Water Year 2025 Annual Summary Report

Burnt Bridge Creek Water Quality Monitoring Program

Prepared for
City of Vancouver Surface Water Management

Prepared by
Herrera Environmental Consultants, Inc.

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Executive Summary

Since 2004, the City of Vancouver (the City) has conducted water quality monitoring in Burnt Bridge Creek as part of a long-term program to collect credible data, evaluate trends, and assess compliance with state regulations. The primary goal is to support adaptive surface water management to protect recreational uses, public health, and salmonid habitat while advancing the City's Climate Action Framework goals. An Advance Restoration Plan (pre-total maximum daily load) for Burnt Bridge Creek is also in the final stages of development by Ecology and will identify water quality targets and activities needed to meet state standards.

This report summarizes the results for Water Year 2025 (WY2025) including base and storm flow monitoring conducted at 11 stations in accordance with the Quality Assurance Project Plan (QAPP) and associated QAPP Addendum. A primary addition to the WY2025 program was a Microbial Source Tracking (MST) study designed to identify specific human and animal fecal sources to prioritize best management practices for bacteria reduction.

Key Findings

The data quality assurance review determined that WY2025 data were all valid and usable. Key findings pertaining to water quality include:

- Water Quality Criteria Comparison: Criteria for temperature, dissolved oxygen, nutrients, and *Escherichia coli* (*E. coli)* were frequently exceeded, while pH, metals, and turbidity generally met standards. The 7-day average daily maximum water temperature criterion was exceeded at all continuous monitoring stations, with the percentage of days during the monitoring period (May through October) exceeding the criterion ranging from a low of 48 percent at the uppermost station BBC10.4 to a high of 73 percent at the next downstream station BBC8.8. Acute dissolved zinc criteria were exceeded twice during storm events at stations BBC10.4 and Burton Channel (BUR0.0).
- Microbial Source Tracking: Fecal contamination in the samples collected for the MST study was dominated by animal sources, particularly general mammal and bird markers. Human markers were largely trace or below detection limits during dry weather base flow but were consistently detected above trace levels and intermittently detected at elevated levels during storm events, indicating that stormwater runoff and infiltration is a primary vector for human sources of fecal bacteria in Burnt Bridge Creek.
- Historical Data Comparison: Compared to the WY2020 through WY2024 period, WY2025 showed a continued decrease in nitrate+nitrite concentrations at most stations, which may reflect positive outcomes from the Sewer Connection Incentive Program. However, median total phosphorus and geometric mean *E. coli* concentrations during base flow were higher than historical medians or geometric means at most mainstem stations.

Water Quality Influences

The water quality patterns in WY2025 were likely driven by a combination of natural landscape features and urban activities:

- Tributary Impacts: Inputs from the three main tributaries impact downstream mainstem water quality. Peterson Channel contributed relatively high copper and nutrients during base flow, while Burton Channel is a source of storm-driven zinc and *E. coli* loading. Cold Creek remains a primary contributor of storm flow turbidity, total suspended solids, and *E. coli* to the lower reach at BBC1.6.
- Stormwater Pathway: Storm driven runoff events remain the primary mechanism for transporting metals, turbidity, and bacteria into the creek. Runoff from the Burton Channel and Cold Creek basins impact mainstem water quality and should be prioritized for stormwater improvements. A large portion of the Cold Creek subbasin, however, is located outside of City limits.
- Stream Sediment as a Bacteria Reservoir: Elevated summer *E. coli* levels may be supported by a streambed sediment reservoir, where bacteria sorbed to fine solids are suspended by stormwater input or physical disturbance during relatively low flows. Increased wildlife activity in the stream during warm summer months also may increase *E. coli* concentrations from direct deposits of fecal matter.

Recommendations

Consistent with past recommendations, the City should continue its multifaceted management approach, including:

- Continued Long-Term Monitoring: Maintain current sampling frequencies and stations to support long-term trend detection, which is essential for identifying environmental responses to management activities. The City should continue to monitor the safety of station COL0.0 and re-establish monitoring to this impactful tributary if feasible.
- Riparian and Stream Restoration: Prioritize riparian plantings in the headwaters and reaches with minimal cover to address chronic temperature exceedances. Vegetation monitoring and canopy cover estimates can be utilized to inform riparian planting recommendations and prioritize gaps in riparian canopy cover. Protection of existing mature canopy is also vital as a buffer against climate change impacts in downstream reaches.
- Targeted Stormwater Retrofits: Prioritize additional stormwater treatment facilities in subbasins with high-traffic runoff, specifically targeting BUR0.0 and BBC2.6. Coordination with Washington State Department of Transportation for retrofits (such as biofiltration or enhanced treatment vaults) can help mitigate acute metals exceedances and turbidity impacts from nearby highways including Interstates 5 and 205 and State Route 500.
- Enhanced Source Control: Continue prioritizing the Sewer Connection Incentive Program, with an emphasis on septic clusters nearest to the creek to further reduce potential impacts on nutrient and bacteria loading. Use MST results to investigate potential illicit discharges or failing septic systems in subbasins like BUR0.0 that showed anomalously high Human marker concentrations during storms.

Consider targeted MST monitoring to evaluate future management activities or identify changes related to improvements.

- Public Outreach and Coordination: Expand public outreach regarding pet waste disposal, particularly in park corridors confirmed for dog markers, and strengthen coordination with human services to manage unauthorized encampments while ensuring access to sanitation.
- Integrated Hydrologic Studies: Implement continuous stream flow and turbidity monitoring to improve pollutant loading estimates and understanding of temperature relationships. These data can support future hydrodynamic and climate modeling to protect and enhance watershed resiliency.

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Introduction

Burnt Bridge Creek is an urban stream that flows westward 12.6 miles, from the eastern edge of Vancouver's city limits to its discharge into Vancouver Lake (Figure 1). Since 2004, the City of Vancouver, Washington (the City) has conducted water quality monitoring in Burnt Bridge Creek as part of a long-term monitoring program. The City continues its long-term monitoring activities for Burnt Bridge Creek under the Ambient Water Quality Monitoring Program (the Project). The purpose of the Project is to collect credible water quality data that supports and informs City and state efforts to improve and protect water quality in Burnt Bridge Creek. Data collected under the Project is used to assess the effectiveness of water quality improvement activities throughout the watershed.

Water quality in Burnt Bridge Creek has been monitored extensively for more than 40 years, including a total maximum daily load (TMDL) study (Ecology 2008). Monitoring data have shown that segments of Burnt Bridge Creek do not meet state water quality standards for temperature, dissolved oxygen, and fecal coliform bacteria at varying times of the year. A Source Assessment conducted by McCarthy (2020) analyzed impairments to the watershed, including a shade analysis in relation to temperature impairments. An Advance Restoration Plan (pre-TMDL) is in the final stages of development by Ecology and will identify water quality targets and activities needed to meet state standards before completion of a full TMDL plan (Vancouver 2023). Temperature, dissolved oxygen, and fecal coliform bacteria are parameters of primary focus. Other parameters of concern include nutrients and contaminants associated with stormwater runoff.

It is the City's intent to bring Burnt Bridge Creek into compliance with state water quality standards. To meet this goal, the following objectives have been defined for this project:

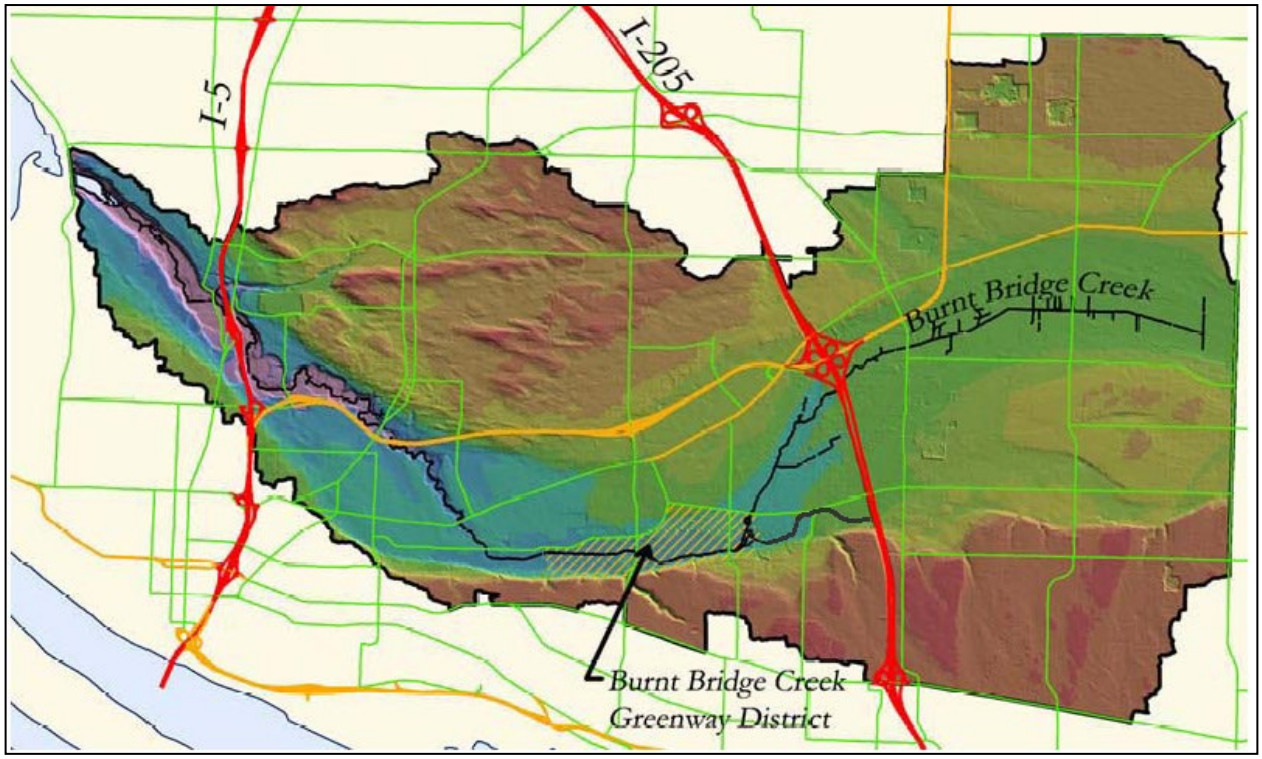
- Accurately characterize specific water quality parameters within the creek
- Maintain consistency with past monitoring efforts
- Monitor water temperature continuously at the selected monitoring locations during the critical season
- Provide high quality data for the City and other users
- Determine whether trends or correlations are present in the water quality data
- Identify stream reaches or tributaries that show improvement in water quality related to the application of best management practices in the watershed
- Provide feedback for adaptive strategies in stormwater management programs

For further background information regarding the TMDL Program and monitoring history see the Water Year 2024 Trend Report (Herrera 2025).

This report describes base and storm flow monitoring conducted during water year (WY; hydrologic year from October 1 through September 30) 2025 in accordance with procedures in the Quality Assurance

Project Plan (QAPP; Herrera 2023) for the ambient water quality monitoring program and associated addenda (Herrera 2023, 2024a, 2024b).

Figure 1. Burnt Bridge Creek Watershed.



Monitoring Methods

The field monitoring, laboratory analysis, and data management and analysis methods are described below. A detailed description of these methods is provided in the QAPP and Addenda (Herrera 2024a; 2024b). The Water Year 2024 Trend Report (Herrera 2025) provides detailed information regarding parameters of concern.

Monitoring Stations

Water quality sampling and field measurements were conducted at 11 stations along Burnt Bridge Creek and its tributaries (Figure 2). Continuous temperature monitoring data was collected seasonally at all stations except BUR0.0, BBC5.2, and COL0.0. The same 11 monitoring stations have been monitored by Herrera since 2011 and are described in detail in the QAPP and Appendix A.

Monitoring station subbasin attributes including zoning, septic system density, stormwater treatment facilities are summarized in the MST Study Report (Appendix A). Subbasin boundaries and riparian cover were originally delineated in the *Integrated Scientific Assessment Report* (Herrera and PGG 2019). Zoning, septic density, impervious surfaces, and stormwater infrastructure have been updated using current GIS datasets from Clark County and the City. Number of outfalls and road crossings are included to illustrate stormwater infrastructure density within the basin. Subbasin characteristics are not cumulative and do not reflect total upstream area, but rather the exclusive area that drains to Burnt Bridge Creek between a given station and the next upstream station. The subbasins are primarily residential (median of 60 percent) but range widely from 33 percent in BBC8.8 to 81 percent in BUR0.0, typically contain between 40 and 50 percent impervious surface cover, and have less than 20 percent tree canopy cover. Riparian canopy cover in the 100-foot-wide riparian buffer within 0.5 mile upstream of monitoring stations range from 25 to 56 percent (Herrera and PGG 2019). Septic systems are present in all subbasins with the greatest septic system densities in the BUR0.0, BBC10.4 and BBC8.4 subbasins.

