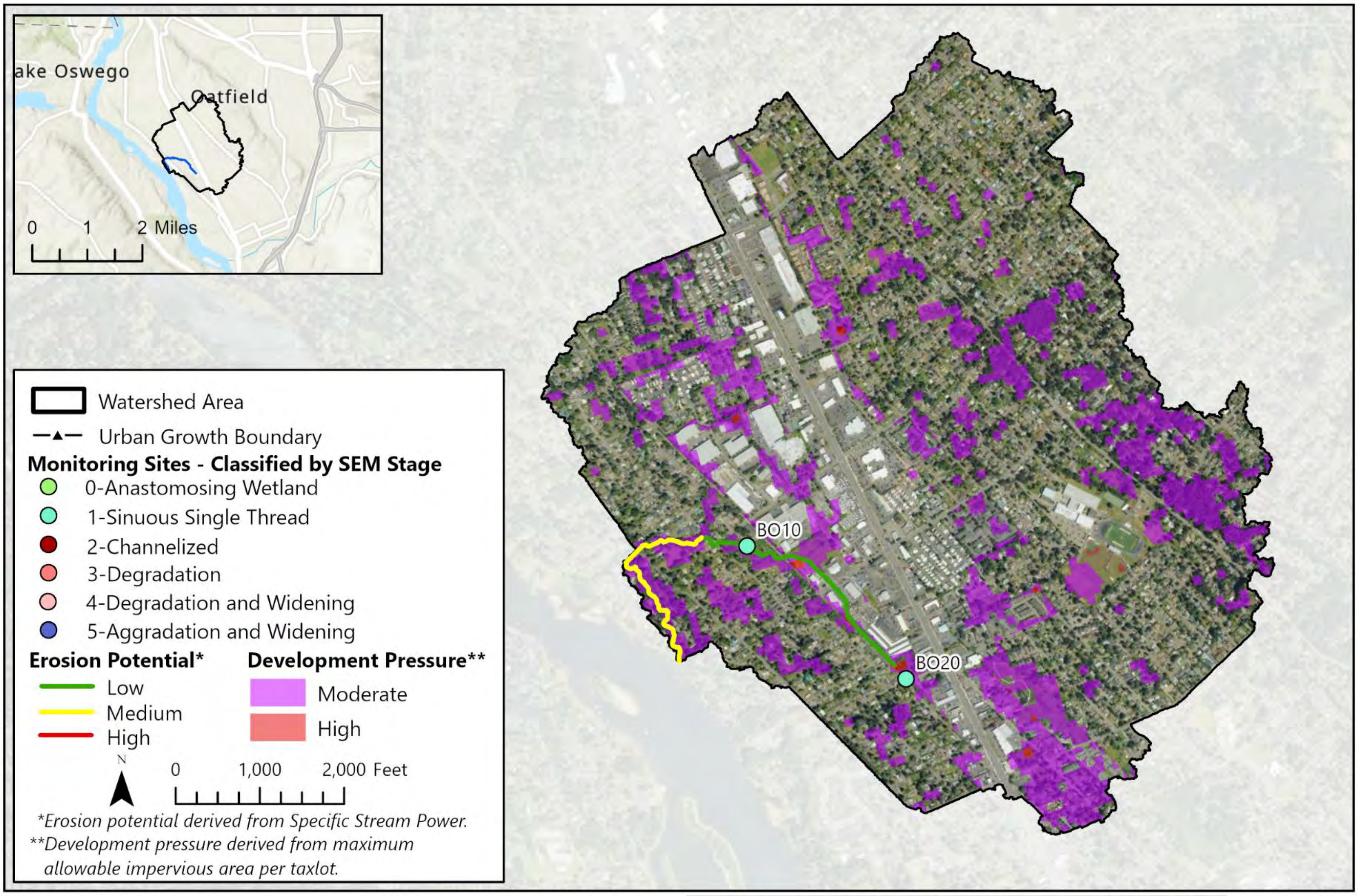
Ball Creek is a moderately steep creek with a small drainage area that is highly developed. The watershed is approximately 99.5% private and 0.5% public land.

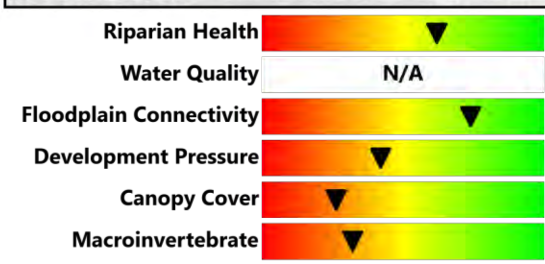
Canopy cover is relatively high, particularly in the lower watershed. Only one site was visited on the creek, but it exhibited confinement and moderate invasive vegetation.

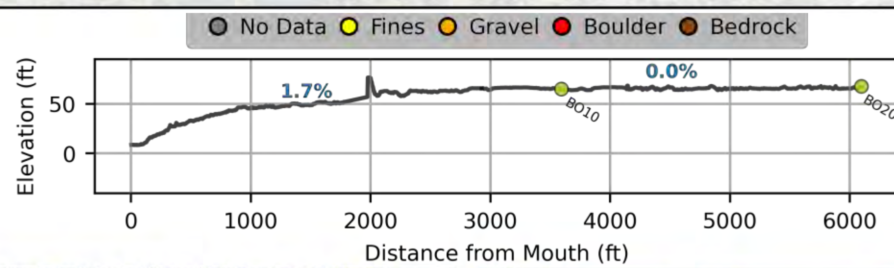
The trends analysis comparing 2018 and 2024 data found that macroinvertebrate health has remained unchanged between sampling years.



Ball Creek





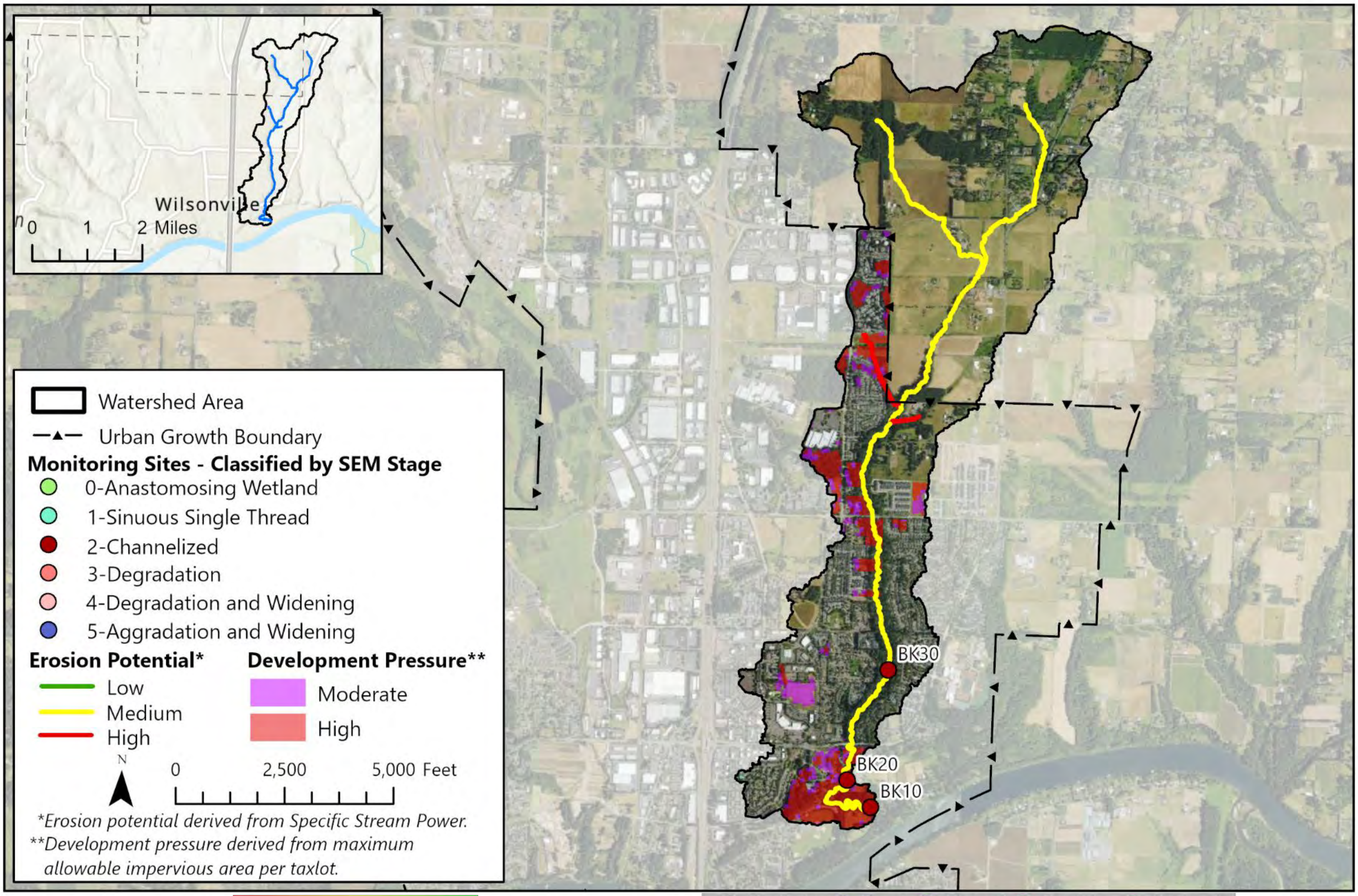


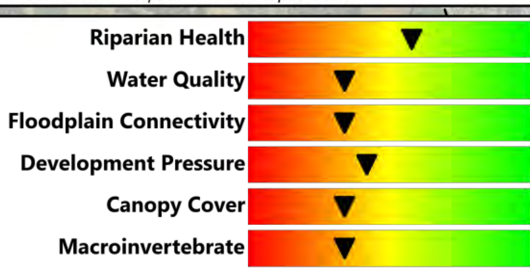
Boardman Creek is a gently sloping, fine-bedded tributary of the Willamette River. The creek flows through a developed area with a small portion flowing through the Stringfield Family Park. The watershed is approximately 95% private and 5% public land.

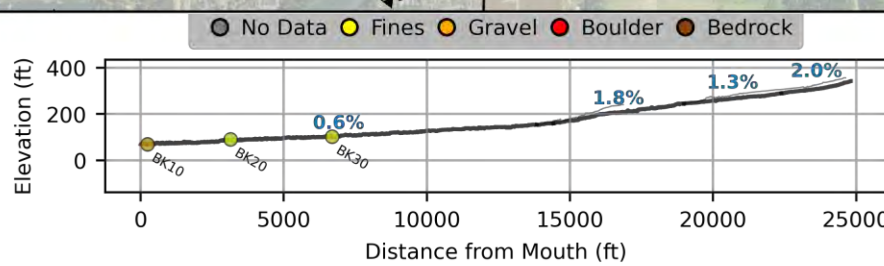
Canopy cover throughout the watershed is relatively low, but the two sites that were visited showed healthy riparian corridors with low invasives presence. Water quality was not measured in this creek.

The trends analysis comparing 2018 and 2024 data found that macroinvertebrate health decreased slightly at one site (BO10) and increased at the other (BO20).

Boardman Creek



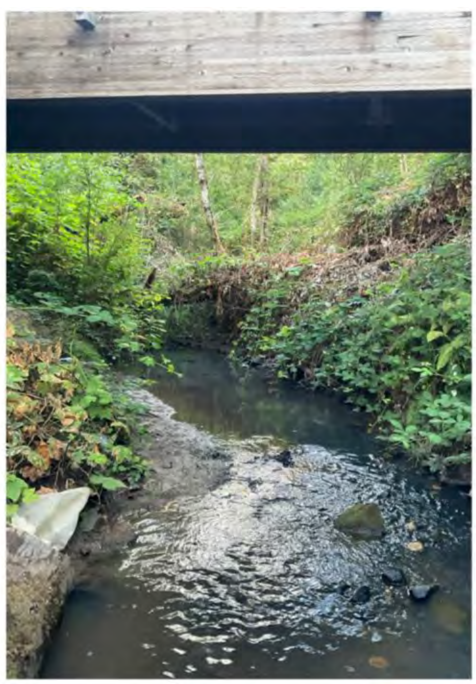




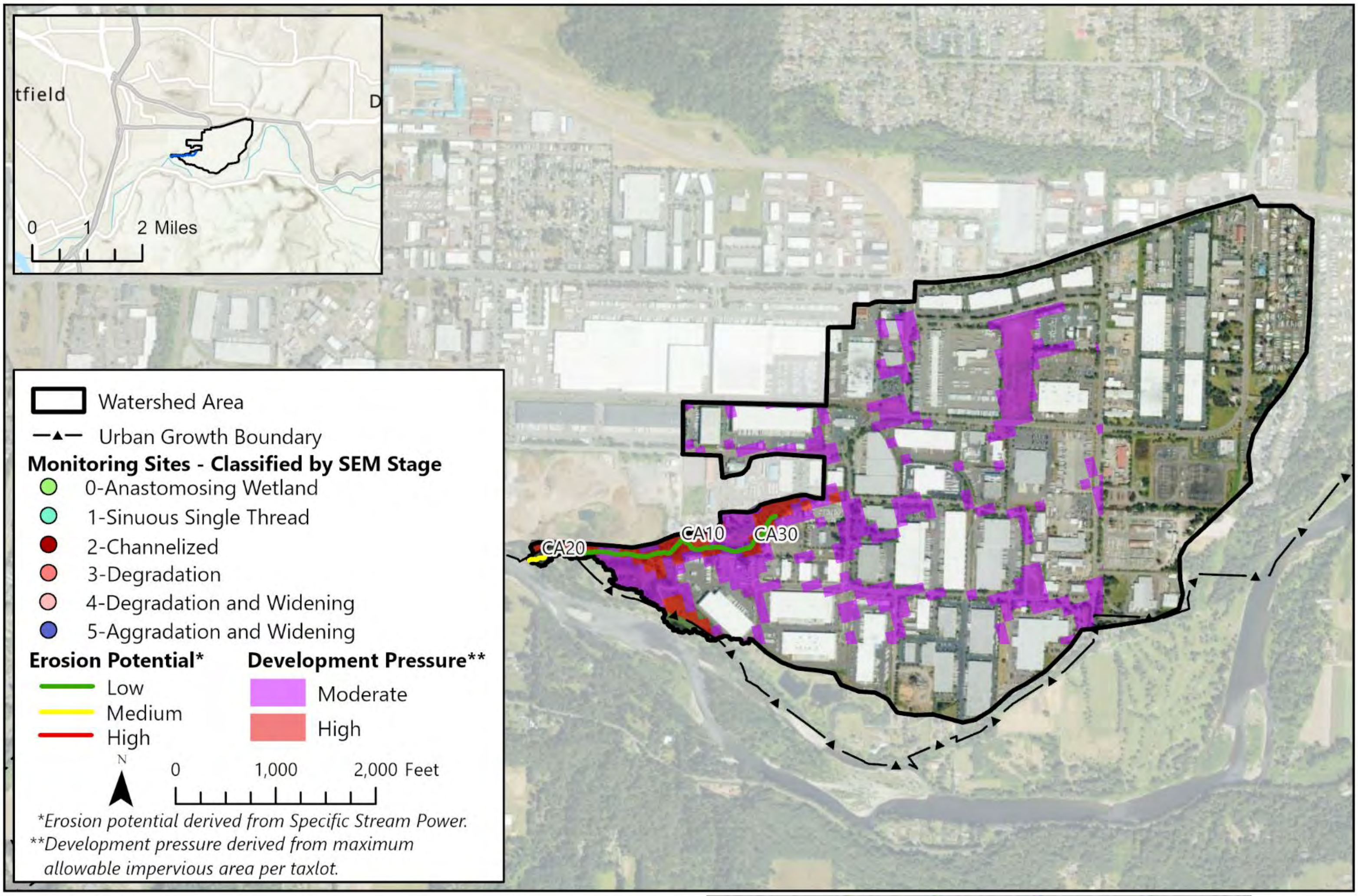
Boeckman Creek is a moderately-low sloping, mostly fine-bedded tributary of the Willamette River. Much of the creek flows through the Boeckman Creek Natural Area.

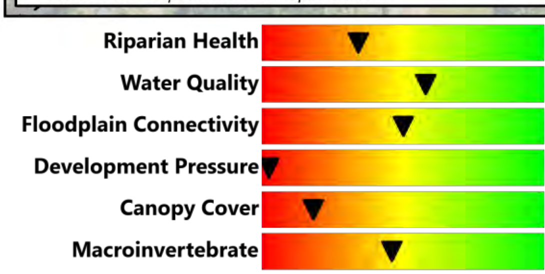
Although the canopy coverage in the watershed is relatively low, the overall floodplain connectivity and riparian health are higher due to the creek's protection in the natural area. Water quality was not measured in this creek.

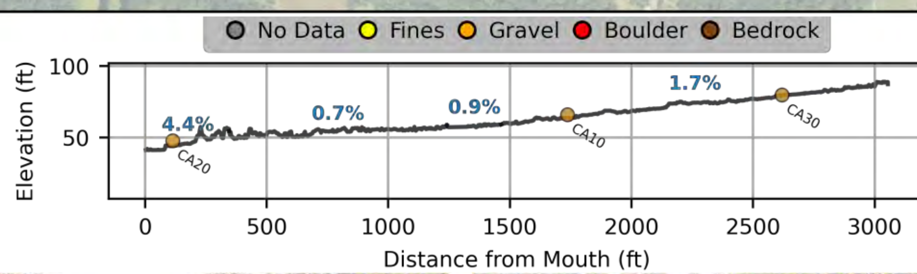
The trends analysis comparing 2018 and 2024 data found that macroinvertebrate health varied between sites, with the community at BK10 exhibiting no change and community health increasing at BK20 and BK30.



Boeckman Creek



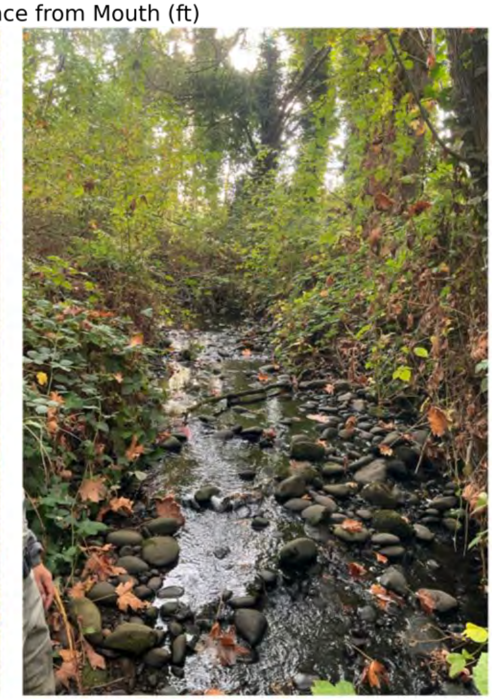




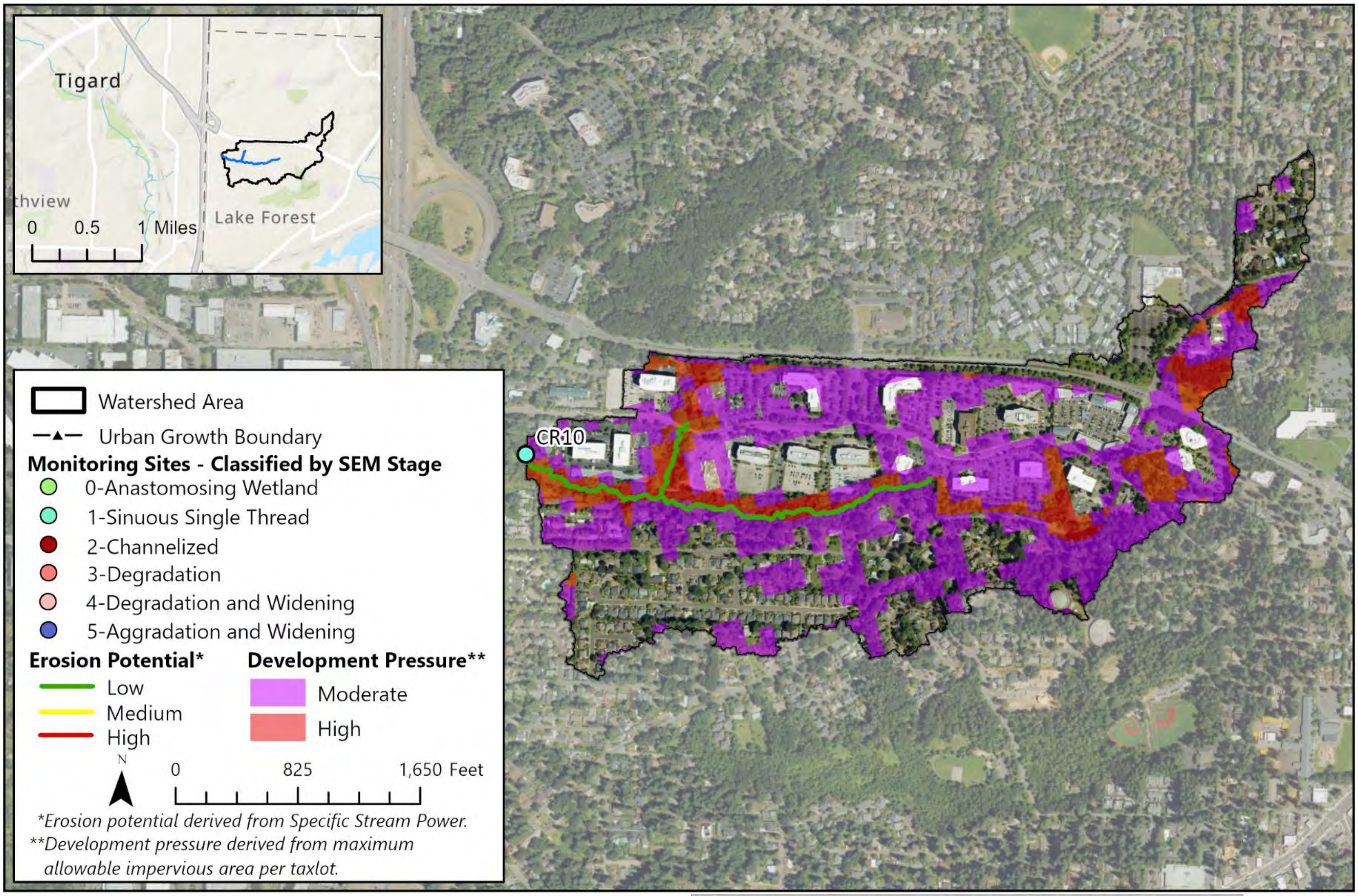
Carli Creek flows westward into the Clackamas River and drains industrial and commercial areas with extensive impervious areas. The watershed is approximately 96% private and 4% public land.

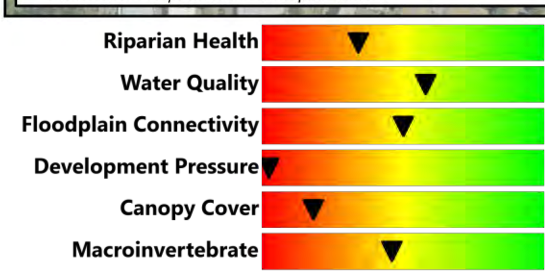
The creek exhibits moderate floodplain connectivity partly due to recent restoration projects. The gravel-bedded creek exhibited some complexity with large wood but also had prevalent invasive vegetation.

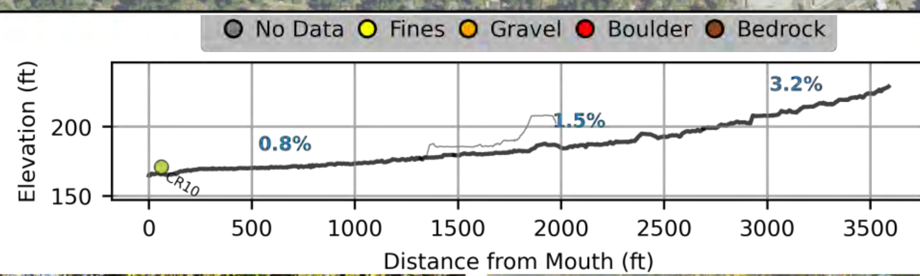
The trends analysis showed no change in floodplain connectivity, but the macroinvertebrate health has improved since 2021.



Carli Creek



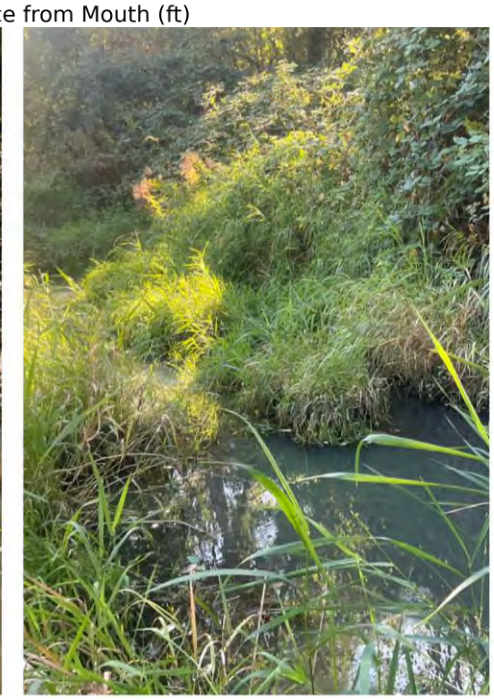




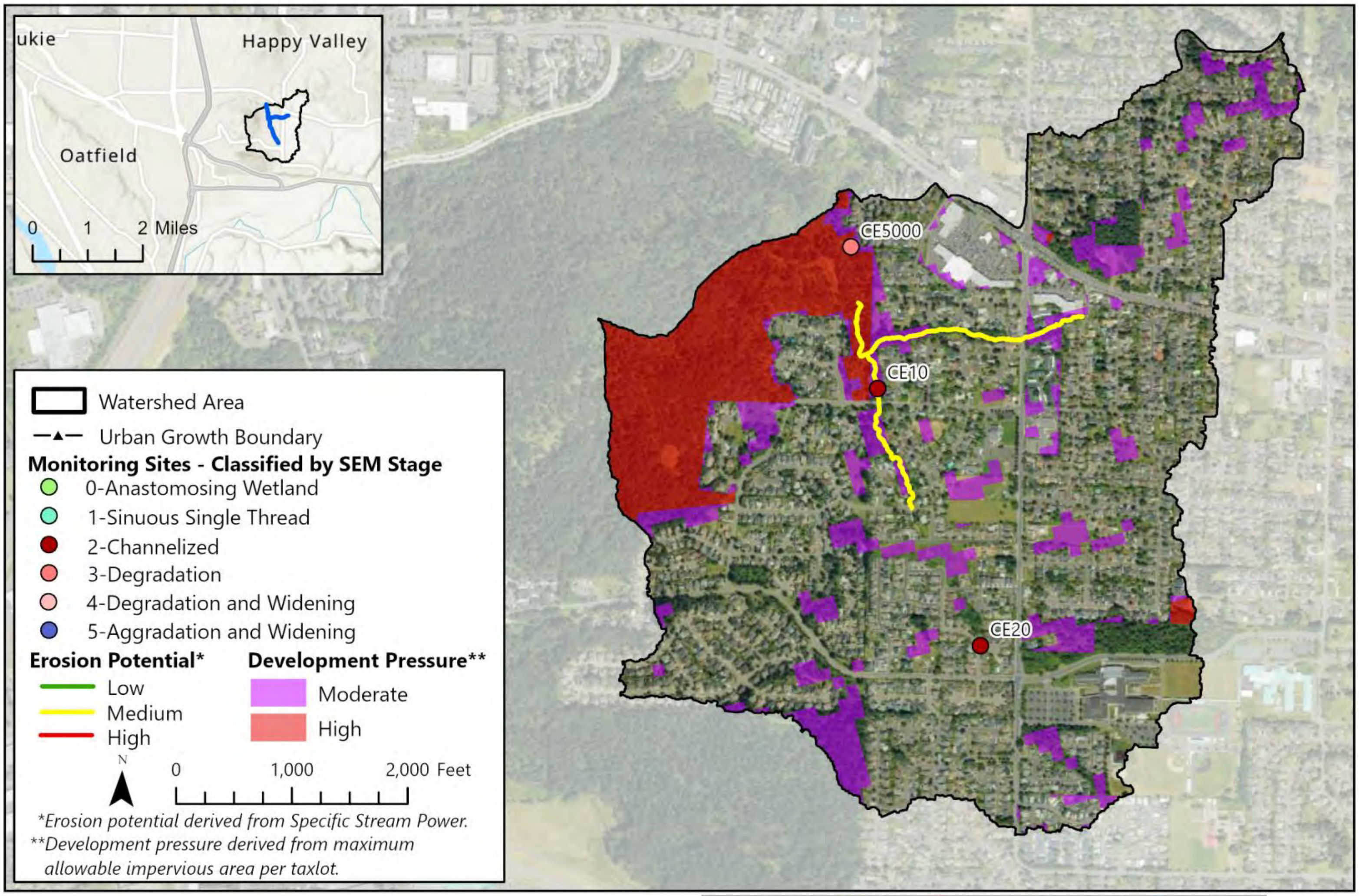
Carter Creek is a moderately sloping, fine-bedded creek that mainly flows through a commercial area with extensive impervious areas. The watershed is approximately 98% private and 2% public land.

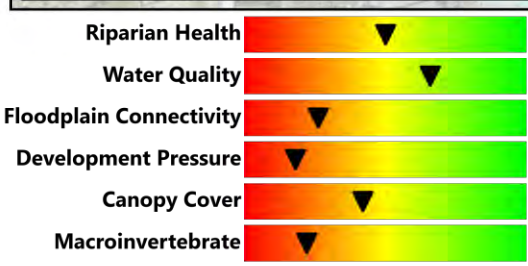
The creek is heavily confined and exhibits low floodplain connectivity. The site visited at Carter Creek showed signs of beaver activity and exhibited low dissolved oxygen and high conductivity.

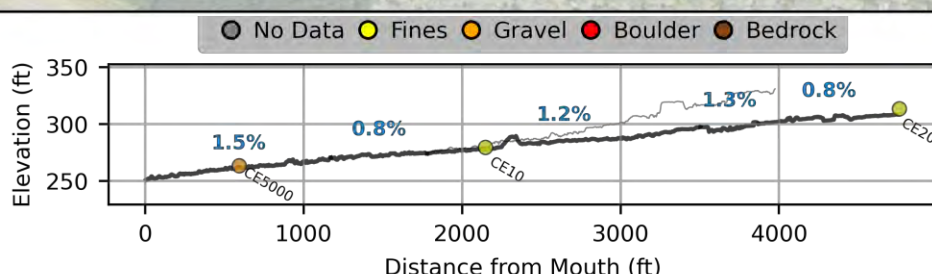
The trends analysis found that macroinvertebrate health has decreased since 2021.



Carter Creek





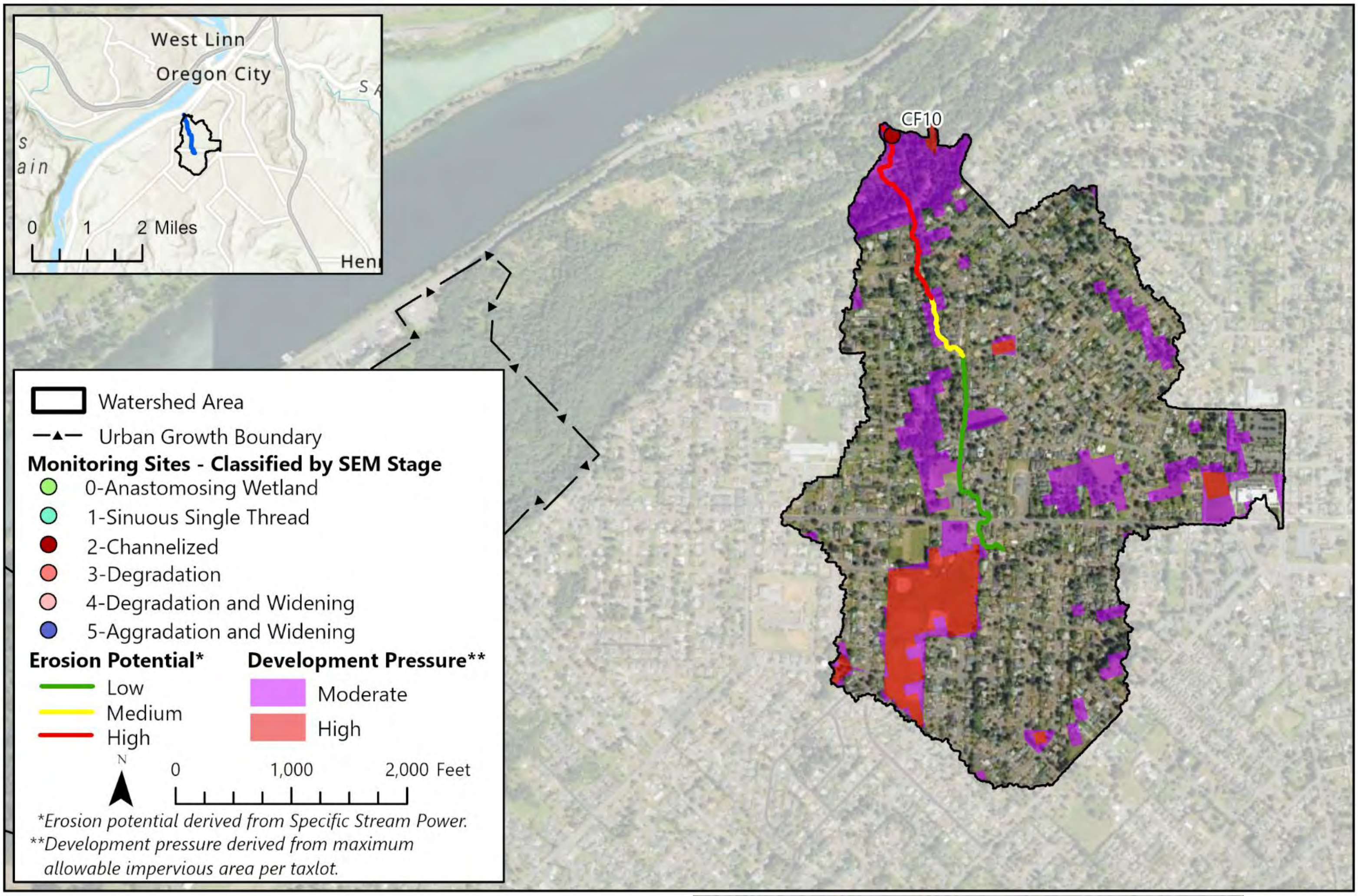


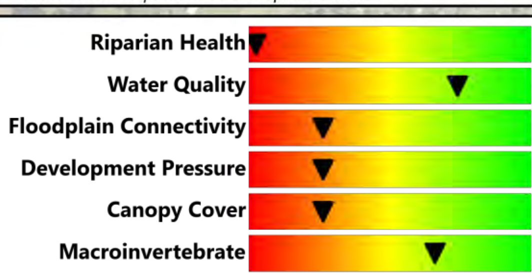
Cedar Creek flows north to its confluence with Mt Scott Creek at the upstream end of the Mt Talbert Nature Park. The watershed is approximately 81% private and 19% public land and is dominated by impervious area.

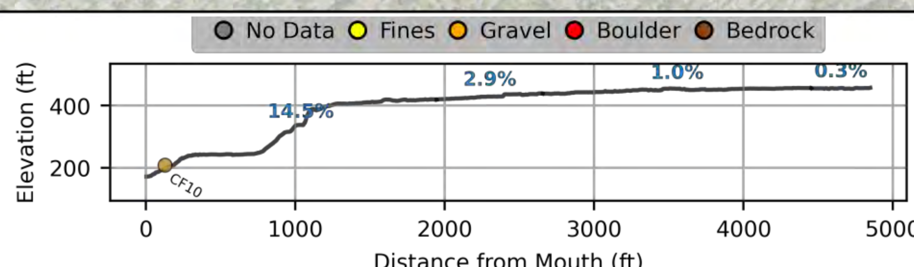
Land use impacts are obvious throughout the watershed as many sections of the creek have been straightened, pass through infrastructure, and/or are piped underground.

Trends analysis reveal decreasing macroinvertebrate health and decreasing floodplain connectivity since 2021.

Cedar Creek





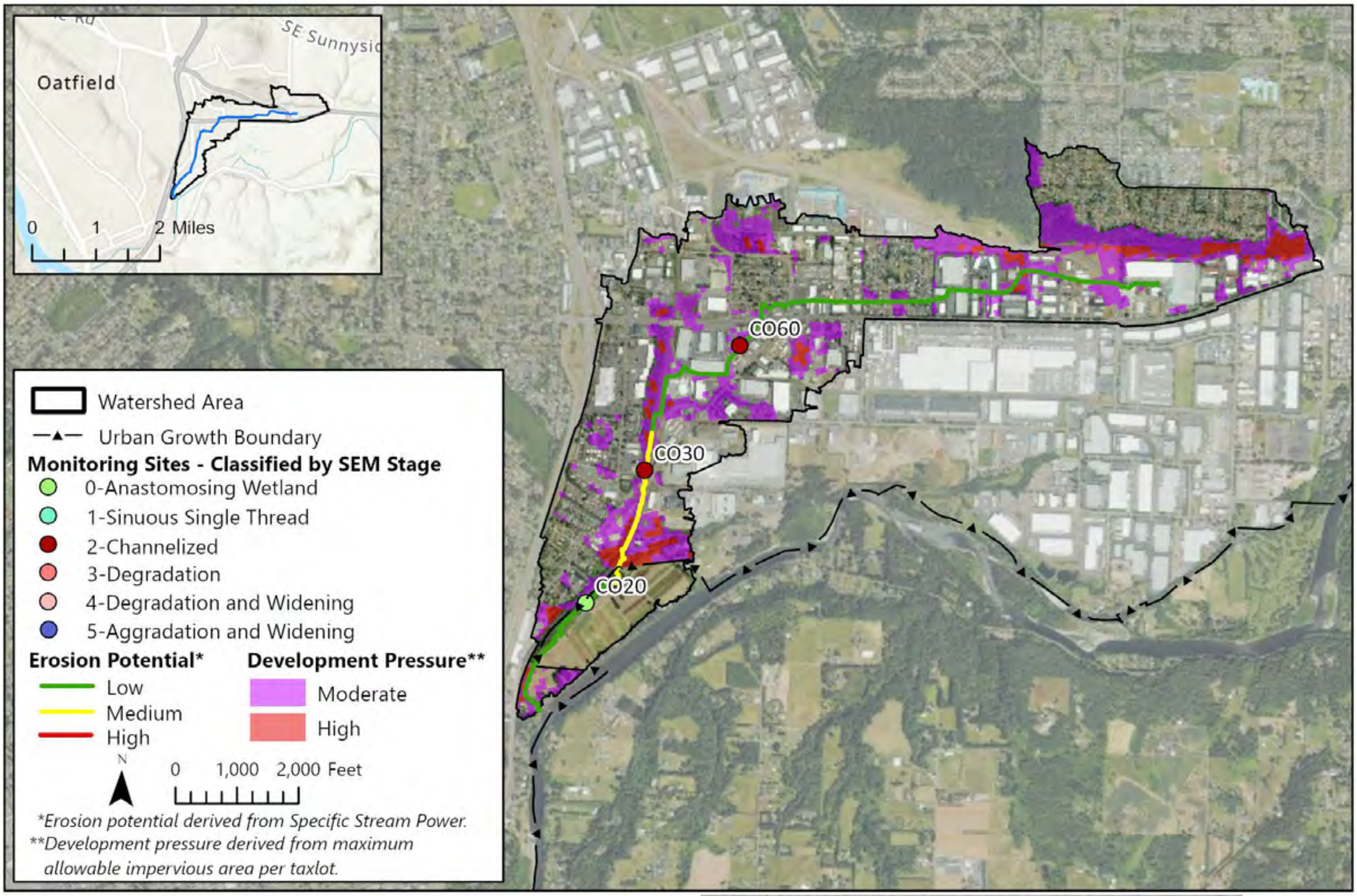


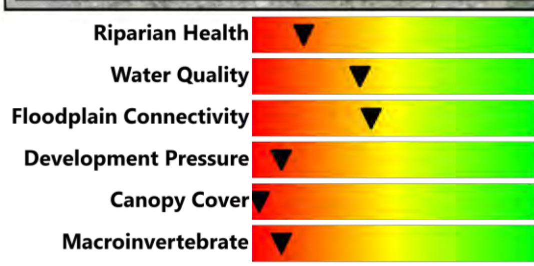
Coffee Creek drains a primarily residential area of Oregon City before steeply descending into the Willamette River near Old Canemah Park. The watershed is approximately 91% private and 9% public land and is dominated by impervious area.

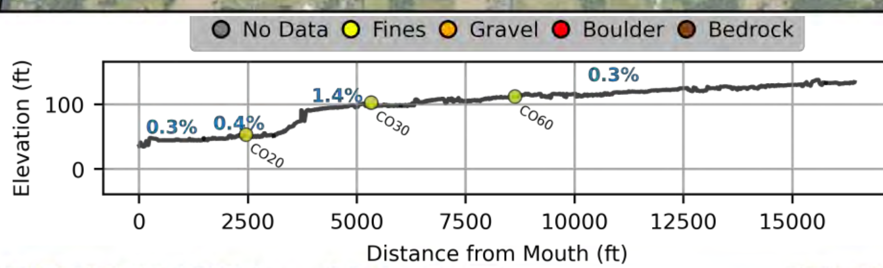
The creek is confined and exhibits limited floodplain connectivity. At the site visited on Coffee Creek, the riparian corridor was dominated by blackberry and non-native grasses, including lawn species. The site also exhibited low specific conductivity.

