Stormwater Management Program Plan

CITY OF Vancouver WASHINGTON

Utility Engineering | Public Works

February 2024

Introduction

This Stormwater Management Program Plan (SWMP) has been prepared to document recent (2023) and future (2024) actions that the City of Vancouver is undertaking to protect water resources and improve water quality in our community. These activities meet requirements established under the Federal Clean Water Act and implemented through the National Pollutant Discharge Elimination System Permit (NPDES Permit) program by Washington State Department of Ecology (Ecology) to manage and treat stormwater discharges to surface waters. Ecology also regulates stormwater infiltration to groundwater, as authorized under the Federal Safe Drinking Water Act through the Underground Injection Control (UIC) Program, to protect all waters of the state from contaminants carried in stormwater runoff.

The first Western Washington Phase II Municipal Stormwater Permit (NPDES Permit) was issued to the City of Vancouver in 2007 as a Regulated Small Municipal Separate Storm Sewer System (MS4). The stormwater permit has been updated and reissued in approximately five-year intervals. The current permit term will expire on July 31, 2024. With each permit cycle additional requirements are added to ensure that communities reduce pollutants in stormwater to the maximum extent practicable (MEP) through use of all known, available, and reasonable methods of prevention, control, and treatment (AKART) to restore water quality in lakes, rivers, streams, and underground aquifers. Municipalities covered under this permit are allowed to discharge stormwater from systems they own and operate into waters of the state when the prescribed program elements are implemented to protect water resources.

This document has been organized to align with programmatic components outlined in the permit, with details to demonstrate compliance with required activities and highlight key elements of the City's stormwater program.

- Stormwater Planning
- Public Education and Outreach
- Public Involvement and Participation
- MS4 Mapping and Documentation
- Illicit Discharge Detection and Elimination
- Controlling Runoff from New Development, Redevelopment & Construction Sites
- Operations and Maintenance
- Source Control for Existing Development
- Monitoring & Assessment
- Underground Injection Control (UIC) Regulation & Groundwater Protection

The SWMP is revised annually and submitted to Ecology with an Annual Report; both are posted on the City's website at Stormwater Management Plan -The City of Vancouver, WA by May 31 of each year. Members of the community are invited to review and provide comments to support development and implementation of the Stormwater Management Program Plan. Please submit comments to surfacewater@cityofvancouver.us.

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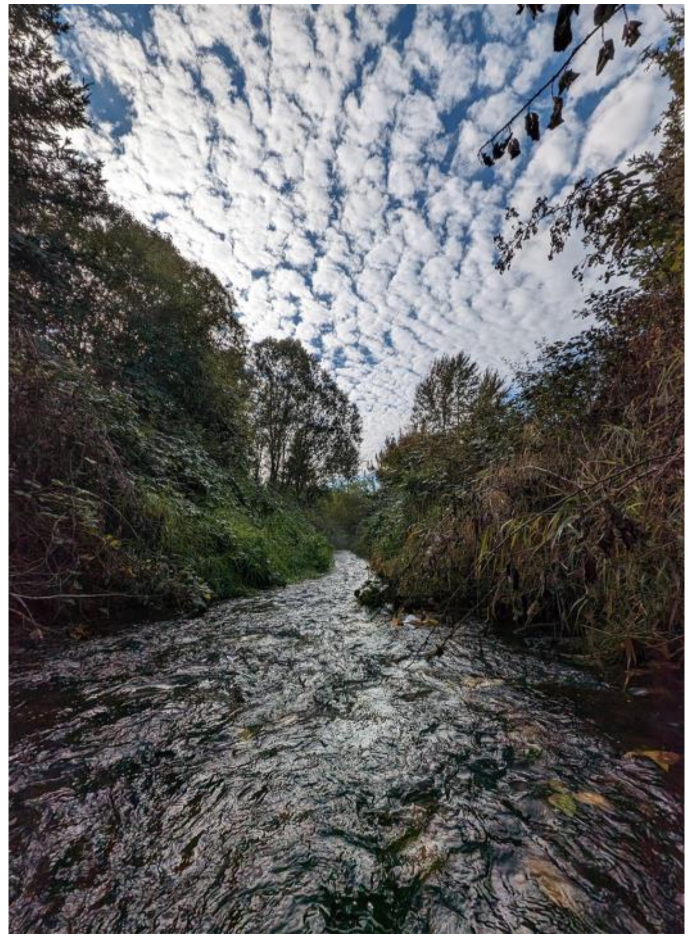
Stormwater Planning

The City of Vancouver implements a Stormwater Planning Program to inform and assist in development of policies and strategies as water quality management tools to protect receiving waters.

Vancouver is currently working on updates to its Comprehensive Plan which will shape how the community looks and feels, how it functions and operates over time. The plan will guide the City's growth and development over the next 20 years into 2045. Internal coordination as well as extensive public outreach will ensure stormwater management and watershed protection strategies are incorporated.

The City is also updating its Critical Areas ordinance which regulates development within sensitive habitats, wetlands, floodplains, aquifer recharge areas and geologic hazard areas. The entire city has been designated a Critical Aquifer Recharge Area (CARA) to protect Vancouver's drinking water, which is pumped from regional groundwater aquifers. City Planning staff are leading the update effort while working with Public Works teams to ensure stormwater impacts are addressed.

Vancouver continues to implement Low Impact Development (LID) Principles and Best Management Practices (BMPs) as the preferred approach for site development per the city's land use and development codes. City staff continues to assess and document any newly identified administrative or regulatory barriers to implementation of LID principles or LID BMPs and develop measures to address the barriers.



The city completed a Stormwater Management Action Plan in 2023 identifying the Middle Burnt Bridge Creek basin for prioritizing stormwater management actions to help lower stream temperature, increase dissolved oxygen and reduce bacteria. The City plans to begin identifying and prioritizing specific stormwater retrofit projects in the basin for conceptual design for installation of water quality BMPs.

Public Education and Outreach

Vancouver's education and outreach programs aim to engage members of the community to increase understanding of the impact stormwater runoff has on water quality and encourage positive behaviors to reduce the use of common practices that cause or contribute to stormwater pollution.

Public education and outreach is a vital component of the City of Vancouver's ongoing actions to protect and enhance water resources and aquatic habitat. Central to these efforts is the Water Resources Education Center, funded and operated directly by the City of Vancouver.

General Awareness:

Vancouver's Water Resources Education Center provides opportunities to the general public, K-12 students, and other community groups to engage and learn about local watersheds, drinking water, surface water and stormwater management.

The City partners with the Watershed Alliance of Southwest Washington, Lower Columbia Estuary Partnership, Stormwater Partners, and other agencies and organizations on a variety of water quality activities. Educational material on various topics is distributed online, at local community events, and during in-person site visits to support clean water and watershed health.

City staff provide technical assistance and outreach to local businesses and industries. Vancouver is a member of Ecology's statewide Pollution Prevention Assistance Program which offers free, hands-on technical assistance to help businesses identify and initiate practical methods to reduce and eliminate non-stormwater discharges to stormwater systems. Funding from the federal Environmental Protection Agency is allowing the City to help support local small businesses safely dispose of dangerous waste (that could impact public health and our water systems if not stored and disposed of properly) by providing free waste disposal drop off services for a limited time.

Behavior Change:

Urban Forestry's Yard Tree Giveaway Program began in 2021 to increase opportunities to meet Vancouver's tree canopy goals and support the many environmental, economic, health and social benefits that a healthy tree canopy provides. The Program provides free yard trees each fall for planting on private, residential properties in the City of Vancouver. Tree planting and care information is provided to each recipient with a free bag of mulch for each tree. Care information is emailed to residents during the first year and tree survival data is collected. The City will complete an evaluation and prepare a report documenting changes in understanding of tree ownership care and water quality benefits.

Public Education and Outreach (continued)

Stewardship Opportunities:

Vancouver partners with the Watershed Alliance of Southwest Washington annually to host two large-scale events and several smaller events to enhance natural spaces and promote sustainability with riparian plantings, ivy removal, and trash pickup activities.

The Water Resources Education Center offers numerous stewardship opportunities throughout the year to engage the public in learning about the environment. The Student Watershed Monitoring Network serves thousands of students annually and the Storm Drain Medallion Program allows residents to install markers at catch basins in their neighborhoods to reduce the risk of pollution entering water resources.

Public Involvement and Participation

On-going opportunities for public involvement and participation in stormwater management planning provides valuable insight on the community's priorities and concerns for mitigating stormwater impacts.

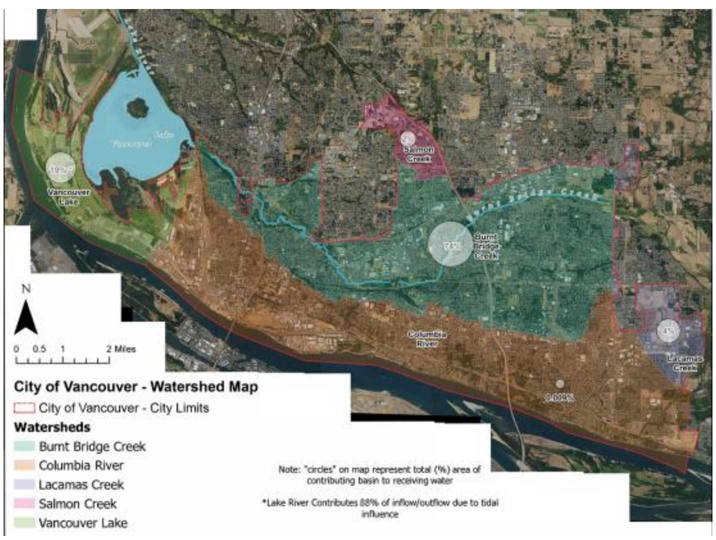
A variety of platforms are available for the public to provide input on Vancouver's stormwater management plans, including an invitation to comment on annual updates to the Stormwater Management Program (SWMP). The SWMP and Annual Report are submitted to the Department of Ecology and posted on the City website by May 31 each year.

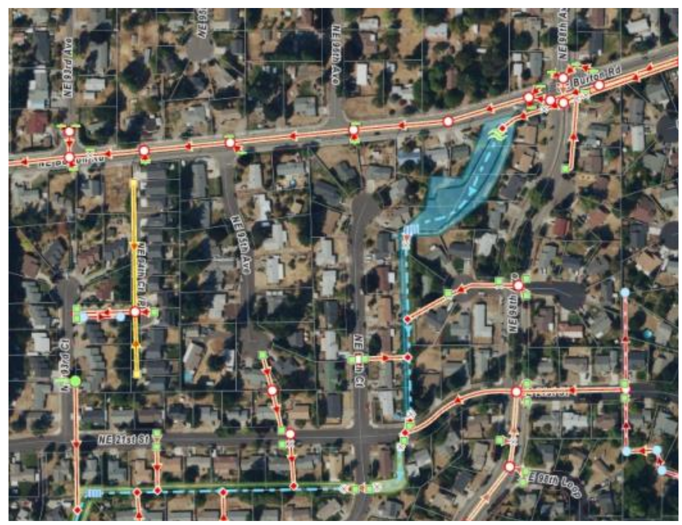
Vancouver City Council enacts ordinances and resolutions, adopts rules and regulations, and approves the city budget and utility rate structure. City Council meets the first through fourth Mondays of each month (except holidays or fifth Mondays). Council meetings are open to the public and provide various opportunities for public comment or testimony. Meetings are held at City Hall Council Chambers and aired (live closed captioning available) via Clark/Vancouver Television (CVTV) and on the City's Facebook page.

MS4 Mapping and Documentation

Vancouver maintains GIS data of the stormwater system. Vancouver's mapping program includes attributes of all known outfalls to surface waters, receiving waters, stormwater treatment and flow control BMPs/facilities owned and operated by the City, tributary conveyances to known outfalls and discharge points (24-inch diameter or larger), and connections with other public and private stormwater systems.

This data is regularly updated by the City's team of GIS technicians that maintain and update electronic maps and databases for the stormwater utility. Field reconnaissance and televised inspections support the ongoing process of identifying pipe type and verifying public and private connections to and from the city's stormwater system to fill in missing data gaps. Mapping information is regularly updated as new public and private projects are completed and existing systems inspected. Stormwater mapping data is available upon request.





Illicit Discharge Detection and Elimination

Vancouver's Illicit Discharge Detection and Elimination (IDDE) program is designed to prevent, detect, characterize, trace, and eliminate illicit connections and illicit discharges into water resources to reduce the risk of non-stormwater contaminants entering water resources. In Vancouver, the IDDE program addresses pollution issues associated with the MS4 as well as water quality concerns related to storm, surface, and groundwater outside the scope of the NPDES permit. Vancouver Municipal Code (VMC) Chapter 14.26 prohibits the discharge of contaminants to water resources and requires certain operations and activities to utilize best management practices to protect the health, safety, and welfare of the residents of the city and preserve the integrity of the city's water resources.

The City provides education and technical assistance to businesses, industries, and the general public on how to implement water resource protection and pollution control practices. When those measures have been unsuccessful in eliminating illicit discharges, the use of escalating enforcement procedures and legal actions are supported through VMC Chapter 22.

The City works with local, state and federal agencies to locate, assess, characterize, trace and remove sources of illicit discharges. When discharges contribute to violations of state water quality standards the Washington State Department of Ecology (Ecology) is notified. The City maintains a hotline (360-487-7130) and email address (CityWaterProtection@cityofvancovuer.us) that allows community members to report illicit discharges or dumping. Calls and emails are directed to the appropriate response authority for investigation, containment, and follow up.

The Water Protection Program actively inspects and monitors industrial facilities, commercial operations and residences for water quality compliance and best management practices. Technical assistance is provided to public employees, businesses, and the general public on the hazards associated with illicit discharges and improper disposal of potentially harmful materials.

Field assessments and outfall inspections take place throughout the year with targeted screening during the dry weather months to locate and accurately map storm system features and look for indicators of illicit discharges. All inspections, investigations, illicit discharges and spill-related activities are tracked in the program's database.

Ongoing efforts include improving clarity in standard operating procedures and methods for tracking, evaluating, categorizing, correcting, and documenting illicit discharges. City staff continue to research, review, and develop technical assistance tools to minimize accidental pollutant releases to waters of the state. Training is conducted for all city staff responsible for identification, investigation, termination, cleanup, and reporting of illicit discharges.

Controlling Runoff

New Development, Redevelopment & Construction Sites

Multiple city departments implement programs to reduce pollutants in stormwater runoff to the City's stormwater system and water resources from new development, redevelopment, and construction activities on both private and public sites.

Vancouver Municipal Code 14.24 (Erosion Prevention and Sediment Control) and 14.25 (Stormwater Control) were established to prevent harm to the health or safety of the public by minimization of stormwater runoff and erosion of sediment from land development and land-disturbing activities. The Water Resources Protection Ordinance (VMC 14.26) was created to protect water resources by establishing development regulations and minimum standards to reduce the risks of contaminants entering water resources. Collectively, these ordinances provide the City with the legal authority to inspect and enforce requirements and standards that protect water quality and reduce the discharge of pollutants.

Citywide processes have been established for controlling runoff from new development, redevelopment, and construction sites through planning review and field inspection. The City's Community Development department coordinates the overall site planning process while Public Works staff review proposals to determine the applicability of Minimum Requirements for stormwater management following Appendix 1 of the Stormwater Permit. An integrated permitting database system and GIS mapping are some of the tools used to track and record reviews, inspections, and enforcement actions for property development and construction activity.

The City has qualified engineering and planning staff reviewing all site plans for stormwater management, erosion control, and water resource protection compliance on private and public projects, including roads.

The link to the electronic Notice of Intent (NOI) forms for the Construction Stormwater General Permit and the Industrial Stormwater General Permit are provided to applicants during the site plan review process.

The City inspects all development sites that meet the minimum thresholds of the Stormwater Permit prior to land clearing, during construction, and upon completion of construction. All primary inspection staff have completed required and appropriate training to implement these program elements; follow -up training is routinely scheduled to address changes in procedures, techniques or staffing.

Operations & Maintenance

Vancouver implements an operations and maintenance (O&M) program to regulate and conduct activities that ensure facilities continue to prevent or reduce stormwater impacts by setting standards and timely maintenance intervals for facilities owned, operated, or regulated by the City.

Publicly-owned System:

City Stormwater Operations has an ongoing program to inspect and clean or maintain publicly owned catch basins, manholes, conveyance pipes, and stormwater facilities as well as regularly sweeping City streets. Inspections are conducted at intervals prescribed in the NPDES Stormwater Permit. Maintenance actions are performed in accordance with standards. Spot checks of stormwater facilities are conducted following major storm events that exceed the 10-year 24-hour storm (3.0-3.5 inches of rainfall in 24 hours) to identify any damage and additional maintenance needs.

Privately-owned System:

The City's Stormwater Control ordinance (VMC 14.25) and land use process are the mechanisms used to identify maintenance responsibilities and inspection authority for privately owned stormwater facilities in Vancouver. Stormwater facilities that discharge to the MS4 are inspected in accordance with the Permit and Stormwater Manual.

Staff Training:

City staff with construction, operations, or maintenance activities related to stormwater control and treatment receive in-person training at regular intervals on preventing or reducing pollutant runoff from municipal operations. Recently developed training videos for field staff are available to all City employees through a city-wide learning program (Workday). Videos can be viewed on demand and assigned to new personnel.

Stomwater Pollution Prevention Plan (SWPPP):

The SWPPP for the City's Operations Center details stormwater best management practices used to protect water resources from equipment, materials and activities that may be exposed to precipitation and where runoff could result in contaminating water resources.

Record Maintenance:

A computerized maintenance management system (INFOR) and GIS mapping applications are used to schedule and document inspections, maintenance activities and enforcement actions.

Source Control Program for Existing Development

The City of Vancouver implements the Water Resource Protection Program to prevent and reduce pollutants in stormwater runoff with legal authority adopted in Vancouver Municipal Code (14.26).

This program includes requiring application of operational and structural source control Best Management Practices (BMPs) for sites that have the potential to generate pollutants; city staff maintain a site inventory, conduct inspections of sites identified through evaluation of potential risk, and initiate enforcement procedures for sites that fail to adequately implement required BMPs.

City staff will annually conduct site visits equal to 20% of the inventory to ensure businesses are effectively implementing operational and/or structural BMPs to prevent illicit discharges and reduce pollutant discharges to surface water or the stormwater drainage system. Initial site visits will focus on providing information and technical assistance regarding appropriate pollution prevention strategies. Follow-up, education, and progressive enforcement actions are used to bring sites into compliance.

Inspection staff responsible for implementing the source control program receive on-going training on source control BMPs and their proper application, inspection protocols, and enforcement procedures to remain current with technological advances in stormwater management and compliance with regulatory requirements.

Monitoring & Assessment

Regional status and trends monitoring:

Vancouver, in collaboration with other Southwest Washington stormwater permittees, developed a regional status and trends monitoring program to meet state receiving water monitoring objectives. All permittees in the Lower Columbia River Basin pay into a collective fund to implement monitoring of urban streams across Clark and Cowlitz Counties. Vancouver supports this effort by annually contributing $43,077 towards the Lower Columbia urban streams monitoring administered by the Department of Ecology. One site in the Burnt Bridge Creek watershed is included as a long-term trend site in the regional monitoring program.

Effectiveness studies and source identification:

Vancouver contributes annual payments of $53,323 into a collective fund to implement effectiveness studies undertaken by the Western Washington Stormwater Action Monitoring (SAM) program. The city provides information as requested for effectiveness and source identification studies that are under contract with Ecology as active SAM projects.

City stream monitoring:

Ongoing water quality monitoring in the Burnt Bridge Creek watershed is undertaken by the City to maintain consistency with past monitoring efforts, identify stream reaches that show improvement, and provide feedback for adaptive strategies in stormwater management. Eleven sites are currently monitored for a broad suite of parameters in twelve events each year. Washington Department of Ecology is finalizing development of an Advance Restoration Plan (ARP) to improve water quality in Burnt Bridge Creek. The ARP will identify water quality targets and activities needed to meet state standards before completion of a full Total Maximum Daily Load (TMDL) plan. TMDL compliance requirements, identified in the stormwater permit (S7), are not applicable until a formal TMDL plan has been completed and approved by EPA.

Monitoring along the Columbia Slope watershed has been supported by grants from the U.S. Environmental Protection Agency (EPA) since 2020. This effort will enhance our understanding of stormwater contaminants that potentially reach the Columbia River.

City departments and partners collaborate to enhance the efficiency and effectiveness of these programs and activities. The results from effectiveness studies inform the adoption of proactive and adaptive stormwater treatment measures as best available science is integrated into new water quality treatment options.

Underground Injection Control (UIC) Regulation and Groundwater Protection

Stormwater management and source water protection are integrally tied in the City of Vancouver. Infiltration to manage stormwater runoff has been extensively used through large portions of the city as the underlying geology allows water to easily be drained into the ground. Reliance on groundwater to supply the city's drinking water increases the need to protect all water resources from stormwater runoff that may carry contaminants to surface or groundwater resources.

The UIC program was created under the federal Safe Drinking Water Act to regulate fluid discharges into subsurface areas through drywells and similar infiltration facilities. In the state of Washington all groundwater is considered a potential source of drinking water, and the state Department of Ecology administers the UIC program. Although the NPDES Stormwater Permit program was established under the Clean Water Act to protect water quality in surface waters, the state of Washington implements the permit and regulates discharges to all waters of the state, including groundwater. Washington State Department of Ecology regulates all UIC discharges through 173-218 WAC (Washington Administrative Code) and section I-4 of the 2019 Stormwater Management Manual of Western Washington. All existing UICs operated and maintained by Surface Water Management are considered Class V injection wells. The City is directed to use all known, available, and reasonable methods of prevention, control and treatment to prevent and control pollution (AKART) to waters of the state. All new UICs are reviewed for compliance with both Ecology and City requirements and are registered with Ecology as required by the WAC. All UICs receive rule-authorization from Ecology prior to being placed into service.

Stormwater runoff that enters infiltration systems can combine with shallow groundwater that reaches surface water or eventually recharges deeper groundwater aquifers. Burnt Bridge Creek and springs along the Columbia Slope are fed by surface water and shallow groundwater that also carries stormwater from infiltration systems such as drywells. Vancouver inspects and maintains close to 3,800 drywells and nearly 60 miles of infiltration trenches, many in place for over 40 years. Stormwater Operations staff inspect UICs on a regular basis, and clean when sediment accumulates above the sump or when standing water is present for over 48 hours after a moderate rainfall event. Special attention is paid to systems that have shown signs of diminished functionality, and non-functioning systems are retrofit or rehabilitated in place where feasible. If a UIC needs a complete rehabilitation, additional BMPs such as pre-sedimentation manholes and catch basins with additional sediment capture capability are installed. If rehabilitation of a non-functioning UIC is considered infeasible, the City utilizes a Capital Improvement Program to design and construct new UICs which meet all current regulatory and functional requirements.

In addition to maintenance on specific UICs, Stormwater Operations conducts targeted

Underground Injection Control (UIC) Regulation and Groundwater Protection

rotational cleaning of drainage systems that flow into the UICs throughout the City. These supplemental maintenance activities include street sweeping, more frequent cleaning of catch basins, and line flushing to increase the longevity and functionality of the systems. Over time, and where feasible, the City has added water quality treatment to infiltration systems that are not providing removal of sediment and contaminants to bring them up to current standards.

A primary source of Vancouver's drinking water is the Troutdale Aquifer which has been federally designated for protection as a Sole Source Aquifer, providing over 99% of the drinking water consumed in western Clark County. The entire City of Vancouver has also been designated as a Critical Aquifer Recharge Area (CARA) to protect groundwater that is the source of the city's drinking water supply. Vancouver enacted a Stormwater Control Ordinance in 1995 requiring water quality treatment for new development and redevelopment activities which create or replace impervious surfaces. The Water Resources Protection Program implements Vancouver Municipal Code Chapter 14.26 (VMC 14.26) which prohibits the discharge of contaminants to water resources and requires certain operations to utilize best management practices to protect the health, safety, and welfare of the residents of the city and the integrity of the city's water resources. VMC 14.26 also establishes greater standards of compliance for businesses and industries that manage hazardous materials and creates Special Wellhead Protection Areas around the City's water stations.

More Information

Webpage: www.cityofvancouver.us/stormwater
Email: surfacewater@cityofvancouver.us

City of Vancouver | Public Works
PO Box 1995
Vancouver, WA 98668-1995

Annual Report

Number	Permit Section	Question
1	S5.A	Attach a copy of any annexations, incorporations or boundary changes resulting in an increase or decrease in the Permittee's geographic area of permit coverage during the reporting period per S9.D.6. **Vancouver 2023 Annexations_1_02262024094445**
2	S5.A	Attach updated annual Stormwater Management Program Plan (SWMP Plan). (S5.A.2)
3	S5.A	Implemented an ongoing program to gather, track, and maintain information per S5.A.3, including costs or estimated costs of implementing the SWMP. **Yes**
4	S5.A.5.b	Coordinated among departments within the jurisdiction to eliminate barriers to permit compliance. (S5.A.5.b) **Yes**
5	S5.C.1.	Have you convened an interdisciplinary team to inform and assist in the development, progress, and influence of the comprehensive stormwater planning program? (S.5.c.1). August 1, 2020 **Yes**
14	S5.C.1.b	Did you submit a report as described in S5.C.1.b.i(b)? (Required to submit no later than January 1, 2023) **Yes**
15	S5.C.1.c	Continue to design and implement local development-related codes, rules, standards, or other enforceable documents to minimize impervious surfaces, native vegetation loss, and stormwater runoff, where feasible? See S5.C.1.c.i. (Required annually) **Yes**
16	S5.C.1.c	From the assessment described in S5.C.1.c.i(a), did you identify any administrative or regulatory barriers to implementation of LID Principles or LID BMPs? (Required annually) **No**
20	S5.C.2	Did you choose to adopt one or more elements of a regional program? (S5.C.2) **No**
21	S5.C.2	Attach a description of general awareness efforts conducted, including your target audiences and subject areas, per S5.C.2.a.i. **Q21 Outreach Efforts 2023_21_03082024144418**
24	S5.C.2	Began implementing strategy outlined in S.5.C.2.a.ii(c) (S5.C.2.a.ii(d) – Required by April 1, 2021) **Yes**

Number	Permit Section	Question
25	S5.C.2	Attach the report developed in accordance with S5.C.2.a.ii(e), which evaluated the changes in understanding and adoption of targeted behaviors resulting from the implementation of the strategy and any planned or recommended changes to the program in order to be more effective. (Required no later March 31, 2024) **Q25 Behavior Change Report 202_25_03222024072155**
26	S5.C.2	Promoted stewardship opportunities (or partnered with others) to encourage resident participation in activities such as those described in S5.C.2.a.iii. **Yes**
26a	S5.C.2	Attach a list of stewardship opportunities provided. **Q26a Stewardship Opportunities_26a_03082024144419**
27	S5.C.3.	Describe in Comments field the opportunities created for the public, including overburdened communities, to participate in the decision-making processes involving the development, implementation, and updates of the Permittee's SWMP and the SMAP. (S5.C.3.a) **The City's Stormwater Management Program plan is posted on the website and is open for public comment. The City conducted a Community Survey in 2022 as part of the SMAP process. Feedback was invited through a variety of communication channels including social media posts, newsletter distribution lists and the City website. The public may address stormwater issues through division budget approvals, stormwater rates and public hearings at City Council meetings. City Council meetings are open to in-person attendance; options for viewing/participating remotely are accommodated. All City Council meetings are broadcast (live closed captioning available) on www.cvtv.org, CVTV cable channels 23/HD323, and on the City's Facebook page.**
28	S5.C.3.	Posted the updated SWMP Plan and latest annual report on your website no later than May 31. (S5.C.3.b) **Yes**
28a	S5.C.3.	List the website address in Comments field. **https://www.cityofvancouver.us/government/department/public-works/water-sewer-and-stormwater/stormwater-management-plan/**
29	S5.C.4.	Maintained a map of the MS4 including the requirements listed in S5.C.4.a.i-vii? **Yes**
30	S5.C.4.	Started mapping outfall size and material in accordance with S5.C.4.b.i? (Required no later than January 1, 2020) **Yes**
30a	S5.C.4.	Attach a spreadsheet that lists the known outfalls' size and material(s). **COV Outfalls_30a_02262024095252**
31	S5.C.4.	Completed mapping connections to private storm sewers in accordance with S5.C.4.b.ii? (Required no later than August 1, 2023) **Yes**
33	S5.C.5	Informed public employees, businesses, and the general public of hazards associated with illicit discharges and improper disposal of waste? (S5.C.5.b) **Yes**

Number	Permit Section	Question
33a	S5.C.5	Actions taken to inform public employees, businesses, and the general public of hazards associated with illicit discharges and improper disposal of waste. **Updated websites for spill reporting, water resource protection, and pollution prevention actions for businesses and homeowners. Distributed materials with updated illicit discharge information to neighborhoods and businesses during source control and private stormwater facility inspections. Attended Local Interagency Networking Cooperative (LINC) meetings to share information with enforcement staff from other public agencies.**
34	S5.C.5	Implemented an ordinance or other regulatory mechanism to effectively prohibit non-stormwater, illicit discharges as described in S5.C.5.c. **Yes**
35	S5.C.5	Implemented procedures for conducting illicit discharge investigations in accordance with S5.C.5.d.i. **Yes**
35a	S5.C.5	Cite field screening methodology in Comments field. **Herrera's 2013 Illicit Connection and Illicit Discharge Field Screening and Source Tracing Guidance Manual for ECY.**
36	S5.C.5	Percentage of MS4 coverage area screened in the reporting year per S5.C.5.d.i. (Required to screen 12% on average each year.) **68**
36a	S5.C.5	Cite field screening techniques used to determine percent of MS4 screened. **The outfalls are screened annually by watershed, rotating between the Burnt Bridge Creek and Columbia Slope watershed. In 2023, 118 of 174 outfalls were screened.**
37	S5.C.5	Percentage of total MS4 screened from permit effective date through the end of the reporting year. (S5.C.5.d.i.) **100**
38	S5.C.5	Describe how you publicized a hotline telephone number for public reporting of spills and other illicit discharges in the Comments field. (S5.C.5.d.ii) **Information is on the city website and on spill rack cards handed out to businesses.**
39	S5.C.5	Implemented an ongoing illicit discharge training program for all municipal field staff per S5.C.5.d.iii. **Yes**
40	S5.C.5	Implemented an ongoing program to characterize, trace, and eliminate illicit discharges into the MS4 per S5.C.5.e. **Yes**
41	S5.C.5	Municipal illicit discharge detection staff are trained to conduct illicit discharge detection and elimination activities as described in S5.C.5.f. **Yes**
42	S5.C.5	Attach a report with data describing the actions taken to characterize, trace, and eliminate each illicit discharge reported to, or investigated by, the Permittee as

Number	Permit Section	Question
		described in S5.C.5.g. The submittal must include all of the applicable information and must follow the instructions, timelines, and format described in Appendix 12. **Imported from WQWebIDDE**
43	S5.C.6.	Implemented an ordinance or other enforceable mechanism to effectively address runoff from new development, redevelopment, and construction sites per the requirements of S5.C.6.b.i-iii. **Yes**
45	S5.C.6.	Number of adjustments granted to the minimum requirements in Appendix 1. (S5.C.6.b.i. and Section 5 of Appendix 1) **Not Applicable**
46	S5.C.6.	Number of exceptions/variances granted to the minimum requirements in Appendix 1. (S5.C.6.b.i., and Section 6 of Appendix 1) **Not Applicable**
47	S5.C.6.	Reviewed Stormwater Site Plans for all proposed development activities that meet the thresholds adopted pursuant to S5.C.6.b.i. (S5.C.6.c.i) **Yes**
47a	S5.C.6.	Number of site plans reviewed during the reporting period. **242**
48	S5.C.6.	Inspected, prior to clearing and construction, permitted development sites per S5.C.6.c.ii, that have a high potential for sediment transport as determined through plan review based on definitions and requirements in Appendix 7 – Determining Construction Site Sediment Damage Potential? **No**
48a	S5.C.6.	If no, inspected, prior to clearing and construction, all construction sites meeting the minimum thresholds (S5.C.6.c.ii)? **Yes**
49	S5.C.6.	Inspected permitted development sites during construction to verify proper installation and maintenance of required erosion and sediment controls per S5.C.6.c.iii. **Yes**
49a	S5.C.6.	Number of construction sites inspected per S5.C.6.c.iii. **889**
49b	S5.C.6.	Inspected stormwater treatment and flow control BMPs/facilities and catch basins in new residential developments every 6 months per S5.C.6.c.iv? **Yes**
50	S5.C.6.	Inspected all permitted development sites upon completion of construction and prior to final approval or occupancy to ensure proper installation of permanent stormwater facilities. (S5.C.6.c.v) **Yes**
51	S5.C.6.	Verified a maintenance plan is completed and responsibility for maintenance is assigned for projects prior to final approval and occupancy being granted. (S5.C.6.c.v)

Number	Permit Section	Question
		Yes
52	S5.C.6.	Number of enforcement actions taken during the reporting period (based on construction phase inspections at new development and redevelopment projects). (S5.C.6.c.ii-iv)(S5.C.7.c.viii) **46**
53	S5.C.6.	Achieved at least 80% of scheduled construction-related inspections. (S5.C.6.c.vi) **Yes**
54	S5.C.6.	Made Ecology's Notice of Intent for Construction Activity and Notice of Intent for Industrial Activity available to representatives of proposed new development and redevelopment? (S5.C.6.d) **Yes**
55	S5.C.6.	All staff whose primary job duties are implementing the program to control stormwater runoff from new development, redevelopment, and construction sites including permitting, plan review, construction site inspections, and enforcement are trained to conduct these activities? (S5.C.6.e) **Yes**
56	S5.C.7.	Implemented maintenance standards that are as protective, or more protective, of facility function than those specified in the Stormwater Management Manual for Western Washington or a Phase I program approved by Ecology per S5.C.7.a.? **Yes**
58	S5.C.7.	Applied a maintenance standard for a facility or facilities which do not have maintenance standards specified in the Stormwater Management Manual for Western Washington? If so, note in the Comments field what kinds of facilities are covered by this alternative standard. (S5.C.7.a) **Yes**
58a	S5.C.7.	Note what kinds of facilities are covered by this alternative standard. (S5.C.7.a) **Proprietary BMPs maintained per manufacturers' recommendations.**
59	S5.C.7.	Verified that maintenance was performed per the schedule in S5.C.7.a.ii when an inspection identified an exceedance of the maintenance standard. **Yes**
59a	S5.C.7.	Attach documentation of maintenance time frame exceedances that were beyond the Permittee's control. **Not Applicable**
60	S5.C.7.	Implemented an ordinance or other enforceable mechanisms to verify long-term operation and maintenance of stormwater treatment and flow control BMPs/facilities regulated by the permittee per (S5.C.7.b.i (a))? **Yes**
61	S5.C.7.	Annually inspected stormwater treatment and flow control BMPs/facilities regulated by the Permittee per S5.C.7.b.i(b) **Yes**
61a	S5.C.7.	If using reduced inspection frequency for the first time during this permit cycle, attach documentation per S5.C.7.b.i (b)

Number	Permit Section	Question
		Not Applicable
62	S5.C.7.	Achieved at least 80% of scheduled inspections to verify adequate long-term O&M. (S5.C.7.b.ii) **Yes**
63	S5.C.7.	Annually inspected all municipally owned or operated permanent stormwater treatment and flow control BMPs/facilities. (S5.C.7.c.i) **Yes**
63a	S5.C.7.	Number of known municipally owned or operated stormwater treatment and flow control BMPs/facilities. (S5.C.7.c.i) **1691**
63b	S5.C.7.	Number of facilities inspected during the reporting period. **1691**
63c	S5.C.7.	Number of facilities for which maintenance was performed during the reporting period. **610**
64	S5.C.7.	If using reduced inspection frequency for the first time during this permit cycle, attach documentation per S5.C.7.c.i. **Not Applicable**
65	S5.C.7.	Conducted spot checks and inspections (if necessary) of potentially damaged stormwater facilities after major storms as per S5.C.7.c.ii. **Not Applicable**
66	S5.C.7.	Inspected municipally owned or operated catch basins and inlets every two years or used an alternative approach? Cleaned as needed? (S.5.C.7.c.iii) **Yes**
66a	S5.C.7.	Number of known catch basins? **16014**
66b	S5.C.7.	Number of catch basins inspected during the reporting period? **10508**
66c	S5.C.7.	Number of catch basins cleaned during the reporting period? **9344**
67	S5.C.7.	Attach documentation of alternative catch basin cleaning approach, if used. (S5.C.7.c.iii.(a)-(c)) **Not Applicable**
68	S5.C.7.	Implemented practices, policies and procedures to reduce stormwater impacts associated with runoff from all lands owned or maintained by the Permittee, and road maintenance activities under the functional control of the Permittee. (S5.C.7.d) **Yes**

Number	Permit Section	Question
70	S5.C.7.	Implemented an ongoing training program for Permittee employees whose primary construction, operations or maintenance job functions may impact stormwater quality. (S5.C.7.e) **Yes**
71	S5.C.7.	Implemented a Stormwater Pollution Prevention Plan (SWPPP) for all heavy equipment maintenance or storage yards, and material storage facilities owned or operated by the Permittee in areas subject to this Permit that are not required to have coverage under an NPDES permit that covers stormwater discharges associated with the activity. (S5.C.7.f) **Yes**
74	S5.C.8	Established an inventory per S5.C.8.b.ii. (Required by August 1, 2022.) **Yes**
74a	S5.C.8	Number of total sites identified for the inventory. **3995**
75	S5.C.8	Implemented an inspection program S5.C.8.b.iii (Required by January 1, 2023). **Yes**
76	S5.C.8	Implemented a progressive enforcement policy per S5.C.8.b.iv (Required by January 1, 2023). **Yes**
77	S5.C.8	Attach a summary of actions taken to implement the source control program per S5.C.8.b.iii and S5.C.8.b.iv. **Q77 Source Control Summary 202_77_03082024144455**
78	S5.C.8	Attach a list of inspections, per S5.C.8.b.iii, organized by the business category, noting the amount of times each business was inspected, and if enforcement actions were taken. **2023 Source Control Inspection_78_02262024160627**
79	S5.C.8	Implemented an ongoing source control training program per S5.C.8.b.v? **Yes**
80	S7	Complied with the Total Maximum Daily Load (TMDL)-specific requirements identified in Appendix 2. (S7.A) **Not Applicable**
81	S7	For TMDLs listed in Appendix 2: Attach a summary of relevant SWMP and Appendix 2 activities to address the applicable TMDL parameter(s). (S7.A) **Not Applicable**
82	S8	Submitted payment for cost-sharing for Stormwater Action Monitoring (SAM) status and trends monitoring no later than December 1, 2019 (S8.A.1); and no later than August 15 of each subsequent year? (S8.A.2.a.) **Yes**
84	S8	Submitted payment for cost-sharing for SAM effectiveness and source identification studies no later than December 1, 2019 (S8.B.1); and no later than August 15 of each

Number	Permit Section	Question
		subsequent year (S8.B.2.a or S8.B.2.c)? **Yes**
87	S8	If conducting stormwater discharge monitoring in accordance with S8.C.1, attach a data and analysis report per S8.C.1. and Appendix 9. (Due annually beginning March 31, 2021.) **Not Applicable**
88	G3	Notified Ecology in accordance with G3 of any discharge into or from the Permittees MS4 which could constitute a threat to human health, welfare or the environment. (G3) **Yes**
89	G3	Took appropriate action to correct or minimize the threat to human health, welfare, and/or the environment per G3.A. **Yes**
90	Compliance with standards	Notified Ecology within 30 days of becoming aware that a discharge from the Permittee's MS4 caused or contributed to a known or likely violation of water quality standards in the receiving water. (S4.F.1) **Yes**
91	Compliance with standards	If requested, submitted an Adaptive Management Response report in accordance with S4.F.3.a. **Not Applicable**
92	Compliance with standards	Attach a summary of the status of implementation of any actions taken pursuant to S4.F.3 and the status of any monitoring, assessment, or evaluation efforts conducted during the reporting period. (S4.F.3.d) **Not Applicable**
93	G20	Notified Ecology of the failure to comply with the permit terms and conditions within 30 days of becoming aware of the non-compliance. (G20) **Yes**
94	G20	Number of non-compliance notifications (G20) provided in reporting year. List permit conditions described in non-compliance notification(s) in Comments field. **2**
94a	G20	List permit conditions described in non-compliance notification(s). **S4.F.1. and S5.C.7**

Attachments:

View Files Attached to Submission

	DocDescr	DocName	DocExt	DocID	SubID	AppName
View	WAR045022_78_02262024160627	2023 Source Control Inspection_78_02262024160627	.xlsx	1501684	1910546	wqwebportal
View	WAR045022_30a_02262024095252	COV Outfalls_30a_02262024095252	.xlsx	1501351	1910546	wqwebportal
View	WAR045022_21_03082024144418	Q21 Outreach Efforts 2023_21_03082024144418	.pdf	1507300	1910546	wqwebportal
View	WAR045022_25_03222024072155	Q25 Behavior Change Report 202_25_03222024072155	.pdf	1513471	1910546	wqwebportal

View	WAR045022_26a_03082024144419	Q26a Stewardship Opportunities_26a_03082024144419	.pdf	1507301	1910546	wqwebportal
View	WAR045022_77_03082024144455	Q77 Source Control Summary 202_77_03082024144455	.pdf	1507303	1910546	wqwebportal
View	WAR045022_1_02262024094445	Vancouver 2023 Annexations_1_02262024094445	.pdf	1501339	1910546	wqwebportal
View	ImportedIDDEsWAR045022-2023-ImportedIDDEs_03042024114511	WAR045022-2023-ImportedIDDEs_03042024114511	.xml	1504969	1910546	wqwebportal

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Vancouver Urban Forestry 2023 Annual Report

Environmental Resources | Public Works

January 2024

Acknowledgements

Mayor Anne McEnerny-Ogle
Councilmember Kim D. Harless
Mayor Pro Tem Erik Paulsen
Councilmember Diana H. Perez
Councilmember Bart Hansen
Councilmember Ty Stober
Councilmember Sarah J. Fox
Vancouver City Council 2024

City Manager Eric Holmes
Deputy City Manager Lisa Brandl
Deputy City Manager Lon Pluckhahn
Director of Public Works Steve Worley
Director of Parks, Recreation and Cultural Services David Perlick

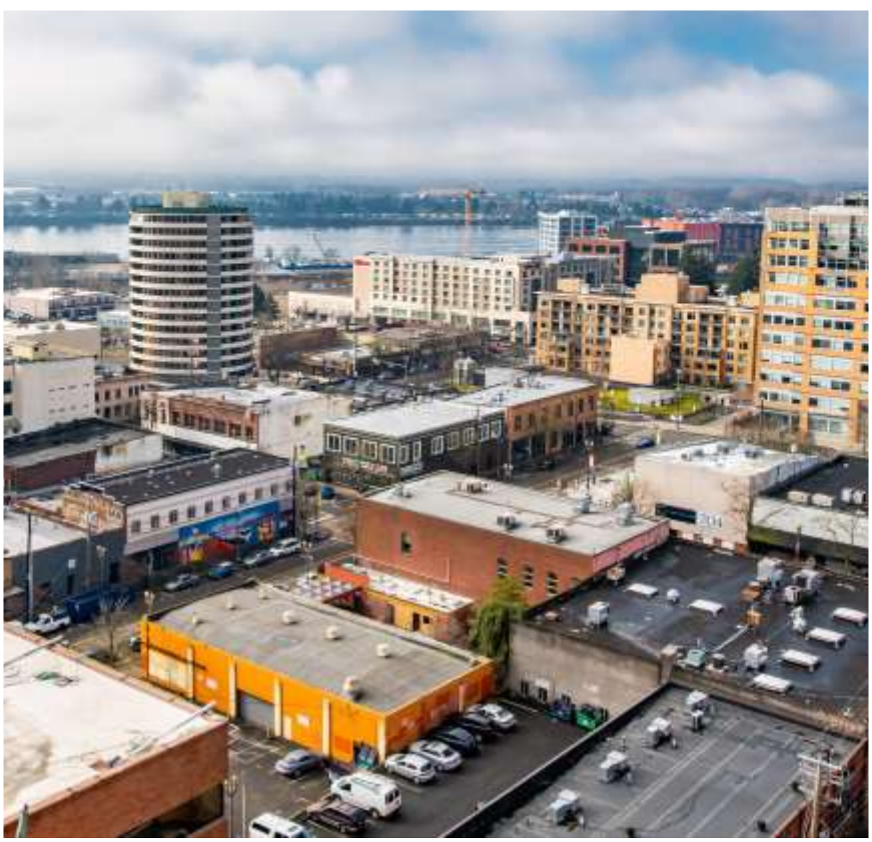


Table of Contents

Vision, Mission and Goals

Introduction

Vancouver's Urban Forestry Program is part of the City's Department of Public Works and works closely across all departments.

Urban Forestry seeks to improve the quality of life in our city by enhancing tree canopy to provide clean air and water for current residents, visitors and future generations. Aesthetic, economic, social and environmental benefits associated with a healthy tree canopy significantly influence overall community health. Tomorrow's community vitality is closely linked with today's prudent management of the urban tree canopy, or green infrastructure.

Vancouver Urban Forestry continues to improve both the level and quality of service it provides to the community. In 2023, these efforts have grown through the participation of volunteers donating more than 3,000 hours of service, the strong support of Urban Forestry's many partners and the continued interest and dedication of the community to improving Vancouver's tree canopy.

Vision

Vancouver's urban forest is a healthy, dynamic, diverse and cohesive ecosystem that is valued and cared for through community stewardship because it balances economic vitality with the conservation of natural resources now and for future generations.

Mission

The mission of Vancouver's Urban Forestry Program is to maximize the aesthetic, environmental and economic benefits that trees provide to City residents and visitors by preserving, managing and enhancing existing trees and other vegetation and promoting the reforestation of the urban area through an active integrated program with community support and participation.

Goals

Preserve existing trees and continue planning, maintenance and operating principles that improve canopy health.

Restore canopy-deficient areas through tree planting to provide equitable distribution of urban forest benefits to all Vancouver residents.

Promote an urban forest stewardship ethic within the community.

Adhere to the City of Vancouver's Operating Principles and establish Vancouver Urban Forestry as a leader in Pacific Northwest municipal forest management.

Program Information

Vancouver Urban Forestry Program

Urban Forestry is supported by the Urban Forestry Commission, a seven-member volunteer commission appointed by the Vancouver City Council. The Commission helps the City to develop good management practices to conserve the community's trees and forests, educate community members on the importance of urban trees, and organize tree plantings.

In 2023, the City of Vancouver's estimated population was 199,600. Increasing urbanization presents ongoing impacts to the health of Vancouver's tree canopy, as well as opportunities to enhance, expand, and appreciate our urban forest benefits.

In 2023, the Urban Forestry Program employed six full-time staff, which equates to about one full-time employee per 33,267 community members. The program is also supported by two AmeriCorps members, seasonal staff members and interns.

Vancouver's urban forest comprises all the trees in parks, in natural areas, along streets and on private property. In addition to improving the livability and vitality, our community's trees - quantified as tree canopy - provide numerous environmental benefits, including reductions in air pollution, greenhouse gases and stormwater runoff. According to the Tree Canopy Report, in 2021 there were 6,066 acres of tree canopy in Vancouver.

Vancouver's tree canopy covers approximately 21 percent of the City, helping to preserve watershed health and reduce runoff, while improving the livability of our neighborhoods.

Program Information

Vancouver's Urban Forestry Program preserves and enhances our community's urban forest through:

- Assisting all City departments, residents and interest groups with tree issues.
- Developing and coordinating effective maintenance and stewardship programs to preserve existing trees and protect safety.
- Planning and managing the urban forest by coordinating related roles, responsibilities, policies, and projects of City departments, other agencies and public and private partners.
- Documenting, inventorying and assessing the health and condition of the urban forest.
- Identifying areas where additional trees and vegetation, especially native and large canopy trees, can be added to improve and enhance the urban forest.
- Administering ordinances that manage street trees, private property hazardous trees and tree conservation in development projects.
- Permitting all trees within the street right-of -way and assisting the City's Community and Economic Development Department with permitting for private trees and hazardous trees. This includes oversight of planting, major pruning, tree removal, alleviating hazardous conditions and mitigating damage to trees by development.
- Assisting in enforcement of effective regulations and in applying planting and design standards that ensure the health, quality and long-term benefits of trees.
- Increasing awareness and understanding of the value and benefits of the urban forest through outreach and education.
- Promoting proper care for the urban forest by instilling environmental stewardship among residents and providing them with the tools and knowledge necessary to make sound tree care decisions.
- Participating in partnerships, team building and networking within the community.
- Educating the Urban Forestry staff and Commission about the history of environmental justice and racism in communities and integrate equity and inclusion into all aspects of the program.

California Bay Tree (*Umbellularia californica*) Heritage Tree located in the Arnada neighborhood.

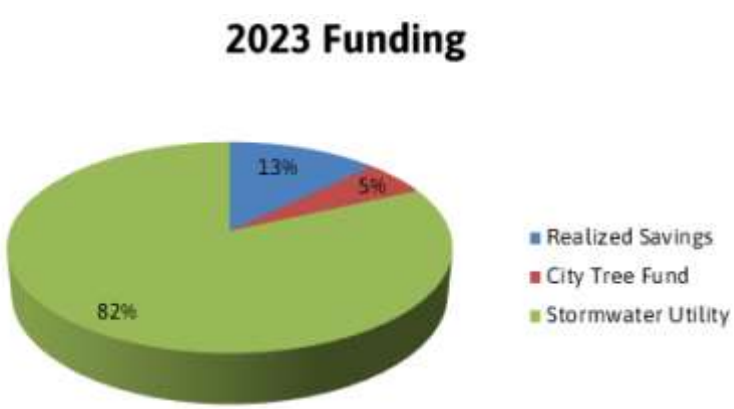
Focused Funding

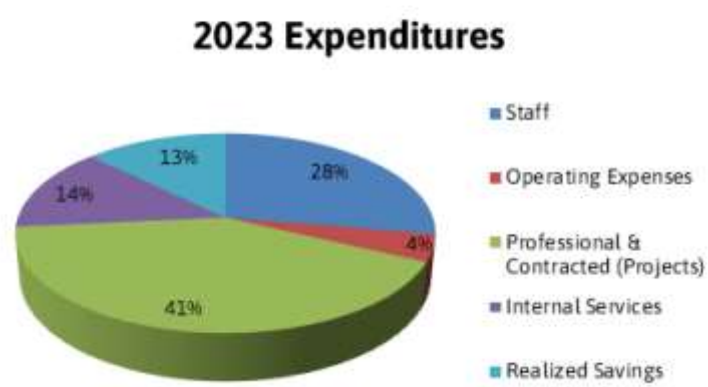
Vancouver's Urban Forestry benefits from a mix of revenues. These include the City's Department of Public Works Stormwater Utility Fund and the City's Tree Fund, for a total budget of $1,903,341.00 in 2023. Funding sources and the expenditures for 2023 are summarized in the following charts.

Including Urban Forestry in the City's Surface Water (stormwater) Management Plan represents a comprehensive watershed approach to improving water quality. These dedicated funding sources are vital to the success of Urban Forestry. The sound public investment will pay dividends for many years to come by effectively improving water quality, decreasing runoff and flooding, improving fish and wildlife habitat and assisting the municipality in meeting state and federal regulations.

In addition to these dedicated funding sources, Urban Forestry receives thousands of hours of volunteer time and in-kind contributions from our many partners. (See pages 18-21). These factors enable the program to be much more accomplished through an active, integrated program that has grown with support and participation at all levels within the community. The in-kind dollars do not include contributions from other City programs based on their impacts related to the urban forest. Without such strong support, the City's Urban Forestry Program would not be able to accomplish its mission.

In 2023, these in-kind contributions, along with grants and donations (including those for Witness Trees), totaled $180,660.00.





Unaudited at the time of publication

Accomplishments

Program Developments

- The U.S. Department of Agriculture Urban and Community Forestry Program awarded a $300,000 grant to increase tree planting capacity through a new workforce development project that provides paid job training for young adults. The grant-funded project will help improve the health of Vancouver's urban natural systems, create green job opportunities, address climate change impacts and environmental justice and enhance community health, safety and quality of life.
- Developed an income-based tree care assistance program. The program will address hazards and long-term needs including invasive species, hazard abatement and planting of new, quality trees on both public and private property.
- City Council adopted the Urban Forestry Management Plan (UFMP) in October 2023. Urban Forestry was awarded a grant from Washington State Department of Natural Resources to partially fund the plan. Staff worked closely with the project consultants to develop the plan, which included extensive research of other communities plans, review of existing plans, policies and workflows, internal and external stakeholder discussions and community outreach which included two virtual and one in-person open house, online surveys and community presentations. The plan recommends directions and actions for Vancouver to optimize the benefits of trees. The plan incorporates an integrated, equitable and sustainable approach to preserving and enhancing the City's urban forest resources over the next 25 years.
- In 2022, City Council adopted the Climate Action Framework (CAF), a blueprint to reduce greenhouse gas emissions and build resiliency to climate change impacts in our community. The CAF provides strategies and specific actions to cut carbon emissions and build community resilience across six focus areas: Building Energy, Transportation and Land Use, Equity and the Green Economy, Solid Waste and Wastewater, Governance and Natural Systems. Urban Forestry is identified as working with natural systems to meet the goals of carbon neutrality by 2040.
- As part of the ambitious goals set by the CAF, in 2023 Urban Forestry increased tree planting, community engagement and tree maintenance goals to ensure an equitable urban forest for all community members. Urban Forestry received two additional positions to help meet these goals.
- Urban Forestry implemented a proactive street tree maintenance and planting program. This new program addresses inequities in tree canopy cover while improving climate resilience by improving street tree health and condition and planting in vacant street tree locations.
- Urban Forestry supported Parks, Recreation and Cultural Services Volunteer Program to develop and implement the pilot Naturespaces Program. Naturespaces brings the community together to help restore and enhance select sites within the Vancouver parks system with a focus on preserving and expanding native habitat.

Accomplishments

Program Developments, cont.

- Urban Forestry supported Community Development by completing the final landscape inspections for all new development to ensure approved plans were followed and appropriate trees are planted in appropriate locations. In 2023, Urban Forestry staff inspected more than 230 sites.
- Urban Forestry hosted the Pop-Up Arboretum series at six parks during the summer. Our parks have wonderful collections of trees, the arboretum series showcases specimen trees with fun, informative signs in multiple languages. Community members were encouraged to explore and learn about the trees in our urban forest.
- Urban Forestry coordinates educational workshops aimed at property owners, homeowners, and landscapers on how what they do in their landscapes has a direct impact on water quality and watershed health. Urban Forestry coordinates on average one workshop a month and one month-long comprehensive volunteer training, Tree Stewards, annually. Participants learn about how behaviors in their landscapes can improve water quality, such as removing high maintenance lawns, planting native trees and shrubs, using organic mulch and fertilizers, preserving existing trees, reducing pesticide use and picking up pet waste.
- Emerald Ash Borer (EAB), an invasive beetle, was detected in nearby Forest Grove, Oregon in June 2022, the first detection on the West Coast. EAB has killed hundreds of millions of ash trees in North America since it's arrival in 2002. EAB has not been detected in Vancouver yet. Staff developed an EAB management plan to guide the response and began implementation in 2023, which included presentations to key stakeholders, beginning to inventory ash trees, and treating priority ash trees with an insecticide.