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Figure 2.
Monitoring Station Map.

N

BBC1.6
COL0.0
BBC2.6
BBC5.2
BBC5.9
BBC7.0
BBC8.4
BUR0.0
BBC8.8
PET0.0
BBC10.4
Burnt Bridge Creek
Peterson Channel
Burton Channel
5
205
500
14

- Monitoring Station
- Burnt Bridge Creek
- Tributary
- Subbasin
- Burnt Bridge Creek Basin
- Vancouver City Limits

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources: WSDOT, Clark County, City of Vancouver, Esri

0 0.5 1 2 Miles

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Field and Laboratory Analysis Methods

Data collection methods followed the protocols outlined in the QAPP with deviations summarized in Appendix B. Table 1 presents the dates and details of each sampling event.

Table 1. WY2025 Sampling Events for the Burnt Bridge Creek Water Quality Monitoring Project.

Event ID	Sample Date	Sample Event Type	Weather Season[a]	Sample Duplicate Station	Antecedent Dry Period (days)[b]	Storm Depth at Start of Sampling (inches)[c]	Total Storm Depth (inches)[d]
1	11/11/2024	Storm	Wet	BBC2.6	5.1	0.62	1.18
2	12/19/2024	Base flow	Wet	BBC7.0	1.5	0	0
3	1/8/2025	Base flow	Wet	BBC8.8/BBC10.4[e]	2.6	0	0
4	2/19/2025	Storm	Wet	BUR0.0	0.8	0.32	0.34
5	2/24/2025	Storm	Wet	BBC1.6	0.6	0.19	1.12
6	3/12/2025	Storm	Wet	BBC5.2	0.3	0.22[f]	0.22
7	4/8/2025	Storm	Wet	PET0.0	0.5	0.05[f]	0.10
8	4/15/2025	Base flow	Wet	BBC10.4	4.9	0	0
9	6/25/2025	Base flow	Dry	BBC8.4	3.7	0	0
10	7/24/2025	Base flow	Dry	BBC5.9	32.7	0	0
11	8/19/2025	Base flow	Dry	BBC2.6	3.5	0	0
12	9/11/2025	Base flow	Dry	BBC1.6	0.4	0	0

[a] Dry and wet weather season are defined as June through September and October through May, respectively.

[b] Antecedent dry periods were defined as the number of consecutive days preceding the event during which less than 0.04 inch of rain in any 6-hour period was recorded.

[c] Storm depth at start of sampling was determined as the cumulative precipitation from the storm onset to the start of the sampling period, as recorded by the Hayden Island Rain Gauge (Portland BES 2025). Storm onset was defined as the end of the antecedent dry period.

[d] Total storm depth was determined as the total precipitation amount recorded by the Hayden Island Rain Gage over the course of the targeted storm event (Portland BES 2025).

[e] On January 8, 2025, duplicate samples were collected at BBC8.8 and duplicate *in situ* water quality measurements were taken at BBC10.4.

[f] The storm events targeted for March 12 and April 8, 2025, resulted in less rainfall than the ≥0.30 inches predicted.

All sampled storm events met storm criteria, defined as at least 0.30 inches of rain predicted to occur during the monitoring day, with storm event thresholds applied to minimize false starts and ensure stream flows were influenced by stormwater runoff during sampling. Therefore, Events 6 and 7 met storm criteria due to sufficient predicted precipitation, and because stormwater influence on stream flows were apparent during the monitoring period.

Continuous Temperature Monitoring

One HOBO® water temperature data logger was deployed from April 29 to November 4, 2025, at each of eight monitoring stations. Backup probes were installed at PET0.0, BBC2.6, and BBC1.6 due to vandalism and other issues making it difficult to locate the probes in previous years.

The data loggers were installed according to procedures identified in the QAPP and the Ecology's Standard Operating Protocols for continuous temperature monitoring. Temperature probe calibration check results are presented in Appendix C.

Laboratory Analysis

Table 2 presents the required analytical methods specified in the QAPP and the total number of samples analyzed in WY2025.

Table 2. Methods and Number of Samples for Water Quality Analysis for WY2025.

Parameter	Analytical Method	Method Number[a]	Number of Samples[b]
Base and Storm Flow			
Turbidity	Nephelometric	EPA 180.1	138
Total suspended solids	Weighed filter	SM 18 2540D	138
Total phosphorus	Persulfate digestion, ascorbic acid	EPA 365.3	138
Soluble reactive (orthophosphate) phosphorus	Ascorbic acid	EPA 365.3	138
Total nitrogen	Kjeldahl digestion, ammonia-selective electrode with known addition, adding to nitrate nitrite	EPA 351.4; SM 4500-NH3 G LL	138
Nitrate + nitrite nitrogen	Automated cadmium reduction	EPA 353.2	138
E. coli bacteria	Colilert® Quanti-Tray/2000®	SM 9223B	138
Storm Flow Only			
Hardness as CaCO3	Titrimetric	SM 2340C	59
Metals, total and dissolved copper and zinc	Inductively Coupled Plasma-Mass Spectrometry	EPA 200.8	59

[a] SM = APHA Standard Methods (APHA et al. 1998), EPA = U.S. Environmental Protection Agency Method Code

[b] For storm flow only parameters, the number of samples is based on 4 samples for COL0.0 and 5 samples for each of the remaining 10 locations plus 5 field duplicates. Base flow samples were collected at COL0.0 for 2 events and the remaining 10 locations for 7 events due to discontinuation of monitoring station COL0.0 on April 8, 2025.

Data Quality Review

A quality assurance review was performed for all field and laboratory data collected in WY2025, as specified in the QAPP. The quality assurance review findings were presented in an interim update report for each sampling event and are summarized in Appendix B. In general, the data quality for all parameters was considered acceptable based on holding time, reporting limit, method blank, control

standard, laboratory duplicate, and field duplicate criteria. However, as summarized below (Table 3), some quality control issues were identified in the data. Results that did not meet quality assurance criteria specified in the QAPP were qualified as estimates for less than 5 percent of results, and no data were rejected.

Table 3. Percentage of Data Qualified as Estimated (J) and Rejected (R) Values.

	Water Year 2025[a]			
	Base Flow (Percent)		Storm Flow (Percent)	
Parameter	**R**	**J**	**R**	**J**
Temperature	0	0	0	0
Dissolved Oxygen	0	0	0	0
pH	0	0	0	0
Conductivity	0	0	0	0
Turbidity	0	1	0	0
Total Suspended Solids	0	0	0	0
Hardness as CaCO3	NS	NS	0	0
Total Phosphorus	0	1	0	0
Soluble Reactive Phosphorus	0	1	0	2
Total Nitrogen	0	0	0	0
Nitrate +Nitrite Nitrogen	0	0	0	0
Total Copper	NS	NS	0	2
Dissolved Copper	NS	NS	0	2
Total Zinc	NS	NS	0	2
Dissolved Zinc	NS	NS	0	2
E. coli	0	4	0	2

a Percentages do not include duplicate samples.

NS – Not sampled during base flow events. Parameter was only analyzed during storm flow events.

Data Analysis Methods

This section describes the data analysis procedures for computation of summary statistics, comparison of results to the applicable water quality criteria, and comparison to historic data. These analyses were performed on recent data collected in WY2025 and historic data collected from WY2020 through WY2024. Historical time series plots include data starting in WY2011, where available. The results from these analyses are summarized in the Results Section.

Summary Statistics

In order to assess water quality conditions at each of the sample locations, R software packages were used to calculate summary statistics from the compiled data and are presented in Appendix D.

When undetected values were present in the data, the reporting limit was used in all calculations. Use of the reporting limit for undetected values is consistent with historical data management practices but may result in a slightly higher bias than other estimating methods, such as using one-half of the reporting limit or zero for undetected values. The summary statistics were then compiled in individual summary tables for each of the monitoring parameters.

Water Quality Criteria Comparison

In order to identify water quality impairment at the Burnt Bridge Creek sampling stations, monitoring data were compared to regulatory criteria from Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A, updated March 2022) and *Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion I* (EPA 2001). Water quality standards for surface waters in the state of Washington are based on specific designated uses that have been identified for the particular waterbody (WAC 173-201A-602).

Water quality criteria associated with designated uses for Burnt Bridge Creek are summarized in Table 4. Burnt Bridge Creek is designated for salmonid spawning, rearing, and migration with associated aquatic life criteria for temperature, dissolved oxygen, pH, turbidity, and dissolved metals. Burnt Bridge Creek is also designated for primary contact recreation with specific recreational use criteria for *E. coli* bacteria. Because the state surface water standards do not include nutrient criteria for streams, criteria recommended by the U.S. Environmental Protection Agency (EPA 2001) for total phosphorus, total nitrogen, and nitrate+nitrite nitrogen in streams located in the Willamette Valley Ecoregion are also presented in Table 3 for comparison to monitoring data.

Washington State *E. coli* water quality criteria are based on geometric means (geomeans) and 90th percentiles. The calculated geomean is to be based on a minimum of three samples collected in one season covering up to 90 days. A maximum value is to be compared to the 90th percentile criterion if less than 10 samples are collected in the averaging period. Frequency of sampling events, particularly during the dry season, during the WY2025 monitoring periods did not meet the recommended sampling frequency for calculating geomeans or 90th percentiles for regulatory evaluation. However, geomeans and 90th percentiles were calculated for each site separately for base flow and storm events using all

samples collected in the entire water year and are intended to provide a general overview of site conditions compared to *E. coli* water quality criteria.

Table 4. Water Quality Criteria Used for Comparison to Data Collected for the Burnt Bridge Creek Water Quality Monitoring Project.

Parameter	Criteria
Aquatic Life Use Criteria for Salmonid Spawning, Rearing, and Migration[a]	
Temperature	The 7-day average of the daily maximum temperature (7-DADMax) shall not exceed **17.5°C**. When a water body's temperature is warmer or within 0.3°C of 17.5°C and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C.
Dissolved Oxygen	The lowest 1-day minimum shall exceed **10 mg/L**. When a water body's dissolved oxygen concentration is lower than or within 0.2 mg/L of 10 mg/L and that condition is due to natural conditions, then human actions considered cumulatively may not cause the dissolved oxygen concentration of that water body to decrease more than 0.2 mg/L.
pH	Shall be within the range of **6.5 to 8.5**, with a human-caused variation within this range of less than 0.5 units.
Turbidity	Shall not exceed 5 NTU over background when the background turbidity is 50 NTU or less; or a 10 percent increase in turbidity when the background turbidity exceeds 50 NTU.
Copper, dissolved	Metals criteria are calculated using hardness and vary
Zinc, dissolved	Metals criteria are calculated using hardness and vary
Recommended Nutrient Levels from Reference Conditions for the Willamette Valley Ecoregion[b]	
Total phosphorus	Shall not exceed 0.040 mg/L
Total nitrogen	Shall not exceed 0.36 mg/L
Nitrate+nitrite nitrogen	Shall not exceed 0.15 mg/L
Total Kjeldahl nitrogen	Shall not exceed 0.21 mg/L
Updated Recreational Use Criteria for Primary Contact Recreation[a]	
Escherichia coli	Geometric mean of at least 3 samples shall not exceed 100 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than 10 sample points exist) obtained for calculating the geometric mean values exceeding 320 colonies/100 mL. Effective on February 23, 2019.

C = Celsius mg/L = milligram/L mL = milliliter NTU = nephelometric turbidity units

[a] Source: Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A).

[b] Source: EPA (2001); 25th percentile of medians for 171 streams for all seasons from 1990–1999 in the Willamette Valley Ecoregion (Table 3a).

Comparison to Previous Data

Time series plots were generated to visualize seasonal variations and temporal trends in water quality parameters. These time series plots include data from the entire monitoring program which varies in timeframe between parameters. Base flow time series plots further designate between wet and dry season events.

Box and whisker plots were generated to compare results from WY2025 to recent historical data (WY2020 through WY2024). More recent historical data was used for comparison in order to highlight current patterns unique to WY2025 or short-term trends. These plots present the following information for each station: the minimum and maximum values as the lower and upper whiskers, respectively; the median and mean as the line and point in the box, respectively; and the 25th and 75th percentiles of the data as the lower and upper boundaries of the box, respectively. For *E. coli*, the 90th percentile of the data is also shown on the plot as a black triangle and the geomean is presented rather than the arithmetic mean for comparison to water quality criteria.