The trends analysis comparing 2018 and 2024 data found that macroinvertebrate health remained unchanged between sampling years.

Coffee Creek



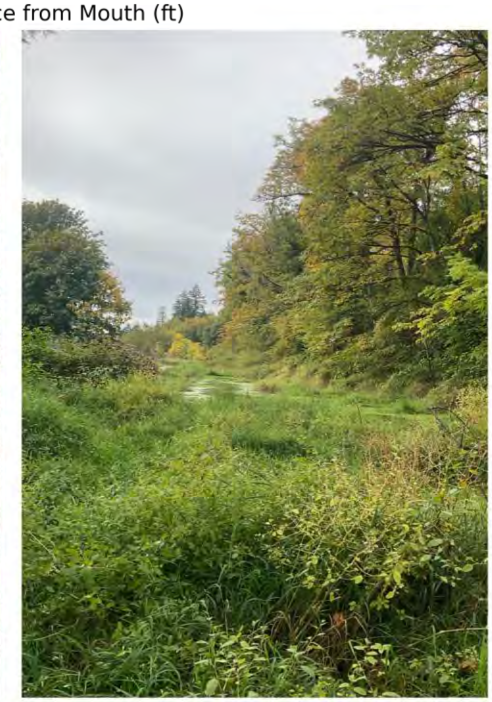




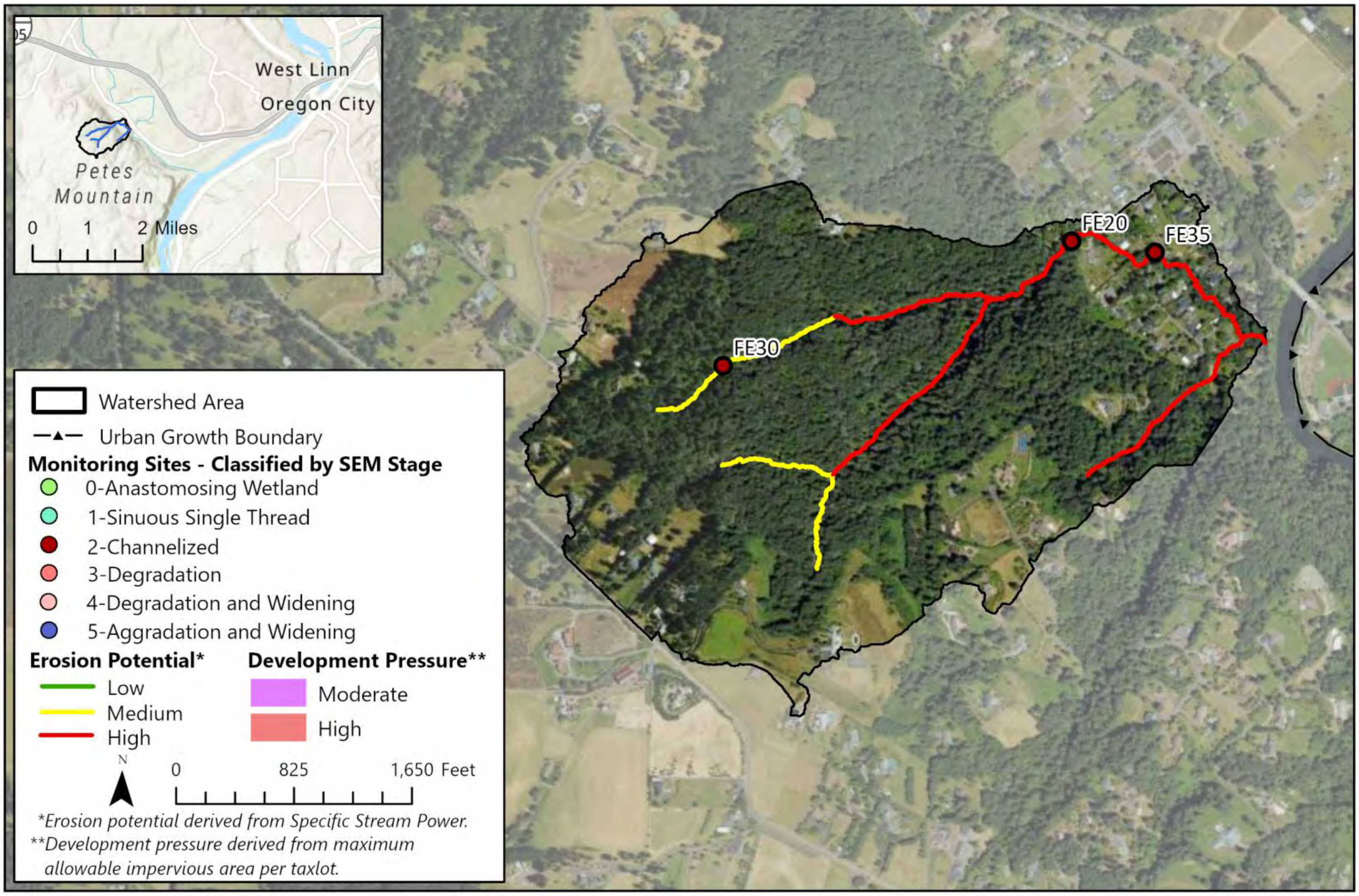
Cow Creek flows west-southwest into the Clackamas River and drains commercial and industrial parks with extensive impervious areas. The watershed is approximately 90% private and 10% public land and is dominated by impervious area.

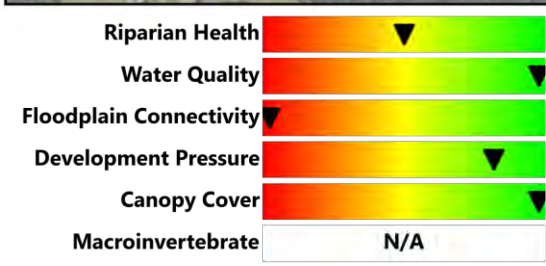
The downstream portion of the creek is low-gradient and appears backwatered, while further upstream the creek is narrowly confined, straightened, and routed through pipes. Water quality at Cow Creek is poor.

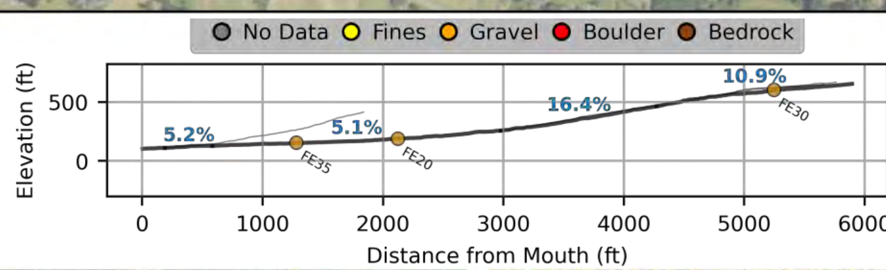
The trends analysis found that both macroinvertebrate health and degree of floodplain connectivity have increased since 2021.



Cow Creek



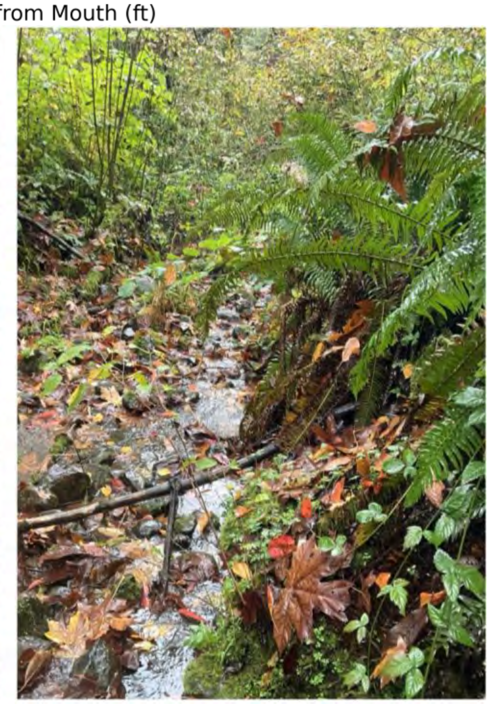




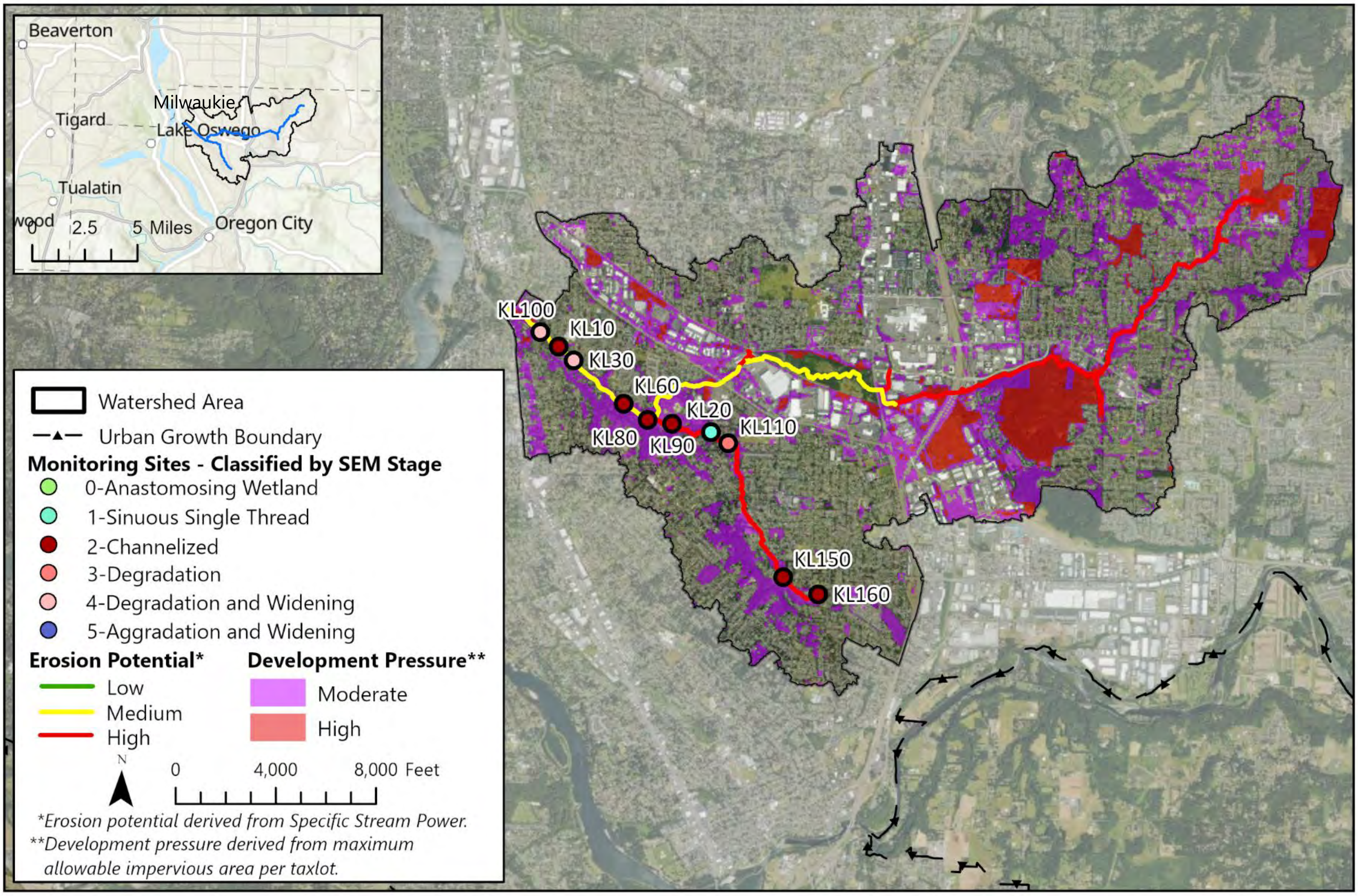
Fields Creek is gravel-dominated and flows northeast off steep bluffs into the Tualatin River. Development pressure and impervious area are both low. The watershed is approximately 97% private and 3% public land.

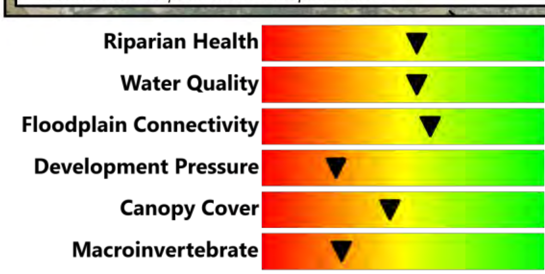
Fields Creek has very high canopy cover and supports only a moderate presence of invasive vegetation. Much of the creek flows through residential properties and is generally incised.

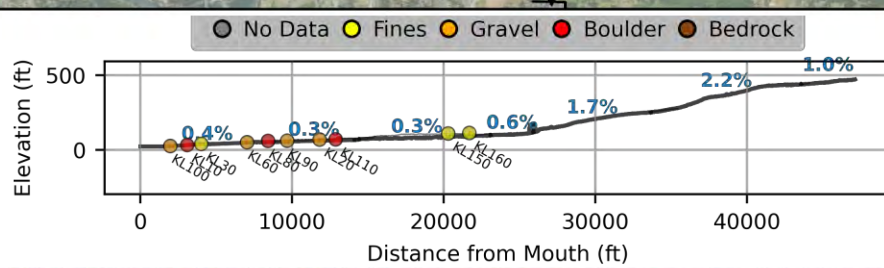
The trends analysis found that degree of floodplain connectivity has significantly decreased since 2021.



Fields Creek



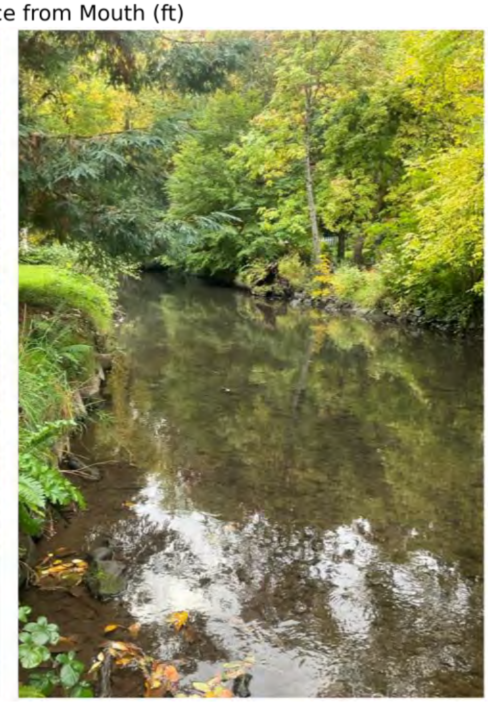




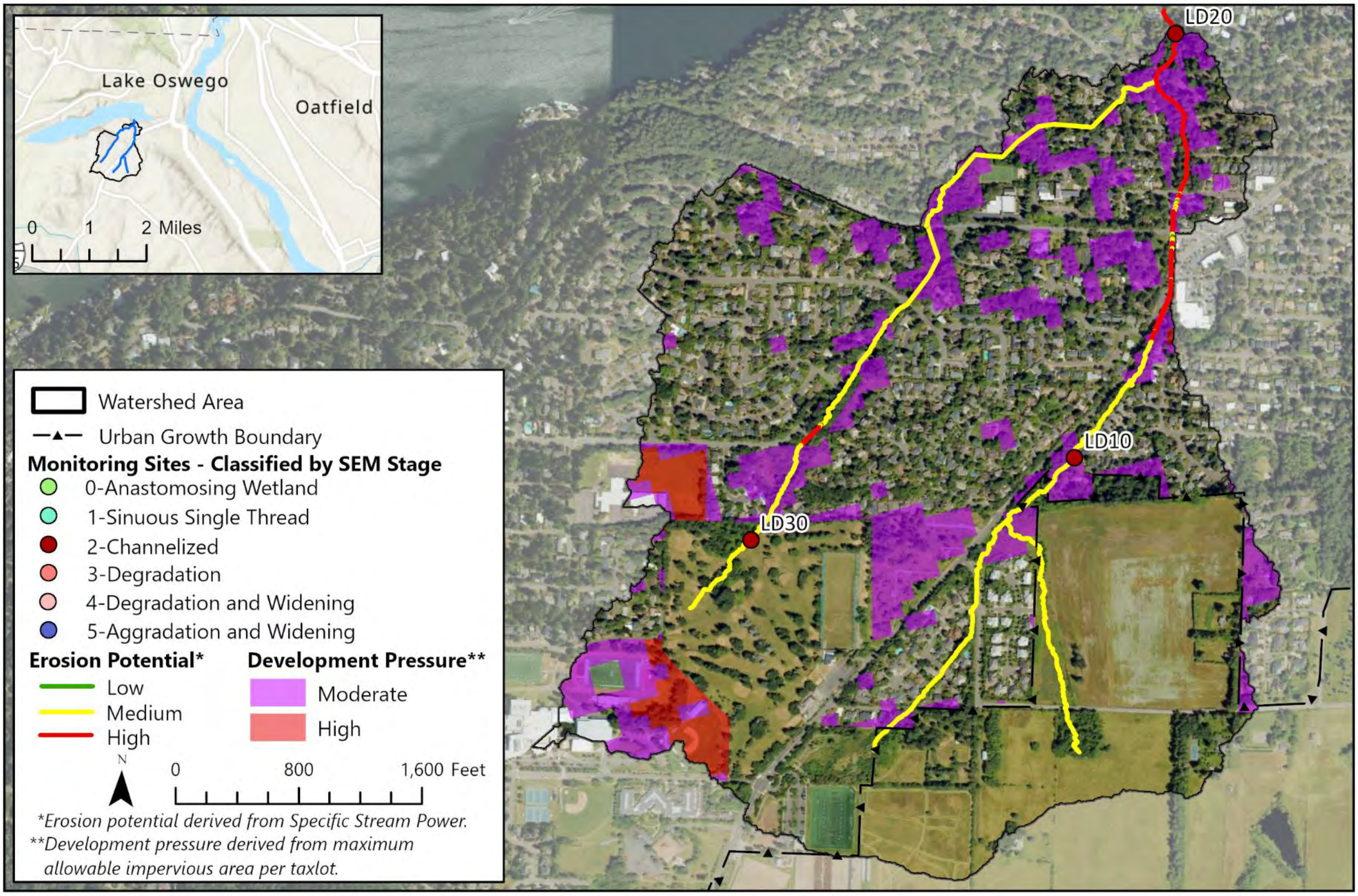
Kellogg Creek flows northwest into the Willamette River. Some portions flow through parks or natural areas, but otherwise it is dominated by residential land use. The watershed is approximately 89% private and 11% public land and the overall impervious area is high.

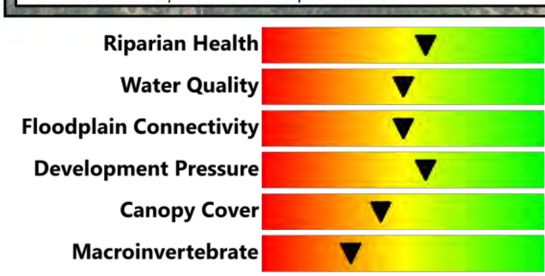
Kellogg Creek is largely channelized, with many sections armored by riprap. Invasive vegetation is present but generally less abundant than in other nearby creeks. The northern tributary shown in the map is Mt. Scott Creek.

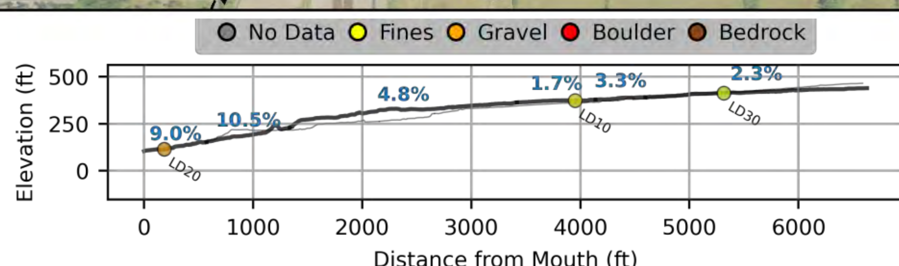
Trends analyses show that macroinvertebrate health has decreased since 2021, but floodplain connectivity has increased.



Kellogg Creek





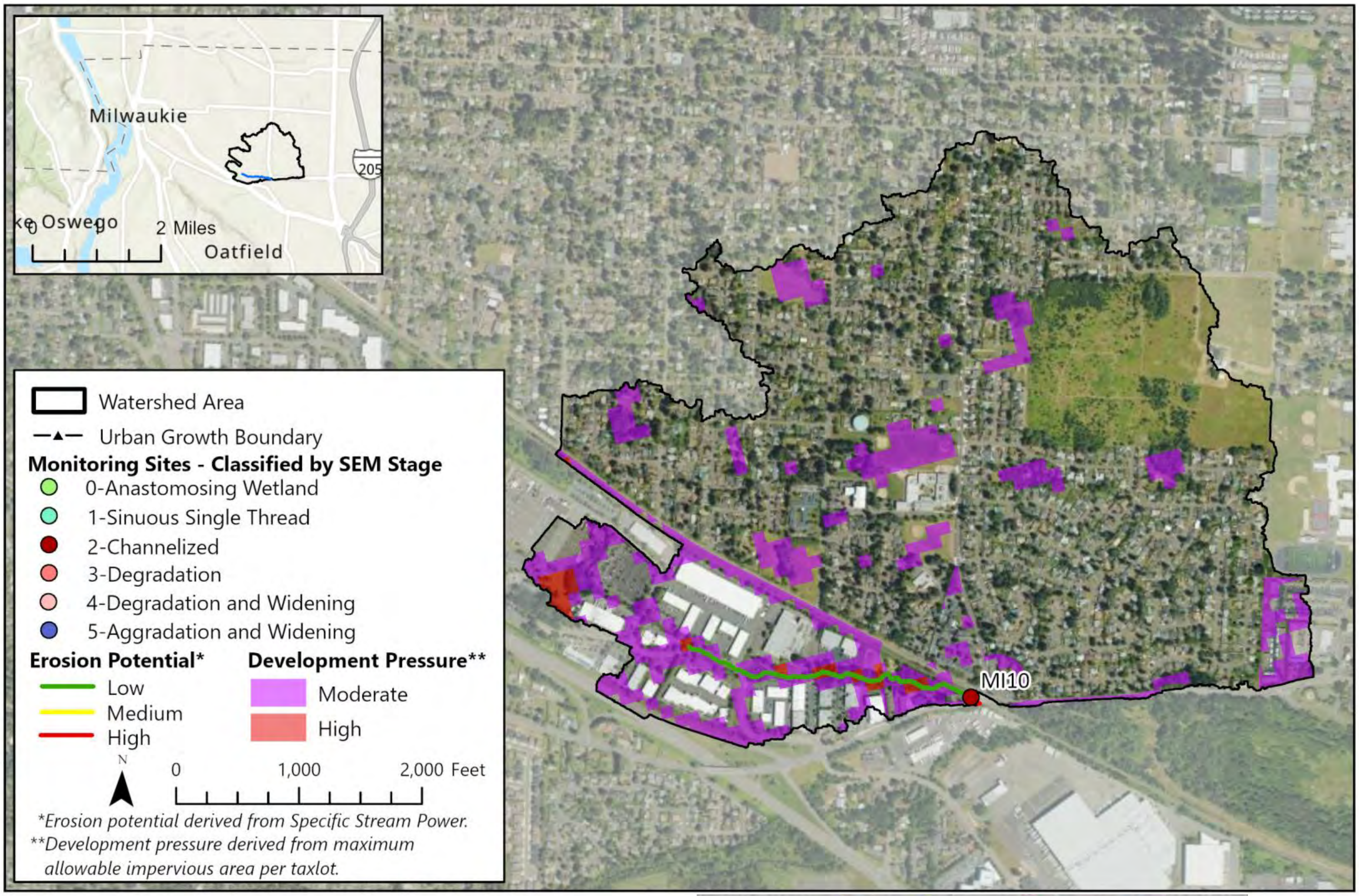


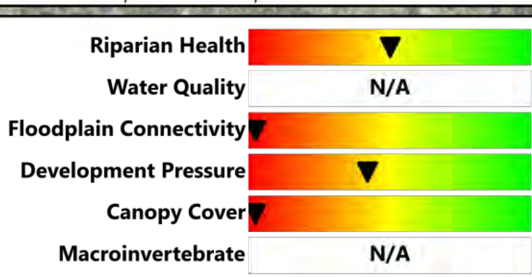
Lost Dog Creek flows north into Lake Oswego. The watershed has moderate impervious area and is approximately 77% private and 23% public land.

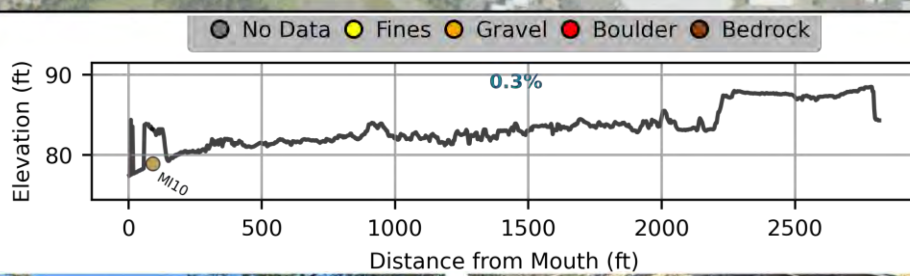
Lost Dog Creek is predominantly channelized and shows signs of widespread bank erosion. Canopy cover is moderate, but invasive species are prevalent throughout the corridor. Several of the sites visited along the creek also had exposed stormwater infrastructure.

Trend analysis indicates a decline in macroinvertebrate health since 2021.

Lost Dog Creek



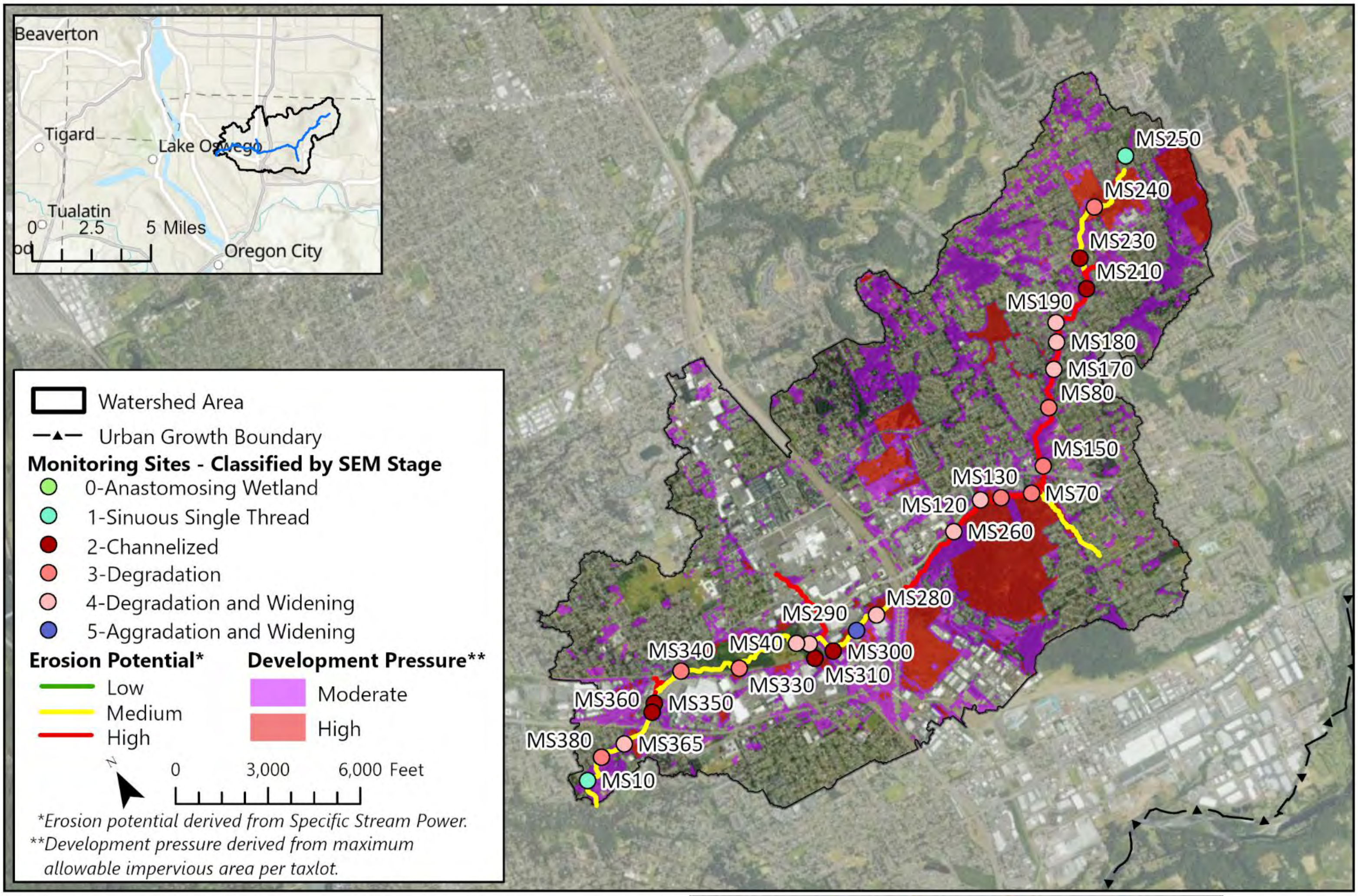


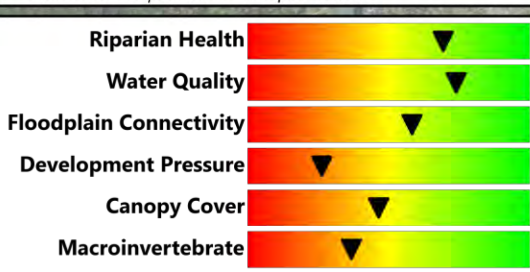


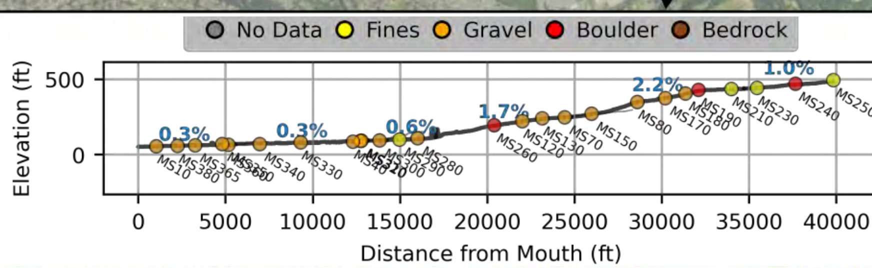
Minthorn Creek flows east into Mt Scott Creek through a predominately industrial area. The watershed has moderate impervious coverage and is approximately 96% private and 4% public land.

The creek exhibits very limited floodplain connectivity and is heavily impacted by surrounding infrastructure. Canopy cover is minimal. The site visited in 2024, located adjacent to railroad tracks, showed severe ecological degradation and lacked active surface flow, preventing the collection of macroinvertebrate samples and water quality measurements.

Minthorn Creek



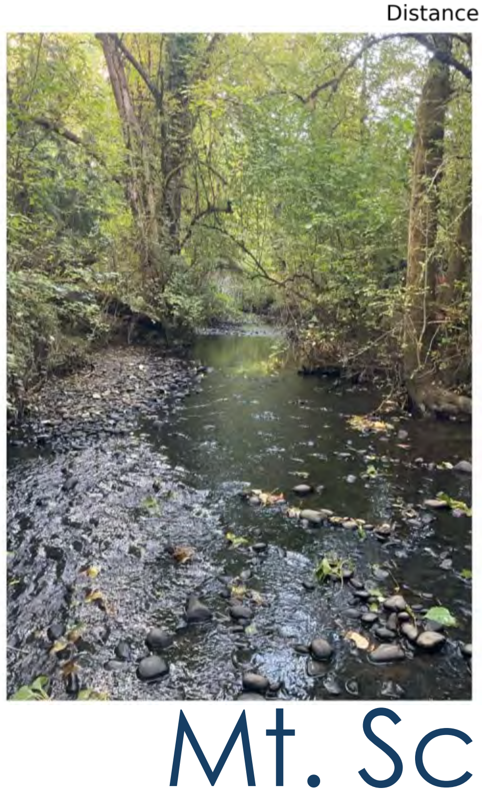


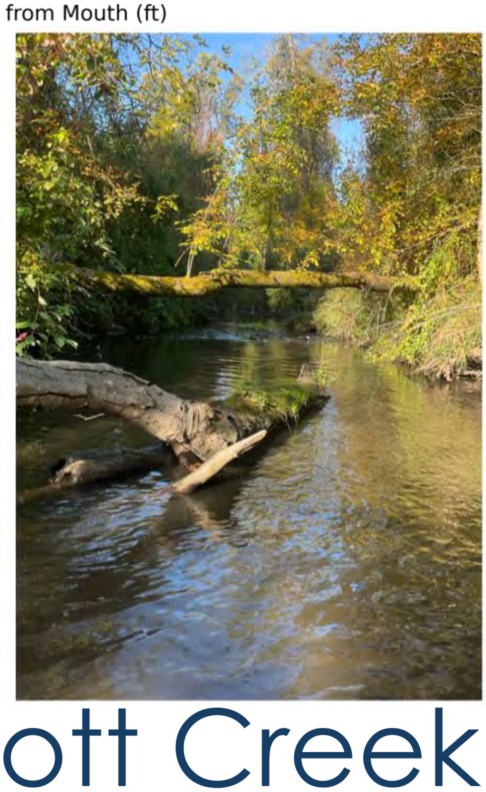


Mt. Scott Creek flows west to its confluence with Kellogg Creek and ultimately into the Willamette River. It passes through both parks and residential areas, with the watershed comprising approximately 86% private and 14% public land.

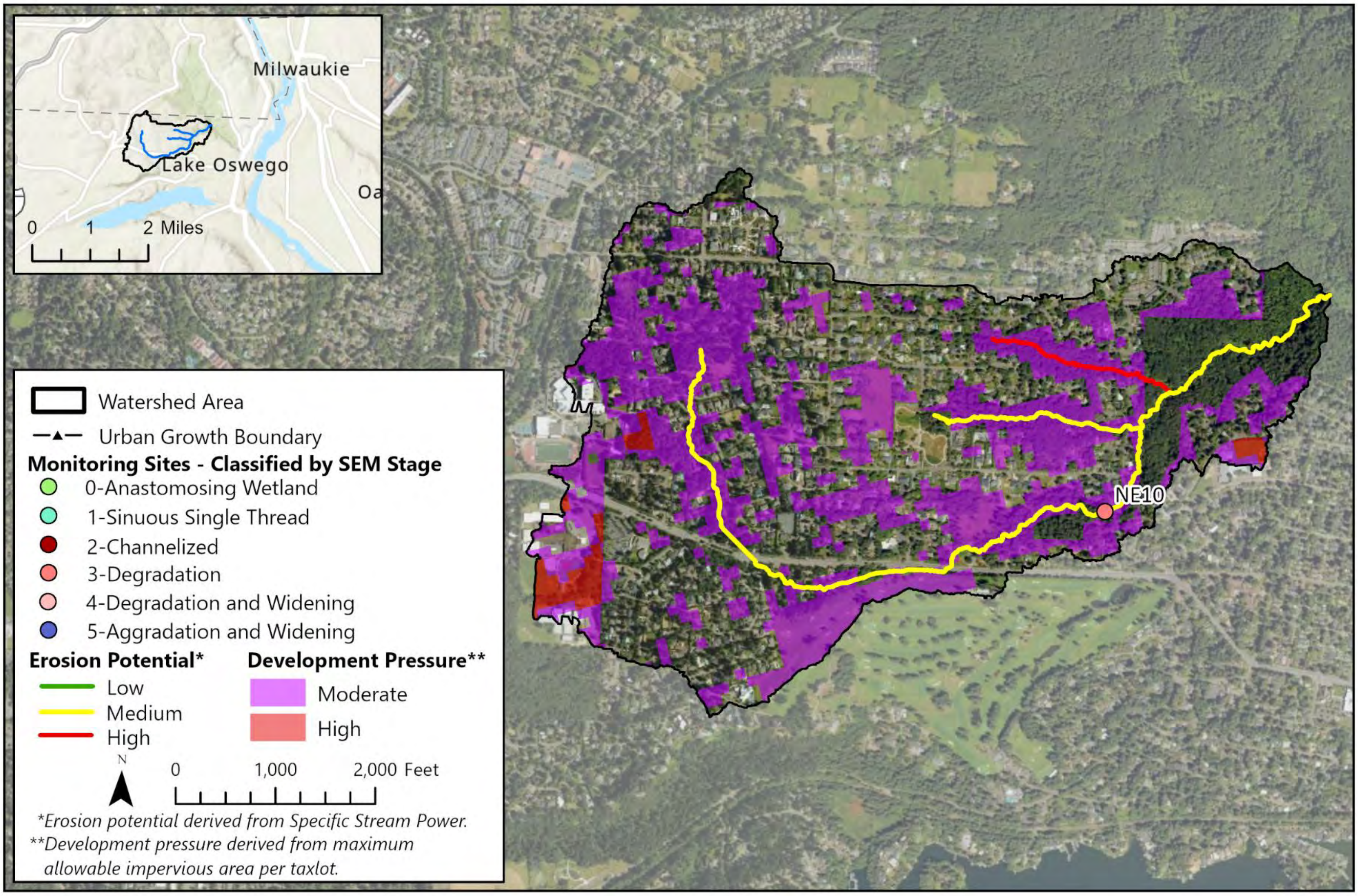
Mt. Scott Creek displays a range of physical conditions, with downstream sections characterized by gentle slopes and broader, more connected floodplains, transitioning to steeper, incised reaches in the headwaters.

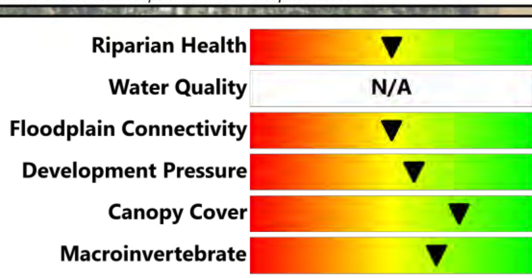
Trend analysis shows macroinvertebrate health has improved at two of three monitored sites, with no notable change in floodplain connectivity since 2021.

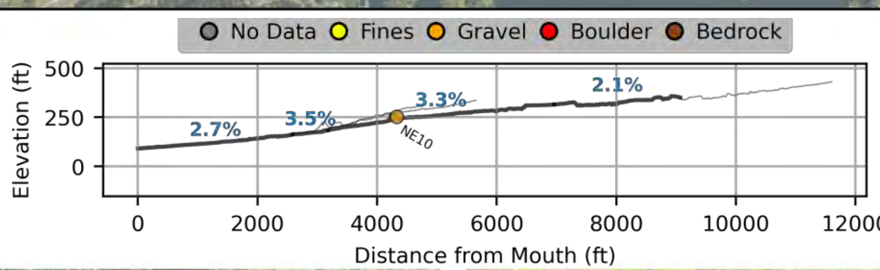




Mt. Scott Creek





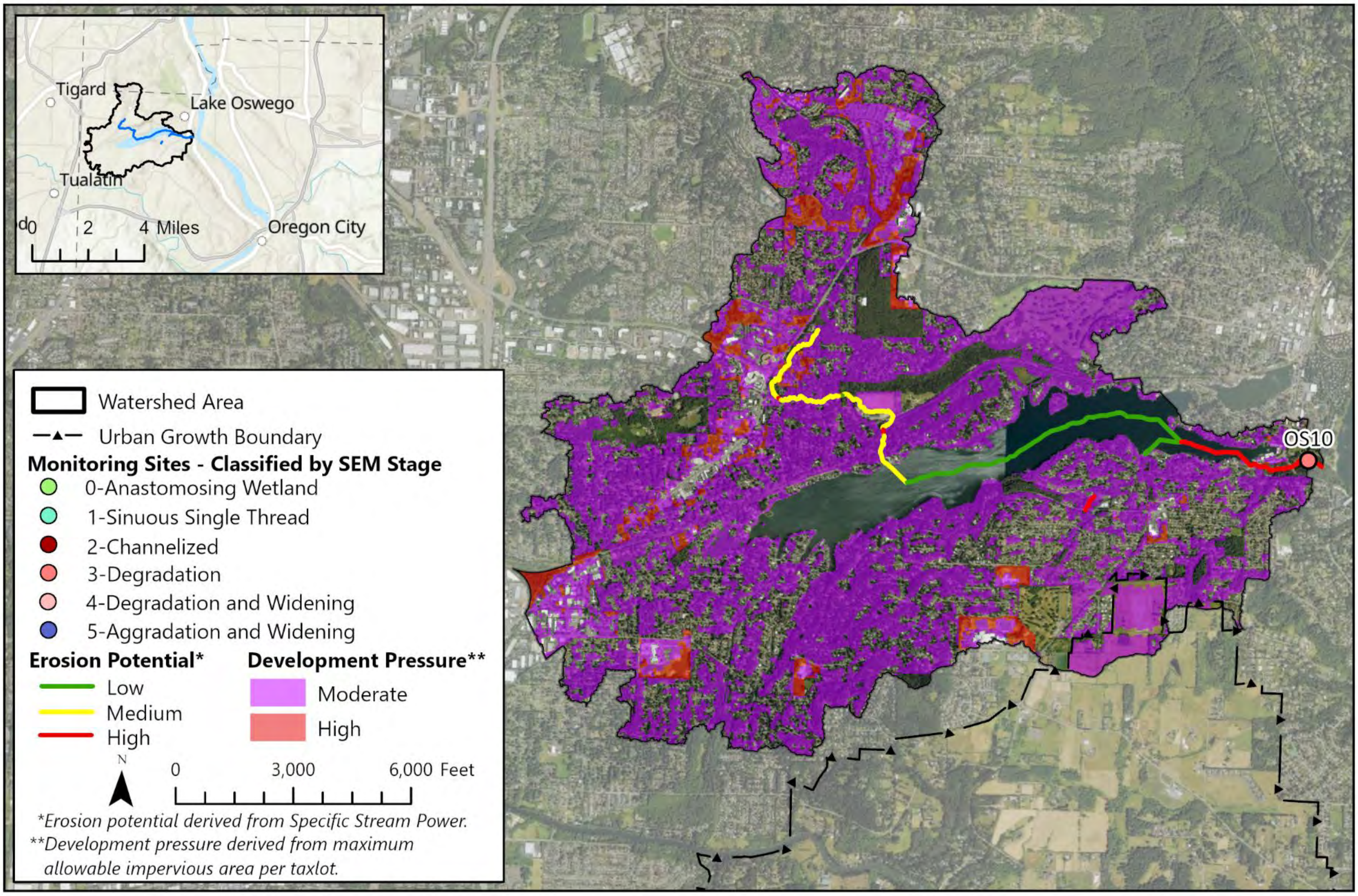


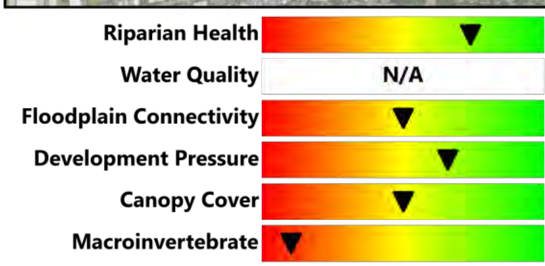
Nettle Creek is a tributary of Tryon Creek that flows through both residential and natural areas. The watershed is approximately 84% private and 16% public land.