Accomplishments

Program Developments, cont.

- Staff and Commissioners attended the Urban Forestry Commission retreat in April, focusing on team building and program goals. Topics included new programming for 2023, canopy goals, equity in the urban forest and reviewing the subcommittees. Urban Forestry Commission subcommittees include corridor, outreach, policy, and added pollinators and invasives.
- The Urban Forestry Commission's corridor subcommittee continues to identify and implement a 'corridor planting' program. The subcommittee collaborates with Transportation Planning to identify locations. In 2023, the group identified the east 18th street corridor to plant free street and yard trees to property owners along the corridor.
- Partnered with Friends of Trees to host an intern through their Adult Urban Forestry Internship program, that trains individuals from underserved communities in the green jobs sector.
- The City recognized Arbor Month in April and was recognized as Tree City USA for the 34th year and received the Growth Award for the 23rd year. The entire month of April was dedicated to celebrating our communities' trees with Pop-Up Arboretums at two parks, family-friendly online activities and an Arbor Day celebration. The celebration included a ceremony to recognize Vancouver's Tree City USA achievements, presented the annual Gordon and Sylvia MacWilliams Evergreen Award (Mac Award) to dedicated community volunteer and teacher Toree Hiebert, and a community tree planting along Campus Drive. The Mac Award honors longtime, dedicated volunteers who have contributed significantly to Vancouver's urban forest, planting and nurturing trees for the next generation. Mrs. Hiebert brought her horticulture students to the event and they planted 30 new trees and 120 pollinator shrubs.
- The Urban Forestry Commission held a Heritage Tree Hearing in October and designated eight new trees and/ or groves as Vancouver Heritage Trees.
- The Urban Forestry Commission honored longtime dedicated volunteer Susan Sanders with the Silva Bolds-Whitfield Urban Forestry Award, recognizing her many contributions to growing and protecting Vancouver's urban forest.

Susan Sanders being honored at the Silva Bolds-Whitfield Urban Forestry Plaza.

Accomplishments

Awards and Recognitions

Vancouver was named “Tree City USA” for the 34th year and received the prestigious Tree City USA Growth Award for the 23rd year

Five full-time staff achieved 100 percent arborist re-certification through the International Society of Arboriculture.

Four staff members hold Tree Risk Assessor Qualification and three hold Municipal Specialists certification through the International Society of Arboriculture.

Staff presented Vancouver’s Emerald Ash Borer Management Plan at a Pest Readiness workshop hosted by the Department of Natural Resources and Washington’s Invasive Species Council which was attended by tree care companies, municipalities, and non-profits. Vancouver’s Plan was one of the first within the Pacific Northwest and a model for other communities.

Accomplishments

Urban Forestry in the Headlines

- 'Vancouver seeks knowledge about trees,' The Columbian, January 14, 2023. The City of Vancouver is soliciting insight from the community about local trees to use toward the creation of its Urban Forestry Management Plan.
- 'City of Vancouver seeks community input on plan to enhance its urban forest,' KPTV-PDX, January 25, 2023. The City of Vancouver wants the community's engagement as it develops a plant to protect its trees.
- 'Vancouver looks to expand its tree canopy,' KATU, January 25, 2023. The City of Vancouver wants your help preserving and enhancing its urban forest.
- 'Vancouver to revise urban forestry plan as it aims for equity, climate goals,' The Columbian, January 27, 2023. As climate change impacts become more severe, notably through heat domes and islands, the need for equitably placed canopies is becoming more immediate.
- 'Naturespace volunteers celebrate Vancouver's literal roots,' The Columbian, February 4, 2023. Goal of city's pilot program is to restore understory's native ecosystem.
- 'Vancouver neighborhood dedicated sequoia to those lost to COVID,' The Columbian, March 4, 2023. Tree could grow to 290 feet tall, a 'testimony to the love and life that we've shared'.
- 'Vancouver on lookout for tree pest the emerald ash borer,' The Columbian, March 14, 2023. Beetle has devastated 'tens of millions' of ash trees across the U.S.
- 'Tree-of-heaven is an otherworldly invader in Northwest,' The Columbian, April 24, 2023. Contrary to its name, fast-growing species is a menace that's difficult to eradicate.
- 'Officials rethink Vancouver forestry plan,' The Columbian, May 10,.2023. Preservation, environmental justice get new focus.
- In Your Neighborhood, The Columbian, April 16, 2023. After months of planning, a group of local women planted a tree to honor the Platinum Jubilee of Queen Elizabeth II by participating in Vancouver's Witness Tree Program.
- 'Vancouver eyes climate-adaptive trees for future,' The Columbian, August 10, 2023. Increasing high temperatures threaten regional natives.
- 'Make your own apple cider,' Woman's Day Magazine, October 2023. Washington is the nation's top producer of apples, and at the Old Apple Tree Festival you can get a cutting from the state's oldest one.
- 'How well do you know the trees in your neighborhood?,' The Columbian, October 2023. Branch out your tree knowledge and learn how to identify Southwest Washington's most common species.
- 'Vancouver to use $300K grant to employ youth to plant trees, fight climate change,' The Columbian, October 12, 2023. Vancouver to employ young people to tend to local trees as it

Accomplishments

Urban Forestry in the Headlines, cont.

- 'Vancouver to use $300K grant to employ youth to plant trees, fight climate change,' The Columbian, October 12, 2023. Vancouver to employ young people to tend to local trees as it fights climate change.
- 'City of Vancouver's Urban Forestry Commission presents prestigious Silva Bolds award,' The Columbian October 14, 2023. The Commission presented longtime volunteer Susan Sanders with the Silva Bolds-Whitfield Award.
- 'A fine balance: Vancouver juggles protecting trees, managing growth as population expands,' The Columbian, November 16, 2023. City officials strive to preserve the urban canopy.
- 'City of Vancouver on track in plan to be carbon neutral by 2040,' The Columbian, December 23,2023. Vancouver approved its Climate Action Framework one year ago.

Accomplishments

Tree Plantings

- Utilized the 2021 Tree Canopy Report and GIS data to identify low canopy and under resourced communities to prioritize for tree plantings. In 2023, Urban Forestry planted 1,817 trees at over 40 sites throughout the Vancouver community to ensure equitable benefits of our urban forest. Following is a snapshot of tree plantings throughout the Vancouver community, in partnership with volunteers, contractors, partner programs and neighborhood associations.
- Partnered with 55 Neighborhoods and Friends of Trees to plant 735 street and yard trees at five large-scale neighborhood plantings (central north, central south, west, northeast and southeast).
- Planted 22 trees at Frontier Middle School with 7th grade science students; the new trees represent a variety of species, providing a unique ongoing educational opportunity for engaging both students and teachers.
- Planted nine trees at the Volunteer Grove in partnership with the Volunteer Program to recognize six dedicated volunteers that have given their time serving with the City of Vancouver.
- Planted 30 new trees and 170 pollinator plants along Campus Drive with Fort Vancouver High School Horticulture students and community volunteers as part of Arbor Day celebrations.
- Planted 23 trees at Washington Elementary school with community volunteers to provide shade and manage stormwater.
- Partnered with property owners along E 18th Street to plant 34 new street and yard trees along the busy corridor with students from Fort Vancouver High School.
- Partnered with Fourth Plain Forward to plant free street and yard trees to residential property owners, planting 24 new trees in Rose Village and Meadow Homes Neighborhoods.
- Planted 15 new trees at Summers Walk Park in partnership with Master Gardeners in training.
- Planted 11 new trees at the Safe Stay Village in Downtown Vancouver to increase shade and access to nature for the residents.
- Planted 15 new trees at Water Station 1 with community volunteers to increase stormwater mitigation and habitat.
- Planted 24 new trees at Overlook Park to increase shade and neighbors access to nature.
- Planted 25 new trees at the Firefighters Union property in Fruit Valley Neighborhood with staff from the City Managers Office as a team building event.
- Friends and family helped to plant and dedicate nine individual Witness Trees across Vancouver in honor of their respective loved ones and significant events.
- In the fall, 85 native and climate-adaptive trees were given away to residential property owners to plant in their yards to grow the urban forest and improve air and water quality, increase shade and provide habitat.

Accomplishments

Tree Plantings, cont.

- Throughout Vancouver, 17 new street and yard trees were planted through the Treefund Program, an opportunity to incentivize planting on private property through a dedicated fund. Property owners who qualify for the Utility e-billing program and purchase and plant an approved tree on their residential properties are eligible to apply for a refund toward a portion of the tree cost.
- Planted 136 new street trees as part of the new proactive street tree management project to address inequities in tree canopy while improving climate resilience.
- Worked with volunteers, contractors, and City staff to plant 180 trees at 13 sites throughout Vancouver, including planting 34 trees along the McGillivray corridor, 43 trees along the Mill Plain corridor, 30 trees along French Rd, 25 trees at Tetra Pak in Fruit Valley, 32 trees at stormwater facilities and 16 trees at miscellaneous sites throughout the city.
- Maintained positive relationships with multiple local contractors to ensure contractual obligations are being met on all urban forestry projects.

Accomplishments

Tree Maintenance and Monitoring

- Achieved 96 percent survival of newly-planted large caliper trees through the critical first summer. The region continues to endure unprecedented drought summers impacting trees.
- Maintained and monitored all 2018 through 2023 plantings to ensure survival rates.
- After five years of monitoring, the tree survival rate was 96 percent for 2018 planting projects, which was the survival rate for 2017 planting projects.
- Partnered with volunteers from 11 community groups, resulting in 160 donated hours on Urban Forestry tree maintenance and restoration projects.
- Pruned 731 young trees with staff, interns, AmeriCorps members and volunteers to improve structure, provide clearance, reduce storm damage and improve the health of trees as they mature.
- Urban Forestry continued partnership with Friends of Trees on the street tree pruning program in Vancouver. Volunteers are trained on proper pruning practices of young trees, then work in groups to prune trees in identified neighborhoods. In 2023, trained volunteers spent a total of 275 hours and pruned 149 trees.
- Urban Forestry continued the partnership with the Parks Department and Public Works' Operations department on the proactive park pruning program. This program has moved the City from reactively to proactively maintaining public trees to increase longevity, reduce hazards and emergency care and maximize the many benefits of this public asset.

Accomplishments

Education and Outreach

- Responded to more than 2,159 requests for service and completed more than 979 site visits for residents with 90 percent customer satisfaction.
- Worked with 907 adults and 233 youth volunteers, contributing a total of 3,667 hours at tree planting and restoration events.
- The Urban Forestry Commission volunteered a total of 710 hours to further Urban Forestry's mission.
- Hosted nine TreeTalk workshops on tree planting and pruning, tree walks, Heritage Tree tours, and Tree of Heaven workshops attended by 130 individuals devoting 250 hours to tree care education.
- Hosted 43 educational presentations or events throughout the community on proper tree care, tree benefits, and tree planting, reaching 873 people.
- Incorporating Community Based Social Marketing strategies into outreach and education programs to promote sustainable behavior change and increase public tree stewardship.
- Continued an outreach strategy to raise awareness of tree permit requirements and proper tree care. The strategy included ads in The Columbian and The Messenger, media releases, social media posts and articles in neighborhood newsletters.
- 14 community members completed the Neighborhood Tree Stewards educational program. Stewards received free education from professionals on tree-related topics with the goal to empower them to be liaisons to their communities. The series took a hybrid approach, with virtual presentations and in-person field days.
- Surveys at Tree Stewards workshops showed 43 percent of participants reported an increased awareness of the role trees have in improving our water quality the active steps they can take to improve watershed health.
- The AmeriCorps team coordinated an Earth Day volunteer event and community festival at Bagley Community Park.
- AmeriCorps members coordinated two tree -related educational activities at Downs Park as part of Fourth Plain Forward's Art in the Park series.
- Staff attended the annual Eastside National Night Out, attended by east Vancouver neighbors, to share information on tree planting and benefits of trees.
- Hosted the annual Heritage Tree Bike Ride and two Heritage Tree walking tours of the five-mile loop through downtown highlighting 12 trees and their historical and arboricultural significance.
- Partnered with Cascade Park Library to host a display at the library entrance highlighting the benefits of trees in our watersheds.
- Implemented a community outreach campaign to ensure robust feedback and engagement while developing the updated Urban Forestry Management Plan, including open houses, surveys, presentations, a Be Heard webpage, press releases and social media outreach.

Performance Measures

		Actual 2022	Goal 2023	Actual 2023
Out-come	**The public is involved in environmental stewardship**			
	Calls for assistance & information	2,302	Work Load	2,159
	Site inspections	1,067	Work Load	979
	Average response time (site inspections)	15 days	10 days	13 days
	Customer satisfaction as rated by program participants (new)	100%	75%	90%
	Presentations and educational events	29	25	43
	Urban Forestry Administers a viable volunteer program			
	Volunteers trained (unique)	12	10	14
	Volunteers participating (adults)	780	300	907
	Volunteers participating (youth)	216	200	233
Out-come	**The public trees management program is effective**			
	Acres of total tree canopy based on latest GIS report	6,066	6,066	6,604
	Technical reviews of projects completed on time	837	200	651
	Young tree survival is improving			
	Trees monitored (all projects in 5-year cycle)	6,921	3,750	7,452
	Survival rate of new trees	96%	≥95%	96%
	Trees pruned to improve health	621	≥500	731
	Estimated acres of added canopy from monitored trees at maturity	112	60	121
	New trees are added to the existing canopy			
	Restoration projects (contractor, volunteer, youth)	40	10	50
	Trees planted	1,323	750	1,817
	Tree seedlings and shrubs planted	100	500	170
	Other plants distributed or planted	551	500	0
	Native species composition of new plants	>50%	50%	>50%
	Estimated increase in tree canopy this year, in square feet	16,538	9,375	22,713
Out-come	**Urban Forestry is a good investment**			
	Value of grants, donations, sponsorships, and reductions	$98,971	$35,000	$180,660
	Estimated value of benefits from newly planted trees over 40 -year period*	2.7 million	1.6 million	3.6 million
	Value of program per tree cost (planted and maintained for 5 yrs)	$667	$700	$1,047**

*Based on data from Western Washington and Oregon Community Tree Guide: Benefits, Costs and Strategic Planting

**Due to one time costs of UFMP, new truck purchase and new programming

Benefits of Trees

Trees Working for Us

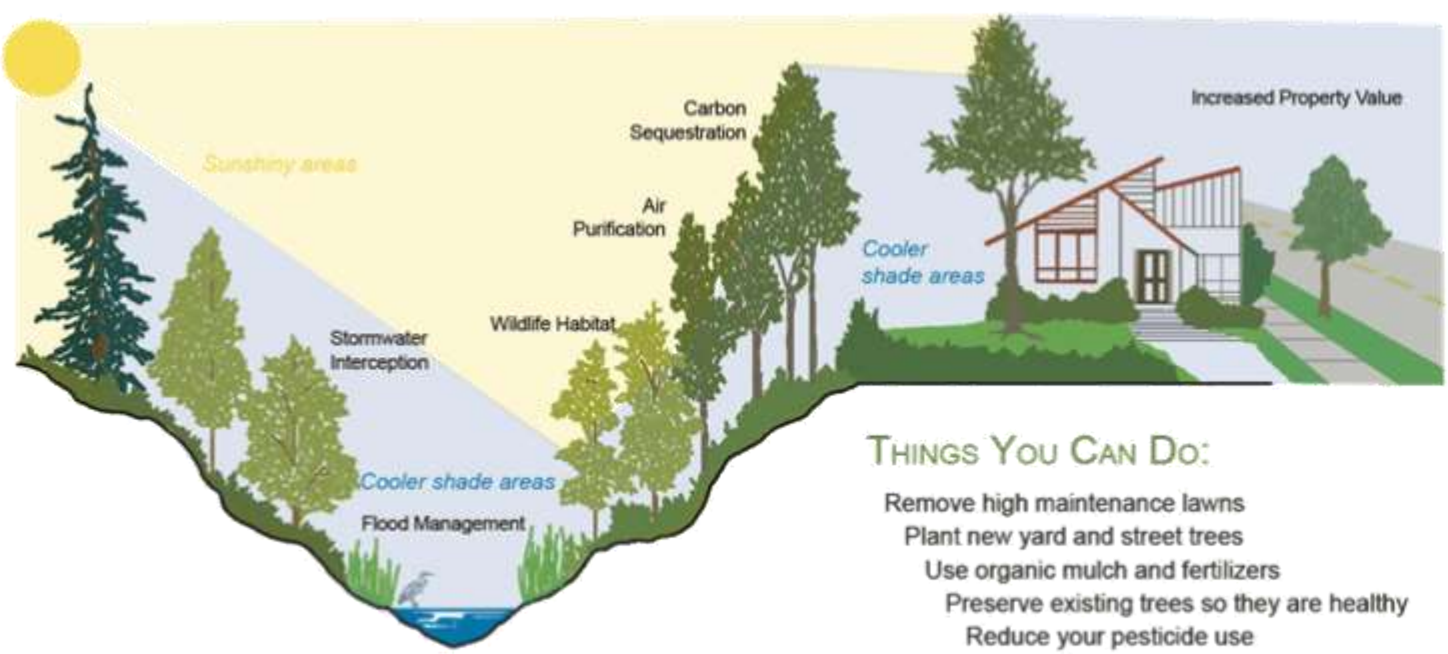
A healthy urban forest in Vancouver builds a strong sense of community and improves quality of life for all community members.

Urban trees can help the City manage stormwater as part of an integrated stormwater management plan to improve water quality, reduce pollutants and enhance wildlife habitat. Increased tree canopy aids in Clean Water Act, Clean Air Act and Endangered Species Act compliance.

Other benefits of urban trees include city beautification, downtown revitalization, increased civic pride, outdoor recreation opportunities, natural resource education, air quality improvement, energy conservation, shading and cooling and many other environmental, social and economic benefits. Tree benefits can be optimized by reversing the trend of declining tree canopy within the city.

The 1,817 new trees planted in 2023 can be expected at maturity to intercept approximately 1,380,290 gallons of stormwater annually, equal to more than seven Marshall Center swimming pools, and absorb more than 18,170 lbs. of pollutants each year from the air we breathe.

Overall, these 1,817 new trees as they mature will provide greater than $3 million worth of benefits, a 250 percent return on this wise investment.



Benefits of Trees

Did You Know These Facts About Trees...

The average tree absorbs 10 pounds of pollutants from the air each year.

Trees reduce the energy needed to heat and cool our homes by 15 to 35 percent nationwide.

The leaves of a mature tree intercept an average of 760 gallons of rainfall a year, reducing flooding, erosion and pollution from runoff.

A typical tree produces about 260 pounds of oxygen each year; two trees can supply a person's oxygen needs each year.

An average tree reduces greenhouse gases by absorbing 26 pounds of carbon dioxide per year.

Trees contribute to neighborhood livability by reducing noise, heat and by calming traffic.

Trees improve habitat for endangered fish, migratory birds and other wildlife.

Trees stabilize soil, reduce erosion and mitigate flooding.

For every dollar spent on Vancouver's urban forest, $2.50 in value is returned in benefits such as energy conservation, stormwater abatement and pollution reduction.

Unlike many other investments that depreciate, a tree's value increases with each passing year. Houses on tree-lined streets can sell for up to 20 percent higher than houses in like neighborhoods without trees.

Visit www.naturewithin.info for more information on the environmental, social, economic and human health benefits of trees.

Partners

Urban Forestry strongly values our relationships with our community partners. We value volunteers and partners to help us achieve our mission. Businesses and organizations improve the quality of life in Vancouver by becoming a partner and sponsoring a tree planting project and supporting a healthy urban forest.

Neighborhood Associations

Airport Green Neighborhood Association

Arnada Neighborhood Association

Bagley Downs Neighborhood Association

Bella Vista Neighborhood Association

Bennington Neighborhood Association

Burnt Bridge Creek Neighborhood Association

Burton Evergreen Neighborhood Association

Carter Park Neighborhood Association

Cascade Highlands Neighborhood Association

Cascade SE Neighborhood Association

Central Park Neighborhood Association

Countryside Woods Neighborhood Association

Countryside Woods Neighborhood Association

Dubois Park Neighborhood Association

East Old Evergreen Neighborhood Association

Edgewood Park Neighborhood Association

Ellsworth Springs Neighborhood Association

Father Blanchet Park Neighborhood Association

Fircrest Neighborhood Association

First Place Neighborhood Association

Fisher’s Creek Neighborhood Association

Fisher’s Landing East Neighborhood Association

Forest Ridge Neighborhood Association

Fourth Plain Village Neighborhood Association

Fruit Valley Neighborhood Association

Green Meadows Neighborhood Association

Harney Heights Neighborhood Association

Hearthwood Neighborhood Association

Hough Neighborhood Association

Hudson’s Bay Neighborhood Association

Image Neighborhood Association

Kevanna Park Neighborhood Association

Landover-Sharmel Neighborhood Association

Lewis and Clark Woods Neighborhood Association

Lincoln Neighborhood Association

Maplewood Neighborhood Association

Marrion Neighborhood Association

Meadow Homes Neighborhood Association

Mountainview Neighborhood Association

North Garrison Heights Neighborhood Association

North Image Neighborhood Association

Northcrest Neighborhood Association

Northwest Neighborhood Association

Northwood Neighborhood Association

Oakbrook Neighborhood Association

Ogden Neighborhood Association

Old Evergreen Highway Neighborhood Association

Parkway East Neighborhood Association

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Neighborhood Associations, cont.

Riverridge Neighborhood Association

Rose Village Neighborhood Association

Shumway Neighborhood Association

Vancouver Heights Neighborhood Association

VanMall Neighborhood Association

Village at Fishers Landing Neighborhood Association

Walnut Grove Neighborhood Association

West Minnehaha Neighborhood Association

Wildwood Neighborhood Association

Non-Profit and Community Organizations

Americans Building Community

Boys and Girls Club of Southwest Washington

Clark County Parks Foundation

Columbia Springs Environmental Education Center

ELSO, Inc

Fort Vancouver Lions Club

Fort Vancouver Historic Trust

Fourth Plain Forward

Friends of the Carpenter

Friends of Trees

International Society of Arboriculture

Latino Community Resource Group

Lower Columbia Nature Network

Master Gardner Foundation of Clark County

NAACP Vancouver Branch

National Arbor Day Foundation

Nature Play Designs

Pacific Education Institute

Parks Foundation of Clark County

SW WA LULAC Council 47013

The Confluence

The Corps Network

Urban Abundance

Vancouver Ridge Garden Club

Vancouver Dawn Lions Club

Vancouver Downtown Association

Vancouver Farmers Market

Washington Community Forestry Council

Watersheds Alliance of SW Washington

Faith-Based Organizations

First United Methodist Church

Saint Andrews Church

Mill Plain United Methodist Church

Unitarian Church

Public Agencies

Bonneville Power Administration

City of Portland, Bureau of Environmental Services

Partners

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Public Agencies

City of Portland, Bureau of Parks and Recreation, Urban Forestry Division

City of Vancouver, City Manager's Office

City of Vancouver, Community and Economic Development Department

City of Vancouver Fire Department

City of Vancouver Neighborhood Traffic Safety Alliance

City of Vancouver, Office of Neighborhoods

City of Vancouver Parks, Recreation and Cultural Services Commission

City of Vancouver Planning Commission

City of Vancouver, Public Works

City of Vancouver, Vancouver Parks, Recreation and Cultural Services

City of Vancouver, Water Resources Education Center

Clark College

Clark County Public Health

Clark Public Utilities

Clark/Vancouver Television (CVTV)

Evergreen School District

Fort Vancouver Regional Library District

National Parks Service

USDA Forest Service

Vancouver School District

Washington Department of Agriculture

Washington Department of Natural Resources, Urban & Community Forestry

Washington Department of Transportation

Washington Service Corps (AmeriCorps)

City of Vancouver, Public Works

City of Vancouver, Vancouver Parks, Recreation and Cultural Services

City of Vancouver, Water Resources Education Center

Clark College

Clark County Green Business

Clark County Green Schools

Clark County Public Health

Clark Public Utilities

Clark/Vancouver Television (CVTV)

Evergreen School District

Fort Vancouver Regional Library District

National Parks Service

USDA Forest Service

Vancouver School District

Washington Department of Agriculture

Washington Department of Commerce

Washington Department of Fish and Wildlife

Washington Department of Natural Resources, Urban & Community Forestry

Washington Department of Transportation

Washington Service Corps (AmeriCorps)

Partners

Urban Forestry strongly values our relationships with our community partners. We value volunteers and partners to help us achieve our mission. Businesses and organizations improve the quality of life in Vancouver by becoming a partner and sponsoring a tree planting project and supporting a healthy urban forest.

Public Agencies, cont.

Washington State University

Washington State University Clark County Extension Service, Master Gardeners

Private Organizations/ Business

Arborscape LTD

Bartlett Tree Experts

J. Frank Schmidt & Son Co

Joe's Farm

KIND Snacks

Paper Tiger Coffee

Seize the Bagel

Shorty's Nursery—Dennis' 7 Dees

Starbucks Corporation

SOMA Kombucha

The Columbian

Tetra Pak

TreeWise, LLC

Urban Forestry Commission

Established for the purpose of preserving, managing, and increasing the City's urban forest thereby protecting a vital environmental, social and economic resource that benefits all residents and visitors, and for the purpose of assisting property owners and public agencies in improving and maintaining the urban forest in a manner consistent with adopted City policies. Seven members are appointed by City Council to four-year terms.

Meetings are the third Wednesday of each month from 6 to 8 p.m. at Vancouver City Hall, 415 W. Sixth Street and virtually. For information, to submit comments, or attend, email urbanforestry@cityofvancouver.us.

Current membership of the Commission
Melissa Johnston, Chair
Clif Barnes, Vice-Chair
Susan Law, past Chair
Jamie Beyer
Khanh Tran
Jeff Kessenich
Vacant

More Information

Webpage: www.cityofvancouver.us/urbanforestry
Email: urbanforestry@cityofvancouver.us

City of Vancouver | Public Works
PO Box 1995
Vancouver, WA 98668-1995

Water Resources Education Center 2023 Annual Report

CITY OF Vancouver WASHINGTON

Environmental Resources | Public Works
January 2024

Acknowledgements

Mayor Anne McEnerny-Ogle
Councilmember Kim D. Harless
Mayor Pro Tem Erik Paulsen
Councilmember Diana H. Perez
Councilmember Bart Hansen
Councilmember Ty Stober
Councilmember Sarah J. Fox
Vancouver City Council 2024

City Manager Eric Holmes
Deputy City Manager Lisa Brandl
Deputy City Manager Lon Pluckhahn
Director of Public Works Steve Worley

Table of Contents

Vision, Mission, Values, Goals

The Water Resources Education Center (Water Center) opened in February of 1996 and operates within the Environmental Resources Division of the City of Vancouver's Public Works Department. The Water Center is funded with primary support from the City's Water Fund. Integration of the City's water and other utility functions within the context of our local watersheds is what we define and value as a "healthy water system." It is our objective to fulfill our mission through communicating and connecting the community with this theme.

Vision

The Water Resources Education Center is a vibrant and welcoming space where everyone is included in place-based nature discovery, environmental observation and positive change to benefit the waters that sustain us. Our programs and exhibits inspire curiosity and foster connections between people and the watersheds we call home, while our building and outdoor spaces are a model of environmental responsibility. We aim to create a regenerative culture where we work with the natural world to improve the ability of the land, water, soil and air to support people and wildlife in a beneficial way.

Mission

To inspire connections between healthy water and people through education, exploration and stewardship of the natural world.

Values

Innovation: We value creativity and continual improvement in our processes, programming and public offerings.

Collaboration: We recognize that partnerships expand our capacity, build connections and support the public we serve.

Communication: We aim to be honest, transparent and inclusive in all our services.

Connection: We aim to offer meaningful, hands-on experiences that inspire curiosity of the natural world and foster lifelong learning about healthy water systems.

Inclusion: We embrace all individuals and value the unique characteristics that each embodies, knowing that together we are stronger.

Goals

Exhibit Master Plan

The exhibit hall is one of the main attractions for Water Center walk-in visitors. Since the Center opened in 1996, new exhibits have been added piecemeal, when time and budget allowed for upgrades. After being in operation for 25 years, the Water Center exhibits need a significant upgrade. Many exhibits are outdated, some do not work, and others simply take up space and do not fill a role in our desired messaging to the public. This is a long-term goal that began in 2022. Exhibit hall planning and updating should be a significant undertaking for the next 5 years.

Visitor Experience

The Water Center is a public education center with free entry to all. As such, we aspire to make the visitors experience one that is welcoming, enjoyable and diverse as well.

Vision, Mission, Values, Goals

We want visitors to be inspired by the content and the staff they engage with during their visit. Our goal is to have a thriving education center where people share what they learned with their friends and family and are excited to return. The Water Center website and Public Works social media platforms provide great opportunities for connecting with our target audience and we value this connection as well.

Education Programs
The Water Center currently engages the public by offering educational opportunities via onsite school field trips, community programming, volunteer stewardship opportunities and offsite/ in classroom field trips via the Student Watershed Monitoring Network. The Center offers mentorship and learning opportunities via part time employment to student education Interns which is currently paused and AmeriCorps members. Mentorships are also available through partnerships with community organizations and area high schools.

Environmentally Safe and Innovative Facility
The Water Center was built in 1996. As a public facility that welcomes visitors to learn about water resources, we aim to make improvements that will convey educational messaging around water, conservation and climate change issues.

Program Information

The Water Resources Education Center operates within the Environmental Resources Division of the City of Vancouver's Public Works Department. This division also includes the City's Urban Forestry Program and Solid Waste Program, both of which rely on separate funding sources than the Water Center. All of these programs share an educational mission related to communications on environmentally focused outcomes.

The Water Center's mission also connects with the selected other Public Works programs and services that are housed in other Public Works divisions.

The following is an overview of key Public Works Services. The Water Center's educational mission supports many of these community infrastructure areas.

Public Works

- **Utility Engineering**
    - **Drinking Water**
    - **Wastewater**
    - **Stormwater**
- **Environmental Resources**
    - **Solid Waste**
    - **Urban Forestry**
- **Operations**
    - **Water**
    - **Wastewater**
    - **Surface Water**
    - **Fleet**
    - **Grounds**
- **Cemetery**
- **Streets and Transportation**
- **Construction**
- **Finance and Assets**
    - **Utility Billing**

*General Fund-supported or partially General Fund-supported programs

[1] Utility Services handles billing & customer account for all City Utilities, with the exception of garbage & recycling

[2] Construction Services provides inspection, engineering, surveying & contract management for all capital projects including Utilities

Funding and Facility

Location: The Water Center, at 4600 S.E. Columbia Way, is a part of the Marine Park Natural Resource Area. The Water Center's site includes a 50-acre protected wetland natural area, one of the few remaining metropolitan area riparian/off-channel rearing and nesting habitats along this reach of the Columbia River for more than 120 species of fish and wildlife. The Water Center is located within the Fort Vancouver National Historic Site.

Capital Cost: $3.5 million, included in $40 million bond package for the Marine Park wastewater treatment plant.

Indoors: 16,000 square feet of floor area that includes the Bruce E. Hagensen Community Room, with catering kitchen, seating for 180 and view balconies; River and Garden Classrooms; Exhibit Hall; laboratory; aquaria; and offices.

Outdoors: Certified Backyard Habitat Garden demonstrates effective native and climate-friendly landscaping practices and a 3,000 square-foot observation platform overlooking the wetlands and Columbia River. Also an outdoor Classroom to the east of the building developed through a grant from the Washington Department of Natural Resources with participation of the Arbor Day Foundation, the City's Greenway Sensitive Lands Team, Urban Forestry Program and others.

Adjacent Facilities: The Marine Park Water Reclamation Facility to the north and west, and the City's Public Works Marine Park Engineering Building to the west. The Water Reclamation Facility provides opportunities for student and community group tours and learning through a partnership with Jacobs, the contracted operator.

Nearby: The Columbia River Renaissance Trail and Marine Park (both managed by Vancouver Parks & Recreation) reflect the City's ongoing efforts to establish an attractive, vital and safe urban waterfront, restore access to the Columbia River and enhance historical and natural resources.

Hours and Admission: 10 a.m. to 5 p.m., Monday through Friday. Closed most holidays. Admission is free.

Funding and Facility

Vancouver's Water Resources Education Center receives funding within the City's biennial budget and relies primarily upon the City's Water Utility fund to cover operating expenses. Water Center's budget for 2023 was $2,226,409. Actual Water Center expenditures for the year totaled $1,192,821 about 53 percent of the approved budget. Key partnerships for the Water Center include Columbia Springs and the Watershed Alliance of Southwest Washington. Through annual grants, as well as some Solid Waste funding, these organizations contribute to the City's goals of providing effective public education and outreach. Separate annual reports for these non-profits detail progress and outcomes that resulted in 2023 from these partnership efforts.

Current staff costs include salaries and benefits for the following budgeted positions:

- 3 Water Educators
- 1 Water Center Supervisor
- 1 Support Specialist
- 1 AmeriCorps member

The Water Center also is proud to be supported by a great group of committed volunteers. In 2023, volunteers invested 670 hours in the Water Center at an estimated value of $21,306.

Other support for Water Center outreach is provided by our many partners whose roles are described in the report sections which

Accomplishments

Public Education and Outreach

Public education and outreach supportive of drinking water, surface water, stormwater management and related goals has long been a vital component of the City of Vancouver's ongoing efforts to protect and enhance water resources and our aquatic and wetland habitats. The Water Resources Education Center and its programs have been central to meeting this community objective for more than 25 years.

Other City departments and divisions of Public Works (see page 6) support this charge to actively engage the community through a variety of communication channels including local media advertisements, newspaper articles, social media and websites.

In addition, the City is an active partner with many other agencies and non-profits in offering ongoing education and outreach programs for the community, including Vancouver's Urban Forestry Program and Urban Forestry Commission, Watershed Alliance of Southwest Washington and Columbia Springs.

This Accomplishments section of the report provides a discussion of the Water Resources Education Center's normal 2023 programs and activities, as well as those of our partners, which help to build general awareness among target audiences and help change behaviors that address stormwater-related impacts and challenges.

These shared efforts help Vancouver meet Public Education and Outreach and Public Involvement and Participation requirements (under sections S5 C2 and S5 C3) outlined in the City's 2023 Stormwater Management Program for responsibilities under the MS4 (Municipal Separate Storm Sewer System) program also know as the NPDES (National Pollutant Discharge Elimination System) Phase II Municipal Stormwater Permit for Western Washington.

We also summarize stewardship activities undertaken with the goal of encouraging residents to participate in activities related to stream teams, storm drain marking, volunteer monitoring, riparian plantings and related education activities. Vancouver Urban Forestry, the Watershed Alliance, and Columbia Springs have prepared separate documents which detail their efforts in 2023.

Accomplishments

Water Center On-site Opportunities & Activities

School Group Visits (K-12 Classrooms and includes summer camp type groups)
During the 2022-2023 school year, the Water Center hosted 72 field trips for a total of 1414students plus teachers and chaperones.

School and Group Visit Options
Available programming for classrooms and groups, normally provided by Water Center staff and interns, is summarized on our website and includes the following:

- Exhibit Hall Tour/Exploration
- Classroom Programs/Hands-On Activities
- Marine Park Water Treatment Plant Tour (grades 4 to 12)
- Water Science Laboratory/Water Quality Activities (Grades 5-12)
- Nature/Wetlands Tour/Walk
- Beach Cleanup/Scout Badges

Other Group Visits
Preschools, play groups, day cares, retirement facilities and community organizations including scout troops, service clubs, garden clubs and others frequently arrange for visits to the site and may request educational activities or tours, sometimes associated with a service learning experience, a tour of the treatment plant, the wetlands, or the facility tailored to their particular interests and needs.

Water Center Programs
The Water Center held Public Nature Programming in 2023. Staff held 25 nature programs centered around the Water Center, Columbia River, Burnt Bridge Creek and other locations. 393 people attended and were able to participate in walks, learn about bats, tree pruning and animal tracking.

Reading in the Wild
Reading in the Wild, a morning reading series for preschoolers and their parents that offers them an opportunity to listen to a fun story and to explore nature in the “wild” areas of our site. We were able to offer a successful four weeks of programming in July. The four Wednesday’s attendance saw 92 adults and 127 kids (range infant to 6 years, most pre-K).

Accomplishments

Walk-in and Community Room Visitors

Families, individuals, out-of-town visitors as well as small or large groups make frequent visits. Many of these guests arrive with plans to view educational displays, interactive exhibits, aquaria and other features on the exhibit floor areas or to spend time on our grounds or meet up with others after walking the trail. The Water Center welcomed 3152 walk-in visitors. 119 events were held in the Bruce E. Hagensen Community Room in 2023.

Student Watershed Monitoring Network

During the 2022-23 school year, the Water Center's countywide Student Watershed Monitoring Network program (SWMN), now in its 25th year, served a total of 6892 students from 25 schools and was supported by 32 teachers. Grades 3 through 12 were represented and are in schools located in Clark County areas (including in other cities) outside of Vancouver's City limits. The program functions in these areas through a $60,000 annual grant provided by Clark County's Clean Water program.

Accomplishments

Critical Support for Water Center Programs

Water Center Volunteer, Service Learning and Internships

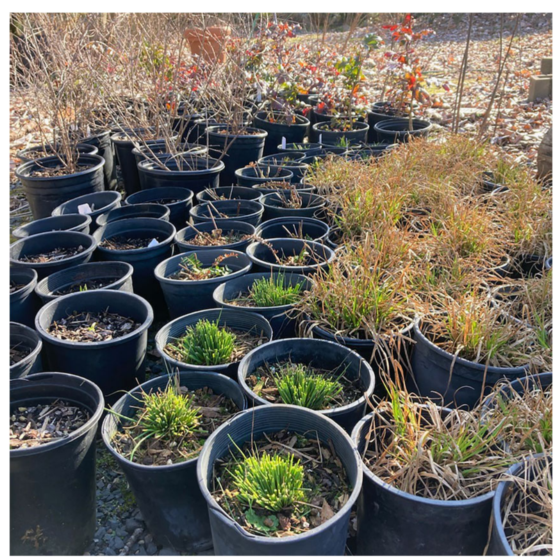
Typically there are a number of ways the public and area students participate in helping the Water Center to deliver our programs while gaining valuable experience and pursuing areas of personal interest in learning about the environment. These are summarized below.

Volunteer roles typically include:

- **Garden and Wetlands Volunteers**
  Volunteers help with the wildlife habitat demonstration garden and outdoor classroom and/or help in wetland areas to collect litter, remove blackberries, ivy and other invasive plants, and to replant with native species or perform other hands-on projects. They also help with beach cleanups at Wintler and Marine Parks.

- **Special Project Volunteers**
  Volunteers work with staff on specific projects.

- **Water Center Interns & AmeriCorps Members**
  The Water Center offers both paid and non-paid internships for those enrolled in college or high school course work in areas of science and environmental education aligned with their academic and career goals. Interns are classified as temporary city employees and currently the program is on pause. Our current AmeriCorps member working at the Water Center started in early September and is able to support our programs through the end of her term in July 2024.



Accomplishments

Partnerships

Columbia Springs Environmental Education and Outreach Program
The City of Vancouver is one of a half dozen partners in the region that support the work of the Columbia Springs Environmental Education Center, which provides educational, volunteer stewardship and related programs to school children, teachers and adults throughout Clark County. A full explanation of their efforts is available on their website.

The City has provided a 5 year grant agreement with the non-profit in order to support ongoing efforts. The City's total support for Columbia Springs in 2023 was $60,000.

Watershed Alliance of Southwest Washington

This local 501(c)(3) non-profit organization works to educate and engage community members to be active stewards of Southwest Washington's natural legacy with a focus on creeks, lakes and other water bodies. They educate children and adults, while giving them hands on opportunities to participate in the restoration and protection of waterways.

In 2023, the City of Vancouver contributed $150,000 through an ongoing grant agreement directed at two general areas: Private Property Programs (Project Restore, Backyard Habitat Certification, Other - including multi-family and commercial sites), and Public Programs (Stewardship, Outreach and Education, Neighborhood Grants, Don't Drip and Drive).

The Watershed Alliance of Southwest Washington's website provides a helpful overview of their overall efforts on behalf of the community.

Solid and Hazardous Waste Outreach and Education
The City of Vancouver, with Solid Waste Services as the lead, participates as a partner in offering the regional Household Hazardous Waste program, that is detailed within the Clark County Comprehensive Solid Waste Management Plan, both in the Moderate Risk Waste Plan Chapter (11) and the Education & Outreach Chapter (5). Clark County Public Health is the designated Local Solid Waste Financial Assistance grant (LSWFA) recipient for our region and takes the lead in directing this Department of Ecology funding support to implement quality programs related to toxics reduction, alternatives to pesticides, outreach for properly managing household hazardous waste (HHW) and conditionally exempt small quantity generator (CESQG) waste programs, implementing the Green Neighbors, Green Business, and Green Schools Programs as well as the Master Composter/Recycler program.

All of these efforts address awareness and encourage behavior changes for the targeted audiences. Besides helping to reduce and divert these waste streams, the outreach efforts are critical for informing the general public, homeowners and businesses about how their behaviors and practices can benefit our local water quality and ecology.

Key Partner Programs

Columbia Springs
Ongoing support is provided through our budget for this non-profit providing environmental education and youth/teacher outreach including the annual Columbia River Watershed Festival offered each fall for area fourth graders.

Clark County Public Works & Public Health
Provides grants and in-kind support for the Water Center's Student Watershed monitoring network and manages regional sustainability, solid waste and hazardous waste outreach and education programs.

Watershed Alliance of Southwest Washington
This non-profit organization provides support in outreach and education as well as through selected stewardship projects and through developing watershed restoration efforts in coordination with private property owners and offering sustainability micro-grants to city neighborhood associations.

Fort Vancouver National Historic Site
The Water Center is a partner in coordinating our outreach and education efforts with those of the Trust, the National Park Service and Pearson Air Museum.

Contact Information

Current as of February 2024

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Vancouver, WA 98668
4600 SE Columbia Way
360-487-7111 | Fax: 360-693-8878
vanwrec@cityofvancouver.us
www.cityofvancouver.us/watercenter

Environmental Resources Manager
VACANT

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VACANT

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desi.lizarraga@cityofvancouver.us
361-487-7111

Ashley Conley, Water Educator
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Suzanne Hebert, Water Educator
suzanne.hebert@cityofvancouver.us
360-487-7114

Rainy Rau, Water Educator
rainy.rau@cityofvancouver.us
360-487-7121

Water Center Results—Measures

Outcomes & Measures	2021	2022	2023
Outcome: We meet the community's demand for services and programs			
Walk in visitors - over 12 months	393	2362	3152
K-12 School visits academic* year (students/ classes)	31 3	684 42	1414 72
Community room: participants - over 12 months	NA	2431	2,431
Scheduled events		61	61
Outcome: We offer special events of interest to the community (participation/attendance)			
Reading in the Wild	NA	69 adults 111 kids	92 adults 127 kids
Outcome: Supporting remotely and on-site learning at county-wide schools: Student Watershed Monitoring Network			
Students served (academic year*)	2969	6892	9160
Schools/Teachers served	100	25 / 32	36 Classes
Outcome: We operate a cost-effective program			
Budgeted expenditures	$1,499,083	$1,826,342	$2,226,409
Actual expenditures	$1,001,172 67%	$1,202,516 66%	1,192,821 53%

NA - Not Available for indicated year
* - Academic year is Sept 2022-June 2023

More Information

Webpage: www.cityofvancouver.us/watercenter
Email: vanwrec@cityofvancouver.us

City of Vancouver | Public Works
PO Box 1995
Vancouver, WA 98668-1995

CITY OF
Vancouver
WASHINGTON

Water Years 2022–2023 Monitoring Report

Burnt Bridge Creek Water Quality Monitoring Program

Prepared for
City of Vancouver Surface Water Management

Prepared by
Herrera Environmental Consultants, Inc.

Water Years 2022–2023 Monitoring Report

Burnt Bridge Creek Water Quality Monitoring Program

Prepared for
City of Vancouver Surface Water Management
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February 6, 2024

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EXECUTIVE SUMMARY

Since 2004, the City of Vancouver, Washington (the City) has conducted water quality monitoring in Burnt Bridge Creek (BBC) as part of a long-term monitoring program. This report describes water quality monitoring conducted in accordance with procedures in the Quality Assurance Project Plan (QAPP) for this monitoring program and associated addendums (Herrera 2019a, 2022a) during Water Years 2022 and 2023 (WY; defined as the period between the 1st of October through the 30th of September).

A quality assurance review (QA) was performed in accordance with the QAPP to ensure that all data collected under this monitoring program were valid and useable for analysis. In general, the data met quality objectives with some exceptions causing results to be flagged as estimates, but no data were rejected due to QA concerns. Bacteria and soluble reactive phosphorus (SRP) data were most commonly qualified due to colony counts falling outside of the ideal range and SRP concentrations exceeding 120 percent of the total phosphorus fraction, respectively. Discussion of corrective actions to address these recurring QA issues are included below.

The following summary describes major patterns pertaining to median concentrations as well as water quality criteria exceedances observed during the monitoring period:

- Seasonal Trends: Warmer temperatures in the summer base flow events were generally associated with lower dissolved oxygen (DO), dissolved organic carbon (DOC), and total and dissolved zinc concentrations, with higher pH, hardness, and *Escherichia coli* (*E. coli*) bacteria concentrations. Conversely, lower temperatures during winter base flow events were generally associated with higher DO and DOC, and lower bacteria concentrations.
- Spatial Patterns: Upstream stations generally had lower pH and total phosphorus, and higher total nitrogen and nitrate+nitrite concentrations for both base and storm flow events. DOC concentrations and base flow turbidity were lower in the tributaries than the main stem stations. Total and dissolved metals concentrations tended to be lower at the tributaries than main stem stations during base flow, and higher at the tributaries during storm flow.
- Storm and Base Flow Comparison: Compared to base flow, storm flow events had lower temperature and pH, and higher DO, turbidity, total suspended solids (TSS), DOC, metals, and bacteria. This is expected due to the mobilization of pollutants from higher flow rates and adsorption of metals and other pollutants to fine solids.
- Historical Data Comparison: Compared to historical data (WY2011–WY2021 for most base flow parameters and WY2020–WY2021 for storm flow parameters), base and storm flow DO and chloride concentrations, and base flow turbidity were higher. Base and storm flow bacteria concentrations and storm flow total phosphorus concentrations were lower at most or all monitoring stations. Base flow total and dissolved zinc concentrations were greater than WY2020–WY2021 concentrations at most monitoring stations.
- Water Quality Criteria Comparison: Applicable criteria for several parameters were exceeded. The 7-day average daily maximum (7-DADMax) criterion for temperature was exceeded at all stations with continuous temperature probes during the summer monitoring period. Most stations did not

meet DO criterion for one or more events during base flow events and U.S. Environmental Protection Agency (EPA) nutrient criteria were typically exceeded at all stations with few exceptions. pH and metals concentrations were generally within applicable criteria except for cases of low pH at BBC10.4, particularly during storm events, and two acute metals exceedances at tributary stations (Burton Channel [BUR0.0] and Cold Creek [COL0.0]) during storm flow events. The turbidity criterion was exceeded during two storm events and two base flow events.

BBC10.4 had unique water quality characteristics including the lowest DO concentrations and pH, both often below their respective criteria. This is consistent with historical data and likely influenced by natural wetland conditions. DO and pH concentrations increased substantially at BBC8.8, the downstream station nearest BBC10.4. Moving further downstream, DO decreased to the lowest median values at BBC5.9 and then increased again in the lower reach. The three tributary stations had unique water quality characteristics including the most days of temperature exceedance at PET0.0 and metals criteria exceedances during storm events at BUR0.0 and COL0.0.

No changes to monitoring locations or sampling frequency are recommended as a consistent dataset will facilitate statistical analyses planned at the conclusion of WY2024. However, to accommodate significant laboratory cost increases and address quality assurance findings, recommended changes to parameters include discontinuing monitoring DOC and chloride; analyzing total and dissolved metals and hardness for storm events only, analyzing *E. coli* using method SM 9223B by Quanti-Tray, and discontinuing analysis of fecal coliform. Transitioning to *E. coli* analysis via SM 9223B will minimize data qualified as estimated due to colony counts falling outside of the ideal range and confluent growth.

Pending recommendations presented in the WY2024 Trend Analysis Report and in the Washington State Department of Ecology's TMDL Advance Restoration Plan, the City should consider supplementing the monitoring program with additional studies 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. Additional studies considered to be of greatest potential value include continuous stream flow monitoring, annual benthic macroinvertebrate sampling, microbial and pollutant source tracking, and comprehensive aquatic and riparian vegetation surveys.

We recommend that the City continue its existing and planned activities that address pollutant sources (e.g., reduce the number of septic systems through connection to sanitary sewer), reduce water temperature through increased riparian vegetation and urban tree cover, and provide additional treatment of stormwater through construction and maintenance of stormwater facilities. For subbasins impacted by highway runoff, we recommend using Washington State Department of Transportation (WSDOT) stormwater funds for stormwater treatment. We also recommend pursuing partnerships and funding for instream restoration such as reconnecting floodplains, restoring wetlands, and addressing erosion of streambanks. The City should document and compile key information (e.g., timing, geographic extents, and design documents) to support effectiveness evaluation of management activities.

1. INTRODUCTION

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. This report describes base and storm flow monitoring conducted in accordance with procedures in the Quality Assurance Project Plan (QAPP) for the monitoring program and associated addendum (Herrera 2019a, 2022a) during WY2022 and WY2023.

1.1. Overview

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.

State water quality standards have been established to restore and maintain beneficial uses in Washington's waters as required by the federal Clean Water Act (WAC 173 201A). These standards are specifically designed to protect public health, public recreation in the waters, and the propagation of fish, shellfish, and wildlife. Beneficial uses of Burnt Bridge Creek as defined by the Washington State Department of Ecology (Ecology) are primary contact recreation and salmonid spawning, rearing, and migration (Ecology 2008).

Water quality in Burnt Bridge Creek has been monitored extensively for more than 40 years, including a total maximum daily load (TMDL) study by Ecology, with 19 monitoring stations along the stream and its tributaries in 2008 through 2009 (Ecology 2008). Monitoring data have shown that segments of Burnt Bridge Creek do not meet state water quality standards for temperature, DO, 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, DO, 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

1.2. Study Area

Burnt Bridge Creek is a highly modified urban stream that flows westward 12.6 miles, from the eastern edge of Vancouver's city limits to the western boundary, where it discharges into Vancouver Lake (Figure 1). The oversized valley that Burnt Bridge Creek now occupies was created when the Missoula floods swept down the Columbia River 15,000 to 13,000 years ago, emptying a lake created by ice dams formed in the last ice age. Historically the upper portion of Burnt Bridge Creek, between Northeast 162nd Avenue to East 18th Street, carried groundwater and precipitation from the marshlands that were dispersed through the broad plains of the basin.

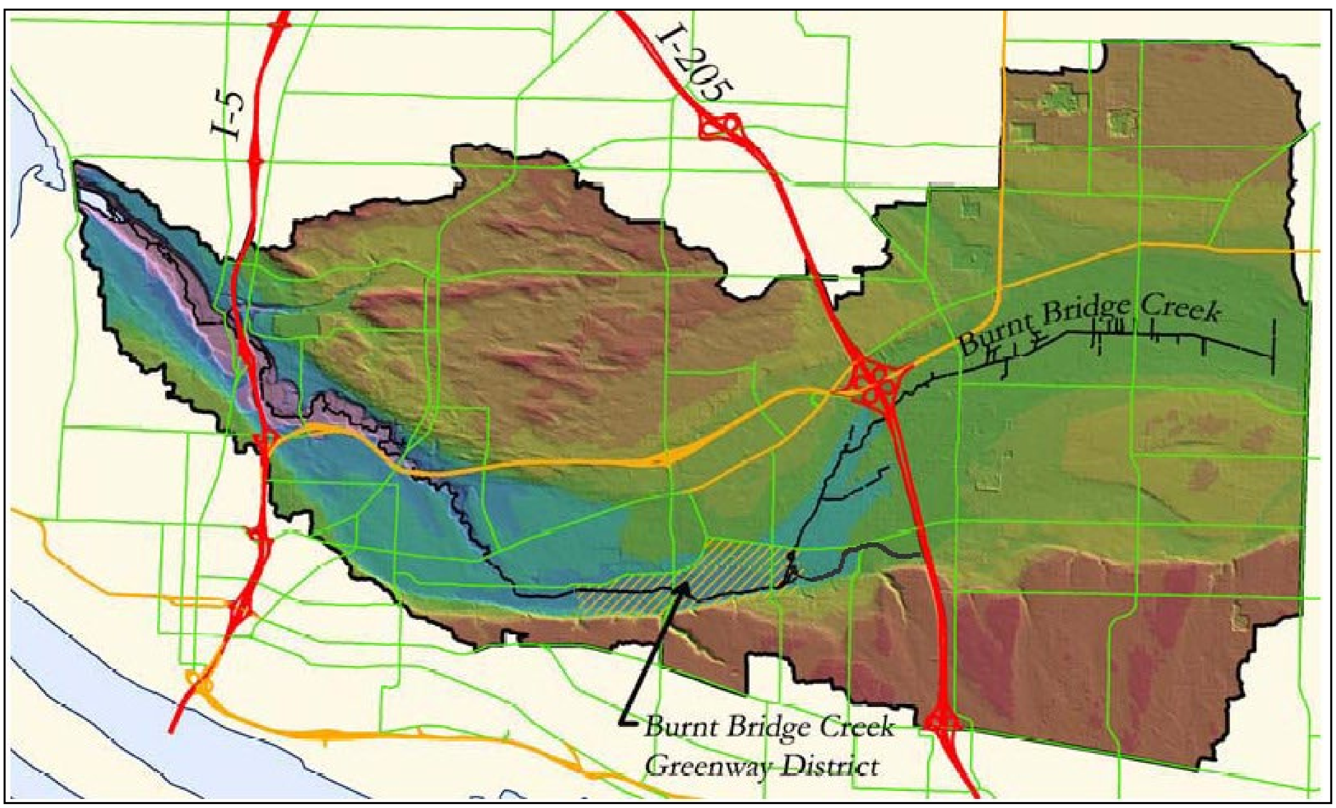

Figure 1. Burnt Bridge Creek Watershed.

What is now referred to as the city of Vancouver is within unceded territory of the Chinookan peoples who lived in the area from 4000 BCE or earlier until forced displacement by European colonizers in the 1800s. As settlement expanded the marshlands became valuable for agricultural use and the wetlands and prairies were ditched and connected to drain the marshes. Today, wetland and upland prairie areas remain evident in the topography and vegetation (Figure 2).