Time series and box and whisker plots are presented in Appendix E.

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Results

Key results are summarized below, followed by notable observations pertaining to each monitoring station. Results of the microbial source tracking sampling program conducted as part of the WY2025 ambient water quality monitoring program are discussed in Appendix A. Complete tables of summary statistics are available in Appendix D. Summary figures available in Appendix E include:

- Time series plots of all base flow data.
- Time series plots of all storm flow data.
- Box and whisker plots of recent (WY2025) and historical (WY2020 through WY2024) storm and base flow data.

In the following discussion of results, the description of "substantially different" is used to describe results with non-overlapping interquartile ranges that are likely to be statistically significant but were not tested.

Hydrology and Climate

Daily precipitation totals for WY2025 showing each monitoring event are presented in Figure 3. Rainfall data were collected in 1-hour intervals by Portland Bureau of Environmental Services at Hayden Island Rain Gage (Portland 2025), which is located 7.5 miles southwest of station BBC2.6. In WY2025, the gage recorded 43.5 inches of rain with a maximum daily precipitation value of 1.85 inches. This is generally comparable to recent annual rainfall with 38.0 and 43.5 inches of rain recorded on the same gage in WY2023 and WY2024, respectively. All sampled storm events met the targeted storm depth criterion of at least 0.30 inches of rain forecasted to occur during the monitoring day. All sampled base flow events met the criterion of less than 0.04 inch of rain in the previous 24 hours.

There was little or no precipitation in July through September of WY2025 (see Figure 3).

Mean monthly minimum, average, and maximum air temperatures are presented in Table 5 for the last three years of water temperature monitoring periods. Changes in air temperatures across this period generally coincide with recent year-to-year patterns in 7-DADMax water temperature exceedances in Burnt Bridge Creek, with August and September 2025 exhibiting particularly high temperatures relative to 2024. Changes in climate and increases in air temperatures will continue to impact the creek temperature and other water quality parameters such as decreased dissolved oxygen, which is less soluble in warmer water.

Table 5. Monthly Summer Air Temperature Averages in Vancouver, Washington.									
	Mean Minimum Monthly Air Temperatures[a]			Average Monthly Air Temperatures[b]			Mean Maximum Monthly Air Temperatures[c]		
Month	2023	2024	2025	2023	2024	2025	2023	2024	2025
May	50.9	47.1	47.6	62.7	57.6	58.6	74.5	68.2	69.6
June	53.1	53.2	53.2	64.9	64.5	64.8	76.8	75.8	76.3
July	58.5	58.6	58.4	71.8	72.5	70.7	85.1	86.3	83.0
August	61.5	58.0	60.0	74.0	69.7	71.9	86.5	81.5	83.8
September	54.2	54.3	55.2	64.8	65.9	66.7	75.4	77.4	78.1
October	47.0	45.6	44.3	56.4	55.8	53.7	65.8	66.0	63.2

[a] Mean minimum monthly air temperature is defined as the monthly average of the daily minimum air temperatures.

[b] Average monthly air temperature is defined as the monthly average of the daily average air temperatures.

[c] Mean maximum monthly air temperature is defined as the monthly average of the daily maximum air temperatures.

Air temperature data from National Weather Service (NOAA 2025) for the Vancouver, Washington area.

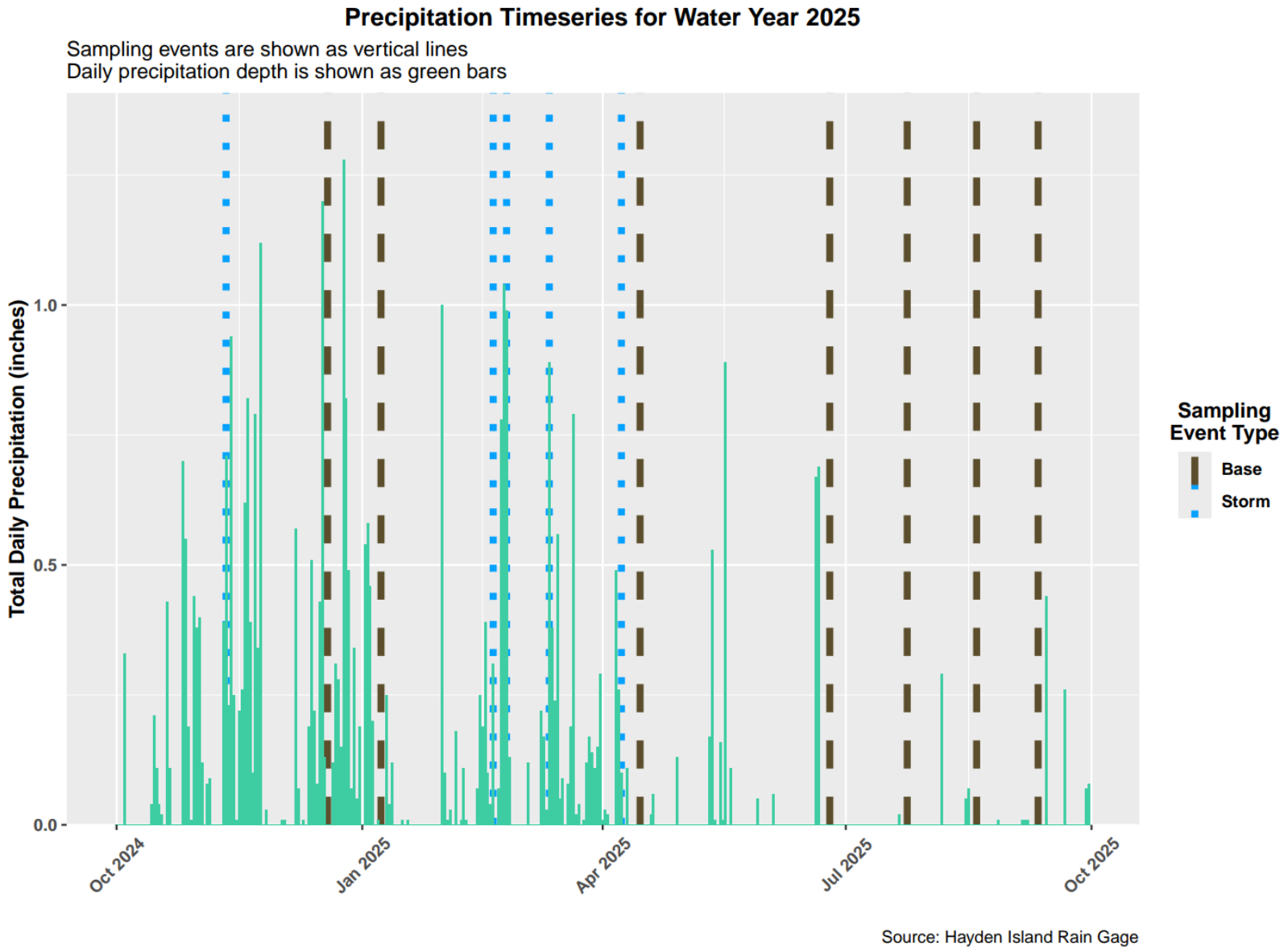


Figure 3. Burnt Bridge Creek Precipitation 7.5 Miles Southwest of BBC2.6 During Water 2025 (Portland 2025).

Summary of Water Quality Results

Water quality results from WY2025 have generally remained consistent with trends and patterns identified in previous summary reports and the 2024 Trend Analysis Report (Herrera 2025). These key patterns include:

- Seasonal patterns in base flow water quality have been consistently present throughout the monitoring program. With rising air temperatures and decreased stream flows in late summer, water temperature and *E. coli* concentrations tend to increase. Dissolved oxygen, which is less soluble in warmer temperatures, generally decreases to lows during the same period.
- Spatial patterns from station to station vary with some consistent patterns, but few continuous stream-wide patterns. Total phosphorus and pH, for example, followed an increasing pattern from upstream to downstream stations, while total nitrogen generally followed a decreasing pattern from upstream to downstream.
- Base and storm flow water quality varies in a consistent and predictable manner with several common stormwater contaminants exhibiting higher concentrations during storm flow events. Dissolved oxygen, turbidity, total suspended solids, metals, and bacteria concentrations were generally higher during storm flow events, whereas pH and conductivity were generally highest during base flow events.

WY2025 data were generally consistent with WY2020 through WY2024 data (see boxplots in Appendix E). Parameter-specific temporal patterns are summarized below:

- Dissolved Oxygen: For most stations, median base flow DO concentrations were lower than historical data at most stations but concentrations were not substantially different.
- Nitrogen: Median nitrate+nitrite concentrations were lower than historical data at most stations during base and storm flow. This is consistent with widespread decreasing nitrate+nitrite trends identified in the WY2024 Trend Analysis Report (Herrera 2025).
- Phosphorus: Median total phosphorus concentrations were greater than historical medians at most stations during base and storm flow events. The difference was most prominent during base flow where WY2025 concentrations were substantially higher at all mainstem monitoring stations except for BBC10.4 (Figure 4). Statistically significant increasing trends in soluble reactive phosphorus (SRP) were identified at the majority of monitoring stations in the WY2024 Trend Analysis Report. The WY2025 dry season base flow data appear consistent with this pattern (Figure 5).
- Bacteria: Base flow geomean *E. coli* concentrations were greater than historical geomeans at most stations, particularly midstream through downstream mainstem stations.
- Dissolved Copper: Metals and hardness were only analyzed during storm flow events in WY2025. Median concentrations were lower at all stations with substantial differences at several stations (Figure 6).

Figure 4. Total Phosphorus WY2025 and Historical Box Plots.

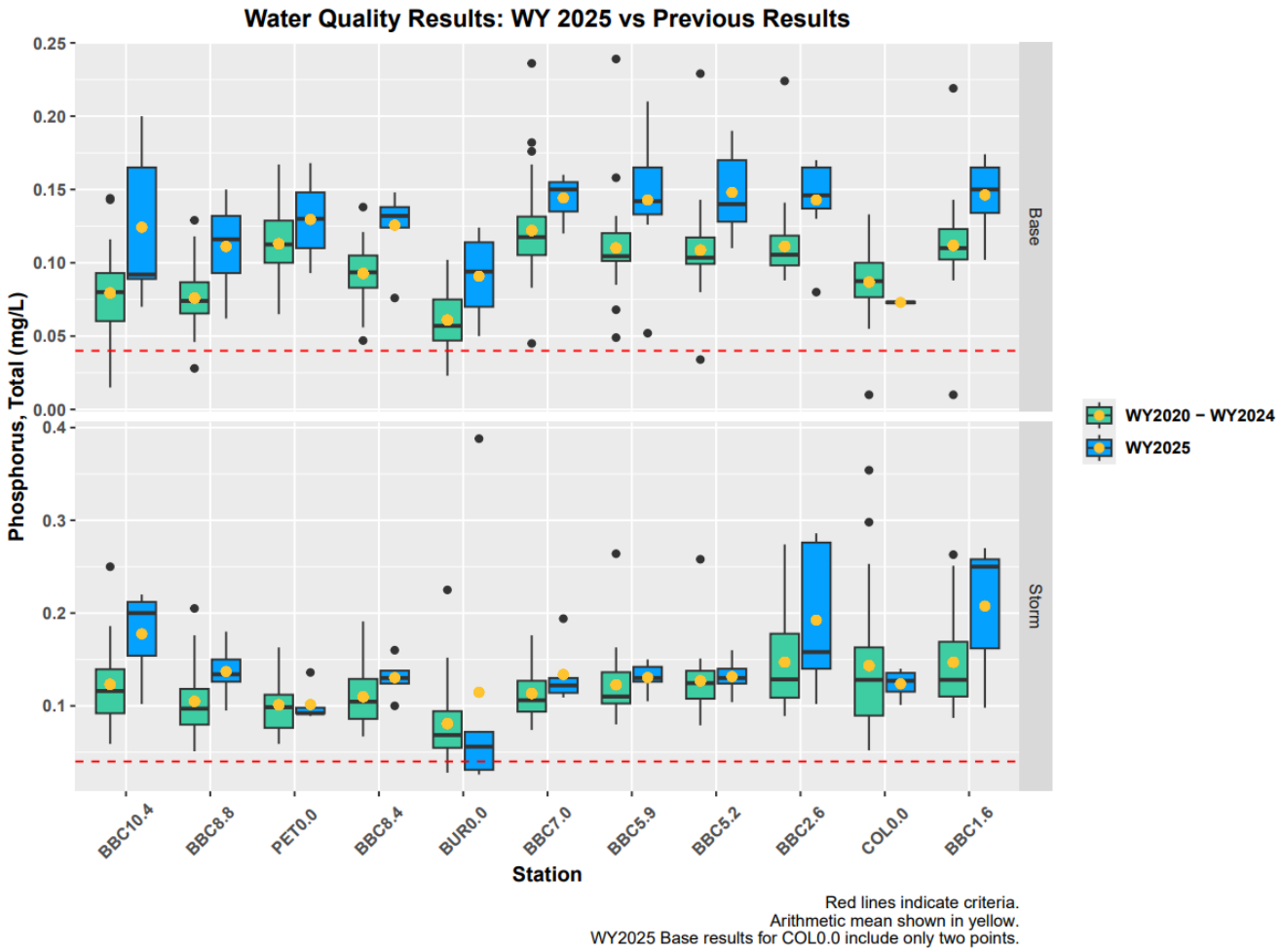


Figure 5. Base Flow Orthophosphate Concentrations Time Series.