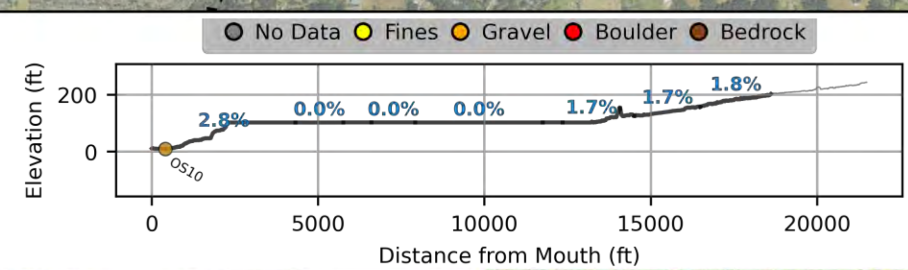
Canopy cover is high throughout the watershed. The site visited in 2024 showed moderate invasive species presence, signs of historic beaver activity, and a culvert contributing to backwatered flow conditions.

Trend analysis indicates a decline in macroinvertebrate health since 2021.

Nettle Creek





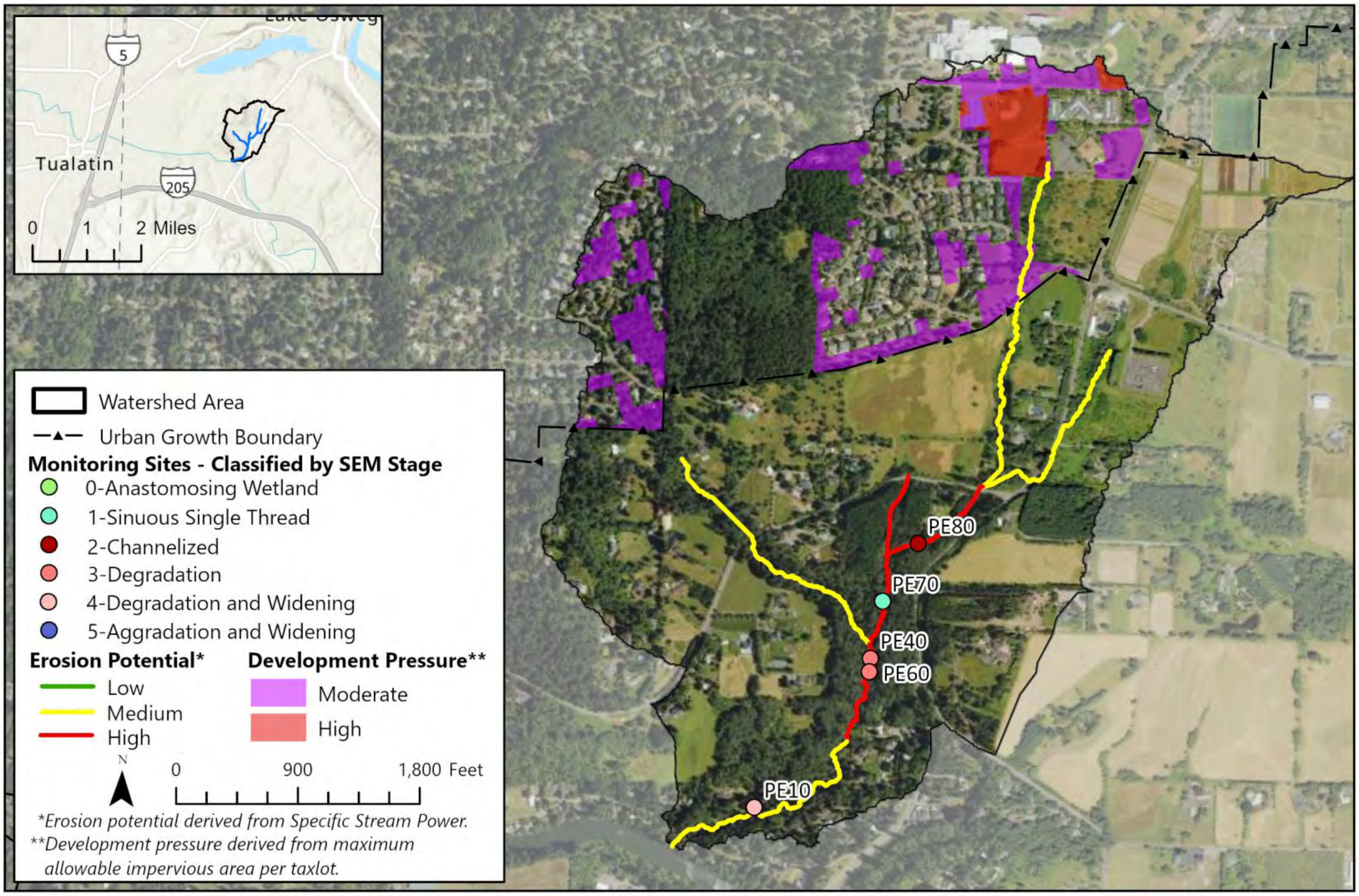


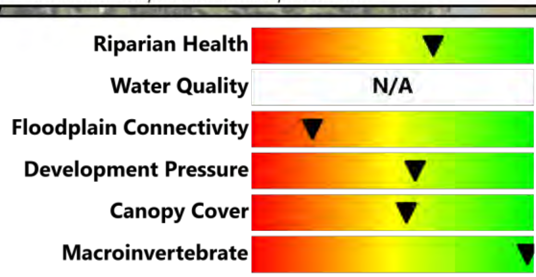
Oswego Creek is a gently sloping tributary of the Willamette River The watershed is approximately 90% private and 10% public land.

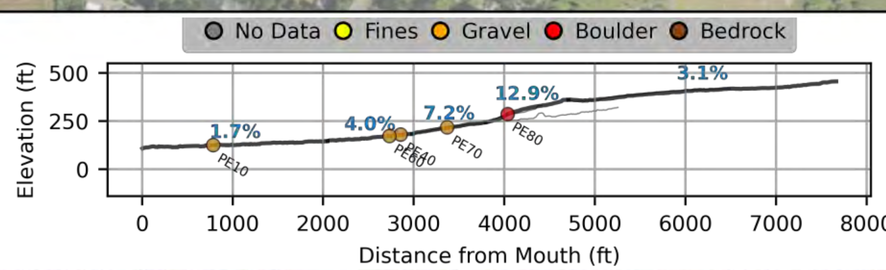
The site visited in 2024 was experiencing backwatered conditions from the Willamette River and there was a decommissioned hydropower structure towards the upstream limits of the reach. The site exhibited moderate floodplain connectivity with minimal invasive vegetation present.

Trend analysis indicates a decline in macroinvertebrate health since 2021.

Oswego Creek



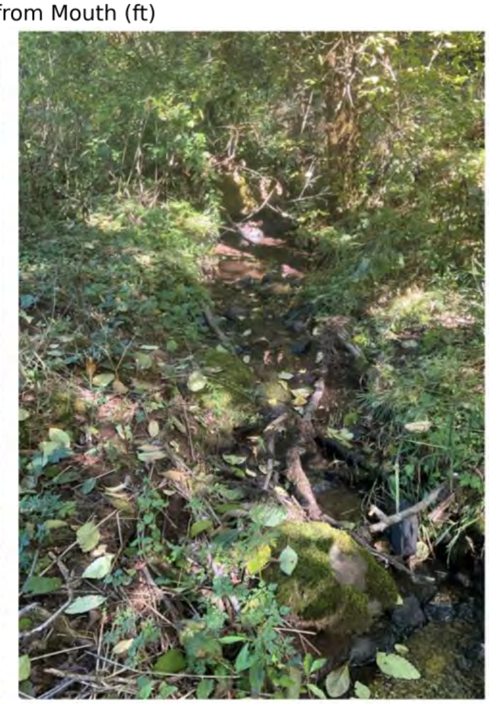




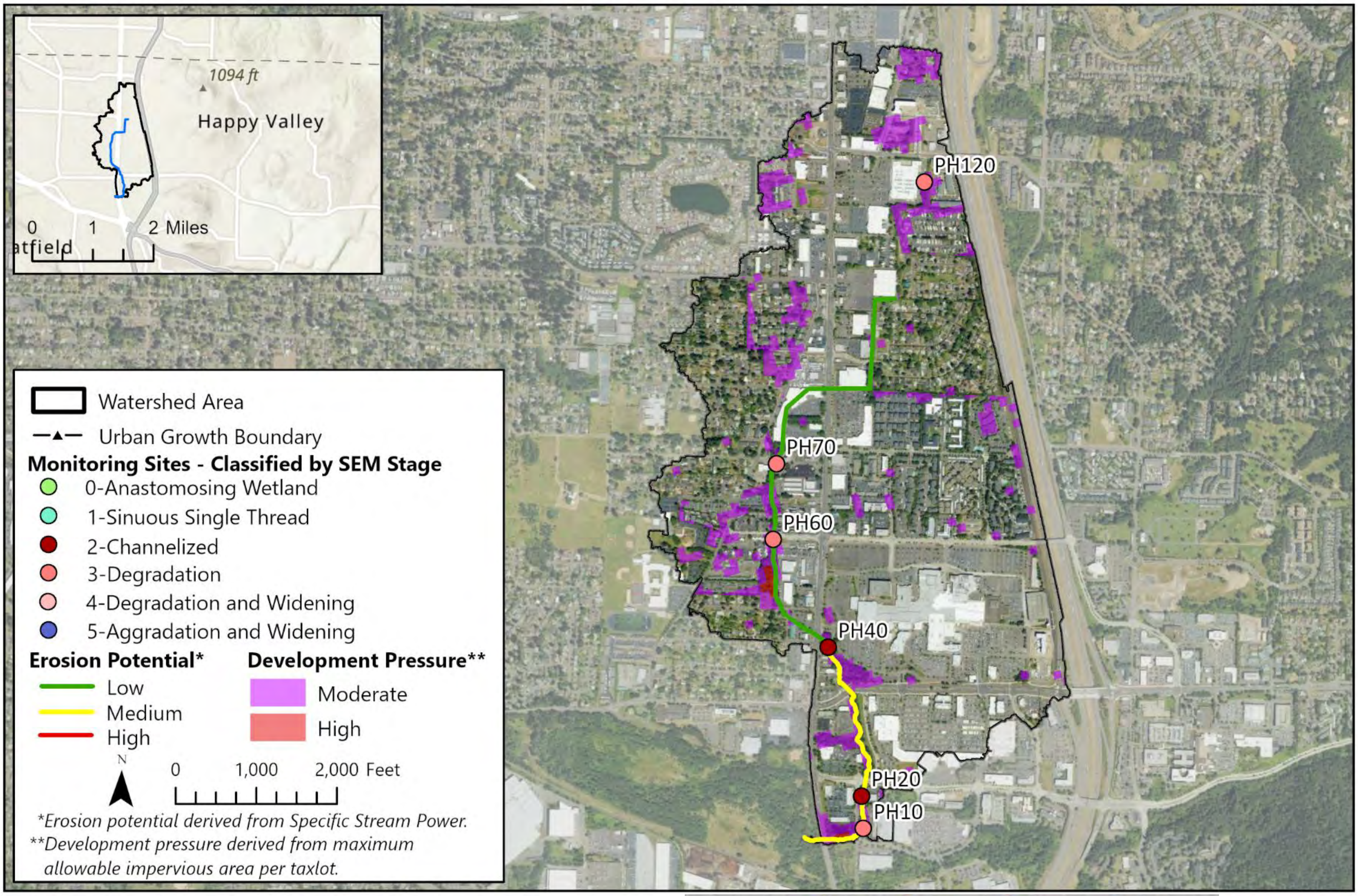
Pecan Creek flows southeast into the Tualatin River. A large portion of the creek flows through Pecan Creek Natural Area and then the Stevens Meadows Natural Area. The watershed is approximately 68% private and 32% public land.

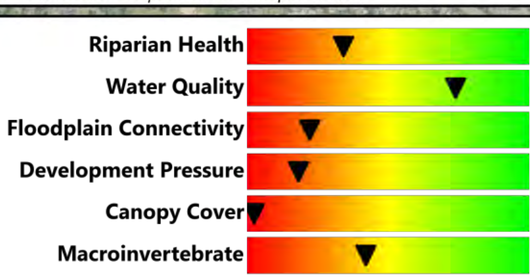
Much of Pecan Creek exhibits confined conditions. Invasive vegetation in the watershed is low and there appears to be adequate recruitment of small and large wood.

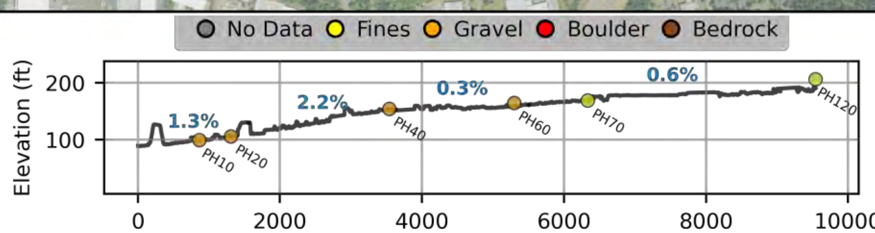
Trend analysis indicates an increase in both macroinvertebrate health and floodplain connectivity since 2021.



Pecan Creek



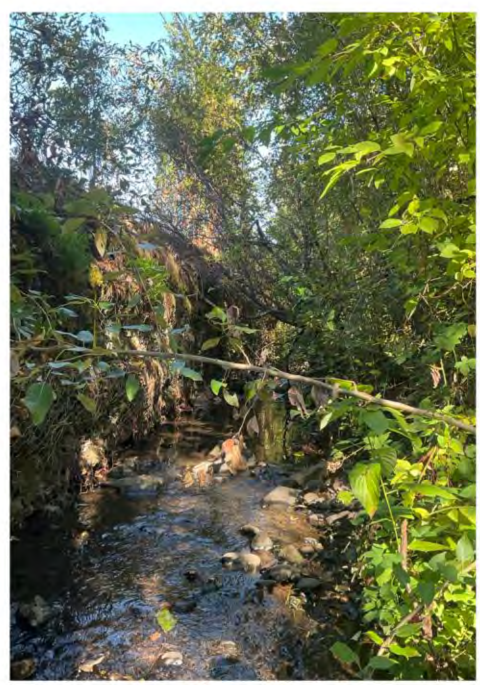




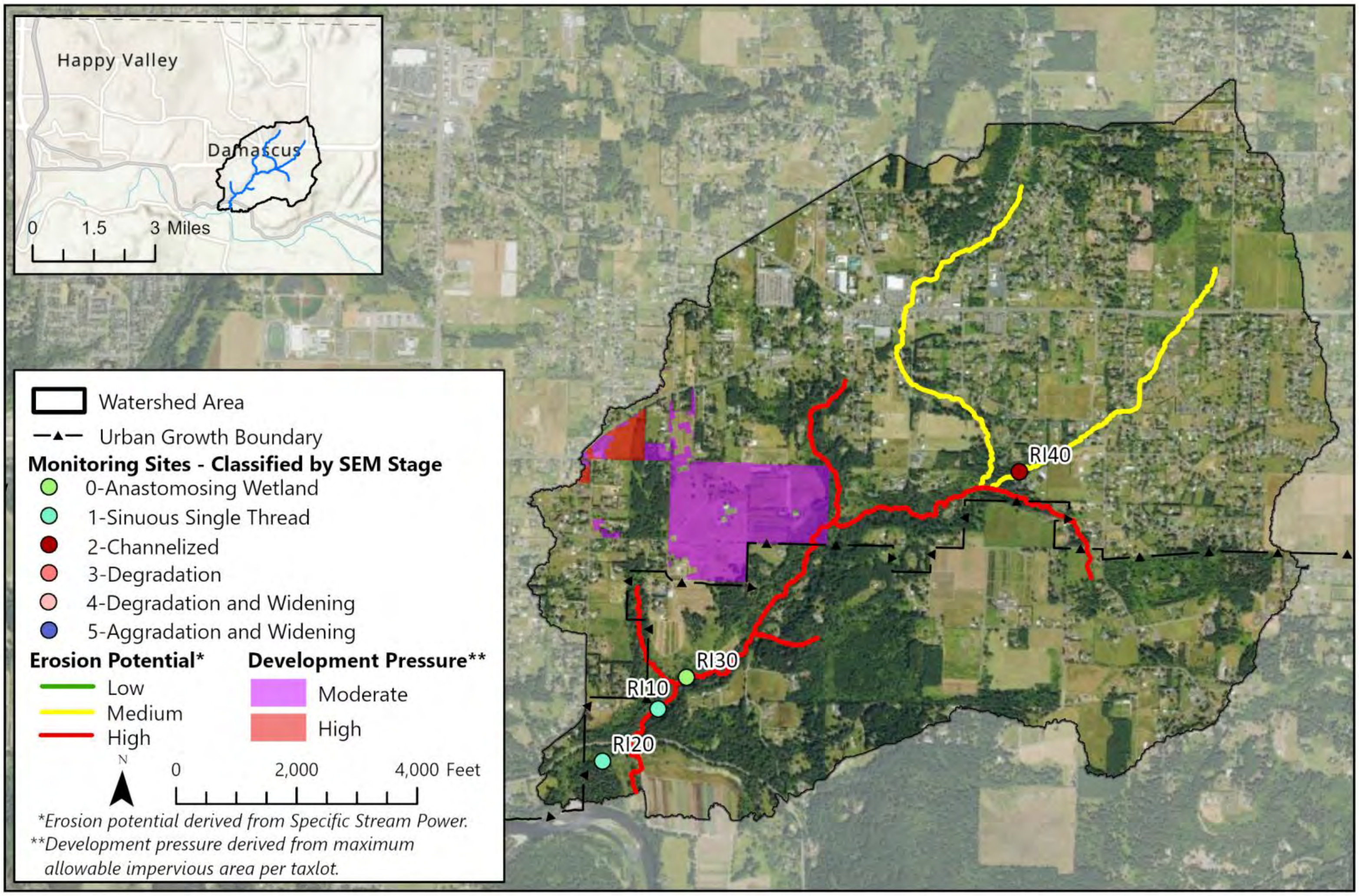
Philips Creek flows south to its confluence with Mt Scott Creek and flows through both commercial and industrial areas. The watershed is approximately 96% private and 4% public land and has the highest impervious area of all monitored watersheds.

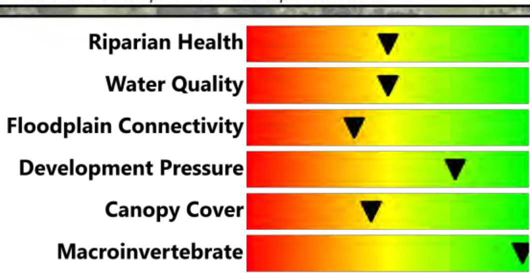
The creek is very straightened and wholly entrenched along its entire length. There is a lot of rip-rap and retaining walls present and canopy cover is very low.

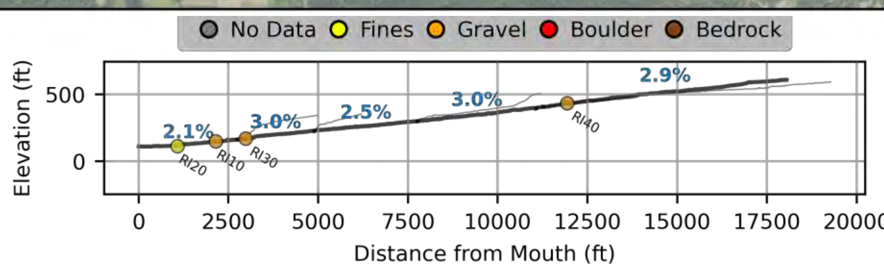
Trend analysis indicates no change in macroinvertebrate health and a decrease in floodplain connectivity since 2021.



Phillips Creek



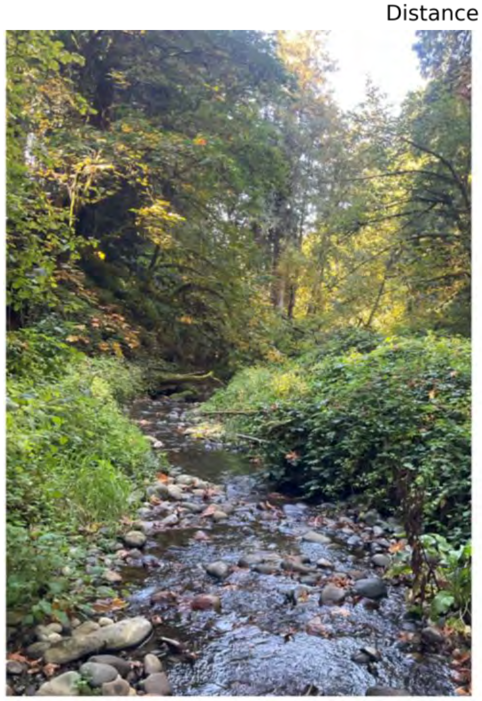




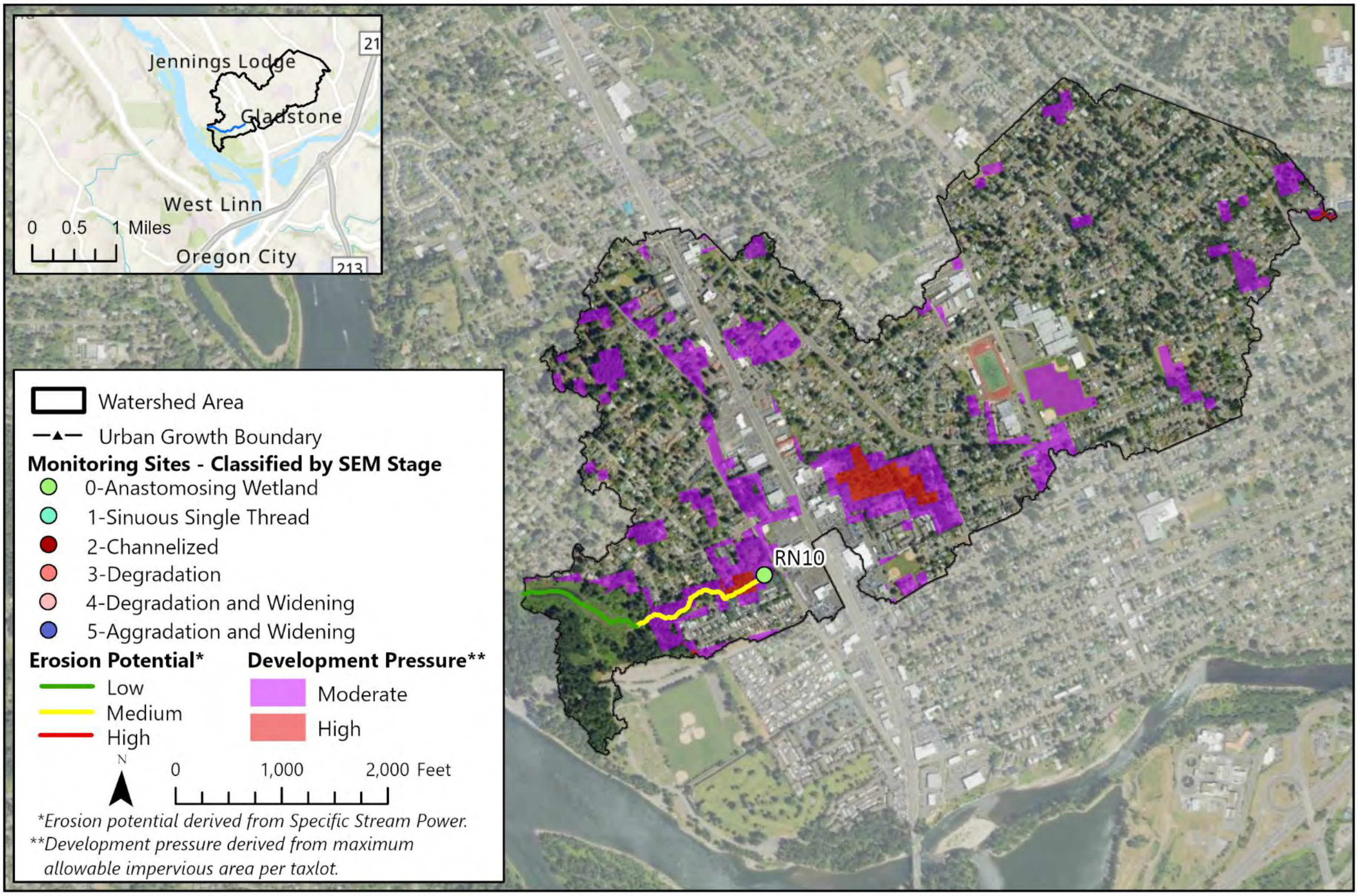
Richarson Creek flows southwest into the Clackamas River. The watershed has moderate impervious coverage and is approximately 97% private and 3% public land.

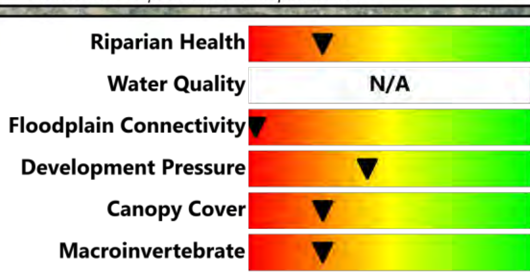
The creek has a consistent slope as it has cut a deep canyon through gravel rich soils. Dissolved oxygen levels are impacting water quality along parts of the creek, but macroinvertebrate health remains high.

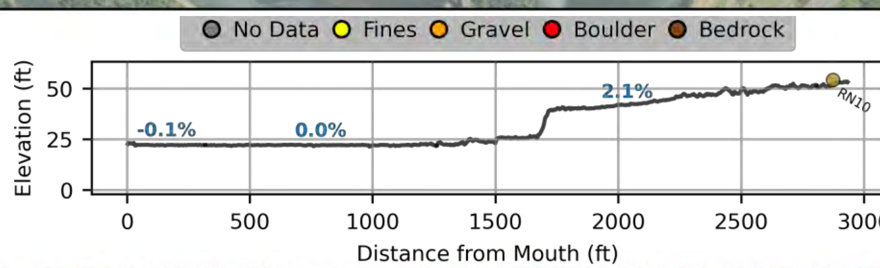
Trend analysis indicates no change in macroinvertebrate health and a decrease in floodplain connectivity since 2021.

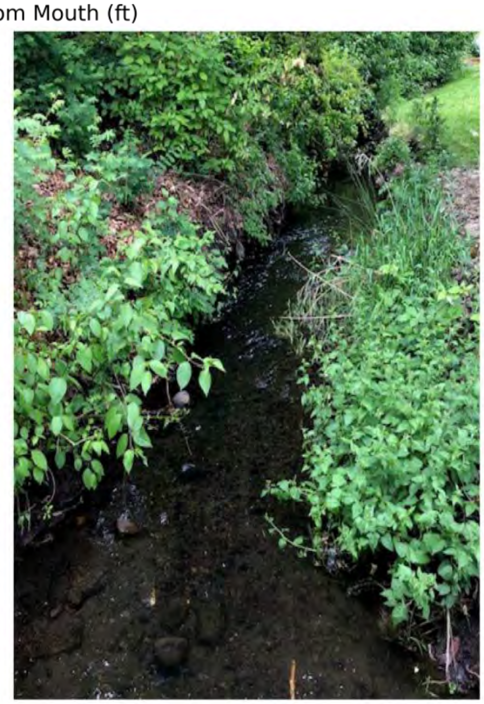


Richardson Creek







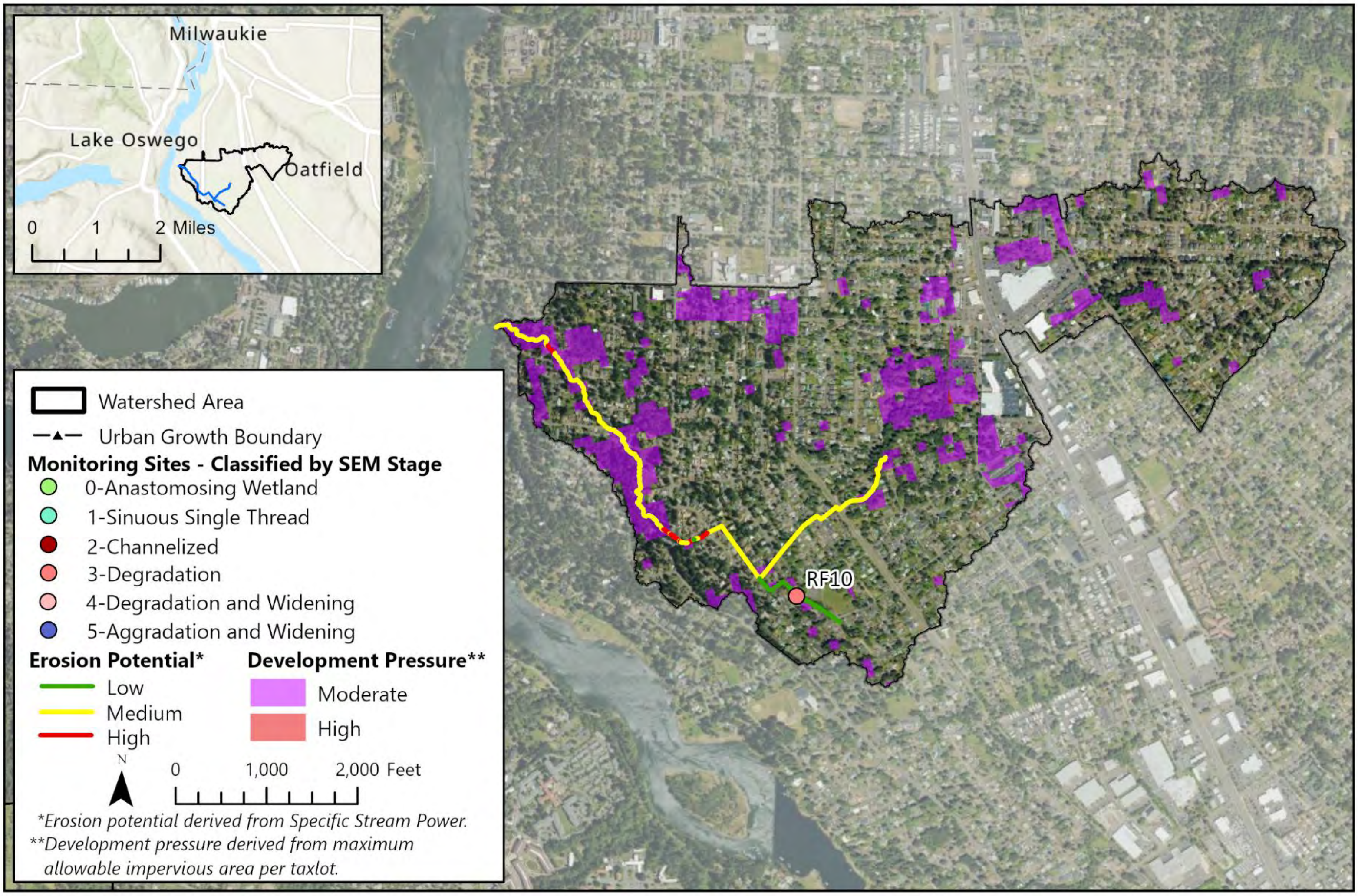


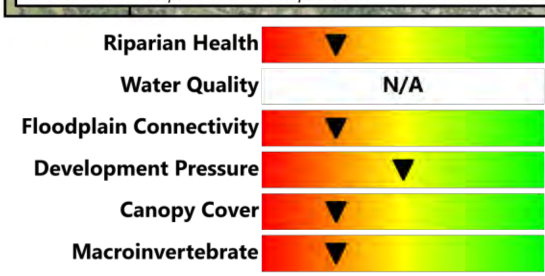
Rinearson Creek flows west into the Willamette River. The downstream portion of the creek is backwatered from the Willamette River and relic water control structures. The watershed has high impervious area and is approximately 86% private and 14% public land.

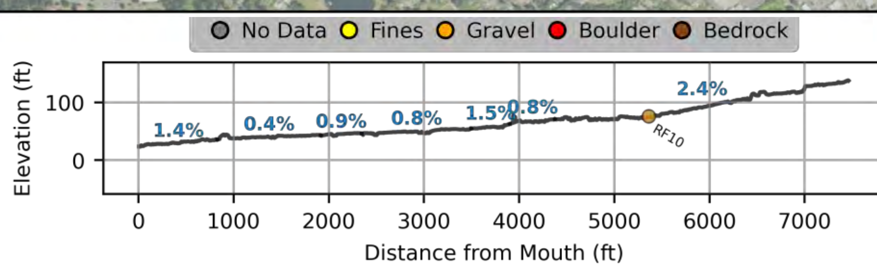
The site visited on Rinearson Creek in 2024 was incised and confined on either side by riprap. Evidence of bank erosion was observed, along with a moderate presence of invasive vegetation.

The trends analysis comparing 2018 and 2024 data found that macroinvertebrate health increased slightly between sampling years.

Rinearson Creek





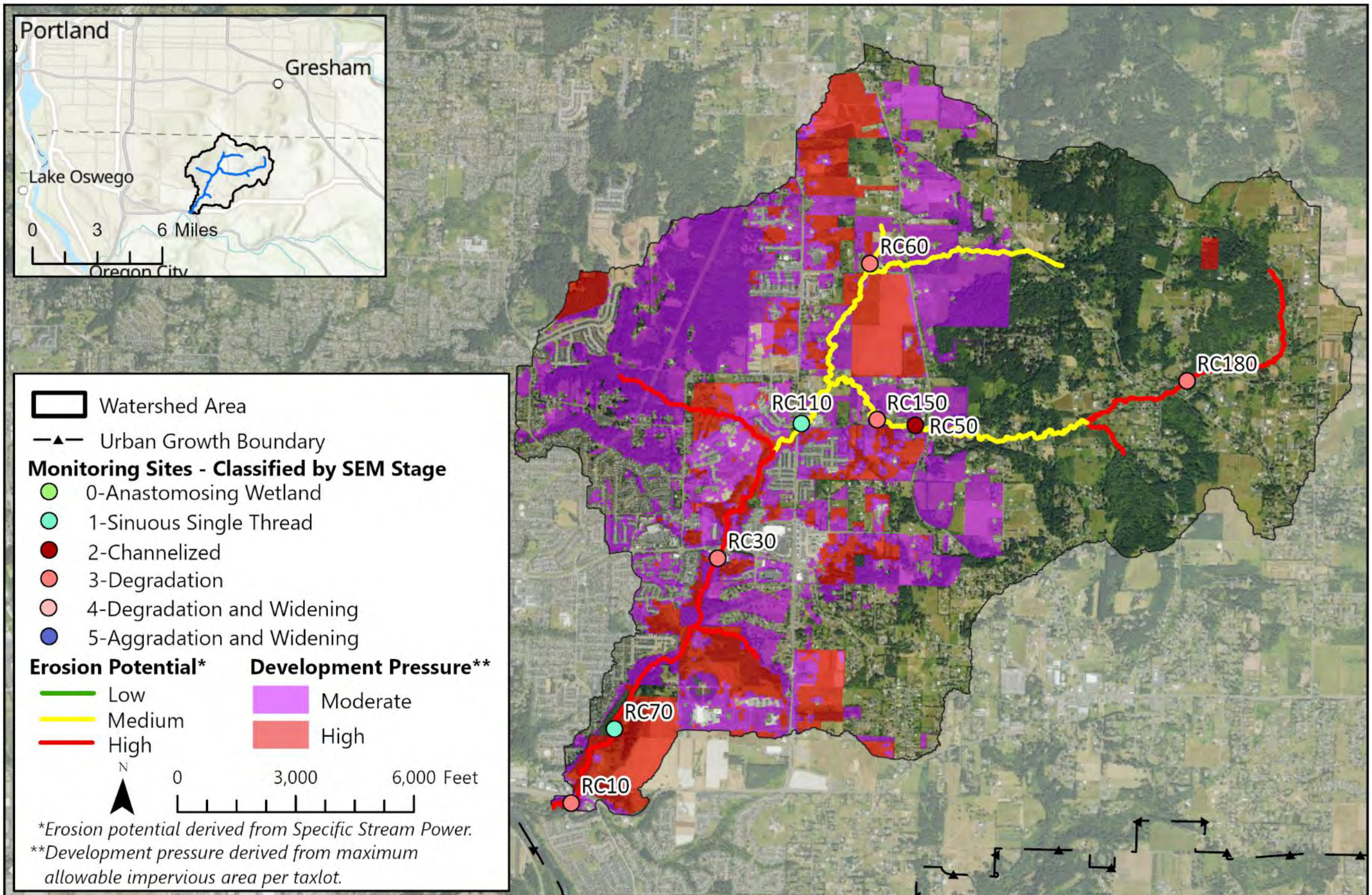


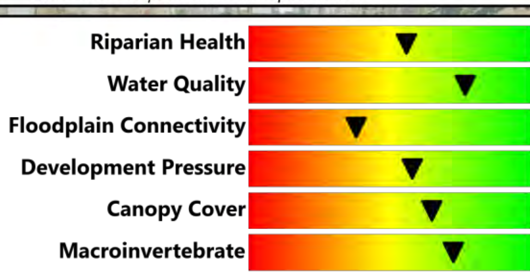
River Forest Creek flows northwest into the River Forest Lake and then the Willamette River. The watershed has high impervious area and is approximately 98% private and 2% public land.

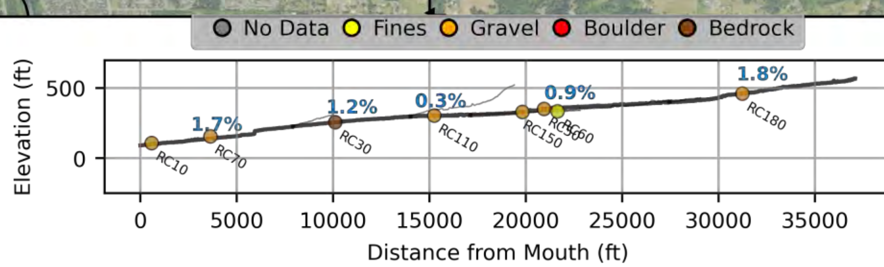
The site visited on River Forest Creek in 2024 was bounded on either end by culverts. The creek was straightened and confined by rip rap on the left bank, resulting in a low degree of floodplain connectivity.

The trends analysis comparing 2018 and 2024 data found that macroinvertebrate health decreased slightly between sampling years.