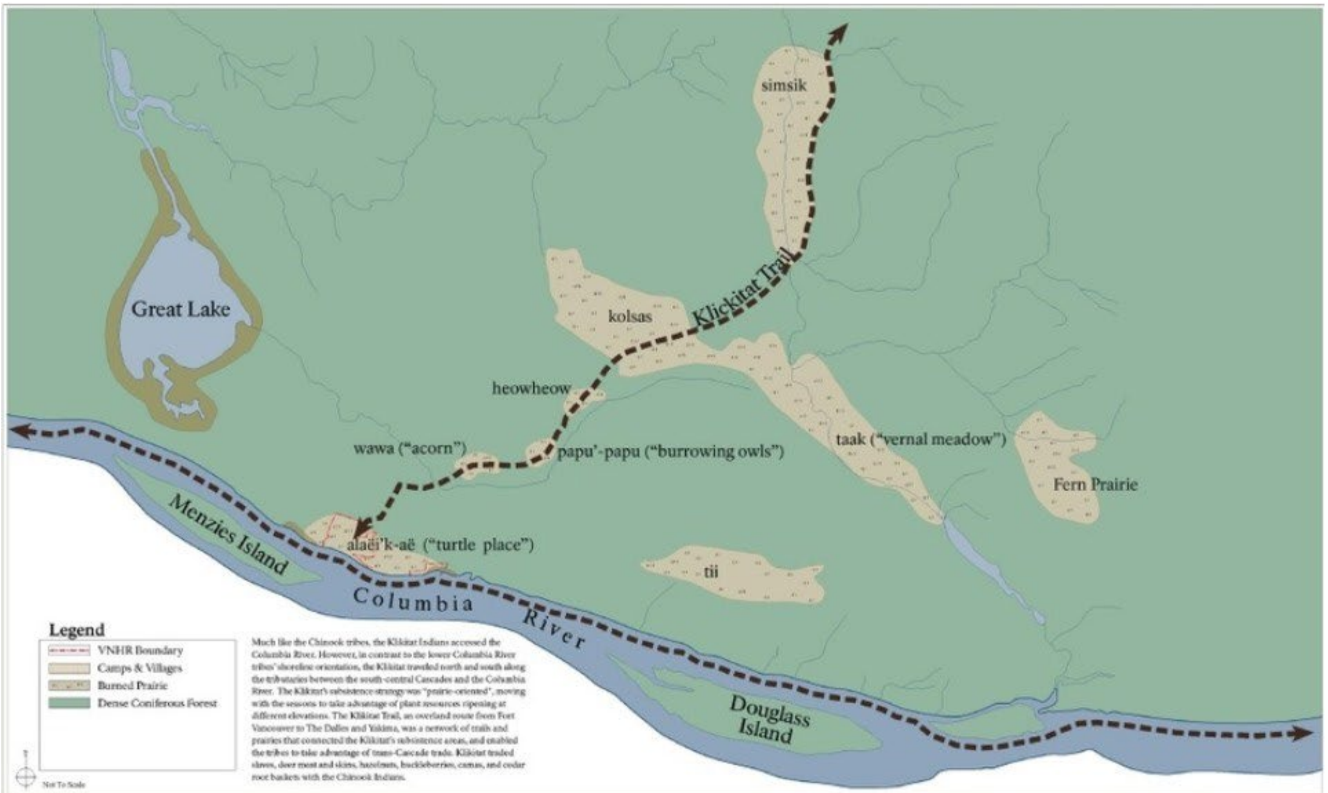

Figure 2. **The Area of the City of Vancouver, As It Appeared Prior to 1824.**
Image Credit – National Park Service (NPS 2018).

On average, the gradient of the stream is less than 1 percent (Tetra Tech 2015). Stream flow from late fall through spring is driven by precipitation, while summer flow is maintained by natural groundwater inflow coupled with industrial discharge from a manufacturing facility located east of Interstate 205 (I-205). The manufacturing facility extracts groundwater for cooling operations and contributes a significant amount of discharge water, which helps sustain summer base flow in the creek.

Peterson Channel and Burton Channel are two minor tributaries that flow into Burnt Bridge Creek east of Northeast 86th Avenue. Peterson Channel begins east of I-205 and conveys industrial discharge and urban stormwater runoff to Burnt Bridge Creek near the southern end of Royal Oaks Country Club. Burton Channel also initiates east of I-205 and joins Burnt Bridge Creek south of Burton Road, near the southern end of Meadowbrook Marsh. A third tributary, Cold Creek, flows west through unincorporated Clark County and joins Burnt Bridge Creek just west of Interstate 5 (I-5) approximately 2 miles upstream of Vancouver Lake (Figure 3).

1.3. Background Review

Monitoring in Burnt Bridge Creek has been ongoing for decades. The following sections summarize pertinent current and previous studies in the watershed related to water quality and biological health management.

1.3.1. Surface Water Quality

1.3.1.1. Long-Term Monitoring Program

In 2004, the City of Vancouver's Surface Water Management Program launched a long-term ambient monitoring program to collect credible water quality data and provide periodic data analysis reports. This work supports City and state programs and activities designed to improve water quality and protect the environment throughout the watershed. The program initially started with six sites in the central corridor (2004–2007) and expanded to 14 monitoring locations in 2011 following a state monitoring study in the watershed. Eleven key monitoring locations were selected for ongoing monitoring under base flow conditions in 2012 and 2013. Herrera conducted annual summer base flow monitoring of Burnt Bridge Creek and its tributaries as well as storm event monitoring during the winter 2012–2013 season. Monitoring conducted from 2014 to 2023 has targeted the same 11 monitoring locations, as shown in Figure 3. In addition to collecting water quality data during base flow events, monitoring under storm flow conditions resumed in 2020.

Data collected in 2011–2021 were summarized in separate annual monitoring reports (Herrera 2012a, 2013a, 2014a, 2015a, 2016a, 2017a, 2018a, 2019b, and 2022b). The 2013 and 2017 monitoring reports included evaluation of water quality trends for data collected from 2011–2013 (Herrera 2014a) and 2011–2017 (Herrera 2018a).

Methods outlined in this QAPP are intended to be consistent with previous methods for monitoring. Methods for previous monitoring have been described in QAPPs and subsequent QAPP addenda for the following monitoring periods:

- 2011–2013: 2011 QAPP and subsequent addenda (Herrera 2011, 2012b, 2013b)
- 2014–2018: 2014 QAPP and subsequent addenda (Herrera 2014b, 2015b, 2016b, 2017b, 2018b)
- 2019–2023: 2019 QAPP and subsequent addenda (Herrera 2019a, 2022a)

1.3.1.2. Total Maximum Daily Load

In 2008, the state initiated a multiple parameter Total Maximum Daily Load (TMDL) study and collected water quality data throughout the Burnt Bridge Creek watershed over a 2-year period. Monitoring stations for the original TMDL study, which were used in the Source Assessment Report, are shown on Figure 3. Ecology's Burnt Bridge Creek Partnership is currently in the final stages of an Advance Restoration Plan (ARP) based on the recommendations of the Burnt Bridge Creek Source Assessment Report (McCarthy 2020). The ARP is a near-term plan that includes a schedule of actions that will be taken to achieve water quality standards and is intended to benefit water quality more immediately than the TMDL Plan. It will focus on temperature, DO, pH, and fecal coliform bacteria. Other parameters of concern include human contributions of nutrients and contaminants entering water resources through runoff.

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Figure 3.
Burnt Bridge Creek TMDL Study Monitoring Stations.

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

1.3.2. Groundwater Influence

1.3.2.1. Vancouver Watershed Health Assessment

The results of the Vancouver watershed health assessment conducted by Herrera and Pacific Groundwater Group (PGG) are described in the *Integrated Scientific Assessment Report* (Herrera and PGG 2019). Key findings of the study include:

- While groundwater quality is generally very good within the watershed, it is vulnerable to contaminants introduced from the land surface as well as pollutants from septic systems and stormwater infiltration facilities. Pharmaceuticals have been detected in a number of groundwater sampling locations and elevated nitrate concentrations, particularly within the shallow groundwater system, indicate likely contamination from septic systems. The city relies solely on groundwater for its drinking water.
- The results of a GIS-based statistical analysis identified statistically significant correlations indicating that septic systems are increasing nitrogen and fecal bacteria concentrations, and that urban development likely is increasing phosphorus concentrations in Burnt Bridge Creek. The analysis also found statistically significant correlations between increasing riparian canopy cover and increasing DO and pH.

Recommendations of the study include:

- Build upon stormwater data to allow for future analysis of stormwater management on water quality during storm flow conditions.
- Expand the Sewer Connection Incentive Program to incentivize septic disconnects.
- Continue efforts to improve and retrofit wells subject to underground injection control requirements.

This Project will assist the City with its continued efforts to assess the effectiveness of existing programs and to implement adaptive management strategies to protect water resources.

1.3.3. Stormwater Management

The City developed a Stormwater Management Action Plan (SMAP) as a condition of their National Pollutant Discharge Elimination System permit. The Receiving Water Prioritization identified the middle Burnt Bridge Creek basin as the basin that would benefit most from stormwater management planning through the SMAP process. The middle basin contains the highest concentration of high traffic corridors, including Interstate 205 (I-205). In 2022, the City conducted an outfall impact assessment to prioritize outfalls and catchment areas for water quality improvement projects.

The SMAP identified the following most feasible best management practices (BMPs):

- Replacement of existing catch basins with treatment catch basins to provide basic treatment
- Retrofit of existing treatment facilities to provide enhanced treatment where possible
- Priority tree planting through City of Vancouver Urban Forestry
- Increased street sweeping in high traffic corridors and areas of high sediment loading
- Focused community outreach and education events

1.3.4. Urban Forestry

1.3.4.1. Greenway Restoration Improvements

In 2005, a 3-mile stretch in the central riparian corridor of Burnt Bridge Creek was transformed through the Burnt Bridge Creek Greenway Improvement Project (see Figure 1). The 11-million-dollar investment added water quality treatment through stormwater ponds and restored wetlands. The City's Greenway and Sensitive Lands program continues to increase riparian shade and expand natural habitat through the ongoing planting of hundreds of thousands of trees and shrubs. An 8-mile trail follows Burnt Bridge Creek's path as it winds through neighborhoods, forested riparian areas, open meadows and past wetlands, water quality treatment ponds, and enhanced upland and riparian habitats. Ongoing restoration throughout the watershed is being facilitated by a dedicated greenway/sensitive lands maintenance team. Stream ambient water quality monitoring, initiated in 2004 by the City, focused on the central greenway project and expanded over time to include other sites along the main stem and tributaries.

1.3.5. Biological Health

1.3.5.1. Biologic Condition Assessment

A biological condition assessment was conducted in 2015 at four stations along Burnt Bridge Creek (BBC10.4, BBC8.4, BBC7.0, and BBC1.6) previously assessed in 2001. The study evaluated substrate, pools, large woody debris, stream morphology, channel slope, erosion, riparian vegetation, stream shading, fish cover and benthic macroinvertebrates.

The habitat types in the study reaches varied dramatically, and the authors recommend assessing each site over time, rather than comparing them to each other. Low gradient surface water slopes were observed along the stream segments, with the reach between BBC10.4 and BBC7.0 having the lowest gradient slopes. The highest percentage of bank erosion was observed at BBC8.4. Vegetative cover for fish ranged from 10 percent (BBC1.6) to 60 percent (BBC7.0). Salmonid species were observed at BBC 1.6 during sampling, and other species of fish were observed at BBC7.0. Channel shading was high at all four of the sites, with mid channel shading ranging from 74 to 80 percent, and bank shading ranging from 80 to 96 percent. Benthic index of biotic integrity (B-IBI) scores ranged from very poor to poor. BBC7.0 had the highest B-IBI score but was dominated by the nonnative New Zealand mud snail (Tetra Tech 2015).

1.3.5.2. Lower Columbia Urban Streams Monitoring

The City of Vancouver, in collaboration with other southwest Washington agencies operating under state National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permits, contributes funds for a regional receiving water monitoring program. Clark County is performing this long-term study under an Interagency Agreement with Ecology and conducts annual stream health monitoring at small urban streams throughout the Lower Columbia River region. Data collected in this study supports the Status and Trends Monitoring for Watershed Health and Salmon Recovery component of the statewide Stormwater Action Monitoring program. Annual monitoring is conducted at 22 sites; 5 trend sites are visited each year; and 17 status sites are sampled at intervals on a 5-year rotation basis (3 to 4 per year). The final completed QAPP is available at: https://www.clark.wa.gov/public-works/stream-health-and-monitoring (Clark County 2020).

One location on Burnt Bridge Creek (BBC050) met the study selection criteria and has been included as a trend site for annual monitoring. This site is also a current and historical monitoring location in the City's long-term monitoring program (station BBC5.9). The regional stream monitoring program assesses land cover, flow metrics, total impervious area (TIA), daily traffic intensity, B-IBI, stream temperature, sediment, and habitat. In WY2021, TIA in the Burnt Bridge Creek watershed was 86 percent. Burnt Bridge Creek had the lowest B-IBI score of the eight streams monitored and qualified as "Very Poor." BBC5.9 also had the highest 7-day average daily maximum temperature (7-DADMax) at 80.1 degrees Fahrenheit. (Clark County 2023).

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2. MONITORING SUMMARY

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 (Herrera 2019b) and Addendum (Herrera 2022b).

2.1. Monitoring Stations

Water quality sampling and field measurements were conducted at 11 stations along Burnt Bridge Creek and its tributaries, as shown in Figure 4. Continuous temperature monitoring data was collected seasonally at 8 of the 11 stations. The same 11 monitoring stations have been monitored by Herrera since 2011. Monitoring station locations are as follows (listed below from upstream to downstream):

- **Station BBC10.4:** Burnt Bridge Creek at Northeast 110th Avenue near Northeast 51st Circle
- **Station BBC8.8:** Burnt Bridge Creek immediately upstream of the Peterson Channel confluence near Northeast 93rd Avenue
- **Station PET0.0:** Peterson Channel near the mouth at the northern end of Northeast 93rd Avenue
- **Station BBC8.4:** Burnt Bridge Creek south of Northeast Burton Road just west of Northeast 90th Avenue
- **Station BUR0.0:** Burton Channel 0.3 mile upstream of the mouth at Northeast 92nd Avenue and 19th Circle (no continuous temperature monitoring)
- **Station BBC7.0:** Burnt Bridge Creek at the southern end of Northeast 65th Avenue
- **Station BBC5.9:** Burnt Bridge Creek at East 18th Street east of Bryant Street
- **Station BBC5.2:** Burnt Bridge Creek at Algona Drive (no continuous temperature monitoring)
- **Station BBC2.6:** Burnt Bridge Creek in Leverich Park near lower parking lot
- **Station COL0.0:** Cold Creek near the mouth at Hazel Dell Road (no continuous temperature monitoring)
- **Station BBC1.6:** Burnt Bridge Creek at Alki Road and below the Cold Creek confluence

Monitoring station subbasin attributes including land cover, septic system density and information about stormwater treatment facilities are provided in the *Integrated Scientific Assessment Report* (Herrera and PGG 2019). All the subbasin statistics are cumulative (including total upstream area). The subbasins consist of primarily residential land use (at least 80 percent), approximately half of impervious surface cover, and 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. Septic systems are present in all subbasins with the greatest septic system densities in the BUR0.0, BBC10.4 and BBC8.4 subbasins.

2.2. Parameters of Concern

Parameters monitored in WY2022 and WY2023 are described in detail below and include *in situ* measurements, conventionals, nutrients, metals, and bacteria.

2.2.1. Temperature

Water temperature is critical to the health and survival of fish and other aquatic species in many life stages including embryonic development, juvenile growth, and adult migration. The composition, metabolism, and reproductive effectiveness of cold-blooded aquatic species are also regulated by the water temperature. An increase in water temperature accelerates the biodegradation of organic matter and increases the DO demand as well as decreasing the solubility of oxygen. The state water quality standards for temperature are based on a 7-day average daily maximum (7-DADMax). The maximum allowable 7-DADMax is 17.5 degrees Celsius (°C) in waters designated for salmon and trout spawning, noncore rearing, and migration. In Burnt Bridge Creek, temperature is category 5 listed (requiring an improvement project) due to state criteria exceedances, according to Washington State's 303(d) list of impaired waters.

2.2.2. pH

pH is a measure of the hydrogen ion activity in water, which can have a direct effect on aquatic organisms or an indirect effect since the toxicity of various common pollutants are markedly affected by changes in pH. Waters that have pH levels ranging from 0 to 7 are considered acidic, while waters with pH levels ranging from 7 to 14 are considered alkaline. Waters that have a pH of approximately 7 are considered neutral. Washington State surface water quality standards for noncore salmonid rearing require pH to be within the range of 6.5 to 8.5 (WAC 173-201A). Some wetlands such as peat bogs are naturally acidic with a pH between 5 and 6.

2.2.3. Dissolved Oxygen

DO is another important water quality parameter for salmonids and other aquatic organisms. Low DO levels can be harmful to larval life stages and respiration of juveniles and adults, directly affecting the survival of aquatic organisms. Depletion of oxygen in water bodies can also lead to a shift in the composition of the aquatic community. Washington State surface water quality standards require that DO concentrations exceed 10 mg/L in fresh waters designated for noncore salmonid rearing (WAC 173-201A). DO naturally decreases as waters warm because DO decreases with increasing temperature. Higher nutrient concentrations are often found in warmer waters, so low DO is also associated with high nutrient concentrations.

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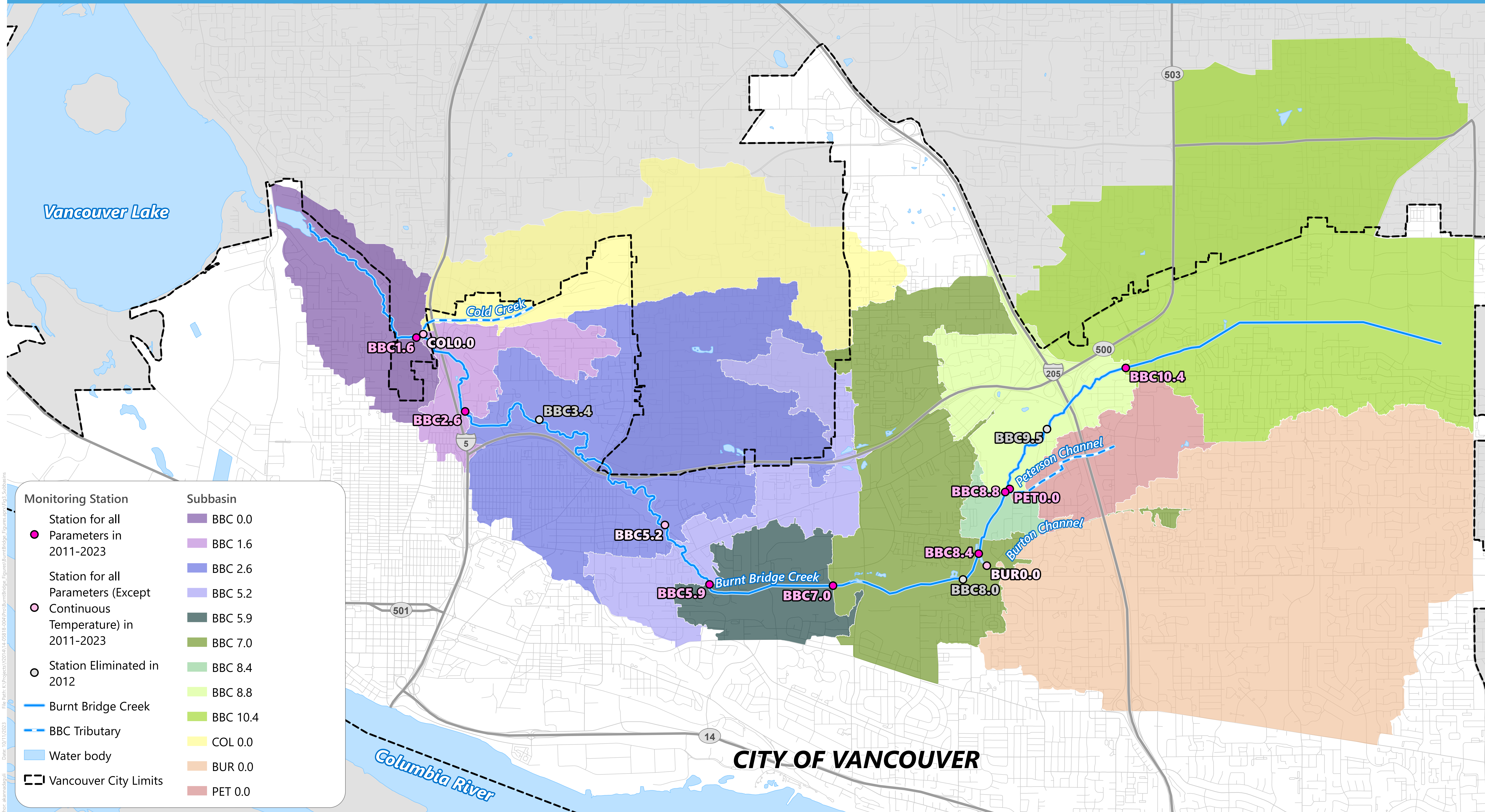
Figure 4.
Burnt Bridge Creek Monitoring Stations and Subbasins.



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

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2.2.4. Conductivity

Conductivity is a measure of the ability of water to conduct an electrical current, which is directly related to the content of dissolved ions in the water. Conductivity varies with temperature and is typically measured as specific conductance, which is normalized to a temperature of 25 °C. Although there is no state surface water quality standard established for conductivity, this measurement is useful for identifying sources of dissolved solids (primarily salts) and for determining the relative flow contributions attributed to groundwater, since conductivity is typically higher in groundwater than in surface water.

2.2.5. Turbidity

Turbidity is a measure of water clarity that is determined by how the transmission of light is scattered as it passes through water. An increase in the amount of particulate matter in water reduces clarity (or transparency) by increasing the scattering of light. Measurements of turbidity are expressed in nephelometric turbidity units (NTU). Washington State surface water quality standards restrict turbidity increases to a maximum of 5 NTU more than background when background turbidity is 50 NTU or less, and to no more than a 10 percent increase in turbidity when the background turbidity is greater than 50 NTU (WAC 173-201A). Typically, background turbidity is measured at an upstream location and turbidity criteria are applied to downstream location.

2.2.6. Total Suspended Solids

Total suspended solids (TSS) are the most widespread pollutants entering surface waters. Solids, especially the finer fractions, reduce light penetration in water and can have a smothering effect on fish spawning and benthic biota. Suspended solids are also closely associated with other pollutants such as nutrients, bacteria, metals, and organic compounds. These pollutants tend to adsorb to the solids particles and are transported in surface runoff to receiving waters if onsite controls are not implemented for solids removal. Thus, the presence of suspended solids is used to evaluate the overall pollutant loading within a basin. No state surface water quality standards have been established for total suspended solids.

2.2.7. Nitrate+Nitrite Nitrogen

Washington State does not have a surface water quality standard for nitrate+nitrite nitrogen; however, it is a regulated parameter in state groundwater and drinking water standards (WAC 173-200-040 and WAC 246-290-310, respectively) for the protection of human health. To prevent a potentially fatal blood disorder in infants called "blue baby syndrome" as well as other human health problems, both standards specify that nitrate+nitrite nitrogen concentrations shall not exceed 10 mg/L. Nitrate+nitrite nitrogen is also a concern in freshwaters because it may contribute to an overabundant growth of algae and aquatic plants and to a decline in diversity of the biological community. EPA (2001) recommended a nutrient criterion of 0.15 mg/L for nitrate nitrogen in rivers and streams in the Willamette Valley ecoregion. This criterion was used for comparison to sampling results.

2.2.8. Total Nitrogen

Currently, Washington State has not established surface water quality criteria for total nitrogen. However, the EPA (2001) has established a nutrient criterion of 0.31 mg/L for total nitrogen in streams located in the Willamette Valley Ecoregion. This criterion was used for comparison to these sampling results. Nitrogen can come from natural or anthropogenic sources including atmospheric deposition, wastewater treatment plants or septic system failures, animal manure storage, and fertilizer runoff. Total nitrogen concentrations for each sample were calculated by the analytical laboratory using results from nitrate+nitrite and total Kjeldahl nitrogen analyses.

2.2.9. Soluble Reactive Phosphorus

Soluble reactive phosphorus, also known as orthophosphate, is the dissolved inorganic fraction of phosphorus that is produced by natural processes and from sources similar to those for total phosphorus such as septic system failure, animal waste, decaying vegetation and animals, resuspension from the bottom of a lake, and fertilizer runoff. It is a very unstable form of phosphate that is directly absorbed by aquatic vegetation and microbes such as algae. Neither Washington State nor the EPA have established surface water quality criteria for soluble reactive phosphorus.

2.2.10. Total Phosphorus

Total phosphorus is a combination of inorganic and organic forms of phosphorus, which can come from natural sources or anthropogenic sources (e.g., wastewater treatment plants, septic system failures, animal manure storage, and fertilizer runoff). Phosphorus is a concern in fresh water because high levels can lead to accelerated plant growth, algal blooms, low DO, decreases in aquatic diversity, and eutrophication. Currently, Washington State does not have surface water quality standards for total phosphorus in rivers and streams. The EPA recommended a nutrient criterion of 0.040 mg/L for total phosphorus in streams located in the Willamette Valley ecoregion (EPA 2001).

2.2.11. Dissolved Organic Carbon

Dissolved organic carbon (DOC) is a measure of the amount of dissolved organic matter in water. Surface water sources of DOC include precipitation, leaching, and organic decomposition. DOC is a key driver in stream metabolism and can reduce acute toxicity of many contaminants to aquatic organisms through removal of free metal ions by ligand complexation, or sorption of chemicals to DOC. DOC can vary greatly among water body type and region; in Washington state, DOC in surface water samples vary from approximately 0.2 to 81 mg/L, with a mean of 2.1 mg/L according to Ecology's EIM database.

2.2.12. Hardness as CaCO3

Hardness is a measurement of the dissolved mineral content (primarily calcium and magnesium) of water. Hard water contains a high mineral content and soft water contains a low mineral content. High hardness values can increase or decrease the toxicity of metals in runoff, depending on the aquatic species that is exposed. Hardness values are therefore used to calculate dissolved metals toxicity criteria. Natural sources of hardness include limestone (which introduces calcium into groundwater) and dolomite (which introduces magnesium). No state surface water quality standards have been established for hardness.

2.2.13. Chloride

Chloride is a measurement of dissolved chloride in association with sodium, potassium, calcium, and magnesium as salts. Chlorides are present in a variety of products, such as water and wastewater treatment products (i.e., chlorine, iron chloride), roadway deicing salts (e.g., sodium chloride, magnesium chloride), and fertilizers (e.g., potassium chloride). Thus, anthropogenic sources of chloride may include road deicer, landfill leachate, septic tank or industrial effluent, and irrigation drainage. Chlorides may also occur naturally in surface and groundwater, originating from natural sources like seawater intrusion in coastal areas and weathering of various rocks.

Chloride can increase the corrosivity of water, so as it reacts with the metal ions in pipes, this can increase the concentration of metals in drinking water or waterways. Measuring chloride in freshwater systems is thus an important indicator of impairment and is often used to specifically evaluate potential inputs from septic systems. According to the World Health Organization (WHO) (2003), chloride levels in unpolluted waterways are often below 10 mg/L, and sometimes below 1 mg/L. There are no Washington State human health criteria for chloride. Healthy individuals can tolerate large quantities of chloride as long as it is accompanied by an intake of fresh water (WHO 2003). However, Washington State does maintain a criterion for aquatic life uses, which restricts chloride concentrations to less than 860 mg/L for acute exposure and 230 mg/L for chronic exposure (WAC 173-201A-240).

2.2.14. Total and Dissolved Metals

Copper and zinc are two of the most common heavy metals observed in urban streams. The total fractions of these heavy metals were included in both the storm and base flow monitoring program to evaluate acute and chronic aquatic toxicity within the project area. Potential sources of these heavy metals within the Burnt Bridge Creek watershed include vehicle components, petroleum-based fuels and oil, electronics waste, metal roofs, and eroding soils. Washington State surface water quality standards (WAC 173-201A) for these two heavy metals are based on the dissolved fraction and vary directly with hardness concentrations such that toxicity decreases with increasing hardness.

2.2.15. Fecal Coliform Bacteria

Urban and agricultural runoff characteristically contains elevated levels of fecal coliform bacteria. These organisms are used as indicators of fecal contamination from humans and other warm-blooded animals. Human sources include failing septic systems, waste from unhoused encampments, leaking wastewater conveyance systems or side sewers, and cross-connections with municipal wastewater systems. Animal sources include pets, livestock, and wildlife (e.g., birds and mammals). Fecal coliform bacteria are also present in the natural environment from decaying vegetation and other organic matter. The simple presence of these bacteria does not necessarily indicate a threat to public health because only a small portion is likely to be pathogenic to humans. However, their use as an indicator is considered important in the early detection of problems that could lead to public health concerns. Washington State surface water quality standards (WAC 173-201A) for fecal coliform bacteria are presented in Table 3 in Section 2.5.4, Comparison to Water Quality Criteria.

2.2.16. E. coli Bacteria

In July 2018, Ecology proposed a transition from fecal coliform to the use of *E. coli* criteria for freshwater bodies due to the more robust correlation of gastrointestinal illness with these bacteria parameters and in conformance with EPA recommendations (Finch 2018). In January 2019, Ecology adopted the *E. coli* water quality standard (WAC 173-201A).

2.3. Data Collection Methods

Data collection methods followed the protocols outlined in the QAPP (Herrera 2019a) and are summarized in the following sections. Table 1 presents the dates and details of each sampling event.

Table 1. WY2022–WY2023 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)	Total Storm Depth (inches)[c]
1	11/11/2021	Storm	Wet	BBC7.0	1	0.51	2.89
2	11/17/2021	Base flow	Wet	BBC1.6	1.9	0	0.01
3	1/5/2022	Storm	Wet	BBC10.4	0.5	0.11	1.77
4	2/9/2022	Base flow	Wet	PET0.0	6.3	0	0
5	3/2/2022	Storm	Wet	PET0.0	0.7	0.37	0.96
6	3/21/2022	Storm	Wet	BBC8.4	1.4	0.39	0.7
7	4/4/2022	Storm	Wet	BBC8.8	1.9	0.65	0.71
8	5/11/2022	Base flow	Wet	BUR0.0	1.8	0	0
9	6/15/2022	Base flow	Dry	BBC5.9	1.3	0	0
10	7/19/2022	Base flow	Dry	COL0.0	13.2	0	0
11	8/23/2022	Base flow	Dry	BBC2.6	48.6	0	0
12	9/21/2022	Base flow	Dry	BBC5.2	9.2	0	0
13	11/1/2022	Storm	Wet	BBC5.9	1.1	0.75	0.82
14	12/14/2022	Base flow	Wet	PET0.0	3.9	0	0
15	1/25/2023	Base flow	Wet	BBC10.4	3.9	0	0
16	2/7/2023	Storm	Wet	COL0.0	2	0.1	0.14[d]
17	3/13/2023	Storm	Wet	BBC2.6	1.9	1.1	1.65
18	3/23/2023	Storm	Wet	BBC8.4/BBC5.9[e]	2.5	0.07	0.12[f]
19	4/6/2023	Storm	Wet	BBC5.2	1.4	0.75	0.86
20	4/26/2023	Base flow	Wet	BUR0.0	3	0	0

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)	Total Storm Depth (inches)[c]
21	6/28/2023	Base flow	Dry	BBC7.0	8.8	0	0
22	7/26/2023	Base flow	Dry	BBC8.8	36.8	0	0
23	9/6/2023	Base flow	Dry	BBC1.6	5.7	0	0
24	10/4/2023	Base flow	Dry	BBC1.6	1.7	0	0

Table 1 (continued). WY2022–WY2023 Sampling Events for the Burnt Bridge Creek Water Quality Monitoring Project.

[a] Dry and wet weather season are defined as June through September and October through May, respectively, with the exception that the October 4, 2023, event is considered a dry season event.

[b] Antecedent dry period was defined as the number of days with less than 0.04 inch of rain in a 6-hour period that preceded the event date (Portland BES 2023).

[c] Storm depth was determined as the total precipitation amount measured over the course of the targeted storm event (as defined by storm criteria) or base flow event (as determined by base flow sampling criteria) (Portland BES 2023).

[d] A storm event was targeted for February 7, 2023, but the event resulted in less rainfall than was predicted. A total of 0.14 inch was observed on the sampling day.

[e] On March 23, 2023, duplicate samples were collected at BBC8.4, and duplicate *in situ* water quality measurements were taken at BBC5.9.

[f] A storm event was targeted for March 23, 2023, but the event resulted in less rainfall than was predicted. A total of 0.12 inch was observed on the sampling day.

2.3.1. Continuous Temperature Logging Data

One HOBO Pro v2 water temperature data logger was installed at each of eight monitoring stations. Additional probes were installed at stations BBC8.8, PET0.0, BBC8.4, BBC2.6, and BBC1.6 for backup because of vandalism and other issues making it difficult to locate the probes in previous years. For WY2022, the temperature probes were deployed from May 4 to November 28, 2022. For WY2023, the loggers were deployed from May 26 to October 31, 2023.

The data loggers were installed and operated according to the Washington State Department of Ecology's protocols for continuous temperature sampling as described in the QAPP (Herrera 2019a). Temperature loggers were installed inside a shade device consisting of a perforated PVC pipe that was attached to rebar set in the stream bed. Due to concerns of vandalism, the PVC pipe was painted brown to camouflage the loggers. Temperature loggers were placed in well-mixed locations that were shaded from direct sunlight (wherever possible) to minimize influence from direct solar radiation. All temperature loggers were programmed to record temperature at an interval of 15 minutes.

Continuous temperature data were downloaded from all temperature data loggers during each base flow monitoring event using the Onset HOBOware® software. Missing and qualified continuous temperature data are identified in the Data Quality Review in Appendix A. Temperature probe calibration check results are presented in Appendix B and the complete record of logged continuous temperature for each monitored station is available in Appendix C.

2.3.2. Field Water Quality Data

In situ water quality measurements were made at each of the 11 monitoring stations by submerging the probe of a calibrated water quality multimeter into the water column. Herrera's YSI Pro DSS multimeter was used for all events, except August 23, 2022, when a rented Aquaread AP-2000-D was used. To ensure accuracy and minimize variability across different multimeters standardized field calibration procedures, including post-event calibration checks, were followed (Herrera 2019a)

Upon arrival at a monitoring station, the probe was submerged in the stream where the current was estimated to be at least 1 foot per second in order to avoid false low readings and was left to stabilize for several minutes. The probe was placed upstream of all instream activity. When the meter's readings were stabilized, measurements were recorded for each water quality parameter on standardized field forms. Field duplicate measurements were collected once during each sampling event by re-submerging the multi-probe meter in the stream during the sampling event.

2.3.3. Grab Sample Collection

Water samples were collected by hand from each of the 11 monitoring stations using precleaned bottles supplied by the laboratories (ALS Environmental, and LabCor, Inc.). Samples were collected from the center of the stream by wading into the channel and using an aseptic technique. Water samples were collected after the *in situ* measurements were recorded in order to ensure that both the *in situ* measurements and water sampling would occur upstream of all channel disturbance from monitoring activities. One field duplicate sample was collected from a different station during each sampling event by consecutively filling each pair of sample bottles and labeling the field duplicate sample bottles with a blind sample identification number. The collected water samples were immediately stored in a cooler with ice at a temperature less than 6 degrees Celsius (°C). Bacteria samples were shipped overnight to LabCor, Inc. via Federal Express. All other samples were picked up by the ALS laboratory courier the morning after the sampling event. Chain-of-custody forms were completed and included with each batch of samples sent to the laboratory.

2.4. Laboratory Analysis Methods

Table 2 presents the required analytical methods and the total number of samples analyzed in WY2022–WY2023. These methods are consistent with the methods used during the WY2011–WY2021 monitoring with the exception of the addition of *E. coli* analysis in 2018. LabCor, Inc. (Seattle, Washington) analyzed all *E. coli* and fecal coliform samples. ALS Environmental (Kelso, Washington) analyzed samples for the additional laboratory parameters.

Table 2. Methods and Number of Samples for Water Quality Analyses in WY2022–WY2023.				
Parameter	**Events**	**Analytical Method**	**Method Number[a]**	**Number of Samples[b]**
Turbidity	All	Nephelometric	EPA 180.1	288
Total suspended solids	All	Weighed filter	SM 18 2540D	288
Total phosphorus	All	Persulfate digestion, ascorbic acid	EPA 365.3	288
Orthophosphate phosphorus	All	Ascorbic acid	EPA 365.3	288
Total Nitrogen	All	Kjeldahl digestion, ammonia-selective electrode with known addition, adding to nitrate nitrite	EPA 351.4; SM 4500-NH3 G LL	288
Nitrate+nitrite nitrogen	All	Automated cadmium reduction	EPA 353.2,	288
Hardness as CaCO3	All	Titrimetric	SM 2340C	288
Chloride	All	Ion chromatography	EPA 300.0	288
Dissolved Organic Carbon	All	Persulfate UV or Heated-Persulfate Oxidation	SM 5310C	288
Metals, total and dissolved	All	Inductively Coupled Plasma-Mass Spectrometry	EPA 200.8	288
E. coli bacteria	All	Membrane filtration	SM 9222 – G1c1	286
Fecal coliform bacteria	All	Membrane filtration	SM 9222-D	286

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

[b] Number of samples based on 24 samples for each of the 11 locations plus 24 field duplicates for quality control. Bacteria samples were collected but not analyzed on 4/6/2023 at one location (BUR0.0) because they were lost by the laboratory. Bacteria samples were collected but not analyzed on 7/26/2023 at one location (COL0.0) due to sample container breakage.

Sample preservation, maximum holding times, and analytical methods met federal requirements for the Clean Water Act (Federal Register 40 CFR Part 136; EPA 2011) and recommendations by Standard Methods (APHA et al. 1998) with the following exceptions specified in the QAPP:

- *E. coli* and fecal coliform bacteria samples were analyzed within 30 hours of sample collection. EPA guidance allows for up to 30-hour holding times for drinking water samples, 8 hours for source water compliance samples, and up to 48 hours on a case-by-case basis where 30 hours is not feasible (EPA 2008). A review of nine studies on holding time exceedances for *E. coli* samples found that most samples can be analyzed up to 48 hours after collection if they are stored below 10°C (Thapa et al. 2020).
- Soluble reactive (orthophosphate) phosphorus, dissolved organic carbon, and dissolved metals samples were filtered at the laboratory within 30 hours of sample collection. Field filtration within 15 minutes is recommended primarily for groundwater and wastewater samples with a low DO concentration to prevent oxidation and precipitation of orthophosphate and dissolved metals. However, the collected surface water samples were not expected to be in a reduced (low oxygen) state or contain high biochemical oxygen demand. Field filtration increases the potential for sample contamination.

2.5. Data Analysis Methods

This section includes a subsection for each of the following procedures: data management, computation of summary statistics, and comparison of results to the applicable water quality criteria. These analyses were performed on recent data collected in WY2022 and WY2023. In addition, the recent data were compared to WY2011–WY2021 monitoring results. The results from these analyses are summarized in Section 4, Results.

2.5.1. Data Management

Field measurements were entered into a Microsoft Excel spreadsheet along with the laboratory analytical results. Data flags representing estimated values or rejected values were also entered in the spreadsheet database based on results of the data quality review. Database input was checked after entry to ensure that any transcription errors were corrected. Continuous temperature data were transferred from the manufacturer's software system (HOBOware) to a Microsoft Excel spreadsheet. The data were visually reviewed and erroneous spikes and drops while the probe was out of water were removed.

2.5.2. Computation of Summary Statistics

In order to assess water quality conditions at each of the sample locations, R software packages were used to calculate the following summary statistics from the compiled data:

- Minimum
- Mean
- Geometric mean and 90th percentile (*E. coli* and fecal coliform only)
- Median
- 25th percentile
- 75th percentile
- Maximum

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. Summary statistics are presented in Appendix D.

In addition to the tabular data summaries, graphical data summaries consisting of "line" plots and "box and whisker" plots were generated. The line plots were generated to present the seasonal pattern of recent base flow data collected at each station and include:

- Water year 2022 wet and dry season base flow
- Water year 2023 wet and dry season base flow

The box and whisker plots were generated to 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 fecal coliform bacteria and *E. coli*, the 90th percentile of the data is also shown on the plot as a black triangle and the geometric mean is presented rather than the arithmetic mean for comparison to water quality criteria. The following box and whisker plots are plotted:

- Recent (WY2022–WY2023) and historical (WY2011–WY2021; WY2020–WY2021 for metals) base flow data are plotted together for comparison on one set of box and whisker plots.
- Recent (WY2022–WY2023) and historical (WY2020–WY2021) storm flow data are plotted together for comparison on one set of box and whisker plots.
- Recent (WY2022–WY2023) storm flow and base flow data are plotted together for comparison on one set of box and whisker plots.

Line plots and box and whisker plots are presented in Appendix E.

2.5.3. Seasonal and Spatial Patterns

No statistical tests were performed to identify significant seasonal or spatial trends in water quality data collected during this monitoring period. Future reports, including the WY2024 monitoring report, will include more comprehensive trend analyses. The box and whisker plots and line plots described above were reviewed to identify obvious visual trends in the data. Spatial patterns were typically identified by comparing median (or geometric mean for bacteria) concentrations and comparing interquartile ranges on box plots.

2.5.4. Comparison to Water Quality Criteria

In order to identify water quality impairment at the Burnt Bridge Creek sampling stations, monitoring data were compared to regulatory criteria from the following sources:

- Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A, updated March 2022)
- 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 water body (WAC 173-201A-602).

Water quality criteria associated with designated uses for Burnt Bridge Creek are summarized in Table 3. Burnt Bridge Creek is designated for salmonid spawning, rearing, and migration with associated aquatic life criteria for temperature, DO, pH, turbidity, and dissolved metals. Burnt Bridge Creek is also designated for primary contact recreation with specific recreational use criteria for *E. coli* and fecal coliform 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 fecal coliform and *E. coli* water quality criteria are based on a 90-day averaging period with at least three measurements per period. Frequency of sampling events, particularly during the dry season, during the WY2022 and WY2023 monitoring periods did not meet the required sampling frequency used to evaluate compliance with state water quality criteria. The geometric mean and 90th percentile were calculated for each site using the combined dataset across both water years, and are intended to provide a general overview of site conditions compared to water quality criteria. Exceedance of the geometric mean or 90th percentile criteria does not necessarily mean that the monitoring station was in exceedance for the entire monitoring period.

Table 3. 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.
Chloride	860 mg/L acute; 230 mg/L chronic
Copper, dissolved[c]	Acute: 12.81 μg/L (base), 12.18 μg/L (storm) Chronic: 8.78 μg/L (base), 8.38 μg/L (storm)
Zinc, dissolved[c]	Acute: 88.68 μg/L (base), 84.70 μg/L (storm) Chronic: 80.97 μg/L (base), 77.34 μg/L (storm)
Nutrient Criteria 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
Recreational Use Criteria for Primary Contact Recreation[a]	
Fecal coliform bacteria	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 200 colonies/100 mL. Use of fecal coliform to determine compliance expired on December 31, 2020.
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).

[c] Criteria for dissolved metals are based on average hardness of 74.0 and 70.1 mg/L for base flow and storm events, respectively. The average was calculated from combined data for WY2022 and WY2023. Criteria were calculated for each event based on actual event hardness.

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3. DATA QUALITY REVIEW

A quality assurance review was performed for all field and laboratory data collected in WY2022–WY2023, as specified in the QAPP (Herrera 2019a). The quality assurance review findings were presented in an interim update report for each sampling event and are compiled in Appendix A. 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 specified in the QAPP. However, as summarized below, some quality control issues were identified in the data. Results that did not meet QA criteria specified in the QAPP were qualified as estimates or rejected. Conductivity data were rejected for one base flow event. SRP data were rejected for 10 events.

Data quality review findings are summarized below for field and laboratory data collected in WY2022–WY2023.

3.1. Field Data

The water quality meter was calibrated and then checked before and after each event as documented in the calibration logs provided as an attachment to the Interim Reports. The accuracy of the continuous temperature loggers was checked prior to their installation and upon their removal using a thermometer certified by National Institute of Standards and Technology (see Appendix B). In general, *in situ* measurements and continuous temperature logging met all data measurement quality objectives, with one exception on August 23, 2022, where conductivity results were rejected due to a water quality meter calibration issue as described in Appendix A.

Continuous temperature logging met all data measurement quality objectives, with the exceptions of the following corrections:

- Erroneous logged temperature spikes and drops from probes being out of the water during data download were removed. The temperature probes include timestamps and log entries each time the probe is connected to or disconnected from a compatible download shuttle. Deletion of out of water temperature spikes was limited to the two entries immediately before and after the probe logged connection with the download shuttle.
- The main probe at BBC2.6 was partially out of the water from August 14, 2023, until September 6, 2023, while the backup probe remained submerged. Data from the backup probe was used for this time period.

3.2. Laboratory Data

As noted in Section 2.3, Data Collection Methods, all scheduled samples were collected, and the laboratory reported all parameters with few exceptions. All laboratory methods were consistent with those specified in the QAPP (Herrera 2019a). Method- and QAPP-specified analytical and filtration holding times were generally met with a few exceptions. No method blanks analyzed contained levels of target parameters above the reporting limit, and all laboratory control standard samples met the established control limits. Laboratory matrix spike samples met control limits with two exceptions. All laboratory duplicate samples met the established control limits except for one total phosphorus result and numerous bacteria results, which were flagged as estimated (J). Field duplicate samples generally met the established control limits except for 6 results for parameters including hardness, total suspended solids, and turbidity, and 16 results for bacteria. The dissolved fraction of target parameters was generally less than the total fraction, with some exceptions in which SRP was at least 20 percent greater than total phosphorus. The laboratory proactively conducted an internal review of their procedures to address this issue, but SRP results from February 9 through November 1, 2022, were flagged as rejected (R) due to consistently high concentrations relative to historical ranges and associated total phosphorus concentrations.

Exceptions to QAPP specified data quality criteria and resulting data qualifiers, if applicable, are detailed in the individual Interim Reports and are presented in Appendix A.

3.3. Data Quality Summary

In general, data quality criteria were met with relatively few exceptions, as detailed in the individual Interim Reports and in Appendix A.

The percentage of estimated (J flag) and rejected (R flag) values are summarized in Table 4 by parameter, excluding field duplicate samples. In addition to the reasons discussed in the above subsections, some results were flagged as estimated due to detections below the reporting limit, or due to fecal coliform bacteria and *E. coli* plate counts outside the ideal range of 20 to 60 colonies.

Table 4. Percentage of Data Qualified as Estimated (J) and Rejected (R) Values.

Parameter	Water Year 2022[a]				Water Year 2023[a]			
	Base Flow		Storm Flow		Base Flow		Storm Flow	
	J	R	J	R	J	R	J	R
Temperature	0	0	0	0	0	0	0	0
Dissolved Oxygen	0	0	0	0	0	0	0	0
pH	0	0	0	0	0	0	0	0
Conductivity	0	14	0	0	0	0	0	0
Turbidity	1	0	4	0	0	0	0	0
Total Suspended Solids	0	0	0	0	0	0	2	0
Hardness as CaCO3	1	0	2	0	0	0	0	0
Chloride	10	0	2	0	0	0	0	0
Dissolved Organic Carbon	4	0	0	0	3	0	0	0
Total Phosphorus	18	0	0	0	1	0	0	0
Soluble Reactive Phosphorus	0	86	0	60	6	0	13	20
Total Nitrogen	8	0	0	0	14	0	11	0
Nitrate +Nitrite Nitrogen	0	0	0	0	0	0	0	0
Total Copper	0	0	0	0	0	0	0	0
Dissolved Copper	0	0	0	0	0	0	20	0
Total Zinc	1	0	0	0	0	0	0	0
Dissolved Zinc	5	0	0	0	4	0	20	0
Fecal Coliform	65	0	60	0	69	0	85	0
E. coli	65	0	73	0	60	0	81	0

[a] Percentages do not include duplicate samples.

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4. RESULTS

Key results are summarized below, followed by a detailed discussion by monitoring station. Complete tables of summary statistics are available in Appendix D. Summary figures available in Appendix E include:

- Line plots of WY2022 and WY2023 base flow data.
- Box and whisker plots of recent (WY2022–WY2023) and historical (WY2011–WY2021; WY2020–WY2021 for metals) base flow data.
- Box and whisker plots of recent (WY2022–WY2023) and historical (WY2020–WY2021) storm flow data.
- Box and whisker plots of recent (WY2022–WY2023) 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.

4.1. Summary of Results

4.1.1. Seasonal Patterns

The concentrations of many water quality parameters measured in Burnt Bridge Creek varied seasonally over the WY2022 to WY2023 monitoring period. Key conclusions related to seasonal patterns include:

- Consistent Seasonal Concentrations: Base flow chloride concentrations were relatively consistent across both WYs except for a single event peak for most main stem stations on May 11, 2022, and a subsequent low point on June 15, 2022. Sources of chloride may include road deicers, which may cause peaks during winter weather events, or human septic influence, which may cause higher concentrations during periods of lower stream flow. Reported chloride concentrations during this event on May 11, 2022, are flagged as estimates due to a laboratory dilution calculation error.
- Summer Trends: Summer and, more broadly, dry season base flow events were typically sampled during periods of warmer weather and visibly lower stream stage. A higher proportion of flow during these conditions is associated with groundwater, which is reflected in several seasonal patterns detailed below.
    - Instantaneous water temperature was highest during summer base flow events and DO was generally lowest during summer and fall base flow events. These trends are related because oxygen solubility decreases with increased temperature, whereas DO may be further depressed by microbial decay of algae and other organic matter in the stream during this time of year.
    - pH and hardness were generally higher while DOC concentrations were lower during summer base flow events (though more pronounced in WY2022 than WY2023). Higher hardness is

generally associated with higher dissolved calcium and magnesium in groundwater. Additionally, carbon dioxide uptake by algae increases pH in the summer and lower rainfall decreases DOC export from watersheds in the summer.

  - *E. coli* bacteria concentrations were highest during summer base flow events, which indicates a potential chronic source of fecal bacteria including livestock access, wildlife influence, or leaking sewer pipes or septic systems. Trends in other human sewage indicators including nutrients and chloride were not clearly visible.

- **Winter Trends:** Winter wet season base flow events were typically sampled during the colder and rainier parts of the year and during periods of relatively higher stream stage from higher inputs of shallow groundwater.
  - Lower temperatures in winter base flow events likely drove the higher DO concentrations. Increased rainfall and groundwater seepage flushed DOC into the stream, and fecal bacteria concentrations may have decreased from groundwater dilution and less animal activity in the stream.
  - Total and dissolved zinc concentrations were generally higher during winter base flow events. Zinc is a common urban stormwater contaminant and is likely carried to the stream during wet season storm events.
- **Limited Seasonal Variation:** Total suspended solids and turbidity were relatively variable from event to event and did not have any consistent seasonal patterns across the monitoring stations. Small groups of stations such as downstream stations BBC2.6 and BBC1.6 displayed somewhat consistent patterns with the highest TSS and turbidity values in the spring or early summer.

4.1.2. Spatial Patterns

The concentrations of many water quality parameters measured in Burnt Bridge Creek varied spatially over this 2022–2023 monitoring period. In addition to general changes in concentrations from upstream to downstream, water quality at multiple stations appeared to be directly affected by concentrations from nearby tributaries. Key conclusions related to spatial patterns include:

- **pH:** During both base and storm flow events, median pH values were lowest at the most upstream station (BBC10.4), increased at BBC8.8 and remained stable across midstream stations until increasing again at BBC2.6.
- **Turbidity:** Median base flow turbidity at all tributary stations were lower than all main stem stations. Median storm flow turbidity at COL0.0 exceeded all other stations by over two-fold and may have contributed to the increases in turbidity observed between BBC2.6 and BBC1.6. BBC1.6 had the greatest storm flow median of all main stem stations (12 NTU versus 6.4 to 10 NTU for other main stem stations).
- **Dissolved Organic Carbon:** Median DOC concentrations were lowest at the three tributary stations during both storm and base flow events. During base flow events, low DOC concentrations at PET0.0 may have contributed to the low median DOC concentration at BBC8.4 relative to other nearby main stem stations.

- **Phosphorus.** Median base flow total phosphorus generally increased from lows at BBC10.4 and BBC8.8 to highs from BBC7.0 through BBC1.6. Median storm flow total phosphorus concentrations were relatively stable within main stem stations. Median storm and base flow total phosphorus concentrations were lowest at BUR0.0.
- **Nitrogen:** Median base and storm flow total nitrogen and nitrate+nitrite concentrations generally decreased from the high at BBC10.4 to lows at BBC5.9 through BBC1.6.
- **Copper:** Median base flow total and dissolved copper was lowest at the upstream station BBC10.4, highest at midstream station BBC8.4, then gradually decreased across the downstream stations. Tributary stations generally had lower copper concentrations than main stem stations except for PET0.0, which was substantially higher than other stations, potentially contributing to the main stem high at BBC8.4. Median storm flow copper concentrations were lowest at the upstream stations and then increased to higher values at BBC8.4 through BBC1.6. High storm flow concentrations at tributary stations PET0.0 and COL0.0 may be contributing to relatively high median concentrations at BBC8.4 and BBC1.6.
- **Zinc:** Median base flow total zinc was lowest at the upstream station BBC10.4, peaked at midstream station BBC7.0, and then decreased slightly downstream. Tributary stations BUR0.0 and COL0.0 had substantially higher total and dissolved zinc concentrations during storm flow but did not appear to affect the zinc concentrations of downstream stations. Dissolved zinc and storm flow total zinc concentrations were more comparable between stations.

4.1.3. Storm and Base Flow Comparison

The results for most parameters reflected the inherent variability in storm and base flow contributions. Two storm events did not meet the 0.3-inch criterion, so storm patterns may be less evident.

- **Storm Flow** tended to have cooler water and lower pH, with higher concentrations of DO, turbidity, TSS, DOC, total and dissolved metals, and bacteria. Higher concentrations are expected for these water quality indicators, due to mobilization of pollutants from higher flow rates, which are associated with greater weathering, erosion, and sediment transport capacity. TSS concentrations are positively associated with heavy metals and other pollutants due to the adsorption of metals and other pollutants to fine solids. Lower pH potentially indicates greater input of acidic pollutants during storm flow but can be a result of the naturally low pH of clean rain (5.0 to 5.5) or wetlands. *E. coli* geometric mean concentrations in storm flow were greater at all stations and more variable than base flow likely due to mobilization from surfaces during storm events and variable mixing of storm and base flows, respectively.
- **Base Flow** tended to have warmer, more basic water (higher pH), with greater measurements of conductivity, nitrate+nitrite, total nitrogen, and hardness. Higher conductivity during base flow is expected, because groundwater typically has higher conductivity, and warmer temperatures cause ions to become more mobile. Similarly, increased hardness (as a measure of dissolved minerals) can be caused by warmer temperatures that increase the solubility of most salts. Higher median concentrations of total nitrogen and nitrate+nitrite at most stations during base flow may be due to septic influence, though other parameters associated with septic influence (e.g., elevated chloride and nutrients) have not been seen.