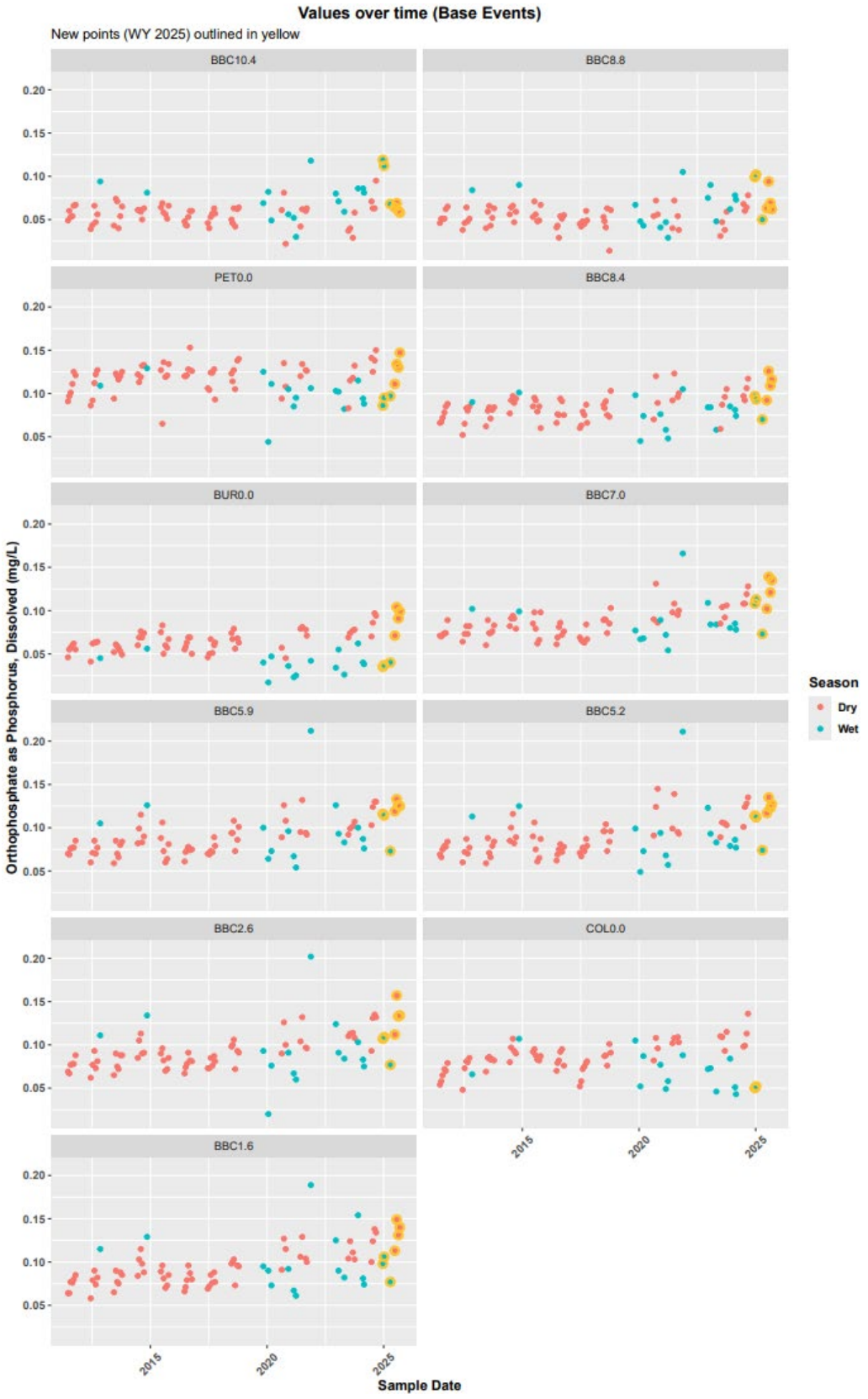
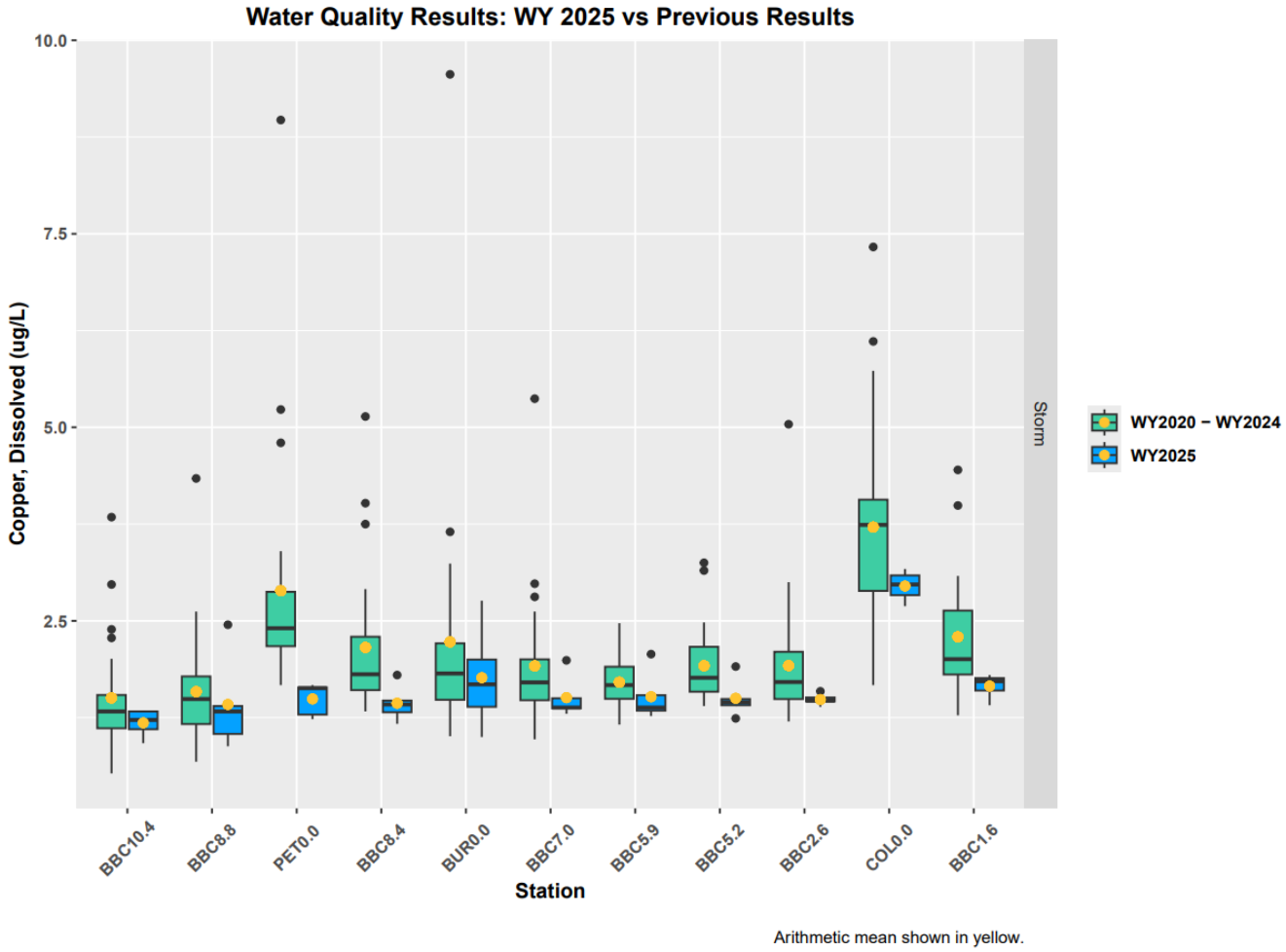


Figure 6. Dissolved Copper WY2025 and Historical Box Plots.



Water quality in Burnt Bridge Creek exceeded applicable criteria for several monitored parameters. Water quality standard exceedances during the WY2025 monitoring period are summarized below:

- **Temperature:** The temperature criterion (17.5°C) was exceeded at all stations during continuous temperature monitoring. Table 6 summarizes 7-DADMax temperature exceedances between April 29 and November 4, 2025, compared to the two previous monitoring periods. Days exceeding the criteria ranged from 91 (48 percent) at BBC10.4 to 139 (73 percent) at BBC8.8 with similarly high exceedances at BBC8.4 and BBC7.0 (134 and 135 days, respectively). Compared to the previous monitoring periods, the number of days exceeding the 7-DADMax criterion increased at all stations from 2024 to 2025 ranging from a 22 percent increase at BBC8.8 (114 to 139 days) to a 120 percent increase at BBC8.4 (61 to 134 days). Compared to 2023, 7-DADMax exceedances are similar and generally slightly less frequent. In general, apparent patterns in 7-DADMax exceedances in recent years are consistent with patterns in maximum and average air temperatures, as discussed in the Hydrology and Climate section, above.

- **Dissolved Oxygen:** Median dissolved oxygen concentrations did not meet criterion (minimum value shall be at least 10.0 milligrams per liter [mg/L]) at 10 stations for base and seven stations for storm flow. Dissolved oxygen criterion was met for median both storm and base flow concentrations at COL0.0 as well as median storm flow concentrations at BUR0.0, BBC2.6, and BBC1.6.
- **pH:** The pH criterion (6.5 to 8.5) was met during base flow events at all monitoring stations except for BBC10.4 where the pH was below the criterion in the majority of samples. Storm flow pH was generally within the criterion except for BBC10.4 (all events) and BBC8.8 and BUR0.0 (at least one event).
- **Turbidity:** Using an upstream station as background, the turbidity standard was not met due to a greater than 5 Nephelometric turbidity units (NTU) increase during the following events:
  - January 8, 2025, base flow event: increase from 4.8 NTU at BBC5.9 to 10.0 at BBC5.2.
  - February 24, 2025, storm flow event had multiple exceedances including:
    - Increase from 10.7 NTU at BBC8.4 to 20.3NTU at BBC7.0.
    - Increase from 11.4 NTU at BBC5.2 to 33.1 NTU at BBC2.6
    - Increase from 33.1 NTU at BBC2.6 to 38.7 NTU at BBC1.6
  - March 12, 2025, storm flow event had multiple exceedances including:
    - Increase from 4.9 NTU at BBC8.8 to 10.2NTU at BBC8.4.
    - Increase from 14.6 NTU at BBC5.2 to 45.7 NTU at BBC2.6
  - August 19, 2025, base flow event: increase from 1.1 NTU at BBC10.4 to 8.4 NTU at BBC8.8.
- **Nutrients:** Total phosphorus, total nitrogen, and nitrate+nitrite criteria were exceeded at all stations during all base and storm flow events except for total phosphorus during several storm flow events at BUR0.0.
- **Metals:** Table 7 summarizes all metals exceedances from For WY2025. Metals were only analyzed during storm flow events, for which acute criteria are most applicable. The acute criteria for dissolved zinc were exceeded once at BBC10.4 during the March 12, 2025, storm event, and once at BUR0.0 during the November 11, 2024, storm event.
- **Bacteria:** *E. coli* concentrations met criteria for geomean and 90th percentile during base flow events at BBC8.8, PET0.0, BBC8.4, BUR0.0, and COL0.0. During storm flow events, the criteria were met for BBC8.8 and BBC8.4 only. At least one of the geomean or 90th percentile criterion were exceeded at all other stations. Because the *E. coli* criteria specify a 90-day averaging period, these exceedances do not necessarily mean that the relevant monitoring stations were in exceedance of state water quality criteria during the entire monitoring period.