River Forest Creek





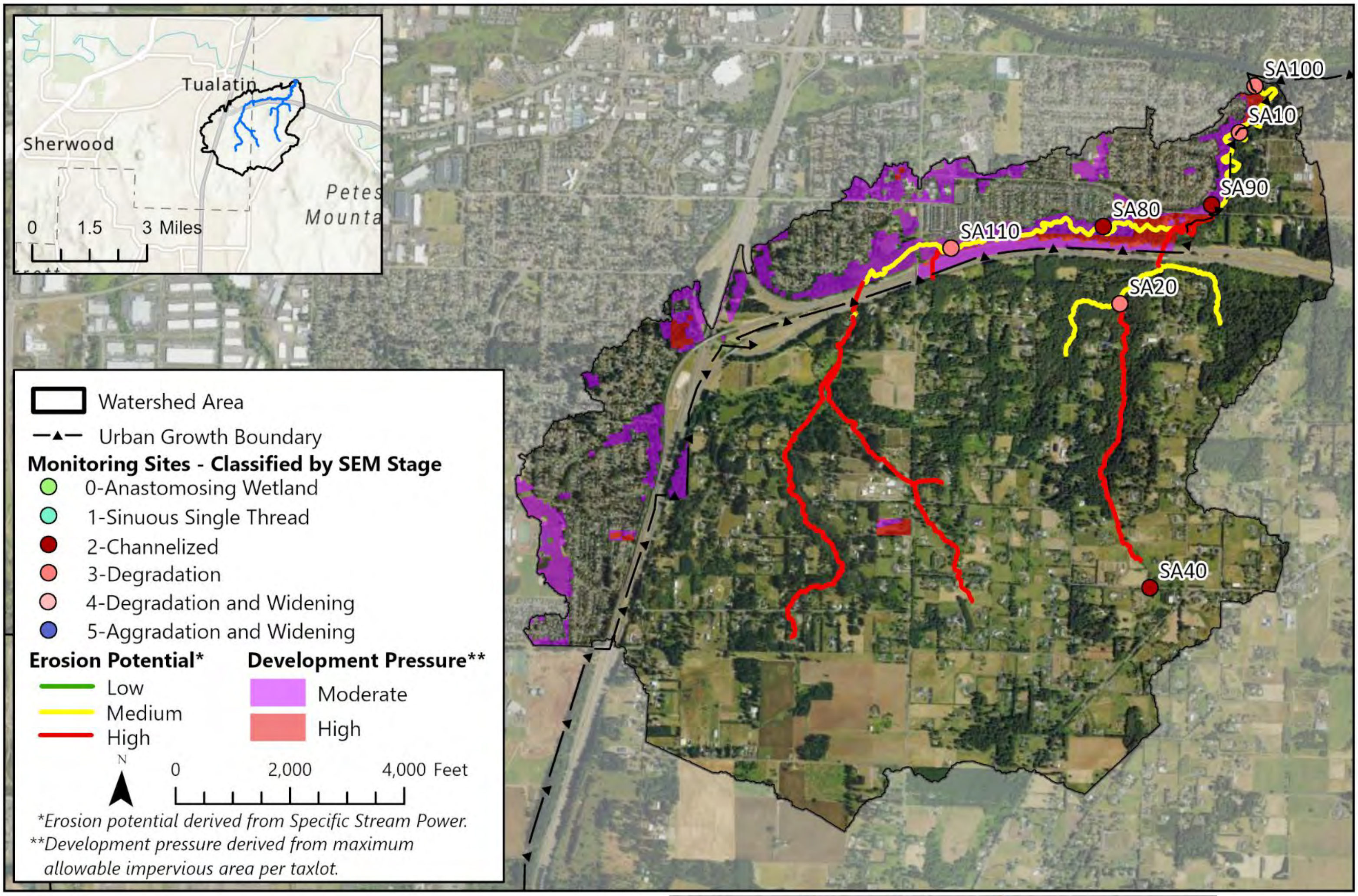


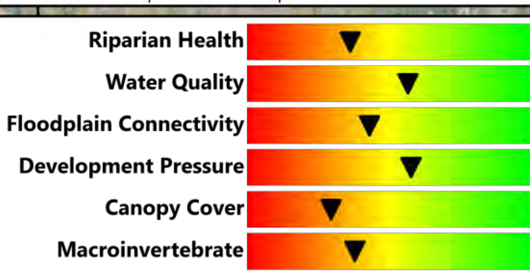
Rock Creek flows southwest into the Clackamas River. The watershed has relatively low impervious area and is approximately 96% private and 4% public land.

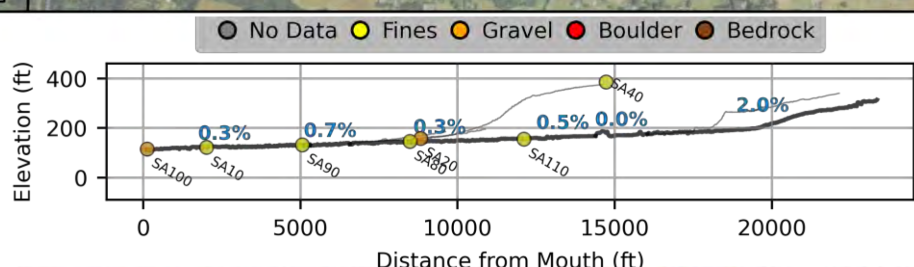
Although Rock Creek includes some low-gradient sections with adequate floodplain access, many areas are incised with some even down to bedrock. Infrastructure was observed at all visited sites, and one site showed evidence of beaver activity.

Trend analysis indicates that 2 of the 3 sites have shown a decline in macroinvertebrate health, but floodplain connectivity has improved since 2021.

Rock Creek



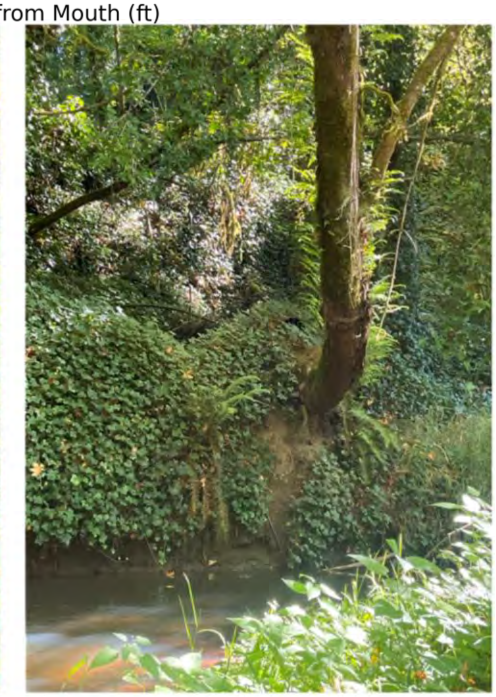




Saum Creek flows north into the Tualatin River. Portions of the creek flow through the Saum Creek Greenway while the rest is mainly residential. The watershed has relatively low impervious area and is approximately 98% private and 2% public land.

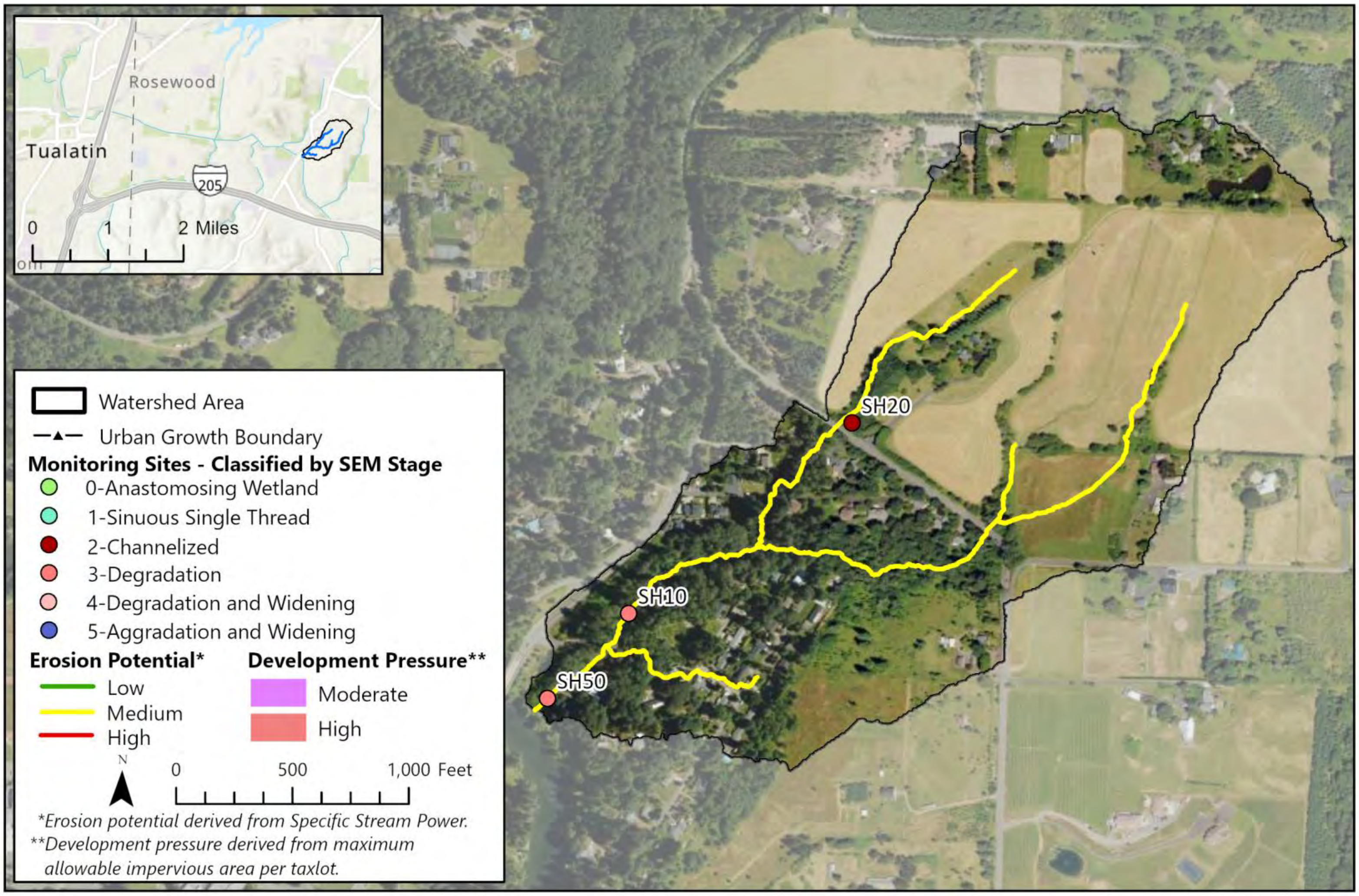
Overall, Saum creek is entrenched and has moderate floodplain connectivity. There are, however, some low gradient portions along I-205 that are less confined.

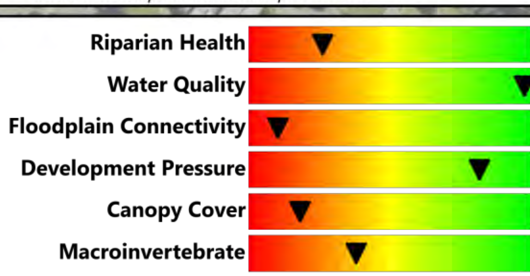
Trend analysis indicates that macroinvertebrate health has increased since 2021, but floodplain connectivity has slightly decreased.

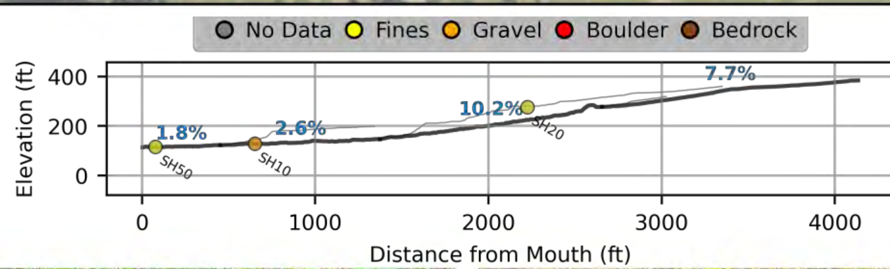


Saum Creek

Shipley Creek



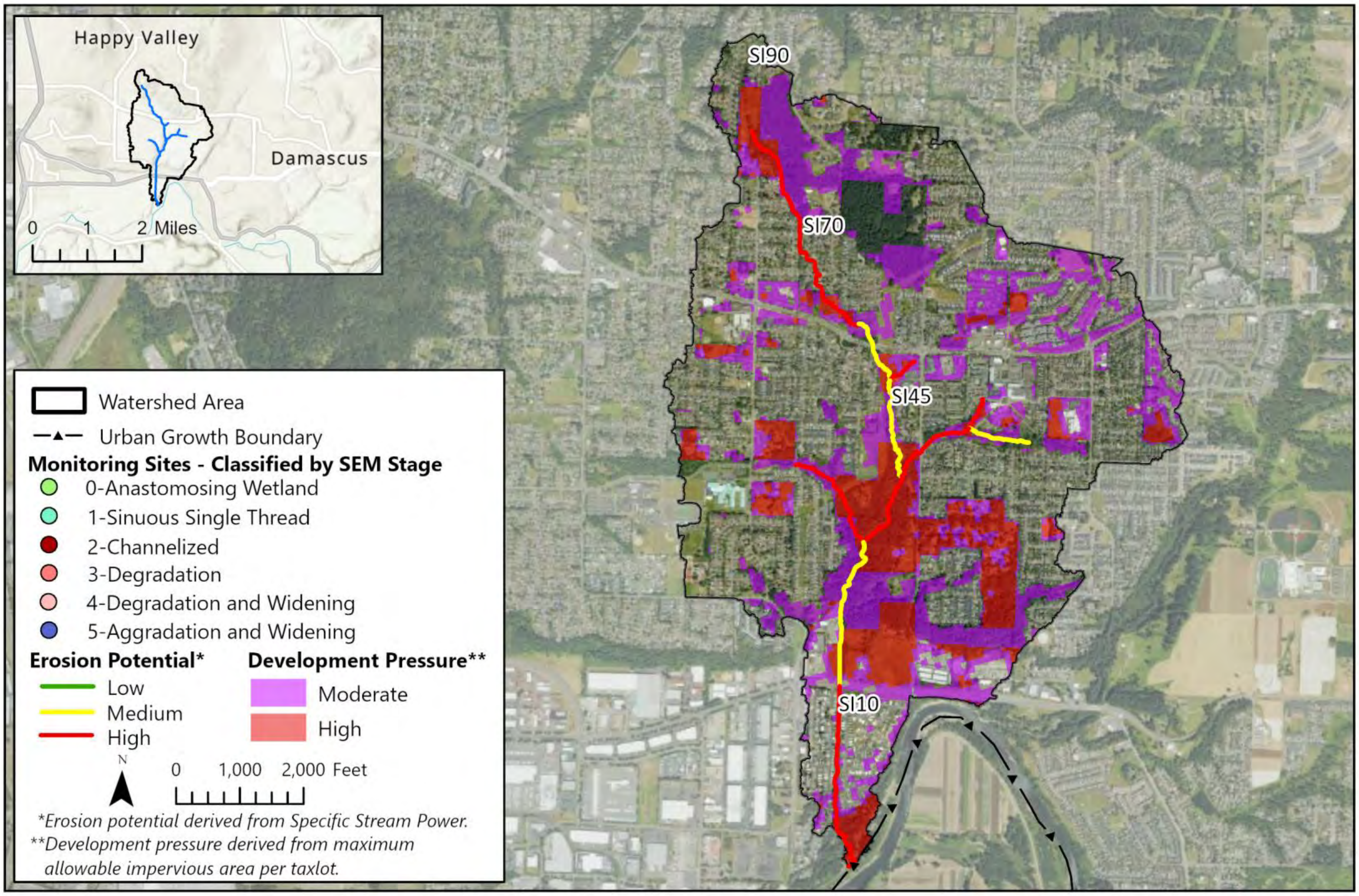


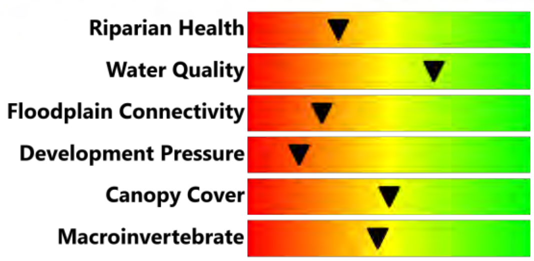


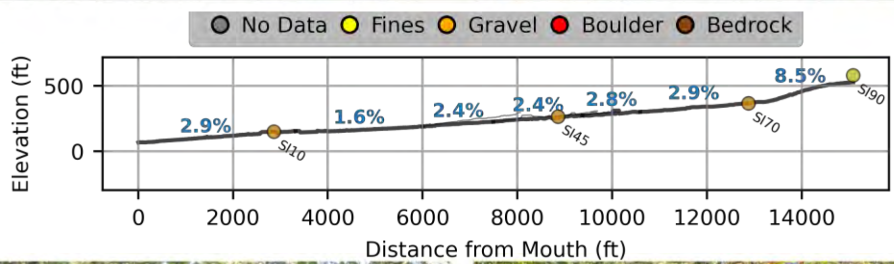
Shipley Creek flows southwest into the Tualatin River. The watershed has low impervious area and is approximately 98% private and 2% public land.

The creek is small and overrun with invasive riparian vegetation, leading to incision and floodplain disconnection. The creek has relatively low flow, with some portions running dry and just holding stagnant water, possibly leading to some of the water quality concerns observed.

Trend analysis indicates that macroinvertebrate health has decreased since 2021, but floodplain connectivity has slightly increased.



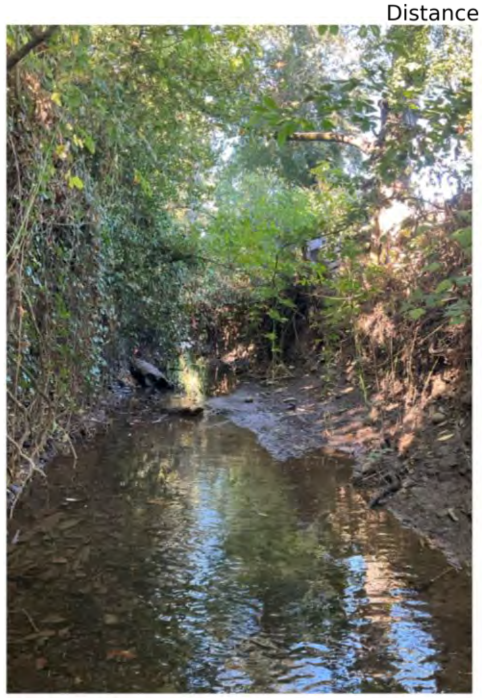




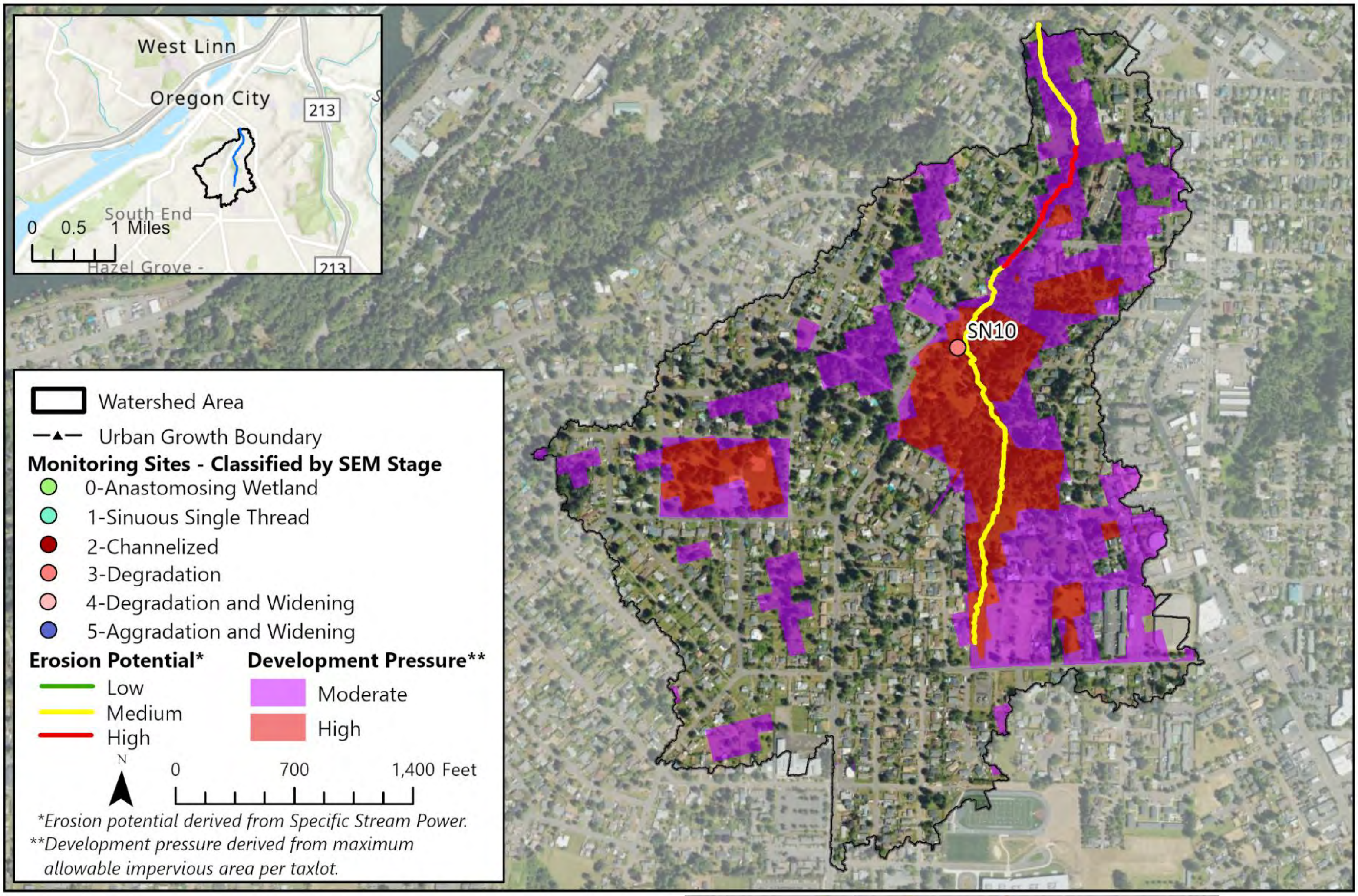
Sieben Creek flows south into the Clackamas River. The watershed has moderate impervious area and is approximately 93% private and 7% public land.

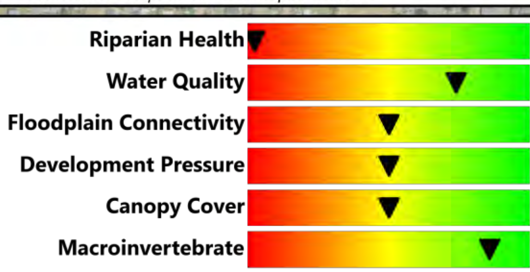
Most of the creek is entrenched and no longer connected to its floodplain. Canopy cover is moderate, but invasive vegetation was present throughout. There are numerous areas of stagnant water and other areas where the creek acts more as a drainage ditch.

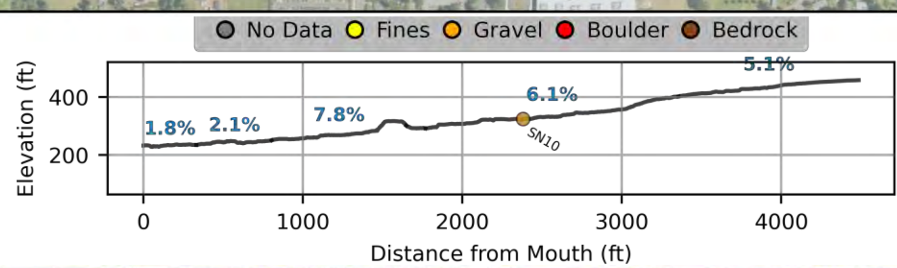
Trend analysis indicates that macroinvertebrate health has decreased since 2021, but floodplain connectivity has slightly increased.



Sieben Creek





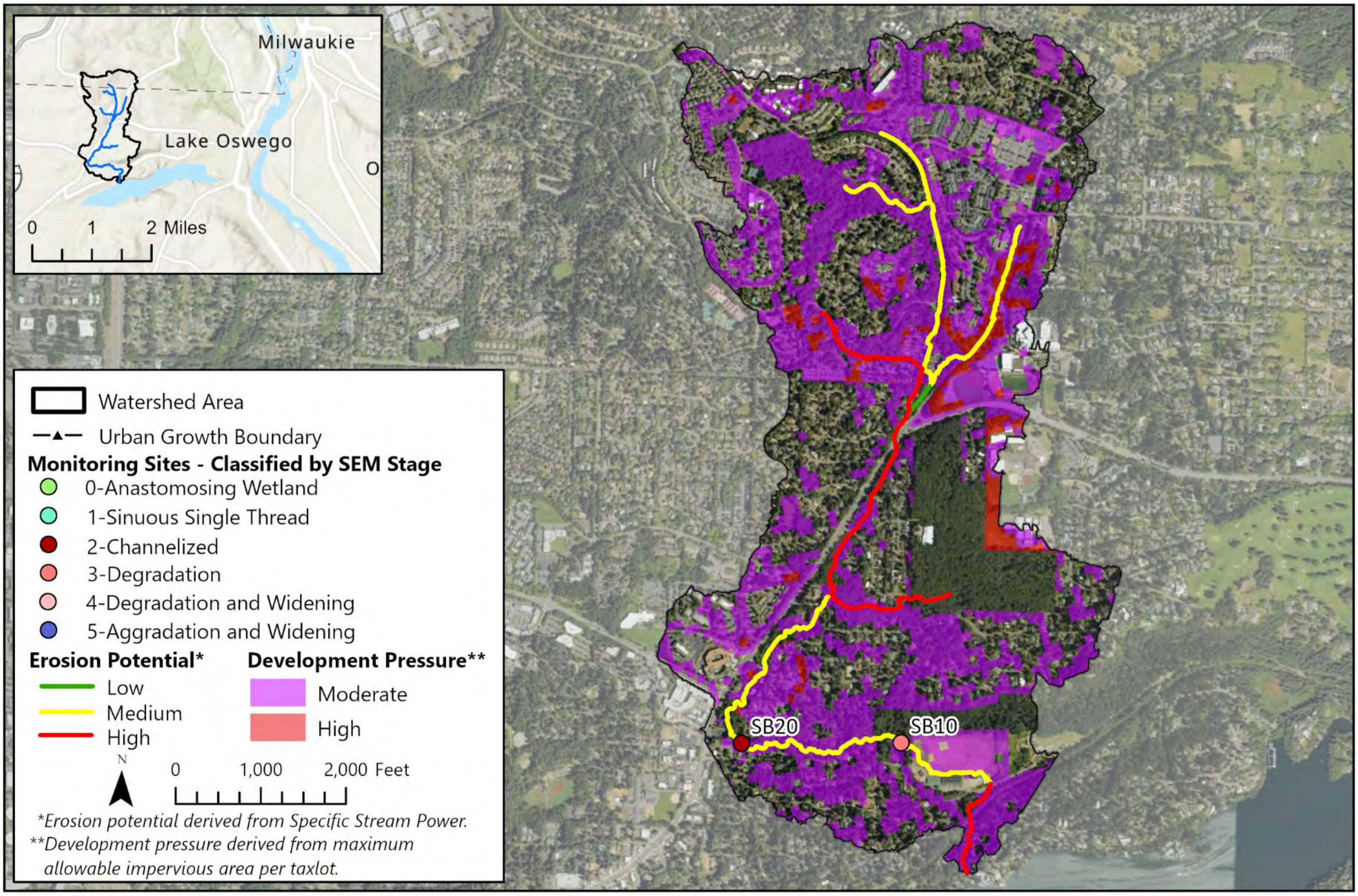


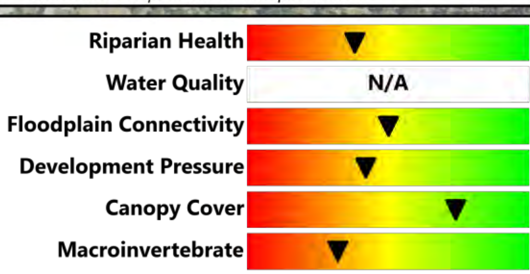
Singer Creek flows north into the Willamette River. Part of the creek flows through Singer Creek Park. The watershed has moderate impervious area and is approximately 86% private and 14% public land.

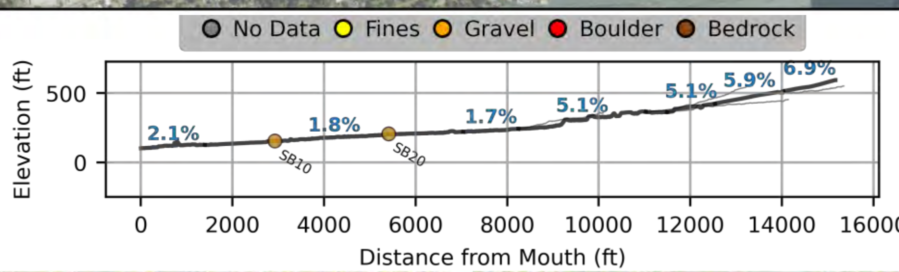
The site visited along Singer Creek in 2024 was dominated by invasive vegetation, particularly knotweed. There was a culvert present, as well as an area where flow went subsurface.

The trends analysis comparing 2018 and 2024 data found that macroinvertebrate health decreased between sampling years.

Singer Creek



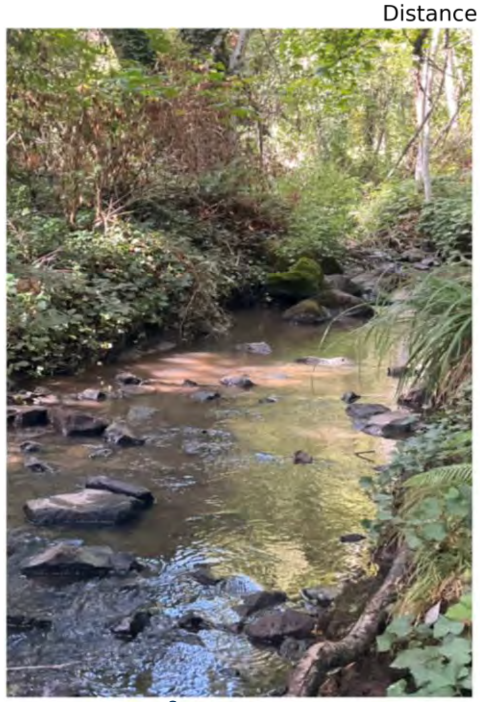


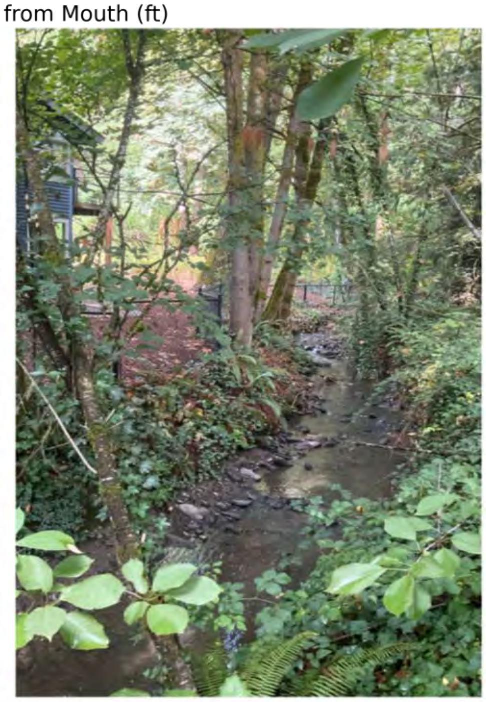


Springbrook Creek flows south into Lake Oswego. Much of the creek flows through parks and natural areas. The watershed has moderate impervious area and is approximately 86% private and 14% public land.

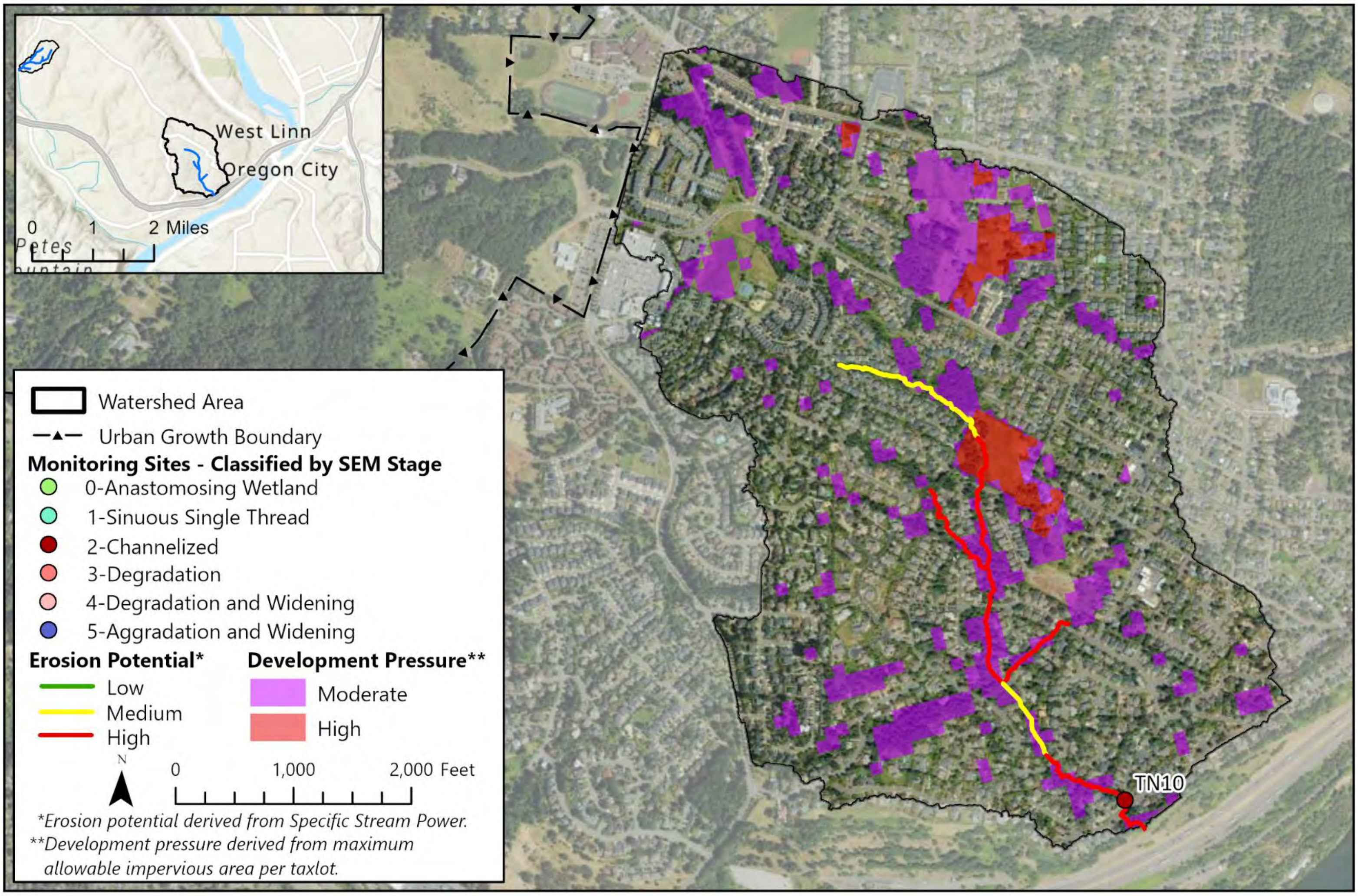
Some portions of Springbrook Creek exhibit higher floodplain connectivity, particularly those portions in natural areas further away from infrastructure.

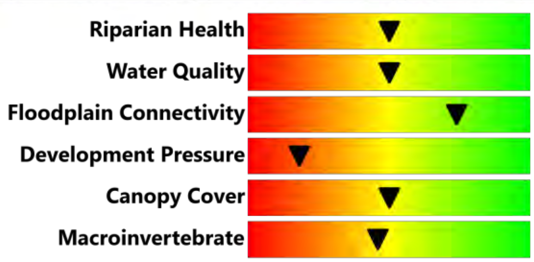
The trends analysis found that macroinvertebrate health increased at one site and decreased at the other as compared to 2021.

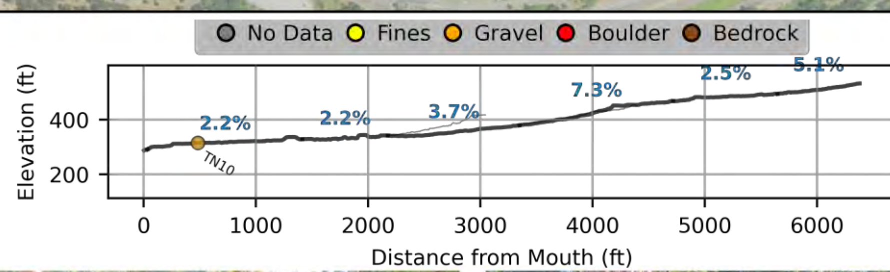




Springbrook Creek





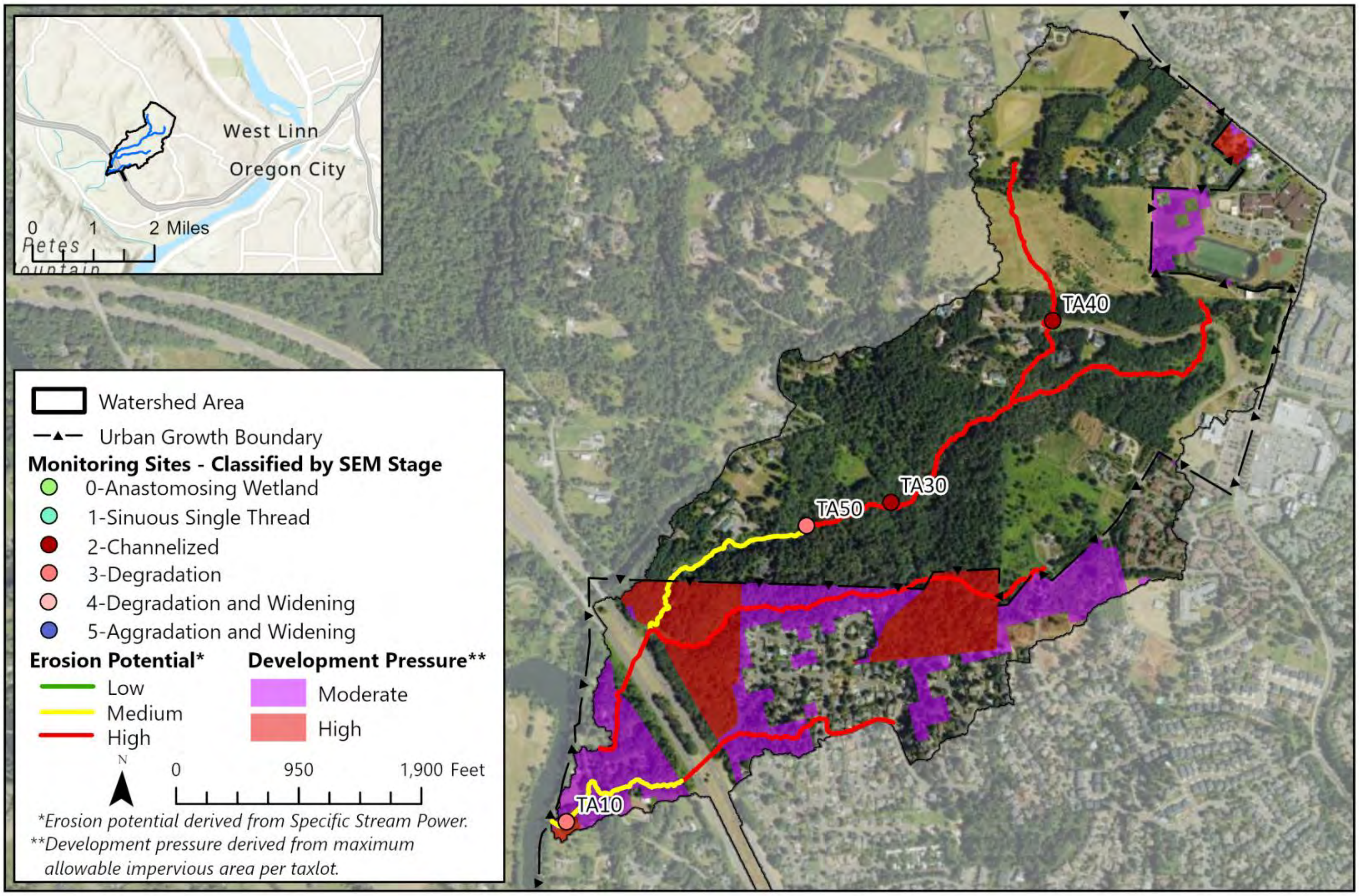


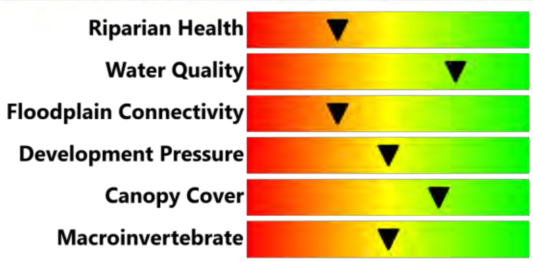
Tanner Creek flows south toward the Willamette River near Willamette Falls Reservoir. The watershed has high impervious area and is approximately 90% private and 10% public land.

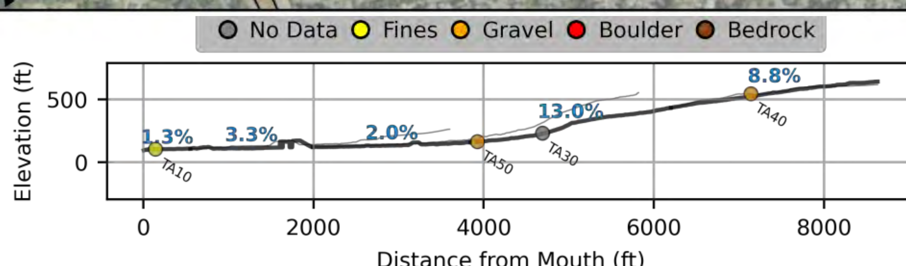
The site visited on Tanner Creek in 2024 showed some signs of degradation due to the proximity of residential yards, but in general displayed a higher degree of floodplain connectivity. Development pressure in the watershed, however, is high.