4.1.4. Historical Data Comparison

Water quality data from WY2022–WY2023 were compared to historical datasets with varying data ranges. For base flow, historical data for most parameters was from WY2011–WY2021; data was limited to WY2018–WY2021 for *E. coli* and WY2020–WY2021 for hardness, chloride, DOC, and metals. Historical data from WY2020–WY2021 was used for comparison for storm data. While samples were collected during storm flow conditions in WY2013, this data was excluded because the data were not collected continuously between WY2013 and WY2020. Key differences are summarized below:

- Dissolved Oxygen: Median DO concentrations were greater than historical medians at all stations in both base and storm flow with substantial differences at BBC8.8 and BUR0.0 during storm flow events.
- Turbidity: Median base flow turbidity was greater than historical medians at all main stem stations with substantial differences at BBC10.4, BBC5.9, BBC2.6, and BBC1.6.
- Chloride: Median chloride base and storm flow concentrations were greater than historical medians; however, all historical data is limited to WY2020–WY2021. Recent base and storm flow concentrations were substantially higher than historical concentrations at all main stem stations, except for BBC10.4, BBC5.9, and BBC2.6 during storm flow events.
- Phosphorus: Median storm flow total phosphorus concentrations were lower than historical medians at all monitoring stations.
- Nitrogen: Median base flow total nitrogen concentrations were higher than historical medians at all monitoring stations except for upstream main stem stations BBC10.4 and BBC8.8. However, median storm flow total nitrogen concentrations were lower than historical medians at all monitoring stations except for BBC10.4, BBC8.8, and PET0.0.
- Zinc: Median base flow total and dissolved zinc concentrations were higher than historical medians (WY2020–WY2021) at all monitoring stations except for BBC10.4.
- Bacteria: Geometric mean fecal coliform and *E. coli* concentrations were lower than historical geometric means at all monitoring stations except for *E. coli* at BBC8.4 and BUR0.0 during base flow and BBC10.4 during storm flow. Recent base flow *E. coli* concentrations were substantially lower than historical concentrations at PET0.0.

4.1.5. Water Quality Criteria Comparison

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

- Temperature: The temperature criterion (17.5°C) was exceeded at all stations during continuous temperature monitoring in both years. Table 5 summarizes 7-day average daily maximum (7-DADMAX) temperature exceedances between May 26 and October 31 of both 2022 and 2023.
- Dissolved Oxygen: Median DO concentrations did not meet criterion (minimum value shall not exceed 10.0 mg/L) at seven and four stations for base and storm flow, respectively. DO criterion was

met for median storm and base flow concentrations at BBC8.8, BBC2.6, COL0.0 and BBC1.6 as well as median storm flow concentrations at BBC8.4, BUR0.0 and BBC5.2,

- **pH:** The pH criterion (6.5 to 8.5) was not met at BBC10.4 during three base and six storm flow events in which the pH was below the range. The criterion was met for all other stations during storm and base flow events with the exception of COL0.0, which exceeded the range during one base flow event, and BBC8.8, which was below the range during one storm flow event.
- **Turbidity:** Using an upstream station as background, the turbidity standard was not met due to a greater than 5 NTU increase during the following events:
    - March 21, 2022, storm event: increase from 11 NTU at BBC5.2 to 17 NTU at BBC2.6.
    - March 13, 2023, storm event had multiple exceedances, likely because it had the most rainfall preceding sampling (1.1 inches). Exceedances included:
        - Increase from 27 NTU at BBC10.4 to 39 NTU at BBC8.8
        - Increase from 14 NTU at BBC5.9 to 26 NTU at BBC5.2
        - Increase from 26 NTU at BBC5.2 to 52 NTU at BBC2.6
        - Increase from 52 NTU at BBC2.6 to 66 NTU at BBC1.6
    - September 6, 2023, base flow event: increase from 2 NTU at BBC8.4 to 8 NTU at BBC7.0.
    - October 4, 2023, base flow event: increase from 3 NTU at BBC8.4 to 8 NTU at BBC7.0.
- **Chloride:** No chloride concentrations exceeded acute or chronic criteria at any station.
- **Nutrients:** Total phosphorus, total nitrogen, and nitrate+nitrite criteria were exceeded at all stations during most events. BBC10.4, BBC8.8, BUR0.0, and BBC5.2 met the total phosphorus criterion during a few base flow events. COL0.0 met the total nitrogen criterion during one storm flow event.
- **Metals:** Table 6 summarizes all metals exceedances from WY2022–WY2023. All metals exceedances occurred during storm events. Acute criteria for zinc were exceeded at COL0.0 during one event and at BUR0.0 during three events. While chronic criteria are more applicable to base flow events, exceedances for storm events are listed in Table 6 and described here. Chronic criteria for zinc were exceeded during three events each at COL0.0 and BUR0.0. Chronic criteria for copper were exceeded at COL0.0 during one event. No acute or chronic criteria were exceeded at any station during any base flow events.
- **Bacteria:** Fecal coliform and *E. coli* criteria were not met during storm events at any station, except PET0.0, which did meet *E. coli* criteria. *E. coli* criteria were met during base flow events at all stations, except for BUR0.0. Fecal coliform criteria were not met during base flow events at BBC10.4, BBC8.4, BUR0.0, BBC7.0, and COL0.0. Because the fecal coliform and *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 5. Total Number of Days the 7-DADMax Temperature Exceeds the Temperature Criterion of 17.5°C in 2022 and 2023 from May 26 to October 31.				
	Water Year 2022		**Water Year 2023**	
Station	**Total Days 7-DADMax Exceeds 17.5°C**	**Percent of Days Exceeding Criterion**	**Total Days 7-DADMax Exceeds 17.5°C**	**Percent of Days Exceeding Criterion**
BBC10.4	103	65	104	65
BBC8.8	92	58	115	72
PET0.0	117	74	127	80
BBC8.4	107	67	120	75
BBC7.0	105	66	115	72
BBC5.9	91	57	113	71
BBC2.6	85	53	98	62
BBC1.6	83	52	85	53

Table 6. Metals Results that Exceeded Acute and Chronic Water Quality Criteria.							
Station	**Date**	**Type**	**Parameter**	**Result (µg/L)**	**Hardness (mg/L)**	**Criteria Type**	**Criteria Value (µg/L)**
COL0.0	3/2/2022	Storm	Copper, Dissolved	3.8	22	Chronic	3.1
COL0.0	1/5/2022	Storm	Zinc, Dissolved	32.7	24	Chronic	31.2
COL0.0	3/2/2022	Storm	Zinc, Dissolved	29.7	22	Chronic	29.0
BUR0.0	2/7/2023	Storm	Zinc, Dissolved	65.8	42	Acute	55.3
BUR0.0	2/7/2023	Storm	Zinc, Dissolved	65.8	42	Chronic	50.5
COL0.0	2/7/2023	Storm	Zinc, Dissolved	98.4	76	Acute	91.1
COL0.0	2/7/2023	Storm	Zinc, Dissolved	98.4	76	Chronic	83.2
BUR0.0	3/13/2023	Storm	Zinc, Dissolved	23.9	14	Acute	22.2
BUR0.0	3/13/2023	Storm	Zinc, Dissolved	23.9	14	Chronic	20.2
BUR0.0	3/23/2023	Storm	Zinc, Dissolved	84.4	56	Acute	70.5
BUR0.0	3/23/2023	Storm	Zinc, Dissolved	84.4	56	Chronic	64.3

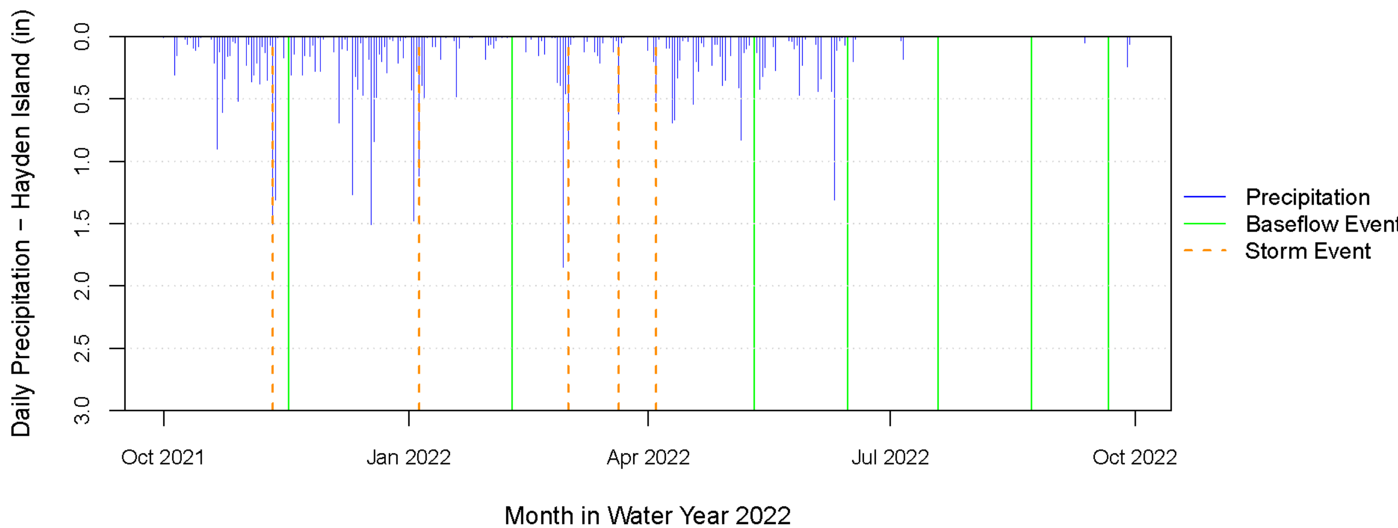
4.2. Hydrology

Precipitation data from monitoring events and collected by others are presented in Figure 5. Rainfall data were collected in 1-hour intervals by Portland Bureau of Environmental Services (BES) at Hayden Island Rain Gage (Portland BES 2023), which is located 7.5 miles southwest of station BBC2.6. In WY2022, the gage recorded 43.4 inches of rain with a maximum daily precipitation value of 1.85 inches. There was less precipitation recorded by the rain gage in WY2023 events (38 inches). Maximum daily precipitation was greater in WY2023 (1.85 inches in WY2022 versus 2.85 inches in WY2023). Two sampled storm events did not meet the storm depth criterion of at least 0.3 inch of rain with only 0.14 and 0.12 inch of rain on February 7, 2023, and March 23, 2023, respectively. All sampled base flow events met the criterion of less than 0.04 inch of rain in the previous 24 hours.

Monthly precipitation amounts from October through September are presented as a box plot for WY2011–WY2021 data and as points for WY2022–WY2023 data in Figure 6. Precipitation amounts in WY2022 were substantially higher in November, December, April, May, and June compared to WY2011–WY2021. There was substantially less precipitation in August and September compared to historical data. All other months in WY2022 were comparable to historical ranges.

In WY2023, there was substantially less precipitation in May compared to WY2011–WY2021. Precipitation amounts in WY2023 were substantially higher in December, April, and August compared to WY2011–WY2021. All other months in WY2023 were comparable to historical ranges.

There was little or no precipitation in July through September of WY2022, and in July of WY2023 (see Figure 4).



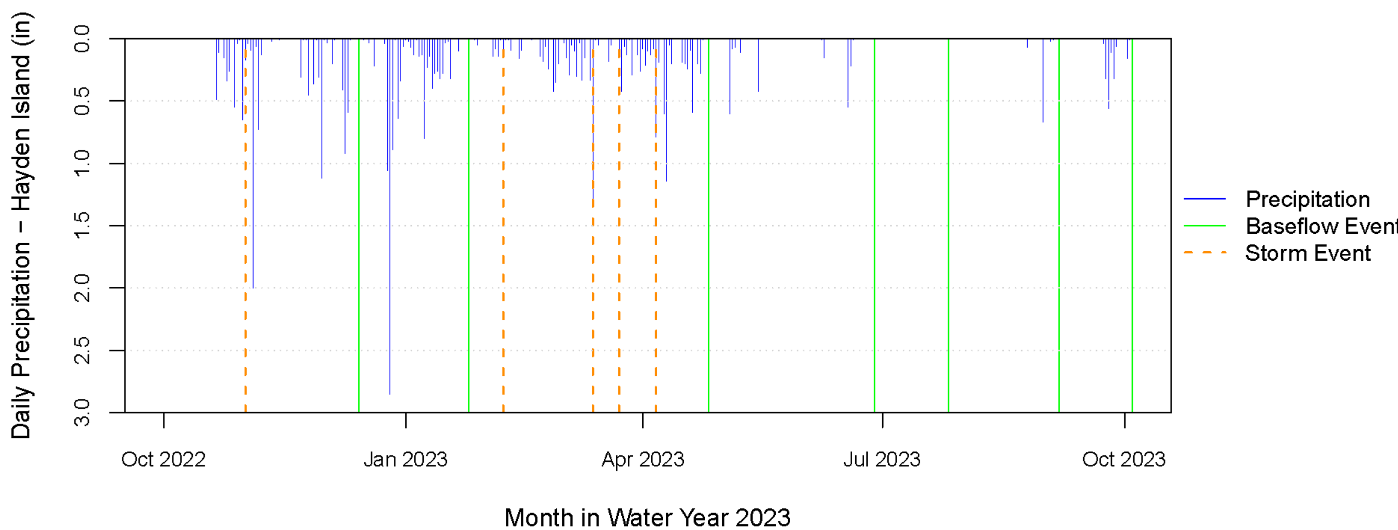


Figure 5. Burnt Bridge Creek Precipitation 7.5 Miles Southwest of BBC2.6 During Water Years 2022 and 2023 (Portland BES 2023).

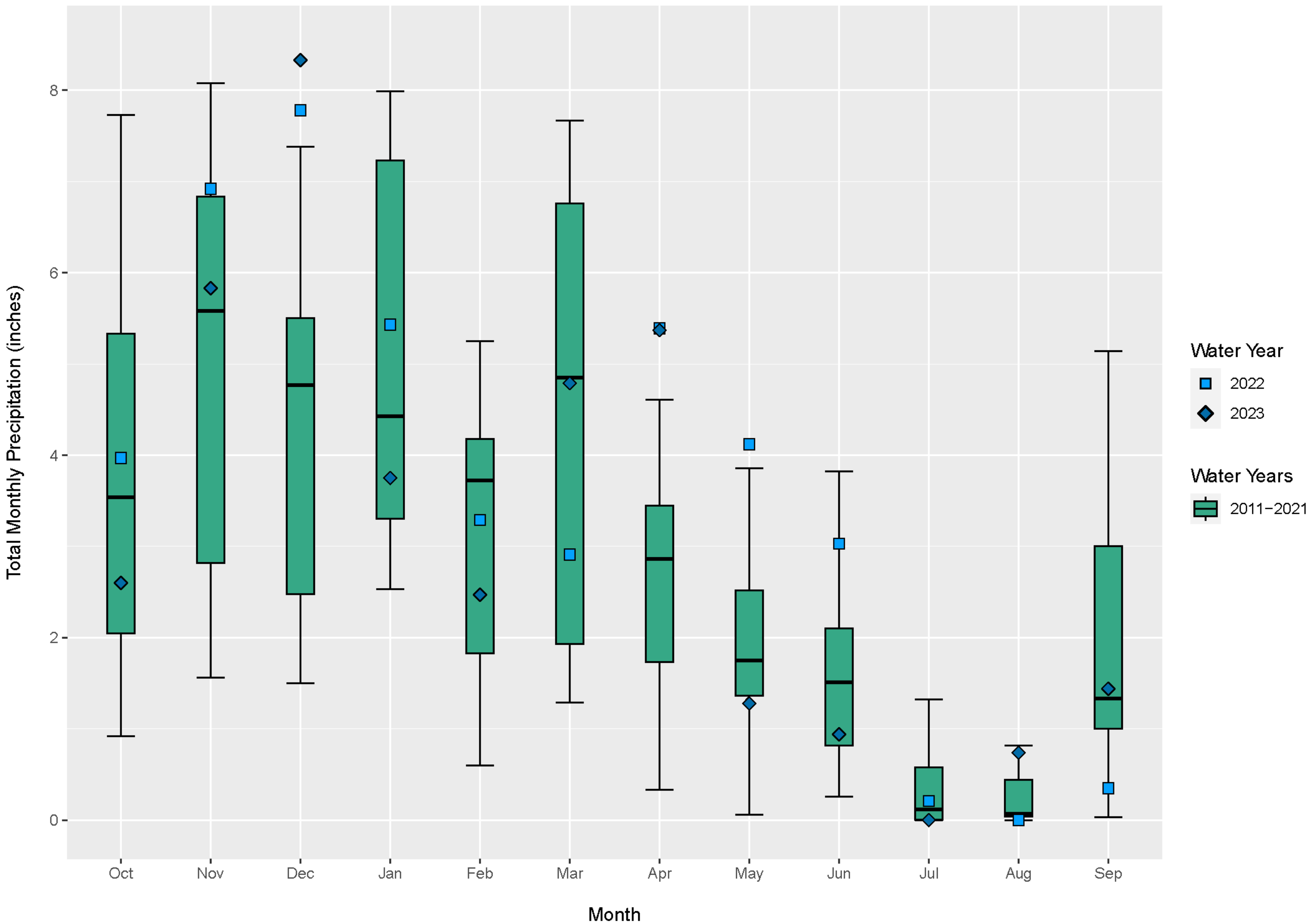


Figure 6. Total Monthly Precipitation at Burnt Bridge Creek for 2011 to 2023 (Portland BES 2023).

4.3. Water Quality

Water quality results are presented and described separately for each monitoring station in the sections below. Tabulated summary statistics are presented for each parameter and station in Appendix D. Where applicable, each station section presents results and summarizes implications of:

- "Line" plots, presenting the seasonal patterns among the sampling stations for base flow
- "Box and whisker" plots, presenting spatial patterns among the sampling stations for base flow and storm flow
- "Box and whisker" plots, comparing base and storm flow concentrations for each station
- Water quality criteria comparison

4.3.1. BBC10.4

The contributing area draining to the most upstream monitoring station, BBC10.4, consists primarily of residential land use with inputs from State Route 500 (SR 500) as well as some agriculture, commercial/industrial, and forest/field/other. Upstream riparian canopy cover within 0.5 mile of BBC10.4 is 25 percent. Septic systems are present within the BBC10.4 subbasin. Stormwater is conveyed to infiltration facilities such as dry wells, some stormwater treatment facilities, and untreated stormwater also discharges directly to the creek. Much of the stormwater to the south of the creek discharges to dry well facilities, without piped conveyance to the creek.

Monitoring at this station typically occurred in the morning as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at BBC10.4 are summarized below.

- Temperature: The 7-DADMax temperature exceeded the criterion for 65 percent of days from May 26 through October 31 in both WY2022 and WY2023.
- Dissolved Oxygen: Consistent with historical data, median DO concentrations at this station are low compared to most other stations (base and storm events). Unlike other stations where one or more events met the 10 mg/L DO criterion, DO concentrations at BBC10.4 were measured below the criterion for all events. However, median concentrations for both storm and base flow events in WY2022–WY2023 were both 1.4 mg/L greater than historical data. Consistent with historical data, base flow DO concentration (median of 8.3 mg/L) was substantially lower than all stations except BBC5.9.
- pH: In a similar pattern to DO, base and storm flow pH levels at BBC10.4 were substantially lower than all other stations. BBC10.4 and BBC8.8 were the only stations with pH measurements below the criterion (six storm and three base flow events respectively). Median pH at BBC10.4 during storm events was just below the lower criterion of 6.5 at 6.48, and base flow median pH met criterion at 6.7. These patterns are consistent with historical base flow data.

- **Turbidity:** Like most other main stem stations, base flow turbidity was substantially greater than historical data (medians of 4.2 NTU and 1.6 NTU, respectively) and substantially lower than storm flow concentrations. Median storm flow turbidity (10 NTU) exceeded median base flow turbidity by 5.9 NTU and storm concentrations were comparable to other main stem stations.
- **Nutrients:** The EPA recommended concentrations for total phosphorus and total nitrogen were exceeded for all but one event on July 19, 2022, for total phosphorus. Nutrient concentrations were comparable to BBC8.8, with greater median nitrogen concentrations and lower median phosphorus concentrations than downstream stations. Base flow total phosphorus and total nitrogen concentrations were substantially lower and greater, respectively, than downstream main stem stations starting at BBC7.0. The storm flow nitrate+nitrite concentrations (median of 1.8 mg/L) were substantially greater than all other stations except PET0.0. Total phosphorus and total nitrogen criteria were not met during any event, except for total phosphorus during the July 19, 2022, base flow event. Median nutrient concentrations were consistent with historical data (overlapping interquartile ranges).
- **Metals:** There were no exceedances for metals during any monitoring event at this station. Total and dissolved metals concentrations were comparable to most other stations, except base and storm flow metals concentrations were substantially lower than one or more tributary stations.
- **Bacteria:** Fecal coliform and *E. coli* were comparable to all other stations and to historical data. Base flow bacteria criteria were met with the exception of the 90th percentile for fecal coliform (231 CFU/100 mL versus criterion of 200 CFU/100 mL) while storm flow geometric mean and 90th percentile criteria were exceeded.

4.3.2. BBC8.8

Monitoring station BBC8.8 is located approximately 70 feet upstream from the confluence with tributary Peterson Channel. The contributing area between BBC10.4 and BBC8.8 includes SR 500 and I-205, residential and commercial/industrial areas and a large golf course directly upstream of the monitoring station. Upstream riparian canopy cover within 0.5 mile of BBC8.8 is 52 percent. Stormwater is primarily managed through infiltration facilities such as dry wells, and the majority of septic systems are located just downstream of BBC10.4, south of the creek.

Monitoring at this station typically occurred in the morning as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at BBC8.8 are summarized below.

- **Temperature:** The 7-DADMax temperature exceeded the criterion for 58 percent of days in WY2022 and 72 percent in WY2023 from May 26 through October 31.
- **Dissolved Oxygen:** DO increased substantially from BBC10.4 with storm and base flow median concentrations (10.8 mg/L and 10.2 mg/L, respectively); however, three storm and six base flow events did not meet the 10 mg/L criterion. Median values for both storm and base flow events in WY2022–WY2023 were greater than historical medians, but not substantially—this pattern is consistent at all main stem stations.

- **pH:** Like DO, BBC8.8 pH was substantially greater than BBC10.4 and similar to midstream stations (BBC8.4 to BBC5.2). pH measurements were within criteria during every monitoring event, except for one storm event on February 9, 2022, when the pH was 6.4.
- **Turbidity:** Like most other main stem stations, base flow turbidity was substantially greater than historical data (medians of 4.2 NTU and 1.6 NTU, respectively). The turbidity criterion was exceeded during the storm event on March 13, 2023, when turbidity increased from 27 NTU at BBC10.4 to 39 NTU at BBC8.8 (increase of 12 NTU versus criterion of 5).
- **Nutrients:** The EPA recommended concentrations for total phosphorus and total nitrogen were exceeded for all but one event on September 21, 2022, for total phosphorus. Nutrient concentrations were comparable to other upstream stations, with greater nitrogen concentrations and lower phosphorus concentrations than downstream stations. Base flow total phosphorus (median of 0.07 mg/L) was substantially lower than PET0.0 and downstream main stem stations starting at BBC7.0. Base flow total nitrogen (median of 2.6 mg/L) was substantially greater than PET0.0 and downstream stations starting at BBC7.0.
- **Metals:** Acute and chronic metals criteria were not exceeded during any monitoring event.
- **Bacteria:** BBC8.8 met criteria (geometric mean and 90th percentile) during base flow events for fecal coliform and *E. coli* (geometric mean 63 CFU/100 mL and 46 CFU/100 mL, respectively) but exceeded criteria for both during storm events (geometric mean of 213 CFU/mL for fecal coliform and 142 CFU/100 mL for *E. coli*).

4.3.3. PET0.0

Monitoring station PET0.0 is located in Peterson Channel, just upstream of its confluence with Burnt Bridge Creek. The subbasin draining to PET0.0 includes primarily residential land use but also includes a large portion of commercial/industrial land use. Upstream riparian canopy cover within 0.5 mile of the PET0.0 is 46 percent.

The basin includes clusters of septic systems in the northwest and southeast portions of the basin. Stormwater is managed by dry wells and bioretention facilities, with some areas draining directly to the creek. Dry season base flow in Peterson Channel is primarily sustained through industrial non-contact cooling water discharge that displays unique water quality characteristics that may affect water quality at the downstream station BBC8.4.

Monitoring at this station typically occurred in the morning as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at PET0.0 are summarized below.

- **Temperature:** PET0.0 exceeded the temperature criterion for the most days of any station in both years. The 7-DADMax temperature exceeded the criterion for 74 percent of days in WY2022 and 80 percent in WY2023 from May 26 through October 31.
- **Dissolved Oxygen:** Storm and base flow DO water quality criterion was not met during all but one storm and base flow event (median of 9.1 mg/L and 8.8 mg/L for storm and base flow respectively). Storm and base flow DO was substantially lower than BBC8.8 and may have contributed to lower median concentrations observed just downstream at BBC8.4.

- **pH:** Storm (median 6.9) and base flow (median 7.3) pH levels were comparable to other midstream stations and met pH criteria during every monitoring event.
- **Turbidity:** PET0.0 had the lowest median storm flow turbidity of all monitoring stations (3.7 NTU). Base flow turbidity (median 1.2 NTU) was substantially lower than most stations, except BUR0.0. Turbidity concentrations were consistent with historical data.
- **Dissolved Organic Carbon:** Consistent with historical data, the storm (median 0.9 mg/L) and base flow (median 0.6 mg/L) DOC concentrations were substantially lower than all other stations.
- **Nutrients:** Like most other stations, the EPA recommended concentrations for total phosphorus and total nitrogen were not met during any event. Total phosphorus base flow concentrations (median 0.1 mg/L) were substantially greater than BBC10.4 and BBC8.8 and BUR0.0, while storm flow concentrations were comparable to all stations except BBC5.2. Base flow total phosphorus was substantially lower than historical concentrations (medians 0.1 mg/L versus 0.14 mg/L).
- **Metals:** There were no exceedances for metals during any monitoring event at this station. PET0.0 had greater total and dissolved copper concentrations than all other stations, except COL0.0, in both storm and base flow. Total and dissolved zinc concentrations were comparable to other stations, though storm concentrations were substantially lower than BUR0.0 and COL0.0.
- **Bacteria:** Bacteria concentrations were comparable to other stations, except the storm flow concentrations for both *E. coli* and fecal coliform, which were substantially less than BUR0.0. PET0.0 met criteria for *E. coli* during all events (geometric means 74 CFU/100 mL storm and 47 CFU/100 mL base flow) and met criteria for fecal coliform during base flow events (geometric mean 44 CFU/100 mL). The fecal coliform 90th percentile exceeded the criterion during storm events (299 CFU/100 mL versus 200 CFU/100 mL).

4.3.4. BBC8.4

The contributing area between BBC8.8 and BBC8.4 includes primarily residential and forested/open space land use and a large golf course upstream of the monitoring station. Upstream riparian canopy cover within 0.5 mile of the BBC8.4 is 38 percent. Septic systems are clustered in the eastern portion of the subbasin. Water quality at this station tended to display noticeable differences from upstream stations BBC10.4 and BBC8.8. These distinct changes may be due to influence from the nearby tributary Peterson Channel.

Monitoring at this station typically occurred in the morning as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at BBC8.4 are summarized below.

- **Temperature:** The 7-DADMax temperature exceeded the criterion for 67 percent of days in WY2022 and 75 percent of days in WY2023 from May 26 through October 31.
- **Dissolved Oxygen:** The median storm flow DO concentration was above the state criterion (10.5 mg/L versus criterion of 10 mg/L), but measurements were below the state standard infour storm events. The median base flow concentration (9.4 mg/L) was below the criterion. Both storm and base flow concentrations were greater, but not substantially greater, than historical concentrations.

- **pH:** Storm (median 7.0) and base flow (median 7.4) pH levels were comparable to other midstream stations and met pH criteria during every monitoring event.
- **Turbidity:** Base flow turbidity concentrations were substantially greater than the historical concentrations (medians 3.0 NTU versus 2.0 NTU), which is a consistent pattern among all main stem stations.
- **Chloride:** Storm (median 5.6 mg/L) and base flow (median 5.7 mg/L) chloride concentrations were substantially greater than the historical concentrations (medians 3.8 mg/L and 4.7 mg/L, respectively), which is a consistent pattern at all stations.
- **Nutrients:** The EPA recommended concentrations for total phosphorus and total nitrogen were exceeded during all monitoring events. Nutrient concentrations were comparable to other upstream stations, with greater median nitrogen concentrations and lower median phosphorus concentrations than downstream stations. BBC8.4 base flow total phosphorus (median 0.09 mg/L) was substantially greater than BUR0.0, and substantially lower than downstream main stem stations starting at BBC7.0. Base flow total phosphorus was substantially lower than the historical concentrations (medians 0.09 mg/L versus 0.11 mg/L). Base flow total nitrogen (median 2.4 mg/L) was comparable to other stations, though slightly greater than downstream stations.
- **Metals:** There were no exceedances for metals during any monitoring event at this station. Total and dissolved metals concentrations were comparable to most other stations, with the exception that base flow copper concentrations (medians 2.3 µg/L total and 1.3 µg/L dissolved) were substantially greater than BBC10.4, BBC8.8, and BUR0.0.
- **Bacteria:** BBC8.4 met criteria for *E. coli* during base flow events (geometric mean 60 CFU/100 mL) but the 90th percentile exceeded criteria for *E. coli* in storm flow (344 CFU/100 mL versus 300 CFU/100 mL). The fecal coliform geometric mean exceeded the criterion during storm events (143 CFU/100 mL versus 100) and the 90th percentile exceeded the criterion for base flow events (214 CFU/100 mL versus 200 CFU/100 mL).

4.3.5. BUR0.0

Monitoring station BUR0.0 is located in Burton Channel, about 1,000 feet upstream of its confluence with Burnt Bridge Creek. The subbasin draining to BUR0.0 includes primarily residential as well as commercial/industrial land use. Upstream riparian canopy cover within 0.5 mile of the BUR0.0 is 28 percent.

Compared to other monitoring station subbasins, the area includes a relatively high septic system density with clusters of septic systems distributed throughout most of the subbasin. Most stormwater is managed by infiltration and discharge to the stream. Flows at this station during base flow events appear to be very low relative to the main BBC channel and other tributaries. Pollutant concentrations at BUR0.0 did not appear to visually impact water quality at the adjacent downstream BBC station BBC7.0, likely due to the relatively low flow volumes.

Monitoring at this station typically occurred in the morning as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at BUR0.0 are summarized below.

- **Dissolved Oxygen:** The base flow median concentration (9.2 mg/L) was below the state standard while the storm flow median concentration (10.7 mg/L) was above the standard. Recent base flow concentrations were comparable to historical results while storm flow DO was substantially higher than historical results.
- **pH:** Instantaneous pH measurements (medians of 7.1 and 6.8 for base and storm flow, respectively) were all within the water quality criteria for all base and storm flow events.
- **Conductivity:** Median conductivity (202 µS/cm^2) was greater than all main stem stations and substantially lower than other tributary stations during base flow events but had the second lowest median concentration (95 µS/cm^2) of all monitoring stations for storm flow.
- **Turbidity:** Base flow turbidity (median of 1.2 NTU) was substantially lower than all main stem stations, but storm flow median turbidity (10 NTU) was higher than all main stem stations except for BBC10.4 and BBC1.6. Median storm flow turbidity exceeded median base flow turbidity by 8.8 NTU.
- **Chloride:** Base flow chloride concentrations (median of 7.6 mg/L) were substantially higher than all other monitoring stations and the recent maximum concentration (9.9 mg/L) greatly exceeded the historical maximum (7.8 mg/L). BUR0.0 was the only station with substantially lower storm flow chloride concentrations (median of 4.2 mg/L) compared to base flow.
- **Metals:** The chronic and acute water quality criteria were both exceeded on three occasions for dissolved zinc during storm events. Median base flow copper concentrations (0.80 and 0.55 µg/L for total and dissolved copper, respectively) were the lowest of all monitoring stations whereas median storm flow copper concentrations (2.8 µg/L and 1.8 µg/L for total and dissolved copper, respectively) were similar to other nearby main stem stations. Median base flow zinc concentrations (9.7 µg/L and 9.3 µg/L for total and dissolved zinc, respectively) were high relative to other stations with median total zinc the third highest of all monitoring stations and dissolved zinc the highest of all monitoring stations. Similarly, storm flow zinc concentrations (medians of 36 µg/L and 27 µg/L for total and dissolved zinc, respectively) were substantially higher than all main stem stations. Hardness, which is used to calculate dissolved metals criteria, had a maximum value in WY2022 (121 mg/L) that greatly exceeded the historical maximum (82 mg/L).
- **Nutrients:** The EPA recommended concentrations for total phosphorus and total nitrogen were exceeded for all but two base flow events for total phosphorus. Median total phosphorus concentrations (0.055 mg/L and 0.056 mg/L for base and storm flow, respectively) were the lowest of all monitoring stations. While base and storm flow total phosphorus concentrations were not substantially different, storm flow total nitrogen was substantially lower than base flow. Median base flow total nitrogen (2.8 mg/L) was the highest of all monitoring stations whereas median storm flow total nitrogen (1.4 mg/L) was the second lowest of all monitoring stations.
- **Bacteria:** BUR0.0 bacteria concentrations were above all applicable water quality criteria and generally had among the highest concentrations of all monitoring stations. Base flow geometric means (124 CFU/100 mL and 125 CFU/100 mL for fecal coliform and *E. coli,* respectively) were the highest of all monitoring stations. The storm flow fecal coliform geometric mean (373 CFU/100 mL) was the second highest of all monitoring stations and the *E. coli* geometric mean (270 CFU/100 mL) was the highest of all monitoring stations. Storm flow *E. coli* concentrations were substantially higher than monitoring stations PET0.0, BBC8.4, BBC7.0 and BBC5.9.

4.3.6. BBC7.0

The contributing area between BBC8.4 and BBC7.0 includes primarily residential land use with inputs from SR 500 and commercial/industrial areas. Upstream riparian canopy cover within 0.5 mile of the BBC7.0 is 53 percent. A duck pond is located immediately upstream of the sampling location. Septic systems are clustered throughout the subbasin. Stormwater is managed through infiltration facilities such as dry wells, in addition to conveyance that discharges to the creek.

Monitoring at this station typically occurred in the late morning as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at BBC7.0 are summarized below.

- **Temperature:** The continuous temperature data showed exceedance of the 7-DADMax criterion for 66 percent of days in WY2022 and 72 percent of days in WY2023 during the monitoring period.
- **Dissolved Oxygen:** Base flow median concentration (9.6 mg/L) was below the state criterion, and concentrations were not substantially different from other main stem stations. The storm flow median DO concentration (10.1 mg/L) was above the state criterion. Median concentrations were greater than historical medians (8.9 mg/L and 8.0 mg/L for base and storm flow, respectively).
- **pH:** Instantaneous pH measurements (base and storm flow medians of 7.3 and 7.0, respectively) met water quality criteria for all base and storm flow events. During both base and storm flow events, pH at BBC7.0 was comparable to other midstream main stem stations.
- **Turbidity:** Unlike most monitoring stations, storm flow turbidity was not substantially greater than base flow with medians of 4.1 NTU and 6.4 NTU respectively. Median storm flow turbidity was lowest of all the monitoring stations. Criteria exceedances occurred during the September 6, 2023, and October 4, 2023, base flow events where turbidity increased from background levels (BBC8.4) by 5.9 NTU and 5.1 NTU, respectively.
- **Total Suspended Solids:** In a pattern similar to turbidity, the median base flow TSS concentration (7.5 mg/L) was the highest of all monitoring stations, but the median storm flow concentration (6.3 mg/L) was the lowest of all main stem stations and the only station with the storm flow median below the base flow median. BBC7.0 is located immediately downstream of a large duck pond that likely contributes to the elevated TSS during base flow but controls TSS during storm flow events.
- **Metals:** There were no exceedances for metals during any monitoring event at this station. Median base flow total and dissolved copper concentrations (2.08 µg/L and 1.27 µg/L, respectively) were the second highest of all main stem stations. Median base flow total zinc (9.8 µg/L) was the highest of any main stem station, but dissolved zinc concentrations (median of 5.4 µg/L) were similar to other main stem stations. Storm flow metals concentrations were generally similar to other main stem stations except for dissolved zinc, which had the highest median (15.2 µg/L) of all main stem stations. Hardness, which is used to calculate dissolved metals criteria, had a maximum value in WY2022 (128 mg/L) that greatly exceeded the historical maximum (98 mg/L) but to a lesser extent than several other monitoring stations.

- **Nutrients:** The EPA recommended concentrations for total phosphorus and total nitrogen were exceeded for all monitoring events at this station. Base flow median total phosphorus (0.112 mg/L) was the highest of all monitoring stations, but the storm flow median (0.099 mg/L) was generally similar to other mid- and downstream main stem stations. BBC7.0 was the only monitoring station with lower median total phosphorus concentration in storm flow. Base and storm flow total nitrogen concentrations (medians of 2.1 mg/L and 1.7 mg/L, respectively) were generally similar to other mid- and downstream main stem stations.
- **Bacteria:** Applicable water quality criteria were not met except for *E. coli* during base flow events. Base flow bacteria concentrations (geometric means of 84 and 56 CFU/100 mL for fecal coliform and *E. coli*, respectively) were either the highest or second highest of all main stem stations. During storm flow, bacteria concentrations (geometric means of 180 and 106 CFU/100 mL for fecal coliform and *E. coli*, respectively) were among the lower half of main stem stations. Base flow *E. coli* concentrations were lower than historical concentrations.

4.3.7. BBC5.9

The contributing area between BBC7.0 and BBC5.9 includes primarily residential land use with inputs from commercial/industrial areas. Upstream riparian canopy cover within 0.5 mile of the BBC5.9 is 34 percent. There are relatively few septic systems. Stormwater is managed through infiltration facilities such as dry wells as well as conveyance that discharges to the creek.

Monitoring at this station typically occurred in the late morning as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at BBC5.9 are summarized below.

- **Temperature:** The continuous temperature data showed exceedance of the 7-DADMax criterion for 57 percent of days in WY 2022 and 71 percent of days in WY 2023 during the monitoring period.
- **Dissolved Oxygen:** Base and storm flow median DO concentrations (8.1 mg/L and 9.3 mg/L, respectively) were the lowest and second lowest of all monitoring stations, respectively, and were below criteria for the majority of events. Median concentrations are greater, but not substantially, than historical medians for both base and storm flow.
- **pH:** Instantaneous pH measurements (base and storm flow medians of 7.2 and 7.0, respectively) were all within the water quality criteria for all base and storm flow events. pH measurements were generally consistent with other mid-stream monitoring stations.
- **Turbidity:** No water quality criterion exceedances were identified during the monitoring period. Median base and storm flow concentrations (3.0 NTU and 6.9 NTU, respectively) were the second lowest of the main stem stations despite substantially higher base flow concentrations relative to historical results.
- **Chloride:** Base flow concentrations (median of 6.0 mg/L) were substantially higher than historical results. Storm flow median concentration (5.9 mg/L) was the second highest of all monitoring stations.

- **Metals:** There were no exceedances for metals during any monitoring event at this station. The median storm flow total zinc concentration (15.2 µg/L) was lower than any other main stem station, but dissolved zinc concentrations (median of 13.1 µg/L) were more comparable to other main stem stations. Hardness, which is used to calculate dissolved metals criteria, had a maximum value in WY2022 (177 mg/L) that greatly exceeded the historical maximum (95 mg/L).
- **Nutrients:** The EPA recommended concentrations for total phosphorus and total nitrogen were exceeded for all monitoring events. Despite no substantial differences in storm flow total phosphorus concentrations across all main stem stations, median storm flow total phosphorus concentration (0.107 mg/L) was higher than all main stem stations upstream of BBC5.9, but lower than all main stem stations downstream of BBC5.9. Median base flow total nitrogen concentration (1.89 mg/L) was the lowest of all monitoring stations and the median storm flow total nitrogen concentration (1.63 mg/L) was the second lowest of all main stem stations.
- **Bacteria:** Base flow fecal coliform and *E. coli* concentrations were both below water quality criteria, but storm flow concentrations were both above water quality criteria. Bacteria geometric means (58 CFU/100 mL and 38 CFU/100 mL for base flow fecal coliform and *E. coli*, and 171 CFU/100 mL and 87 CFU/100 mL for storm flow fecal coliform and *E. coli*) at BBC5.9 were generally either the lowest of all monitoring stations, or the lowest of all main stem stations. All geometric means were lower than historical values.

4.3.8. BBC5.2

The contributing area between BBC5.9 and BBC5.2 includes primarily residential land use with inputs from a small portion of SR 500 and commercial/industrial areas. Upstream riparian canopy cover within 0.5 mile of the BBC5.2 is 40 percent. Septic systems are mostly clustered to the west of the creek and north of SR 500. Stormwater is largely managed through infiltration facilities such as dry wells as well as conveyance that discharges to the creek. Monitoring station BBC5.2 is located in a residential neighborhood with open access to the creek through private property. Potential localized sources of pollution at this station may include pet waste and fertilizer nutrient runoff.

Monitoring at this station typically occurred in the late morning or early afternoon as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at BBC5.9 are summarized below.

- **Dissolved Oxygen:** The base flow median concentration (9.4 mg/L) was below the water quality criterion, and the storm flow median concentration (10.3 mg/L) was above the criterion.
- **pH:** Water quality criteria was met for all pH measurements at BBC5.2 with medians of 7.4 and 7.2 for base and storm flow, respectively.
- **Turbidity:** Turbidity criterion was exceeded during the March 13, 2023, storm event, when turbidity increased by over 12 NTU from background levels at BBC5.9.
- **Chloride:** Base flow concentrations were substantially higher than historical results (median of 6.1 mg/L). The base flow median concentration is the highest of all main stem stations.

- **Metals:** There were no exceedances for metals during any monitoring event at this station. Storm flow metals concentrations (median of 2.90 μg/L for total copper, 1.65 μg/L for dissolved copper, 22.0 μg/L for total zinc, and 13.7 μg/L for dissolved zinc) were generally consistent with those of nearby main stem stations BBC5.9 through BBC1.6, with the exception that median total zinc concentrations were slightly higher than the adjacent upstream and downstream main stem stations. Hardness, which is used to calculate dissolved metals criteria, had a maximum value in WY2022 (147 mg/L) that greatly exceeded the historical maximum (106 mg/L).
- **Nutrients:** The EPA recommended concentrations for total phosphorus and total nitrogen were exceeded for all but one base flow event for total phosphorus on September 21, 2022. Base flow total phosphorus concentrations were substantially higher than the upstream main stem stations BBC10.4 through BBC8.4, but the median (0.106 mg/L) was comparable to other mid- and downstream main stem stations. Storm flow total phosphorus concentrations (median of 0.112 mg/L) followed a similar pattern as base flow, but less pronounced, with no substantial differences relative to the upstream stations. The median base and storm flow total nitrogen concentrations (2.0 mg/L and 1.7 mg/L, respectively) were comparable to other nearby mid- and downstream main stem stations and were both substantially lower than the upstream BBC10.4 and BBC8.8 concentrations.
- **Bacteria:** Base flow *E. coli* concentrations were below the applicable water quality criteria, but base flow fecal coliform and all storm flow bacteria were above applicable water quality criteria. All bacteria geometric means for all event types in WY2022 and WY2023 at BBC5.2 were below historical geometric means.

4.3.9. BBC2.6

BBC2.6, located in Leverich Park, is the second furthest downstream main stem monitoring station. The contributing area between BBC5.2 and BBC2.6 includes primarily residential land use with inputs from a portion of SR 500 and commercial/industrial areas. Upstream riparian canopy cover within 0.5 mile of the BBC2.6 is 46 percent. There is high septic systems density in the basin, particularly to the north of the creek. Stormwater is managed through infiltration facilities such as dry wells as well as conveyance that discharges to the creek.

Monitoring at this station typically occurred in the early afternoon as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at BBC2.6 are summarized below.

- **Temperature:** The continuous temperature data showed exceedance of the 7-DADMax criterion for 53 percent of days in WY2022 and 62 percent of days in WY2023 during the monitoring period.
- **Dissolved Oxygen:** All storm flow events across both water years met the water quality criterion. Several base flow events in both water years also met the criterion, particularly during the winter and spring, which coincided with the coldest weather and lowest instantaneous water temperature measurements. The median base flow concentration (9.9 mg/L) was just below the criterion.
- **pH:** Instantaneous pH measurements (median of 7.8 and 7.5 for base and storm flow, respectively) met water quality criteria for all base and storm events across both water years. pH measurements for all event types were substantially higher than the mid- and upstream main stem stations from BBC10.4 through BBC5.9.

- **Turbidity:** The turbidity criterion was exceeded on storm events occurring on March 21, 2022, and March 13, 2023, where turbidity increased by 5.9 NTU and 26 NTU respectively from background levels at BBC5.2.

- **Metals:** There were no exceedances for metals during any monitoring event at this station. Base flow total and dissolved copper (medians of 1.66 µg/L and 1.15 µg/L, respectively) were comparable to other mid- and downstream main stem stations and were substantially higher than upstream main stem stations BBC10.4 and BBC8.8. Storm flow metals concentrations (median of 2.96 µg/L for total copper, 1.63 µg/L for dissolved copper, 19.0 µg/L for total zinc, and 7.8 µg/L for dissolved zinc) were likewise comparable to nearby mid- and downstream main stem stations; and median dissolved zinc (7.8 µg/L) was the lowest concentration of all monitoring stations. Hardness, which is used to calculate dissolved metals criteria, had a maximum value in WY2022 (151 mg/L) that greatly exceeded the historical maximum (108 mg/L).

- **Nutrients:** The EPA recommended concentrations for total phosphorus and total nitrogen were exceeded for all events at this monitoring station. Base flow total phosphorus concentrations (median of 0.107 mg/L) were comparable to other mid- and downstream main stem stations but was substantially higher than upstream main stem stations BBC10.4 through BBC8.4. Storm flow median total phosphorus concentration (0.115 mg/L) was the highest of any monitoring stations, but the concentrations were not substantially higher than other main stem monitoring stations. Base and storm flow total nitrogen concentrations (medians of 2.0 mg/L and 1.7 mg/L, respectively) were comparable to other mid- and downstream main stem stations, but were generally lower than medians at upstream stations BBC10.4 through BBC8.4.

- **Bacteria:** Base flow *E. coli* results are below the water quality criterion at BBC2.6, but storm flow *E. coli*, base flow fecal coliform, and storm flow fecal coliform were all above water quality criteria. Bacteria concentrations during base and storm flow events generally were not substantially different from other mid- and downstream main stem stations. Geometric means for base and storm flow fecal coliform (77 CFU/100 mL and 229 CFU/100 mL, respectively) and *E. coli* (50 CFU/100 mL and 139 CFU/100 mL, respectively) were all below historical values.

4.3.10. COL0.0

Cold Creek is the third major tributary of Burnt Bridge Creek and connects to the main channel in between monitoring stations BBC 2.6 and BBC 1.6 at Hazel Dell Road. The associated monitoring station, COL0.0, is located just upstream of Cold Creek's confluent with Burnt Bridge Creek. The subbasin draining to COL0.0 includes primarily residential as well as substantial commercial/industrial land use. Upstream riparian canopy cover within 0.5 mile of the COL0.0 is 56 percent.

The tributary is heavily influenced by its groundwater source during base flow conditions, which results in many noticeable differences from the main BBC channel and between the tributary's base and storm flow characteristics. The area includes septic systems distributed throughout most of the subbasin. Unlike the other stations, there are few mapped dry wells within the COL0.0 subbasin. Evidence of encampments have been noted by field staff around monitoring station COL0.0 along Cold Creek and Burnt Bridge Creek.

Monitoring at this station typically occurred in the afternoon as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at COL0.0 are summarized below.

- Dissolved Oxygen: The water quality criterion was met for all storm flow events. While some base flow events did not meet the criterion, the median (10.1 mg/L) and the 25th percentile concentrations were above the water quality criterion.
- pH: All base and storm flow events were within the pH criterion except for one elevated measurement during the August 23, 2022, base flow event (8.6).
- Conductivity: Base flow conductivity (median of 251 µS/cm^2) was substantially greater than all stations except PET0.0 while storm median concentration (81 µS/cm^2) was lowest of all monitoring stations.
- Turbidity: The greatest difference between storm and base flow medians was observed at this station (22 NTU greater for storm flow) and the storm flow median concentration (25 NTU) was greater than all other stations. The base flow median concentration was substantially lower than most main stem stations, and not substantially different than the other two tributary stations.
- Total Suspended Solids: Similar to turbidity, base flow concentrations (median of 3.2 mg/L) are comparable to main stem stations, but the storm flow median concentration (23.6 mg/L) is the highest of all monitoring stations.
- Dissolved Organic Carbon: The median base flow (1.2 mg/L) and storm flow (2.3 mg/L) concentrations were below all main stem station median concentrations.
- Metals: The acute water quality criterion was exceeded for dissolved zinc during a storm flow event on February 7, 2023. Chronic water quality criteria were not exceeded during any base flow events but were exceeded for dissolved zinc during three storm events and dissolved copper during one storm event. Base flow median total copper (0.98 µg/L) and dissolved copper (0.63 µg/L) concentrations were below most of the main stem stations, whereas median total zinc (10.9 µg/L) and dissolved zinc (8.7 µg/L) concentrations were higher than all of the main stem stations. Storm flow median metals concentrations (7.40 µg/L for total copper, 3.03 µg/L for dissolved copper, 53.5 µg/L for total zinc, and 21.1 µg/L for dissolved zinc) were all greater than the main stem stations.
- Nutrients: The EPA recommended concentrations for total phosphorus and total nitrogen were exceeded for all monitoring events at this station. Base flow median total phosphorus concentration (0.087 mg/L) was substantially lower than nearby mid- and downstream main stem stations, but was generally comparable to or greater than upstream main stem and other tributary stations. Base flow total nitrogen concentrations (median 2.09 mg/L) were comparable to nearby mid- and downstream main stem stations, but the storm flow median concentration (1.00 mg/L) was lower than all other monitoring stations and substantially lower than the base flow total nitrogen concentrations.
- Bacteria: Fecal coliform and *E. coli* concentrations were all above water quality criteria except for base flow *E. coli* concentrations. Storm and base flow event geometric means for fecal coliform and *E. coli* (105 CFU/100 mL for base flow fecal coliform, 69 CFU/100 mL for base flow *E. coli*, 514 CFU/100 mL for storm flow fecal coliform, and 214 CFU/100 mL for storm flow *E. coli*) were also above all main stem stations.

4.3.11. BBC1.6

BBC1.6, located along the Burnt Bridge Creek Greenway near Alki Road, is the most downstream monitoring location. Water quality at this station is likely impacted by houseless encampments and influence from Cold Creek during storm flow conditions. The contributing area between BBC2.6 and BBC1.6, includes primarily residential land use with inputs from a portion of Interstate 5 (I-5) and commercial/industrial areas. Upstream riparian canopy cover within 0.5 mile of the BBC1.6 is 56 percent. There are relatively few septic systems in the area. Stormwater is managed through infiltration facilities such as dry wells as well as conveyance that discharges to the creek.

Monitoring at this station typically occurred in the afternoon or late afternoon as sampling was conducted from upstream to downstream stations. Key results pertaining to water quality at BBC1.6 are summarized below.

- **Temperature:** The continuous temperature data showed exceedance of the 7-DADMax criterion for 52 percent of days in WY2022 and 53 percent of days in WY2023 during the monitoring period. While this represents a consistent exceedance of the water quality standards, these were the lowest percentages exceeding the 7-DADMax criterion of any monitoring station for both years.
- **Dissolved Oxygen:** All storm flow events across both water years met the water quality criterion. Several base flow events in both water years were also above the water quality criterion, particularly during the winter and spring, which coincided with the coldest weather and lowest instantaneous water temperature measurements. The median base flow concentration (9.9 mg/L) was just below the water quality criterion.
- **pH:** Instantaneous pH measurements were within water quality criteria for all base and storm events across both water years.
- **Turbidity:** This station had the greatest base and storm flow median turbidity (4.3 NTU and 12 NTU, respectively) of any main stem station, but concentrations were generally not substantially different from main stem stations. All storm flow values were greater than the maximum base flow concentration. The turbidity criterion was exceeded during the storm event on March 13, 2023, when turbidity increased from 52 NTU at BBC2.6 to 66 NTU at BBC1.6 (increase of 14 NTU, or 27 percent). Turbidity at COL0.0 was also high during this event (83 NTU), and likely contributed to the increase at BBC1.6.
- **Chloride:** Base flow chloride concentrations (median of 6.0 mg/L) were generally comparable to other main stem stations. Storm flow chloride concentrations (median of 5.1 mg/L) were also substantially higher than historical values but were within the historical range.
- **Metals:** There were no exceedances for metals during any monitoring event at this station. Median storm flow total (3.6 µg/L) and dissolved (1.9 µg/L) copper concentrations were the second highest or highest of all main stem stations (depending on monitoring event). Median storm flow total zinc (22.9 µg/L) was similar to copper, the highest of all main stem stations. However, median storm flow total zinc (10.8 µg/L) was the second lowest of all monitoring stations. Hardness, which is used to calculate dissolved metals criteria, had a maximum value in WY2022 (206 mg/L) that greatly exceeded the historical maximum (102 mg/L).

- **Nutrients:** The EPA recommended concentrations for total phosphorus and total nitrogen were exceeded for all events at this station. The median base flow total phosphorus concentration (0.111 mg/L) was second highest of any station and the median base flow total nitrogen concentration (2.0 mg/L) was second lowest of any main stem station. Similarly, the median storm flow total phosphorus concentration (0.112 mg/L) was the third highest of any station and the median base flow total nitrogen concentration (1.5 mg/L) was the lowest of any main stem station.
- **Bacteria:** Base flow concentrations were below the fecal coliform and *E. coli* criteria (geometric means of 76 CFU/100 mL and 54 CFU/100 mL, respectively) but storm flow concentrations were both above the fecal coliform and *E. coli* criteria. The geometric mean of the storm flow fecal coliform concentrations (259 CFU/100 mL) was the highest of all main stem stations and the *E. coli* concentrations (geometric mean of 139 CFU/100 mL) were comparable to other main stem stations. Relatively high fecal coliform concentrations at this station during storm events may be driven by the high storm flow concentrations at tributary COL0.0.

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5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Monitoring Stations and Frequency

No changes to monitoring locations or sampling frequency are proposed for WY2024. Building upon the existing dataset will support data analysis activities planned for the WY2024 Trend Analysis report (see Section 5.4, Data Analysis, below) and potential modifications will be reevaluated at that time.

Monitoring at the same 11 stations (and 8 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 144 samples (including 12 duplicate samples).

5.2. Monitoring Parameters and Methods

It is recommended that the monitoring parameters and analytical methods used in recent monitoring be continued in the future, with the following exceptions:

- Discontinue monitoring of dissolved organic carbon. This parameter was added in 2020 for correction of optical brightener measurements and is also used to calculate aquatic toxicity of dissolved copper in some jurisdictions. Optical brighteners are no longer being analyzed and Washington State surface water standards do not use dissolved organic carbon in its calculations for dissolved copper criteria.
- Discontinue monitoring of chloride. This parameter was added in 2020 and can be useful for tracking contamination from septic systems as well as impacts from deicing salts during winter weather. Median base flow chloride concentrations were similar across stations, except at Burton Channel (BUR0.0) where concentrations are elevated relative to other stations. Additional chloride data would not be useful for tracking septic or road salt sources.
- Analyze total and dissolved metals (copper and zinc) and hardness (used for calculating metals criteria) for storm events only. Metals were added to the monitoring program in 2020 for base and storm flow and were measured during storm events in WY2013. Metals criteria were exceeded only during storm events since 2020 and were never exceeded in WY2013.
- Analyze *E. coli* using method SM 9223B by Quanti-Tray at ALS Environmental (Kelso, Washington), discontinuing analysis using method SM 9222D by membrane filtration at LabCor Inc (Seattle, Washington). Several studies have established that *E. coli* results by the Quanti-Tray method are

either statistically similar or more precise than when analyzed by membrane filtration (e.g., Buckalew et al. 2006, Warden et a. 2011, Gibson et al. 2021). In comparison to membrane filtration, the Quanti-Tray method preparation procedures require less sample handling and transfer, which reduces risk of contamination and risk of holding time exceedances by laboratory staff. The method reagent (Colilert or Colilert-18) and incubation of a sealed tray containing the sample, as opposed to a covered plate with growth medium, eliminates interference by confluent growth of other bacteria and results in greater confidence in quantification results.