Table 6. Total Number of Days the 7-DADMax Temperature Exceeds the Temperature Criterion of 17.5°C from 2023 through 2025.

Station	Days Exceeding 7-DADMax Criterion			Percent of Days Exceeding Criterion 2025
	2023 (May 26 to October 31)[a]	2024 (April 26 to November 5)	2025 (April 29 to November 4)	
BBC10.4	104	49	91	48
BBC8.8	115	114	139	73
PET0.0	127	76	117	62
BBC8.4	120	61	134	71
BBC7.0	115	82	135	71
BBC5.9	113	92	127	67
BBC2.6	98	75	92	49
BBC1.6	85	63	96	51

7-DADMax: 7-day average daily maximum.

°C: Degrees Celsius.

[a] Due to temperature probe installation delays, the 2023 7-DADMax exceedances are likely underestimated. 7-DADmax temperatures at several monitoring stations exceeded the criterion at the earliest available datapoint.

Table 7. Metals Water Quality Criteria Exceedances.

Station	Date	Type	Parameter	Result (µg/L)	Hardness (mg/L)	Criteria Type	Criteria Value (µg/L)
BBC10.4	3/12/2025	Storm	Zinc, Dissolved	139	60.2	Acute	74.4
						Chronic	68.0
BUR0.0	11/11/2024	Storm	Zinc, Dissolved	155	29.6	Acute	40.8
						Chronic	37.3

µg/L: micrograms per liter

mg/L: milligrams per liter

Monitoring Station Summary

A summary of site characteristics, key water quality observations and a site photograph are provided for each monitoring station below.

BBC10.4

Subbasin characteristics

Primarily residential with second highest septic system density of any station (0.28 septic systems per acre). Some commercial and industrial zoned land and highway inputs (43 percent impervious).

WY2025 Observations

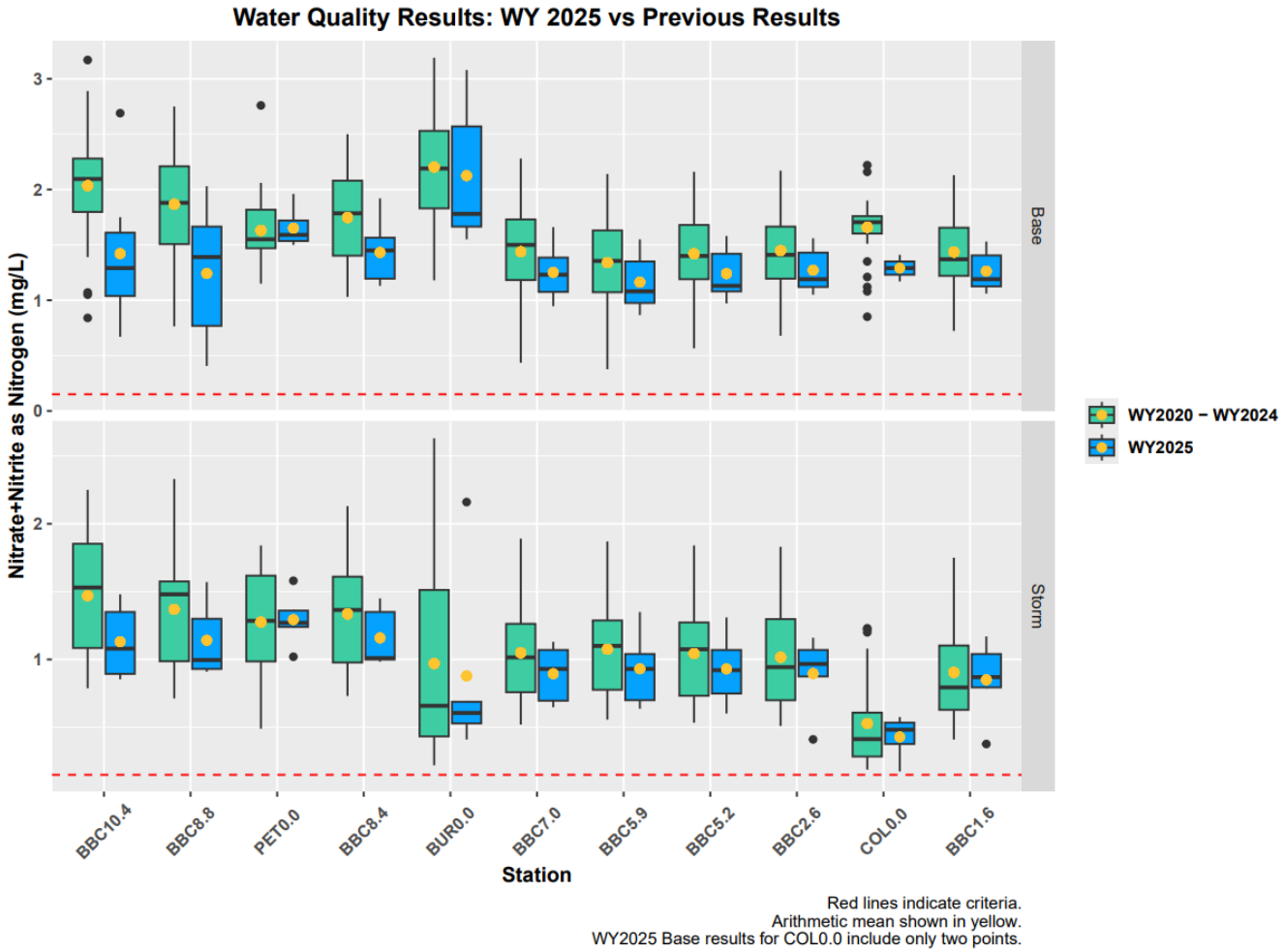
Dissolved oxygen was slightly lower than recent historical results (WY2020 through WY2024) and substantially lower than all other stations (consistent with historical data).

Nitrate+Nitrite was substantially lower than historical concentrations and is now comparable to other mainstem stations, whereas historically the site has had substantially greater concentrations (Figure 7). **Total phosphorus** concentrations, however, were higher than historical concentrations with increases in base and storm flow medians and a substantial increase in WY2025 storm flow concentrations compared to historical results (Figure 4). Historically, base flow total phosphorus concentrations at BBC10.4 have been substantially lower than midstream and downstream mainstem stations but were not substantially different in WY2025.

Dissolved zinc exceeded the acute criteria during one storm event (March 12, 2025) and was greater than historical concentrations at this station. This was one of only two metals exceedances during the entire WY2025 monitoring period.

BBC10.4 on July 24, 2025

Figure 7. Nitrate+Nitrite Base and Storm Flow Box Plots.



BBC8.8

Subbasin characteristics

Primarily residential with very low septic system density (0.06 septic systems per acre). Some commercial zoned land and highway inputs from SR-500 and I-205 (41 percent impervious). Contributions from a large golf course located directly upstream from the monitoring station.

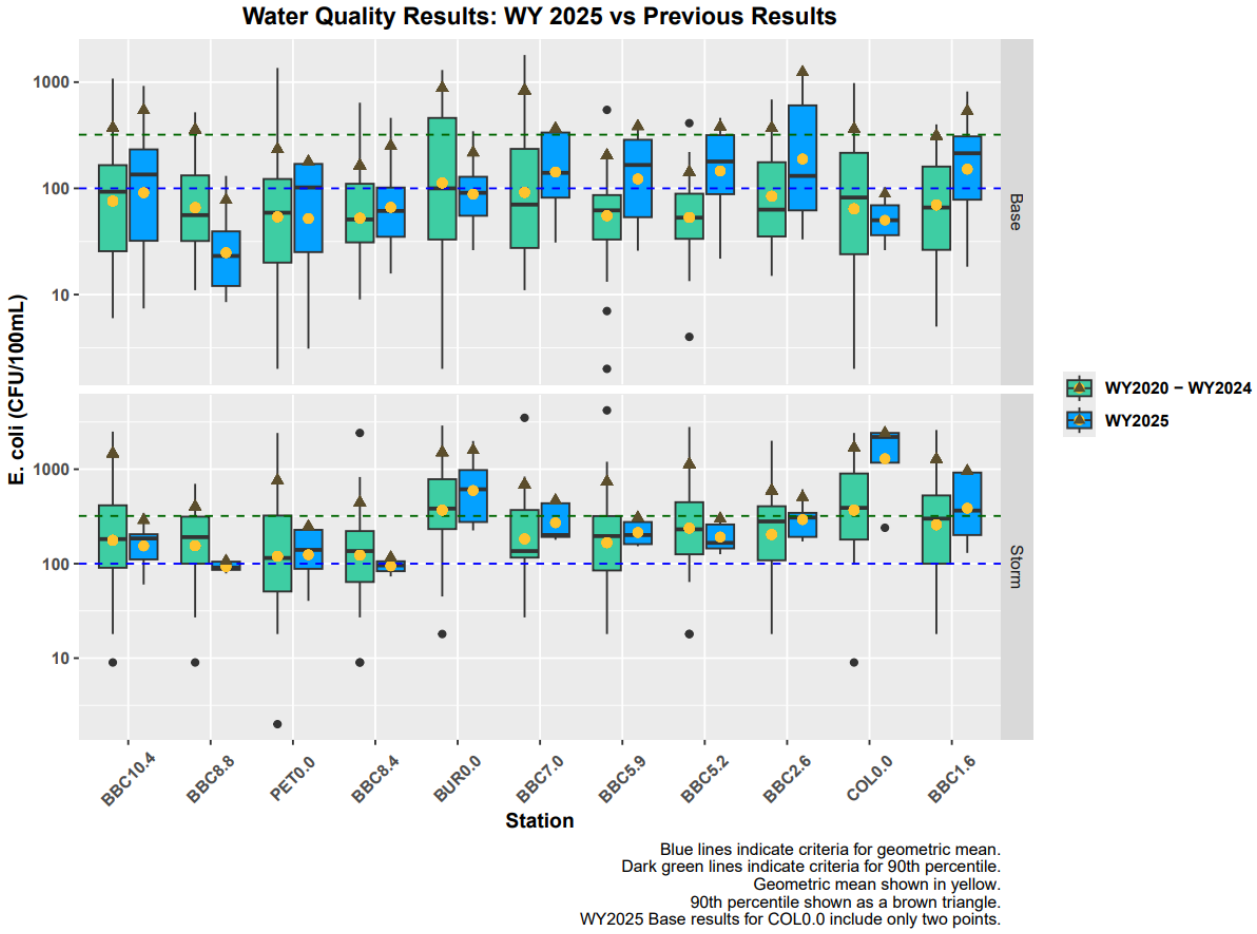
WY2025 Observations

The **7-DADMax temperature** exceeded the criterion for 139 days in WY2025, the most of any station. 7-DADMax temperatures peaked in early July through late August, overlapping with the lowest **dissolved oxygen** concentrations (below 9.0 mg/L) observed in June through September.

Geomean ***E. coli*** concentration during base flow events at BBC8.8 was the lowest of all monitoring stations and concentrations were substantially lower than most midstream and downstream mainstem stations during storm flow events (Figure 8). *E. coli* concentrations at BBC8.8 have historically appeared to be more comparable to other stations. The one decreasing *E. coli* trend identified in the WY2024 Trend Analysis was for BBC8.8 base flow results.

BBC8.8 on December 19, 2024

Figure 8. *E. Coli* Storm and Base Flow Box Plots.



PET0.0

Subbasin characteristics

The PET0.0 subbasin is primarily residential (56 percent) and industrial (39 percent) with moderate septic system density (0.14 septic systems per acre) primarily clustered in the northwest and southeast portions of the basin. Dry season base flow in Peterson Channel is primarily sustained through industrial non-contact cooling water discharge.

WY2025 Observations

The **7 DADMax temperature** exceeded the criterion for 117 days during the WY2025 monitoring period, a moderate frequency relative to other stations in WY2025. 7-DADMax temperatures peaked in mid-July through late August but rarely exceeded 20°C. **Dissolved oxygen** concentrations were slightly lower (below 9.0 mg/L versus typical ranges from 8 to 10 mg/L) during this period but generally did not exhibit much seasonal variability.

Unlike most mainstem monitoring stations, median base and storm flow **nitrate+nitrite** concentrations at this tributary station were comparable to historical concentrations. Likewise, base and storm flow **total phosphorus** concentrations in WY2025 were not substantially different than historical results.