The trends analysis comparing 2018 and 2024 data found that macroinvertebrate health increased slightly between sampling years.

Tanner Creek





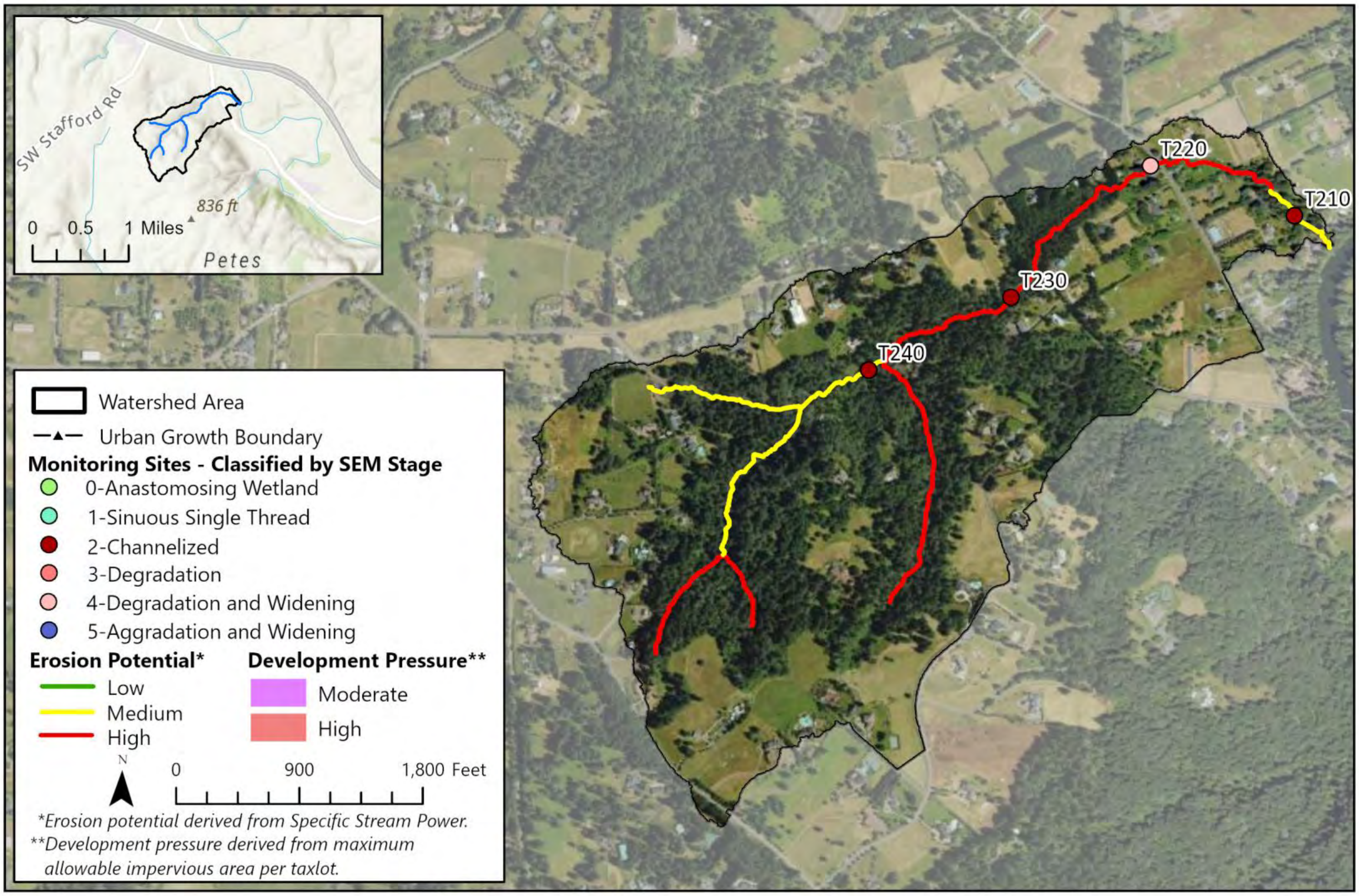


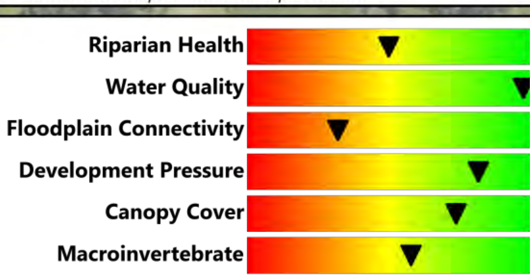
Tate Creek flows south-southwest into the Tualatin River. The watershed has moderate impervious area and is approximately 94% private and 6% public land.

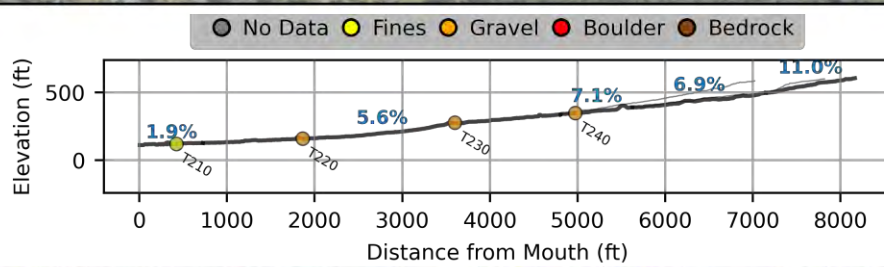
The downstream portions of Tate Creek are backwatered by the Tualatin River, but further upstream in the watershed the creek steepens and has eroded down to bedrock in some locations. The watershed generally has good canopy cover.

Trend analysis indicates that macroinvertebrate health has decreased since 2021, but floodplain connectivity has remained unchanged.

Tate Creek





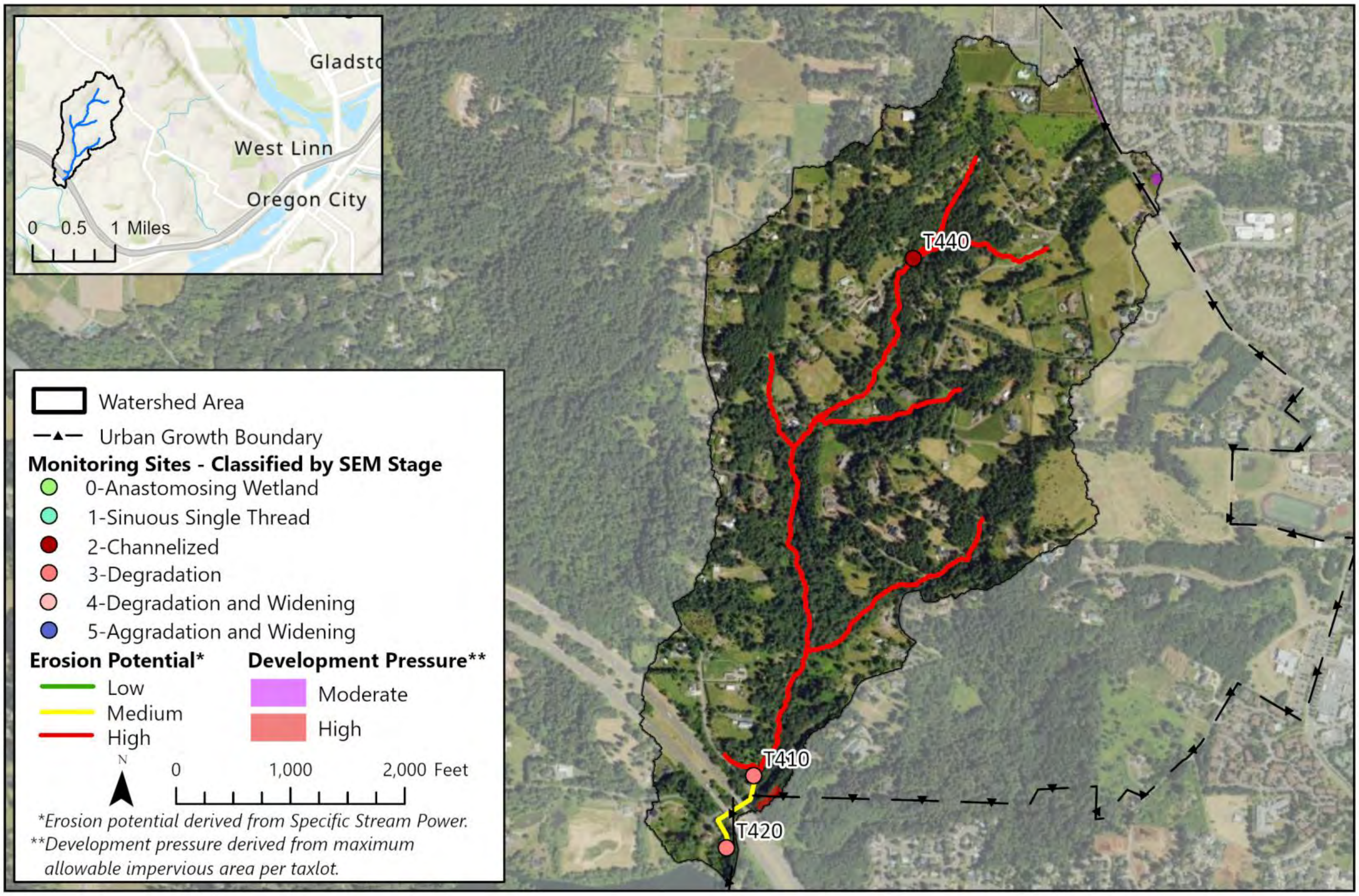


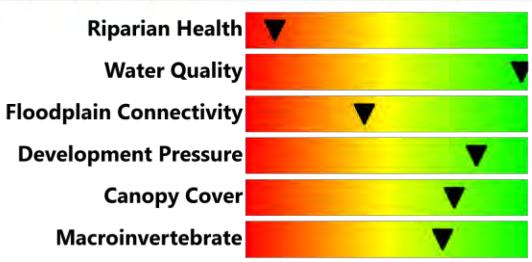
Tributary 2 flows northwest into the Tualatin River. The watershed has low impervious area and is approximately 100% private land.

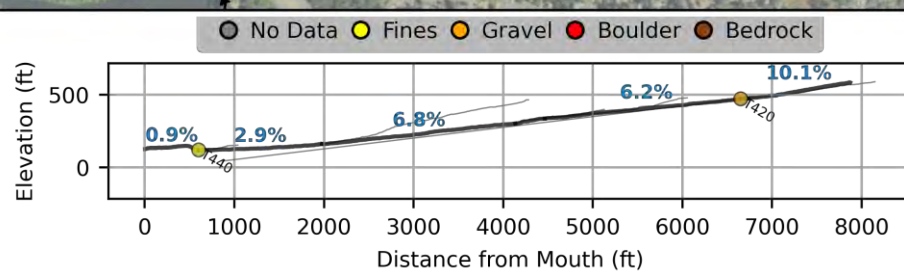
Tributary 2 transitions from a low-gradient, channelized reach downstream to a steep, incised reach upstream. The watershed experiences low development pressure and maintains high canopy cover.

Trend analysis indicates that both macroinvertebrate health and floodplain connectivity have increased since 2021.

Tributary 2



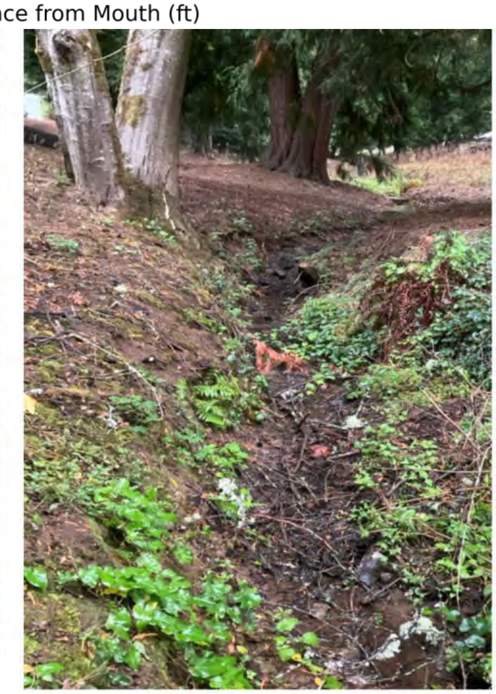




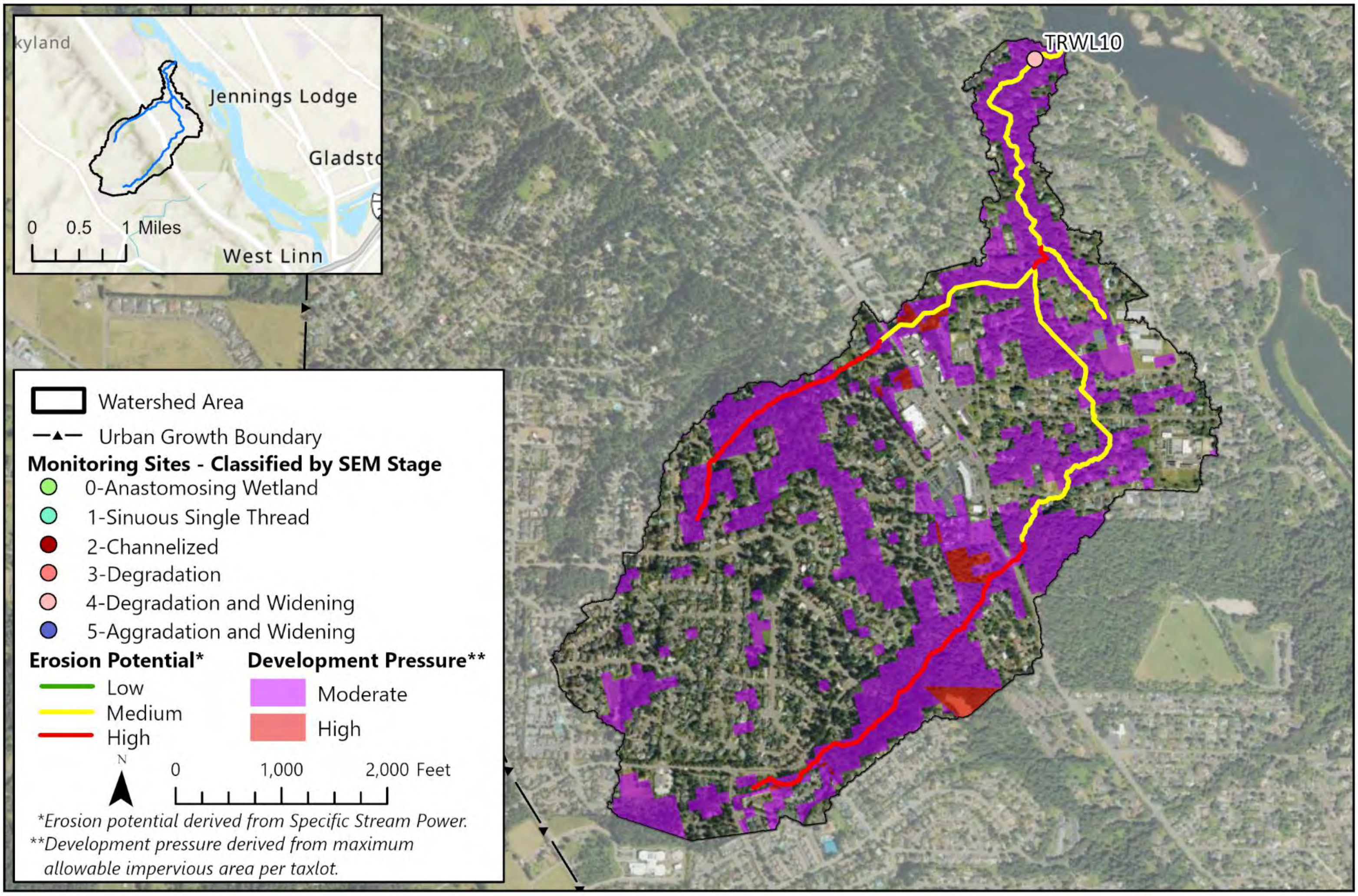
Tributary 4 flows southwest into the Tualatin River. The watershed has moderate impervious area and is approximately 99% private and 1% public land.

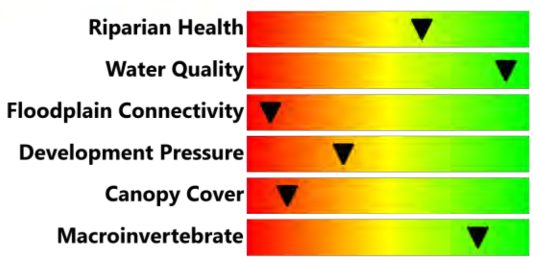
Both sites visited in 2024 exhibited signs of degradation associated with adjacent infrastructure, and in some sections, the creek functioned more like a stormwater ditch. Invasive species were prevalent at both locations. Despite these impacts, the watershed overall experiences low development pressure.

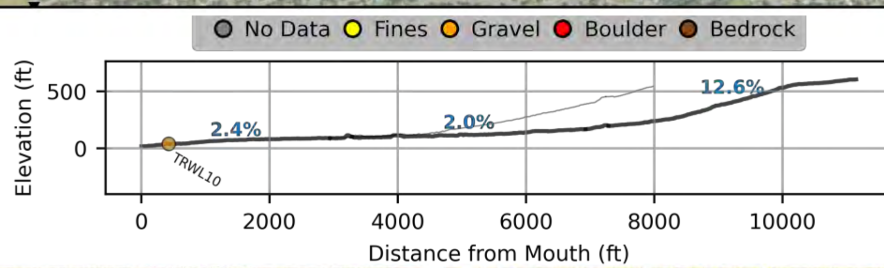
Trend analysis indicates that macroinvertebrate health has improved, and floodplain connectivity has remained unchanged since 2021.



Tributary 4



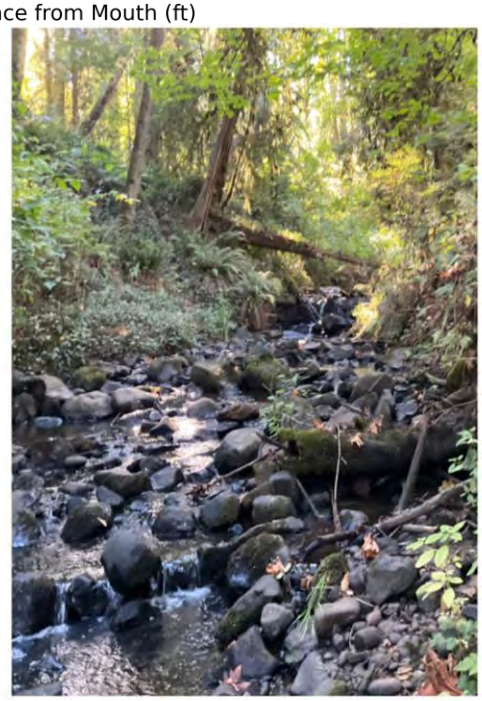




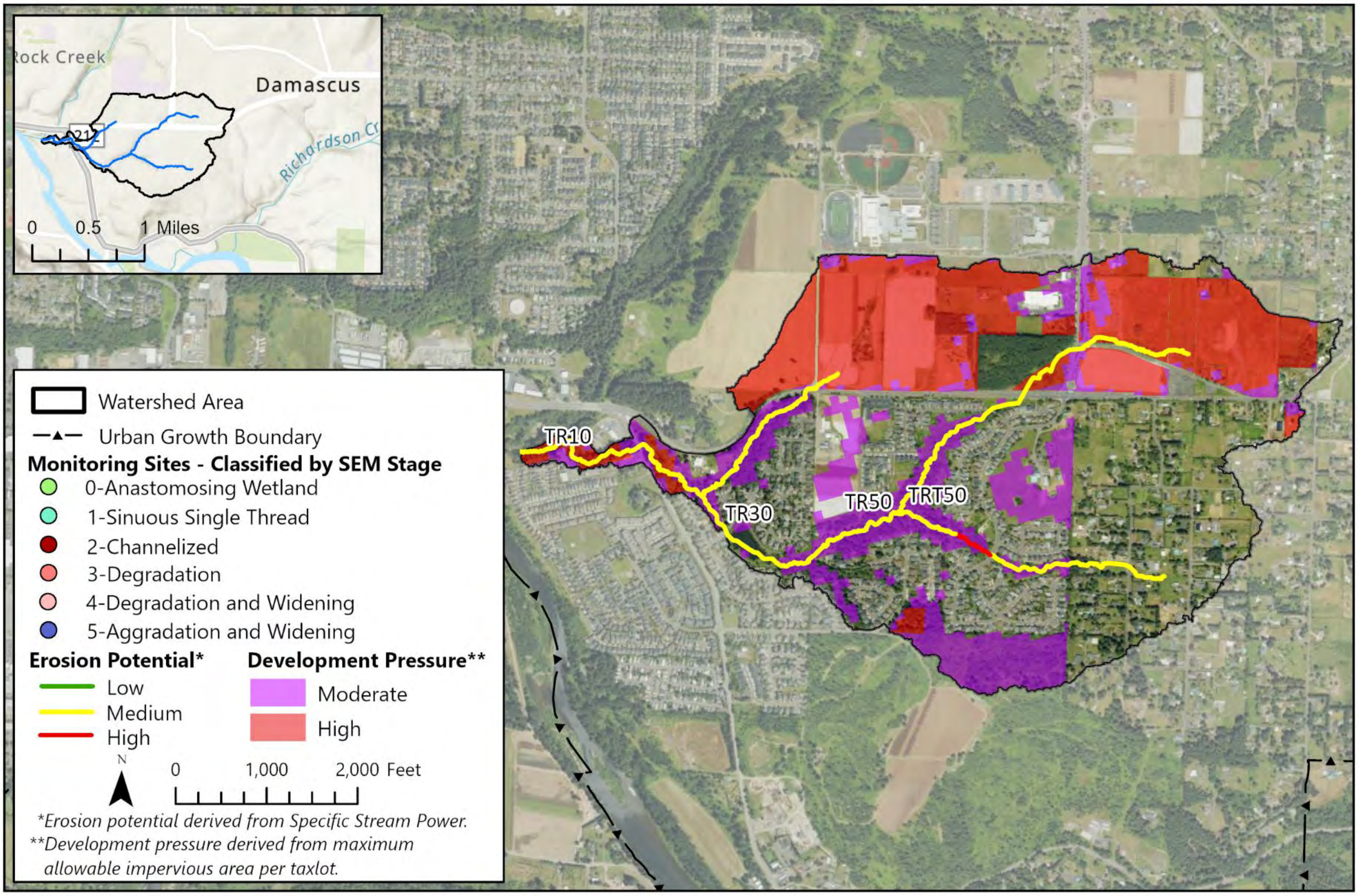
Trillium Creek in West Linn flows north into the Willamette River. The watershed has moderate impervious area and is approximately 75% private and 16% public land.

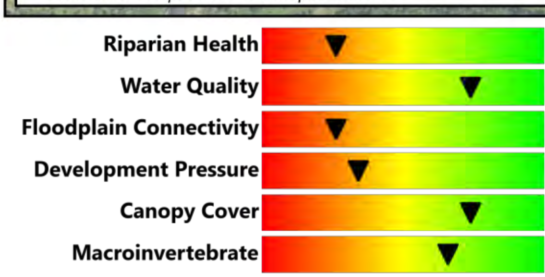
The site visited on the creek was towards the confluence with the Willamette River where there is a series of cascades and accumulation of boulders. The riparian corridor was dominated by blackberry.

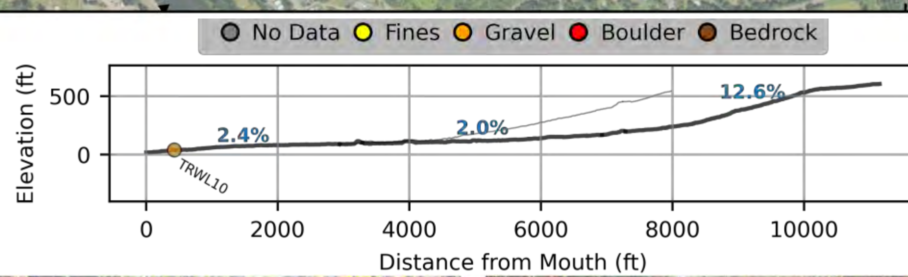
The trends analysis found that macroinvertebrate health has increased since 2018.



Trillium Creek (West Linn)



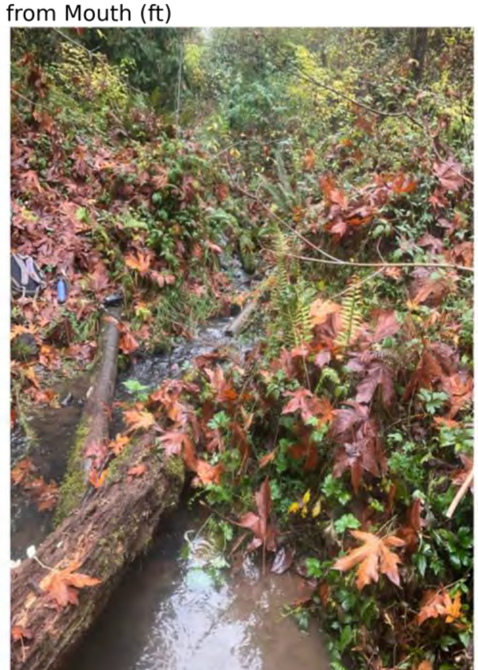




Trillium Creek flows west to its confluence with Rock Creek just upstream of the Clackamas River. The watershed has moderate impervious area and is approximately 94% private and 6% public land.

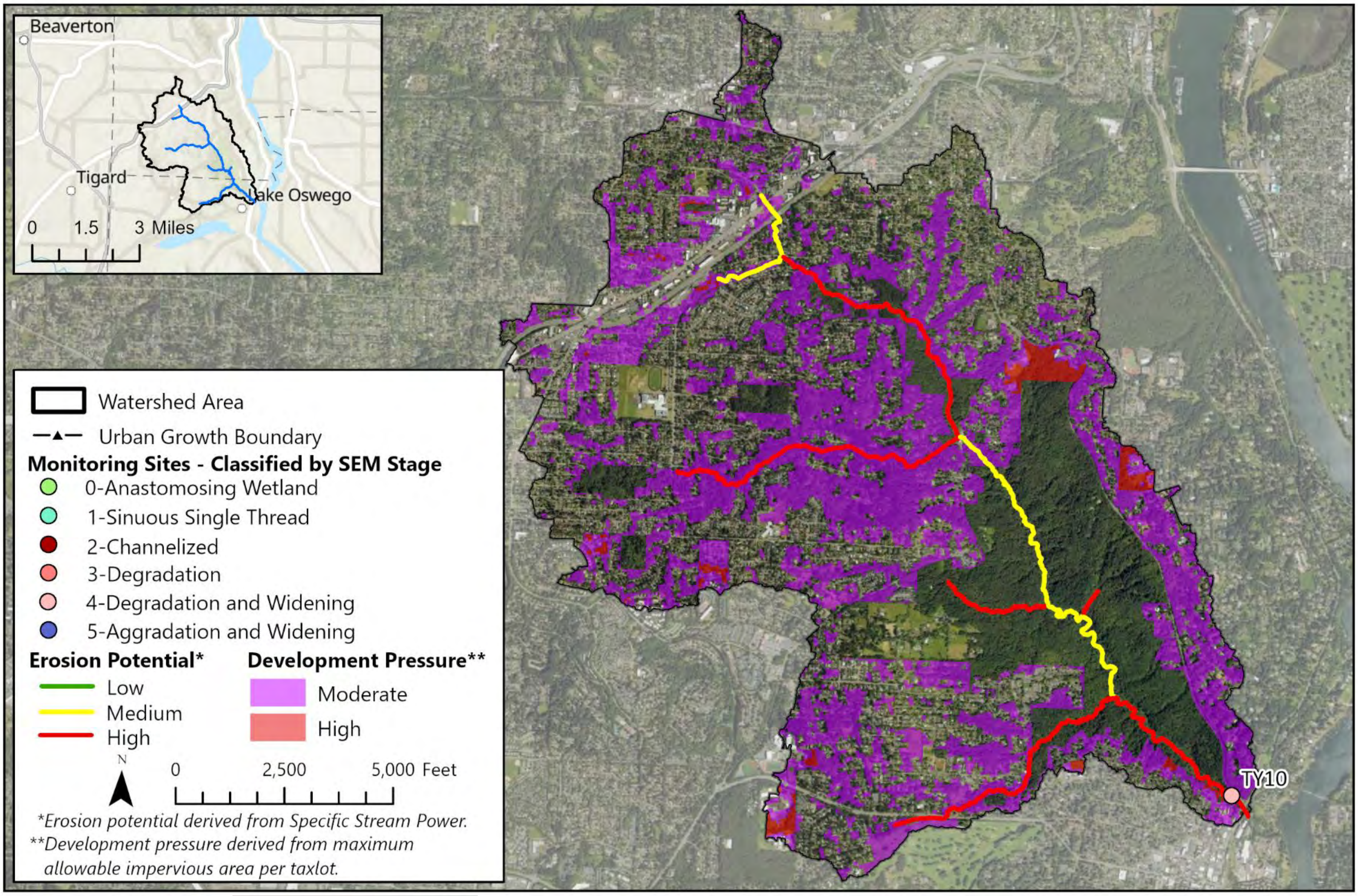
The upstream portion of the creek is steep and bounded by overhanging canyon walls, resulting in limited floodplain connectivity. Although canopy cover is generally low throughout the watershed, two of the sites visited supported healthy riparian vegetation.

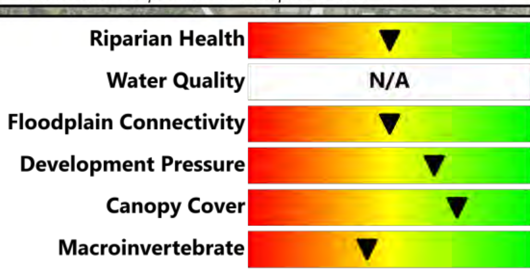
Trend analysis indicates that both macroinvertebrate health and floodplain connectivity have decreased since 2021.

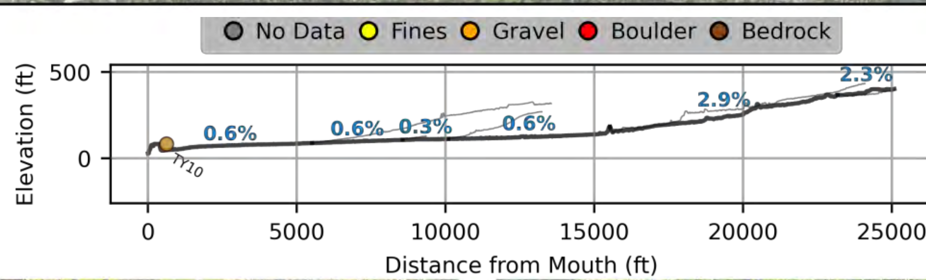


Trillium Creek (WES)

Tryon Creek



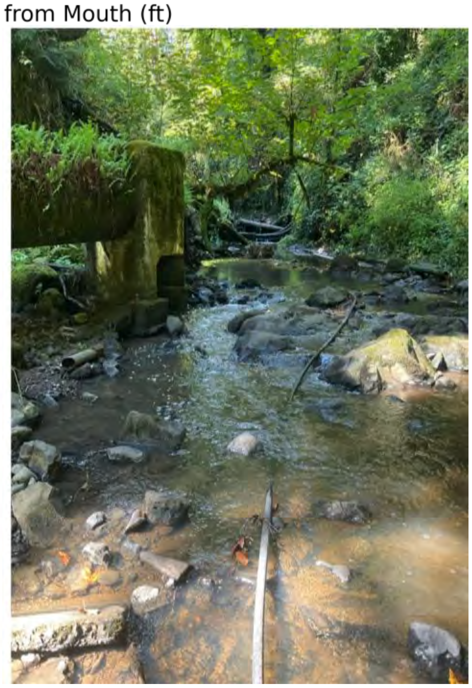


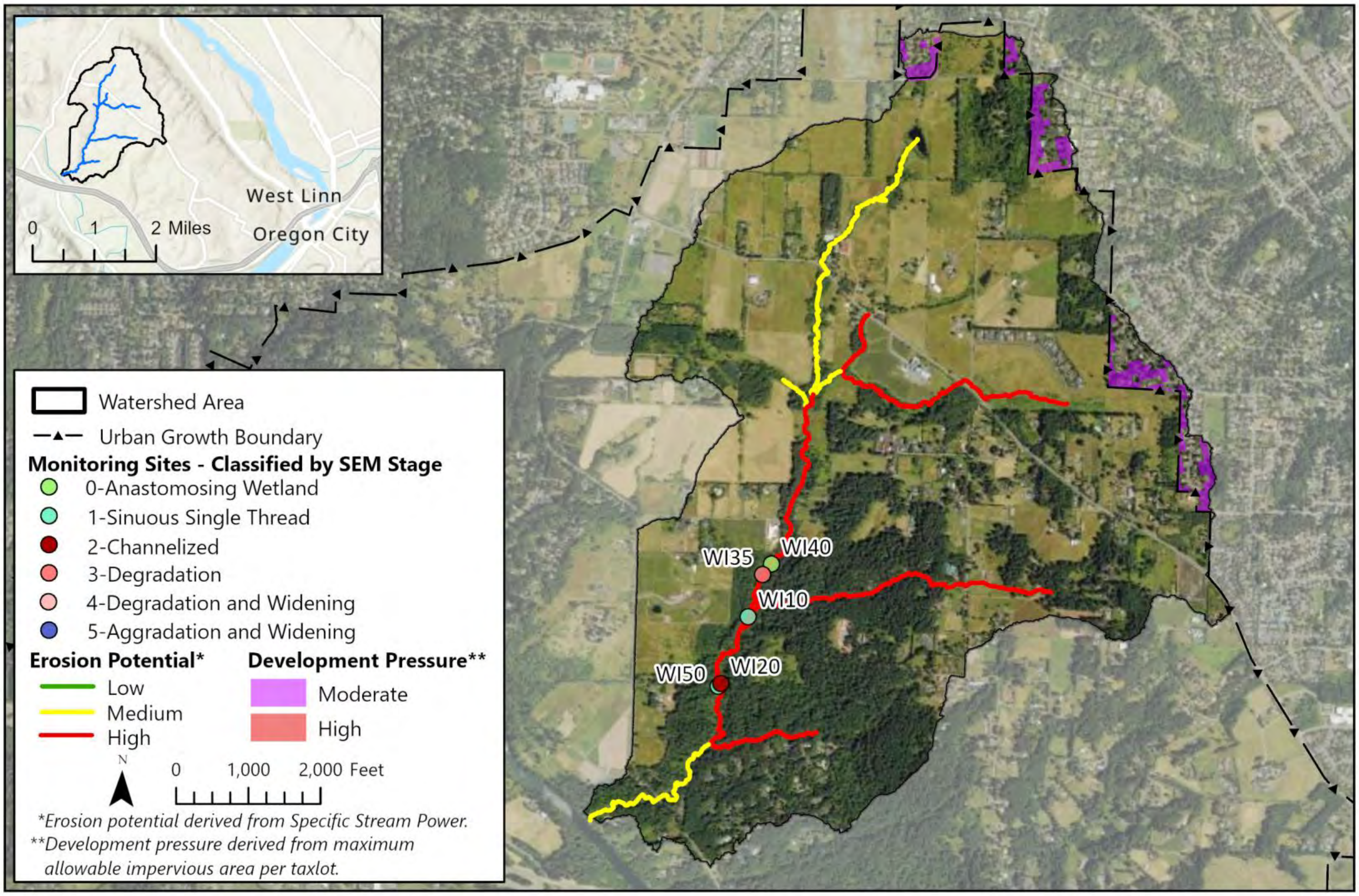


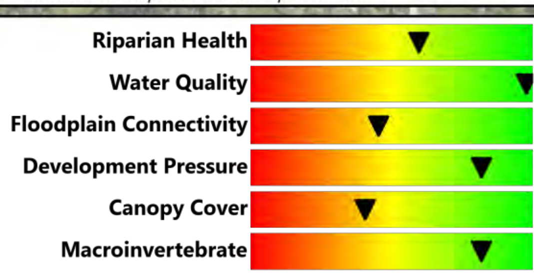
Tryon Creek flows southeast towards its confluence with the Willamette River. A large portion of Tryon Creek flows through Tryon Creek State Park. The watershed has moderate impervious area and is approximately 81% private and 19% public land.

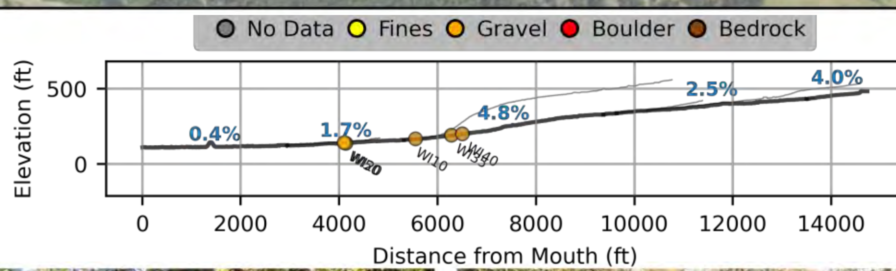
The site visited in 2024 showed moderate floodplain connectivity and habitat complexity from downed trees and boulders in the channel. Due to the state park, the watershed has low development pressure and high canopy coverage.

The trends analysis found that macroinvertebrate health has decreased since 2021.





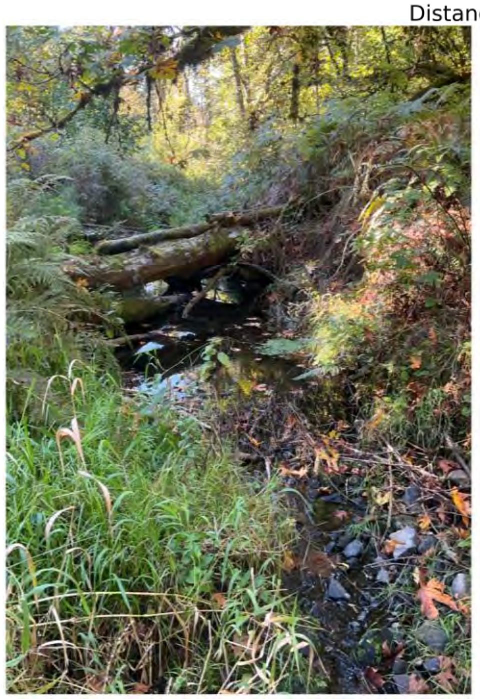




Wilson Creek flows south-southwest into the Tualatin River. The watershed has low impervious area and is approximately 90% private and 10% public land.

The creek is low gradient near the Tualatin where it experiences backwater conditions and then steepens as it flows through Wilson Creek Natural Area. The creek is well-connected to its floodplain within the Wilson Creek Natural Area.

Trend analysis indicates that both macroinvertebrate health and floodplain connectivity have increased since 2021.



Wilson Creek

Appendix D – Full Macroinvertebrate Results

Appendix D – Full Macroinvertebrate Results

D.1 Trends analysis

Table 1: Changes in M-IBI and PREDATOR O/E model scores at WES sites sampled in 2021 and 2024. Orange = severe impairment (M-IBI)/ poor biological condition (O/E); blue = moderate impairment (M-IBI) / fair biological condition (O/E); green = slight impairment (M-IBI) / good biological condition (O/E); yellow = minimally impaired (M-IBI). Grey shading in the Change column indicates a change that suggests declining habitat conditions; bold type indicates >25% difference between values.

		M-IBI			O/E		
Site ID	**Water body**	**2021**	**2024**	**change**	**2021**	**2024**	**change**
AT10	Athey Creek	14	22	**+8**	0.34	0.53	**+0.19**
CA10	Carli Creek	16	18	+2	0.24	0.29	+0.05
CO20	Cow Creek	14	16	+2	0.29	0.24	-0.05
CE10	Cedar Creek	12	22	**+10**	0.24	0.34	**+0.10**
KL10	Kellogg Creek	26	20	**-6**	0.39	0.44	+0.05
KL20	Kellogg Creek	16	18	+2	0.48	0.39	-0.09
MS10	Mt. Scott Creek	20	20	0	0.39	0.29	**-0.10**
MS40	Mt. Scott Creek	22	24	+2	0.48	0.34	**-0.14**
MS80	Mt. Scott Creek	20	22	+2	0.48	0.59	+0.11
PE40	Pecan Creek	38	40	+1	0.78	0.94	+0.16
PH10	Philips Creek	16	17	+1	0.44	0.24	**-0.20**
RC10	Rock Creek	38	30	-8	0.68	0.82	+0.14
RC30	Rock Creek	26	22	-4	0.68	0.63	-0.05
RC50	Rock Creek	36	34	-2	0.92	0.92	0

		M-IBI			O/E		
RI10	Richardson Creek	36	38	+2	0.82	0.87	+0.05
SA10	Saum Creek	14	22	**+8**	0.44	0.63	**+0.19**
SH10	Shipley Creek	28	22	-6	0.53	0.34	**-0.19**
SI10	Sieben Creek	28	34	+6	0.77	0.58	**-0.19**
T410	Unnamed Tributary 4	16	32	**+16**	0.24	0.68	**+0.44**
TA10	Tate Creek	26	24	-2	0.58	0.64	+0.06
TR10	Trillium Creek (WES)	30	34	+4	0.87	0.82	-0.05
T210	Unnamed Tributary 2	18	26	**+8**	0.34	0.73	**+0.39**
WI10	Wilson Creek	22	34	**+12**	0.39	0.82	**+0.43**

Table 2: Changes in temperature stressor, fine sediment stressor, and MTTI scores at WES sites sampled in 2021 and 2024. Green= score below the threshold value at which temperature or fine sediment are considered potential stressors (18.4°C and 19% fine sediment, respectively). Grey shading in the Change column indicates a change that suggests declining habitat conditions; bold type indicates ≥25% difference between values.