- Discontinue analysis of fecal coliforms using method SM 9222D by membrane filtration and instead estimate fecal coliform from *E. coli* concentrations in each sample using a simple regression model. The regression model will be developed from long-term fecal coliform and *E. coli* data from Burnt Bridge Creek, for which *E. coli* concentrations historically are strongly correlated with fecal coliform concentrations and typically represent greater than 90 percent of the fecal coliform concentrations. Fecal coliforms will be a primary focus of the near-term Advance Restoration Plan for the state TMLD. Fecal coliforms were replaced with *E. coli* in 2019 as the bacterial indicator for protecting recreational water quality (Ecology 2019), and Ecology supports a transition to *E. coli* monitoring, aligning with their recent TMDL effectiveness monitoring requirements (e.g., as accepted by Ecology in the East Fork Lewis River Alternative Restoration Plan [Ecology 2021]).

5.3. Uncertainty and Data Gaps

Conclusions and recommendations are based on the available data. Alternative causes to impaired water quality and potential solutions may be identified with collection of different types of data. Limitations to current data and potential new areas to investigate are listed below:

- The historical storm data used in this report are limited to 10 monitoring events in the two previous water years. Therefore, comparisons to historical storm data may be more indicative of annual variability than long-term trends.
- Past monitoring in Burnt Bridge Creek has not included stream discharge measurements. Clark County and USGS previously operated gages in the creek, but both have been discontinued.
- The previous monitoring report attributed an increase in bacteria concentrations between BBC8.4 and BBC7.0 to waterfowl at a nearby stormwater treatment pond. However, that trend was not observed during this monitoring period. Median bacteria concentrations were comparable at BBC8.4 and BBC7.0, suggesting that the difference observed in WY2020–WY2021 may not have been due to a greater presence of waterfowl.
- 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 City offers a Sewer Connection Incentive Program (SCIP) to encourage homeowners with septic systems to connect to the sanitary sewer system; however, information on the numbers, dates, and specific locations of sewer connections has not been compared to monitoring data. Data on decommissioned septic systems may help evaluate the effectiveness of the SCIP in reducing sources of pollution to the creek.

5.4. Data Analysis

It is recommended that statistical data analysis follow anticipated procedures and reporting schedule as outlined in the QAPP for the Burnt Bridge Creek Water Quality Monitoring Program 2024–2027 (Herrera 2023). This includes ongoing evaluations of summary statistics (e.g., sample size, minimum, maximum, means, median, percentiles) and water quality criteria comparisons with supporting graphical and tabular representations of the data in each annual report.

Statistical analyses to identify long-term trends among stations, seasons, and hydrologic conditions are recommended to further understand water quality conditions in Burnt Bridge Creek and to support evaluation of the impact of water quality programs. These analyses will be performed for the WY2024 Trend Analysis Report, which will summarize WY2024 study findings, calculate water quality indices, and statistically evaluate water quality trends over time and differences among stations, hydrologic conditions (base versus storm flow), and historical datasets.

Spatial statistical analyses, such as those conducted for the Vancouver Watershed Health Assessment (Herrera and PGG 2019) or the Columbia Slope Water Quality Monitoring Project 2021–2022 Summary Report (Herrera 2022c), are also recommended to better understand the impacts of variables such as land use and land cover, septic and stormwater utilities, population growth, climate change, and source control or habitat restoration on water quality in Burnt Bridge Creek.

Specific statistical and spatial analyses conducted for the WY2024 Trend Analysis Report may include:

- Computation of Kendall Tau correlation coefficients to understand relationships between water quality parameters.
- Seasonal Mann-Kendall tests to evaluate long-term seasonal trends, with rainfall as a covariate.
- Mann-Whitney U (aka Wilcoxon rank-sum) tests to identify differences between historical and contemporary datasets.
- Mann-Whitney U tests to characterize differences in pollutant sources between upstream and downstream reaches.
- Analysis of variance (ANOVA) or Friedman tests with pairwise comparison of sampled stations to determine significant differences in water quality among stations (Helsel and Hirsch 2002).
- Wilcoxon signed rank tests to assess differences in water quality between base and storm events at each monitored station (Helsel and Hirsch 2002).
- Multiple regression analyses to identify basin characteristics (e.g., land cover, population density, septic system density) that have statistically significant relationships with water quality at sampled stations and inform prioritization of areas needing improvement.

5.5. Additional Studies

The monitoring program should be supplemented with additional studies 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. Those studies may be best identified following completion of the WY2024 Trend Analysis Report and Ecology's TMDL ARP, which is noted below, and will focus on temperature, bacteria, DO (and associated oxygen-demanding nutrient inputs), and pH.

Pending recommendations by those reports, additional studies considered to be of greatest potential value include:

- Continuous stream flow monitoring to document low flow conditions, quantify stormwater inputs, evaluate long-term hydrologic trends, and inform fish habitat restoration needs by installing one or more continuous gage stations (e.g., reinstall USGS gages near BBC1.6 or BBC0.0 at the mouth of Vancouver Lake and/or Clark County gage at BBC5.9).
- 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.
- Microbial and pollutant source tracking to locate human fecal inputs from septic systems and human encampments, identify sources of nutrients and fecal bacteria in basins of concern, and evaluate effectiveness of watershed BMPs as source control actions are implemented to quantify water quality improvements and inform adaptive management.
- Partner with the City's Greenway team to perform comprehensive aquatic and riparian vegetation surveys, with particular attention on stream shading and invasive species, to characterize in-stream habitat quality and complexity, evaluate effectiveness of vegetation management, and protect against the spread of invasive species.

Additional studies worthy of consideration include:

- 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.
- Creek substrate (e.g., particle size distribution) study to understand in-stream habitat quality and complexity, and identify areas for improvement, especially related to supporting salmonid beneficial uses.
- Continued shoreline habitat assessments and stability/erosion surveys to inform priority areas for erosion control, flood hazard mitigation, and habitat restoration or reconnection.
- Fish surveys to better understand fish populations in the watershed and inform restoration and/or protection priorities.

5.6. Water Quality Improvement

Ecology is currently developing a TMDL Advance Restoration Plan that will drive activities to address water quality issues prior to the development of a formal TMDL. The desired outcome is for the City to voluntarily meet water quality standards through the implementation of BMPs. The City is already taking an active and multi-faceted approach to improve water quality in the Burnt Bridge Creek Watershed. We recommend that the City continue its existing and planned activities that address pollutant sources (e.g., reduce the number of septic systems through connection to sanitary sewer), reduce water temperature through increased riparian vegetation and urban tree cover, and provide additional treatment of stormwater through construction and maintenance of stormwater facilities. For subbasins impacted by highway runoff, we recommend using WSDOT stormwater funds for stormwater treatment. We also recommend pursuing partnerships and funding for instream restoration such as reconnecting floodplains, restoring wetlands, and addressing erosion of streambanks.

Continuing efforts to increase shade along the creek, particularly in Peterson Channel and in river reaches upstream of river mile 7 is recommended to help reduce high stream temperatures and increase DO concentrations. Future planting of recently acquired property near BBC10.4 will contribute to these efforts, however, green spaces along the creek can be popular areas for human encampments. The effects of human habitation can be detrimental to water quality, particularly bacteria. Increasing services to the houseless community and providing restrooms and dumpsters near encampments may help mitigate impacts to water quality.

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6. REFERENCES

APHA, AWWA, and WEF. 1998. Standard Methods for the Examination of Water and Wastewater. 20th edition. Edited by A.E. Greenberg, American Public Health Association; A.D. Eaton, American Water Works Association; and L.S. Clesceri, Water Environment Federation.

Buckalew, D.W., L.J. Hartman, G.A. Grimsley, A.E. Martin, K.M. Register. 2006. A Long-Term Study Comparing Membrane Filtration with Colilert Defined Substrates in Detecting Fecal Coliforms and *Escherichia coli* in Natural Waters. Journal of Environmental Management (80):191–197.

Clark County. 2020. Quality Assurance Project Plan for Status and Trends: Monitoring of Urban Streams in Clark and Cowlitz Counties in the Lower Columbia River Region. Clark County Public Works, Vancouver, Washington. September.

Clark County. 2023. Lower Columbia Urban Streams (LCUS) Monitoring: Annual Status Report (2021–2022). Clark County Public Works, Clean Water Division, Vancouver, Washington. October.

Ecology. 2008. Burnt Bridge Creek Fecal Coliform Bacteria, Dissolved Oxygen, and Temperature Total Maximum Daily Load, Water Quality Design (Quality Assurance Project Plan). Washington State Department of Ecology, Olympia, Washington. Publication No. 08-03-110. July. <https://fortress.wa.gov/ecy/publications/publications/0803110.pdf>.

Ecology. 2019. Chapter 173-201A WAC Amendments. Adopted January 23, 2019. Effective February 23, 2019. Washington State Department of Ecology. Water Quality Program. Olympia, Washington.

Ecology. 2021. East Fork Lewis River Alternative Restoration Plan. Washington State Department of Ecology. Water Quality Program. Olympia, Washington. Publication No. 21-10-051. October.

EPA. 2001. Ambient Water Quality Criteria Recommendations, Information Supporting the Development of State and Tribal Nutrient Criteria, Rivers and Streams in Nutrient Ecoregion I. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 822-B-01-012. December.

EPA. 2011. Federal Register 40 CFR Part 136 – Guidelines for Establishing Test Procedures for the Analysis of Pollutants. U.S. Environmental Protection Agency, Water Programs, Washington, DC. Accessed May 26, 2011. <https://www.federalregister.gov/documents/2007/03/26/07-1455/guidelines-establishing-test-procedures-for-the-analysis-of-pollutants-analytical-methods-for>.

EPA. 2012. 2012 Recreational Water Quality Criteria. U.S. Environmental Protection Agency. Office of Water. Accessed November 15, 2023. <https://www.epa.gov/sites/production/files/2015-10/documents/rec-factsheet-2012.pdf>.

Finch. 2018. Recreational Use Criteria: Preliminary Decisions. Water Quality Program. Department of Ecology, State of Washington. Accessed January 22, 2019.

Gibson, C.J., A.K. Maritim, J.W. Marion. 2021. Comparison of the ColiPlate™ Kit with Two Common *E. coli* Enumeration Methods for Water. Water 13(13), 1804. <https://doi.org/10.3390/w13131804>.

Helsel, D.R., and R.M. Hirsch. 2002. Statistical Methods in Water Resources, Elsevier, Amsterdam.

Herrera. 2011. Burnt Bridge Creek Ambient Water Quality Monitoring Project – Quality Assurance Project Plan. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Seattle, Washington. August 15.

Herrera. 2012a. Burnt Bridge Creek Ambient Water Quality Monitoring Program – 2011 Monitoring Report. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Seattle, Washington. March 6.

Herrera. 2012b. Burnt Bridge Creek Ambient Water Quality Monitoring Project – Quality Assurance Project Plan: 2012 Addendum. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Seattle, Washington. May 2.

Herrera. 2013a. Burnt Bridge Creek Ambient Water Quality Monitoring Program – 2012 Monitoring Report. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Seattle, Washington. March 27.

Herrera. 2013b. Burnt Bridge Creek Ambient Water Quality Monitoring Project – Quality Assurance Project Plan: 2013 Addendum. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Seattle, Washington. May 29.

Herrera. 2014a. Burnt Bridge Creek Ambient Water Quality Monitoring Program – Monitoring and Trend Analysis Report. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. June 30.

Herrera. 2014b. Burnt Bridge Creek Ambient Water Quality Monitoring Program – Quality Assurance Project Plan: 2014 Ambient Monitoring. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Seattle, Washington. July 3.

Herrera. 2015a. Burnt Bridge Creek Ambient Water Quality Monitoring Program – 2014 Monitoring Report. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. March 10.

Herrera. 2015b. Burnt Bridge Creek 2015 Monitoring – Modifications to QAPP. Technical Memorandum prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. June 15.

Herrera. 2016a. Burnt Bridge Creek Ambient Water Quality Monitoring Program – 2015 Monitoring Report. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. March 24.

Herrera. 2016b. Burnt Bridge Creek 2016 Monitoring – Modifications to QAPP. Technical Memorandum prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. May 26.

Herrera. 2017a. Burnt Bridge Creek Ambient Water Quality Monitoring Program – 2016 Monitoring Report. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. February 21.

Herrera. 2017b. Burnt Bridge Creek 2017 Monitoring – Modifications to QAPP. Technical Memorandum prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. May 17.

Herrera. 2018a. 2017 Trend Analysis Report. Burnt Bridge Creek Ambient Water Quality Monitoring Program. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. March 20.

Herrera. 2018b. Burnt Bridge Creek 2018 Monitoring – Modifications to QAPP. Technical Memorandum prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. May 11.

Herrera. 2019a. Quality Assurance Project Plan: Burnt Bridge Creek Water Quality Monitoring Program 2019–2021. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland Oregon. October 19.

Herrera. 2019b. Burnt Bridge Creek Ambient Water Quality Monitoring Program – 2018 Monitoring Report. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. March 4.

Herrera. 2022a. Burnt Bridge Creek 2021–2023 Monitoring – QAPP Addendum. Technical Memorandum prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. January 26.

Herrera. 2022b. Water Year 2020–2021 Monitoring Report. Burnt Bridge Creek Water Quality Monitoring Program. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. January 25.

Herrera. 2022c. 2021–2022 Summary Report. Columbia Slope Water Quality Monitoring Project. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. July 7.

Herrera. 2023. Quality Assurance Project Plan. Burnt Bridge Creek Water Quality Monitoring Program 2024–2027. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon. December 29.

Herrera and PGG. 2019. Integrated Scientific Assessment Report, Vancouver Watershed Health Assessment. Prepared for the City of Vancouver, Washington, by Herrera Environmental Consultants, Inc., Portland, Oregon, and Pacific Groundwater Group, Seattle, Washington. February 20.

McCarthy, S. 2020. Burnt Bridge Creek Watershed Fecal Coliform Bacteria, Temperature, Dissolved Oxygen, and pH: Source Assessment. Publication 20-03-016. Washington State Department of Ecology, Olympia, Washington. October. <https://fortress.wa.gov/ecy/publications/SummaryPages/2003016.html>.

NPS. 2018. The Cultural Landscape of Fort Vancouver National Historic Site: Indian Country, pre-1824. National Park Service. Updated February 8, 2018. <https://www.nps.gov/articles/fovaclrindiancountry.htm>.

Portland BES. 2023. City of Portland Rainfall HYDRA Network – Hayden Island Rain Gage. Oregon Water Science Center, USGS, Portland, Oregon. Accessed November 16, 2023. <http://or.water.usgs.gov/non-usgs/bes/>.

Tetra Tech. 2015. Burnt Bridge Creek Biologic Condition Assessment: 2015 Monitoring Report. Prepared for City of Vancouver, Washington, by Tetra Tech. November 2015.

Vancouver. 2023. Stormwater Management Action Plan. City of Vancouver, Washington, Surface Water Management. March. <https://www.cityofvancouver.us/wp-content/uploads/2023/06/smap_march_2023.pdf>.

Warden, P.S., M.S. DeSarno, S.E. Volk, J. Eldred. 2011. Evaluation of Colilert-18® for Detection and Enumeration of Fecal Coliform Bacteria in Wastewater Using the U.S. Environmental Protection Agency Alternative Test Procedure Protocol. Journal of AOAC International 94(5):1–8.

WHO. 2003. Chloride in Drinking-Water. Background document for development of WHO Guidelines for drinking-water quality. World Health Organization, Geneva. (WHO/SDE/WSH/03.04/03). Originally published in 1996, revised 2003.

APPENDIX A

Data Quality Assurance Review

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Appendix A: Data Quality Review

Contents

Tables

Field Data

In Situ Measurements

The water quality meter was calibrated before each event, and a calibration check was conducted at the end of the event. All meter calibration checks in WY2022 and WY2023 were within 5 percent of the calibration standard, with the following exceptions:

- During the August 23, 2022, event, upon noticing a consistent pattern of irregularly high conductivity values, the meter was recalibrated for conductivity halfway through sampling, with a recalibrated value of only 56 percent of the initial value. The post-event calibration check was acceptable with a 1 percent difference between the calibration standard and measured value. Conductivity values for those stations monitored before the recalibration were corrected based on a linear interpolation of a two-point calibration curve (y = 0.5559x) generated from the initial and recalibrated values for BBC5.9 and a y-intercept of zero. Adjusted conductivity values and those collected after re-calibration were anomalously low compared to typical stream conductivity readings. All readings were flagged as rejected (R).

Continuous Temperature Loggers

A pre-deployment accuracy check of the temperature loggers was conducted in April 2022 and May 2023 prior their installation using a thermometer certified by National Institute of Standards and Technology (NIST-certified). Temperatures from the NIST-certified thermometer and the temperature loggers were recorded ten times after at least a 20-minute equilibration period in both ice water and ambient water. The average difference between each measurement was within 0.2°C of the NIST-certified thermometer for all deployed probes during the ambient and ice water tests. Several probes did not meet the required 0.2°C average difference but were not deployed at any monitoring stations during either continuous temperature monitoring period.

A post-deployment accuracy check of the temperature loggers was conducted in December 2022 and November 2023 after the probes were retrieved using the same procedures as the pre-deployment accuracy check. The average difference between each measurement was within 0.2°C of the NIST-certified thermometer for all retrieved probes during the ambient and ice water tests with the following exceptions:

- The probe deployed at BBC5.9 and the backup BBC2.6 probe during WY2022 (serial numbers 20374825 and 20894313) failed the initial ice water calibration check but passed the second attempt in accordance with calibration standard operating procedures (SOP).
- The backup probe deployed at BBC1.6 during WY2022 (serial number 20894315) failed both rounds of the ambient and ice water calibration checks. The main probe deployed at BBC1.6 passed both calibration checks so no corrective action was necessary.

- The probes deployed at BBC10.4 and BBC7.0 during WY2023 (serial numbers 20900947 and 21459626, respectively) failed the initial ice water calibration check but passed the second attempt in accordance with calibration SOPs.
- The probe deployed at BBC8.8 during WY2023 (serial number 20900948) failed the initial ambient and ice water calibration checks but passed the second attempt in accordance with calibration SOPs.

Continuous temperature data were complete with the following exceptions:

- Temperature probes were deployed on May 4, 2022, and May 26, 2023, for WY2022 and WY2023, respectively. Because the QAPP-specified continuous temperature monitoring period is from May through October, early-season 7-DADMax exceedances may not be identified. The WY2023 monitoring period start was delayed due to extended lead times for calibration of the reference thermometer used to check the continuous temperature probe calibrations prior to deployment.

Laboratory Data

Measurement quality objectives are presented in Table A-1 below.

Table A-1. Summary of Measurement Quality Objectives and Required Reporting Limits of Field and Laboratory Parameters.

Parameter	Lab Duplicates (RPD[a])	Field Duplicates (RPD[a])	Control Sample (percent recovery)	Matrix Spike (percent recovery)	Reporting Limit
Field Measurements					
Temperature	NA	5	NA	NA	+0.2°C
pH	NA	5	NA	NA	+0.1 std. units
Dissolved Oxygen	NA	5	NA	NA	+0.2 mg/L
Specific Conductivity	NA	5	NA	NA	+2 µS/cm
Laboratory Analysis					
Turbidity	<20	<20	90–110	NA	0.2 NTU
Total suspended solids	<20	<20	85–115	NA	1 mg/L
Nitrate+nitrite nitrogen	<20	<20	90–110	90–110	0.05 mg/L
Total nitrogen	<20	<20	70–130	70–130	0.2 mg/L
Orthophosphate phosphorus	<20	<20	85–115	85–115	0.02 mg/L
Total phosphorus	<20	<20	85–115	85–115	0.02 mg/L
Dissolved organic carbon	<20	<20	80–120	80–120	0.5 mg/L
Hardness as CaCO3	<20	<20	90–120	90–120	2 mg/L
Chloride	<20	<20	90–110	90–110	0.1 mg/L
Copper (total and dissolved)	<20	<20	85–115	85–115	0.1 µg/L
Zinc (total and dissolved)	<20	<20	85–115	NA	2 µg/L
Fecal coliform	<35	<35	NA	NA	2 CFU/100 mL
E. coli bacteria	<35	<35	NA	NA	2 CFU/100 mL

CFU/100 mL = colony forming units per 100 milliliters

µS/cm = microsiemens per centimeter

mg/L = milligrams per liter

µg/L = micrograms per liter

NA = not applicable

NTU = nephelometric turbidity unit

[a] RPD = Relative percent difference, or within two reporting limits if a value is less than five times the reporting limit

Completeness

As noted in the *Data Collection Methods* section of the main report, all scheduled samples were collected, and the laboratory reported all parameters for all samples with the following exceptions:

- One bacteria sample (BUR0.0) collected April 6, 2023, was lost by the laboratory and could not be analyzed.
- The duplicate values for *in situ* measurements were taken but not recorded on June 28, 2023.
- One bacteria sample bottle (COL0.0) that was shipped to LabCor for the July 26, 2023, sampling event was broken in transit, so neither fecal coliform nor *E. coli* analyses were performed for this sample.

Methodology

The laboratories met all analytical method requirements specified in the QAPP (Herrera 2019a[1]). However, abnormally high chloride concentrations of roughly twice the historical values were reported for 9 of the 12 samples during the base flow event on May 11, 2022. Upon further review, it was identified that these nine samples were analyzed at 10x dilutions compared to the 5x dilution used for the three samples that were comparable to historical ranges. Laboratory review concluded that the nine samples were likely analyzed at 5x dilutions and incorrectly entered into laboratory software as 10x dilutions. The nine recalculated chloride results were reported in a revised laboratory report and qualified as estimates (J flag).

Raw data for all fecal coliform and *E. coli* bacteria analyses were reviewed to evaluate whether the plate counts used to calculate the results met quality control objectives established by the method. The quality control objectives established for the fecal coliform and *E. coli* membrane filter procedure (Standard Methods 9222D and 9221 G1c1, respectively, in APHA et al. 1998) are to filter a sample volume that yields an ideal range of 20 to 60 positive colonies on a culture plate to obtain statistically reliable results, and for not more than 200 colonies of all bacteria types to be present on a culture plate to ensure that the results are not underestimated due to crowding (e.g., merged colonies or false negatives). The analysis method also provides guidance for calculation of fecal coliform and *E. coli* density as follows:

- If one of the plate counts is between 20 and 60, then calculate the density for the sample volume yielding a plate count in this ideal range.
- If duplicate sample volumes were analyzed, then calculate the average density for both analyses.
- If all counts are outside the ideal range, then calculate the average density for all sample volumes analyzed, excluding counts greater than 200, by dividing the sum of the plate counts by the sum of the sample volumes.
- If no plate counts less than 200 were obtained, but a plate had a total bacterial colony count greater than 200, then report the density as greater than the value associated with this plate count.

[1] Citations refer to the *References* section of the main report.

- If all plate counts were too numerous to count, then report the density as greater than the value associated with a count of 200 for the smallest sample volume.

Fecal coliform bacteria and *E. coli* results for the Burnt Bridge Creek project were qualified as estimates (J) if the plate count was outside the ideal range of 20 to 60 colonies and were qualified as greater than (>) if the plate count exceeded 200 colonies or was too numerous to count. If there was confluent growth for one volume of a sample, then the volume without confluent growth was used regardless of colony count. If both volumes had confluent growth, then the ideal range rules were followed, and the result was flagged as estimated (J). 69 percent of fecal coliform results and 67 percent of *E. coli* results were flagged as estimates (J) for one or both of the above reasons.

Holding Times

All holding times specified in the QAPP were met with the exception of parameters with shorter holding times (dissolved fraction) and due to laboratory reanalysis of specific samples as requested by Herrera. Results flagged as estimated (J) due to holding time exceedances are detailed in the event Interim Report and include:

- All total phosphorus results collected on June 15, 2022, exceeded holding times due to need for re-analysis. Initial results were analyzed within holding time but rejected because they were substantially lower than the dissolved fraction measured.
- Five SRP results from November 1, 2022, exceeded filtration holding times (31.5 hours versus the objective of 30 hours).
- All dissolved metals results from March 23, 2023, exceeded filtration holding times (92 hours versus the objective of ≤30 hours).

All results with holding time exceedances were flagged as estimated (J flag).

Blanks

No blanks analyzed contained levels of target parameters above the reporting limit.

Control Standards

All control standard samples met the established control limits (see Table A-1).

Matrix Spikes

All matrix spike samples met the established control limits (see Table A-1) with the following exception:

- The matrix spike recovery for chloride for the sample collected on January 5, 2022 (86 percent) was below the 90 to 110 percent range established by the QAPP. One result was qualified as estimated (J).

- The matrix spike recovery for total phosphorus for the sample collected on July 15, 2022 (120 percent) exceeded the 85 to 115 percent range established by the QAPP. One result was qualified as estimated (J).

Laboratory Duplicates

All laboratory duplicate samples met the established control limits specified in the QAPP with the exception of bacteria results flagged as estimated (J) for a number of samples:

- The RPD values for fecal coliform for the laboratory duplicate collected on November 17, 2021 (67 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the laboratory duplicate collected on November 17, 2021 (69 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the laboratory duplicate collected on January 5, 2022 (67 percent) exceeded the 35 percent criterion.
- The RPD values for fecal coliform for the laboratory duplicate collected on February 9, 2022 (38 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the laboratory duplicate collected on March 2, 2022 (58 percent) exceeded the 35 percent criterion.
- The RPD values for fecal coliform for the laboratory duplicate collected on March 21, 2022 (61 percent) exceeded the 35 percent criterion.
- The RPD values for fecal coliform for the laboratory duplicate collected on April 4, 2022 (73 percent) exceeded the 35 percent criterion.
- The laboratory duplicate difference for total phosphorus collected on June 15, 2022 (0.05 mg/L) exceeded the criterion of 0.04 mg/L (two times the reporting limit of 0.02 mg/L).
- The RPD values for fecal coliform for the laboratory duplicate collected on June 15, 2022 (100 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the laboratory duplicate collected on June 15, 2022 (140 percent) exceeded the 35 percent criterion.
- The RPD values for fecal coliform for the laboratory duplicate collected on August 23, 2022 (80 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the laboratory duplicate collected on August 23, 2022 (80 percent) exceeded the 35 percent criterion.
- The RPD values for fecal coliform for the laboratory duplicate collected on November 1, 2022 (72 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the laboratory duplicate collected on November 1, 2022 (80 percent) exceeded the 35 percent criterion.

- The RPD values for *E. coli* for the laboratory duplicate collected on December 14, 2022 (41 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the laboratory duplicate collected on January 25, 2023 (97 percent) exceeded the 35 percent criterion.
- The laboratory duplicate difference for *E. coli* collected on February 7, 2023 (37 CFU/100 mL) exceeded the criterion of 18 CFU/100 mL (two times the reporting limit of 9 CFU/100 mL).
- The RPD values for fecal coliform for the laboratory duplicate collected on March 13, 2023 (56 percent) exceeded the 35 percent criterion.
- The RPD values for fecal coliform for the laboratory duplicate collected on April 6, 2023 (59 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the laboratory duplicate collected on April 6, 2023 (49 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the laboratory duplicate collected on April 26, 2023 (55 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the laboratory duplicate collected on July 26, 2023 (50 percent) exceeded the 35 percent criterion.

Field Duplicates

One field duplicate sample was collected during each sampling event, as specified in the QAPP. Results were flagged as estimate (J) due to field duplicate criteria exceedance most frequently for bacteria, hardness, total suspended solids, and turbidity. The following results were flagged as estimated due to field duplicate RPD or difference exceedances greater than those specified in the QAPP:

- The RPD values for hardness for the field duplicate collected on November 11, 2021 (45 percent) exceeded the 20 percent criterion.
- The RPD values for fecal coliform for the field duplicate collected on November 11, 2021 (69 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the field duplicate collected on November 11, 2021 (69 percent) exceeded the 35 percent criterion.
- The RPD values for fecal coliform for the field duplicate collected on November 17, 2021 (58 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the field duplicate collected on November 17, 2021 (43 percent) exceeded the 35 percent criterion.
- The RPD values for turbidity for the field duplicate collected on January 5, 2022 (42 percent) exceeded the 20 percent criterion.
- The RPD values for fecal coliform for the field duplicate collected on January 5, 2022 (144 percent) exceeded the 35 percent criterion.

- The RPD values for *E. coli* for the field duplicate collected on January 5, 2022 (133 percent) exceeded the 35 percent criterion.
- The RPD values for turbidity for the field duplicate collected on March 21, 2022 (68 percent) exceeded the 20 percent criterion.
- The RPD values for fecal coliform for the field duplicate collected on March 21, 2022 (127 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the field duplicate collected on March 21, 2022 (67 percent) exceeded the 35 percent criterion.
- The RPD values for fecal coliform for the field duplicate collected on May 11, 2022 (115 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the field duplicate collected on May 11, 2022 (115 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the field duplicate collected on June 15, 2022 (37 percent) exceeded the 35 percent criterion.
- The RPD values for hardness for the field duplicate collected on July 16, 2022 (24 percent) exceeded the 20 percent criterion.
- The RPD values for *E. coli* for the field duplicate collected on August 23, 2022 (50 percent) exceeded the 35 percent criterion.
- The RPD values for turbidity for the field duplicate collected on September 21, 2022 (33 percent) exceeded the 20 percent criterion.
- The RPD values for fecal coliform for the field duplicate collected on January 25, 2023 (58 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the field duplicate collected on January 25, 2023 (54 percent) exceeded the 35 percent criterion.
- The RPD values for total suspended solids for the field duplicate collected on April 6, 2023 (25 percent) exceeded the 20 percent criterion.
- The RPD values for *E. coli* for the field duplicate collected on April 6, 2023 (51 percent) exceeded the 35 percent criterion.
- The RPD values for fecal coliform for the field duplicate collected on July 26, 2023 (83 percent) exceeded the 35 percent criterion.
- The RPD values for *E. coli* for the field duplicate collected on July 26, 2023 (46 percent) exceeded the 35 percent criterion.
- The RPD values for fecal coliform for the field duplicate collected on September 6, 2023 (53 percent) exceeded the 35 percent criterion.

Dissolved Versus Total Fraction

Total and dissolved metals and total phosphorus and SRP were flagged as estimates (J) if the dissolved fraction exceeded the total fraction by 20 percent. In addition, laboratory-reported SRP results were consistently abnormally high relative to historical values and associated total phosphorus results during WY2022. All SRP results from February 9 through November 1, 2022, were flagged as rejected (R) due to this discrepancy. The laboratory was aware of potential issues related to low-level SRP analyses at the time and performed internal review of methodology and procedures. No cause was identified, but the issue appears to have been remedied.

In addition to these rejected data, the following results were flagged as estimated (J):

- One SRP and one total phosphorus result from June 28, 2023, qualified as estimated (J) based on SRP exceeding total phosphorus.
- One SRP and one total phosphorus result from February 7, 2023, qualified as estimated (J) based on SRP exceeding total phosphorus.
- Four SRP results from October 4, 2023, qualified as estimated (J) based on SRP exceeding total phosphorus.

APPENDIX B

Water Temperature Probe Calibration Checks

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Table B-1-a. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.

	Probe Serial Number	**031412006 and 11874**		**20900950**			
	Probe Name	**NIST Standard Thermometer**		**BBC10.4_backup**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.70	0.10	0.22	0.02
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.68	0.08	0.22	0.08
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.68	0.08	0.25	0.05
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.68	0.08	0.25	0.05
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.68	0.08	0.27	0.03
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.68	0.08	0.33	0.03
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.68	0.08	0.33	0.03
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.65	0.05	0.33	0.03
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.65	0.05	0.33	0.03
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.65	0.15	0.33	0.03
				Mean Absolute Value	0.08		0.04

Table B-1-b. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20416482**			
	Probe Name	**NIST Standard Thermometer**		**BBC 8.8 (BBC 8.8)**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.65	0.05	0.38	0.18
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.65	0.05	0.38	0.08
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.63	0.03	0.38	0.08
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.63	0.03	0.38	0.08
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.63	0.03	0.38	0.08
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.63	0.03	0.38	0.08
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.63	0.03	0.41	0.11
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.63	0.03	0.41	0.11
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.61	0.01	0.41	0.11
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.61	0.11	0.44	0.14
				Mean Absolute Value	0.04		0.11

Table B-1-c. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20894311**			
	Probe Name	**NIST Standard Thermometer**		**PET 0.0 (PET 0.0)**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.70	0.10	0.41	0.21
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.70	0.10	0.41	0.11
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.68	0.08	0.41	0.11
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.68	0.08	0.41	0.11
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.68	0.08	0.44	0.14
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.68	0.08	0.44	0.14
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.68	0.08	0.44	0.14
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.68	0.08	0.44	0.14
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.68	0.08	0.44	0.14
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.65	0.15	0.44	0.14
				Mean Absolute Value	0.09		0.14

Table B-1-d. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20894317**			
	Probe Name	**NIST Standard Thermometer**		**PET 0.0_backup**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.68	0.08	0.11	0.09
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.68	0.08	0.08	0.22
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.65	0.05	0.11	0.19
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.65	0.05	0.11	0.19
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.65	0.05	0.11	0.19
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.65	0.05	0.11	0.19
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.65	0.05	0.11	0.19
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.65	0.05	0.14	0.16
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.65	0.05	0.14	0.16
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.63	0.13	0.14	0.16
				Mean Absolute Value	0.06		0.17

Table B-1-e. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20900947**			
	Probe Name	**NIST Standard Thermometer**		**BBC 8.4 (BBC 8.4)**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.65	0.05	0.19	0.01
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.65	0.05	0.19	0.11
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.65	0.05	0.19	0.11
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.65	0.05	0.19	0.11
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.63	0.03	0.19	0.11
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.63	0.03	0.19	0.11
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.63	0.03	0.22	0.08
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.63	0.03	0.22	0.08
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.63	0.03	0.22	0.08
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.63	0.13	0.22	0.08
				Mean Absolute Value	0.05		0.09

Table B-1-f. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20374823**			
	Probe Name	**NIST Standard Thermometer**		**BBC7.0**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.58	0.02	0.27	0.07
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.58	0.02	0.27	0.03
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.58	0.02	0.27	0.03
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.56	0.04	0.25	0.05
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.56	0.04	0.25	0.05
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.56	0.04	0.27	0.03
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.56	0.04	0.27	0.03
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.56	0.04	0.27	0.03
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.56	0.04	0.27	0.03
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.53	0.03	0.27	0.03
				Mean Absolute Value	0.03		0.04

Table B-1-g. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.							
Probe Serial Number		**031412006 and 11874**		**20374825**			
Probe Name		**NIST Standard Thermometer**		**BBC5.9**			
Temperature		**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.65	0.05	0.38	0.18
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.65	0.05	0.38	0.08
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.65	0.05	0.38	0.08
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.65	0.05	0.41	0.11
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.65	0.05	0.41	0.11
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.65	0.05	0.41	0.11
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.63	0.03	0.41	0.11
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.63	0.03	0.41	0.11
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.63	0.03	0.41	0.11
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.63	0.13	0.41	0.11
				Mean Absolute Value	0.05		0.11

Table B-1-h. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20900949**			
	Probe Name	**NIST Standard Thermometer**		**BBC2.6**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.68	0.08	0.30	0.10
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.65	0.05	0.33	0.03
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.65	0.05	0.33	0.03
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.65	0.05	0.33	0.03
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.65	0.05	0.33	0.03
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.65	0.05	0.33	0.03
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.65	0.05	0.33	0.03
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.63	0.03	0.36	0.06
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.63	0.03	0.36	0.06
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.63	0.13	0.36	0.06
				Mean Absolute Value	0.06		0.05

Table B-1-i. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.							
Probe Serial Number		**031412006 and 11874**		**20894313**			
Probe Name		**NIST Standard Thermometer**		**BBC2.6_backup**			
Temperature		**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.63	0.03	0.08	0.12
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.63	0.03	0.08	0.22
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.63	0.03	0.08	0.22
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.63	0.03	0.11	0.19
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.63	0.03	0.11	0.19
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.63	0.03	0.11	0.19
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.63	0.03	0.11	0.19
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.61	0.01	0.11	0.19
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.61	0.01	0.11	0.19
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.61	0.09	0.11	0.19
				Mean Absolute Value	0.03		0.19

Table B-1-j. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.

	Probe Serial Number	**031412006 and 11874**		**20900946**			
	Probe Name	**NIST Standard Thermometer**		**BBC1.6**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.68	0.08	0.19	0.01
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.65	0.05	0.19	0.11
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.65	0.05	0.19	0.11
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.65	0.05	0.19	0.11
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.65	0.05	0.19	0.11
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.65	0.05	0.19	0.11
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.65	0.05	0.19	0.11
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.63	0.03	0.19	0.11
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.63	0.03	0.19	0.11
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.63	0.13	0.19	0.11
				Mean Absolute Value	0.06		0.10

Table B-1-k. Continuous Temperature Probe 2022 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20894315**			
	Probe Name	**NIST Standard Thermometer**		**BBC1.6_backup**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
4/22/2022 14:45	4/22/2022 9:55	17.6	0.2	17.63	0.03	0.16	0.04
4/22/2022 14:50	4/22/2022 10:00	17.6	0.3	17.63	0.03	0.16	0.14
4/22/2022 14:55	4/22/2022 10:05	17.6	0.3	17.63	0.03	0.16	0.14
4/22/2022 15:00	4/22/2022 10:10	17.6	0.3	17.61	0.01	0.16	0.14
4/22/2022 15:05	4/22/2022 10:15	17.6	0.3	17.61	0.01	0.16	0.14
4/22/2022 15:10	4/22/2022 10:20	17.6	0.3	17.61	0.01	0.16	0.14
4/22/2022 15:15	4/22/2022 10:25	17.6	0.3	17.61	0.01	0.16	0.14
4/22/2022 15:20	4/22/2022 10:30	17.6	0.3	17.61	0.01	0.16	0.14
4/22/2022 15:25	4/22/2022 10:35	17.6	0.3	17.58	0.02	0.19	0.11
4/22/2022 15:30	4/22/2022 10:40	17.5	0.3	17.58	0.08	0.19	0.11
				Mean Absolute Value	0.02		0.12

Table B-2-a. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.							
Probe Serial Number		**031412006 and 11874**		**20900950**			
Probe Name		**NIST Standard Thermometer**		**BBC10.4_backup**			
Temperature		**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/10/2022 10:10	12/11/2022 14:35	21.2	0.3	20.97	0.23	0.44	0.14
12/10/2022 10:15	12/11/2022 14:40	21.2	0.3	21.04	0.16	0.46	0.16
12/10/2022 10:20	12/11/2022 14:45	21.2	0.3	21.04	0.16	0.46	0.16
12/10/2022 10:25	12/11/2022 14:50	21.1	0.3	21.04	0.06	0.46	0.16
12/10/2022 10:30	12/11/2022 14:55	21.1	0.3	21.12	0.02	0.46	0.16
12/10/2022 10:35	12/11/2022 15:00	21.2	0.3	21.12	0.08	0.48	0.18
12/10/2022 10:40	12/11/2022 15:05	21.2	0.3	21.08	0.12	0.48	0.18
12/10/2022 10:45	12/11/2022 15:10	21.2	0.3	21.08	0.12	0.53	0.23
12/10/2022 10:50	12/11/2022 15:15	21.2	0.3	21.04	0.16	0.53	0.23
12/10/2022 10:55	12/11/2022 15:20	21.2	0.3	21.04	0.16	0.53	0.23
Mean Absolute Value					0.13		0.18

Table B-2-b. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20416482**			
	Probe Name	**NIST Standard Thermometer**		**BBC 8.8 (BBC 8.8)**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/10/2022 10:10	12/11/2022 14:35	21.2	0.3	21.33	0.13	0.55	0.25
12/10/2022 10:15	12/11/2022 14:40	21.2	0.3	21.33	0.13	0.52	0.22
12/10/2022 10:20	12/11/2022 14:45	21.2	0.3	21.29	0.09	0.52	0.22
12/10/2022 10:25	12/11/2022 14:50	21.1	0.3	21.29	0.19	0.49	0.19
12/10/2022 10:30	12/11/2022 14:55	21.1	0.3	21.29	0.19	0.47	0.17
12/10/2022 10:35	12/11/2022 15:00	21.2	0.3	21.29	0.09	0.47	0.17
12/10/2022 10:40	12/11/2022 15:05	21.2	0.3	21.29	0.09	0.47	0.17
12/10/2022 10:45	12/11/2022 15:10	21.2	0.3	21.29	0.09	0.44	0.14
12/10/2022 10:50	12/11/2022 15:15	21.2	0.3	21.29	0.09	0.44	0.14
12/10/2022 10:55	12/11/2022 15:20	21.2	0.3	21.29	0.09	0.44	0.14
				Mean Absolute Value	0.12		0.18

Table B-2-c. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20894311**			
	Probe Name	**NIST Standard Thermometer**		**PET 0.0 (PET 0.0)**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/10/2022 10:10	12/11/2022 14:35	21.2	0.3	21.34	0.14	0.33	0.03
12/10/2022 10:15	12/11/2022 14:40	21.2	0.3	21.37	0.17	0.33	0.03
12/10/2022 10:20	12/11/2022 14:45	21.2	0.3	21.37	0.17	0.33	0.03
12/10/2022 10:25	12/11/2022 14:50	21.1	0.3	21.34	0.24	0.33	0.03
12/10/2022 10:30	12/11/2022 14:55	21.1	0.3	21.37	0.27	0.36	0.06
12/10/2022 10:35	12/11/2022 15:00	21.2	0.3	21.37	0.17	0.36	0.06
12/10/2022 10:40	12/11/2022 15:05	21.2	0.3	21.37	0.17	0.36	0.06
12/10/2022 10:45	12/11/2022 15:10	21.2	0.3	21.37	0.17	0.36	0.06
12/10/2022 10:50	12/11/2022 15:15	21.2	0.3	21.34	0.14	0.36	0.06
12/10/2022 10:55	12/11/2022 15:20	21.2	0.3	21.34	0.14	0.36	0.06
				Mean Absolute Value	0.18		0.05

Table B-2-d. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.							
Probe Serial Number		**031412006 and 11874**		**20894317**			
Probe Name		**NIST Standard Thermometer**		**PET 0.0_backup**			
Temperature		**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/10/2022 10:10	12/11/2022 14:35	21.2	0.3	21.40	0.20	0.52	0.22
12/10/2022 10:15	12/11/2022 14:40	21.2	0.3	21.40	0.20	0.52	0.22
12/10/2022 10:20	12/11/2022 14:45	21.2	0.3	21.37	0.17	0.52	0.22
12/10/2022 10:25	12/11/2022 14:50	21.1	0.3	21.37	0.27	0.49	0.19
12/10/2022 10:30	12/11/2022 14:55	21.1	0.3	21.34	0.24	0.46	0.16
12/10/2022 10:35	12/11/2022 15:00	21.2	0.3	21.34	0.14	0.49	0.19
12/10/2022 10:40	12/11/2022 15:05	21.2	0.3	21.34	0.14	0.49	0.19
12/10/2022 10:45	12/11/2022 15:10	21.2	0.3	21.34	0.14	0.52	0.22
12/10/2022 10:50	12/11/2022 15:15	21.2	0.3	21.34	0.14	0.52	0.22
12/10/2022 10:55	12/11/2022 15:20	21.2	0.3	21.34	0.14	0.49	0.19
				Mean Absolute Value	0.18		0.20

Table B-2-e. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20900947**			
	Probe Name	**NIST Standard Thermometer**		**BBC 8.4 (BBC 8.4)**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/10/2022 10:10	12/11/2022 14:35	21.2	0.3	21.22	0.02	0.16	0.14
12/10/2022 10:15	12/11/2022 14:40	21.2	0.3	21.22	0.02	0.19	0.11
12/10/2022 10:20	12/11/2022 14:45	21.2	0.3	21.25	0.05	0.19	0.11
12/10/2022 10:25	12/11/2022 14:50	21.1	0.3	21.28	0.18	0.22	0.08
12/10/2022 10:30	12/11/2022 14:55	21.1	0.3	21.28	0.18	0.22	0.08
12/10/2022 10:35	12/11/2022 15:00	21.2	0.3	21.25	0.05	0.19	0.11
12/10/2022 10:40	12/11/2022 15:05	21.2	0.3	21.22	0.02	0.22	0.08
12/10/2022 10:45	12/11/2022 15:10	21.2	0.3	21.22	0.02	0.22	0.08
12/10/2022 10:50	12/11/2022 15:15	21.2	0.3	21.22	0.02	0.19	0.11
12/10/2022 10:55	12/11/2022 15:20	21.2	0.3	21.22	0.02	0.22	0.08
				Mean Absolute Value	0.06		0.10

Table B-2-f. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20374823**			
	Probe Name	**NIST Standard Thermometer**		**BBC7.0**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/10/2022 10:10	12/11/2022 14:35	21.2	0.3	21.04	0.16	0.33	0.03
12/10/2022 10:15	12/11/2022 14:40	21.2	0.3	21.04	0.16	0.33	0.03
12/10/2022 10:20	12/11/2022 14:45	21.2	0.3	21.04	0.16	0.36	0.06
12/10/2022 10:25	12/11/2022 14:50	21.1	0.3	21.04	0.06	0.36	0.06
12/10/2022 10:30	12/11/2022 14:55	21.1	0.3	21.04	0.06	0.36	0.06
12/10/2022 10:35	12/11/2022 15:00	21.2	0.3	21.04	0.16	0.36	0.06
12/10/2022 10:40	12/11/2022 15:05	21.2	0.3	21.04	0.16	0.36	0.06
12/10/2022 10:45	12/11/2022 15:10	21.2	0.3	21.04	0.16	0.36	0.06
12/10/2022 10:50	12/11/2022 15:15	21.2	0.3	21.04	0.16	0.36	0.06
12/10/2022 10:55	12/11/2022 15:20	21.2	0.3	21.04	0.16	0.36	0.06
				Mean Absolute Value	0.14		0.05

Table B-2-g. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20374825**			
	Probe Name	**NIST Standard Thermometer**		**BBC5.9**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/10/2022 10:10	12/17/2022 9:10	21.2	0.1	21.12	0.08	0.36	0.26
12/10/2022 10:15	12/17/2022 9:15	21.2	0.1	21.12	0.08	0.32	0.22
12/10/2022 10:20	12/17/2022 9:20	21.2	0.1	21.10	0.10	0.32	0.22
12/10/2022 10:25	12/17/2022 9:25	21.1	0.2	21.12	0.02	0.32	0.12
12/10/2022 10:30	12/17/2022 9:30	21.1	0.2	21.12	0.02	0.36	0.16
12/10/2022 10:35	12/17/2022 9:35	21.2	0.2	21.12	0.08	0.36	0.16
12/10/2022 10:40	12/17/2022 9:40	21.2	0.2	21.12	0.08	0.36	0.16
12/10/2022 10:45	12/17/2022 9:45	21.2	0.2	21.12	0.08	0.36	0.16
12/10/2022 10:50	12/17/2022 9:50	21.2	0.2	21.12	0.08	0.36	0.16
12/10/2022 10:55	12/17/2022 9:55	21.2	0.2	21.12	0.08	0.36	0.16
				Mean Absolute Value	0.07		0.18

Table B-2-h. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.

	Probe Serial Number	**031412006 and 11874**		**20900949**			
	Probe Name	**NIST Standard Thermometer**		**BBC2.6**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/10/2022 10:10	12/11/2022 14:35	21.2	0.3	20.92	0.28	0.48	0.18
12/10/2022 10:15	12/11/2022 14:40	21.2	0.3	20.96	0.24	0.48	0.18
12/10/2022 10:20	12/11/2022 14:45	21.2	0.3	21.00	0.20	0.48	0.18
12/10/2022 10:25	12/11/2022 14:50	21.1	0.3	21.04	0.06	0.48	0.18
12/10/2022 10:30	12/11/2022 14:55	21.1	0.3	21.04	0.06	0.48	0.18
12/10/2022 10:35	12/11/2022 15:00	21.2	0.3	21.00	0.20	0.52	0.22
12/10/2022 10:40	12/11/2022 15:05	21.2	0.3	20.96	0.24	0.52	0.22
12/10/2022 10:45	12/11/2022 15:10	21.2	0.3	20.96	0.24	0.52	0.22
12/10/2022 10:50	12/11/2022 15:15	21.2	0.3	21.02	0.18	0.52	0.22
12/10/2022 10:55	12/11/2022 15:20	21.2	0.3	21.02	0.18	0.52	0.22
				Mean Absolute Value	0.19		0.20

Table B-2-i. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20894313**			
	Probe Name	**NIST Standard Thermometer**		**BBC2.6_backup**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/10/2022 10:10	12/17/2022 9:10	21.2	0.1	21.29	0.09	-0.02	0.12
12/10/2022 10:15	12/17/2022 9:15	21.2	0.1	21.29	0.09	0.07	0.03
12/10/2022 10:20	12/17/2022 9:20	21.2	0.1	21.29	0.09	0.01	0.09
12/10/2022 10:25	12/17/2022 9:25	21.1	0.2	21.29	0.19	0.04	0.16
12/10/2022 10:30	12/17/2022 9:30	21.1	0.2	21.29	0.19	0.07	0.13
12/10/2022 10:35	12/17/2022 9:35	21.2	0.2	21.29	0.09	0.07	0.13
12/10/2022 10:40	12/17/2022 9:40	21.2	0.2	21.29	0.09	0.04	0.16
12/10/2022 10:45	12/17/2022 9:45	21.2	0.2	21.29	0.09	0.04	0.16
12/10/2022 10:50	12/17/2022 9:50	21.2	0.2	21.29	0.09	0.04	0.16
12/10/2022 10:55	12/17/2022 9:55	21.2	0.2	21.29	0.09	0.04	0.16
				Mean Absolute Value	0.11		0.13

Table B-2-j. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.

	Probe Serial Number	031412006 and 11874		20900946			
	Probe Name	**NIST Standard Thermometer**		**BBC1.6**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/10/2022 10:10	12/11/2022 14:35	21.2	0.3	20.98	0.22	0.46	0.16
12/10/2022 10:15	12/11/2022 14:40	21.2	0.3	20.98	0.22	0.46	0.16
12/10/2022 10:20	12/11/2022 14:45	21.2	0.3	20.98	0.22	0.43	0.13
12/10/2022 10:25	12/11/2022 14:50	21.1	0.3	20.98	0.12	0.43	0.13
12/10/2022 10:30	12/11/2022 14:55	21.1	0.3	20.98	0.12	0.43	0.13
12/10/2022 10:35	12/11/2022 15:00	21.2	0.3	20.98	0.22	0.56	0.26
12/10/2022 10:40	12/11/2022 15:05	21.2	0.3	20.98	0.22	0.43	0.13
12/10/2022 10:45	12/11/2022 15:10	21.2	0.3	20.98	0.22	0.43	0.13
12/10/2022 10:50	12/11/2022 15:15	21.2	0.3	20.98	0.22	0.46	0.16
12/10/2022 10:55	12/11/2022 15:20	21.2	0.3	20.98	0.22	0.46	0.16
				Mean Absolute Value	0.20		0.16

Table B-2-k. Continuous Temperature Probe 2022 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20894315**			
	Probe Name	**NIST Standard Thermometer**		**BBC1.6_backup**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
12/17/2022 16:50	12/17/2022 9:10	20.9	0.1	21.34	0.44	0.50	0.40
12/17/2022 16:55	12/17/2022 9:15	20.9	0.1	21.34	0.44	0.50	0.40
12/17/2022 17:00	12/17/2022 9:20	20.9	0.1	21.34	0.44	0.50	0.40
12/17/2022 17:05	12/17/2022 9:25	20.9	0.2	21.34	0.44	0.50	0.30
12/17/2022 17:10	12/17/2022 9:30	20.9	0.2	21.41	0.51	0.50	0.30
12/17/2022 17:15	12/17/2022 9:35	20.9	0.2	21.37	0.47	0.53	0.33
12/17/2022 17:20	12/17/2022 9:40	20.9	0.2	21.37	0.47	0.53	0.33
12/17/2022 17:25	12/17/2022 9:45	20.9	0.2	21.37	0.47	0.53	0.33
12/17/2022 17:30	12/17/2022 9:50	20.9	0.2	21.37	0.47	0.53	0.33
12/17/2022 17:35	12/17/2022 9:55	20.9	0.2	21.37	0.47	0.53	0.33
				Mean Absolute Value	0.46		0.35

Table B-3-a. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.

	Probe Serial Number	**031412006 and 11874**		**20900947**			
	Probe Name	**NIST Standard Thermometer**		**BBC 10.4**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23	0.3	0.1	0.2
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.1	0.2	0.1	0.2
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.1	0.2	0.1	0.2
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.1	0.2	0.1	0.2
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.1	0.2	0.2	0.2
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.1	0.2	0.2	0.2
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.1	0.2	0.2	0.2
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.1	0.2	0.2	0.2
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.1	0.2	0.2	0.2
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.1	0.2	0.2	0.2
				Mean Absolute Value	0.2		0.2

Table B-3-b. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20900948**			
	Probe Name	**NIST Standard Thermometer**		**BBC 8.8**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23.2	0.1	0.3	0.0
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.2	0.1	0.3	0.0
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.2	0.1	0.3	0.0
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.2	0.1	0.3	0.0
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.2	0.1	0.3	0.1
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.2	0.1	0.3	0.1
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.2	0.1	0.3	0.1
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.2	0.1	0.3	0.1
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.2	0.1	0.3	0.1
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.2	0.1	0.3	0.1
				Mean Absolute Value	0.1		0.1

Table B-3-c. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.							
Probe Serial Number		**031412006 and 11874**		**20894313**			
Probe Name		**NIST Standard Thermometer**		**PET 0.0**			
Temperature		**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23.3	0.0	0.1	0.2
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.3	0.0	0.2	0.1
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.3	0.0	0.2	0.1
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.3	0.0	0.2	0.1
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.3	0.0	0.2	0.2
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.3	0.0	0.2	0.2
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.3	0.0	0.2	0.2
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.3	0.0	0.2	0.2
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.4	0.1	0.2	0.2
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.3	0.0	0.2	0.2
Mean Absolute Value					0.0		0.2

Table B-3-d. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20900949**			
	Probe Name	**NIST Standard Thermometer**		**PET 0.0 Backup**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23.0	0.3	0.3	0.0
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.0	0.3	0.3	0.0
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.0	0.3	0.3	0.0
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.0	0.3	0.3	0.0
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.1	0.2	0.3	0.1
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.1	0.2	0.3	0.1
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.1	0.2	0.3	0.1
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.1	0.2	0.3	0.1
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.1	0.2	0.3	0.1
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.1	0.2	0.3	0.1
				Mean Absolute Value	0.2		0.1

Table B-3-e. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**21459623**			
	Probe Name	**NIST Standard Thermometer**		**BBC 8.4**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23.3	0.0	0.2	0.1
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.3	0.0	0.2	0.1
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.3	0.0	0.2	0.1
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.3	0.0	0.2	0.1
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.3	0.0	0.2	0.2
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.3	0.0	0.2	0.2
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.3	0.0	0.2	0.2
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.3	0.0	0.2	0.2
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.3	0.0	0.2	0.2
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.3	0.0	0.2	0.2
				Mean Absolute Value	0.0		0.2

Table B-3-f. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.							
Probe Serial Number		**031412006 and 11874**		**21459626**			
Probe Name		**NIST Standard Thermometer**		**BBC 7.0**			
Temperature		**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23.2	0.1	0.2	0.1
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.2	0.1	0.2	0.1
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.2	0.1	0.2	0.1
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.2	0.1	0.2	0.1
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.2	0.1	0.2	0.2
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.2	0.1	0.2	0.2
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.2	0.1	0.2	0.2
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.2	0.1	0.2	0.2
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.2	0.1	0.2	0.2
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.3	0.0	0.2	0.2
				Mean Absolute Value	0.1		0.2

Table B-3-g. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20894315**			
	Probe Name	**NIST Standard Thermometer**		**BBC 5.9**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23.2	0.1	0.6	0.3
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.2	0.1	0.6	0.3
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.1	0.2	0.6	0.3
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.1	0.2	0.6	0.3
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.1	0.2	0.6	0.2
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.1	0.2	0.6	0.2
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.1	0.2	0.6	0.2
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.1	0.2	0.6	0.2
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.1	0.2	0.6	0.2
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.1	0.2	0.6	0.2
				Mean Absolute Value	0.2		0.2

Table B-3-h. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20900946**			
	Probe Name	**NIST Standard Thermometer**		**BBC 2.6**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23.5	0.2	0.4	0.1
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.5	0.2	0.5	0.2
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.5	0.2	0.5	0.2
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.5	0.2	0.6	0.3
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.5	0.2	0.6	0.2
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.5	0.2	0.6	0.2
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.5	0.2	0.6	0.2
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.5	0.2	0.6	0.2
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.5	0.2	0.6	0.2
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.5	0.2	0.6	0.2
				Mean Absolute Value	0.2		0.2

Table B-3-i. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20894317**			
	Probe Name	**NIST Standard Thermometer**		**BBC 2.6 Backup**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23.3	0.0	0.1	0.2
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.4	0.1	0.2	0.1
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.4	0.1	0.2	0.1
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.4	0.1	0.2	0.1
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.4	0.1	0.2	0.2
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.4	0.1	0.2	0.2
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.4	0.1	0.2	0.2
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.4	0.1	0.2	0.2
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.5	0.2	0.2	0.2
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.5	0.2	0.2	0.2
				Mean Absolute Value	0.1		0.2

Table B-3-j. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.