Dissolved copper concentrations (analyzed during storm events only in WY2025) at PET0.0 were substantially lower than historical concentrations and are no longer substantially different from mainstem BBC stations.

PET0.0 on December 19, 2024

BBC8.4

Subbasin characteristics

The smallest subbasin in this study, BBC8.4 is primarily residential (74 percent) with some open green spaces and a relatively low impervious area (29 percent). Septic system density is relatively high (0.23 septic systems per acre) with most units located in the eastern portion of the subbasin.

WY2025 Observations

The **7 DADMax temperature** exceeded the criterion for 134 days during the WY2025 monitoring period, a high frequency relative to other stations in WY2025. 7-DADMax temperatures peaked in late June through early September with consistent 7-DADMax temperatures above 20°C. **Dissolved oxygen** concentrations were slightly lower (below 8.5 mg/L versus typical ranges from 8 to 11 mg/L) during July and August base flow events.

Similar to the upstream tributary PET0.0, **dissolved copper** concentrations (analyzed during storm events only in WY2025) at BBC8.4 were substantially lower than historical concentrations.

BBC10.4 on February 19, 2025

BUR0.0

Subbasin characteristics

Primarily residential (81 percent) with limited commercial, industrial or green spaces, BUR0.0 has the highest septic system density (0.29 septic systems per acre) distributed throughout the subbasin. Discharge during base flow events appear to be very low relative to mainstem BBC stations and other tributaries.

WY2025 Observations

The base flow median **dissolved oxygen** concentration (8.6 mg/L) was lower than the historical median and below the state standard while the storm flow median concentration (10.6 mg/L) was above the standard.

Storm flow median **turbidity** (25.5 NTU) was higher than the historical median and higher than all mainstem stations in WY2025. The station exhibited a high turbidity outlier of 81.5 NTU during the March 12, 2025, storm flow event.

Base flow ***E. coli*** concentrations met water quality standards in WY2025 whereas the historical dataset did not meet water quality criteria. WY2025 storm flow concentrations were substantially higher than other stations.

Storm flow **nitrate+nitrite** concentrations were substantially lower than most mainstem stations. Storm flow **total phosphorus** concentrations were substantially lower than all other monitoring stations in WY2025 despite a high outlier concentration of 0.388 mg/L on March 12, 2025, that exceeded all historical concentrations at any station since WY2020.

Dissolved zinc exceeded the acute criteria during one storm event at BUR0.0 on November 11, 2024. This was one of only two metals exceedances during the entire WY2025 monitoring period. The dissolved zinc concentration that exceeded the acute criteria was higher than any historical concentration at this station. **Total zinc** concentrations remained substantially higher than most other stations, consistent with historical results.

BUR0.0 on February 19, 2025

BBC7.0

Subbasin characteristics

Primarily residential (59 percent) subbasin with some commercial (22 percent) and green spaces. BBC7.0 includes inputs from SR 500 and a duck pond located directly upstream of the monitoring station. Septic systems are clustered throughout the subbasin with a moderate density (0.11 units per acre).

WY2025 Observations

The **7-DADMax temperature** exceeded the criterion for 135 days during the WY2025 monitoring period, the second highest of any station in WY2025. 7-DADMax temperatures peaked in early July through early September with 7-DADMax temperatures briefly exceeding 25°C and consistently exceeding 22°C. A minimum **dissolved oxygen** concentration of 7.7 mg/L was measured during the September 2025 base flow event.

Similar to other mainstem stations, base flow ***E. coli*** concentrations increased to peaks in July through September with concentrations exceeding 300 most probable number per 100 mL (MPN/100 mL).

Base flow **total phosphorus** concentrations in WY2025 were substantially greater than historical results and remained the highest median concentration of 0.15 mg/L (tied with BBC1.6). Storm flow total phosphorus concentrations were not substantially different than historical results despite an increase in median concentration, with limited substantial differences compared to other mainstem stations.

BBC7.0 on December 19, 2024

BBC5.9

Subbasin characteristics

The BBC5.9 subbasin is primarily residential (60 percent) with limited (less than 25 percent) industrial and green spaces. Septic system density (0.02 septic systems per acre) is the lowest of all BBC subbasins.

WY2025 Observations

The **7-DADMax temperature** exceeded the criterion for 127 days during the WY2025 monitoring period, a moderate frequency relative to other stations in WY2025. 7-DADMax temperatures peaked in early July through early September with 7-DADMax temperatures briefly exceeding 25°C and consistently exceeding 22°C. Base flow **dissolved oxygen** concentrations were substantially lower than nearby mainstem stations BBC7.0 and BBC5.2 through BBC1.6. Base flow dissolved oxygen concentrations remained below 8.0 mg/L from June through September events.

Similar to other mainstem stations, base flow ***E. coli*** concentrations increased to peaks in August and September with concentrations exceeding 400 and 300 MPN/100 mL, respectively.

Base flow **nitrate+nitrite** concentrations were the lowest of any station in WY2025.

BBC5.9 on July 24, 2025

BBC5.2

Subbasin characteristics

The BBC5.2 subbasin contains majority residential (69 percent) and some commercial (21 percent) lands with small inputs from SR 500. Density of septic systems is relatively low (0.07 units per acre), and most are clustered to the west of the creek. Potential local sources of pollution at this station may include pet waste and fertilizer nutrient runoff from the residential neighborhood that abuts the stream.

WY2025 Observations

Base flow **dissolved oxygen** concentrations dropped slightly during the late dry season but remained above 8.8 mg/L during the entire monitoring period.

WY2025 base flow ***E. coli*** concentrations exceeded both applicable criteria whereas historical concentrations were below these criteria.

Dissolved copper concentrations were substantially lower in WY2025 compared to historical results. Dissolved copper concentrations generally decreased at all stations in WY2025 but may be related to storm characteristics and sample timing versus temporal trends. The difference was not present in **dissolved zinc** or **total metals** concentrations.

BBC5.2 on December 19, 2024

BBC2.6

Subbasin characteristics

BBC2.6, located in Leverich Park, is the second furthest downstream mainstem monitoring station. This subbasin contains the largest percentage of greenspace (34 percent) with a majority percentage of residential land (61 percent) and minor contributions from commercial areas and SR 500. Septic system density is moderate (0.12 systems per acre) and are primarily located north of the creek.

WY2025 Observations

The **7-DADMax temperature** exceeded the criterion for 92 days during the WY2025 monitoring period, a low frequency relative to other stations in WY2025. 7-DADMax temperatures peaked in late June through late August with 7-DADMax temperatures rarely exceeding 20°C. Base flow **dissolved oxygen** concentrations were slightly lower during June through base flow events but consistently remained above 8.8 mg/L.

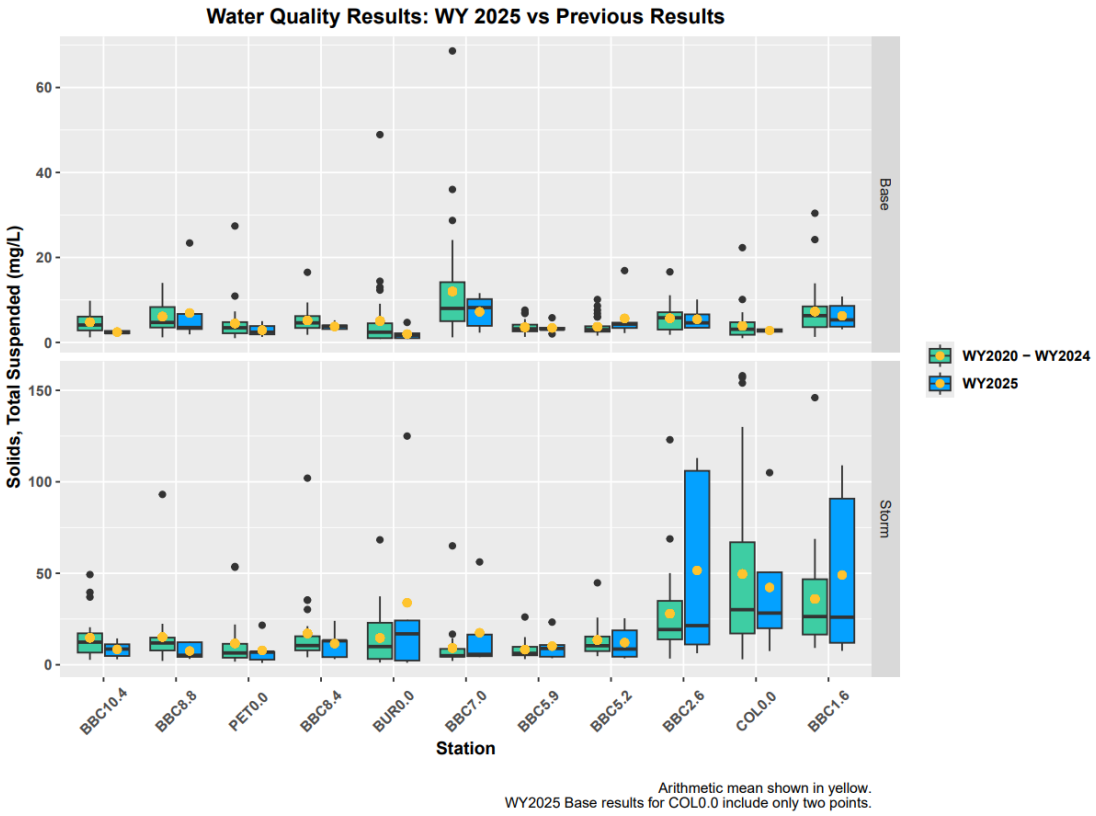
The base flow ***E. coli*** geomean increased from below 100 MPN/100 mL in historical samples to 189 MPN/100 mL in WY2025 samples driven by concentrations above 1,100 MPN/100 mL in August and September base flow events.

Storm flow median **nitrate+nitrite** concentration increased slightly in WY2025. BBC2.6 exhibited the highest storm flow **total phosphorus** concentration of mainstem stations.

Storm and base flow **turbidity** and **total suspended solids** were similar at BBC2.6 and BBC1.6, with both exhibiting much higher levels during storm flow events, consistent with historical results (Figure 9).

BBC2.6 on February 19, 2025

Figure 9. Total Suspended Solids Base and Storm Flow Box Plots



COL0.0

Subbasin characteristics

The COL0.0 subbasin consists of a majority, through relatively low, residential (54 percent) land with contributions from industrial (35 percent) areas. Septic systems are evenly distributed throughout the subbasin with a moderate density (0.14 systems per acre). The tributary is heavily influenced by its groundwater source during base flow conditions. Evidence of encampments have been noted by field staff around COL0.0.

WY2025 Observations

Due to the safety concerns at COL0.0, only two of seven **base flow events** and four of five storm flow events were successfully completed. Due to the seasonal variability of certain parameters during base flow, WY2025 base flow events are representative of wet season base flow only.

Wet base flow **dissolved oxygen** concentrations were consistent with historical seasonal results and were above 11.0 mg/L in both wet season base flow events sampled (Figure 10). All storm flow concentrations in WY2025 also met the 10 mg/L criterion which is consistent with historical concentrations.

Storm flow ***E. coli*** concentrations, which have typically had some of the highest geomeans of any station, were substantially higher than historical concentrations and substantially higher than WY2025 results at other stations.

Dissolved copper concentrations, which have historically been substantially higher than all other stations, were lower in WY2025 (median of 3.0 micrograms per liter [µg/L] compared to historical median of 3.8 µg/L).

Storm **flow turbidity** remained high at COL0.0 in WY2025 with the highest median (32.6 NTU) and substantially higher turbidity than all other stations except for BBC2.6 and BBC1.6 (Figure 11).

COL0.0 on December 19, 2024

Figure 10. Dissolved Oxygen Base Flow Time Series.