		Temperature stressor model score (°C)			Sediment stressor model score (% fine sediment)			MTTI (°C)		
Site ID	**Water body**	**2021**	**2024**	**change**	**2021**	**2024**	**change**	**2021**	**2024**	**change**
AT10	Athey Creek	18.5	19.2	+0.7	17.4	42.4	**+25**	20.8	22.5	+1.7
CA10	Carli Creek	18.9	17.6	-1.3	18.4	23.2	+4.8	28.0	20.6	**-7.4**
CO20	Cow Creek	24.9	24.6	-0.3	87.8	75.3	-12.5	26.5	25	-1.5
CE10	Cedar Creek	21.3	21.8	+0.5	39.1	55.8	**+16.7**	24.9	24.1	-0.8
KL10	Kellogg Creek	23.5	24.1	+0.6	36.6	30.9	-5.7	24.9	26.9	+2.0
KL20	Kellogg Creek	22.2	22.6	+0.4	32.4	48.7	**+16.3**	30.4	23.3	**-7.1**

		Temperature stressor model score (°C)			Sediment stressor model score (% fine sediment)			MTTI (°C)		
MS10	Mt. Scott Creek	24.1	20.3	-3.8	52.3	23.4	**-28.9**	26.9	25	-1.9
MS40	Mt. Scott Creek	20.9	21.0	+0.1	35.1	32.6	-2.5	25.7	26.5	+0.8
MS80	Mt. Scott Creek	22.4	21.8	-0.6	32.0	29.4	-2.6	29.1	30	+0.9
PE40	Pecan Creek	17.5	17.8	+0.3	17.6	20.9	+3.3	18.1	19.4	+1.3
PH10	Philips Creek	19.0	18.9	-0.1	29.8	23.9	-5.9	23.4	20.6	-2.8
RC10	Rock Creek	18.8	18.4	-0.4	10.4	10.7	+0.3	20.8	20.0	-0.8
RC30	Rock Creek	22.4	21.4	-1.0	31.0	29.6	-1.4	24.2	23.3	-0.9
RC50	Rock Creek	20.2	20.2	0	25.1	22.8	-2.3	21.9	21.8	-0.1
RI10	Richardson Creek	17.9	17.7	-0.2	11.0	13.1	+2.1	19.4	20.5	+1.1
SA10	Saum Creek	23.2	23.4	+0.2	35.4	39.2	+3.8	26.3	27.9	+1.6
SH10	Shipley Creek	16.2	18.8	+2.6	20.8	55.9	**+35.1**	22,2	22.0	-0.2
SI10	Sieben Creek	19.2	20.2	+1.0	21.9	33.3	**+11.4**	20.6	23.9	+3.3
T410	Unnamed Tributary 4	19.4	18.8	-0.6	31.1	27.1	-4.0	23.7	21.2	-2.5
TA10	Tate Creek	19.6	19.8	+0.2	26.3	34.4	**+8.1**	21.7	22.7	+1.0
TR10	Trillium Creek (WES)	19.3	19.5	+0.2	17.3	20.8	+3.5	20.1	21.3	+1.2
T210	Unnamed Tributary 2	22.0	20.0	-2.0	31.1	50.3	**+19.2**	-----	21.2	-----
WI10	Wilson Creek	19.2	18.2	-1.0	36.3	27.6	**-8.7**	20.7	22.1	+1.4

Table 3: Trends over time in selected metrics among WES sites sampled ≥3 years. INC = increase, DEC = decrease, N = no overall change. Highlighted cells show statistically significant unidirectional trends over time (alpha = 0.05). Orange highlight = significant trend suggesting declining habitat conditions, green = significant trend suggesting improving habitat conditions. Trends for IBI, O/E, total taxa, and EPT taxa were assessed using data from 2002, 2007, 2009, 2011, 2017, 2021, and 2024. Sediment and temperature stressor scores weren't implemented until 2017; trends for these models were assessed using data from 2017, 2021, and 2024.

Site ID	Water body	IBI	O/E	# total taxa	# EPT taxa	Temp. stressor score	Sediment stressor score
AT10	Athey Creek	DEC	DEC	DEC	DEC	INC	INC
CA10	Carli Creek	INC	INC	INC	INC	INC	DEC
CO20	Cow Creek	INC	DEC	INC	DEC	DEC	DEC
CE10	Cedar Creek	INC	DEC	INC	N	DEC	INC
KL10	Kellogg Creek	INC	N	INC	INC	INC.	INC
KL20	Kellogg Creek	DEC	DEC	INC	DEC	INC.	INC
MS10	Mt. Scott Creek	INC	INC	INC	INC	DEC	INC
MS40	Mt. Scott Creek	INC	INC	INC	INC	DEC	INC
MS80	Mt. Scott Creek	INC	INC	INC	INC	INC	INC
PE40	Pecan Creek	INC	INC	INC	INC	INC	INC
PH10	Philips Creek	INC	DEC	INC	INC	INC	INC
RC10	Rock Creek	INC	INC	INC	INC	INC	INC
RC30	Rock Creek	DEC	DEC	INC	INC	DEC	INC
RC50	Rock Creek	INC	INC	INC	INC	INC	INC
RI10	Richardson Creek	INC	INC	INC	N	DEC	INC
SA10	Saum Creek	INC	INC	INC	INC	INC	INC
SH10	Shipley Creek	INC	INC	INC	N	INC	INC

SI10	Sieben Creek	INC	INC	INC	INC	INC	INC
T410	Unnamed Tributary 4	INC	DEC	INC	DEC	INC	INC
TA10	Tate Creek	INC	DEC	INC	INC	INC	INC
TR10	Trillium Creek (WES)	INC	INC	INC	INC	INC	INC
T210	Unnamed Tributary 2	INC	INC	INC	INC	INC	INC
WI10	Wilson Creek	INC	INC	INC	DEC	INC	INC

Table 4: Changes in M-IBI and PREDATOR O/E model scores at Lake Oswego sites sampled in 2021 and 2024. Orange = severe impairment / poor biological condition; blue = moderate impairment / fair biological condition. No sites scored as slightly or minimally impaired (M-IBI) or fair or good biological condition (O/E). Grey shading in the Change column indicates a change that suggests declining habitat conditions; bold type indicates ≥25% difference between values.

Next		**M-IBI**			**O/E**		
Site ID	**Water body**	**2021**	**2024**	**change**	**2021**	**2024**	**change**
NE10	Nettle Creek	18	22	+4	0.49	0.48	-0.01
SB20	Springbrook restored	16	16	0	0.53	0.44	-0.09
SB10	Springbrook lower	12	14	+2	0.39	0.39	0
LD10	Lost Dog	20	14	**-6**	0.44	0.24	**-0.20**
LD20	Lost Dog east	dry	22	-----	dry	0.49	-----
LD30	Lost Dog west	14	18	**+4**	0.19	0.19	0
TY10	Tryon Creek	20	20	0	0.44	0.53	+0.09
BA10	Ball Creek	24	24	0	0.39	0.44	+0.05
CR10	Carter Creek	18	16	-2	0.34	0.34	0
OS10	Oswego Creek	16	16	0	0.34	0.29	-0.05

Table 5: Changes in temperature stressor, fine sediment stressor, and MTTI scores at Lake Oswego sites sampled in 2021 and 2024. Green= score below the threshold value at which temperature or fine sediment are considered potential stressors (18.4ºC and 19% fine sediment, respectively). Grey shading in the Change column indicates a change that suggests declining habitat conditions; bold type indicates >25% difference between values.

		Temperature stressor model score (ºC)			Sediment stressor score (% fine sediment)			MTTI (ºC)		
Site ID	**Water body**	**2021**	**2024**	**change**	**2021**	**2024**	**change**	**2021**	**2024**	**change**
NE10	NettleCreek	16.7	17.0	+0.3	15.0	19.3	**+4.3**	22.3	21.8	-0.5
SB20	Springbrook restored	22.7	22.8	+0.1	36.1	31.8	-4.3	29.3	28.8	-0.5
SB10	Springbrook lower	24.0	20.6	-3.4	31.5	25.7	-5.8	28.8	21.3	**-7.5**
LD10	Lost Dog	17.7	19.1	+1.4	21.7	69.5	**+47.8**	21.4	24.3	+2.9
LD20	Lost Dog east	dry	18.2	-----	dry	29.0	-----	dry	21.5	-----
LD30	Lost Dog west	20.2	20.8	+0.6	48.1	78.4	**+30.3**	23.0	23.0	0
TY10	Tryon Creek	22.3	23.1	+0.8	18.2	19.5	+1.3	26.0	26.9	+0.9
BA10	Ball Creek	19.7	17.9	-1.8	27.2	15.9	**-11.3**	20.1	20.4	+0.3
CR10	Carter Creek	20.8	21.1	+0.3	43.7	51.4	+7.7	23.6	25.9	+2.3
OS10	Oswego Creek	24.0	25.2	+1.2	40.1	42.4	+2.3	25.6	28.1	+2.5

Table 6: Trends over time in selected metrics among Lake Oswego sites sampled >3 years. INC = increase, DEC = decrease, N = no overall change. Highlighted cells show statistically significant unidirectional trends (alpha = 0.05). Orange = significant trend suggesting declining habitat conditions, green = significant trend suggesting improving habitat conditions. Trends for IBI, O/E, total taxa, and EPT taxa were assessed using data from 2004, 2007, 2009, 2013, 2018, 2021, and 2024. Sediment and temperature stressor scores weren't implemented until 2018; trends for these models were assessed using data from 2018, 2021, and 2024.

Site ID	**Water body**	**IBI**	**O/E**	**# total taxa**	**# EPT taxa**	**Temp. stressor**	**Sediment stressor**
NE10	Nettle Creek	INC	INC	INC	INC	DEC	DEC
SB20	Springbrook restored	INC	INC	INC	DEC	INC	DEC

SB10	Springbrook lower	INC	INC	INC	DEC	DEC	DEC
LD10	Lost Dog	DEC	INC	INC	DEC	INC	INC
LD20	Lost Dog east	INC	INC	INC	N	INC	DEC
LD30	Lost Dog west	INC	DEC	DEC	DEC	INC	INC
TY10	Tryon Creek	INC	INC	INC	DEC	INC	INC
BA10	Ball Creek	INC	INC	INC	INC	DEC	DEC
CR10	Carter Creek	INC	DEC	INC	DEC	INC	INC
OS10	Oswego Creek	INC	DEC	INC	INC	DEC	DEC

Table 7: Changes in M-IBI and MTTI scores and selected metrics scores at co-permittee sites sampled in 2018 and 2024. Orange = severe impairment; blue = moderate impairment; green = slight impairment; yellow = minimal impairment. O/E scores were not available for the 2018 data. Grey shading in the Change column indicates a change that suggests declining habitat conditions; bold type indicates >25% difference between values.

		IBI score			MTTI score (°C)			# total taxa			# EPT taxa		
Site ID	**Water body**	**2018**	**2024**	**change**	**2018**	**2024**	**change**	**2018**	**2024**	**change**	**2018**	**2024**	**change**
BK10	Boeckman Creek	20	20	0	25.1	27.4	+2.3	32	28	-4	4	5	+1
BK20	Boeckman Creek	22	24	+2	28.0	23.1	-4.9	27	39	**+12**	6	7	+1
BK30	Boeckman Creek	16	20	+4	21.1	25.5	+4.4	34	42	+8	4	6	**+2**
SN10	Singer Creek	42	36	-6	18.2	18.2	0	49	51	+2	16	14	-2
TN10	Tanner Creek	20	22	+2	20.7	21.7	+1	21	21	0	1	3	**+2**
BO10	Boardman Creek	18	16	-2	25	19.9	-5.1	24	17	**-7**	1	0	**-1**
BO20	Boardman Creek	10	18	**+8**	26.2	24.3	-1.9	12	18	**+6**	0	0	0
RF10	River Forest Creek	18	16	-2	23.2	23.7	+0.5	15	27	**+12**	0	1	**+1**
CF10	Coffee Creek	30	30	0	20.5	20.1	-0.4	33	33	0	9	7	**-2**

RN10	Rinearson Creek	12	14	+2	25.2	27.2	+2.0	19	26	**+7**	2	2	0
TRWL10	Trillium Creek (West Linn)	20	28	**+8**	25.1	21.8	-3.3	30	32	+2	6	7	+1

Table 8: Site summary table indicating statistically significant trends in metrics and score and implications for habitat conditions and stressors at Lake Oswego and WES sites. Insufficient data from prior years was available for additional co-permittee sites to conduct correlation analysis.

Site ID	Water body	Significant unidirectional trends	Implications for habitat conditions/potential stressors
NE10	Nettle Creek	none	Impaired habitat but supporting some sensitive taxa; overall improvement in model scores, taxa diversity and EPT taxa suggest improving conditions; disturbance is potential stressor
SB20	Springbrook restored	none	Impaired habitat supporting few sensitive taxa; increase in M-IBI & O/E scores suggests some improvement; temperature and sediment are potential stressors
SB10	Springbrook lower	none	Impaired habitat supporting few sensitive taxa; increase in M-IBI & O/E scores suggests some improvement; disturbance, sediment, and organic enrichment are potential stressors
LD10	Lost Dog lower	none	Impaired habitat supporting very few sensitive taxa; temperature, sediment, and organic enrichment are potential stressors
LD20	Lost Dog east	INC: M-IBI	Impaired habitat that does not support sensitive taxa; increase in M-IBI score suggests some improvement; disturbance, temperature, and organic enrichment are potential stressors
LD30	Lost Dog west	INC: sediment stressor score	Impaired habitat that does not support sensitive taxa; changes in metrics over time suggest declining conditions; disturbance and sediment are potential stressors
TY10	Tryon Creek	DEC: # EPT taxa	Impaired habitat that still supports some sensitive taxa; changes in metrics over time suggest some improved condition; disturbance, temperature, and organic enrichment are potential stressors
BA10	Ball Creek	INC: O/E score, # EPT taxa	Impaired habitat that still supports some sensitive taxa; changes in metrics over time suggest improving conditions; disturbance is potential stressor
CR10	Carter Creek	none	Impaired habitat supporting very few sensitive taxa; lack of significant trends and mixture of indications of improving and declining conditions suggest little habitat change over time; temperature, sediment, organic enrichment are potential stressors
OS10	Oswego Creek	none	Impaired habitat supporting very few sensitive taxa; lack of significant trends suggests little habitat change over time

			though overall trends indicate some improvement; temperature, sediment, organic enrichment are potential stressors
AT10	Athey Creek	none	Impaired habitat supporting very few sensitive taxa; indications of some habitat decline over time; disturbance, sediment are potential stressors
CA10	Carli Creek	INC: M-IBI score	Impaired habitat supporting very few sensitive taxa; some habitat improvement over time; disturbance, organic enrichment, temperature are potential stressors
CO20	Cow Creek	none	Impaired habitat that does not support sensitive taxa; lack of significant trends and mixture of indications of improving and declining conditions suggest little habitat change over time; sediment, temperature, organic enrichment are potential stressors
CE10	Cedar Creek	none	Impaired habitat supporting few sensitive taxa; lack of significant trends and mixture of indications of improving and declining conditions suggest little habitat change over time; sediment, organic enrichment are potential stressors
KL10	Kellogg Creek	INC: # total taxa, temp. stressor score	Impaired habitat supporting few sensitive taxa; organic enrichment, temperature are potential stressors
KL20	Kellogg Creek	INC: temp. stressor score	Very impaired habitat that does not support sensitive taxa; temperature, sediment are potential stressors
MS10	Mt. Scott Creek	INC: M-IBI score, # total taxa	Impaired habitat supporting few sensitive taxa but trends suggest improvement over time; sediment, organic enrichment are potential stressors
MS40	Mt. Scott Creek	INC: M-IBI, #total and EPT taxa	Impaired habitat that supports some sensitive taxa; trends suggest improvement over time; organic enrichment, sediment are potential stressors
MS80	Mt. Scott Creek	INC: # total and EPT taxa	Impaired habitat supporting few sensitive taxa but trends suggest improvement over time; disturbance, organic enrichment are potential stressors
PE40	Pecan Creek	INC: M-IBI score; # total and EPT taxa	Higher quality habitat supporting a greater diversity of taxa, including more sensitive types; some improvement over time with almost 2X more taxa in 2024 as in 2002
PH10	Philips Creek	none	Impaired habitat supporting very few sensitive taxa; lack of significant trends and mixture of indications of improving and declining conditions suggest little habitat change over time
RC10	Rock Creek	INC: # total taxa	Higher quality habitat supporting a greater diversity of taxa, including more sensitive types; some improvement over time
RC30	Rock Creek	INC: # total taxa	Impaired habitat that supports some sensitive taxa; trend suggests improvement over time; sediment is potential stressor

RC50	Rock Creek	INC: M-IBI score, # total taxa	Less impaired habitat supporting a diversity of taxa including more sensitive types; trends suggest improvement over time
RI10	Richardson Creek	none	Less impaired habitat supporting a diversity of taxa including sensitive types; lack of significant trends suggests little habitat change over time
SA10	Saum Creek	none	Impaired habitat that supports some sensitive taxa; lack of significant trends and mixture of indications of improving and declining conditions suggest little habitat change over time; temperature and sediment are potential stressors
SH10	Shipley Creek	none	Impaired habitat supporting few sensitive taxa; lack of significant trends and mixture of indications of improving and declining conditions suggest little habitat change over time; disturbance and sediment are potential stressors
SI10	Sieben Creek	INC: O/E score, # total and EPT taxa	Impaired habitat supporting few sensitive taxa; trends suggest improving conditions over time; sediment, disturbance, organic enrichment are potential stressors
T410	Unnamed Tributary 4	none	less impaired habitat supporting a diversity of taxa including sensitive types; lack of significant trends suggests little habitat change over time though M-IBI score 2x higher in 2024 compared to 2002; sediment is potential stressor
TA10	Tate Creek	none	Impaired habitat supporting very few sensitive taxa; lack of significant trends and mixture of indications of improving and declining conditions suggest little habitat change over time; sediment is potential stressor
TR10	Trillium Creek	INC: O/E score, # total taxa	less impaired habitat supporting a diversity of taxa including sensitive types; trends suggest improving conditions over time; disturbance is potential stressor
T210	Unnamed Tributary 2	none	Impaired habitat that still supports a moderate diversity of taxa including some sensitive types; lack of significant trends and mixture of indications of improving and declining conditions suggest little habitat change over time; sediment is potential stressor
WI10	Wilson Creek	none	less impaired habitat supporting a diversity of taxa including sensitive types; lack of significant trends and mixture of indications of improving and declining conditions suggest little habitat change over time; sediment is potential stressor
BK10	Boeckman Creek	N/A	Moderately impaired habitat supporting few sensitive types; disturbance, sediment, and temperature may be stressors
BK20	Boeckman Creek	N/A	Moderately impaired habitat supporting a fair diversity of taxa but few to no sensitive or sediment-sensitive types; temperature, sediment, and organic enrichment may be stressors
BK30	Boeckman Creek	N/A	Impaired habitat supporting a fair diversity of taxa but few to no sensitive or sediment-sensitive types; sediment, organic enrichment, and disturbance may be stressors

SN10	Singer Creek	N/A	Slightly impaired habitat supporting a high diversity of taxa including sensitive and sediment-sensitive types;
TN10	Tanner Creek	N/A	impaired habitat supporting low diversity of taxa with few to no sensitive or sediment-sensitive types; sediment may be a stressor
BO10	Boardman Creek	N/A	Severely impaired habitat supporting a low diversity of taxa, no EPT, and no sensitive or sediment-sensitive types; disturbance, pollution, organic enrichment, sediment may be stressors
BO20	Boardman Creek	N/A	Severely impaired habitat supporting a low diversity of taxa, no EPT, and no sensitive or sediment-sensitive types; disturbance, pollution, organic enrichment, sediment may be stressors
RF10	River Forest Creek	N/A	Severely impaired habitat supporting a low diversity of taxa, few EPT, and no sensitive or sediment-sensitive types; disturbance; disturbance, pollution, organic enrichment, sediment may be stressors
CF10	Coffee Creek	N/A	Slightly impaired habitat supporting a moderate diversity of taxa including sensitive and sediment-sensitive types; disturbance and sediment may be stressors
RN10	Rinearson Creek	N/A	Slightly impaired habitat supporting a high diversity of taxa including sensitive and sediment-sensitive types;
TRWL10	Trillium Creek (West Linn)	N/A	Severely impaired habitat supporting a low diversity of taxa, few EPT, and no sensitive or sediment-sensitive types; disturbance; disturbance, pollution, organic enrichment, sediment, and temperature may be stressors

D.2 Full Macroinvertebrate Results

Cell highlighting indicates level of disturbance. Orange = severe impairment (M-IBI) / poor biological condition (O/E); blue = moderate impairment (M-IBI) / fair biological condition (O/E); green = slight impairment (M-IBI) / good condition (O/E); yellow = minimal impairment (M-IBI)

For temperature and sediment stressor models, green highlight = below the threshold value at which temperature or fine sediment are considered potential stressors (18.4°C and 19% fine sediment, respectively).

Site	Dominant taxon	# taxa	# Ephemeroptera taxa	# Plecoptera taxa	# Trichoptera taxa	# sensitive taxa	# sediment-sensitive taxa	% dominant taxon	% tolerant organisms	% sediment-tolerant organisms	Comm. BI	M-IBI	O/E	Temp. Stressor (° C)	Sediment stressor (% fine sediment)	MTTI (° C)
BK30	Sludge worm	42	2	0	4	0	1	38.7	55.9	44.3	6.3	20	0.535	21.8	45.9	25.5
BK20	Biting midge	39	4	0	3	0	0	13.2	29.9	12.2	6	24	0.535	21.8	60.1	23.1
SN10	Prong-gilled mayfly	51	6	5	3	4	2	24.9	6.4	13.8	3.6	36	0.678	16.6	25.2	18.1
TN10	Riffle beetle	21	1	0	2	0	1	28.2	29	2.7	5.3	22	0.339	18.7	21.9	21.7
LD10	Segmented worm	24	0	0	1	0	0	28	49.8	50.9	6.5	14	0.243	19.1	69.5	24.2
BO20	Nonbiting midge	18	0	0	0	0	0	17.3	42.9	24	7.3	18	0.242	19.8	57.2	24.3
LD30	scud	17	0	0	0	0	0	81.7	9.6	9.5	5.9	18	0.194	20.9	78.4	23.9
BO10	Biting midge	17	0	0	0	0	0	65.2	32.4	3.3	7.1	16	0.242	20.5	34.0	19.9
PE40	Common forestly (stonefly)	50	5	6	6	4	3	18.1	17.8	11.3	3.5	40	0.872	17.8	20.9	19.4
OS10	Common netspinnder caddisfly	18	1	0	2	0	0	37.7	46.3	6.2	5.6	16	0.291	25.2	42.4	28.1
WI10	Riffle beetle	52	3	5	5	3	1	12.5	33.9	3.5	4.4	34	0.823	18.2	27.6	22.1
CR10	scud	37	1	0	0	0	0	20.9	49.5	21.4	7.4	16	0.339	21.1	51.4	25.9
SA10	Common netspinner caddisfly	35	2	1	4	1	2	27.3	64.7	10.7	5.6	22	0.630	23.4	39.2	27.9

Site	Dominant taxon	# taxa	# Ephemeroptera taxa	# Plecoptera taxa	# Trichoptera taxa	# sensitive taxa	# sediment-sensitive taxa	% dominant taxon	% tolerant organisms	% sediment-tolerant organisms	Comm. BI	M-IBI	O/E	Temp. Stressor (° C)	Sediment stressor (% fine sediment)	MTTI (° C)
TRWL10	Small minnow mayfly	32	2	0	5	0	1	19	10.3	2.2	5.2	28	0.629	19.7	19.5	21.8
MS40	Small minnow mayfly	32	3	1	2	2	1	28.1	42.9	4.6	6	24	0.339	21.0	32.6	26.5
MS10	isopod	26	1	0	2	0	0	29.8	32.4	1.9	6.5	20	0.290	20.3	23.4	25.0
PH10	Small minnow mayfly	19	1	0	1	0	0	69.5	12.1	1.9	6.2	17	0.242	18.9	23.9	20.6
TR10	Small minnow mayfly	45	5	3	4	2	1	33.9	8.7	3.3	5.2	34	0.822	19.5	20.8	21.3
BA10	Black fly	30	2	0	3	0	1	38.4	2.8	2.6	5.8	24	0.436	17.9	15.9	20.4
KL20	Nonbiting midge	36	0	0	0	0	0	22.6	32.5	49.1	6	18	0.387	22.6	48.7	23.3
SB20	Common netspinner caddisfly	31	2	0	3	0	0	43.6	57.1	1.6	5.7	16	0.436	22.8	31.8	28.8
T410	Common forestfly (stonefly)	47	2	5	3	3	1	21.4	9	3.6	4.8	32	0.678	18.8	27.1	21.2
RF10	Sludge worm	27	0	1	0	0	0	20.4	41.6	45.5	6.6	16	0.339	20.7	52.9	23.7
SB10	Nonbiting midge	34	2	1	1	0	0	19.8	6.5	6.3	5.8	24	0.388	20.5	25.7	21.3
NE10	scud	35	3	2	4	1	0	44.5	4	10.1	5.3	22	0.484	17.0	19.3	21.8

Site	Dominant taxon	# taxa	# Ephemeroptera taxa	# Plecoptera taxa	# Trichoptera taxa	# sensitive taxa	# sediment-sensitive taxa	% dominant taxon	% tolerant organisms	% sediment-tolerant organisms	Comm. BI	M-IBI	O/E	Temp. Stressor (° C)	Sediment stressor (% fine sediment)	MTTI (° C)
CE10	Sludge worm	40	1	0	2	1	0	18.4	38.9	23.6	6.5	22	0.338	21.8	55.8	24.1
RC10	Small minnow mayfly	34	6	4	3	2	1	26.1	15.7	1.1	4.8	30	0.822	18.4	10.7	20.0
RC30	scud	45	2	2	6	1	0	14.9	45.3	10.8	4.9	22	0.628	21.4	29.6	23.3
BK10	Common netspinner caddisfly	28	2	0	3	0	1	47.8	49.5	1.1	4.7	20	0.437	22.0	31.9	27.4
TY10	Common netspinner caddisfly	28	2	1	3	1	1	28.3	54.9	4.4	5.1	20	0.532	23.1	19.5	26.9
CA10	Small minnow mayfly	18	1	0	0	0	0	38	24.9	3	6.4	18	0.290	17.6	23.3	20.6
TA10	scud	38	2	0	0	0	0	27.5	13.1	5.9	5.4	24	0.532	19.8	34.4	22.7
RI10	Small minnow mayfly	47	5	8	5	4	3	29.3	36.1	5.5	4.3	38	0.870	17.7	13.1	20.5
SH10	scud	22	3	2	0	1	0	50.9	0.2	0.3	4.9	22	0.339	18.8	55.9	22.0
SI10	Sludge worm	39	1	1	5	2	1	43.4	49.7	45.1	5.8	20	0.580	20.2	33.3	23.9
RC50	Prong-gilled mayfly	58	7	3	7	1	2	24.5	28	7.5	4	34	0.918	20.2	22.8	21.8

Site	Dominant taxon	# taxa	# Ephemeroptera taxa	# Plecoptera taxa	# Trichoptera taxa	# sensitive taxa	# sediment-sensitive taxa	% dominant taxon	% tolerant organisms	% sediment-tolerant organisms	Comm. BI	M-IBI	O/E	Temp. Stressor (° C)	Sediment stressor (% fine sediment)	MTTI (° C)
MS80	Common netspinner caddisfly	37	2	2	4	1	0	48.8	60.2	6.2	5	22	0.586	21.8	29.4	30.0
CO20	scud	34	1	0	0	0	0	20	46.6	10.8	6.9	16	0.242	24.6	75.2	25.0
TA10D UP	scud	43	3	1	0	1	0	14.5	19.7	23.2	5.7	17	0.435	19.1	36.6	22.7
T210	Nonbiting midge	43	5	2	2	1	0	18.8	22.6	5.8	5.1	26	0.726	20.0	50.3	21.2
AT10	scud	30	1	2	1	0	0	56.7	6.4	4.8	4.7	22	0.532	19.2	42.4	22.5
AT20	Nonbiting midge	34	1	0	0	1	0	35.1	62.1	12.1	7.3	16	0.242	21.4	81.9	23.1
AT10D UP	scud	33	1	1	1	0	0	40.2	23.9	16.9	5.4	16	0.241	19.3	48.3	22.8
AT20D UP	Nonbiting midge	31	1	0	0	1	0	35.2	62.1	9.4	7.3	18	0.387	21.8	82.1	23.1
CF10	Nonbiting midge	33	3	3	1	2	2	25.4	6.3	3.9	5.4	30	0.436	16.9	30.4	20.1
LD20	Black fly	30	2	0	0	0	0	34	0.6	1.3	6	22	0.485	18.2	29.0	21.5
KL10	Common netspinner caddisfly	33	2	0	3	0	0	27.5	35	1.3	5.7	20	0.435	24.1	30.9	26.9
RN10	isopod	26	1	0	1	0	0	67.7	73.3	11.8	7.3	14	0.387	20.6	43.8	27.2

Appendix E – Refined Database

Name	Description
OBJECTID	GIS Identifier
FID_1	GIS Identifier
Stream	Stream Name
Site	Site ID
DT24	Date data collected in 2024
DA	Drainage area
VW	Valley width
MBS	Mean basin slope
SLOPE	Stream slope
TEMP21	Temperature measured in 2021
TEMP24	Temperature measured in 2024
pH21	pH measured in 2021
pH24	pH measured in 2024
DO21	DO measured in 2021
DO24	DO measured in 2024
COND21	Conductivity measured in 2021
COND24	Conductivity measured in 2024
BFW21	Bankfull width measured in 2021
BFW24	Bankfull width measured in 2024
BTW21	Bank top width measured in 2021
BTW24	Bank top width measured in 2024
BFD21	Bankfull depth measured in 2021
BFD24	Bankfull depth measured in 2024
BTD21	Bank top depth measured in 2021
BTD24	Bank top depth measured in 2024
RD21	Riffle depth measured in 2021
RD24	Riffle depth measured in 2024
PD21	Pool depth measured in 2021
PD24	Pool depth measured in 2024
WDR21	Width to depth ratio in 2021
WDR24	Width to depth ratio in 2024
CONF21	Confinement ratio in 2021
CONF24	Confinement ratio in 2024
RESD21	Residual depth in 2021
RESD24	Residual depth in 2024
LWD21	Large wood material present in 2024
LWD24	Large wood material present in 2021
SUB21	Substrate observed in 2021
SUB24	Substrate oberserved in 2024
BEDR21	Note if bedrock was present in 2021
BEDR24	Note if bedrock was present in 2024
EMBED21	Note if embeddedness was observed in 2021
EMBED24	Note if embeddedness was observed in 2024
CAN19	Canopy density from 2019 Metro data
IMP23	Impervious cover from 2023 Metro data
Q2_nat	Q2 flows under pre-development conditions
Q25_nat	Q25 flows under pre-development conditions
Q2_EC	Q2 flows under existing conditions
Q25_EC	Q25 flows under existing conditions
SSPQ2_PD	Specific stream power under Q2 flows for pre-development conditions
SSPQ2_EC	Specific stream power under Q2 flows for existing conditions
SSPQ25_PD	Specific stream power under Q25 flows for pre-development conditions
SSPQ25_EC	Specific stream power under Q25 flows for existing conditions
Infra	Score for instrastructure presence
snap_dist	GIS tool
BIN_O_E	O/E Score bin
Mean	Mean macro score
SD	Standard deviation for macro score
Invasive_1	Presence of invasives scored
IMP_POT	Impervious potential calculated for future development
IBI	M-IBI index macro score
O_E	PREDATOR O/E Model score
EPT_taxa	Number of EPT taxa score
MTTI	MTTI model score
Temp_stress	Temperature stressor model score
Sed_stress	Fine sediment stressor model score

OBJECTID	FID_1	Stream	Site	DT24	DA	VW	MBS	SLOPE	TEMP21	TEMP24	pH21	pH24
1	77	ATHEY	AT10	2024/10/14	0.578004986	73.41568051	8.327270916	0.004223093	11.7	11.4	7.53	7.02
2	78	ATHEY	AT20	2024/10/09	0.47097891	58.39427948	8.655693233	0.039823738	0	13.9	0	6.93
3	79	ATHEY	AT40	1899/12/30	0.051111155	58.04419192	8.829686514	0.027117694	0	0	0	0
4	80	ATHEY	AT60	2024/10/14	0.485292073	53.71048995	8.61862488	0.037776159	0	12.4	0	7.29
5	81	BALL	BA10	2024/10/01	0.031196879	62.80122826	7.588935879	0.064238215	0	11.9	0	7.78
6	82	BOECKMAN	BK10	2024/09/11	2.341731564	66.90682064	6.25336105	0.001500576	0	16.3	0	6.85
7	83	BOECKMAN	BK20	2024/09/11	2.243427547	80.42669795	6.209760683	0.004396543	0	16.5	0	6.6
8	84	BOECKMAN	BK30	2024/09/12	1.863281815	89.06585383	6.370203309	0.000576614	0	17	0	6.51
9	0	BOARDMAN	BO10	2024/09/25	1.494315387	257.0205589	5.033154534	0.005063552	0	0	0	0
10	1	BOARDMAN	BO20	2024/09/25	1.231640316	114.5437146	5.179360955	0.000263531	0	0	0	0
11	2	CARLI	CA10	2024/10/08	0.038304878	37.77490274	7.711305412	0.022774154	12.5	13.9	7.82	7.64
12	3	CARLI	CA20	0000/00/00	0.17917005	43.08702875	7.746424693	0.048083792	0	13.3	0	7.13
13	4	CARLI	CA30	2024/10/18	0.019060438	46.28755089	6.999481714	0.022606514	0	14	0	7.42
14	5	CEDAR	CE10	2024/10/03	0.548876686	72.42548903	6.230743877	0.015581174	14.6	12.8	7.121	6.92
15	6	CEDAR	CE20	2024/10/18	0.107566786	40.01978714	5.086818348	0.012422622	0	11.5	0	6.7
16	7	CEDAR	CE5000	2024/10/24	0.859011908	39.70978169	6.68893784	0.01366004	0	9.5	0	7.25
17	8	COFFEE	CF10	2024/09/24	0.459724713	48.68970729	3.65349196	0.234204403	0	14.6	0	0
18	9	COW	CO20	2024/10/08	1.016039311	95.32699939	4.853835377	0.007513195	13.3	13.8	7.25	6.88
19	10	COW	CO30	2024/10/18	0.047631887	62.61153965	4.688880484	0.000347497	0	10	0	-6.5
20	11	COW	CO60	2024/10/18	0.014540746	87.97905616	4.982337837	0.0058265	0	0	0	0
21	85	CARTER	CR10	2024/10/01	0.281312303	31.62679795	5.670363631	0.019207285	0	13.3	0	7
22	86	FIELDS	FE20	2024/10/30	0.293978802	83.99887718	14.82654735	0.071157214	0	9.4	0	7.02
23	87	FIELDS	FE30	2024/10/30	0.041864527	36.7396522	11.19850205	0.105157964	0	0	0	0
24	88	FIELDS	FE35	2024/10/30	0.30593576	53.78832438	14.78445014	0.043182538	0	0	0	0
25	12	KELLOGG	KL10	2024/10/08	13.72009552	106.6714926	6.649259139	0.010738952	16.1	14.6	7.68	7.66
26	13	KELLOGG	KL100	2024/10/08	13.88169491	133.5316347	6.650207501	0.007527514	0	15	0	7.78
27	14	KELLOGG	KL110	2024/10/16	2.204528694	127.6813132	5.494156764	0.010714676	0	14.6	0	6.71
28	15	KELLOGG	KL150	2024/10/16	1.016665244	156.1499039	5.133573959	0.000382198	0	13.8	0	6.69
29	16	KELLOGG	KL160	2024/10/16	0.665798888	153.1328184	5.133573959	0.006958769	0	14.8	0	6.65
30	17	KELLOGG	KL20	2024/10/02	2.224782891	129.4181453	5.522405589	0.007144052	14.4	14.4	6.95	6.85
31	18	KELLOGG	KL30	2024/10/08	13.43078103	131.4697608	6.683840957	0.002484523	0	15.3	0	7.61
32	19	KELLOGG	KL60	2024/10/16	13.13786944	165.8285744	6.636729285	0.014030767	0	14.6	0	7.29
33	20	KELLOGG	KL80	2024/10/16	13.00103974	111.3703778	6.618877935	0.004063147	0	14.6	0	7.23
34	21	KELLOGG	KL90	2024/10/16	2.40537622	127.2982317	5.642431657	0.005267102	0	14.5	0	6.96
35	89	LOST DOG	LD10	2024/09/12	0.215079986	72.66611934	5.7732655	0.005725692	0	15.9	0	7.06
36	90	LOST DOG	LD20	2024/09/12	0.560288415	13.06643044	7.162886823	0.09083249	0	17.1	0	6.76
37	91	LOST DOG	LD30	1899/12/30	0.057047991	70.92519453	5.050354892	0.036216774	0	16.3	0	7.01
38	22	MINTHRON	MI10	2024/10/02	0.113134648	71.92217695	4.149143413	0.012315655	0	0	0	0
39	23	MT SCOTT	MS10	2024/10/02	9.546880739	202.3154921	7.012459266	0.005100203	15.6	13.7	7.18	7.58
40	24	MT SCOTT	MS120	2024/10/24	3.671005093	94.14482528	8.642769933	0.01710493	0	8.7	0	7.55
41	25	MT SCOTT	MS130	2024/10/24	3.610665387	120.218625	8.568594864	0.017083024	0	8.9	0	7.19

DO21	DO24	COND21	COND24	BFW21	BFW24	BTW21	BTW24	BFD21	BFD24	BTD21	BTD24	RD21
9.43	9.3	218.1	217.9	4.6	6.966666667	8.5	6.933333333	1.233333333	1.133333333	2.7	1.166666667	0.566666667
0	9.53	0	141.9	4.8	6.3	14.2	12	1.3	2.5	1.5	4.433333333	0.6
0	0	0	0	3.8	0	10	0	1	0	1.9	0	0.1
0	10.2	0	142.4	6.5	6.2	11.1	12	1	0.5	1.7	2.5	0.4
0	10.19	0	172.1	0	11.96666667	0	18.93333333	0	1.733333333	0	4.833333333	0
0	7.73	0	219.1	0	13.6	0	16.4	0	2.533333333	0	3.4	0
0	6.1	0	210	0	10.86666667	0	13.36666667	0	2.966666667	0	4	0
0	5.55	0	208.7	0	13.1	0	19.8	0	2.533333333	0	2.833333333	0
0	0	0	0	0	19.2	0	29.86666667	0	3.3	0	5.5	0
0	0	0	0	0	7.25	0	7.25	0	0.9	0	0.9	0
10.8	9.89	238.3	247.2	15.95	11.1	22.475	9.466666667	1.175	0.933333333	1.6	4.6	0.3
0	6.88	0	769.5	19.4	25.4	30.3	43	1.3	1.8	3	7	0.3
0	9.46	0	225.2	15	55	37	55	1.2	3.2	2.5	3.2	0.2
7.96	7.48	59.6	118.7	9.366666667	7.833333333	17.7	13.16666667	1.366666667	1.4	1.866666667	2.533333333	0.7
0	8.63	0	127.9	3.9	6.9	6.5	14	1.9	1.1	2.1	2.6	1.3
0	12.72	0	132.9	13.1	17.2	18.2	27.7	1.9	2.3	2.1	4.4	0.3
0	9.3	0	88.5	0	10.8	0	12.06666667	0	1.766666667	0	2.4	0
0.73	7.44	192.7	216.4	43.33333333	44.43333333	48.33333333	58.33333333	3.166666667	2.166666667	5	7.333333333	2.1
0	5.95	0	202.8	13.6	5.9	18	6.6	3.4	1.9	5.5	2.2	1.6
0	0	0	0	14	15	19	18	2.7	2	4.4	3	0.9
0	5.06	0	252.1	0	13	0	46.33333333	0	3	0	7.433333333	0
0	11.19	0	85.9	9.766666667	10	11.63333333	15	1.5	2.3	2.033333333	4.5	0.333333333
0	0	0	0	8.5	0	14.2	0	1.4	0	1.8	0	0.2
0	0	0	0	4.2	6	13	10	1.2	2	1.2	2	0.3
9.6	10.45	196.2	205.1	37.16666667	27.4	43.5	35.33333333	3.266666667	1.633333333	2.733333333	3.4	1.966666667
0	10.38	0	204.4	32.5	30.56666667	37.5	36.73333333	3	1.666666667	2.9	2.666666667	0.8
0	7.55	0	204	15.5	12	17.5	18	4.2	3.5	3.8	4	1.7
0	0.15	0	218.2	10	15.8	16	20	2.5	2.5	3	3.5	1.1
0	1.64	0	170.5	9.1	8	13.3	16	2.3	1.7	2.8	4	0.9
6.79	8.38	205	202.9	13.66666667	13.33333333	18.93333333	15.06666667	1.633333333	1.566666667	1.6	2.233333333	0.9
0	10.2	0	205.4	22.1	26.5	24.35	28.66666667	3.05	2.266666667	2.85	3.766666667	1.55
0	8.62	0	208.6	30.4	32	31	33	2.9	2.2	3.2	3	1.1
0	8.52	0	210.5	24.5	26	30.5	35	3.5	2.3	4	3.9	1.3
0	8.59	0	208.8	21	18	26	20	2.3	0.8	2.7	1.2	0.5
0	7.18	0	101.2	0	4.9	0	8.766666667	0	0.9	0	1.9	0
0	9.36	0	106.2	0	10.8	0	16.3	0	2.033333333	0	4	0
0	6.14	0	68.3	0	3.2	0	8.5	0	1.2	0	2.1	0
0	0	0	0	0	9.5	0	13.5	0	2	0	5.7	0
6.62	7.58	190.1	209.7	29.125	26.66666667	33.7	29.66666667	1.75	1.7	2.2	2.633333333	1.125
0	13.85	0	128.3	25.5	30.8	45	42	2.7	4.2	5	8	1
0	13.25	0	128.3	29	29.5	32	40.4	3.2	3.1	2.6	5.2	0.8