	Probe Serial Number	**031412006 and 11874**		**21459624**			
	Probe Name	**NIST Standard Thermometer**		**BBC 1.6**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23.4	0.1	0.5	0.2
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.4	0.1	0.5	0.2
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.4	0.1	0.5	0.2
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.5	0.2	0.5	0.2
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.5	0.2	0.5	0.1
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.5	0.2	0.5	0.1
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.5	0.2	0.5	0.1
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.5	0.2	0.5	0.1
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.5	0.2	0.5	0.1
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.5	0.2	0.5	0.1
				Mean Absolute Value	0.2		0.1

Table B-3-k. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20416480**			
	Probe Name	**NIST Standard Thermometer**		**BBC 1.6 Backup**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3	23.6	0.3	0.5	0.2
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3	23.5	0.2	0.5	0.2
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3	23.5	0.2	0.5	0.2
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3	23.5	0.2	0.5	0.2
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4	23.5	0.2	0.5	0.1
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4	23.5	0.2	0.5	0.1
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4	23.5	0.2	0.5	0.1
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4	23.5	0.2	0.5	0.1
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4	23.5	0.2	0.5	0.1
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4	23.5	0.2	0.5	0.1
				Mean Absolute Value	0.2		0.1

Table B-3-l. Continuous Temperature Probe 2023 Pre-Deployment Accuracy Check.							
Probe Serial Number		**031412006 and 11874**					
Probe Name		**NIST Standard Thermometer**					
Temperature		**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
5/20/2023 10:50	5/22/2023 7:35	23.3	0.3				
5/20/2023 10:55	5/22/2023 7:40	23.3	0.3				
5/20/2023 11:00	5/22/2023 7:45	23.3	0.3				
5/20/2023 11:05	5/22/2023 7:50	23.3	0.3				
5/20/2023 11:10	5/22/2023 7:55	23.3	0.4				
5/20/2023 11:15	5/22/2023 8:00	23.3	0.4				
5/20/2023 11:20	5/22/2023 8:05	23.3	0.4				
5/20/2023 11:25	5/22/2023 8:10	23.3	0.4				
5/20/2023 11:30	5/22/2023 8:15	23.3	0.4				
5/20/2023 11:35	5/22/2023 8:20	23.3	0.4				
Mean Absolute Value							

Table B-4-a. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20900947**			
	Probe Name	**NIST Standard Thermometer**		**BBC 10.4**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/4/23 11:35	11/11/23 7:55	20.2	0.0	20.1	0.1	-0.2	0.2
11/4/23 11:40	11/11/23 8:00	20.2	0.0	20.1	0.1	-0.1	0.1
11/4/23 11:45	11/11/23 8:05	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 11:50	11/11/23 8:10	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 11:55	11/11/23 8:15	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 12:00	11/11/23 8:20	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 12:05	11/11/23 8:25	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 12:10	11/11/23 8:30	20.2	0.1	20.2	0.0	-0.1	0.2
11/4/23 12:15	11/11/23 8:35	20.2	0.1	20.2	0.0	-0.1	0.2
11/4/23 12:20	11/11/23 8:40	20.2	0.1	20.2	0.0	-0.1	0.2
				Mean Absolute Value	0.07		0.19

Table B-4-b. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.

	Probe Serial Number	**031412006 and 11874**		**20900948**			
	Probe Name	**NIST Standard Thermometer**		**BBC 8.8**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/11/23 17:10	11/11/23 7:55	21.0	0.0	20.8	0.2	0.2	0.2
11/11/23 17:15	11/11/23 8:00	21.0	0.0	20.8	0.2	0.2	0.2
11/11/23 17:20	11/11/23 8:05	21.0	0.1	20.8	0.2	0.2	0.1
11/11/23 17:25	11/11/23 8:10	21.0	0.1	20.9	0.1	0.2	0.1
11/11/23 17:30	11/11/23 8:15	21.0	0.1	20.9	0.1	0.2	0.1
11/11/23 17:35	11/11/23 8:20	21.0	0.1	20.9	0.1	0.2	0.1
11/11/23 17:40	11/11/23 8:25	21.0	0.1	20.9	0.1	0.2	0.1
11/11/23 17:45	11/11/23 8:30	21.0	0.1	20.9	0.1	0.2	0.1
11/11/23 17:50	11/11/23 8:35	21.0	0.1	20.9	0.1	0.2	0.1
11/11/23 17:55	11/11/23 8:40	21.0	0.1	21.0	0.0	0.2	0.1
				Mean Absolute Value	0.12		0.12

Table B-4-c. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20894313**			
	Probe Name	**NIST Standard Thermometer**		**PET 0.0**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/4/23 11:35	11/5/23 8:15	20.2	0.1	20.4	0.2	0.1	0.0
11/4/23 11:40	11/5/23 8:20	20.2	0.2	20.4	0.2	0.2	0.0
11/4/23 11:45	11/5/23 8:25	20.2	0.1	20.4	0.2	0.2	0.1
11/4/23 11:50	11/5/23 8:30	20.2	0.1	20.4	0.2	0.2	0.1
11/4/23 11:55	11/5/23 8:35	20.2	0.1	20.4	0.2	0.3	0.2
11/4/23 12:00	11/5/23 8:40	20.2	0.1	20.3	0.1	0.3	0.2
11/4/23 12:05	11/5/23 8:45	20.2	0.1	20.3	0.1	0.3	0.2
11/4/23 12:10	11/5/23 8:50	20.2	0.1	20.3	0.1	0.3	0.2
11/4/23 12:15	11/5/23 8:55	20.2	0.1	20.3	0.1	0.3	0.2
11/4/23 12:20	11/5/23 9:00	20.2	0.1	20.3	0.1	0.3	0.2
				Mean Absolute Value	0.15		0.14

Table B-4-d. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20900949**			
	Probe Name	**NIST Standard Thermometer**		**PET 0.0 Backup**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/4/23 11:35	11/5/23 8:15	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 11:40	11/5/23 8:20	20.2	0.2	20.0	0.2	-0.1	0.3
11/4/23 11:45	11/5/23 8:25	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 11:50	11/5/23 8:30	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 11:55	11/5/23 8:35	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 12:00	11/5/23 8:40	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 12:05	11/5/23 8:45	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 12:10	11/5/23 8:50	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 12:15	11/5/23 8:55	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 12:20	11/5/23 9:00	20.2	0.1	20.0	0.2	0.1	0.0
				Mean Absolute Value	0.20		0.11

Table B-4-e. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.

	Probe Serial Number	**031412006 and 11874**		**21459623**			
	Probe Name	**NIST Standard Thermometer**		**BBC 8.4**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/4/23 11:35	11/5/23 8:15	20.2	0.1	20.2	0.0	-0.1	0.2
11/4/23 11:40	11/5/23 8:20	20.2	0.2	20.2	0.0	-0.1	0.3
11/4/23 11:45	11/5/23 8:25	20.2	0.1	20.2	0.0	-0.1	0.2
11/4/23 11:50	11/5/23 8:30	20.2	0.1	20.2	0.0	-0.1	0.2
11/4/23 11:55	11/5/23 8:35	20.2	0.1	20.2	0.0	-0.1	0.2
11/4/23 12:00	11/5/23 8:40	20.2	0.1	20.2	0.0	-0.1	0.2
11/4/23 12:05	11/5/23 8:45	20.2	0.1	20.2	0.0	-0.1	0.2
11/4/23 12:10	11/5/23 8:50	20.2	0.1	20.2	0.0	-0.1	0.2
11/4/23 12:15	11/5/23 8:55	20.2	0.1	20.2	0.0	0.0	0.1
11/4/23 12:20	11/5/23 9:00	20.2	0.1	20.2	0.0	0.0	0.1
				Mean Absolute Value	0.00		0.19

Table B-4-f. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**21459626**			
	Probe Name	**NIST Standard Thermometer**		**BBC 7.0**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/4/23 11:35	11/11/23 7:55	20.2	0.0	20.1	0.1	-0.1	0.1
11/4/23 11:40	11/11/23 8:00	20.2	0.0	20.1	0.1	-0.1	0.1
11/4/23 11:45	11/11/23 8:05	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 11:50	11/11/23 8:10	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 11:55	11/11/23 8:15	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 12:00	11/11/23 8:20	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 12:05	11/11/23 8:25	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 12:10	11/11/23 8:30	20.2	0.1	20.0	0.2	-0.1	0.2
11/4/23 12:15	11/11/23 8:35	20.2	0.1	20.1	0.1	-0.1	0.2
11/4/23 12:20	11/11/23 8:40	20.2	0.1	20.1	0.1	-0.1	0.2
				Mean Absolute Value	0.11		0.18

Table B-4-g. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.

	Probe Serial Number	**031412006 and 11874**		**20894315**			
	Probe Name	**NIST Standard Thermometer**		**BBC 5.9**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/4/23 11:35	11/5/23 8:15	20.2	0.1	20.1	0.1	0.2	0.1
11/4/23 11:40	11/5/23 8:20	20.2	0.2	20.1	0.1	0.3	0.1
11/4/23 11:45	11/5/23 8:25	20.2	0.1	20.1	0.1	0.3	0.2
11/4/23 11:50	11/5/23 8:30	20.2	0.1	20.1	0.1	0.3	0.2
11/4/23 11:55	11/5/23 8:35	20.2	0.1	20.1	0.1	0.3	0.2
11/4/23 12:00	11/5/23 8:40	20.2	0.1	20.1	0.1	0.3	0.2
11/4/23 12:05	11/5/23 8:45	20.2	0.1	20.0	0.2	0.3	0.2
11/4/23 12:10	11/5/23 8:50	20.2	0.1	20.0	0.2	0.3	0.2
11/4/23 12:15	11/5/23 8:55	20.2	0.1	20.0	0.2	0.4	0.3
11/4/23 12:20	11/5/23 9:00	20.2	0.1	20.0	0.2	0.4	0.3
				Mean Absolute Value	0.11		0.20

Table B-4-h. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20900946**			
	Probe Name	**NIST Standard Thermometer**		**BBC 2.6**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/4/23 11:35	11/5/23 8:15	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 11:40	11/5/23 8:20	20.2	0.2	20.0	0.2	0.0	0.2
11/4/23 11:45	11/5/23 8:25	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 11:50	11/5/23 8:30	20.2	0.1	20.1	0.1	0.0	0.1
11/4/23 11:55	11/5/23 8:35	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 12:00	11/5/23 8:40	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 12:05	11/5/23 8:45	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 12:10	11/5/23 8:50	20.2	0.1	20.0	0.2	0.0	0.1
11/4/23 12:15	11/5/23 8:55	20.2	0.1	20.0	0.2	0.1	0.0
11/4/23 12:20	11/5/23 9:00	20.2	0.1	20.0	0.2	0.1	0.0
				Mean Absolute Value	0.19		0.09

Table B-4-i. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.							
Probe Serial Number		**031412006 and 11874**		**20894317**			
Probe Name		**NIST Standard Thermometer**		**BBC 2.6 Backup**			
Temperature		**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/4/23 11:35	11/5/23 8:15	20.2	0.1	20.4	0.2	0.3	0.2
11/4/23 11:40	11/5/23 8:20	20.2	0.2	20.4	0.2	0.3	0.1
11/4/23 11:45	11/5/23 8:25	20.2	0.1	20.4	0.2	0.3	0.2
11/4/23 11:50	11/5/23 8:30	20.2	0.1	20.4	0.2	0.4	0.3
11/4/23 11:55	11/5/23 8:35	20.2	0.1	20.4	0.2	0.3	0.2
11/4/23 12:00	11/5/23 8:40	20.2	0.1	20.4	0.2	0.3	0.2
11/4/23 12:05	11/5/23 8:45	20.2	0.1	20.3	0.1	0.3	0.2
11/4/23 12:10	11/5/23 8:50	20.2	0.1	20.3	0.1	0.3	0.2
11/4/23 12:15	11/5/23 8:55	20.2	0.1	20.4	0.2	0.3	0.2
11/4/23 12:20	11/5/23 9:00	20.2	0.1	20.4	0.2	0.3	0.2
				Mean Absolute Value	0.18		0.20

Table B-4-j. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**21459624**			
	Probe Name	**NIST Standard Thermometer**		**BBC 1.6**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/4/23 11:35	11/5/23 8:15	20.2	0.1	20.5	0.3	0.0	0.1
11/4/23 11:40	11/5/23 8:20	20.2	0.2	20.4	0.2	0.0	0.2
11/4/23 11:45	11/5/23 8:25	20.2	0.1	20.4	0.2	0.0	0.1
11/4/23 11:50	11/5/23 8:30	20.2	0.1	20.4	0.2	0.0	0.1
11/4/23 11:55	11/5/23 8:35	20.2	0.1	20.4	0.2	0.0	0.1
11/4/23 12:00	11/5/23 8:40	20.2	0.1	20.4	0.2	0.1	0.0
11/4/23 12:05	11/5/23 8:45	20.2	0.1	20.4	0.2	0.1	0.0
11/4/23 12:10	11/5/23 8:50	20.2	0.1	20.3	0.1	0.0	0.1
11/4/23 12:15	11/5/23 8:55	20.2	0.1	20.3	0.1	0.0	0.1
11/4/23 12:20	11/5/23 9:00	20.2	0.1	20.3	0.1	0.0	0.1
				Mean Absolute Value	0.18		0.09

Table B-4-k. Continuous Temperature Probe 2023 Post-Deployment Accuracy Check.							
	Probe Serial Number	**031412006 and 11874**		**20416480**			
	Probe Name	**NIST Standard Thermometer**		**BBC 1.6 Backup**			
	Temperature	**Room Temperature (°C)**	**Ice Bath (°C)**	**Room Temperature (°C)**		**Ice Bath (°C)**	
Room Temperature Time Stamp	**Ice Bath Time Stamp**	**Reading**	**Reading**	**Reading**	**Absolute Value Difference**	**Reading**	**Absolute Value Difference**
11/4/23 11:35	11/5/23 8:15	20.2	0.1	20.4	0.2	-0.1	0.2
11/4/23 11:40	11/5/23 8:20	20.2	0.2	20.4	0.2	-0.1	0.3
11/4/23 11:45	11/5/23 8:25	20.2	0.1	20.4	0.2	0.0	0.1
11/4/23 11:50	11/5/23 8:30	20.2	0.1	20.3	0.1	0.0	0.1
11/4/23 11:55	11/5/23 8:35	20.2	0.1	20.3	0.1	0.0	0.1
11/4/23 12:00	11/5/23 8:40	20.2	0.1	20.4	0.2	0.0	0.1
11/4/23 12:05	11/5/23 8:45	20.2	0.1	20.3	0.1	0.0	0.1
11/4/23 12:10	11/5/23 8:50	20.2	0.1	20.3	0.1	0.0	0.1
11/4/23 12:15	11/5/23 8:55	20.2	0.1	20.3	0.1	0.0	0.1
11/4/23 12:20	11/5/23 9:00	20.2	0.1	20.3	0.1	0.0	0.1
				Mean Absolute Value	0.14		0.13

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APPENDIX C

Water Temperature Probe Data

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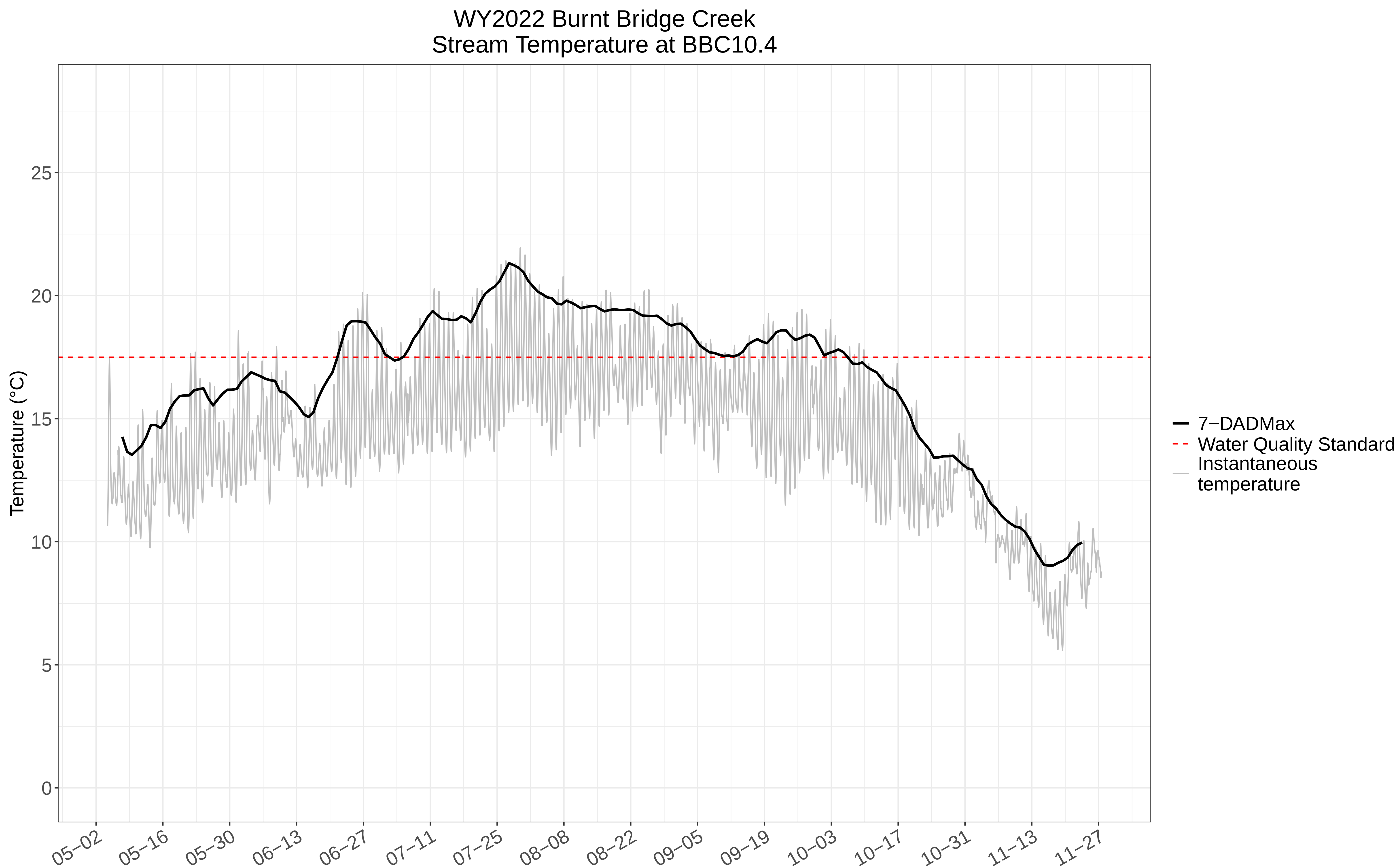
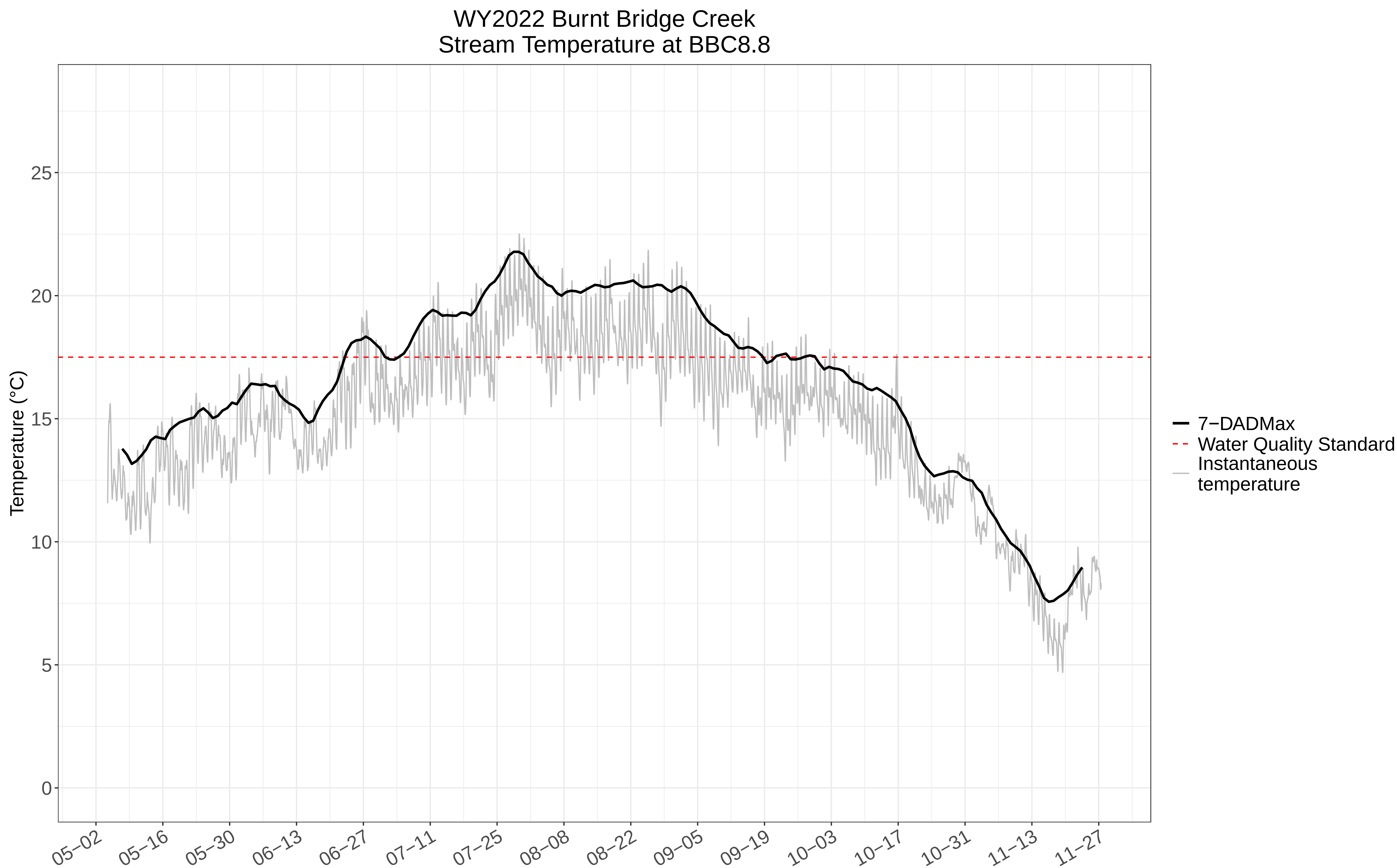
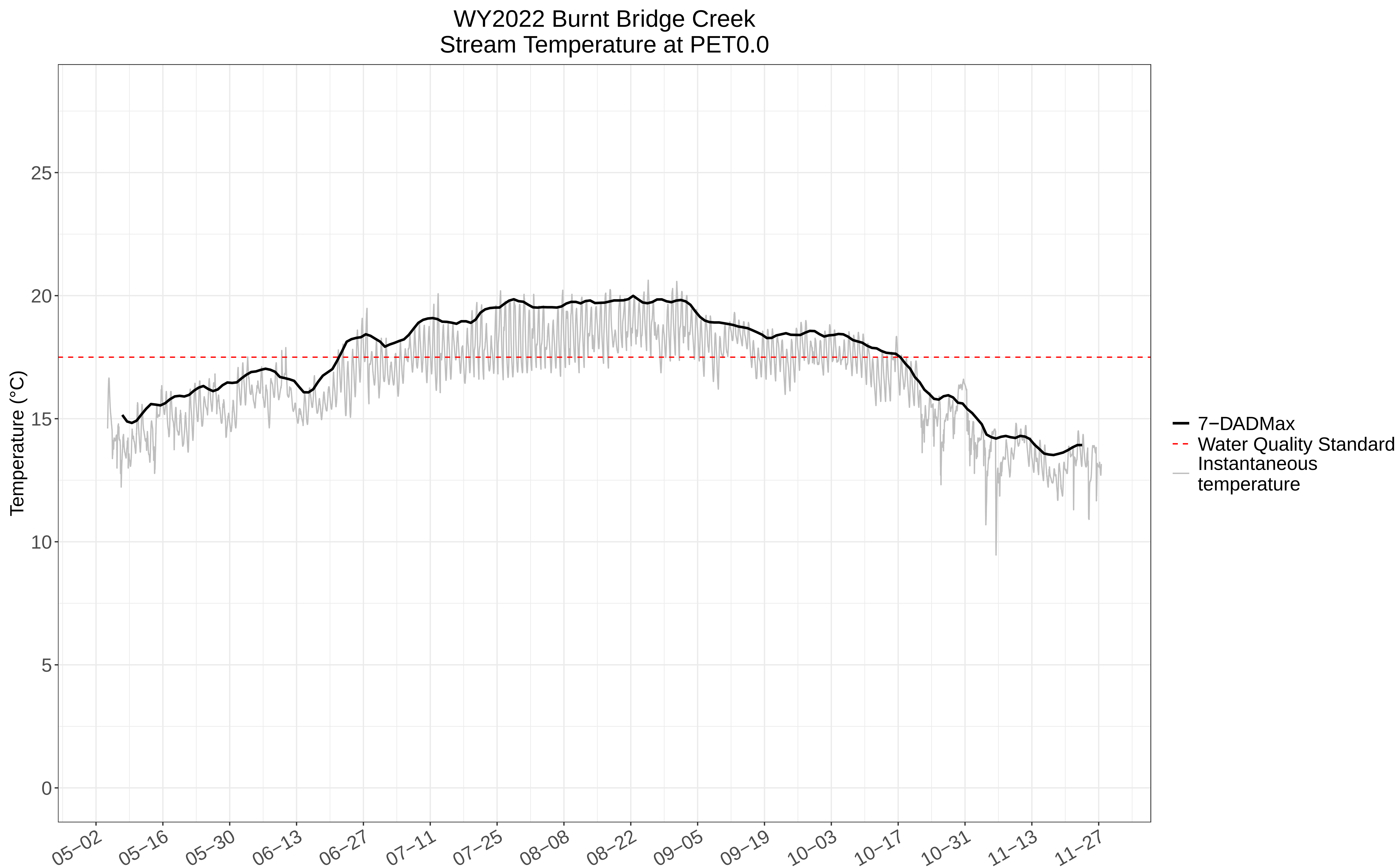
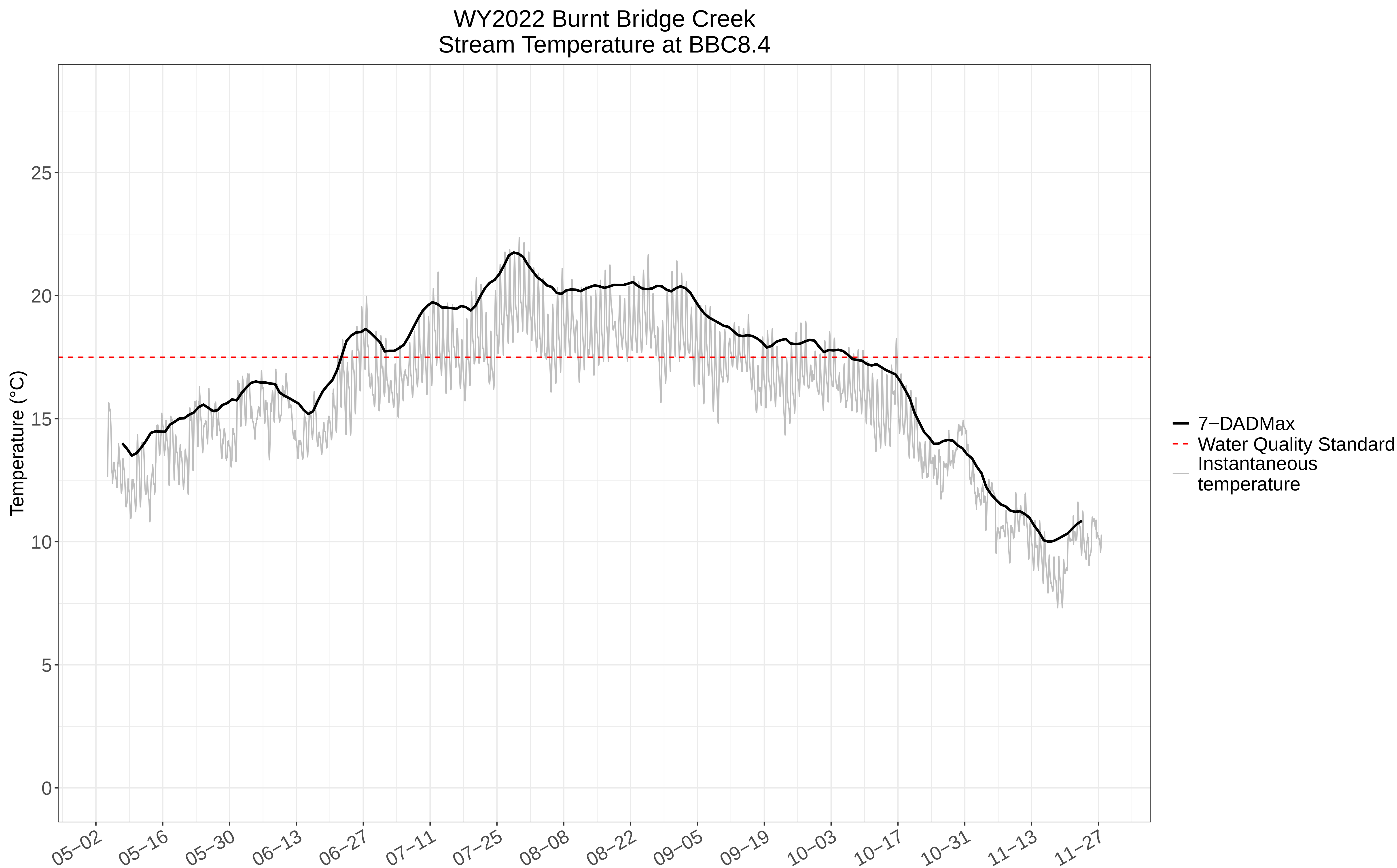
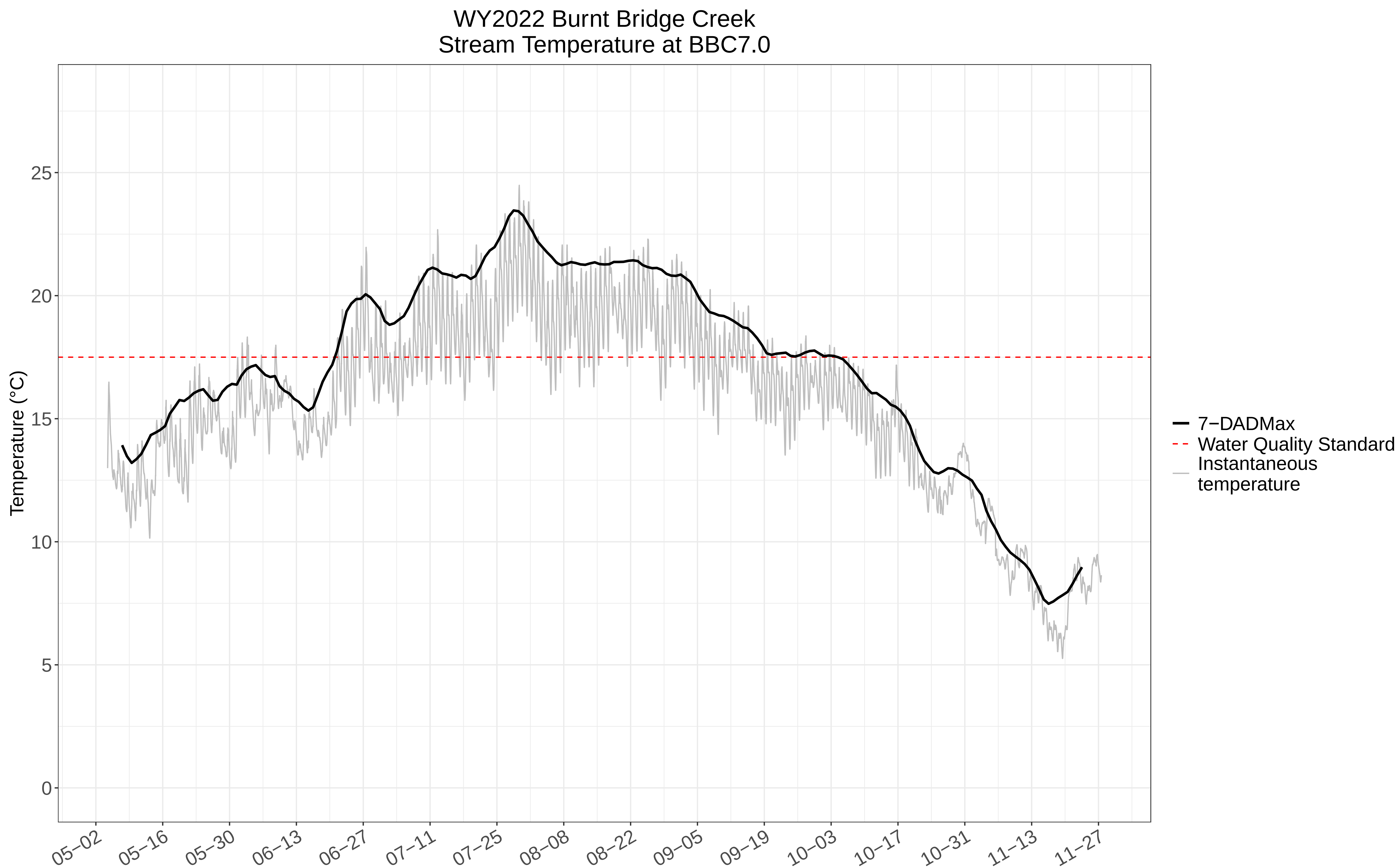

WY2022 Burnt Bridge Creek
Stream Temperature at BBC10.4
Temperature (°C)
0
5
10
15
20
25
05−02
05−16
05−30
06−13
06−27
07−11
07−25
08−08
08−22
09−05
09−19
10−03
10−17
10−31
11−13
11−27
7−DADMax
Water Quality Standard
Instantaneous temperature

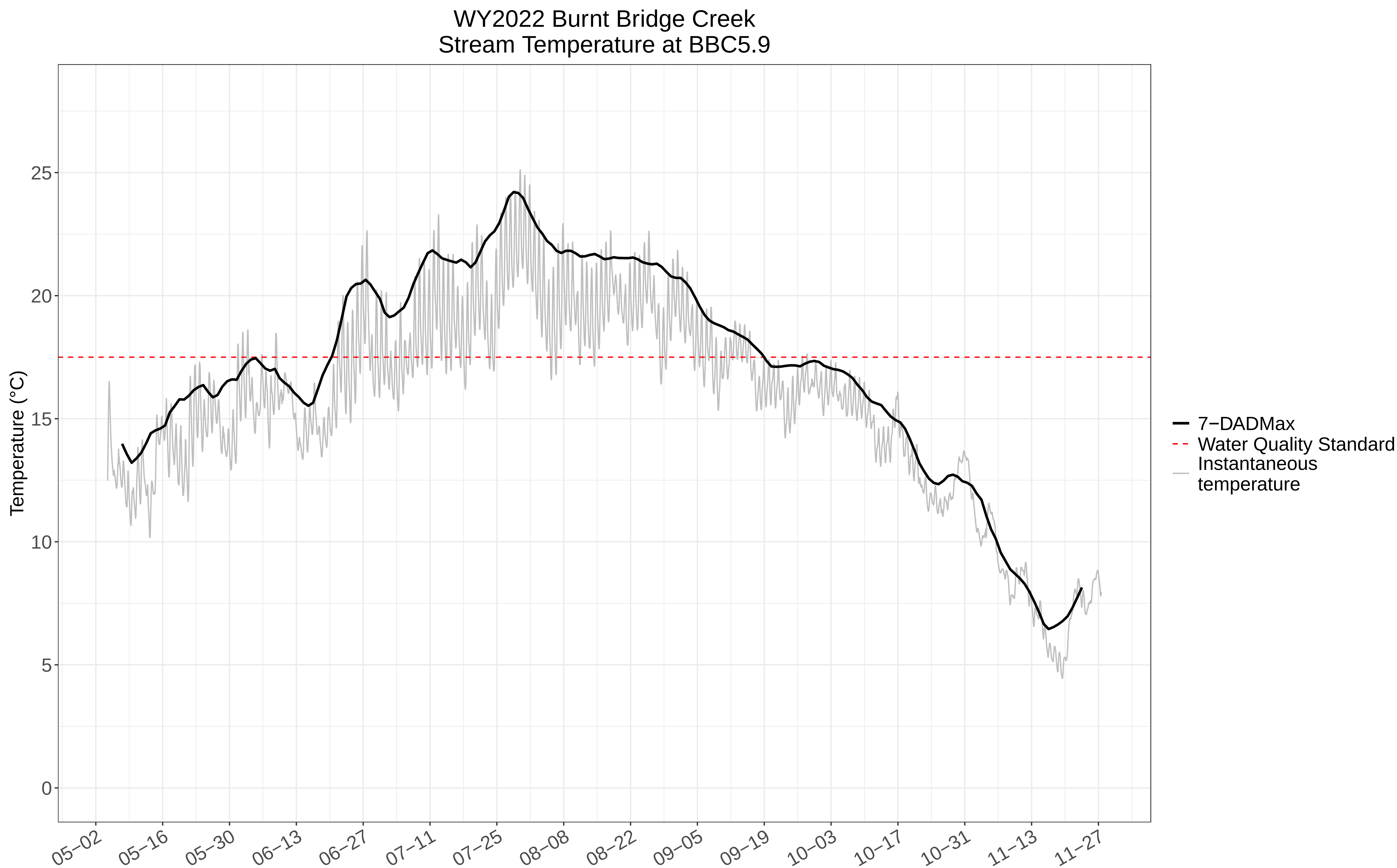


WY2022 Burnt Bridge Creek
Stream Temperature at BBC8.8
Temperature (°C)
0
5
10
15
20
25
05−02
05−16
05−30
06−13
06−27
07−11
07−25
08−08
08−22
09−05
09−19
10−03
10−17
10−31
11−13
11−27
7−DADMax
Water Quality Standard
Instantaneous temperature

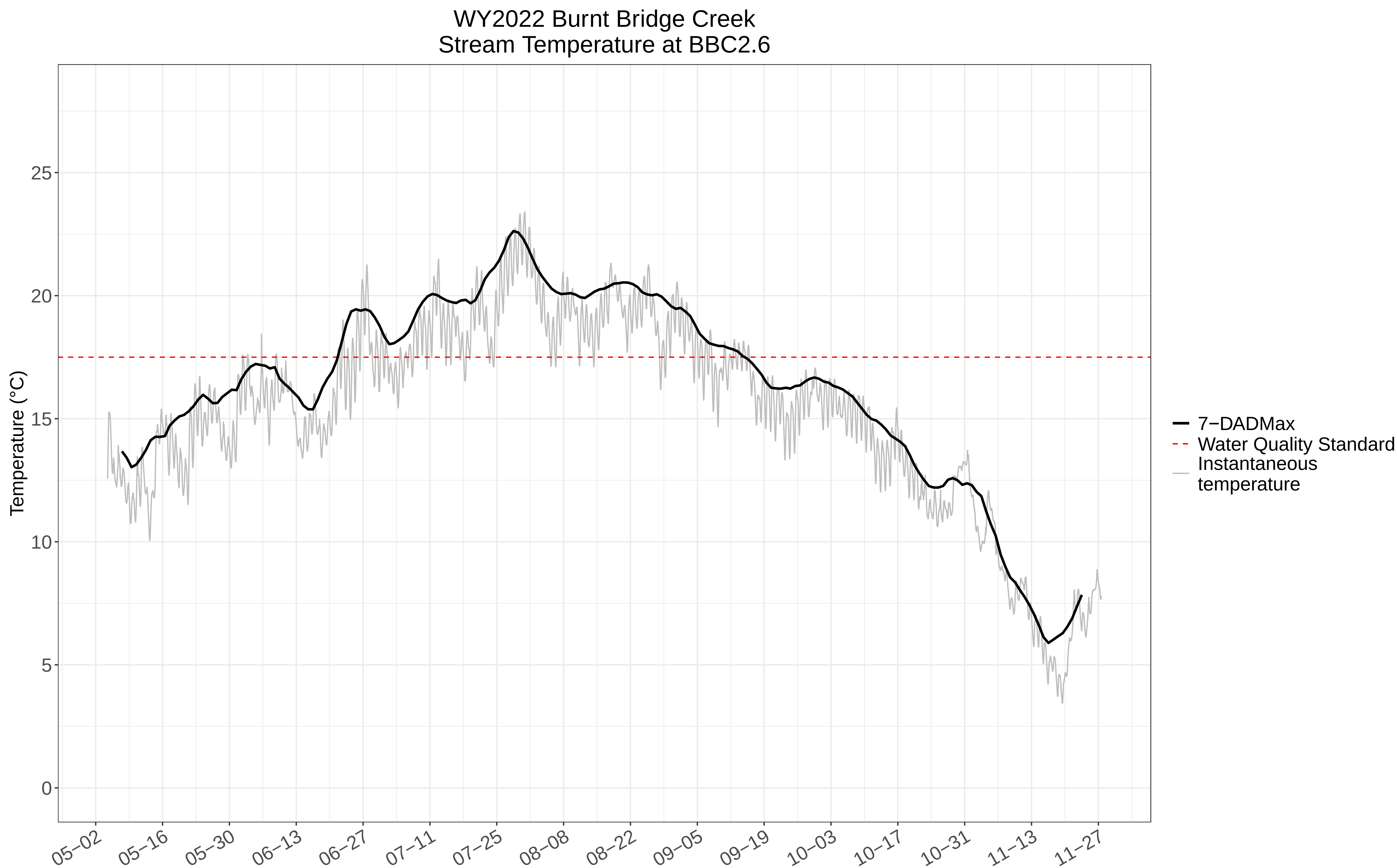

WY2022 Burnt Bridge Creek
Stream Temperature at PET0.0
Temperature (°C)
0
5
10
15
20
25
05−02
05−16
05−30
06−13
06−27
07−11
07−25
08−08
08−22
09−05
09−19
10−03
10−17
10−31
11−13
11−27
7−DADMax
Water Quality Standard
Instantaneous temperature

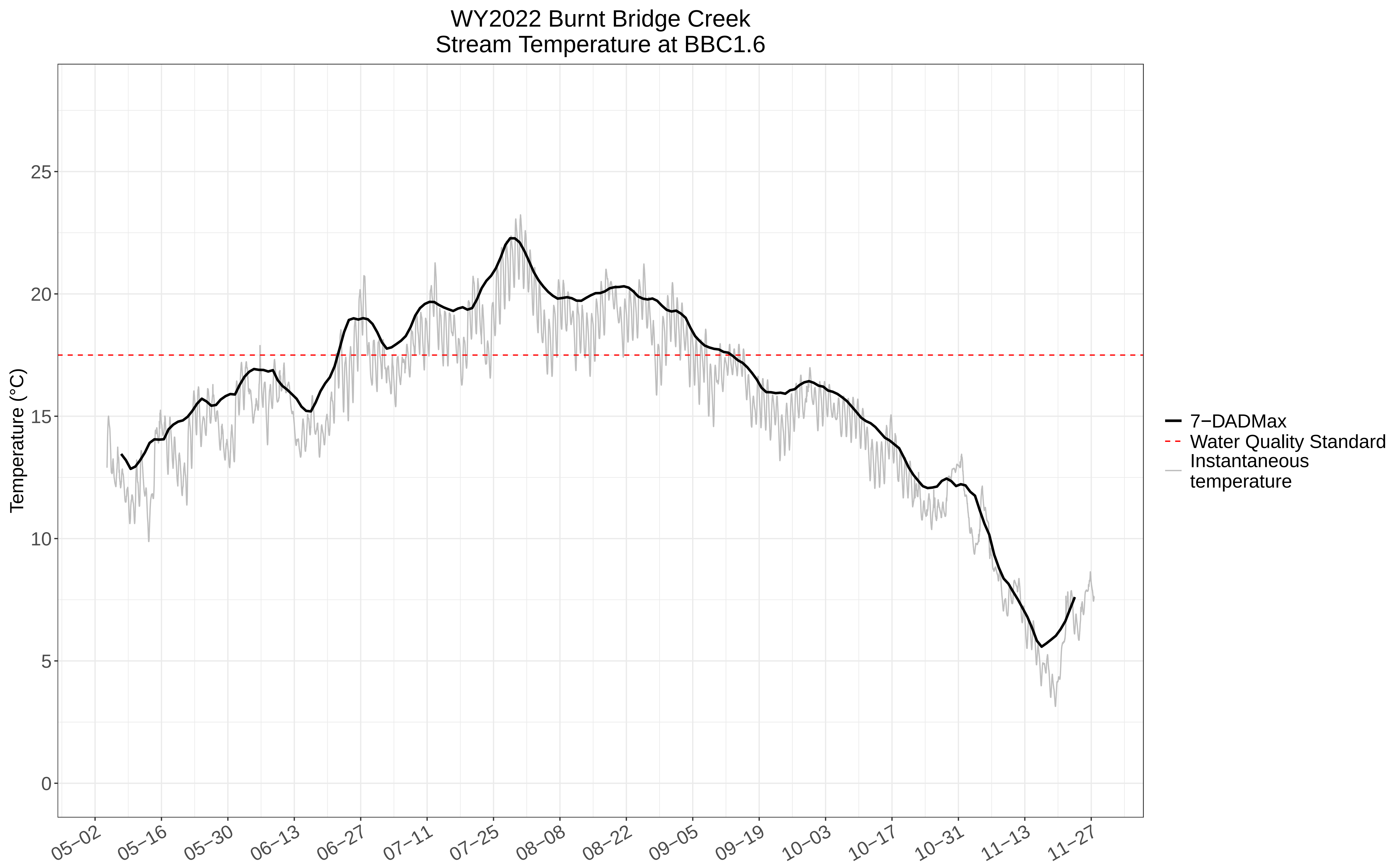

WY2022 Burnt Bridge Creek
Stream Temperature at BBC8.4
Temperature (°C)
0
5
10
15
20
25
05−02
05−16
05−30
06−13
06−27
07−11
07−25
08−08
08−22
09−05
09−19
10−03
10−17
10−31
11−13
11−27
7−DADMax
Water Quality Standard
Instantaneous temperature

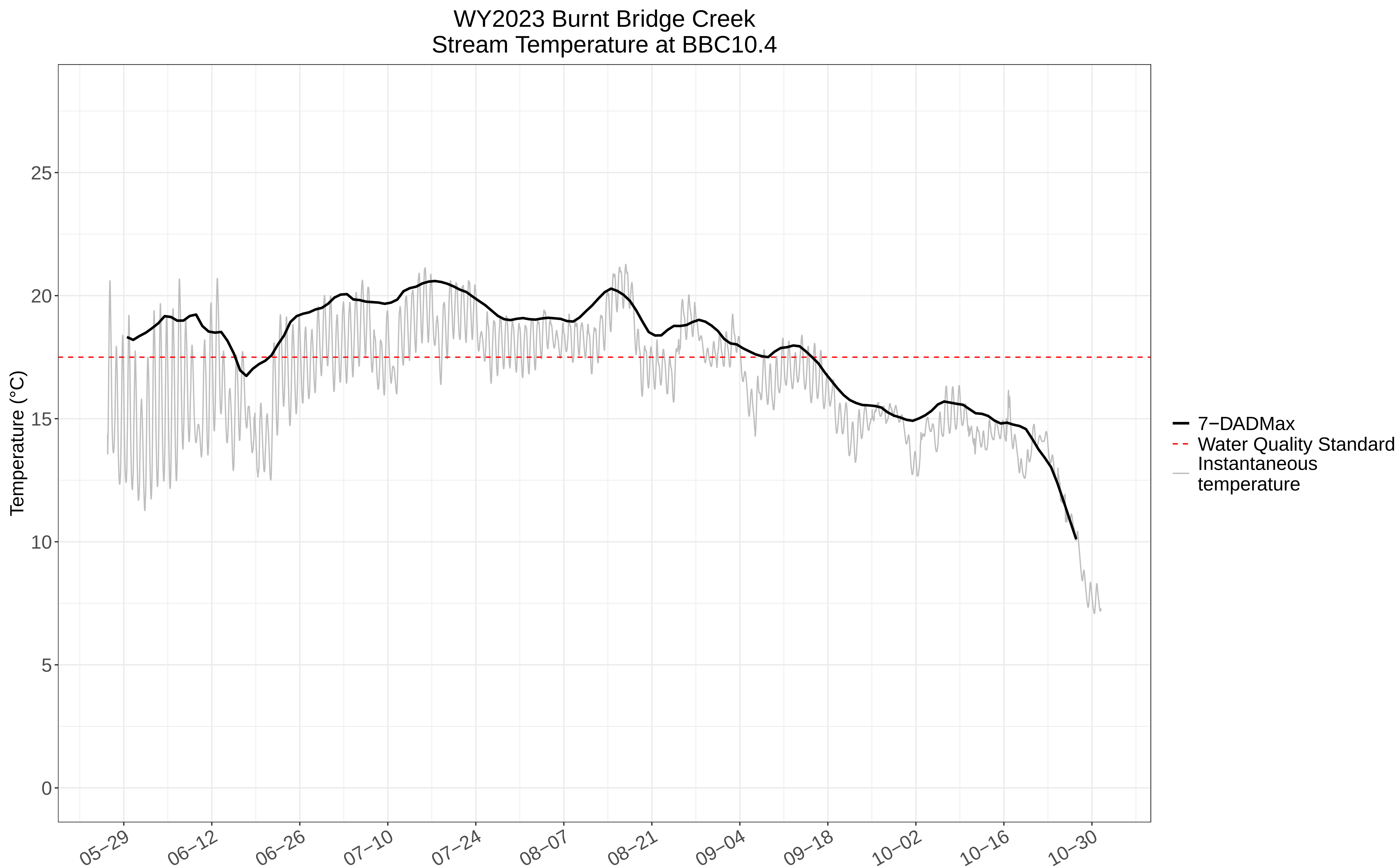

WY2022 Burnt Bridge Creek
Stream Temperature at BBC7.0
Temperature (°C)
0
5
10
15
20
25
05−02
05−16
05−30
06−13
06−27
07−11
07−25
08−08
08−22
09−05
09−19
10−03
10−17
10−31
11−13
11−27
7−DADMax
Water Quality Standard
Instantaneous temperature