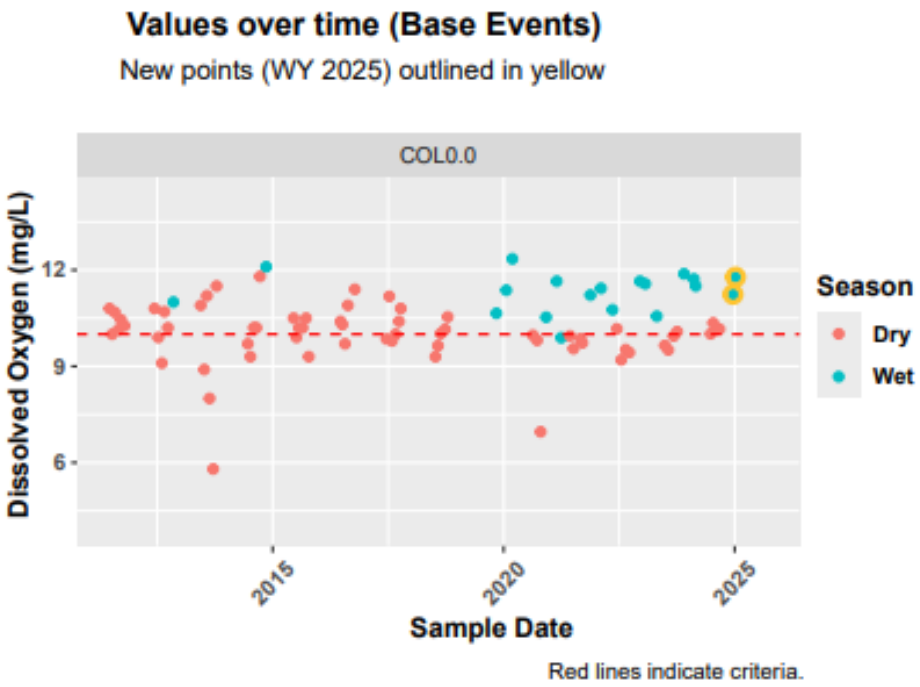
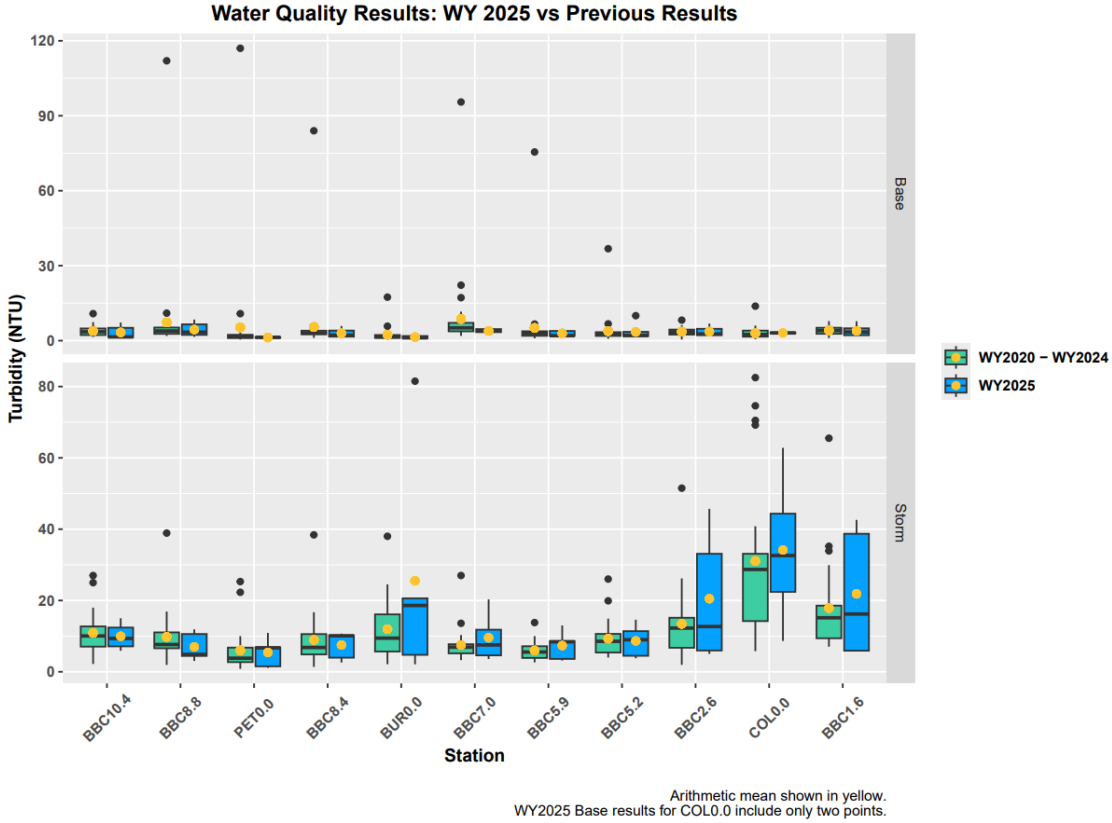


Figure 11. Turbidity Base and Storm Flow Box Plots.



BBC1.6

Subbasin characteristics

BBC1.6 is the most downstream monitoring station and includes primarily residential (58 percent) land with inputs from Interstate 5 (I-5) and industrial (34 percent) land. Septic system density in the subbasin is relatively low (0.06 systems per acre).

WY2025 Observations

The **7-DADMax temperature** exceeded the criterion for 96 days during the WY2025 monitoring period, a low frequency relative to other stations in WY2025. 7-DADMax temperatures peaked in late June through late August with temperatures rarely exceeding 20°C. Base flow **dissolved oxygen** concentrations were slightly lower during July and September base flow events but consistently remained above 8.9 mg/L.

Historical base flow ***E. coli*** concentrations have generally been at or below both applicable criteria, but WY2025 results exceeded both criteria with a geomean and 90th percentile of 152 and 533 MPN/100 mL, respectively. Consistent with other stations, base flow concentrations were highest in August and September with concentrations of over 300 and 800 MPN/100 mL, respectively.

Storm flow **total phosphorus** concentrations were substantially higher than all mainstem stations except for BBC10.4 and BBC2.6 and had the highest median concentration.

Storm and base flow **turbidity** and **total suspended solids** were similar at BBC2.6 and BBC1.6, with both exhibiting much higher levels during storm flow events, consistent with historical results (Figure 9).

BBC1.6 on February 19, 2025.

Discussion and Recommendations

This section discusses the most impactful water quality results throughout Burnt Bridge Creek and its tributaries in WY2025, potential causes, and recommended mitigation strategies. Particular emphasis is placed on Category 5 303(d) listed parameters for reaches of Burnt Bridge Creek (i.e., temperature, dissolved oxygen, pH, and fecal bacteria), but other interconnected results and observations are discussed.

Consistent with previous years and conclusions from the WY2024 Trend Analysis Report, water quality standards were generally met for pH, turbidity, and metals with some exceptions (see Results section), but frequently exceeded for water temperature, dissolved oxygen, and *E. coli* bacteria.

WY2025 Water Quality

Microbial Source Tracking

The MST study was conducted by analyzing water samples collected at the 11 monitoring stations during three base flow events and three storm events for genetic markers in the Bacteroides class of fecal bacteria representing five types of fecal sources: Human, Bird, Dog, Cow, and All Source (all human and warm-blooded animals). Comprehensive results and discussion of the WY2025 MST study are presented in Appendix A. Several targets were consistently present during the WY2025 MST study. While a marker concentration can't be directly compared among the tested fecal sources or with the amount of fecal matter or *E. coli* because different species shed the analyzed genetic material at different rates, frequency of detections and magnitude of concentrations can be used as a high-level line of evidence to evaluate how potential sources vary spatially with season and flow. The following conclusions can be drawn regarding sources of bacteria during the study period:

- The All Source (GenBac) and Bird (GFD) markers were consistently present during storm flow events and had the highest and second highest concentrations, respectively. These markers were present at most stations at much lower concentrations during base flow events as well.
- The Human (HF183) marker was consistently present at most stations during storm flow events but generally only intermittently detected at trace concentrations during base flow events. Storm flow concentrations of the Human marker were much lower than All Source or Bird markers, but presence of Human marker signatures above trace levels represents human impact on the stream. Human marker concentrations exceeded a risk-based limit of 525 copies/100 mL (Boehm and Soller 2020) during at least one of three sampled storm events at BBC8.8, BBC8.4, BUR0.0, and COL0.0.
- Non-trace detections of the Dog (DG37) marker were intermittently detected at all monitoring stations during storm flow but were generally not detected during base flow events.

- All Source marker concentrations were several orders of magnitude higher than any individual source marker analyzed. This finding suggests that other animals in the watershed are more important sources of high fecal bacteria concentrations in Burnt Bridge Creek than humans, birds, dogs, or cows.

The consistent detections and higher concentrations of target markers during storm flow events during the study period indicate that stormwater runoff and infiltration are the primary vectors for these *Bacteroides* in the stream. *E. coli* concentrations during this study were varied with some stations exhibiting a higher geomean concentration during base flow events and some during storm flow events. Differences in hydrologic and seasonal patterns of *Bacteroides* and *E. coli* cells are due to many factors inherent with these fecal parameters including different concentrations in fecal matter, transport mechanisms, loss rates, and growth rates of genetic material versus living cells.

E. coli and *Bacteroides* sources to Burnt Bridge Creek are likely primarily from stormwater discharges where much of the bacteria cells and genetic material sorbs to fine suspended solids present in stormwater runoff. Much of this sediment is transported downstream where fecal matter decays from ultraviolet light or is consumed by microbes. However, some of this sediment is deposited in pools and along the streambanks where it is protected from ultraviolet light exposure during the winter and spring. Under optimum conditions, *E. coli* bacteria can persist in the environment for months (Ishii et al. 2006, Petersen et al. 2020). In streambed sediment, temperatures above 18°C may be associated with increases in *E. coli* concentrations despite being colder than the ideal temperature for *E. coli* growth (Afolabi et al 2023). These insulated conditions followed by sediment suspension from stormwater inflow or physical disturbance by humans or animals can be a source of increases in *E. coli* concentrations during summer base flow. Similarly, genetic material of *Bacteroides* may persist in streambed sediment for subsequent suspension, but it does not multiply in the environment.

The higher *E. coli* concentrations in summer base flow than winter storm flow observed at some locations may be due to increased animal activity in the stream. Beavers, racoons, rodents, birds, and other animals frequently use urban streams as a source of water in dry summer months where they directly deposit feces and disturb sediments containing *E. coli*. For example, racoons have been identified as a particularly important and challenging source of *E. coli* in Colorado urban streams because they defecate directly in storm drains and stream channels (Water Education Colorado 2026).

Water Temperature, Dissolved Oxygen, and E. coli

Water temperature mitigation is a high priority due to the sensitivity of aquatic habitat as well as other water quality parameters to temperature. For example, elevated water temperatures reduce dissolved oxygen by increasing biological oxygen demand via organic matter degradation and by reducing the solubility of oxygen in water. In addition, warmer water can promote growth in fecal bacteria sorbed to streambank sediment, further degrading water quality when those sediments are suspended.

Water temperatures are affected by variables such as air temperature, solar radiation, riparian cover, and stream flow. With climate change driving increased thermal loads to Burnt Bridge Creek in the present and future, managing riparian cover and stream flow variables including recharge and groundwater extraction will be important to mitigate the impacts of climate change. Low stream flow in Burnt Bridge

Creek generally occurs during the late dry season (August through September) (Clark County 2025), overlapping with the July through September period that has the highest air temperatures. The lower in-stream volume requires less energy to increase temperatures.

Unique Conditions

Burton Channel on March 12th, 2025

Field staff noted highly turbid and grayish color (see photo) at BUR0.0 during the storm flow event on March 12, 2025. Water quality results suggest the presence of atypical pollutant sources such as an illicit discharge or septic failure event rather than chronic sources. The following parameters exceeded maximum historical concentrations at this station:

- Turbidity (81.5 NTU) and total suspended solids (125 mg/L)
- Total phosphorus (0.39 mg/L)
- Total copper (19.9 µg/L) and total zinc (136 µg/L)

BUR0.0 on March 12, 2025.

In addition, maximum concentrations for WY2025 were observed for *E. coli* (1,990 MPN/100 mL), Human marker (over 5,700 copies/100 mL), and All Source marker (over 10 million copies/100 mL). High concentrations of Human and All Source markers in addition to elevated *E. coli* and nutrients suggest impacts from septic failure (which are located in relatively high concentration in the basin) or municipal wastewater discharge.

Storm conditions during this event were not unique compared to typical storm conditions with 0.22 inches of precipitation immediately prior to sampling.

BBC10.4 Drainage Area

Upstream monitoring station BBC10.4 consistently exhibits unique water quality characteristics in WY2025 and through historical monitoring periods. Dissolved oxygen and pH at BBC10.4 are typically the lowest of all mainstem stations during base flow events. During WY2025, pH was frequently below the state water quality criterion and dissolved oxygen concentrations dropped to around 5.0 mg/L during summer base flow events. These distinct conditions can be partially attributed to natural wetland conditions and the presence of peat soils or other decaying organic matter in the upstream areas draining to the station. Current riparian restoration activities are underway by the City in the immediate vicinity of the monitoring station.