RD24	PD21	PD24	WDR21	WDR24	CONF21	CONF24	RESD21	RESD24
0.51	0.966666667	0.6	3.72972973	6.147058824	8.637138884	10.58880007	0.4	0.09
0.471428571	0.7	0.3	3.692307692	2.52	4.112273203	4.866189957	0.1	-0.171428571
0	0	0	3.8	0	5.804419192	0	0	0
0.2	1	0.5	6.5	12.4	4.838782879	4.475874163	0.6	0.3
0.235714286	0	0.4	0	6.903846154	0	3.316966282	0	0.164285714
0	0	0	0	5.368421053	0	4.079684185	0	0
2.4	0	2.4	0	3.662921348	0	6.016959947	0	0
0	0	0	0	5.171052632	0	4.498275446	0	0
2.066666667	0	2.066666667	0	5.818181818	0	8.605599069	0	0
0.45	0	0.45	0	8.055555556	0	15.79913304	0	0
0.242857143	0.85	1.166666667	13.57446809	11.89285714	1.680752069	3.990306628	0.55	0.923809524
0.2	1.5	0.9	14.92307692	14.11111111	1.42201415	0	0	0.7
0.3	1.4	0.6	12.5	17.1875	1.251014889	0.841591834	1.2	0.3
0.385714286	0.966666667	0.666666667	6.853658537	5.595238095	4.091835539	5.500670053	0.266666667	0.280952381
0.1	0	0.5	2.052631579	6.272727273	6.156890329	2.858556224	0	0.4
0.2	0.5	0.5	6.894736842	7.47826087	2.181856137	1.433566126	0.2	0.3
0.185714286	0	0.433333333	0	6.113207547	0	4.035058616	0	0.247619048
2.028571429	2.5	2.066666667	13.68421053	20.50769231	1.972282746	1.634177132	0.4	0.038095238
0.6	0	1.3	4	3.105263158	3.478418869	9.486596916	0	0.7
0	0	0	5.185185185	7.5	4.63047664	4.887725342	0	0
1.9	0	2.233333333	0	4.333333333	0	0.682592761	0	0.333333333
0.1	0.766666667	0.3	6.511111111	4.347826087	7.220533855	5.599925145	0.433333333	0.2
0	0.3	0	6.071428571	0	2.587299451	0	0.1	0
0	1.3	0	3.5	3	4.137563414	5.378832438	1	0
0.583333333	2.3	1.433333333	11.37755102	16.7755102	2.452218222	3.019004509	0.333333333	0.85
0.733333333	1.4	1.366666667	10.83333333	18.34	3.560843592	3.635162469	0.6	0.633333333
0	2.3	3	3.69047619	3.428571429	7.296075039	7.093406288	0.6	0
0	1.1	1.3	4	6.32	9.759368995	7.807495196	0	0
0.1	1.1	0.1	3.956521739	4.705882353	11.51374574	9.570801149	0.2	0
0.471428571	1.266666667	0.9	8.367346939	8.510638298	6.83546542	8.589699908	0.366666667	0.428571429
1.866666667	2.05	2.05	7.245901639	11.69117647	5.39916882	4.586154446	0.5	0.183333333
0.5	1.3	0.5	10.48275862	14.54545455	5.34930885	5.025108314	0.2	0
0.3	1.9	1.7	7	11.30434783	3.651487796	3.182010793	0.6	1.4
0.3	2	1	9.130434783	22.5	4.896085834	6.364911584	1.5	0.7
0.15	0	0.8	0	5.444444444	0	8.288910951	0	0.65
0.25	0	0.55	0	5.31147541	0	0.801621499	0	0.3
0.1	0	0.2	0	2.666666667	0	8.344140533	0	0.1
0	0	0	0	4.75	0	5.327568663	0	0
0.48	2.425	1.966666667	16.64285714	15.68627451	6.003427065	6.819623329	1.3	1.486666667
0.2	1	0.7	9.444444444	7.333333333	2.092107228	2.241543459	0	0.5
0.3	2.2	1	9.0625	9.516129032	3.75683203	2.975708539	0	0.7

LWD21	LWD24	SUB21	SUB24	BEDR21	BEDR24	EMBED21	EMBED24	CAN19	IMP23	Q2_nat	Q25_nat
False	False	Fines	Fines	True	False	True	True	34.17830209	30.5053082	31.69804361	68.18999686
False	True	Gravel	Fines	False	False	False	True	36.99250197	24.29423683	26.8439846	57.6330459
False	False			False	False			44.33827969	26.24350871	3.668445638	7.732657039
True	True		Gravel	True	False		True	36.61969099	25.57154897	27.52191537	59.10507489
	True		Gravel		False		False	43.64090913	81.22800568	2.190563535	4.604373151
	True		Gravel		False			30.37832632	40.39004357	97.66068112	213.0028624
	True		Fines		False		True	29.61789698	39.79947163	93.65330357	204.2021808
	True		Fines		False			29.44795028	30.06699719	80.19033329	174.5458272
	True		Fines		False		True	25.39904229	90.95854728	58.85658611	128.1194799
	False		Fines		False		True	26.82014554	90.41492414	50.12306397	108.9105031
True	True	Gravel	Gravel	False	True	False	False	28.77574748	68.37013315	2.655105444	5.589485424
True	True	Gravel	Gravel	False	False	False	False	12.02306935	54.39319387	10.67299945	22.75384773
True	True	Gravel	Gravel	False	False	False	False	28.83829405	81.42742444	1.353328758	2.834942584
True	True	Gravel	Fines	False	False	False	True	30.99734905	81.25316856	26.40418842	56.90947665
False	False	Fines	Fines	False	False	True	True	24.41728014	90.54312792	5.533664119	11.78759975
True	True	Gravel	Gravel	True	False	False	False	32.36515082	81.32368393	40.8593353	88.33882691
	True		Gravel		False		False	25.04568288	88.90315106	17.51934192	37.86631125
False	True	Fines	Fines	False	False	True	True	17.3252681	90.91112718	40.8839075	88.74109379
False	False	Gravel	Fines	False	False	False	True	16.83736846	92.17932735	2.557757587	5.415692341
False	True	Fines	Fines	False	False	True	True	18.24584943	91.08576962	0.904172252	1.895000439
	True		Fines		False		True	35.67055391	84.37775047	13.8383113	29.68533476
False	True	Gravel	Gravel	True	False	False	False	80.41347812	5.158337552	22.60936053	48.14648039
True	False	Gravel		False	False	False		72.83569299	6.287111959	3.426921357	7.198042255
False	False	Gravel		False	False	False		79.61766526	6.139887161	23.40443963	49.85702593
False	True	Cobble	Boulders	False	True	False	False	30.20404905	77.39082952	493.8347583	1092.270467
False	True	Gravel	Gravel	False	False	False	False	30.18208535	77.57576634	499.1023244	1104.026083
False	True	Fines	Boulder	False	False	True	True	30.47065267	84.05932519	87.03988193	189.9409774
False	False	Fines	Fines	False	False	True	True	30.64996532	85.23303298	41.99701297	91.11676615
True	False	Fines	Fines	False	False	True	True	30.64996532	85.23303298	28.68754923	62.02487494
False	True	Gravel	Gravel	False	False	False	False	30.55861022	83.97584521	87.97115	191.9797386
False	True	Fines	Fines	False	False	True	True	30.31811163	77.03360667	485.6298623	1073.8905
False	False	Cobble	Gravel	False	False	False	False	29.93428675	77.36118059	474.5047386	1049.158781
True	False	Gravel	Boulder	False	False	False	True	29.78688723	77.55501693	469.458683	1037.934902
True	True	Gravel	Gravel	False	False	False	False	31.64993923	82.03264898	95.33313201	208.1431995
	True		Fines		False		True	23.29808707	34.66162367	10.95906978	23.45384413
	True		Gravel		False		False	33.89362734	54.01910179	28.71752089	61.83688597
	False		Fines		False		True	31.22751121	40.04651373	3.115599992	6.602686609
	True		Gravel		False			18.50578664	93.44529855	5.262622794	11.23317316
False	True	Cobble	Gravel	False	True	False	False	29.87046669	75.52566155	365.2722394	805.1725551
True	True	Cobble	Gravel	False	False	False	False	35.22616701	68.53025662	170.4135833	372.0888158
True	True	Gravel	Gravel	True	True	False	True	34.73903895	69.07025537	167.2113911	365.0725614

Q2_EC	Q25_EC	SSPQ2_PD	SSPQ2_EC	SSPQ25_PD	SSPQ25_EC	Infra	snap_dist	BIN_O_E	Mean
88.37818609	190.1224033	1.082995572	3.019529703	0.244881403	0.682760566	1	30.38777669	3	2.833333333
69.90334519	150.0799066	5.094611144	13.26667284	2.453785662	6.389804967	2	22.67343234	1	1.5
9.776618249	20.60797498	0.621052296	1.655140027	0.225536098	0.601066651	0	26.90822255	0	0
72.77894668	156.2974465	5.619630989	14.86055089	2.595235574	6.862840356	5	13.66004075	0	0
8.193464777	17.22194706	0.463997424	1.735510744	0.294028326	1.099767569	1	6.668186769	3	3.666666667
296.2115886	646.052388	0.557862639	1.692035901	0.298240365	0.90458362	2	1.671672765	2	2.333333333
282.8044855	616.6284635	1.923112417	5.807214448	0.696890952	2.104398666	4	10.01370884	3	2.333333333
222.6122379	484.5476458	0.145792625	0.404727368	0.070546742	0.195841163	2	4.717413499	3	2.333333333
227.744618	495.7562768	0.622955337	2.410515707	0.157578115	0.609745995	4	15.66906014	1	2.5
193.6019145	420.6702511	0.113742943	0.439335703	0.015643119	0.060422041	1	33.15863949	1	2
9.430651601	19.85325659	0.236368601	0.839556082	0.210379812	0.747246672	5	9.09526724	1	2.833333333
35.39564698	75.4602458	1.057391726	3.506705349	1.585259448	5.257311599	1	3.737656149	0	0
5.065642304	10.6114682	0.041521441	0.155418827	0.086438457	0.323547623	1	11.87986295	0	0
98.76996844	212.8808931	1.664204095	6.225276963	0.764340117	2.85916189	3	8.64111372	1	1.833333333
21.38303974	45.54933374	0.418692833	1.617901863	0.228432138	0.882701474	2	39.71375037	0	0
152.8820193	330.5344578	1.518287125	5.680924563	1.897140215	7.098466601	4	16.31528667	0	0
67.32756921	145.5218297	21.22847822	81.58193631	11.37114575	43.69979227	1	3.386459275	2	3.666666667
158.1748786	343.3285269	0.359560225	1.391094894	0.436643329	1.68932007	2	9.877154162	1	1.333333333
9.936866199	21.03991811	0.004511272	0.017526253	0.001876482	0.007290115	3	29.47833013	0	0
3.500147405	7.335749194	0.017777904	0.068820167	0.007834858	0.030329573	1	85.52105798	0	0
52.35419411	112.307907	0.358136741	1.35493125	1.125501435	4.258086071	2	16.85063832	2	2
36.98632714	78.76213358	7.542321187	12.33837456	2.546263452	4.165395695	4	18.99270944	0	0
5.948938734	12.49538811	1.584350625	2.750341726	1.286218811	2.232802013	0	2.210576486	0	0
40.34097257	85.93587145	5.486582438	9.456926767	2.498848089	4.307129921	4	14.11885193	0	0
1820.490868	4026.58658	8.399569151	30.96448494	6.864945113	25.30718966	2	0.288906104	2	2.166666667
1841.227339	4072.838188	6.319249908	23.31220498	3.885438804	14.3336863	2	7.33573403	0	0
328.9228639	717.7850991	3.280139627	12.39561562	0.995093118	3.760447178	1	4.818459521	0	0
159.3678763	345.764722	0.055670826	0.211256485	0.013923177	0.05283488	1	7.623647964	0	0
108.8618802	235.3684678	0.850710061	3.228226156	0.175963814	0.667737474	1	67.3788543	0	0
332.3430372	725.2733357	2.30796552	8.719179761	0.661604108	2.499450314	2	5.607973736	2	2
1787.76098	3953.33912	2.841576339	10.46076383	1.266982144	4.664172068	4	9.207698243	0	0
1749.030893	3867.213478	12.98868869	47.87648241	5.541873205	20.42741969	4	19.39791726	0	0
1731.730656	3828.715399	3.636151645	13.41297009	2.364048262	8.720458257	2	46.96520263	0	0
357.6348909	780.8331571	1.362953635	5.113015425	0.537656514	2.016976939	4	19.83368541	0	0
31.74887662	67.94675263	0.446848733	1.294539186	0.115372791	0.334239728	3	6.265796421	1	1.833333333
95.04103416	204.6500328	9.990653523	33.06420656	26.83645872	88.81563279	4	2.086897127	3	3.166666667
9.425645642	19.97515227	0.828754436	2.507236377	0.210486015	0.636784759	1	2.632625942	1	1.666666667
20.52907962	43.8197293	0.29972249	1.169193975	0.120085477	0.468444047	1	1.818161095	0	0
1336.734105	2946.573812	3.67084988	13.43367959	1.26718682	4.637340746	4	1.322470318	1	2.5
605.715819	1322.547636	4.183401843	14.86942897	4.220508646	15.00132091	4	24.15343529	0	0
595.7350855	1300.668167	5.572806642	19.85460691	3.238661285	11.53859283	4	25.79214236	0	0

SD	Invasive_1	IMP_POT	IBI	O_E	EPT_taxa	MTTI	Temp_stress	Sed_stress
1.169045194	High	19.15207095	19	0.45947705	3.5	22.7022691	19.27385	45.36146387
0.836660027	High	27.35154069	17	0.24192787	1	23.08474456	21.5646	81.98532271
0		76.8491928						
0	High	25.62782359						
1.505545305	Medium	74.98926959	24	0.435939126	5	20.39379129	17.899	15.89195939
0.816496581	Medium	72.81052729	20	0.43736262	5	27.42795287	22.0311	31.85593422
0.516397779	Medium	64.88709878	24	0.534575432	7	23.13493407	21.7692	60.14804379
0.516397779	Medium	92.45134681	20	0.534542546	6	25.47523597	21.79	45.93721662
1.760681686	Low	10.7256016	16	0.242071222	0	19.86984033	20.478	33.95835815
1.264911064	Medium	10.47924747	18	0.24205449	0	24.26189799	19.8373	57.21520861
2.041241452	High	67.97131031	18	0.290042157	1	20.63185568	17.5733	23.32411453
0	Low	39.85040058						
0	High	52.43055587						
0.752772653	High	26.74315915	22	0.338462158	3	24.12810147	21.8107	55.78348
0	Medium	8.709242366						
0	Medium	29.82242554						
1.366260102	High	21.7007018	30	0.435745448	7	20.12577755	16.9442	30.35048485
0.816496581	High	17.45698505	16	0.241720259	1	24.99315241	24.63	75.25980944
0	High	28.28793635						
0	High	5.854409947						
0.894427191	High	0	16	0.339065141	1	25.90333898	21.0659	51.41066968
0	High	331.7734118						
0	High	134.4372006						
0	Low	291.679925						
0.98319208	Medium	30.00440613	20	0.435281945	5	26.94930878	24.1319	30.89216148
0	Medium	29.77306101						
0	Low	14.31926311						
0	Medium	11.41168179						
0	High	8.582136343						
0.894427191	Low	14.38315187	18	0.387001417	0	23.25392648	22.5921	48.73873547
0	Low	30.4838907						
0	Low	30.33767395						
0	Medium	30.22828891						
0	High	16.3408803						
1.329160136	Medium	58.60323094	14	0.242639753	1	24.23032432	19.083	69.51481491
1.471960144	Medium	38.44461062	22	0.485263276	2	21.4886537	18.2009	28.95276328
1.032795559	Low	59.58104644	18	0.194135503	0	23.85727601	20.8493	78.42120451
0	Low	24.25278718						
1.516575089	Medium	33.88899846	20	0.290268473	3	24.95262793	20.2756	23.43455124
0	Medium	48.88094405						
0	Medium	46.76005529						

OBJECTID	FID_1	Stream	Site	DT24	DA	VW	MBS	SLOPE	TEMP21	TEMP24	pH21	pH24
42	26	MT SCOTT	MS150	2024/10/24	2.523462805	60.76429868	9.146901902	0.022681858	0	8.7	0	7.49
43	27	MT SCOTT	MS170	2024/10/29	2.045257102	59.84848226	9.040268664	0.024722923	0	11.4	0	7.02
44	28	MT SCOTT	MS180	2024/10/29	1.827376076	49.24309032	8.880078672	0.046529011	0	11.5	0	7.23
45	29	MT SCOTT	MS190	2024/10/29	1.805544943	40.18911027	8.88001623	0.016051348	0	11.7	0	6.44
46	30	MT SCOTT	MS210	2024/10/24	1.495776112	138.2989652	8.689315215	0.00016408	0	9.2	0	6.81
47	31	MT SCOTT	MS230	2024/10/29	1.001906923	108.8175168	8.13851945	0.014483936	0	11.9	0	6.8
48	32	MT SCOTT	MS240	2024/10/29	0.617103981	97.69852603	8.13828944	0.007326726	0	11.9	0	6.46
49	33	MT SCOTT	MS250	2024/10/29	0.14094297	78.4	8.13828944	0.016676711	0	10.6	0	6.11
50	34	MT SCOTT	MS260	2024/10/24	3.914259792	93.51385903	8.733071942	0.018865362	0	8	0	7.48
51	35	MT SCOTT	MS280	2024/10/24	5.283614311	267.1488317	8.87557423	0.008744326	0	8.6	0	7.4
52	36	MT SCOTT	MS290	2024/10/24	5.31347378	300.2293638	8.863278653	0.001376581	0	9.4	0	7.19
53	37	MT SCOTT	MS300	2024/10/18	6.128371808	325.3105068	8.686437153	0.005032558	0	12.3	0	7.06
54	38	MT SCOTT	MS310	2024/10/18	7.224891069	376.1451683	7.931308988	0.007470018	0	12.3	0	7.14
55	39	MT SCOTT	MS320	2024/10/03	7.224957891	300.9032383	7.931386008	0.007759515	0	0	0	0
56	40	MT SCOTT	MS330	2024/10/16	7.366251435	248.5086146	7.877145268	0.012142083	0	14.7	0	7.28
57	41	MT SCOTT	MS340	2024/10/16	7.499177044	323.6473086	7.828173068	0.005362409	0	14.9	0	7.14
58	42	MT SCOTT	MS350	2024/10/24	9.153489383	243.3824673	7.118824057	0.001006395	0	9.8	0	6.91
59	43	MT SCOTT	MS360	2024/10/24	9.201221664	277.4828268	7.100931516	0.00245291	0	9.8	0	6.79
60	44	MT SCOTT	MS365	2024/10/02	9.305829555	292.6738332	7.085480969	0.002230383	0	0	0	0
61	45	MT SCOTT	MS380	2024/10/02	9.317565387	238.9147238	7.090033453	0.001187284	0	0	0	0
62	46	MT SCOTT	MS40	2024/10/03	7.241161442	461.7242704	7.932148348	0.003064264	15.5	12.6	7.74	7.29
63	130	MT SCOTT	MS70	2024/10/24	3.548910151	103.1112412	8.486383997	0.007259842	0	9.3	0	7.02
64	47	MT SCOTT	MS80	2024/10/03	2.27220043	76.12954885	9.166364911	0.030006733	13.8	13.2	7.5	7.64
65	92	NETTLE	NE10	2024/09/26	0.520295875	45.99655715	7.206305888	0.060349915	0	0	0	0
66	93	OSWEGO	OS10	2024/09/27	0.454002224	100.2855809	7.400163772	0.013303407	0	0	0	0
67	94	PECAN	PE10	0000/00/00	0.027676614	51.49105073	9.8280828	0.026375371	0	0	0	0
68	95	PECAN	PE40	2024/09/30	0.543819189	42.67157895	9.895731318	0.054909272	11.8	0	7.75	0
69	96	PECAN	PE60	2024/09/30	0.547546055	44.75048521	9.92587577	0.052033418	0	0	0	0
70	97	PECAN	PE70	2024/09/30	0.325487518	50.73955328	7.901117538	0.079800501	0	0	0	0
71	98	PECAN	PE80	2024/09/30	0.007061514	51.8018303	7.572354099	0.137586952	0	0	0	0
72	48	PHILLIPS	PH10	2024/10/03	1.040514598	45.9640208	3.655356482	0.010930896	15.9	8.8	7.5	7.65
73	49	PHILLIPS	PH120	2024/10/30	0.011562805	27.6	2.952035756	0.001064171	0	13	0	7.07
74	50	PHILLIPS	PH20	2024/10/03	1.039490638	29.91614433	3.645268821	0.018819944	0	0	0	0
75	51	PHILLIPS	PH40	2024/10/30	0.814443185	47.08044098	3.424130552	0.000805637	0	12.5	0	6.91
76	52	PHILLIPS	PH60	2024/10/30	0.584841176	43.32251952	3.481192423	0.011981583	0	12	0	6.8
77	53	PHILLIPS	PH70	2024/10/30	0.408690387	27.63943923	3.539226117	0.016262963	0	12.2	0	6.82
78	60	ROCK	RC10	2024/10/04	8.407454268	75.00024281	8.321762357	0.023961035	11.5	10.7	7.93	7.66
79	61	ROCK	RC110	2024/10/04	5.248064311	143.4952149	8.635916705	0.000695237	0	11.5	0	6.74
80	62	ROCK	RC150	2024/10/29	2.498157568	79.77591033	9.215089109	0.017183586	0	10.5	0	6.94
81	63	ROCK	RC180	2024/10/29	0.863115818	117.421229	8.543596199	0.009754361	0	10.8	0	6.83
82	64	ROCK	RC30	2024/10/04	6.98501363	58.949447	8.463119956	0.0140016	13.5	12.8	7.93	7.48

DO21	DO24	COND21	COND24	BFW21	BFW24	BTW21	BTW24	BFD21	BFD24	BTD21	BTD24	RD21
0	13.73	0	119.7	24.6	21.1	25	36.2	2.2	1.7	2.5	2.5	0.4
0	10.72	0	119.9	24.6	20.2	27.5	27.2	1.7	1.2	2.3	1.8	0.4
0	10.76	0	122.9	28.3	13.9	28.3	16.9	2.7	2.6	2	2.6	0.3
0	9.75	0	124.8	22.3	16.5	27.6	21.6	2.5	1.6	3	3.3	0
0	9.5	0	125.2	15	12.7	21	17.5	2.6	3	2.8	3.7	1.4
0	8.85	0	135.8	10.6	14.8	16.2	14.8	2	2.3	1.9	2.3	1.1
0	6.95	0	127.7	14.5	21.9	20	28.4	2.3	1.5	2.3	1.9	0.7
0	3.29	0	103.2	5.5	6	9	6	0.9	1.1	1.4	1.1	0.2
0	13.92	0	128.9	35	32.3	41	50	3.1	3.4	6	13	0.5
0	12.94	0	135.4	17.5	19	22	34	3.3	3.4	4.4	5.7	0.6
0	11.8	0	134	41.8	19.9	53	53	3.7	4	3.8	8	2.5
0	8.5	0	148.3	17.3	10	21.3	15.8	1.5	1.7	2	2.3	0.5
0	8.81	0	148.1	11.3	9.1	16.9	13.2	2.6	1.1	3.2	3	0.9
0	0	0	0	18.5	11.5	26	17	2.3	1.4	2.8	2.9	0.4
0	8.39	0	171.3	22.4	18.4	25.4	20.8	3.7	2	6	4.5	2.1
0	7.62	0	189.2	19	23	27	30	3.9	1.8	6	5.5	2.6
0	10.8	0	159.7	25	27.7	27	36	2.6	3.3	3	5.5	1.2
0	10.9	0	159	24.7	20.6	28.7	24	4	2.3	5.5	8	0.9
0	0	0	0	28.5	25.33333333	31	28.66666667	3.3	2.3	2.5	3.366666667	2.3
0	0	0	0	25.8	23.83333333	31.7	28.83333333	2	1.666666667	2.8	3	0.9
9.16	8.91	180.4	165.1	21.76666667	16.43333333	27.1	19	1.7	1.666666667	4.233333333	2.833333333	0.566666667
0	12.6	0	123.1	32.4	23.6	38.4	30.8	2.5	2.7	2.5	4.2	0.8
9.38	10.19	144.5	141.1	17.575	16.7	33.525	26.36666667	2.05	1.066666667	2.625	2.666666667	1.025
0	0	0	0	0	13.4	0	21	0	1.266666667	0	2.766666667	0
0	0	0	0	0	22.83333333	0	23.66666667	0	1.366666667	0	1.366666667	0
0	0	0	0	11.3	0	15.6	0	2.9	0	3	0	1
10	0	48.7	0	16.16666667	9.366666667	21.63333333	12.83333333	2.833333333	1.366666667	2.933333333	2.766666667	0.466666667
0	0	0	0	11.7	8.466666667	17	11.8	2.6	0.866666667	2.5	2.566666667	0.5
0	0	0	0	11	7.533333333	15.5	12.26666667	2.1	1.3	2	1.933333333	0.4
0	0	0	0	7.6	11.53333333	10.1	14.6	1.4	1.3	1.7	2.533333333	0.3
9.05	10.14	157.1	151	8.65	12.36666667	20.8	18.16666667	1.35	1.466666667	1.85	2.5	0.9
0	9.93	0	119.9	6	10.1	9.8	32	1.1	2.5	1	3.1	1.1
0	0	0	0	9.5	11.2	20	20	1.5	1.8	1.4	2.5	1.1
0	9.01	0	140.8	10.2	12.2	12.1	12.2	1.5	2.2	2.2	2.2	0.4
0	8.24	0	123.5	11.7	10.6	22.3	21.4	1.8	2.2	4.1	2.9	0.6
0	10	0	121.4	8.7	11.2	12.5	21.2	1.7	1	2.4	2.5	1
10.89	10.71	95.5	192.3	39.13333333	28.36666667	42.33333333	36.6	2.866666667	2.566666667	4	4.566666667	0.9
0	4	0	113	24	26.5	28.5	30.1	6	4.4	5	5.3	4.4
0	10.01	0	101.2	14.9	16.3	21.6	21.9	1.9	2.2	1.6	2.9	0.7
0	10.06	0	98.6	16.7	10	22.7	14.5	2.3	1	3.1	3.5	0.8
10.82	10.24	187.7	130.4	26.1	28.06666667	29.83333333	37.63333333	2.733333333	2.533333333	2.633333333	4	1.133333333

RD24	PD21	PD24	WDR21	WDR24	CONF21	CONF24	RESD21	RESD24
0.2	2.4	0.9	11.18181818	12.41176471	2.430571947	1.678571787	2	0.7
0.4	0.7	0.5	14.47058824	16.83333333	2.176308446	2.200311848	0.3	0.1
0.5	0.9	0.7	10.48148148	5.346153846	1.740038527	2.913792327	0	0.2
0.5	0	0.6	8.92	10.3125	1.456127184	1.860606957	0	0.1
1.6	1.4	1.6	5.769230769	4.233333333	6.585665012	7.902798014	0	0
2.1	1.6	2.2	5.3	6.434782609	6.717130669	7.352534922	0.5	0.1
0.6	1.1	0.7	6.304347826	14.6	4.884926302	3.440088945	0	0.1
0.2	0	0.3	6.111111111	5.454545455	0	0	0	0.1
0.4	2	0.6	11.29032258	9.5	2.28082583	1.870277181	1.5	0.2
0.3	3.2	2.5	5.303030303	5.588235294	12.14312871	7.857318579	2.6	2.2
2.5	2.5	2.5	11.2972973	4.975	5.664704977	5.664704977	0	0
0.2	2.6	1.1	11.53333333	5.882352941	15.27279375	20.58927258	2.1	0.9
0.4	1.5	0.8	4.346153846	8.272727273	22.25711055	28.49584608	0.6	0.4
0.3	0.7	0.4	8.043478261	8.214285714	11.57320147	17.70019049	0.3	0.1
0.4	0	2.1	6.054054054	9.2	9.783803723	11.94752955	0	1.7
0.6	3	1.3	4.871794872	12.77777778	11.98693736	10.78824362	0.4	0.7
0.4	3.7	0.9	9.615384615	8.393939394	9.014165457	6.760624093	2.5	0.5
0.5	2	0.5	6.175	8.956521739	9.668391176	11.56178445	1.1	0
0.5	0	1.6	8.636363636	11.01449275	9.441091393	10.20955232	0	1.1
0.433333333	2.5	1.7	12.9	14.3	7.536742076	8.286059785	1.6	1.266666667
0.25	1.3	0.866666667	12.80392157	9.86	17.03779596	24.30127739	0.733333333	0.616666667
0.6	1.5	1.1	12.96	8.740740741	2.685188572	3.347767571	0	0.5
0.171428571	1.8	0.633333333	8.573170732	15.65625	2.270829198	2.887340664	0.775	0.461904762
0.142857143	0	0.4	0	10.57894737	0	2.190312245	0	0.257142857
0.514285714	0	1.033333333	0	16.70731707	0	4.23741891	0	0.519047619
0	0	0	3.896551724	0	3.30070838	0	0	0
0.157142857	1.033333333	0.3	5.705882353	6.853658537	1.972492093	3.3250581	0.566666667	0.142857143
0.166666667	0	0.3	4.5	9.769230769	2.632381483	3.792414001	0	0.133333333
0.166666667	0.5	0.233333333	5.238095238	5.794871795	3.273519566	4.136376626	0.1	0.066666667
0.133333333	0.7	0.3	5.428571429	8.871794872	5.128894089	3.548070569	0.4	0.166666667
0.242857143	1.85	0.9	6.407407407	8.431818182	2.209808692	2.530129585	0.95	0.657142857
0.6	1.8	1.2	5.454545455	4.04	0	0	0.7	0.6
0.4	1.1	0.6	6.333333333	6.222222222	1.495807216	1.495807216	0	0.2
0.2	1.7	1	6.8	5.545454545	3.890945536	3.859052539	1.3	0.8
0.2	0.9	0.4	6.5	4.818181818	1.94271388	2.0244168	0.3	0.2
0.5	1.4	0.6	5.117647059	11.2	2.211155139	1.303747134	0.4	0.1
0.5	1.6	0.733333333	13.65116279	11.05194805	1.771659279	2.049186962	0.7	0.233333333
2.7	0	2.9	4	6.022727273	5.034919821	4.767282887	0	0.2
0.2	1.5	1.1	7.842105263	7.409090909	3.693329182	3.642735632	0	0.9
0.2	1.2	0.4	7.260869565	10	5.172741364	8.098015791	0	0.2
0.342857143	1.466666667	1.033333333	9.548780488	11.07894737	1.975959117	1.566415775	0.333333333	0.69047619

LWD21	LWD24	SUB21	SUB24	BEDR21	BEDR24	EMBED21	EMBED24	CAN19	IMP23	Q2_nat	Q25_nat
True	True	Gravel	Gravel	True	False	False	False	35.12402482	65.38247364	124.8790004	271.7064766
True	False	Gravel	Gravel	True	False	False	True	35.38820853	62.51995028	102.7869076	223.2754005
True	True	Gravel	Gravel	False	False	False	False	34.33622846	62.36349777	92.09685746	199.8981894
True	True		Boulder	True	True		False	34.36460881	62.07706282	91.10529553	197.7265068
False	True	Fines	Fines	True	False	True	False	33.63238956	60.37607622	76.12316593	164.984543
True	True	Gravel	Fines	False	False	False	True	32.77604816	58.16318344	51.45875605	111.2208217
True	True	Gravel	Boulder	False	False	False	False	32.76832827	58.15800659	33.26191176	71.60581218
True	False	Gravel	Fines	False	False	False	True	32.76832827	58.15800659	8.800497912	18.71757275
True	True	Gravel	Boulder	False	False	False	False	35.68791067	68.79769234	181.4315919	396.3215579
True	True	Gravel	Gravel	True	False	False	False	35.48806793	68.98971453	239.5072436	524.4034143
True	True	Gravel	Fines	False	False	False	True	35.56487325	69.03555239	240.5689964	526.758315
True	True	Gravel	Gravel	False	True	False	False	35.08002924	68.36326205	270.9723315	594.120912
True	False	Gravel	Gravel	True	False	False	False	32.0532946	72.98693045	301.1253841	661.6059757
True	True	Gravel	Gravel	False	False	False	False	32.05392302	72.98625541	301.1292647	661.6145005
True	True	Fines	Gravel	True	True	True	False	32.36914133	72.32400091	305.4409105	671.2311009
True	True	Fines	Gravel	True	True	True	True	32.6684847	71.89795661	309.4917403	680.2668154
False	True	Gravel	Gravel	False	False	False	False	30.02536477	75.27623588	354.1861473	780.3720579
True	True	Cobble	Gravel	False	False	False	False	29.95854639	75.39699207	355.4285189	783.1585197
True	True	Gravel	Gravel	False	False	False	True	29.87522756	75.56434519	358.6978178	790.4492036
True	True	Cobble	Gravel	False	False	False	True	29.89702755	75.53211993	359.2134088	791.5895057
True	True	Gravel	Gravel	False	False	False	False	32.15130467	72.87496352	301.7508966	662.9919641
True	True	Gravel	Gravel	True	True	False	False	34.11116308	69.70727419	163.8906149	357.7992919
True	False	Cobble	Gravel	False	False	False	False	35.11711368	64.2636386	113.738987	247.2515574
	True		Gravel		True		False	41.91926402	61.27254599	26.94146446	57.9745178
	True		Gravel		False		False	33.98672515	54.71921504	24.12887399	51.85317989
False		Gravel		True		False		44.05982902	29.15340347	2.22052597	4.653136869
False	True	Gravel	Gravel	True	True	False	False	42.2685438	31.00702765	32.53713348	69.86357857
False	True	Gravel	Gravel	False	False	False	False	42.49705497	30.86041779	32.78462119	70.39721255
True	True		Gravel	True	False		False	28.52464461	37.37830858	18.44012772	39.49931759
True	True	Cobble	Boulder	True	False	False	False	25.92034924	38.95667326	0.57432767	1.192590235
False	True	Gravel	Gravel		False	False	False	14.98684988	99.29940995	36.56276371	79.55755128
True	False	Fines	Fines	False	False	True	True	11.26567521	99.95342062	0.575330563	1.208587185
False	True	Gravel	Gravel	False	False	False	False	14.92063277	99.29871983	36.48299858	79.38510309
True	False	Gravel	Gravel	False	False	False	False	16.58217687	99.31544802	28.43961261	61.7903602
True	False	Gravel		False	False	False	False	16.83525506	99.75459622	21.27137274	46.08459756
True	False	Fines	Fines	False	True	True	True	14.98523626	99.98388666	15.52477215	33.53140856
False	True	Cobble	Gravel	True	True	False	False	37.89729202	28.5326975	353.0386559	776.3314531
False	True		Gravel	True	False		False	41.99022695	19.5203864	235.0159258	514.6538346
False	False	Gravel	Gravel	True	False	False	False	44.96988009	18.03174084	124.1831498	270.1540932
False	False	Gravel	Gravel	True	False	False	False	41.80643071	15.26322108	46.03150305	99.33040155
True	False		Bedrock	True	True		False	39.35045414	25.5084615	301.1459398	661.1246257

Q2_EC	Q25_EC	SSPQ2_PD	SSPQ2_EC	SSPQ25_PD	SSPQ25_EC	Infra	snap_dist	BIN_O_E	Mean
437.650892	952.2224031	5.778830332	20.25248634	6.331745601	22.19023296	2	8.090058967	0	0
355.4212481	772.0518434	5.768969725	19.94820612	5.758122355	19.91069759	2	15.28145619	0	0
318.2174205	690.6976845	9.453127834	32.66289468	11.79181659	40.74364275	4	8.115099259	0	0
314.3568796	682.2510956	3.307801139	11.4134973	4.930163878	17.01142534	1	38.21823184	0	0
260.4811543	564.5504057	0.04050753	0.138610214	0.012220078	0.04181513	2	29.33050532	0	0
174.122035	376.3401467	3.001978064	10.15785397	0.924202666	3.127243278	2	22.42574194	0	0
112.5459991	242.2875669	0.760712445	2.573969371	0.335245975	1.134348306	1	56.33957052	0	0
29.77762785	63.33333876	1.018048524	3.444699424	0	0	4	136.8551702	0	0
645.632037	1410.327121	4.696345008	16.71214347	4.991489899	17.76242912	3	14.57651421	0	0
853.0096751	1867.67289	4.669606585	16.63089406	1.071598021	3.816517052	4	55.99768112	0	0
856.9618682	1876.433773	0.390084711	1.389571089	0.150783346	0.537124814	1	15.91621037	0	0
962.4358269	2110.190542	4.589476567	16.3008402	0.57379779	2.038007156	3	45.92939602	0	0
1090.739138	2396.475255	9.330950107	33.79865336	0.820273973	2.971203936	3	504.9794071	0	0
1090.750168	2396.499484	6.784883446	24.57619908	1.065138398	3.858143405	1	7.702446461	0	0
1103.346543	2424.693252	10.02309321	36.20649645	2.047468204	7.396085091	5	17.82704369	0	0
1115.99957	2452.981371	3.63544442	13.10908784	0.703656319	2.537321833	5	24.24555725	0	0
1294.878261	2852.982311	0.706452199	2.582736793	0.201453207	0.736497968	2	4.972691775	0	0
1300.045277	2864.546542	2.065601995	7.555319778	0.432203778	1.580864929	2	13.47498476	0	0
1312.876309	2893.137291	1.67417083	6.127662648	0.376064975	1.376442153	5	3.192217331	0	0
1314.595199	2896.940199	0.879702604	3.219403261	0.245586814	0.898761678	4	3.248400285	0	0
1092.501581	2400.389783	2.504362394	9.06714746	0.27469142	0.99453163	5	16.36094603	1	2.333333333
585.5143115	1278.270914	2.411703188	8.61603169	1.572729205	5.618719888	2	3.63790066	0	0
396.5509088	862.0424038	7.115165347	24.80701964	6.084120735	21.21228323	4	1.404627557	3	2.5
92.59786576	199.2585305	4.833613261	16.61313818	4.748777421	16.32155723	1	22.68600198	3	3.666666667
80.16393236	172.2730537	0.846751893	2.813183967	0.429430726	1.426707922	2	6.510089295	1	1.333333333
6.107488189	12.79830943	0.234381416	0.644658855	0.148801047	0.409272691	0	21.387009	0	0
91.1627316	195.7441846	6.472156617	18.13372641	5.612432513	15.72494636	5	18.7671036	5	5
91.72563148	196.9590784	7.39576954	20.69206862	5.110147152	14.29729725	5	11.45478234	0	0
54.64492299	117.0510964	6.617121795	19.60898083	3.878304534	11.49285167	5	14.01417276	0	0
1.723194496	3.578209858	0.399450865	1.198499686	0.197750107	0.59332314	1	121.5903324	0	0
145.2522994	316.0569959	1.280633424	5.08755167	1.181170176	4.692415632	2	1.133869164	1	2.666666667
2.290112111	4.810799789	0.001828841	0.007279729	0	0	2	138.9826561	0	0
144.9351156	315.3712562	2.143246829	8.514424222	3.117777026	12.38591648	1	0.906788384	0	0
112.9870626	245.4854569	0.117728028	0.46771889	0.066010447	0.262251341	3	7.196860597	0	0
84.62046206	183.3309014	0.728201549	2.896886452	0.79570047	3.165406497	2	11.02918576	0	0
61.80224332	133.4844886	0.935445167	3.723894255	1.23173016	4.903369033	1	3.676826581	0	0
964.7729327	2121.534173	13.38106604	36.56735632	15.48400894	42.31421251	2	23.25066825	5	4.5
573.1176931	1255.052046	0.357914079	0.872821238	0.15566972	0.379621382	1	8.717165384	0	0
295.715418	643.3137724	6.167598014	14.68680596	3.632845457	8.650838815	1	5.911647901	0	0
104.2675129	224.9966488	1.234870621	2.797147168	0.515142913	1.166867618	1	43.30168264	0	0
795.7603424	1746.982739	7.803487764	20.62025508	9.803352033	25.90477818	2	4.323463287	3	3