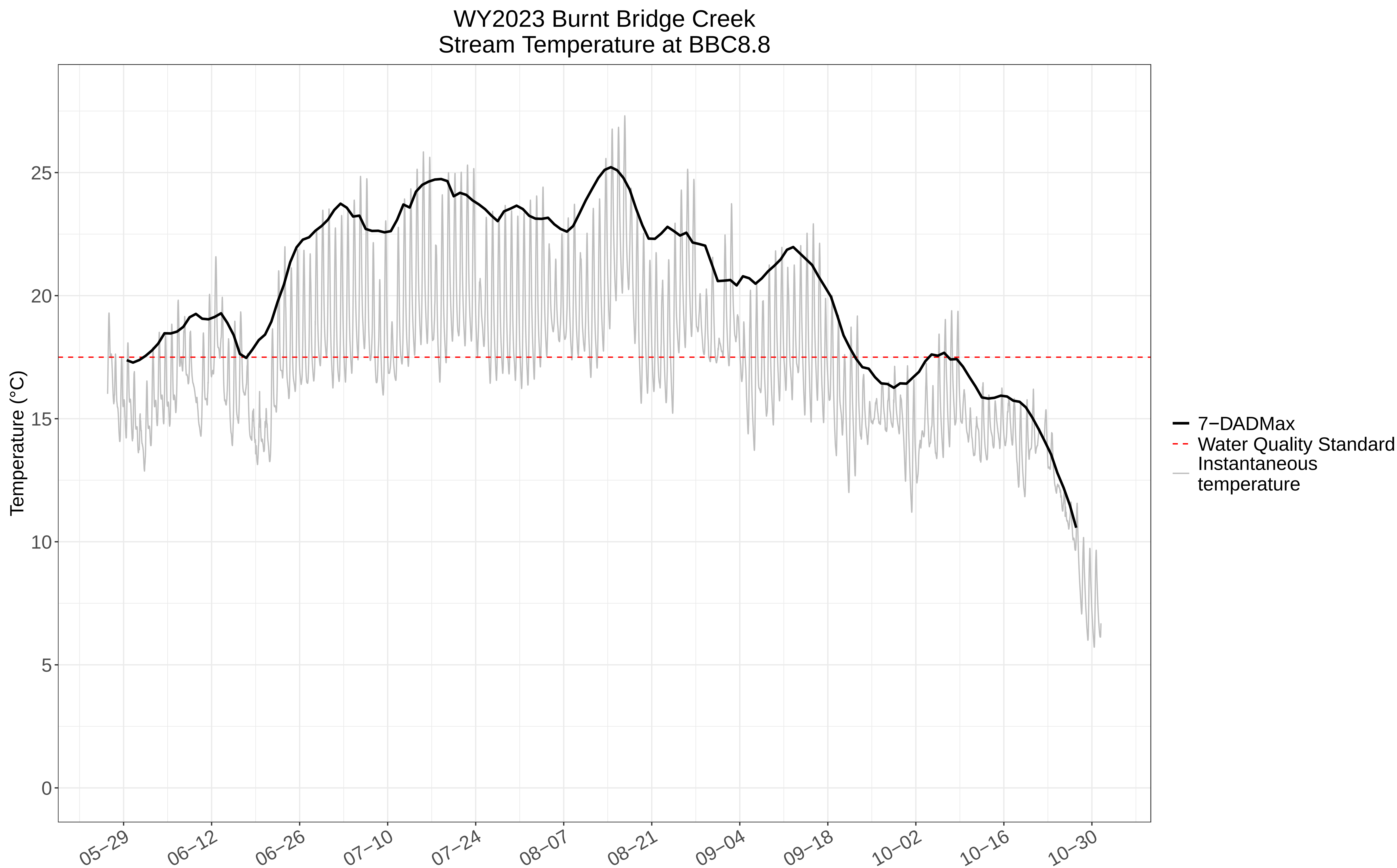


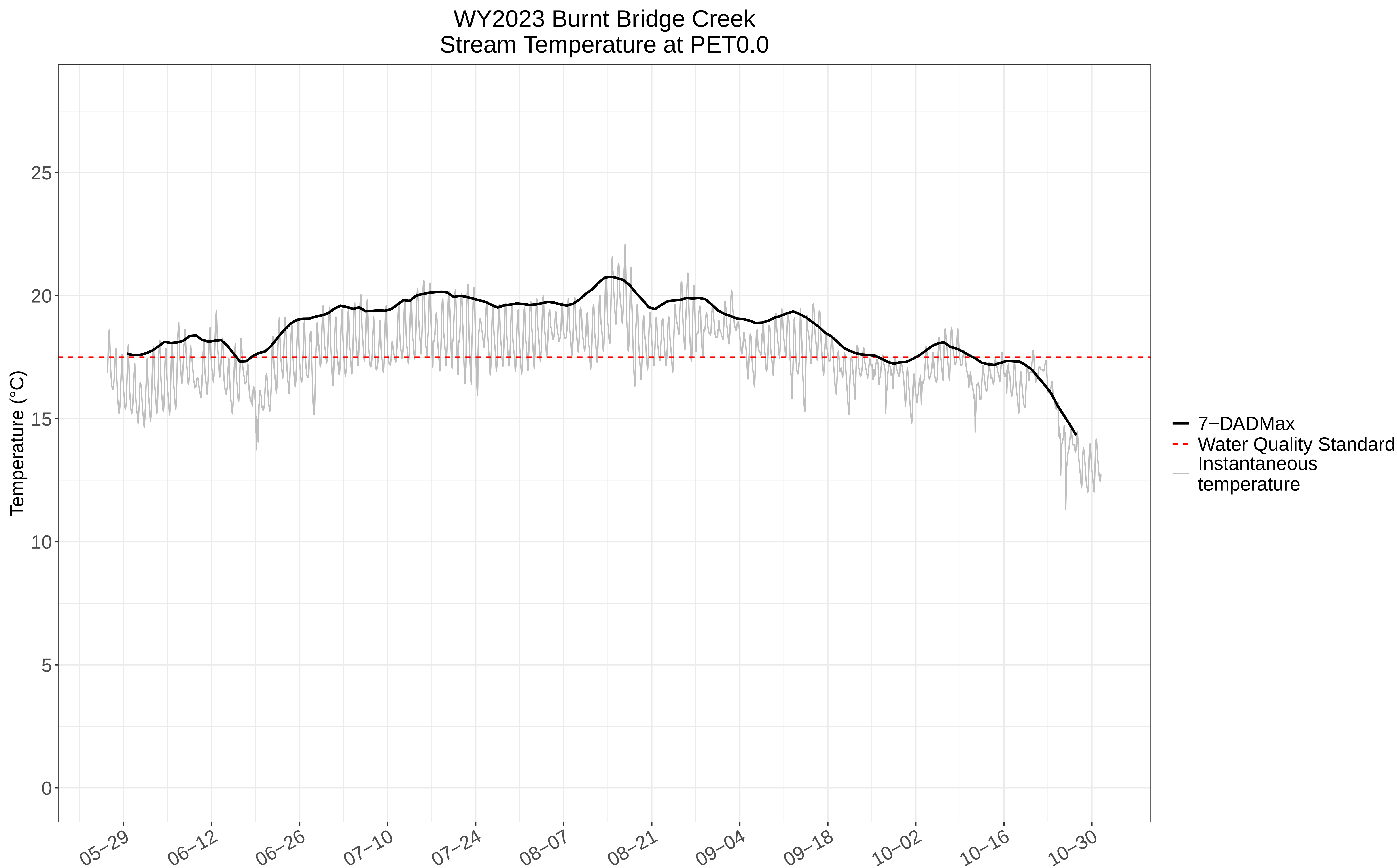
WY2022 Burnt Bridge Creek
Stream Temperature at BBC5.9
Temperature (°C)
0
5
10
15
20
25
05−02
05−16
05−30
06−13
06−27
07−11
07−25
08−08
08−22
09−05
09−19
10−03
10−17
10−31
11−13
11−27
7−DADMax
Water Quality Standard
Instantaneous temperature


WY2022 Burnt Bridge Creek
Stream Temperature at BBC2.6
Temperature (°C)
0
5
10
15
20
25
05−02
05−16
05−30
06−13
06−27
07−11
07−25
08−08
08−22
09−05
09−19
10−03
10−17
10−31
11−13
11−27
7−DADMax
Water Quality Standard
Instantaneous temperature

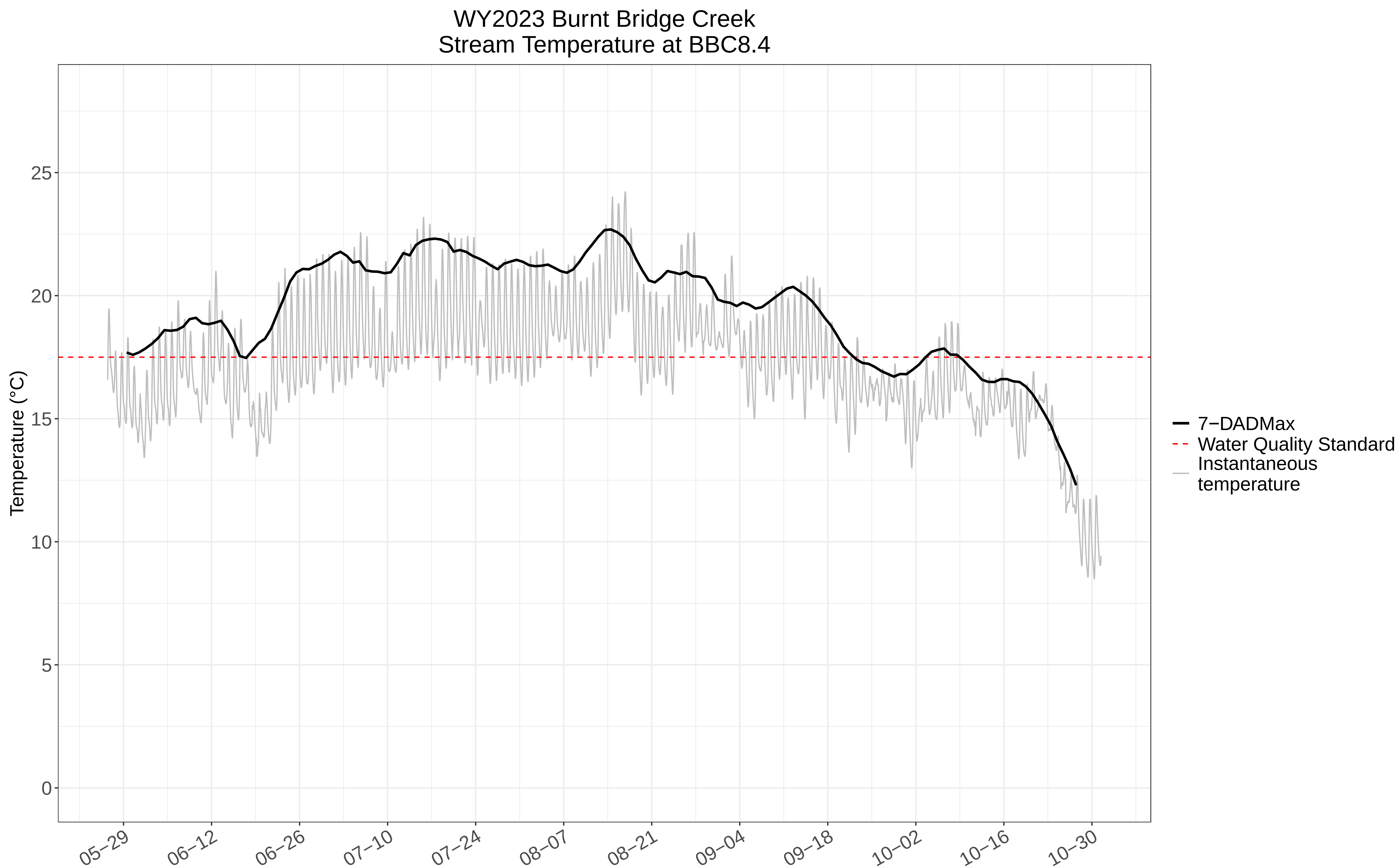

WY2022 Burnt Bridge Creek
Stream Temperature at BBC1.6
Temperature (°C)
0
5
10
15
20
25
05−02
05−16
05−30
06−13
06−27
07−11
07−25
08−08
08−22
09−05
09−19
10−03
10−17
10−31
11−13
11−27
7−DADMax
Water Quality Standard
Instantaneous temperature


WY2023 Burnt Bridge Creek
Stream Temperature at BBC10.4
Temperature (°C)
0
5
10
15
20
25
05−29
06−12
06−26
07−10
07−24
08−07
08−21
09−04
09−18
10−02
10−16
10−30
7−DADMax
Water Quality Standard
Instantaneous temperature

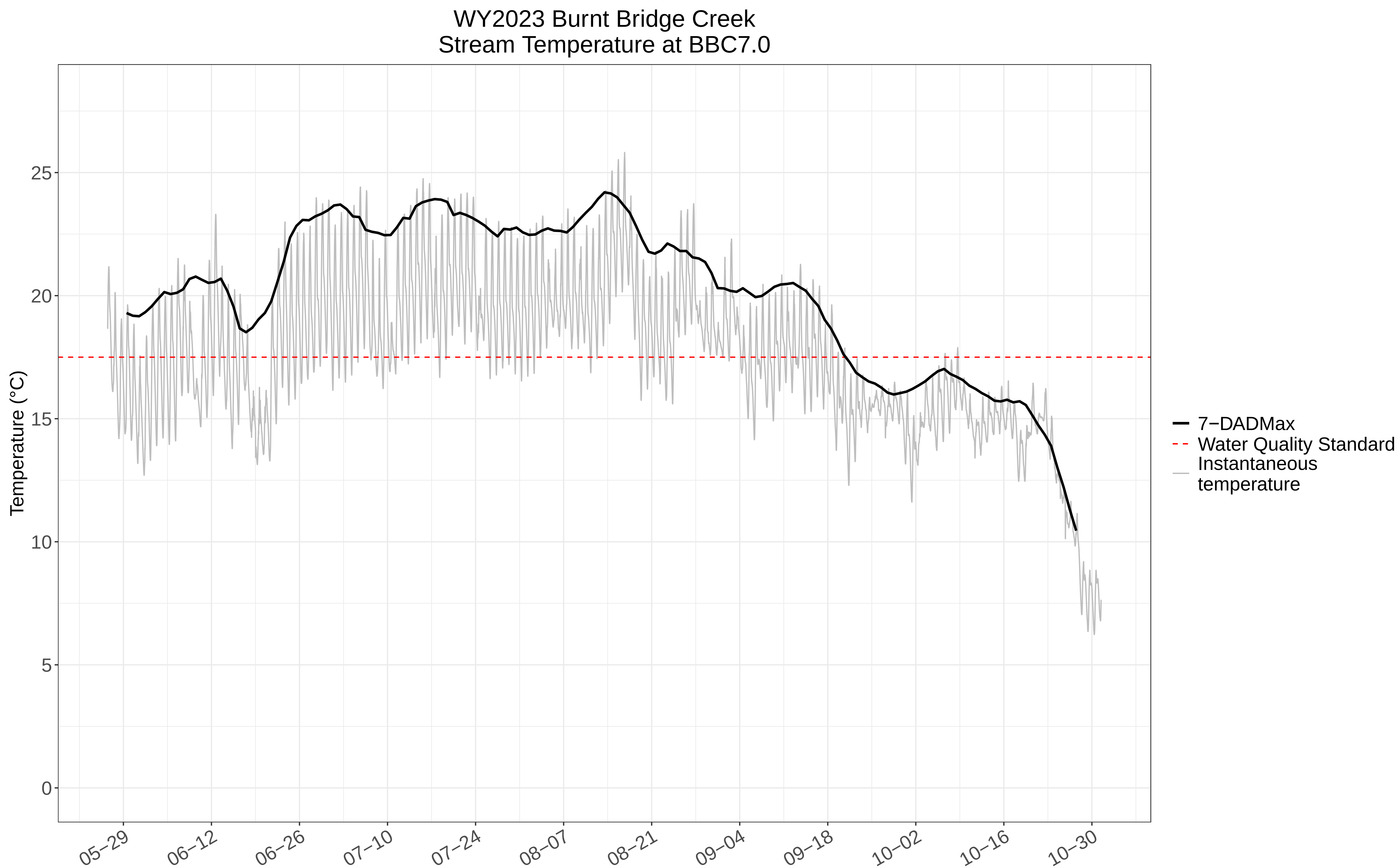

WY2023 Burnt Bridge Creek
Stream Temperature at BBC8.8
Temperature (°C)
0
5
10
15
20
25
05−29
06−12
06−26
07−10
07−24
08−07
08−21
09−04
09−18
10−02
10−16
10−30
7−DADMax
Water Quality Standard
Instantaneous temperature

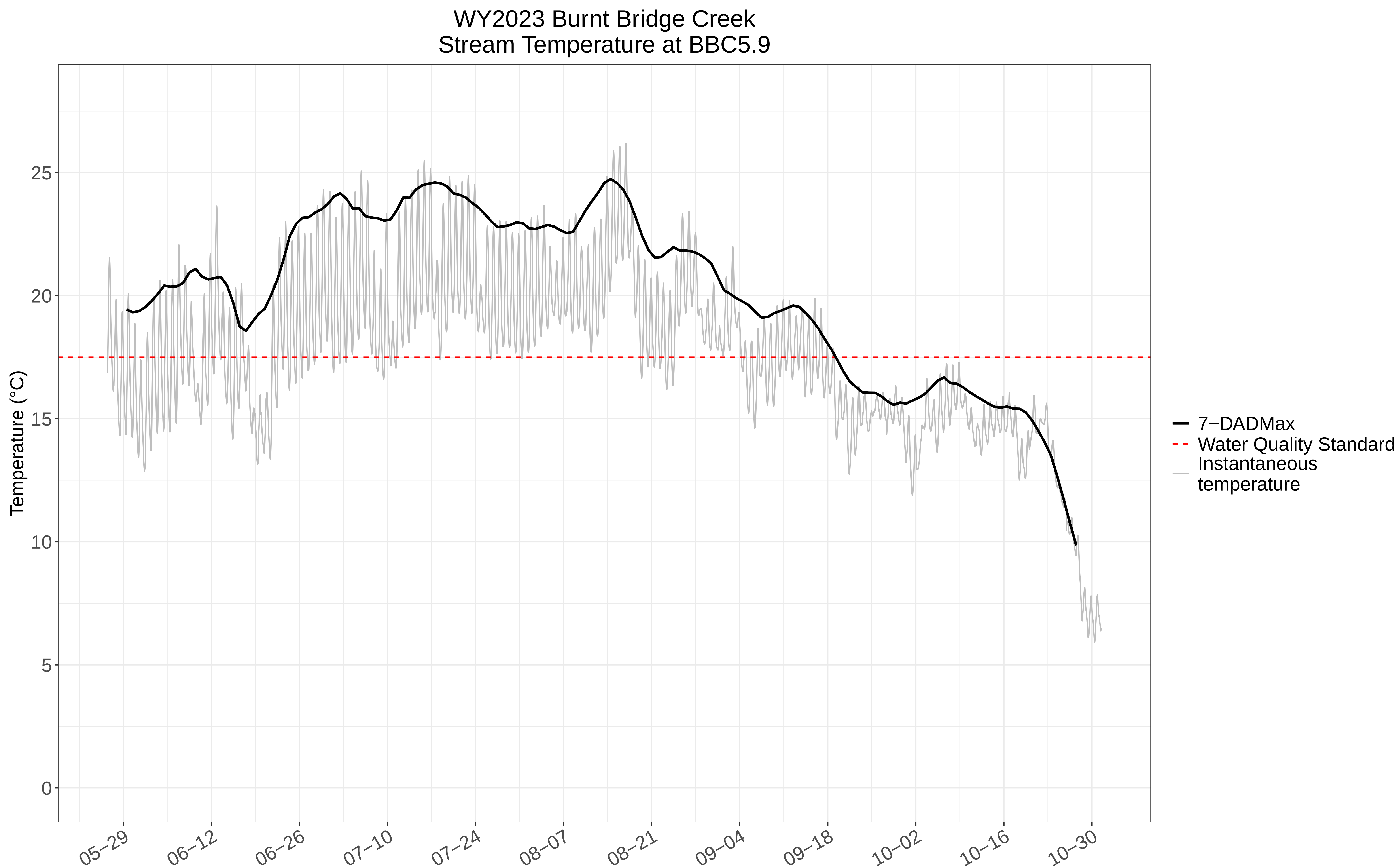


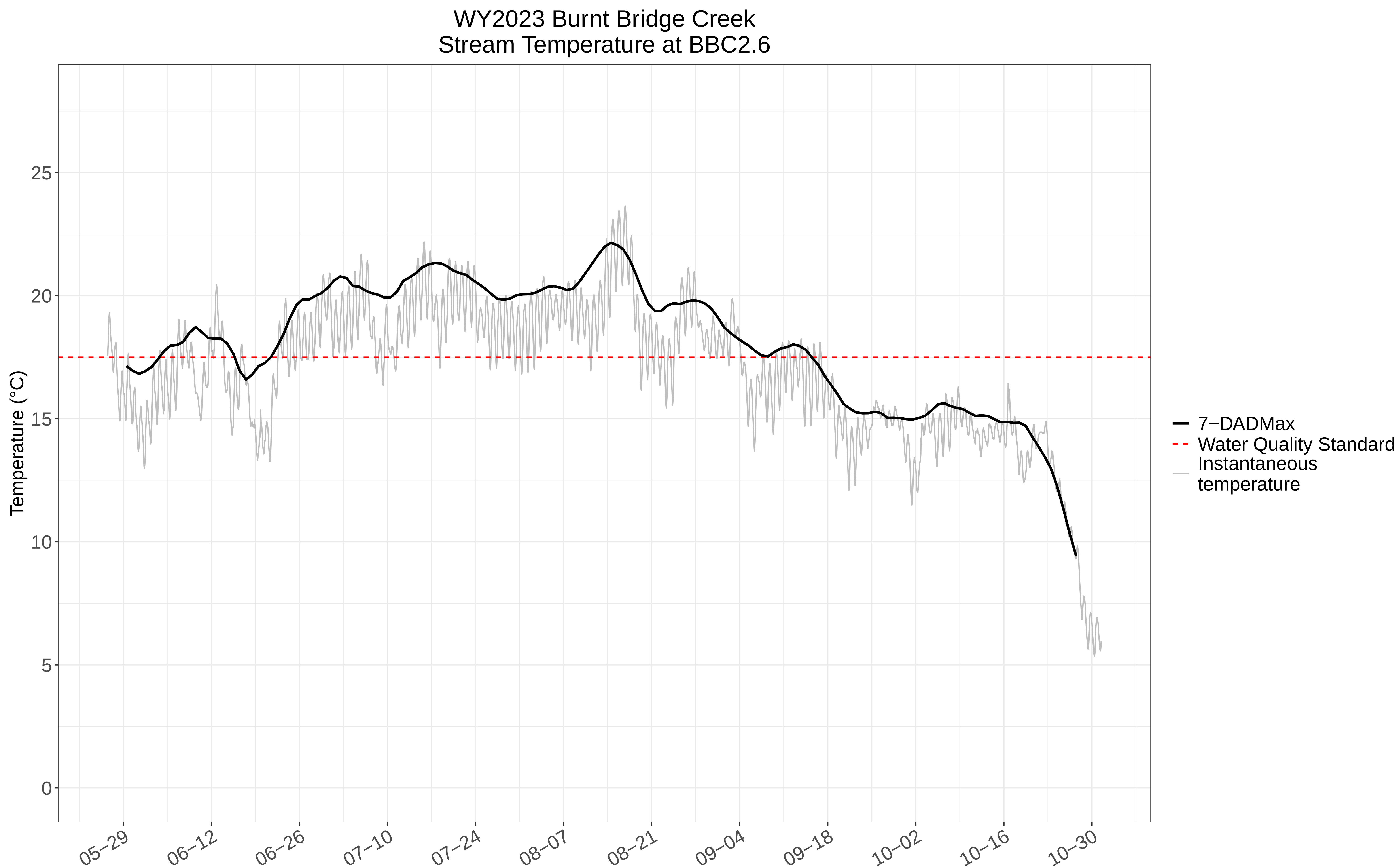
WY2023 Burnt Bridge Creek
Stream Temperature at PET0.0
Temperature (°C)
0
5
10
15
20
25
05−29
06−12
06−26
07−10
07−24
08−07
08−21
09−04
09−18
10−02
10−16
10−30
7−DADMax
Water Quality Standard
Instantaneous temperature



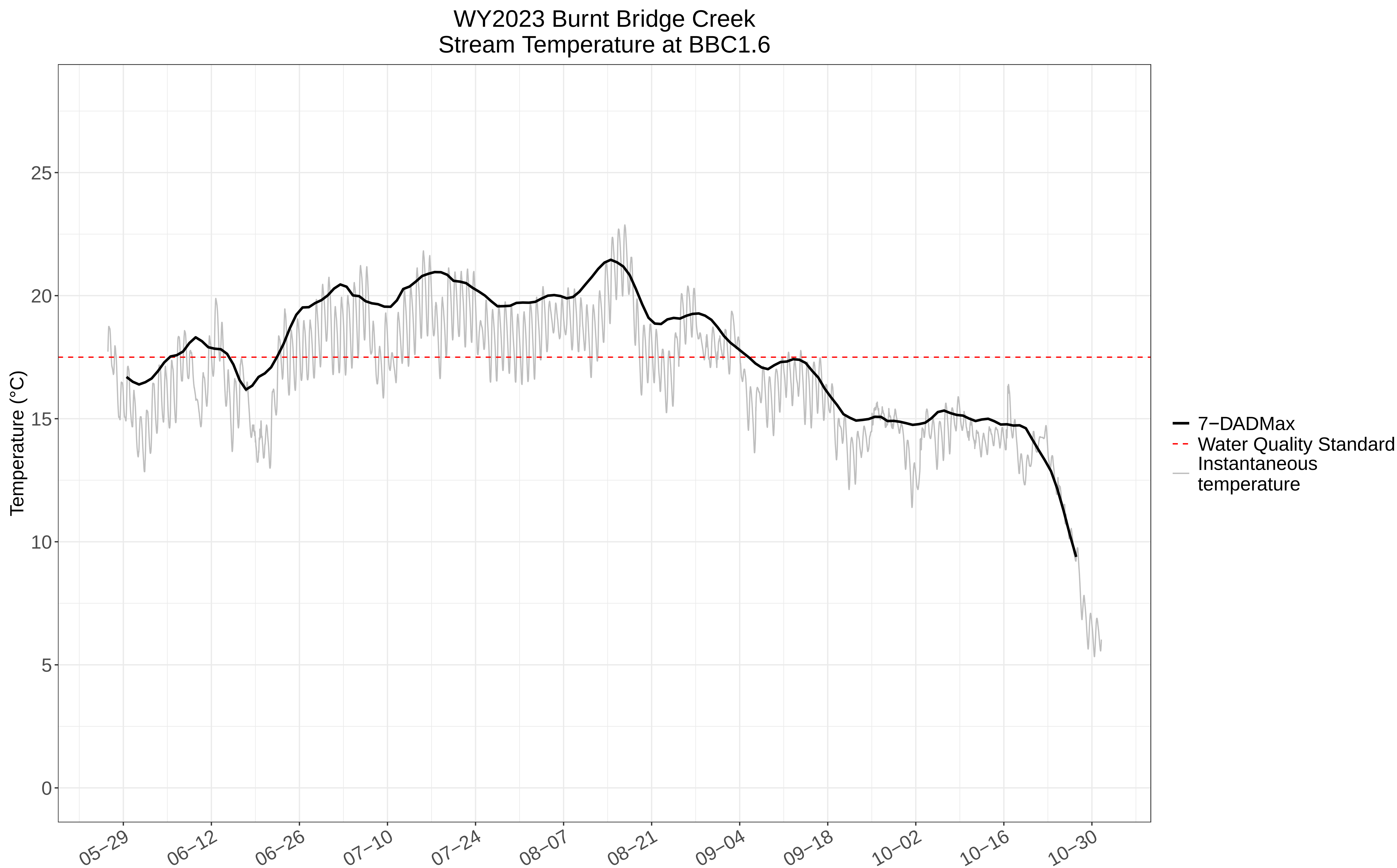
WY2023 Burnt Bridge Creek
Stream Temperature at BBC8.4
Temperature (°C)
0
5
10
15
20
25
05−29
06−12
06−26
07−10
07−24
08−07
08−21
09−04
09−18
10−02
10−16
10−30
7−DADMax
Water Quality Standard
Instantaneous temperature


WY2023 Burnt Bridge Creek
Stream Temperature at BBC7.0
Temperature (°C)
0
5
10
15
20
25
05−29
06−12
06−26
07−10
07−24
08−07
08−21
09−04
09−18
10−02
10−16
10−30
7−DADMax
Water Quality Standard
Instantaneous temperature


WY2023 Burnt Bridge Creek
Stream Temperature at BBC5.9
Temperature (°C)
25
20
15
10
5
0
05−29
06−12
06−26
07−10
07−24
08−07
08−21
09−04
09−18
10−02
10−16
10−30
7−DADMax
Water Quality Standard
Instantaneous temperature



WY2023 Burnt Bridge Creek
Stream Temperature at BBC2.6
Temperature (°C)
0
5
10
15
20
25
05−29
06−12
06−26
07−10
07−24
08−07
08−21
09−04
09−18
10−02
10−16
10−30
7−DADMax
Water Quality Standard
Instantaneous temperature


WY2023 Burnt Bridge Creek
Stream Temperature at BBC1.6
Temperature (°C)
25
20
15
10
5
0
05−29
06−12
06−26
07−10
07−24
08−07
08−21
09−04
09−18
10−02
10−16
10−30
7−DADMax
Water Quality Standard
Instantaneous temperature

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APPENDIX D

Summary Statistics Tables

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Table D-1. Summary of Base Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.

Station	WY 2011–2021								WY 2022–2023							
	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Temperature (degrees Celsius)																
BBC10.4	60	7.5	12.0	13.5	13.9	15.3	16.0	18.5	14	8.2	9.8	12.3	12.4	14.4	16.0	16.3
BBC8.8	60	7.5	12.7	14.6	15.6	16.7	17.9	19.3	14	8.0	10.0	13.3	13.6	16.2	17.8	18.4
PET0.0	60	11.4	14.7	16.2	16.7	17.7	18.1	19.0	14	12.8	13.8	15.4	15.7	17.0	17.3	18.7
BBC8.4	60	8.7	13.9	15.2	16.0	17.1	17.8	19.4	14	9.4	11.0	14.0	14.7	16.7	17.6	18.5
BUR0.0	59	6.4	12.5	13.7	14.5	15.1	15.8	17.6	14	8.7	10.6	13.0	13.7	15.0	16.3	16.4
BBC7.0	60	7.6	13.6	16.3	17.1	19.0	20.3	21.6	14	8.2	10.4	14.7	14.7	18.6	20.2	22.0
BBC5.9	60	6.8	13.2	15.2	16.1	17.5	19.1	21.0	14	7.6	10.2	13.8	14.5	17.3	18.3	19.5
BBC5.2	60	7.2	13.5	15.4	16.5	17.6	19.0	21.4	14	7.7	10.3	14.2	14.7	17.8	19.0	19.8
BBC2.6	60	6.9	12.9	15.4	16.2	17.7	19.2	20.7	14	7.1	10.0	13.9	14.5	17.8	19.2	19.9
COL0.0	59	7.4	12.1	13.0	13.4	14.4	14.8	16.3	14	7.7	9.5	12.5	13.4	14.8	15.5	16.2
BBC1.6	60	7.1	12.9	15.3	16.2	17.9	19.4	20.8	14	7.0	10.0	14.0	14.5	18.1	19.5	20.2
Dissolved Oxygen (mg/L)																
BBC10.4	59	4.9	5.9	7.1	6.9	7.9	9.2	12.6	14	6.3	6.9	7.9	8.3	8.6	8.9	9.3
BBC8.8	59	6.7	9.0	9.8	9.7	10.3	11.4	12.7	14	8.9	9.7	10.4	10.2	11.2	11.9	12.6
PET0.0	59	6.6	8.2	8.8	8.7	9.2	9.7	10.3	14	8.5	8.7	9.0	8.8	9.2	9.7	10.1
BBC8.4	59	5.8	7.6	8.5	8.4	9.2	10.0	11.5	14	8.6	8.7	9.7	9.4	10.6	11.0	11.6
BUR0.0	58	6.2	8.6	9.2	9.3	9.8	10.5	11.6	14	8.4	8.9	9.6	9.2	9.9	10.7	12.4
BBC7.0	59	5.4	7.6	8.8	8.9	9.9	10.6	14.4	14	7.4	8.6	9.3	9.6	9.9	10.2	10.8
BBC5.9	59	4.9	6.3	7.6	7.3	8.8	9.9	11.5	14	6.4	7.1	8.2	8.1	9.1	9.6	10.1
BBC5.2	59	5.3	8.8	9.3	9.2	10.0	10.7	11.9	14	8.8	9.2	9.7	9.4	10.2	10.6	10.8
BBC2.6	59	5.0	9.0	9.5	9.5	10.2	10.9	12.5	14	8.9	9.1	10.1	9.9	10.9	11.5	12.0
COL0.0	58	5.8	9.8	10.2	10.2	10.7	11.3	12.4	14	9.2	9.6	10.3	10.1	11.1	11.5	11.7
BBC1.6	59	4.9	9.0	9.5	9.5	10.2	11.0	12.5	14	8.7	9.4	10.2	9.9	11.0	11.6	12.0
pH																
BBC10.4	59	5.9	6.6	6.9	6.8	7.1	7.5	8.4	14	6.4	6.5	6.7	6.7	6.8	7.2	7.3
BBC8.8	58	6.7	7.3	7.4	7.4	7.6	7.8	8.1	14	6.8	7.2	7.4	7.4	7.7	7.8	7.9
PET0.0	56	6.8	7.3	7.4	7.4	7.5	7.6	8.1	14	7.0	7.2	7.3	7.3	7.4	7.6	7.8
BBC8.4	56	6.8	7.3	7.4	7.4	7.5	7.6	8.1	14	7.0	7.2	7.4	7.4	7.6	7.6	7.7
BUR0.0	55	6.9	7.3	7.4	7.4	7.6	7.7	8.0	14	6.7	7.1	7.1	7.1	7.3	7.4	7.5
BBC7.0	56	6.8	7.3	7.5	7.5	7.7	7.8	8.4	14	6.8	7.1	7.3	7.3	7.5	7.6	7.8
BBC5.9	58	7.0	7.3	7.4	7.4	7.6	7.7	7.9	14	6.6	7.1	7.2	7.2	7.4	7.6	7.6
BBC5.2	57	7.2	7.6	7.7	7.7	7.8	7.9	8.2	14	6.9	7.3	7.5	7.4	7.8	7.9	8.1
BBC2.6	57	7.6	7.8	7.9	7.9	8.0	8.1	9.1	14	7.2	7.7	7.8	7.8	7.9	8.0	8.1
COL0.0	56	7.5	7.9	8.0	8.0	8.1	8.2	8.8	14	7.4	7.9	7.9	8.0	8.0	8.1	8.6
BBC1.6	57	7.3	7.9	7.9	8.0	8.0	8.1	8.5	14	7.5	7.8	7.8	7.8	8.0	8.0	8.1

	WY 2011–2021								WY 2022–2023							
Station	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Conductivity (µS/cm^2)																
BBC10.4	59	127	166	183	180	190	239	254	13	163	171	182	182	190	195	198
BBC8.8	60	127	163	179	177	187	221	250	13	162	168	179	181	187	192	196
PET0.0	60	161	204	229	225	237	272	342	13	209	212	224	227	233	240	248
BBC8.4	60	139	180	201	195	208	241	288	13	175	180	197	193	210	220	223
BUR0.0	59	134	168	186	182	194	237	265	13	192	198	202	202	205	211	213
BBC7.0	60	135	180	199	192	213	243	286	13	169	176	196	194	211	220	225
BBC5.9	60	132	180	200	194	211	245	288	13	161	175	193	193	208	217	227
BBC5.2	60	135	180	199	193	210	245	290	13	162	176	193	193	208	216	225
BBC2.6	60	135	183	202	197	213	249	288	13	160	177	193	188	211	220	224
COL0.0	59	174	223	253	248	273	295	364	13	185	230	244	257	266	276	280
BBC1.6	60	137	185	206	201	218	254	299	13	161	178	196	189	216	227	230
Turbidity (NTU)																
BBC10.4	60	0.5	0.9	2.0	1.6	2.3	3.8	10.0	14	1.6	3.1	4.2	4.2	4.9	6.6	7.4
BBC8.8	60	0.8	1.9	2.8	2.4	3.2	4.5	14.0	14	2.4	3.1	4.1	4.0	5.0	6.0	6.4
PET0.0	60	0.4	0.8	1.4	1.2	1.6	2.1	8.0	14	0.7	0.9	1.3	1.2	1.6	2.2	2.5
BBC8.4	60	0.3	1.4	2.2	2.0	2.9	3.4	11.0	14	1.9	2.8	3.3	3.0	4.0	4.7	4.8
BUR0.0	59	0.4	0.7	1.7	1.1	2.1	2.8	9.4	14	0.6	1.0	1.3	1.2	1.5	2.0	3.3
BBC7.0	60	0.8	2.1	4.2	3.4	4.5	6.2	22.2	14	2.4	3.2	4.8	4.1	6.7	7.8	7.9
BBC5.9	60	0.6	1.4	2.1	1.7	2.3	3.7	14.0	14	1.8	2.6	3.0	3.0	3.5	3.7	4.5
BBC5.2	60	0.5	1.4	2.1	1.8	2.2	3.3	12.0	14	1.8	2.2	2.9	3.0	3.5	4.0	4.5
BBC2.6	60	0.6	1.5	2.5	1.9	2.9	4.2	17.0	14	2.3	3.4	3.8	3.7	4.4	4.9	5.2
COL0.0	59	0.4	1.3	3.1	1.8	2.8	3.6	35.0	14	1.2	1.7	2.6	2.5	3.2	4.1	4.8
BBC1.6	60	0.7	1.7	2.9	2.2	3.5	4.5	20.0	14	2.3	3.6	4.2	4.3	4.6	5.8	5.9
Total Suspended Solids (mg/L)																
BBC10.4	60	0.8	2.1	3.2	2.8	3.9	5.7	8.3	14	2.1	3.1	5.6	5.7	7.6	9.3	9.6
BBC8.8	60	1.8	4.4	8.2	7.1	11.1	16.0	26.0	14	1.7	3.7	6.5	5.2	8.7	11.5	14.0
PET0.0	60	0.7	2.7	4.2	3.8	5.6	6.9	10.9	14	1.0	2.0	3.2	3.5	4.3	4.8	5.9
BBC8.4	60	1.8	5.2	6.7	6.4	7.8	10.6	13.7	14	2.6	3.7	5.8	4.9	7.0	7.6	16.5
BUR0.0	59	0.5	1.0	4.5	1.8	4.0	12.3	42.0	14	1.0	1.0	3.0	1.2	3.1	5.9	14.4
BBC7.0	60	0.8	6.5	12.3	9.3	13.7	19.3	68.6	14	1.2	3.1	9.2	7.5	14.4	17.3	24.1
BBC5.9	60	0.8	2.5	4.0	3.8	5.4	6.2	11.0	14	1.3	2.6	3.2	3.1	3.7	4.2	6.8
BBC5.2	60	1.6	3.2	4.9	4.9	6.5	7.3	10.0	14	1.7	2.7	3.8	3.2	3.8	5.4	10.1
BBC2.6	60	0.7	2.9	5.5	4.2	7.7	10.5	17.0	14	2.2	3.4	5.8	6.1	7.1	8.9	9.7
COL0.0	59	0.8	2.2	4.9	3.2	4.8	7.8	46.0	14	1.0	2.0	3.3	3.2	4.3	4.9	7.1
BBC1.6	60	0.8	3.5	6.1	5.2	8.3	11.0	19.0	14	2.8	3.9	7.9	6.5	7.9	10.5	30.4

Table D-1. Summary of Base Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.

Table D-1. Summary of Base Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.

Station	WY 2011–2021								WY 2022–2023							
	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Hardness (mg/L)																
BBC10.4	12	63	71	72	73	75	78	78	14	59	69	80	71	81	103	155
BBC8.8	12	62	68	71	72	73	78	86	14	62	66	75	72	81	95	108
PET0.0	12	71	82	88	91	94	96	102	14	77	84	96	89	101	110	167
BBC8.4	12	67	71	81	81	91	92	96	14	66	72	84	78	94	100	128
BUR0.0	11	70	73	76	76	78	80	82	14	70	77	85	82	85	102	121
BBC7.0	12	49	70	80	83	92	95	98	14	70	73	86	82	91	113	128
BBC5.9	12	68	72	81	81	87	92	95	14	51	69	86	77	89	114	177
BBC5.2	12	66	71	82	86	88	90	106	14	66	71	86	80	88	120	147
BBC2.6	12	68	72	84	85	90	95	108	14	66	69	88	80	93	119	151
COL0.0	12	94	113	123	126	134	138	138	14	78	104	114	115	125	138	147
BBC1.6	12	68	78	87	87	97	99	102	14	64	71	91	81	94	114	206
Chloride (mg/L)																
BBC10.4	12	4.3	4.6	4.8	4.8	5.0	5.2	5.6	14	4.7	5.2	5.5	5.6	5.6	6.1	6.8
BBC8.8	12	4.7	5.0	5.2	5.2	5.4	5.6	5.8	14	5.0	5.8	6.1	5.9	6.1	6.7	7.9
PET0.0	12	3.7	4.0	4.2	4.3	4.5	4.6	4.6	14	4.3	4.5	5.1	4.8	5.6	6.1	6.7
BBC8.4	12	4.4	4.6	4.7	4.7	4.9	4.9	5.2	14	4.9	5.3	5.6	5.7	5.8	6.1	6.8
BUR0.0	11	4.6	6.5	6.7	6.9	7.4	7.7	7.8	14	5.9	7.3	7.7	7.6	8.1	8.4	9.9
BBC7.0	12	4.7	5.0	5.3	5.2	5.5	5.7	6.3	14	5.0	5.7	6.0	6.0	6.2	6.6	7.0
BBC5.9	12	4.8	4.9	5.2	5.1	5.4	5.6	6.1	14	4.8	5.7	6.0	6.0	6.2	6.7	7.0
BBC5.2	12	4.9	5.0	5.3	5.2	5.4	5.6	6.4	14	5.0	5.7	6.1	6.1	6.3	6.8	7.0
BBC2.6	12	3.6	5.2	5.3	5.3	5.5	5.7	6.5	14	4.9	5.7	6.0	6.1	6.2	6.7	6.8
COL0.0	12	4.1	5.0	5.2	5.1	5.3	5.6	6.8	14	3.9	5.2	5.4	5.6	5.7	5.7	6.0
BBC1.6	12	4.4	5.1	5.3	5.3	5.6	5.7	6.7	14	4.9	5.7	6.0	6.0	6.2	6.7	6.8
Dissolved Organic Carbon (mg/L)																
BBC10.4	12	0.7	1.3	1.8	1.6	1.9	3.1	3.3	14	0.9	1.3	2.4	2.1	3.2	3.9	6.3
BBC8.8	12	0.8	1.4	1.8	1.6	2.0	2.8	3.1	14	1.0	1.4	2.4	2.1	3.0	3.7	5.6
PET0.0	12	0.1	0.3	0.4	0.5	0.5	0.6	0.6	14	0.4	0.5	0.5	0.6	0.6	0.7	0.7
BBC8.4	12	0.3	0.7	1.1	1.0	1.5	2.0	2.2	14	0.7	0.9	1.7	1.4	2.4	2.8	4.1
BUR0.0	11	0.5	0.7	0.9	0.8	1.1	1.3	1.6	14	0.8	0.9	1.2	1.2	1.4	1.5	2.0
BBC7.0	12	0.6	1.3	1.7	1.7	2.3	2.5	2.8	14	1.1	1.4	2.3	1.9	3.0	3.6	5.5
BBC5.9	12	0.7	1.4	1.9	1.8	2.4	3.1	3.3	14	1.2	1.5	2.7	2.1	3.5	4.4	6.6
BBC5.2	12	0.6	1.3	1.9	1.7	2.4	3.1	3.3	14	1.2	1.6	2.7	2.1	3.5	4.3	6.6
BBC2.6	12	1.0	1.4	2.0	1.8	2.4	3.1	3.2	14	1.3	1.5	2.7	2.3	3.6	4.3	6.4
COL0.0	12	0.5	0.7	0.9	0.9	0.9	1.3	2.0	14	0.8	1.0	1.4	1.2	1.6	2.2	3.4
BBC1.6	12	1.0	1.4	1.9	1.7	2.4	3.0	3.2	14	1.3	1.5	2.7	2.2	3.4	4.2	6.7

Table D-1. Summary of Base Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.

Station	WY 2011–2021								WY 2022–2023							
	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Total Phosphorus (mg/L)																
BBC10.4	60	0.05	0.07	0.07	0.07	0.08	0.09	0.14	14	0.02	0.05	0.07	0.07	0.09	0.10	0.14
BBC8.8	60	0.06	0.07	0.08	0.08	0.09	0.10	0.13	14	0.03	0.06	0.07	0.07	0.08	0.09	0.13
PET0.0	60	0.10	0.13	0.14	0.14	0.15	0.16	0.18	14	0.07	0.09	0.10	0.10	0.11	0.12	0.13
BBC8.4	60	0.07	0.10	0.11	0.11	0.11	0.13	0.15	14	0.06	0.07	0.09	0.09	0.09	0.10	0.12
BUR0.0	59	0.04	0.07	0.08	0.07	0.08	0.10	0.15	14	0.02	0.05	0.06	0.05	0.07	0.08	0.08
BBC7.0	60	0.09	0.11	0.12	0.12	0.13	0.15	0.24	14	0.08	0.10	0.11	0.11	0.12	0.13	0.18
BBC5.9	60	0.08	0.09	0.11	0.10	0.12	0.13	0.16	14	0.07	0.10	0.11	0.10	0.12	0.13	0.24
BBC5.2	60	0.07	0.10	0.11	0.10	0.12	0.13	0.15	14	0.03	0.10	0.11	0.11	0.12	0.13	0.23
BBC2.6	60	0.08	0.10	0.11	0.11	0.12	0.13	0.17	14	0.09	0.10	0.12	0.11	0.12	0.13	0.22
COL0.0	59	0.01	0.09	0.10	0.10	0.11	0.11	0.26	14	0.06	0.08	0.09	0.09	0.09	0.10	0.13
BBC1.6	60	0.01	0.10	0.11	0.11	0.12	0.13	0.24	14	0.09	0.10	0.12	0.11	0.12	0.14	0.22
Soluble Reactive Phosphorus (mg/L)																
BBC10.4	60	0.02	0.05	0.06	0.06	0.06	0.07	0.09	8	0.03	0.04	0.06	0.06	0.07	0.09	0.12
BBC8.8	60	0.01	0.05	0.05	0.05	0.06	0.07	0.09	8	0.03	0.04	0.06	0.05	0.08	0.09	0.11
PET0.0	60	0.07	0.11	0.12	0.12	0.13	0.13	0.15	8	0.08	0.10	0.11	0.10	0.12	0.12	0.13
BBC8.4	60	0.05	0.07	0.08	0.08	0.09	0.10	0.12	8	0.06	0.08	0.08	0.09	0.10	0.11	0.11
BUR0.0	59	0.02	0.05	0.06	0.06	0.07	0.08	0.08	8	0.03	0.04	0.06	0.06	0.07	0.08	0.08
BBC7.0	60	0.05	0.07	0.08	0.08	0.09	0.10	0.13	8	0.08	0.08	0.10	0.10	0.11	0.13	0.17
BBC5.9	60	0.05	0.07	0.08	0.08	0.09	0.11	0.13	8	0.08	0.09	0.11	0.10	0.11	0.15	0.21
BBC5.2	60	0.06	0.07	0.08	0.08	0.09	0.11	0.15	8	0.08	0.09	0.11	0.10	0.11	0.15	0.21
BBC2.6	60	0.06	0.07	0.09	0.09	0.09	0.11	0.13	8	0.08	0.10	0.12	0.11	0.12	0.15	0.20
COL0.0	59	0.05	0.07	0.08	0.08	0.09	0.10	0.11	8	0.05	0.07	0.09	0.09	0.11	0.11	0.12
BBC1.6	60	0.06	0.07	0.09	0.09	0.10	0.11	0.13	8	0.08	0.10	0.12	0.11	0.12	0.14	0.19
Total Nitrogen (mg/L)																
BBC10.4	60	1.5	2.5	3.1	3.0	3.3	3.6	12.7	14	2.1	2.5	2.9	2.8	3.1	3.5	3.7
BBC8.8	60	1.3	2.2	2.7	2.7	3.1	3.5	5.9	14	2.1	2.3	2.6	2.6	3.0	3.2	3.2
PET0.0	60	1.0	1.2	2.0	1.5	1.8	2.1	22.7	14	1.7	1.8	2.1	2.0	2.2	2.3	3.1
BBC8.4	60	1.3	1.8	2.4	2.1	2.4	2.6	22.0	14	1.8	2.1	2.4	2.4	2.7	2.7	2.9
BUR0.0	59	1.6	2.2	2.9	2.7	3.0	3.6	15.8	14	2.1	2.5	2.8	2.8	3.1	3.4	3.7
BBC7.0	60	0.9	1.4	1.8	1.8	2.0	2.3	5.4	14	1.7	1.9	2.1	2.1	2.3	2.5	2.8
BBC5.9	60	0.8	1.2	1.6	1.5	1.9	2.1	3.6	14	1.6	1.7	2.0	1.9	2.2	2.4	2.9
BBC5.2	60	0.8	1.3	1.7	1.6	2.0	2.3	2.9	14	1.6	1.8	2.0	2.0	2.1	2.5	2.8
BBC2.6	60	1.0	1.4	1.7	1.7	2.0	2.1	3.6	14	1.6	1.8	2.0	2.0	2.2	2.3	2.6
COL0.0	59	1.2	1.7	1.9	1.9	2.1	2.3	2.7	14	1.1	1.8	1.9	2.1	2.1	2.2	2.2
BBC1.6	60	1.1	1.5	1.8	1.7	1.9	2.2	9.0	14	1.5	1.9	2.0	2.0	2.2	2.3	2.6

	WY 2011–2021								WY 2022–2023							
Station	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Nitrate+Nitrite (mg/L)																
BBC10.4	60	0.8	2.1	2.3	2.4	2.7	2.9	3.1	14	2.0	2.1	2.4	2.2	2.7	2.8	3.2
BBC8.8	60	0.8	1.8	2.1	2.2	2.5	2.7	2.9	14	1.6	1.8	2.2	2.2	2.5	2.7	2.8
PET0.0	60	0.9	1.1	1.3	1.3	1.5	1.7	2.0	14	1.3	1.6	1.8	1.7	1.9	2.0	2.8
BBC8.4	60	0.9	1.4	1.7	1.7	2.0	2.1	2.2	14	1.6	1.8	2.0	2.0	2.1	2.3	2.5
BUR0.0	59	1.1	1.9	2.2	2.2	2.5	2.7	3.2	14	1.8	2.1	2.4	2.3	2.7	3.1	3.2
BBC7.0	60	0.4	1.1	1.4	1.4	1.7	1.8	1.9	14	1.3	1.5	1.7	1.6	1.7	2.1	2.3
BBC5.9	60	0.4	0.9	1.3	1.3	1.6	1.8	1.9	14	1.2	1.3	1.5	1.5	1.6	2.0	2.1
BBC5.2	60	0.5	1.1	1.4	1.4	1.7	1.8	2.0	14	1.2	1.4	1.6	1.6	1.7	2.0	2.2
BBC2.6	60	0.7	1.1	1.4	1.4	1.7	1.8	1.9	14	1.1	1.4	1.6	1.5	1.6	2.0	2.2
COL0.0	59	1.2	1.5	1.7	1.7	1.8	1.9	2.2	14	1.1	1.5	1.6	1.7	1.7	1.8	1.8
BBC1.6	60	0.7	1.2	1.4	1.4	1.6	1.7	1.8	14	1.2	1.4	1.5	1.5	1.6	2.0	2.1
Total Copper (µg/L)																
BBC10.4	12	0.5	0.6	0.8	0.7	1.0	1.1	1.4	14	0.5	0.6	1.0	1.0	1.3	1.7	1.7
BBC8.8	12	0.8	0.8	1.1	0.9	1.1	1.3	2.7	14	0.6	0.8	1.0	1.0	1.2	1.4	1.8
PET0.0	12	3.8	4.3	5.7	5.4	6.7	7.2	9.6	14	2.0	3.9	4.9	5.1	6.1	6.6	6.9
BBC8.4	12	1.4	2.2	2.5	2.4	2.8	3.1	3.6	14	1.7	2.0	2.6	2.3	3.0	3.6	3.7
BUR0.0	11	0.4	0.7	0.8	0.8	1.0	1.0	1.3	14	0.5	0.6	0.8	0.8	0.9	1.0	1.3
BBC7.0	12	1.8	2.0	2.7	2.1	2.8	4.2	6.7	14	1.5	1.8	2.2	2.1	2.6	2.9	3.2
BBC5.9	12	1.1	1.3	1.5	1.4	1.6	1.9	2.1	14	1.2	1.4	1.7	1.7	2.0	2.2	2.5
BBC5.2	12	1.2	1.2	1.5	1.4	1.8	2.0	2.1	14	1.1	1.5	1.7	1.7	1.9	2.1	2.5
BBC2.6	12	1.0	1.1	1.4	1.2	1.6	1.9	2.1	14	1.1	1.3	1.7	1.7	2.0	2.1	2.6
COL0.0	12	0.4	0.5	0.7	0.6	0.8	1.1	2.0	14	0.4	0.8	1.2	1.0	1.5	1.9	2.5
BBC1.6	12	0.9	1.1	1.4	1.3	1.8	2.1	2.1	14	1.1	1.3	1.8	1.7	2.1	2.2	2.8
Dissolved Copper (µg/L)																
BBC10.4	12	0.4	0.4	0.5	0.4	0.5	0.8	1.0	14	0.3	0.4	0.7	0.6	0.8	1.1	1.5
BBC8.8	12	0.6	0.6	0.7	0.6	0.8	0.9	1.7	14	0.3	0.5	0.7	0.8	0.8	1.0	1.5
PET0.0	12	1.1	1.8	2.5	2.3	3.0	3.2	4.7	14	1.2	1.8	2.1	2.2	2.4	2.7	2.8
BBC8.4	12	1.0	1.3	1.5	1.6	1.8	2.0	2.2	14	1.0	1.2	1.4	1.3	1.5	1.8	1.9
BUR0.0	11	0.3	0.4	0.6	0.6	0.7	0.8	1.5	14	0.4	0.5	0.6	0.5	0.7	0.7	1.2
BBC7.0	12	0.8	1.0	1.1	1.1	1.3	1.4	1.6	14	0.9	1.0	1.3	1.3	1.4	1.5	1.9
BBC5.9	12	0.9	1.0	1.2	1.1	1.4	1.6	1.7	14	0.9	0.9	1.2	1.2	1.4	1.5	2.1
BBC5.2	12	0.8	0.9	1.1	1.0	1.2	1.3	1.7	14	0.9	0.9	1.2	1.2	1.3	1.5	2.1
BBC2.6	12	0.8	0.8	1.0	0.9	1.1	1.3	1.7	14	0.8	0.9	1.2	1.2	1.4	1.5	2.3
COL0.0	12	0.3	0.3	0.5	0.3	0.6	0.8	1.5	14	0.3	0.4	0.8	0.6	1.2	1.4	2.0
BBC1.6	12	0.7	0.8	1.0	1.0	1.1	1.3	1.7	14	0.8	0.9	1.2	1.1	1.5	1.6	2.4

Table D-1. Summary of Base Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.