BBC8.8 Drainage Area

Monitoring station BBC8.8 exhibited some unique water quality conditions including the highest frequency of 7-DADMax temperature exceedances (139 days), the lowest geomean base flow *E. coli* concentration, and moderate dissolved oxygen concentrations. The chronic water temperature exceedances may be partly attributed to the station's location directly downstream of a large golf course where sections of the stream have minimal riparian cover. The high temperatures with low *E. coli* and moderate dissolved oxygen does not fit the typical base flow relationship between these parameters discussed above. The discrepancy may be related to low wildlife presence in the contributing drainage area (golf course) where typical sources of *E. coli* such as wild mammals, birds, and septic systems were either absent or not present in as high of density as other mainstem stations. Vegetation management practices in this area may also decrease the quantity of degrading natural materials in stream which can decrease the biological oxygen demand and lead to higher dissolved oxygen concentrations. Also, less shade can increase attached algae growth and their production of dissolved oxygen.

During storm flow events, concentrations of MST markers at BBC8.8 were comparable to the upstream station BBC10.4 but were among the lowest of all stations during base flow events. The substantial decrease in All Sources and Bird markers from BBC10.4 to BBC8.8 during base flow suggests that basin BBC8.8 contributes lower animal and suspended sediment sources of fecal bacteria during summer low flow conditions than other basins downstream.

Tributary Impacts

Consistent with results from previous water years, inputs from the three main tributaries appear to impact water quality at mainstem stations downstream from the tributaries.

Peterson Channel

Downstream impacts from Peterson Channel have generally been minimal compared to impacts from other tributaries. Copper concentrations have been relatively high on occasion and appeared to have an impact on downstream station BBC8.4, which has historically shown an increase in copper concentrations compared to upstream station BBC8.8. Copper concentrations are generally of low concern in this reach of BBC and are not of concern in Peterson Channel where copper criteria exceedances are rare.

Burton Channel

Burton Channel has historically exhibited unique base and storm flow water quality characteristics but, likely due to relatively low flows, have had limited impact on downstream mainstem stations. Storm flow zinc and *E. coli* concentrations, in particular, have appeared to impact the station immediately downstream (BBC7.0) relative to the upstream station (BBC8.4). Ecology's Category 5 listings include Burton Channel for copper and zinc which was supported by high metals concentrations at BUR0.0. Stormwater runoff from impervious surfaces including road crossings in the immediate vicinity of the tributary may be driving both high zinc and *E. coli* concentrations during storm events. While most stormwater in the BUR0.0 drainage basin is controlled by infiltration facilities, untreated runoff from residential areas, Burton Road, and I-205 is conveyed directly to Burton Channel through over 20 outfalls.

Cold Creek

Cold Creek monitoring was discontinued due to safety concerns. Based on data from four storm and one base flow event, impacts on downstream mainstem stations remains consistent with past years including high storm flow *E. coli,* total suspended solids, turbidity, copper, and zinc, and low base flow temperature, total phosphorus, and *E. coli.* Streambank erosion and stormwater runoff from nearby communities and other human impacts are likely key drivers of the unique storm flow water quality conditions. The Cold Creek watershed is primarily residential with some commercial and industrial land use, but much of the channel runs through properties owned by the Bonneville Power Administration and Washington State Department of Transportation. The drainage area in the immediate vicinity of the monitoring station is primarily state-owned and forested land and within County jurisdiction.

Uncertainty and Data Gaps

Conclusions and recommendations are based on the available data. New pathways or sources of surface water impairments may be identified with additional types of monitoring as discussed in the Future Monitoring section. Limitations to current data and potential new areas to investigate are listed below:

- Monitoring at Cold Creek (COL0.0) was discontinued after the March 12, 2025, storm event due to safety concerns pertaining to human activities. As a result, one storm flow event (April 8, 2025) and five base flow events (April 15, July 25, July 24, August 19, and September 11, 2025) were not sampled for monitoring station COL0.0. MST analyses were also not conducted during dry weather base flow events at this station (see Appendix A). Cold Creek represents an important tributary that has historically impacted downstream mainstem water quality. Continued monitoring and understanding of trends and responses to management activities is important to the long-term health of the Burnt Bridge Creek watershed. An alternative Cold Creek monitoring station that addresses field safety concerns has not been identified that includes runoff from the nearby highways and industrial areas.
- Past analyses Burnt Bridge Creek have not included stream discharge measurements. Clark County recently restarted operation of a stream stage gauge near BBC5.9 in WY2022 and provided continuous stream stage measurements from WY2022 through WY2024. Analysis of the relationship between stream flow and water quality is important to ensuring watershed resilience in a changing environment and to enhance future trend analyses. It is recommended to develop rating curves of flow versus stage for this gauge for evaluating hydrologic trends, relationships with water quality, and pollutant loading in Burnt Bridge Creek.
- During monitoring activities, field staff have observed evidence of human habitation near monitoring stations. It is presumed that human encampments are common along the creek, but data on the distribution and density of such camps are unavailable. Such information may be useful in determining the impact of human encampments on water quality.
- The MST study conducted during the WY2025 monitoring program improved the understanding of bacteria sources throughout the watershed but had a limited scope. Limitations of use for this data are discussed in Appendix A.

Future Monitoring

No changes to monitoring locations, sampling frequency, monitoring parameters or analytical methods are proposed for WY2026. A consistent long-term dataset is essential for detecting trends and evaluating the effectiveness of management activities, such as those that will be implemented as part of the Advance Restoration Plan. Monitoring at the same 10 stations (and eight continuous temperature monitoring stations) should continue to include base flow and storm sampling at the same frequency defined in the QAPP:

- Five storm events in the wet season from October through May
- Three base flow events in the wet season from November through April
- Four base flow events in the dry season from June through September

The total number of samples collected annually would be 132 samples (including 12 duplicate samples). Sampling at the Cold Creek tributary station COL0.0 may be resumed depending on field conditions in future water years.

Additional MST monitoring may be conducted in the future to support actions specified in the Advance Restoration Plan (once finalized), evaluate effectiveness of implemented best management practices (BMPs), gather additional data on specific spatial distribution of markers, and/or to measure alternative markers.

Field filtration for SRP and dissolved metals was introduced in WY2025 as a corrective action due to frequent detections of SRP exceeding total phosphorus concentrations or, less frequently, dissolved metals exceeding total metals concentrations. Continuation of field filtration is recommended to identify whether the issue has been addressed and to meet filtration holding times recommended per the associated analytical methods. One SRP and two dissolved metals results were flagged due to exceedance of the total fraction during the WY2025 monitoring period (Appendix B), which is a decrease in frequency compared to monitoring periods where lab filtration was utilized.

Additional studies that would be helpful to fill data gaps, evaluate effectiveness of existing watershed BMPs and identify and prioritize additional actions for improving the water quality and overall watershed health of Burnt Bridge Creek may be added to the monitoring program. Prioritization of these additional studies should be weighed with consideration to relevant recommendations and conclusions from the Advance Restoration Plan, which is currently undergoing draft review. Pending those recommendations, additional studies considered to be of greatest potential value include:

- Evaluate relationships between stream flow and water quality characteristics (storm and base flow). Partnering with Clark County, develop or refine a rating curve to relate stream stage currently monitored near BBC5.9 to stream flow. While additional flow monitoring stations, particularly near the upper and lower reaches of the stream, would be helpful in further understanding surface/groundwater interactions throughout the watershed, initial evaluation of how water quality may vary as a function of flows is an important first step.
- Annual benthic macroinvertebrate sampling at selected stations with calculation of the B-IBI and other metrics, to better understand impacts and trends in habitat quality and inform restoration

and/or protection priorities. This monitoring is already conducted by Clark County at one monitoring station (BBC5.9).

- Establish vegetation monitoring to assess riparian canopy cover and overall vegetation structure, informing planting recommendations and vegetation management strategies. Monitoring results can be used to identify canopy gaps, prioritize functional riparian cover, and guide actions to support improved stream conditions, including moderating temperature impacts.
- Build on the Vancouver Watershed Health Assessment by performing a hydrological study, which may include building a hydrodynamic model, to better understand how groundwater moves through the basin, identify high-risk areas, and improve prioritization of source control activities and/or protection (e.g., areas contributing to drinking water aquifers).
- Hydrogeological and/or climate modeling to understand near- and long-term impacts of climate change and identify actions to mitigate or protect against those impacts.

Water Quality Improvement

As noted previously, Ecology is developing an Advance Restoration Plan, currently in draft review by regulators and stakeholders, that will drive activities to address water quality in Burnt Bridge Creek. The City remains committed to the desired outcome of voluntarily meeting water quality standards through implementation of BMPs and has taken an active and multifaceted approach to improve water quality in the watershed. Specific recommendations regarding BMP implementation, including discussion of certain existing BMPs are described in the following subsections.

Stream Restoration and Urban Canopy

Continued emphasis from the City on restoring riparian cover along the stream is recommended to address water temperature and, indirectly, dissolved oxygen and bacteria water quality criteria. Riparian zones act as natural buffers that stabilize streambanks to prevent erosion and provide filtration to stormwater runoff. As dry season air temperatures continue to rise due to climate change, a mature tree canopy is essential to shield the stream from solar radiation and minimize 7-DADMax exceedances. In addition, continued prioritization of basin-wide urban tree plantings through the City's Urban Forestry Program is important to mitigate the urban heat island effect and decrease temperatures of impervious surfaces which can lead to stormwater driven "heat surges" (Somers et al. 2013). These restoration efforts also offer public health benefits and support broader ecological health. By improving water quality and reducing fecal bacteria loading, the City lowers the risk of human exposure to bacterial pathogens via primary contact recreation. Restoration projects should be coordinated with human services to minimize opportunities for illicit dumping or camping in sensitive areas.

Stormwater Treatment

Continued prioritization of expanding the stormwater treatment infrastructure is recommended to help address stormwater driven water quality impacts including *E. coli*, metals, and turbidity. Stormwater in the Burnt Bridge Creek watershed is currently managed via direct discharges to the stream and through infiltrating dry wells typically located in upland areas further away from the stream. Additional near-stream stormwater treatment would be most beneficial near reaches that exhibit high storm flow total suspended solids concentrations (including BUR0.0, BBC7.0, BBC2.6, COL0.0, and BBC1.6) because typical stormwater contaminants are commonly mobilized with or sorb to fine suspended sediments. Prioritization of areas where high levels of *Bacteroides* were identified in the MST study is also recommended due to the likely primary bacteria loading vector of stormwater runoff and infiltration.

Groundwater

In addition to prioritizing riparian cover to address high water temperature, dissolved oxygen, and bacteria exceedances, further evaluation of groundwater protection during late summer is recommended. The Unconsolidated Sedimentary Aquifer, in which shallow perched groundwater is a primary source of base flow in Burnt Bridge Creek, consists of highly permeable alluvial deposits (Herrera and PGG 2019). Because of these highly conductive soils, there is a relatively short time lag between land-surface infiltration and the resulting increase in the underlying water table. While this high permeability facilitates rapid recharge during the wet season, it also makes the shallow groundwater system and dependent flows in Burnt Bridge Creek more sensitive to climate variability.

Septic Systems

Consistent with the WY2024 Trend Analysis Report, continued prioritization of the Sewer Connection Incentive Program is recommended to reduce the over 2,000 septic systems still in use in the watershed. Findings from the WY2025 MST Study and potential future Human-focused source tracking studies may help further prioritize specific subbasins for Sewer Connection Incentive Program funding. Subbasins with both high concentrations of the Human marker and high density of septic systems near the stream such as BBC8.4 and BUR0.0 are potential priority candidates.

Education and Services

To foster a sense of collective responsibility for watershed protection, the City may consider expanding its education and outreach programs throughout the Greenway and adjacent neighborhoods. Confirmation of availability, functionality, and signage for pet waste disposal along the Burnt Bridge Creek Greenway is recommended due to the confirmed presence of dog-associated fecal markers at all monitored stations during storm flow in the MST Study. Continued coordination with human services to expand access to sanitation and trash management while continuing to enforce environmental codes, such as the 2014 ordinance restricting camping within 200 feet of surface waters, is also recommended to mitigate potential bacteria loading and increased turbidity. Finally, because field staff consistently report broad interest from the community regarding stream health, we recommend evaluating the feasibility of providing improved trail signage and expand digital tools for the public to report a concern, which can empower citizens to act as stewards and support the efforts of community-led volunteer groups.

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