SD	Invasive_1	IMP_POT	IBI	O_E	EPT_taxa	MTTI	Temp_stress	Sed_stress
0	Low	51.08608105						
0	Low	58.3093574						
0	Low	57.31911396						
0	Low	57.66070827						
0	Low	63.33184595						
0	Low	75.54142539						
0	Medium	83.89139602						
0	Medium	17.2282437						
0	Medium	49.77725341						
0	Medium	48.33657572						
0	Medium	48.45851391						
0	Low	53.13459387						
0	Low	41.55640531						
0	Low	41.5754219						
0	Low	41.29195295						
0	Low	41.22653273						
0	High	34.40273897						
0	High	34.29363134						
0	Medium	34.24918841						
0	Low	34.2733946						
1.032795559	Low	41.57049236	24	0.338544479	6	26.49705372	20.9603	32.58499565
0	Low	44.78347176						
1.048808848	Low	53.83279988	22	0.586492395	8	30.01661431	21.8062	29.44559071
1.211060142	Low	54.71297195	22	0.484357251	9	21.75538676	16.9778	19.28550618
0.816496581	Low	0	16	0.290527296	3	28.07989308	25.1728	42.36384812
0		94.80671449						
0	Medium	56.32667161	40	0.871591578	17	19.42236334	17.7936	20.8536196
0	Low	56.62166401						
0	Low	53.42112093						
0	Low	52.61500742						
1.861898673	High	6.025835224	17	0.241810888	2	20.5767904	18.892	23.93195169
0	Medium	0.243557086						
0	High	6.008382583						
0	High	6.52790664						
0	Medium	6.452972777						
0	Low	5.960358529						
0.547722558	Medium	147.1592132	30	0.821756398	13	19.98771229	18.4313	10.73511805
0	Low	214.7985324						
0	Medium	117.1733699						
0	Medium	111.5289786						
0.632455532	Low	148.0231557	22	0.628354928	10	23.30896039	21.4246	29.59654771

OBJECTID	FID_1	Stream	Site	DT24	DA	VW	MBS	SLOPE	TEMP21	TEMP24	pH21	pH24
83	65	ROCK	RC50	2024/10/07	2.407948386	111.7268784	9.310536591	0.016447857	13.2	10.3	7.6	7.19
84	66	ROCK	RC60	2024/10/29	0.749151865	40.86	12.45738381	0.006737303	0	10.8	0	6.22
85	67	ROCK	RC70	2024/10/29	8.243484792	100.497547	8.246778557	0.014650966	0	11.7	0	7.72
86	59	RIVER FOREST	RF10	2024/09/27	0.144303443	3.17724387	3.87180457	0.001057219	0	0	0	0
87	54	RICHARDSON	RI10	2024/10/07	3.535512159	42.30372369	7.236665527	0.027524975	12.2	10.5	7.56	7.47
88	55	RICHARDSON	RI20	2024/10/07	0.039988343	200.5380502	7.306795453	0.003117385	0	12.3	0	6.48
89	56	RICHARDSON	RI30	0000/00/00	3.156947238	61.42274819	7.230931981	0.032441347	0	0	0	0
90	57	RICHARDSON	RI40	2024/10/30	0.622586621	43.953652	6.06138059	0.036855935	0	0	0	0
91	58	RINEARSON	RN10	2024/09/25	0.638295301	58.08267734	4.000219146	0.009955669	0	0	0	0
92	99	SAUM	SA10	2024/10/01	4.171169118	129.2999143	6.442235569	0.008498793	14.2	11.9	7.26	7.48
93	100	SAUM	SA100	2024/10/01	4.217891966	211.9886148	6.468834172	0.005324801	0	12.4	0	7.69
94	101	SAUM	SA110	2024/10/14	2.729552152	148.0106774	5.791014606	0.003262344	0	13.5	0	7.16
95	102	SAUM	SA20	2024/10/01	0.589560043	91.94	6.899771349	0.011462575	0	11.9	0	7.48
96	103	SAUM	SA40	2024/11/07	0.186964993	34.17	5.250198007	0.01114843	0	11.2	0	5.88
97	104	SAUM	SA80	2024/10/14	2.909219333	104.7332591	5.826576554	0.005192865	0	12.5	0	7.39
98	105	SAUM	SA90	2024/10/14	4.022297561	93.76924071	6.399690484	9.54882E-05	0	11.9	0	7.28
99	109	SPRINGBROOK	SB10	2024/09/26	1.099365495	159.0612604	8.850446322	0.014779026	0	0	0	0
100	110	SPRINGBROOK	SB20	2024/09/26	0.981576865	89.57854237	8.938623871	0.027072287	0	0	0	0
101	106	SHIPLEY	SH10	2024/10/09	0.132989849	56.92728432	8.684030074	0.023386751	12	13.5	7.42	7.16
102	107	SHIPLEY	SH20	0000/00/00	0.032164993	31.89	6.735013321	0.059307957	0	0	0	0
103	108	SHIPLEY	SH50	2024/11/07	0.162526184	50.23853488	8.804765362	0.012796102	0	0	0	0
104	68	SIEBEN	SI10	2024/10/07	1.81428411	52.93349951	7.899102312	0.013241938	14.4	13.2	7.7	7.65
105	69	SIEBEN	SI45	2024/10/18	0.717262231	39.06120491	10.10374196	0.04636391	0	10.7	0	7.13
106	70	SIEBEN	SI70	2024/10/24	0.107271736	92.05427695	12.98707536	0.044996488	0	0	0	0
107	71	SIEBEN	SI90	2024/10/24	0.020413343	22.08	12.98707536	0.056787381	0	11	0	6.29
108	72	SINGER	SN10	2024/09/24	0.00665477	39.3414209	5.896124218	0.041594086	0	14.8	0	0
109	116	TRIB 2	T210	2024/10/09	0.42863759	58.46626503	12.2144317	0.041177531	0	13.7	0	7.2
110	117	TRIB 2	T220	2024/11/01	0.359166499	51.90615084	13.1798991	0.032512456	0	10.8	0	7.05
111	118	TRIB 2	T230	2024/11/01	0.331306528	37.2328245	13.17701807	0.057426051	0	10.9	0	7.02
112	119	TRIB 2	T240	2024/11/01	0.204771306	45.77796923	12.35664028	0.055956001	0	11.2	0	6.66
113	120	TRIB 4	T410	2024/09/30	0.039285258	54.46704844	10.99876516	0.009841719	0	0	0	0
114	121	TRIB 4	T420	2024/10/30	0.599995265	130.0136204	10.77822868	0.014777883	0	9.8	0	7.05
115	122	TRIB 4	T440	2024/10/30	0.140673422	40.34793362	9.660406139	0.07210614	0	10.4	0	6.76
116	112	TATE	TA10	2024/10/09	0.102622274	135.0103097	10.56861529	0.030291521	13.7	13.7	7.53	7.29
117	113	TATE	TA30	0000/00/00	0.271122418	47.82675084	10.08577016	0.179391728	0	0	0	0
118	114	TATE	TA40	2024/10/30	0.090030344	72	8.057865034	0.097854758	0	0	0	0
119	115	TATE	TA50	0000/00/00	0.006727403	48.22567216	10.56535557	0.071041614	0	0	0	0
120	111	TANNER	TN10	2024/09/24	0.750241033	251.0641344	8.555315788	0.01734248	0	17.5	0	0
121	73	TRILLIUM	TR10	2024/10/04	0.182301004	26.19634277	7.50383027	0.042041571	12.1	11.2	8.23	7.82
122	74	TRILLIUM	TR30	2024/10/29	0.676687661	106.0622381	6.7132913	0.156186563	0	13.5	0	7.06
123	75	TRILLIUM	TR50	2024/11/01	0.560877547	46.45469764	6.199168686	0.055504408	0	12.5	0	7.21

DO21	DO24	COND21	COND24	BFW21	BFW24	BTW21	BTW24	BFD21	BFD24	BTD21	BTD24	RD21
8.56	10.79	132.8	120.4	13.13333333	11.53333333	21.7	19.66666667	2.9	1.5	4.266666667	4.066666667	0.633333333
0	5.41	0	118.3	12.5	8.8	24.5	21.1	2.8	1.9	6	2.7	0.7
0	11.21	0	141.2	34.5	33	39.5	33	3.2	1.9	2.8	1.9	1
0	0	0	0	0	8.966666667	0	10.66666667	0	1.1	0	1.4	0
10.08	11.72	57.8	108.9	25.63333333	17.36666667	34.76666667	25.4	2.133333333	1.333333333	2.366666667	4.333333333	0.566666667
0	2.05	0	104.4	15	36.43333333	18	45.46666667	3.6	2.033333333	3	2.966666667	2.5
0	0	0	0	25.2	0	29	0	2.4	0	2.7	0	0.7
0	0	0	0	11	13.2	14.5	13.2	1.5	1.1	1.1	1.1	0.5
0	0	0	0	0	8.1	0	9.833333333	0	2.066666667	0	3.566666667	0
7.47	9.06	207.2	202.8	12.73333333	10.23333333	17.16666667	18.23333333	3.033333333	2	3.233333333	4.433333333	1.666666667
0	9.84	0	204.1	14	10.3	20	16.26666667	2.4	1.866666667	5.3	4.4	1.1
0	7.98	0	217.9	12.2	10.1	14	1.7	2.4	3.3	3.9	14.2	1.4
0	9.06	0	202.8	9.5	11.8	15.5	16.1	2.7	2.5	3.3	4.4	0.5
0	3.6	0	107	5.6	5.8	9	9.1	1.1	1.6	1.1	2.2	0.3
0	9.09	0	216.9	11.6	11	16.6	14.5	3.4	2.4	3.9	3.8	2
0	8.79	0	217.1	11.2	10	1	10	2.9	2.5	4.7	2.5	1.3
0	0	0	0	0	9.233333333	0	15	0	1.266666667	0	3.833333333	0
0	0	0	0	0	10.8	0	17.56666667	0	1.7	0	2.633333333	0
8.93	10.23	89.5	231.5	5.666666667	5.966666667	13.06666667	17.66666667	1.233333333	2.366666667	2.4	4.666666667	0.533333333
0	0	0	0	6	0	12.6	0	1.9	0	4.1	0	0.3
0	0	0	0	6.5	5.6	11.2	9	2.6	1.1	4.6	3.9	0.5
9.2	10.99	143.6	172.1	12.6	13.7	18.43333333	19	3.233333333	3.75	11.03333333	11	0.666666667
0	10.27	0	124.4	11.5	14	14	20.5	1.4	2.3	9	5.9	0.5
0	0	0	0	5.4	2	5.4	4.2	1.2	1.4	1	1.5	0.2
0	3.41	0	130.7	5	13.6	11	35	1.3	2.4	1.1	5	0.7
0	9.7	0	100.8	0	4.633333333	0	5.9	0	1.2	0	2.333333333	0
0	10.1	0	98.6	6.333333333	3.9	15.86666667	11.2	1.3	0.733333333	1.833333333	2.533333333	0.333333333
0	10.69	0	91.6	6.3	6	14	7.5	1.4	1.3	4.4	1.8	0.3
0	10.7	0	93.3	8.3	7.5	17.5	8	1.3	1.3	2.4	1.5	0.4
0	10.37	0	93.7	8.6	8	20	8.5	0.5	1.1	1	1.5	0.2
0	0	0	0	13.3	4.833333333	20.3	6.4	1.6	1.333333333	1.8	2	0.4
0	11.04	0	177	14.8	9.1	17.4	12.2	3.1	1.7	3.9	4.2	0.8
0	10.8	0	190.9	4.5	4	6.5	9.2	1	1.8	1.2	2.4	0.2
9.16	9.74	217.5	250.1	6.866666667	7	12.43333333	16.6	2.233333333	2.1	3.9	7.166666667	0.6
0	0	0	0	11.7	0	12	0	2.1	0	2.1	0	0
0	0	0	0	6	6	8.5	7	1.5	1.1	1.3	1	0.2
0	0	0	0	6.7	0	12	0	1.7	0	1.9	0	0.8
0	8.4	0	129.8	0	8.066666667	0	11.7	0	1.333333333	0	3.2	0
9.97	10.42	184.9	176.3	17.9	12.5	23.6	22.5	2.65	2.9	4.2	4.6	0.525
0	9.5	0	106	18.1	13	28	24	2.6	3.9	6	5.5	0.6
0	10.37	0	89.4	12.6	6.5	17.7	14.8	2.9	0.8	3.7	2.4	0.5

RD24	PD21	PD24	WDR21	WDR24	CONF21	CONF24	RESD21	RESD24
0.385714286	1	0.533333333	4.528735632	7.688888889	5.148704075	5.681027716	0.366666667	0.147619048
0.2	1.6	0.3	4.464285714	4.631578947	0	1.936492891	0.9	0.1
0.6	3	1.2	10.78125	17.36842105	2.544241696	3.045380212	0	0.6
0.2	0	0.833333333	0	8.151515152	0	0.297866613	0	0.633333333
0.314285714	0.7	0.4	12.015625	13.025	1.216789751	1.665500933	0.133333333	0.085714286
0.966666667	3	1.066666667	4.166666667	17.91803279	11.14100279	4.410660927	0.5	0.1
0	1.4	0	10.5	0	2.118025799	0	0	0
0.1	0	0	7.333333333	12	3.031286345	3.329822121	0	0
0.333333333	0	1	0	3.919354839	0	5.90671295	0	0.666666667
0.783333333	2.466666667	1.133333333	4.197802198	5.116666667	7.532033844	7.091402979	0.8	0.35
0.4	1.1	0.633333333	5.833333333	5.517857143	10.59943074	13.03208697	0	0.233333333
0.7	1.4	0.8	5.083333333	3.060606061	10.57219124	87.06510435	0	0.1
0.3	0.9	0.9	3.518518519	4.72	0	5.710559006	0	0.6
0.7	0.6	0.7	5.090909091	3.625	0	3.754945055	0	0
0.6	2.4	0.8	3.411764706	4.583333333	6.309232477	7.222983387	0.4	0.2
1.1	0	1.5	3.862068966	4	93.76924071	9.376924071	0	0.4
0.4	0	1.6	0	7.289473684	0	10.60408402	0	1.2
0.242857143	0	0.4	0	6.352941176	0	5.099347763	0	0.157142857
0.16	0.533333333	0.233333333	4.594594595	2.521126761	4.356679922	3.222299112	0	0.073333333
0	0	0	3.157894737	0	0	0	0	0
0.1	0.5	0.2	2.5	5.090909091	4.485583471	5.582059431	0	0.1
0.4	1.5	0.55	3.896907216	3.653333333	2.871618418	2.785973658	0.833333333	0.15
0.2	1	0.3	8.214285714	6.086956522	2.790086065	1.90542463	0.5	0.1
0	0	0	4.5	1.428571429	17.04708832	21.91768499	0	0
0.1	0	0.3	3.846153846	5.666666667	0	0	0	0.2
0.157142857	0	0.233333333	0	3.861111111	0	6.66803744	0	0.076190476
0.128571429	0.7	0.166666667	4.871794872	5.318181818	3.684848636	5.220202235	0.366666667	0.038095238
0.2	0.8	0.4	4.5	4.615384615	3.707582203	6.920820111	0.5	0.2
0.2	0.6	0.5	6.384615385	5.769230769	2.127589971	4.654103063	0.2	0.3
0.3	0.4	0.4	17.2	7.272727273	2.288898462	5.385643439	0.2	0.1
0.225	0.733333333	0.233333333	8.3125	3.625	2.683105835	8.510476319	0.333333333	0.008333333
0.4	1.2	0.6	4.774193548	5.352941176	7.472047151	10.65685413	0.4	0.2
0.2	1.8	0.3	4.5	2.222222222	6.207374403	4.385644959	1.6	0.1
0.442857143	1.266666667	1	3.074626866	3.333333333	10.85873805	8.133151187	0.666666667	0.557142857
0	0	0	5.571428571	0	3.98556257	0	0	0
0	0	0	4	5.454545455	0	10.28571429	0	0
0	0.8	0	3.941176471	0	4.018806014	0	0	0
0.271428571	0	0.433333333	0	6.05	0	21.45847303	0	0.161904762
0.15	0.75	0.3	6.754716981	4.310344828	1.110014524	1.164281901	0	0.15
0.3	1	1	6.961538462	3.333333333	3.787937074	4.41925992	0	0.7
0.4	1.2	0.9	4.344827586	8.125	2.624559189	3.138830922	0.7	0.5

LWD21	LWD24	SUB21	SUB24	BEDR21	BEDR24	EMBED21	EMBED24	CAN19	IMP23	Q2_nat	Q25_nat
True	True	Gravel	Gravel	True	False	False	False	45.3704075	17.53882977	120.7207673	262.5210247
True	False	Gravel	Fines	True	False	False	False	59.67050002	11.80671521	48.37030828	103.9420572
True	True	Gravel	Gravel	False	False	False	False	37.88547259	28.74618526	345.3623101	759.3835225
	True		Gravel		True		False	24.28855313	94.09377656	6.342366506	13.57245752
True	True	Gravel	Gravel	False	False	False	False	35.93065258	32.7289481	151.5629513	331.2977216
True	True	Fines		False	False	True	True	36.19276371	32.59615998	2.691001179	5.669494273
True		Gravel		False		False		36.01005355	32.78819075	136.8186358	298.7927726
False	True	Gravel	Gravel	False	False	False	False	28.89088224	41.12971091	29.19631731	63.00635202
	False		Gravel		True		True	23.87359781	93.71353924	24.56592225	53.20126694
True	True	Fines	Fines	True	False	True	True	29.50970362	29.55628879	166.5467073	364.8835349
True	True	Fines	Gravel	False	False	True	False	29.74754607	29.66964414	168.5512607	369.2968255
False	True	Fines	Fines	False	False	True	True	22.43547747	26.33565	108.1392247	236.2988228
False	True	Gravel	Gravel	False	False	False	False	32.69307889	28.59166436	29.54129878	63.65633519
False	False		Fines	False	False	True	True	20.93637969	34.14536619	9.239079405	19.76515039
True	True	Fines	Fines	False	False	True	True	22.57913691	29.75493544	114.8574558	251.0979956
True	True	Fines	Fines	False	False	True	True	28.8910566	29.00828752	160.6843008	351.9534757
	False		Gravel		True		False	51.64669921	67.09407181	58.19125746	125.7835305
	True		Gravel		True		False	50.66731468	70.34880375	52.79143575	113.9964907
False	True	Gravel	Gravel	False	False	False	True	26.67483872	8.151019606	8.610513981	18.29527795
False		Fines		False		True		14.05404554	3.847852268	2.128953706	4.480272702
True	False	Cobble	Fines	False	False	False	True	29.5540424	12.20052833	10.38182297	22.09275329
False	True	Gravel	Gravel	True	False	False	False	28.45833036	71.55629582	86.60924304	188.1522425
True	True	Gravel	Gravel	True	False	False	False	29.56713314	67.96669906	42.15703877	90.71000545
False	True	Cobble	Gravel	False	False	False	False	45.22053271	49.81434942	8.571479702	18.12183134
True	True	Fines	Fines	False	False	True	False	45.22053271	49.81434942	1.924214629	4.013202847
	True		Gravel		False		True	32.98410403	75.52263876	0.484109159	1.006775996
False	True	Gravel	Fines	False	False	False	False	51.15738437	17.8424249	28.98907166	62.01929946
True	False	Gravel	Gravel	False	False	False	True	55.37099339	15.19155721	25.62125076	54.7014515
True	False	Gravel	Gravel	False	False	False	False	55.15940101	15.27602664	23.82223359	50.8269702
True	False	Gravel	Gravel	False	False	False	True	53.75064665	13.59043157	14.98743048	31.86755761
False	True	Gravel	Fines	True	False	False	True	53.86428772	13.56581217	3.208991471	6.737749937
True	False	Gravel	Fines	False	False	False	True	53.02509962	15.83324904	37.00313725	79.46271035
True	False	Gravel	Gravel	False	False	False	False	45.34581054	16.98192875	9.521792424	20.22360061
False	True	Fines	Fines	True	False	True	True	55.74670028	53.54685893	7.47673013	15.82763901
True				False				46.07561794	34.2434666	17.54190697	37.44583178
False	False		Gravel	False	False		False	35.20780613	25.24184816	5.850800709	12.39926463
True		Cobble		False		False		50.37314238	31.03541302	0.642866339	1.33082931
	True		Gravel		False		False	33.51188528	82.04463702	40.60026613	87.50886139
True	True	Gravel	Gravel	True	False	False	False	19.37483421	42.80556303	10.68004506	22.77790021
True	True	Fines	Fines	False	False	True	True	24.58583217	53.97351815	33.01726123	71.24249821
True	True	Gravel	Gravel	False	False	False	True	23.07635604	54.36536029	26.8592943	57.90299698

Q2_EC	Q25_EC	SSPQ2_PD	SSPQ2_EC	SSPQ25_PD	SSPQ25_EC	Infra	snap_dist	BIN_O_E	Mean
285.0901227	619.9608636	5.993273699	14.15351454	2.412731982	5.697827081	2	10.3241012	5	4.333333333
101.4419483	217.9867188	0.89232575	1.871380725	0	0	4	9.221578579	0	0
945.9082356	2079.865425	7.997190483	21.9033986	6.91138846	18.92950989	5	20.58340448	0	0
24.79245907	53.055054	0.039244686	0.153408397	0.281946165	1.102134157	1	1.326566917	1	2
431.5912862	943.4047605	8.65739766	24.65284134	13.45736777	38.32125604	5	8.892536603	5	5
7.653565799	16.1247969	0.016503723	0.046938786	0.005502135	0.015648805	5	356.6819817	0	0
389.8167459	851.3052744	9.55519328	27.22417402	9.852196444	28.07038043	0	4.081086547	0	0
89.03787205	192.1458604	4.850416851	14.79196127	3.29829983	10.05858359	1	12.46986179	0	0
95.91218283	207.712521	1.552730589	6.062291436	0.569297327	2.222694867	1	16.17555222	2	2
459.9716038	1007.741717	4.99244572	13.78822374	1.497292319	4.135248064	1	32.23549865	4	2.5
466.0426967	1021.10235	3.089947413	8.543676379	0.579108268	1.601229072	2	11.1604278	0	0
288.5004295	630.4124344	2.805670729	7.485139762	0.325155885	0.867470732	4	9.912564652	0	0
80.77954751	174.065805	1.363871387	3.729453953	0	0	4	8.501093363	0	0
26.64576737	57.00325501	0.71448521	2.060595636	0	0	1	8.38404256	0	0
317.8534252	694.8818202	2.394578825	6.626692852	0.777246843	2.150931949	4	6.795403958	0	0
441.296085	966.589083	0.174162071	0.478310824	0.022375239	0.061450343	4	10.79606498	0	0
205.5242096	444.2516251	3.579362142	12.64185734	0.729623004	2.576936775	2	13.17798622	1	2.5
189.1213192	408.3837917	5.079165815	18.19572674	2.150828432	7.705179916	5	6.441881846	2	2
16.15818803	34.33227584	0.818111746	1.535239761	0.469225675	0.880532417	1	7.424904872	1	2.5
3.18956704	6.712278476	0.625607536	0.937275982	0	0	1	33.35143141	0	0
21.98807504	46.79111929	0.821151442	1.739149241	0.351304645	0.744042055	3	1.543649186	0	0
311.859227	677.4913492	3.825433128	13.77447229	2.938486296	10.5807883	2	43.44256774	3	2.833333333
149.471692	321.6207397	7.07382622	25.08090712	6.721759134	23.8326206	1	11.15098257	0	0
27.68612274	58.53402962	5.016334855	16.20290397	0.553006287	1.786226004	1	0.974038587	0	0
6.215267872	12.96275911	0.296599799	0.958025769	0	0	1	364.8156558	0	0
1.771603161	3.684308594	0.213067007	0.779721217	0.06645195	0.243181691	1	0.887322719	4	4.5
68.8129967	147.2187139	5.50659543	13.07131658	2.726937262	6.473084996	2	1.99314118	4	3.333333333
57.95367954	123.7312893	4.837655982	10.94247768	2.139060878	4.838422987	3	3.919413454	0	0
53.9741238	115.1588566	6.698454036	15.17671238	4.89407394	11.08852164	1	12.91032371	0	0
32.78665842	69.71379965	3.674111397	8.037524211	2.431824665	5.319884868	5	1.370773904	0	0
7.01620553	14.73155625	0.147690176	0.322912865	0.076005559	0.166180131	1	2.96613501	4	3.833333333
84.74411711	181.9844946	2.306653715	5.282669176	0.563871432	1.291371225	3	258.0657477	0	0
22.26972294	47.29928591	5.460276504	12.77058347	2.256330764	5.277143077	1	13.02563639	0	0
24.67924704	52.24398986	0.974000577	3.214988429	0.22169894	0.731785528	4	4.426155413	3	3
50.63491912	108.0878303	16.37160678	47.25683396	8.76856149	25.31055504	0	41.68674719	0	0
15.41173917	32.6612103	4.205054815	11.07663912	0	0	1	15.81395426	0	0
1.801681193	3.729749084	0.23759954	0.665890554	0.122391208	0.343010553	0	6.639391481	0	0
152.3154436	328.2971348	3.757055127	14.09492038	0.37737394	1.415751287	4	22.71288568	1	2.833333333
32.96272819	70.3013638	1.18777275	3.665923699	2.282155836	7.043610965	5	41.14180426	5	4.333333333
109.243414	235.7183315	11.49793943	38.04295422	6.549608709	21.670532	1	134.206919	0	0
89.0617612	191.9984506	5.727459658	18.99147605	4.319089577	14.3215127	5	7.743417328	0	0

SD	Invasive_1	IMP_POT	IBI	O_E	EPT_taxa	MTTI	Temp_stress	Sed_stress
0.816496581	Medium	111.5550562	34	0.918127013	17	21.79685482	20.2033	22.79088285
0	Low	354.5622842						
0	Medium	140.421821						
1.095445115	Medium	7.410018862	16	0.33887755	1	23.74530616	20.7292	52.90719069
0	Low	45.37527298	38	0.86979098	18	20.45355826	17.7372	13.13410643
0	Low	45.50969929						
0		39.68151674						
0	High	17.47086061						
0.894427191	Medium	9.99417036	14	0.387251195	2	27.15961009	20.6187	43.79053057
1.224744871	High	33.79643669	22	0.629575737	7	27.93053569	23.3712	39.17714627
0	High	34.28376379						
0	High	27.29694186						
0	High	56.30484575						
0	Medium	74.1092796						
0	High	28.02484305						
0	High	33.89458912						
1.378404875	High	52.84717054	24	0.387595001	4	21.27796779	20.5383	25.72372519
1.095445115	High	50.53891195	16	0.436079668	5	28.82318537	22.8001	31.7707572
1.224744871	High	229.6031522	22	0.338663912	5	22.00271181	18.8109	55.87017428
0	High	791.401382						
0	Low	147.6476645						
0.752772653	High	44.57866946	20	0.580007911	7	23.8780328	20.2359	33.31998944
0	Low	34.3512565						
0	Low	119.0412652						
0	High	0.899890601						
0.547722558	High	285.5993237	36	0.677726141	14	18.16028011	16.5715	25.2135353
0.516397779	Low	142.3122652	26	0.725664131	9	21.24863517	20.0499	50.2691085
0	Low	192.0765652						
0	High	213.176489						
0	High	250.6532104						
0.40824829	High	11.52737646	32	0.677724252	10	21.19928444	18.8481	27.14806428
0	High	70.54723713						
0	High	62.07744053						
1.264911064	Medium	80.32411875	20.5	0.483710307	3	22.69433729	19.4595	35.49382928
0		50.22238505						
0	Low	141.8624502						
0		58.47591207						
1.722401424	High	19.28722304	22	0.338953265	3	21.73707111	18.7265	21.85184613
0.516397779	Low	296.095259	34	0.821762455	12	21.27900385	19.4729	20.82646331
0	High	98.21675484						
0	Low	109.4732812						

OBJECTID	FID_1	Stream	Site	DT24	DA	VW	MBS	SLOPE	TEMP21	TEMP24	pH21	pH24
124	76	TRILLIUM	TRT50	2024/10/29	0.296402152	52.39473068	5.461245861	0.061872434	0	12.6	0	7.54
125	123	TRILLIUM (WES	TRWL10	2024/10/01	0.738063271	36.20089815	10.25248514	0.036066173	0	13.5	0	7.32
126	124	TRYON	TY10	2024/09/27	6.412344727	44.4341472	10.13892273	0.015618337	0	0	0	0
127	125	WILSON	WI10	2024/09/30	1.345688199	113.5326704	7.336761116	0.019658865	14.2	0	6.97	0
128	126	WILSON	WI20	2024/11/01	1.707797453	105.2014095	7.441550486	0.02872409	0	10.6	0	6.89
129	127	WILSON	WI35	2024/11/01	1.307646736	104.03715	7.294909883	0.042510706	0	10.5	0	7.12
130	128	WILSON	WI40	0000/00/00	1.267783321	49.98507529	7.306911945	0.044181954	0	0	0	0
131	129	WILSON	WI50	2024/11/01	1.710906779	146.2324575	7.450269893	0.024015897	0	10.6	0	6.89

DO21	DO24	COND21	COND24	BFW21	BFW24	BTW21	BTW24	BFD21	BFD24	BTD21	BTD24	RD21
0	10.7	0	170.7	6.8	4	9.2	9.1	2.9	1.1	4.6	4.9	0.5
0	9.91	0	163.6	0	14.96666667	0	22.66666667	0	1.9	0	3.033333333	0
0	0	0	0	0	22.5	0	24.66666667	0	1.9	0	2.366666667	0
7.22	0	153.5	0	14.175	23	26.775	24.06666667	2.25	2.8	3.9	3.2	0.45
0	10.29	0	124.9	14.5	7.5	23.5	11	2.7	1	3.4	2	1.3
0	10.68	0	129	17.2	14	24.2	15	3.2	1.7	3.6	4	0.5
0	0	0	0	15.5	0	15.5	0	2.3	0	1.3	0	0.7
0	10.29	0	124.9	16.7	7.5	20.7	11	2.3	1	2.5	2	0.4

RD24	PD21	PD24	WDR21	WDR24	CONF21	CONF24	RESD21	RESD24
0.2	0.9	0.4	2.344827586	3.636363636	5.695079421	5.757662712	0.4	0.2
0.341666667	0	1.066666667	0	7.877192982	0	1.597098448	0	0.725
0.385714286	0	1.966666667	0	11.84210526	0	1.801384346	0	1.580952381
0.183333333	2.85	2	6.3	8.214285714	4.240249127	4.717423976	2.4	1.816666667
0.4	2.3	0	5.37037037	7.5	4.476655723	9.5637645	1	0
0.4	1.3	1	5.375	8.235294118	4.299055785	6.935809999	0.8	0.6
0	1.4	0	6.739130435	0	3.224843567	0	0	0
0.4	1.7	1.3	7.260869565	0	7.06436993	13.29385978	0	0.9

LWD21	LWD24	SUB21	SUB24	BEDR21	BEDR24	EMBED21	EMBED24	CAN19	IMP23	Q2_nat	Q25_nat
True	True		Fines	True	False		True	18.98218674	47.83116312	14.25127372	30.59350032
	True		Gravel		False			47.13478635	67.47120746	43.5540958	93.72708944
	True		Gravel		True		False	55.69428349	53.78229854	303.5039753	664.8725181
True	True	Cobble	Gravel	True	False	False	False	30.30802825	14.886571	63.92476324	138.6139157
True	True	Fines		False	False	True	False	35.39466699	14.83499191	79.752614	173.25349
True	True	Cobble	Gravel	False	False	False	False	29.78499865	15.13444632	62.12824554	134.6928512
True		Cobble		False		False		29.84550308	15.49444391	60.46694782	131.0561906
True	True	Gravel	Gravel	False	False	False	False	35.4599389	14.80803146	79.92727464	173.6338836

Q2_EC	Q25_EC	SSPQ2_PD	SSPQ2_EC	SSPQ25_PD	SSPQ25_EC	Infra	snap_dist	BIN_O_E	Mean
45.47439857	97.62082008	6.016211915	19.19713451	2.255444241	7.196898495	4	19.53129283	0	0
154.0864845	331.589428	4.326480427	15.30630236	5.829605744	20.62408686	1	7.316416399	4	3.666666667
1003.127627	2197.506609	11.99725925	39.65279924	14.58981071	48.22158322	2	52.7999047	3	2.666666667
143.7167972	311.634287	3.086250067	6.938562656	1.498434442	3.368807139	5	6.97733227	5	4.333333333
179.1146549	389.1062314	8.290780899	18.62008385	2.953248855	6.632637138	5	3.469687433	0	0
140.3715355	304.3228114	8.412492101	19.00704621	3.435957243	7.763145251	5	20.27980996	0	0
137.5849231	298.2018534	10.76030565	24.4837201	7.231950554	16.45539252	0	14.76143776	0	0
179.4089908	389.7478047	5.789176812	12.99469266	1.780257627	3.99606049	1	33.27532615	0	0

SD	Invasive_1	IMP_POT	IBI	O_E	EPT_taxa	MTTI	Temp_stress	Sed_stress
0	High	206.0049123						
1.032795559	Medium	42.28803228						
1.211060142	Medium	45.61901286	20	0.532631446	6	26.89306723	23.1191	19.52619584
0.516397779	Low	151.6796623	34	0.823068412	13	22.08760845	18.2216	27.56392977
0	Medium	147.0385828						
0	Low	147.7341643						
0		143.7329022						
0	Medium	147.3661635						

Appendix F – Physical Stream Health Trends Analysis

Appendix F – Physical Stream Health Trends Analysis

W2r used previous geomorphic measurements to evaluate potential historic trends in the channel geometry. Trends analysis targeted bankfull channel dimensions to understand potential trajectories in stream widths (i.e. widening v. narrowing) and bed changes (incision v. aggrading) at monitoring sites measured in 2009, 2011, 2014, and 2021. The channel geometry data collected in 2017 were not used in this analysis since field monitoring methods targeted an alternate definition of the bankfull channel defined by the bank tops. In contrast, in 2009, 2011, 2014, and 2021 the bankfull channel was identified according to field-based indicators of scour and vegetation patterns. The channel geometry parameters analyzed here are bankfull width, bankfull depth, and width to depth ratio (see Appendix B for definitions).

For each parameter, trends were evaluated through least-squared regression analysis at each site. Regression analyses evaluated potential trends between time (year, x-axis) and the measurement (y-axis). The strength of correlation and statistical significance were evaluated via calculation of R-squared values and p-values, respectively. R-squared values provide a relative measure of correlation, whereas p-values indicate the statistical significance relative to a chosen probability. P-values below a chosen significance value indicate a statistically significant trend. In this case, we chose to evaluate statistical significance at the 10% (90% confidence) and 5% (95% confidence) levels, which are identified by yellow and green cell shading in tables 1, 2, and 3 below.

Generally, the analysis revealed relatively few sites with statistically significant trends from 2009-2024. And these sites often exhibit bias in the measurements when data collected shifted from Waterways to W2r in 2021. This bias may be primarily caused by different teams' own interpretations of bankfull width/depth. Further data collection and by more people/teams will provide more statistical insight into the biases present in geomorphic monitoring. We also suggest tracking the personnel and team collecting the data at each site, in order to isolate and detect different individual biases. Tracking this information will provide greater trust and fidelity in the data and analyses.

Because of these inherent biases and that ratios range from zero to infinity, width-to-depth-ratio is very sensitive to small changes, whether real or introduced bias. While there are no trends in bankfull width and depth emerge, there were no statistically significant trends in width to depth ratio. We do not consider this measurement to be an effective monitoring tool.

The presence of relatively few significant trends reflects a combination of complex river processes and relatively few data points with which to assess trends. Future measurements of bankfull dimensions should provide more data to allow for increased confidence in the presence or absence of trends and their significance.

Table 1: Bankfull width trend analysis from measurements in 2009, 2011, 2014, and 2021. Yellow and green shading indicate statistical significance to 90% and 95% confidence, respectively.

	Bankfull Width (ft) by Year							
Site ID	2009	2011	2014	2021	2024	Rate of Change, ft/yr	R^2	p-value
AT10	8.8	7	8.5	4.6	7.0	-0.166	-0.64	0.241
KL10	39.9	41.2	37.7	37.2	27.4	-0.712	-0.85	0.071
KL30	10.3	12.6	8	22.1	26.5	1.123	0.91	0.033
MS40	21.2	24.2	22.6	21.8	16.4	-0.317	-0.70	0.186
MS70	23.1	26.3	23.2	32.4	23.6	0.221	0.36	0.550
MS80	18.8	14.1	12.8	17.6	16.7	0.059	0.15	0.805
PH10	23.1	24.4	21.6	8.7	12.4	-0.998	-0.92	0.029
RC10	37.7	36.6	37.5	39.1	28.4	-0.381	-0.58	0.310
RC30	21.7	23.1	23.1	26.1	28.1	0.395	0.98	0.003
RC50	12.2	13	11.5	13.1	11.5	-0.020	-0.17	0.785
RC60	9.1	11	11.6	12.5	8.8	0.010	0.04	0.951
FE20	6.2	6.1	6.1	9.8	10.0	0.303	0.95	0.014
SA10	18.8	17.8	14.1	12.7	10.2	-0.532	-0.96	0.008
TA10	7.2	8.5	7.2	6.9	7.0	-0.057	-0.56	0.324
T210	4.8	5.3	5.2	6.3	3.9	-0.016	-0.12	0.847
WI10	7.2	9.6	11.8	14.2	23.0	0.876	0.93	0.022
SI10	10.7	11.6	8.8	12	13.7	0.183	0.66	0.229
SA20	8.4	6.9	5.4	9.5	11.8	0.277	0.73	0.162

Table 2: Bankfull depth trend analysis from measurements in 2009, 2011, 2014, and 2021. Yellow and green shading indicate statistical significance to 90% and 95% confidence, respectively.

	Bankfull Depth (ft) by Year							
Site ID	2009	2011	2014	2021	2024	Rate of Change, ft/yr	R^2	p-value
AT10	0.9	0.6	0.6	1.2	1.1	0.033	0.74	0.151
KL10	2.3	2.54	2	3.3	1.6	-0.005	-0.05	0.931
KL30	2.2	2	1.4	3.1	2.3	0.046	0.48	0.410
MS40	2.3	3.6	1.4	1.7	1.7	-0.078	-0.57	0.319
MS70	1.7	2.4	1.7	2.5	2.7	0.054	0.74	0.150
MS80	2.2	1.6	2	2.1	1.1	-0.039	-0.55	0.341
PH10	1.7	1.7	1.6	1.4	1.5	-0.020	-0.94	0.019
RC10	3	2.6	2.4	2.9	2.6	-0.006	-0.17	0.788
RC30	1.5	1.4	1.4	2.7	2.5	0.092	0.91	0.031
RC50	1.7	1.9	1.3	2.9	1.5	0.026	0.27	0.659
RC60	2.1	2.3	2.3	2.8	1.9	0.004	0.08	0.900
FE20	1.1	1.2	0.8	1.5	2.3	0.072	0.81	0.096
SA10	3.5	3.3	2.7	3	2.0	-0.075	-0.82	0.086
TA10	2.1	2.7	1.8	2.2	2.1	-0.011	-0.22	0.728
T210	0.8	1.3	1.2	1.3	0.7	-0.006	-0.15	0.811
WI10	1.2	1.7	1.6	2.3	2.8	0.094	0.97	0.008
SI10	2.5	3.5	1.2	3.5	3.8	0.078	0.47	0.419
SA20	2.2	1.9	1.1	2.7	2.5	0.051	0.52	0.364

Table 3: Bankfull width to depth ratio trend analysis from measurements in 2009, 2011, 2014, and 2021. Yellow and green shading indicate statistical significance to 90% and 95% confidence, respectively.

	Width to Depth Ratio (ft/ft) by Year							
Site ID	2009	2011	2014	2021	2024	Rate of Change [regression]	R^2	p-value
AT10	9.7	11.3	14.6	3.6	6.1	-0.464	-0.69	0.193
KL10	17.1	18.9	19.1	11.6	16.8	-0.261	-0.56	0.331
KL30	5.7	5.4	6.5	7	11.7	0.335	0.85	0.071
MS40	9.1	6.8	15.7	13	9.9	0.154	0.29	0.642
MS70	15.2	11.3	16.4	13	8.7	-0.287	-0.61	0.279
MS80	9.1	8.7	6.5	8.9	15.7	0.356	0.67	0.221
PH10	14.5	16.4	20.1	7.1	8.4	-0.644	-0.76	0.135
RC10	13	18.9	15.5	14.1	11.1	-0.258	-0.57	0.319
RC30	14.4	17.8	17.6	9.8	11.1	-0.439	-0.77	0.124
RC50	7.2	7.3	9.2	4.5	7.7	-0.085	-0.32	0.598
RC60	4.7	5.5	5.2	4.5	4.6	-0.038	-0.58	0.308
FE20	5.6	5.7	8.3	7.5	4.3	-0.034	-0.14	0.823
SA10	5.4	5.5	5.7	4.3	5.1	-0.054	-0.64	0.243
T410		13.3	11	9.1	3.6	-0.638	-0.93	0.069
TA10	3.4	3.2	4.3	3.1	3.3	-0.017	-0.22	0.718
T210	5.9	4.3	4.8	5.2	5.3	0.007	0.08	0.897
WI10	6.3	5.8	7.4	6.3	8.2	0.097	0.64	0.250
SI10	4.6	3.4	7.8	3.9	3.7	-0.068	-0.24	0.692
SA20	3.7	7.3	5.8	3.5	4.72	-0.082	-0.34	0.578