Station	WY 2011–2021								WY 2022–2023							
	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Total Zinc (µg/L)																
BBC10.4	12	2.6	3.3	5.1	3.9	6.8	9.2	9.5	14	1.6	3.0	4.1	3.9	4.3	7.1	8.2
BBC8.8	12	3.8	5.0	6.2	5.7	6.8	9.3	10.6	14	2.4	5.2	7.4	6.1	9.1	11.8	14.9
PET0.0	12	4.0	5.8	7.4	6.8	8.5	10.8	11.7	14	5.4	6.5	7.6	7.3	8.2	9.9	10.5
BBC8.4	12	3.9	4.5	6.1	5.6	7.3	8.3	11.0	14	4.5	5.6	7.6	7.6	8.5	10.8	12.1
BUR0.0	11	5.0	6.9	14.3	8.7	16.0	24.4	45.6	14	4.2	5.7	11.6	9.7	15.8	18.8	27.1
BBC7.0	12	4.5	6.4	11.7	9.2	15.2	19.8	27.1	14	4.1	6.1	10.2	9.8	14.3	16.5	17.4
BBC5.9	12	2.6	3.1	5.6	4.4	6.8	9.8	13.3	14	3.0	4.3	8.4	8.9	11.3	13.8	15.6
BBC5.2	12	2.9	4.0	6.0	4.3	7.5	9.9	13.6	14	3.6	4.9	8.6	9.5	11.4	13.1	15.6
BBC2.6	12	2.6	3.1	5.6	4.2	6.8	9.8	12.4	14	2.9	4.7	7.6	7.5	10.4	12.6	13.2
COL0.0	12	3.8	4.9	10.0	8.7	14.5	16.4	20.4	14	3.4	7.1	10.9	10.9	13.8	17.5	18.1
BBC1.6	12	2.8	3.7	6.0	4.8	7.9	9.8	12.6	14	3.4	5.8	8.0	8.6	10.3	12.0	12.7
Dissolved Zinc (µg/L)																
BBC10.4	12	1.6	2.8	4.0	3.5	5.5	6.2	7.5	14	2.0	3.0	4.4	3.5	5.4	7.8	8.8
BBC8.8	12	1.7	2.5	4.0	3.3	4.8	7.2	8.7	14	1.7	2.6	5.7	6.0	7.3	10.3	12.3
PET0.0	12	2.8	3.6	4.6	4.4	5.8	6.0	7.7	14	3.6	4.2	6.1	5.9	7.7	8.4	10.6
BBC8.4	12	2.7	3.0	4.3	3.9	4.8	6.9	7.9	14	2.5	3.5	5.7	6.0	6.9	8.4	10.4
BUR0.0	11	3.3	4.5	12.5	8.5	14.3	23.7	41.5	14	3.8	5.3	11.3	9.3	15.5	17.6	28.5
BBC7.0	12	1.6	2.2	4.3	3.0	5.5	8.8	10.3	14	1.9	3.0	6.6	5.4	9.1	11.9	14.5
BBC5.9	12	2.2	2.6	4.6	4.1	5.4	7.7	10.0	14	2.4	2.9	6.7	6.0	9.4	12.3	14.6
BBC5.2	12	2.1	2.4	4.5	3.1	6.1	8.3	9.7	14	2.3	3.5	6.7	5.8	9.3	11.7	14.9
BBC2.6	12	1.5	2.0	3.5	2.4	4.8	7.0	7.4	14	1.4	2.2	5.0	4.6	7.1	8.0	11.4
COL0.0	12	1.8	3.8	7.4	5.4	11.3	12.1	18.7	14	2.5	3.7	8.2	8.7	12.0	13.3	14.9
BBC1.6	12	1.9	2.3	3.7	3.6	4.2	6.5	7.3	14	1.6	2.3	4.8	4.9	6.6	7.5	10.6
Fecal Coliform (CFU/100 mL)																
BBC10.4	59	15	64	109	110	190	357	1580	14	7	29	75	109	180	231	247
BBC8.8	59	5	61	107	118	182	335	2550	14	11	36	63	58	109	133	600
PET0.0	59	2	72	121	124	212	352	1820	14	18	23	62	44	142	194	1360
BBC8.4	59	9	48	87	91	164	268	700	14	22	35	80	76	149	214	640
BUR0.0	58	2	123	232	260	494	1043	3840	14	9	52	124	144	320	624	820
BBC7.0	59	11	100	170	145	270	500	3000	14	18	40	84	72	217	294	340
BBC5.9	59	7	92	147	143	231	395	3260	14	4	35	58	72	100	159	256
BBC5.2	59	15	91	145	150	230	379	2650	14	5	42	68	65	144	204	322
BBC2.6	59	20	125	198	200	312	500	2960	14	22	43	77	77	146	220	251
COL0.0	58	2	140	224	274	514	759	1100	13	4	48	105	149	278	404	800
BBC1.6	59	5	165	237	251	373	777	1500	14	24	37	76	84	175	195	255

Table D-1. Summary of Base Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.																
	WY 2011–2021								WY 2022–2023							
Station	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
E. coli **(CFU/100 mL)**																
BBC10.4	18	11	68	107	102	199	411	1080	14	6	23	50	84	118	139	220
BBC8.8	18	15	72	125	146	255	385	480	14	11	30	46	41	61	117	520
PET0.0	18	2	46	79	102	220	283	1380	14	16	20	47	28	79	124	1360
BBC8.4	18	9	32	60	76	130	201	400	14	11	32	60	55	111	136	640
BUR0.0	17	2	36	111	151	340	788	1000	14	9	26	125	227	435	612	1080
BBC7.0	18	11	116	211	192	675	1366	1800	14	16	26	56	44	107	223	340
BBC5.9	18	7	63	95	102	195	210	215	14	2	28	38	53	79	81	88
BBC5.2	18	15	54	74	86	118	141	160	14	4	29	44	46	89	110	220
BBC2.6	18	22	73	172	258	361	500	620	14	15	28	50	48	102	118	147
COL0.0	17	2	27	87	200	300	484	640	13	4	24	69	82	189	320	540
BBC1.6	18	5	50	112	179	264	327	480	14	16	27	54	53	112	136	142

[a] Geometric mean for *E. coli* and fecal coliform bacteria by all studies.

Table D-2. Summary of Storm Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.																
	WY 2020–2021								WY 2022–2023							
Station	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Temperature (degrees Celsius)																
BBC10.4	10	7.6	9.4	11.8	10.0	14.4	16.6	16.9	10	7.6	9.1	9.7	9.8	10.4	11.3	11.7
BBC8.8	10	7.2	9.4	11.7	10.1	14.7	16.2	17.0	10	7.5	9.1	9.8	10.0	10.8	11.3	11.7
PET0.0	10	11.4	12.3	14.2	13.6	15.9	17.4	17.5	10	9.6	11.5	12.3	12.8	13.1	13.5	14.0
BBC8.4	10	9.3	10.1	12.5	11.0	15.2	16.7	17.1	10	8.2	10.5	10.8	10.9	11.4	11.9	12.4
BUR0.0	10	6.6	9.2	11.6	10.3	14.5	16.6	16.8	10	7.1	8.3	9.5	9.8	10.6	11.5	11.7
BBC7.0	10	7.4	9.4	11.8	10.4	14.6	16.2	17.1	10	7.1	9.4	10.1	10.5	11.3	11.8	11.8
BBC5.9	10	7.2	9.2	11.6	10.1	14.2	16.3	17.0	10	6.6	9.4	10.0	10.5	11.1	11.6	11.7
BBC5.2	10	7.3	9.2	11.8	10.2	14.6	16.5	17.1	10	6.7	9.4	10.0	10.6	11.3	11.7	11.9
BBC2.6	10	7.1	9.2	11.6	10.0	14.5	16.3	17.2	10	6.5	9.1	10.0	10.6	11.4	11.7	11.7
COL0.0	10	7.2	9.0	11.2	9.6	14.2	15.6	15.9	10	5.9	8.4	9.4	9.6	10.9	11.3	11.3
BBC1.6	10	7.4	9.2	11.6	9.9	14.4	16.3	17.1	10	6.4	9.0	9.9	10.4	11.4	11.7	11.8
Dissolved Oxygen (mg/L)																
BBC10.4	10	2.4	6.4	6.7	7.0	7.8	8.1	9.2	10	7.1	7.8	8.4	8.4	8.9	9.2	9.9
BBC8.8	10	1.8	7.7	7.8	8.6	9.1	9.5	10.8	10	8.3	9.6	10.3	10.8	10.9	11.2	11.7
PET0.0	10	7.1	7.9	8.4	8.8	9.0	9.1	9.3	10	7.9	9.0	9.1	9.1	9.5	9.7	10.2
BBC8.4	10	6.7	7.7	8.7	9.1	9.8	10.0	10.2	10	8.8	9.3	10.1	10.5	10.6	10.8	11.0
BUR0.0	10	6.9	8.3	9.0	9.3	9.5	10.4	11.0	10	8.9	9.9	10.4	10.7	11.1	11.2	11.6
BBC7.0	10	2.4	6.6	7.8	8.0	9.4	10.2	11.1	10	7.3	8.5	9.6	10.1	10.5	10.9	11.0
BBC5.9	10	5.6	6.2	7.7	8.0	8.7	9.3	9.9	10	7.3	7.8	8.9	9.3	9.7	10.0	10.7
BBC5.2	10	8.0	8.8	9.5	9.4	10.3	10.4	10.8	10	9.1	9.5	10.2	10.3	10.6	10.9	11.4
BBC2.6	10	8.8	9.5	10.3	10.7	11.0	11.2	11.4	10	10.2	10.6	11.0	10.9	11.4	11.6	11.8
COL0.0	10	9.3	10.6	11.0	11.3	11.5	11.8	12.1	10	10.7	11.1	11.5	11.2	11.9	12.4	12.7
BBC1.6	10	2.6	9.3	9.7	10.7	11.1	11.3	11.4	10	10.3	10.6	11.1	11.0	11.5	11.9	12.1
pH																
BBC10.4	10	6.0	6.4	6.7	6.7	6.9	7.3	7.9	10	6.0	6.3	6.4	6.5	6.6	6.6	6.7
BBC8.8	10	6.1	6.8	6.9	7.0	7.1	7.1	7.5	10	6.4	6.6	6.8	6.9	7.0	7.1	7.3
PET0.0	10	6.1	7.0	7.0	7.1	7.2	7.3	7.4	10	6.8	6.8	6.9	6.9	7.0	7.1	7.3
BBC8.4	10	6.1	7.0	7.0	7.1	7.2	7.2	7.2	10	6.7	6.9	7.0	7.0	7.1	7.2	7.4
BUR0.0	10	6.3	6.8	7.0	7.0	7.3	7.4	7.4	9	6.5	6.7	6.8	6.8	7.0	7.0	7.2
BBC7.0	10	6.3	6.7	6.9	6.9	7.1	7.3	7.4	10	6.7	6.9	7.0	7.0	7.0	7.1	7.2
BBC5.9	10	6.5	6.7	6.9	7.0	7.1	7.3	7.4	10	6.6	6.8	6.9	7.0	7.1	7.1	7.2
BBC5.2	10	6.8	7.1	7.2	7.2	7.3	7.4	7.6	10	6.8	7.0	7.1	7.2	7.2	7.3	7.4
BBC2.6	10	6.6	7.1	7.4	7.5	7.6	7.8	7.9	10	7.2	7.3	7.5	7.5	7.6	7.7	7.9
COL0.0	10	6.4	7.1	7.3	7.3	7.6	7.9	8.0	10	7.1	7.3	7.5	7.4	7.6	7.8	8.0
BBC1.6	10	6.8	7.1	7.4	7.4	7.6	7.8	7.9	10	7.2	7.4	7.5	7.5	7.7	7.8	7.9

Table D-2. Summary of Storm Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.																
	WY 2020–2021								WY 2022–2023							
Station	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Conductivity (µS/cm²)																
BBC10.4	10	74	99	120	112	142	150	186	10	85	126	136	141	155	168	175
BBC8.8	10	72	93	117	112	139	145	182	10	91	132	132	133	141	167	168
PET0.0	10	85	125	155	155	186	199	226	10	85	153	161	159	176	196	212
BBC8.4	10	79	112	137	137	149	175	210	10	89	138	140	139	152	181	182
BUR0.0	10	31	55	86	73	107	158	181	10	30	56	92	95	125	140	149
BBC7.0	10	65	122	134	135	157	183	193	10	74	120	133	131	144	178	182
BBC5.9	10	61	124	136	133	167	187	195	10	94	122	141	141	159	181	182
BBC5.2	10	60	120	123	126	129	157	182	10	77	119	134	133	144	179	181
BBC2.6	10	60	103	123	122	153	166	192	10	69	116	134	134	151	179	185
COL0.0	10	40	64	91	86	107	154	154	10	35	63	102	81	128	191	202
BBC1.6	10	57	98	107	109	125	139	153	10	61	106	126	123	145	179	185
Turbidity (NTU)																
BBC10.4	10	2.2	6.5	10.1	8.2	12.3	18.7	25.0	10	6.7	8.9	12.2	10.1	13.8	16.9	27.0
BBC8.8	10	1.9	6.4	18.1	7.2	8.8	26.4	112.0	10	3.7	5.9	11.3	9.7	10.6	15.1	38.9
PET0.0	10	0.8	2.2	15.2	3.7	6.5	19.2	117.0	10	1.8	2.9	5.8	3.7	5.5	9.1	22.3
BBC8.4	10	1.4	4.4	14.1	5.5	10.4	20.6	84.0	10	3.3	5.4	10.8	8.8	10.3	14.8	38.4
BUR0.0	10	2.1	4.2	9.2	8.2	13.5	17.3	17.4	10	3.5	6.8	13.6	10.0	18.4	21.2	38.0
BBC7.0	10	4.0	4.9	17.2	7.3	7.9	33.9	95.5	10	3.3	4.6	6.9	6.4	7.6	10.6	13.6
BBC5.9	10	2.7	3.6	12.2	4.7	7.1	16.6	75.5	10	3.1	5.2	7.0	6.9	7.8	9.0	13.8
BBC5.2	10	4.0	5.8	12.6	9.7	14.3	21.6	36.8	10	4.4	5.4	9.8	9.6	10.7	12.7	26.0
BBC2.6	10	0.5	5.0	10.2	7.9	14.0	19.6	26.2	10	4.6	6.5	13.9	9.8	13.3	20.5	51.5
COL0.0	10	8.1	17.5	29.4	30.1	32.2	43.6	69.2	10	5.8	7.1	24.6	24.7	28.5	35.9	82.5
BBC1.6	10	7.7	10.2	15.5	14.1	17.6	21.7	33.9	10	7.0	7.9	17.2	11.9	16.6	24.5	65.5
Total Suspended Solids (mg/L)																
BBC10.4	10	2.7	4.2	11.5	7.7	16.2	20.9	37.0	10	5.6	11.9	19.7	14.9	19.6	40.6	49.3
BBC8.8	10	2.1	8.0	11.2	10.6	14.1	19.6	22.4	10	5.6	8.6	19.6	12.5	13.5	27.8	93.1
PET0.0	10	1.7	3.7	9.1	5.3	16.6	19.8	22.0	10	2.5	4.0	10.9	6.1	9.2	15.6	53.3
BBC8.4	10	4.1	7.2	12.4	10.3	13.6	18.8	35.4	10	5.8	8.0	22.4	11.1	19.6	42.0	102.0
BUR0.0	10	1.2	2.5	10.5	7.9	18.0	22.6	24.9	10	1.5	5.7	18.3	10.4	22.1	40.5	68.3
BBC7.0	10	4.2	4.7	12.7	5.8	9.3	19.6	65.0	10	2.1	3.7	7.4	6.3	11.2	12.6	16.7
BBC5.9	10	3.9	5.3	8.0	6.0	10.5	13.1	15.1	10	3.8	6.1	10.1	8.6	11.6	15.2	26.1
BBC5.2	10	5.0	7.4	14.2	12.6	22.2	25.6	25.8	10	7.6	8.2	15.1	10.4	16.7	25.5	44.8
BBC2.6	10	3.4	8.1	22.3	15.1	30.7	43.5	68.8	10	8.0	14.4	30.8	19.7	25.6	57.4	123.0
COL0.0	10	10.1	21.5	47.1	29.2	69.7	85.9	130.0	10	3.0	8.8	34.9	23.6	33.1	61.2	158.0
BBC1.6	10	8.5	17.3	31.7	24.4	41.7	63.1	67.2	10	9.2	14.6	36.1	22.4	33.6	62.2	146.0

Table D-2. Summary of Storm Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.

	WY 2020–2021								WY 2022–2023							
Station	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Hardness (mg/L)																
BBC10.4	10	32	43	53	53	58	74	80	10	32	48	54	57	60	63	72
BBC8.8	10	26	42	50	46	58	71	72	10	34	46	51	53	60	62	66
PET0.0	10	38	56	65	62	69	96	98	10	29	55	59	60	65	67	80
BBC8.4	10	35	51	56	56	58	74	81	10	26	51	54	56	63	68	70
BUR0.0	10	9	21	35	33	38	67	70	10	14	24	34	33	42	50	56
BBC7.0	10	31	49	57	56	62	67	94	10	20	46	50	53	56	64	66
BBC5.9	10	30	52	61	60	70	81	82	10	28	49	55	58	65	71	78
BBC5.2	10	26	39	51	52	58	69	82	10	30	46	52	53	65	66	66
BBC2.6	10	33	39	53	53	61	69	86	10	24	46	54	56	67	70	74
COL0.0	10	21	29	49	42	68	78	99	10	22	26	42	35	51	77	78
BBC1.6	10	28	30	44	41	56	61	72	10	22	44	52	53	62	70	72
Chloride (mg/L)																
BBC10.4	10	2.5	3.2	3.9	4.0	4.1	4.8	5.4	10	2.7	4.0	4.8	4.8	5.3	5.6	7.7
BBC8.8	10	2.9	3.4	4.1	3.9	4.9	5.3	5.8	10	3.2	5.7	6.1	6.1	6.7	7.6	8.5
PET0.0	10	2.0	3.5	3.7	3.7	4.1	4.4	4.6	10	2.8	3.8	4.6	4.3	5.9	6.1	6.1
BBC8.4	10	3.0	3.6	4.1	3.8	4.5	5.1	5.9	10	2.6	5.4	5.5	5.6	5.8	6.3	8.0
BUR0.0	10	1.3	1.8	3.7	2.1	5.1	6.5	11.4	10	1.1	1.9	4.5	4.2	6.4	8.5	9.0
BBC7.0	10	2.8	4.4	4.6	4.7	4.8	5.6	6.1	10	4.1	5.2	6.1	5.8	6.9	7.4	9.2
BBC5.9	10	2.8	4.3	4.8	4.9	5.6	5.8	6.0	10	4.4	4.9	6.0	5.9	6.3	7.3	9.6
BBC5.2	10	2.8	3.9	4.3	4.2	4.7	5.5	6.0	10	3.6	4.8	5.7	5.5	6.4	7.2	9.3
BBC2.6	10	2.7	3.4	4.2	4.0	4.5	5.8	6.3	10	3.0	4.6	5.7	5.6	6.2	7.3	9.9
COL0.0	10	1.4	2.5	6.4	4.2	6.6	13.1	22.6	10	1.3	2.6	4.0	3.7	5.4	6.1	8.1
BBC1.6	10	2.7	3.4	4.6	3.8	4.3	6.8	11.0	10	3.0	4.5	5.5	5.1	6.4	7.4	10.2
Dissolved Organic Carbon (mg/L)																
BBC10.4	10	1.9	2.9	4.1	4.7	5.0	5.2	6.1	10	2.3	2.9	3.5	3.3	3.9	5.1	5.2
BBC8.8	10	1.7	3.2	3.8	4.2	4.6	4.7	5.0	10	2.1	2.7	3.3	3.0	3.6	4.7	4.9
PET0.0	10	0.2	0.6	1.0	1.0	1.3	1.9	2.0	10	0.6	0.9	1.0	0.9	1.2	1.4	1.5
BBC8.4	10	0.9	2.6	2.8	3.1	3.4	3.6	4.0	10	1.8	2.0	2.6	2.4	3.2	3.4	3.9
BUR0.0	10	1.2	1.6	2.9	2.8	3.7	4.9	5.0	10	1.3	1.6	1.9	1.8	2.3	2.4	2.4
BBC7.0	10	1.9	2.7	3.3	3.8	4.0	4.0	4.3	10	1.9	2.5	2.9	2.6	3.4	3.8	3.9
BBC5.9	10	2.1	2.7	3.6	3.7	4.4	4.8	5.6	10	2.3	2.6	3.1	3.0	3.4	4.1	4.3
BBC5.2	10	1.9	3.4	3.7	3.8	4.3	4.5	5.2	10	2.1	2.6	3.0	3.0	3.3	3.9	4.2
BBC2.6	10	0.5	2.7	3.3	3.5	4.1	4.5	5.3	10	2.2	2.7	3.1	3.0	3.4	3.9	4.1
COL0.0	10	1.5	2.3	3.1	2.9	3.5	4.5	5.4	10	1.5	2.1	2.3	2.3	2.6	2.6	3.0
BBC1.6	10	1.9	2.8	3.6	3.6	4.4	4.7	5.1	10	2.2	2.7	2.9	2.9	3.1	3.6	3.9

Table D-2. Summary of Storm Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.

Station	WY 2020–2021								WY 2022–2023							
	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Total Phosphorus (mg/L)																
BBC10.4	10	0.06	0.09	0.13	0.11	0.15	0.19	0.25	10	0.08	0.09	0.12	0.10	0.14	0.18	0.18
BBC8.8	10	0.05	0.08	0.10	0.09	0.11	0.15	0.21	10	0.06	0.08	0.10	0.09	0.11	0.15	0.18
PET0.0	10	0.07	0.09	0.11	0.10	0.12	0.16	0.16	10	0.07	0.08	0.09	0.09	0.10	0.11	0.14
BBC8.4	10	0.05	0.09	0.11	0.11	0.13	0.16	0.17	10	0.07	0.08	0.11	0.10	0.12	0.14	0.19
BUR0.0	10	0.03	0.06	0.08	0.08	0.11	0.12	0.13	10	0.04	0.05	0.07	0.06	0.08	0.09	0.15
BBC7.0	10	0.05	0.11	0.13	0.13	0.16	0.17	0.18	10	0.07	0.08	0.10	0.10	0.12	0.13	0.14
BBC5.9	10	0.05	0.10	0.13	0.12	0.15	0.17	0.26	10	0.08	0.10	0.11	0.11	0.12	0.15	0.16
BBC5.2	10	0.08	0.12	0.14	0.13	0.15	0.16	0.26	10	0.08	0.11	0.11	0.11	0.12	0.14	0.15
BBC2.6	10	0.09	0.11	0.17	0.15	0.23	0.26	0.27	10	0.10	0.11	0.13	0.11	0.15	0.18	0.21
COL0.0	10	0.07	0.12	0.15	0.16	0.17	0.22	0.30	10	0.07	0.08	0.11	0.11	0.13	0.15	0.25
BBC1.6	10	0.11	0.12	0.16	0.14	0.18	0.25	0.26	10	0.10	0.10	0.14	0.11	0.16	0.18	0.25
Soluble Reactive Phosphorus (mg/L)																
BBC10.4	10	0.03	0.05	0.07	0.06	0.09	0.10	0.16	6	0.03	0.05	0.06	0.05	0.06	0.08	0.10
BBC8.8	10	0.04	0.05	0.07	0.06	0.08	0.11	0.12	6	0.03	0.04	0.05	0.05	0.06	0.07	0.08
PET0.0	10	0.04	0.06	0.08	0.09	0.10	0.12	0.13	6	0.04	0.07	0.07	0.07	0.09	0.10	0.10
BBC8.4	9	0.05	0.06	0.08	0.08	0.09	0.11	0.14	6	0.03	0.05	0.06	0.07	0.07	0.08	0.09
BUR0.0	9	0.01	0.03	0.04	0.04	0.05	0.06	0.07	6	0.02	0.02	0.03	0.02	0.03	0.04	0.04
BBC7.0	9	0.06	0.06	0.09	0.10	0.11	0.13	0.13	6	0.03	0.06	0.08	0.09	0.10	0.11	0.13
BBC5.9	10	0.06	0.07	0.11	0.12	0.13	0.14	0.20	6	0.04	0.06	0.09	0.09	0.11	0.12	0.13
BBC5.2	10	0.05	0.06	0.09	0.10	0.11	0.13	0.18	6	0.03	0.06	0.07	0.08	0.09	0.10	0.10
BBC2.6	9	0.02	0.06	0.08	0.09	0.10	0.12	0.15	6	0.03	0.06	0.07	0.08	0.08	0.09	0.09
COL0.0	10	0.02	0.04	0.06	0.05	0.07	0.08	0.17	6	0.03	0.03	0.04	0.03	0.05	0.05	0.05
BBC1.6	9	0.05	0.06	0.08	0.09	0.09	0.10	0.13	6	0.03	0.06	0.06	0.07	0.08	0.08	0.08
Total Nitrogen (mg/L)																
BBC10.4	10	1.2	1.7	2.2	2.2	2.7	2.8	3.4	10	1.8	2.1	2.5	2.4	2.7	3.3	3.3
BBC8.8	10	0.8	1.7	2.1	2.3	2.4	2.6	2.9	10	1.5	1.9	2.2	2.1	2.4	3.1	3.4
PET0.0	10	0.7	1.6	1.8	1.8	2.1	2.1	2.4	10	1.2	1.4	1.9	2.0	2.1	2.8	2.8
BBC8.4	10	1.4	1.8	2.1	2.1	2.5	2.6	2.6	10	1.2	1.6	2.1	2.1	2.4	3.2	3.2
BUR0.0	10	0.4	1.1	1.9	1.8	2.6	3.1	3.1	10	0.5	1.2	1.7	1.4	1.7	3.4	3.5
BBC7.0	10	0.9	1.6	2.0	1.8	1.8	2.5	4.7	10	1.0	1.3	1.8	1.7	2.0	2.6	2.9
BBC5.9	10	1.0	1.5	1.8	1.9	2.1	2.4	2.8	10	0.9	1.4	1.7	1.6	1.9	2.5	2.6
BBC5.2	10	1.4	1.7	1.9	1.9	2.2	2.4	2.6	10	0.9	1.3	1.7	1.7	1.9	2.6	2.7
BBC2.6	10	1.0	1.6	1.9	2.0	2.2	2.3	2.4	10	0.7	1.4	1.7	1.7	1.9	2.4	2.5
COL0.0	10	0.8	1.3	1.6	1.4	1.5	2.2	3.8	10	0.3	0.7	1.1	1.0	1.4	1.8	1.9
BBC1.6	10	0.9	1.5	1.9	1.6	2.0	2.9	3.5	10	0.9	1.2	1.7	1.5	1.9	2.7	3.1

Table D-2. Summary of Storm Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.

	WY 2020–2021								WY 2022–2023							
Station	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Nitrate+Nitrite (mg/L)																
BBC10.4	10	0.8	1.0	1.4	1.2	1.8	1.9	2.0	10	0.8	1.7	1.7	1.8	2.0	2.2	2.3
BBC8.8	10	0.7	0.9	1.3	1.2	1.7	1.8	1.9	10	0.7	1.5	1.5	1.6	1.6	2.2	2.3
PET0.0	10	0.5	1.0	1.2	1.2	1.6	1.7	1.7	10	0.8	1.2	1.4	1.5	1.7	1.8	1.8
BBC8.4	10	0.8	1.0	1.3	1.2	1.6	1.8	1.9	10	0.7	1.4	1.5	1.5	1.6	2.1	2.1
BUR0.0	10	0.3	0.4	1.0	0.6	1.7	1.9	2.6	10	0.3	0.6	1.1	1.0	1.5	1.7	2.5
BBC7.0	10	0.6	0.7	1.0	0.8	1.1	1.5	1.8	10	0.5	0.9	1.2	1.2	1.4	1.8	1.9
BBC5.9	10	0.6	0.8	1.0	0.8	1.2	1.4	1.8	10	0.7	0.9	1.2	1.3	1.4	1.8	1.9
BBC5.2	10	0.5	0.7	1.0	0.8	1.3	1.4	1.7	10	0.6	0.8	1.2	1.2	1.3	1.8	1.8
BBC2.6	10	0.5	0.7	0.9	0.8	1.2	1.3	1.6	10	0.5	0.8	1.2	1.2	1.3	1.8	1.8
COL0.0	10	0.2	0.3	0.5	0.4	0.6	0.9	0.9	10	0.2	0.3	0.6	0.4	1.1	1.2	1.2
BBC1.6	10	0.4	0.6	0.8	0.7	0.9	1.2	1.6	10	0.4	0.8	1.1	1.0	1.3	1.7	1.8
Total Copper (µg/L)																
BBC10.4	10	0.8	1.7	2.6	2.2	2.7	3.8	7.5	10	1.3	1.8	2.3	2.0	2.6	3.4	4.8
BBC8.8	10	0.8	1.8	2.2	2.2	2.7	3.1	3.5	10	1.2	2.0	2.5	2.1	2.5	3.0	6.4
PET0.0	10	3.1	4.6	11.4	6.8	14.8	18.7	40.7	10	3.7	5.3	8.6	6.2	7.6	12.1	29.9
BBC8.4	10	2.3	2.7	4.1	3.4	4.9	6.2	8.0	10	2.5	2.8	4.5	3.6	4.2	5.9	14.0
BUR0.0	10	1.1	2.6	3.3	2.7	4.1	4.8	6.3	10	2.1	2.5	3.6	2.8	3.5	5.7	8.3
BBC7.0	10	2.0	2.3	3.2	2.6	3.5	4.4	6.7	10	2.3	2.3	2.7	2.6	3.1	3.1	3.3
BBC5.9	10	1.8	2.2	2.5	2.6	2.7	2.8	3.1	10	1.9	2.2	2.6	2.5	2.8	3.2	3.8
BBC5.2	10	2.2	2.9	3.4	3.0	4.0	4.6	5.1	10	2.3	2.4	3.1	2.9	3.1	3.7	5.4
BBC2.6	10	1.5	2.5	3.5	3.4	4.0	5.3	6.2	10	2.2	2.6	3.5	3.0	3.3	5.3	7.9
COL0.0	10	4.2	8.0	9.3	9.3	11.5	12.5	15.2	10	2.9	4.0	7.1	7.4	8.3	9.7	15.7
BBC1.6	10	2.5	4.1	4.9	4.7	5.5	7.0	7.4	10	2.3	2.9	4.2	3.6	4.1	6.0	10.5
Dissolved Copper (µg/L)																
BBC10.4	10	0.5	1.2	1.8	1.5	2.2	2.5	3.8	10	0.8	1.0	1.2	1.2	1.4	1.4	1.4
BBC8.8	10	0.7	1.2	1.6	1.5	1.9	2.1	2.6	10	0.8	1.1	1.4	1.4	1.6	1.8	2.1
PET0.0	10	1.7	1.9	2.8	2.4	3.2	4.8	5.2	10	1.7	2.2	2.5	2.5	2.5	3.1	3.4
BBC8.4	10	1.3	1.5	2.3	1.9	2.8	3.8	4.0	10	1.5	1.6	1.8	1.7	1.9	2.2	2.6
BUR0.0	10	1.0	1.4	2.1	1.8	2.9	3.3	3.7	10	1.1	1.6	1.8	1.8	1.9	2.3	2.3
BBC7.0	10	1.0	1.5	1.9	1.7	2.1	2.8	3.0	10	1.3	1.4	1.7	1.6	1.9	2.1	2.6
BBC5.9	10	1.2	1.5	1.7	1.6	1.9	2.1	2.4	10	1.2	1.4	1.7	1.6	1.7	2.1	2.5
BBC5.2	10	1.4	1.6	2.0	2.1	2.2	2.5	3.2	10	1.4	1.5	1.7	1.7	1.7	2.1	2.4
BBC2.6	10	1.2	1.5	1.9	1.8	2.3	2.4	3.0	10	1.3	1.4	1.7	1.6	2.0	2.1	2.4
COL0.0	10	2.3	3.3	4.0	3.8	4.5	5.5	7.3	10	1.7	2.7	3.1	3.0	3.8	3.9	4.3
BBC1.6	10	1.6	2.0	2.5	2.4	2.8	3.2	4.0	10	1.3	1.7	1.9	1.9	2.3	2.4	2.4

Table D-2. Summary of Storm Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.																
	WY 2020–2021								WY 2022–2023							
Station	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
Total Zinc (µg/L)																
BBC10.4	10	5.8	17.1	31.5	23.5	41.9	69.6	72.8	10	10.6	14.9	19.5	16.0	24.5	31.6	35.2
BBC8.8	10	6.0	13.6	23.3	19.0	27.0	33.2	66.4	10	9.2	18.2	22.6	20.4	25.1	28.7	52.4
PET0.0	10	4.6	11.2	18.9	14.5	19.7	26.7	61.8	10	10.6	14.6	17.9	15.1	15.9	20.5	48.4
BBC8.4	10	5.2	11.3	17.7	13.4	19.3	26.5	48.5	10	10.5	14.7	21.1	18.5	21.8	28.6	54.2
BUR0.0	10	16.2	28.0	43.8	37.3	58.7	71.3	77.2	10	25.2	30.7	52.8	36.0	65.7	100.7	125.0
BBC7.0	10	12.0	14.1	19.5	18.5	25.0	25.8	29.3	10	15.1	16.4	19.8	17.7	20.3	27.0	32.5
BBC5.9	10	7.9	9.1	13.4	14.0	16.0	19.0	22.1	10	11.3	14.1	16.9	15.2	18.4	20.2	31.1
BBC5.2	10	10.3	20.3	23.8	24.5	28.0	33.5	34.6	10	13.0	17.3	22.9	22.0	23.2	31.8	43.8
BBC2.6	10	4.6	12.9	21.9	18.6	29.8	32.9	50.8	10	10.3	13.6	22.4	19.0	26.7	35.7	55.0
COL0.0	10	25.7	46.3	141.9	48.6	68.6	159.5	951.0	10	18.9	27.3	55.0	53.5	65.8	92.9	125.0
BBC1.6	10	15.0	21.2	49.9	29.5	34.9	68.7	246.0	10	11.6	15.9	26.6	22.9	30.7	38.6	68.2
Dissolved Zinc (µg/L)																
BBC10.4	10	4.6	13.9	22.3	20.6	24.8	31.3	62.3	10	8.5	12.3	14.2	13.7	14.7	17.1	26.7
BBC8.8	10	4.8	10.2	17.5	13.7	18.7	25.6	54.3	10	5.1	12.6	14.4	14.4	18.1	18.8	19.7
PET0.0	10	3.4	7.7	8.2	8.0	8.9	10.8	13.0	10	6.9	10.0	10.9	11.7	12.5	12.7	13.3
BBC8.4	10	3.5	7.9	12.3	10.6	11.5	16.9	38.0	10	5.2	9.7	12.1	11.9	14.6	16.9	17.6
BUR0.0	10	11.9	21.6	32.8	31.7	44.6	51.3	51.6	10	23.6	25.5	37.4	26.7	37.3	67.7	84.4
BBC7.0	10	2.3	9.8	12.9	12.4	16.4	20.9	22.0	10	10.8	11.9	15.4	15.2	18.3	19.0	21.9
BBC5.9	10	5.1	7.0	9.9	10.4	11.9	14.0	15.5	10	7.8	9.3	12.3	13.1	14.6	15.6	16.0
BBC5.2	10	6.9	14.2	14.0	14.9	15.7	17.8	18.4	10	8.7	11.1	14.3	13.7	17.3	19.3	22.4
BBC2.6	10	3.5	7.0	9.8	9.0	10.2	14.6	22.6	10	5.7	6.3	9.7	7.8	12.0	15.7	17.4
COL0.0	10	16.4	23.1	89.9	25.4	31.8	99.9	666.0	10	9.6	16.5	29.0	21.1	29.3	39.3	98.4
BBC1.6	10	6.5	9.7	28.3	11.2	15.7	35.3	177.0	10	5.4	8.0	11.0	10.8	14.6	15.0	16.1
Fecal Coliform (CFU/100 mL)																
BBC10.4	10	36	114	387	438	1515	2560	4000	10	9	145	255	455	832	1110	2500
BBC8.8	10	55	133	296	181	875	1300	3100	10	9	153	213	395	575	710	800
PET0.0	10	2	97	159	199	645	976	2400	10	27	55	99	78	164	299	918
BBC8.4	10	31	41	182	206	720	1002	2100	10	9	105	143	200	428	622	818
BUR0.0	10	18	440	861	770	3575	6220	28000	9	91	230	373	470	818	996	1345
BBC7.0	9	20	200	459	600	791	3866	15400	10	27	98	180	215	370	539	800
BBC5.9	10	40	143	404	295	988	3168	5400	10	18	155	171	205	335	449	800
BBC5.2	10	20	202	544	520	2251	3330	6300	10	18	109	208	310	425	544	1300
BBC2.6	10	40	148	376	577	900	1242	3600	10	18	155	229	350	398	810	900
COL0.0	10	100	458	1165	1409	4325	5770	10000	10	9	325	514	646	1775	2840	3200
BBC1.6	10	80	151	562	987	1404	2344	5800	10	18	167	259	325	625	910	1000

Table D-2. Summary of Storm Flow Water Quality Data for Current and Historical Studies of Burnt Bridge Creek.

Station	WY 2020–2021								WY 2022–2023							
	N	Min.	25th Percentile	Mean[a]	Median	75th Percentile	90th Percentile	Max.	N	Min.	25th Percentile	Mean	Median	75th Percentile	90th Percentile	Max.
E. coli **(CFU/100 mL)**																
BBC10.4	9	18	82	159	133	380	1556	2500	10	9	100	159	216	415	690	1500
BBC8.8	9	55	100	144	118	220	404	700	10	9	123	142	225	300	400	400
PET0.0	9	2	42	103	164	420	727	1236	10	18	38	74	78	132	177	370
BBC8.4	9	27	45	109	136	191	381	827	10	9	57	88	118	200	344	470
BUR0.0	9	18	202	346	358	800	2180	2900	9	45	230	270	300	530	668	1182
BBC7.0	8	24	131	275	249	592	1635	3500	10	27	52	106	118	182	373	400
BBC5.9	9	22	100	247	220	764	1800	4200	10	18	23	87	128	218	365	500
BBC5.2	9	29	162	373	231	1160	2320	2800	10	18	75	131	188	285	474	600
BBC2.6	9	28	64	208	280	520	848	2000	10	18	105	139	137	300	346	400
COL0.0	9	20	193	295	380	430	1416	1700	10	9	129	214	240	548	900	900
BBC1.6	9	66	100	305	360	580	1451	2600	10	18	87	139	150	275	367	700

[a] Geometric mean for *E. coli* and fecal coliform bacteria by all studies.

APPENDIX E

Water Quality Figures

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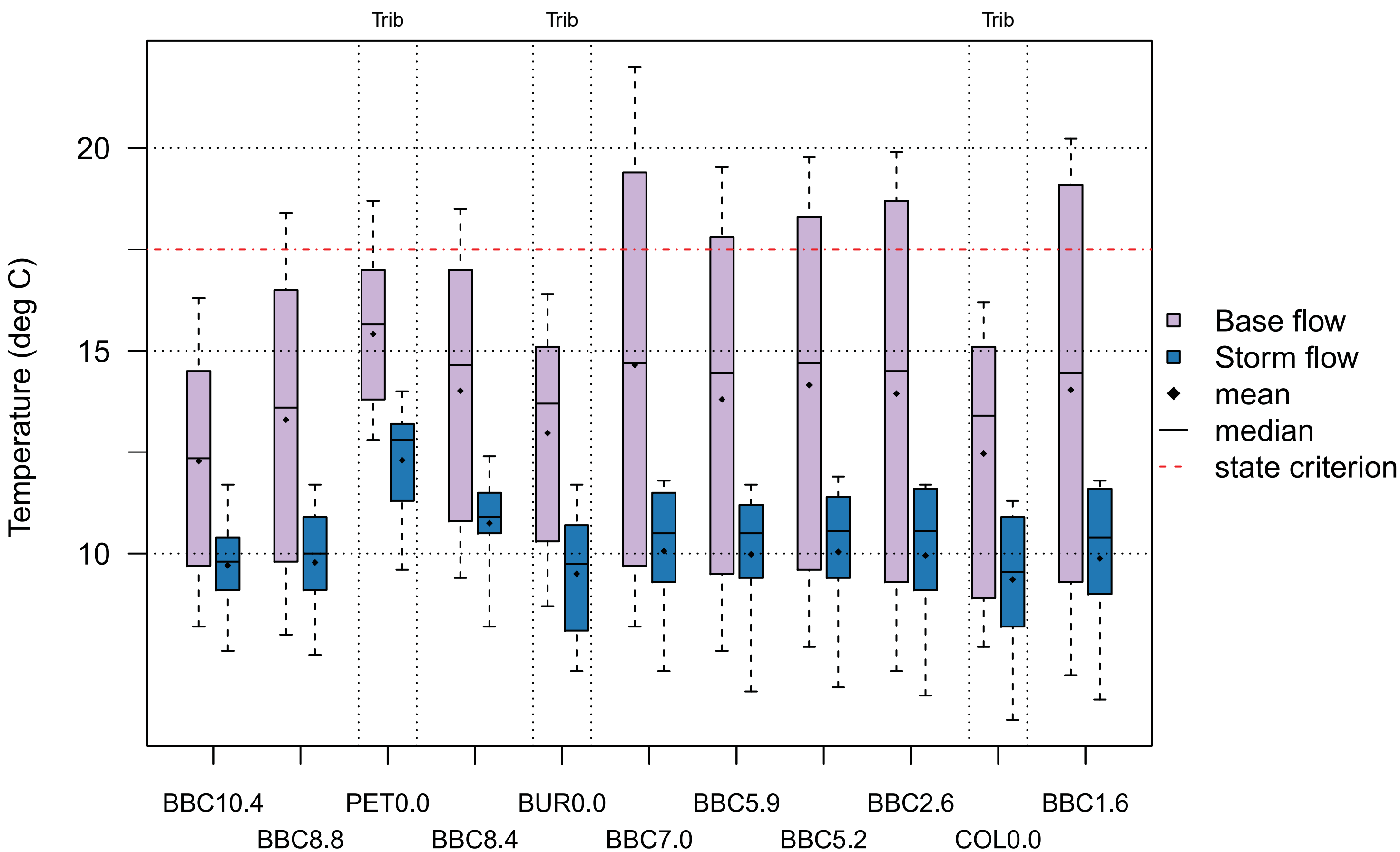
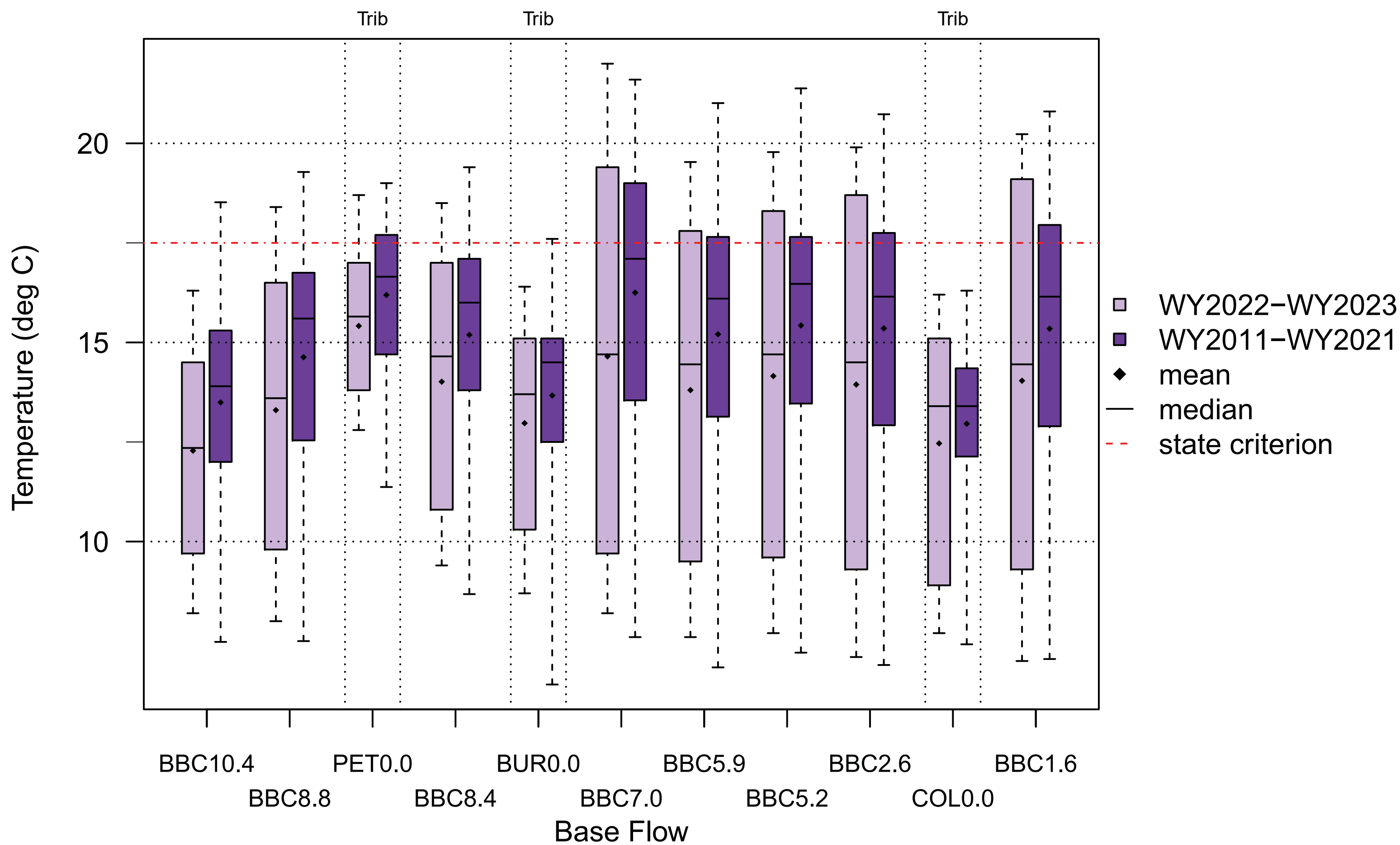
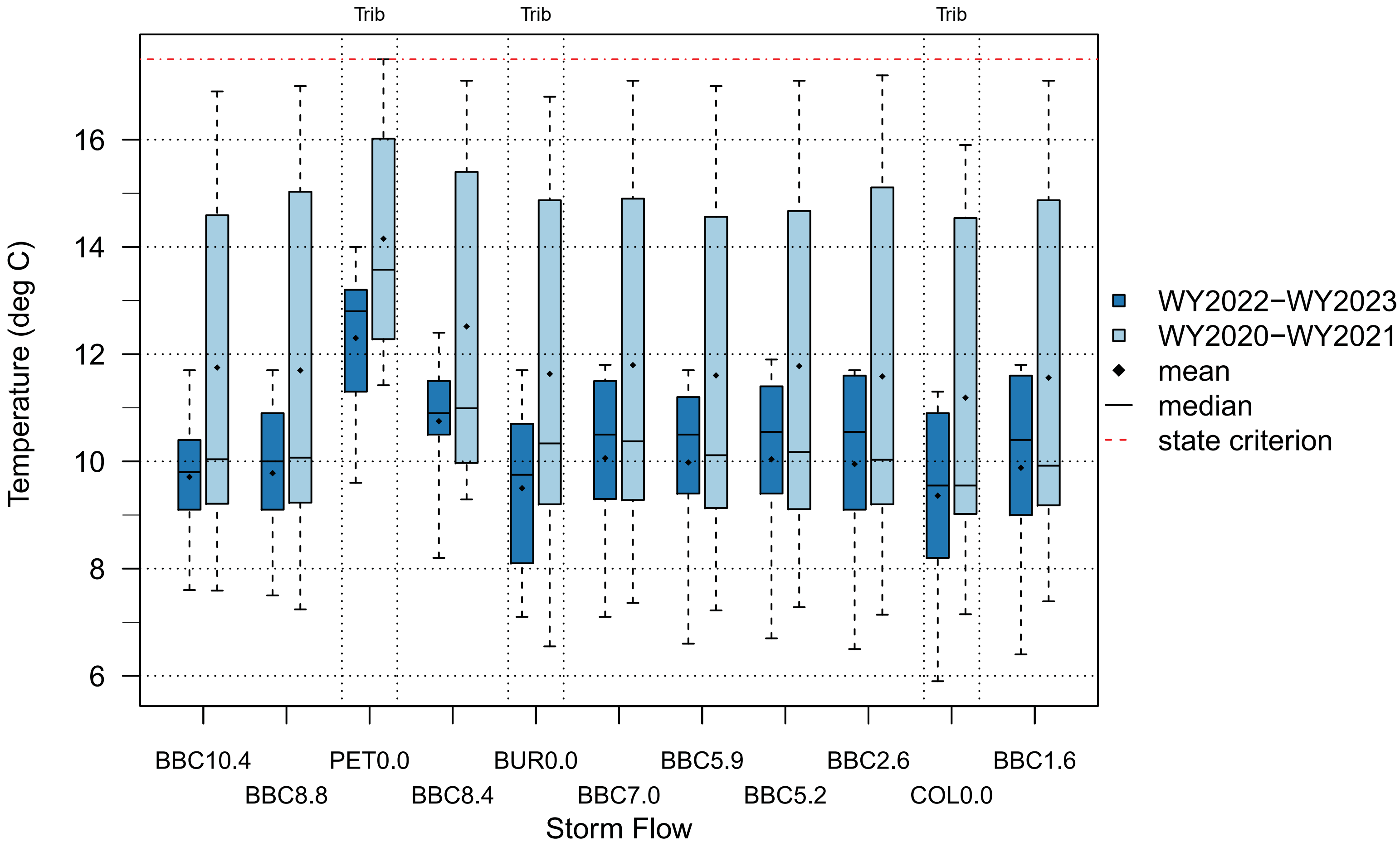
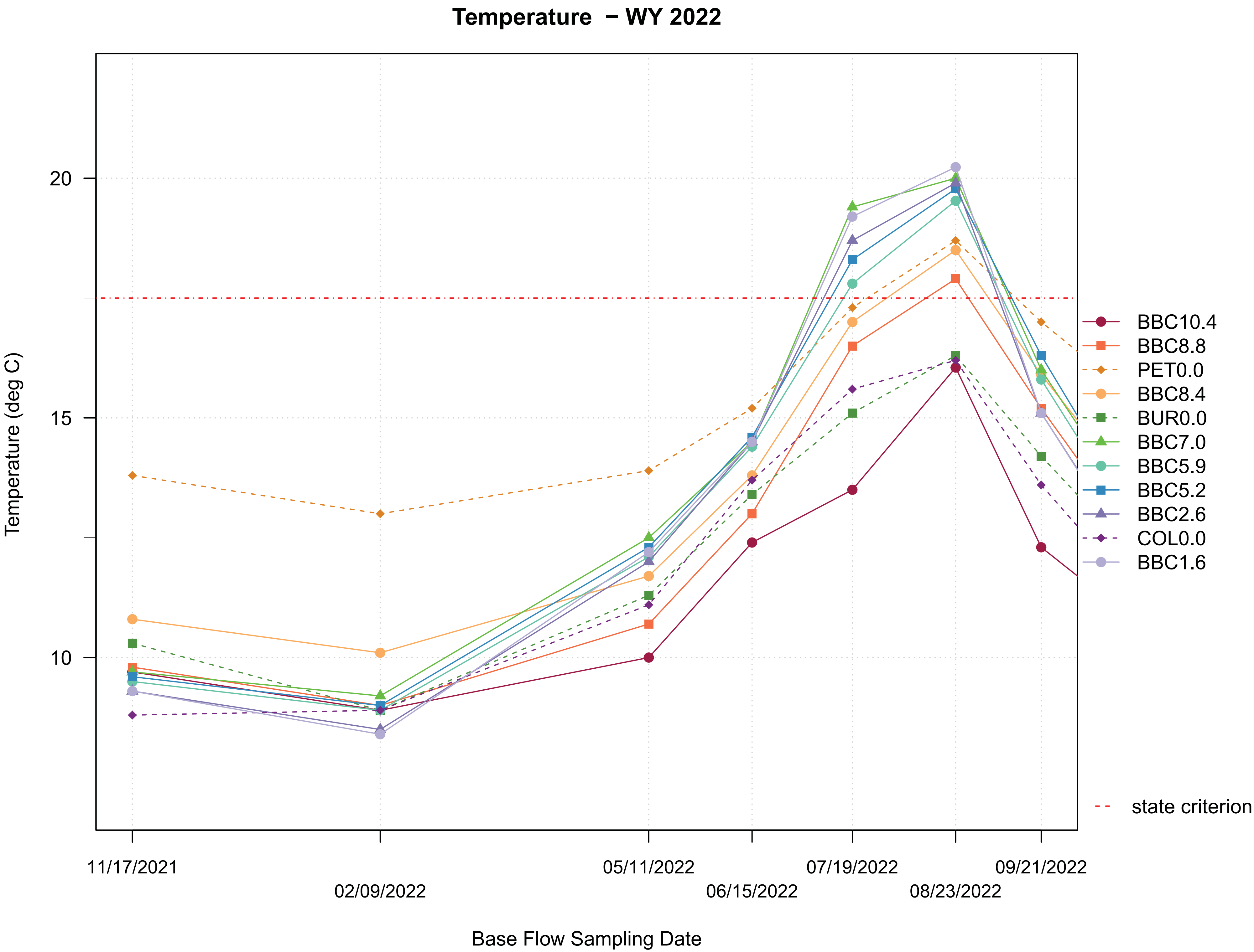


Trib
Trib
Trib
20
15
10
Temperature (deg C)
Base flow
Storm flow
mean
median
state criterion
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

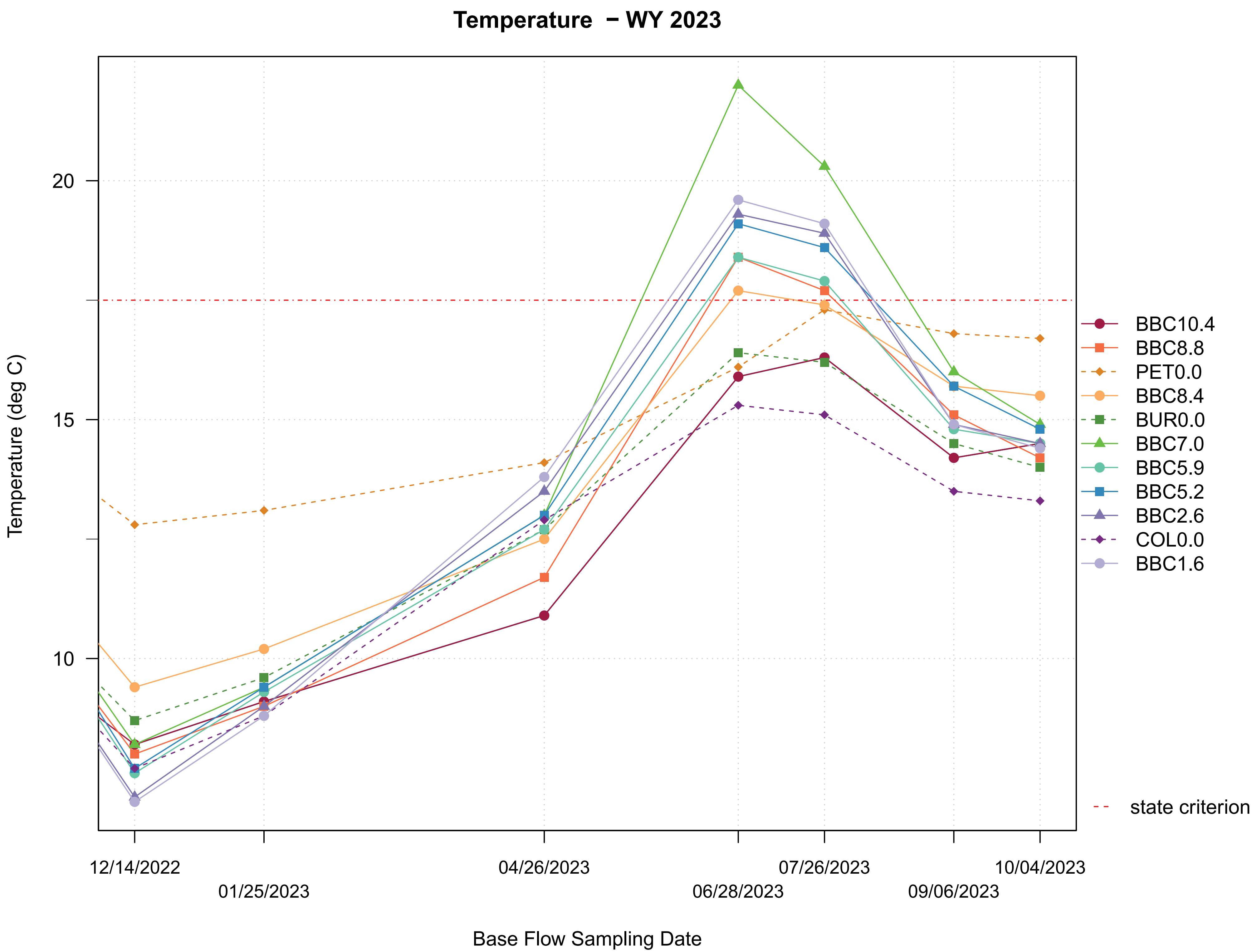

Trib
Trib
Trib
20
15
10
Temperature (deg C)
WY2022−WY2023
WY2011−WY2021
mean
median
state criterion
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow



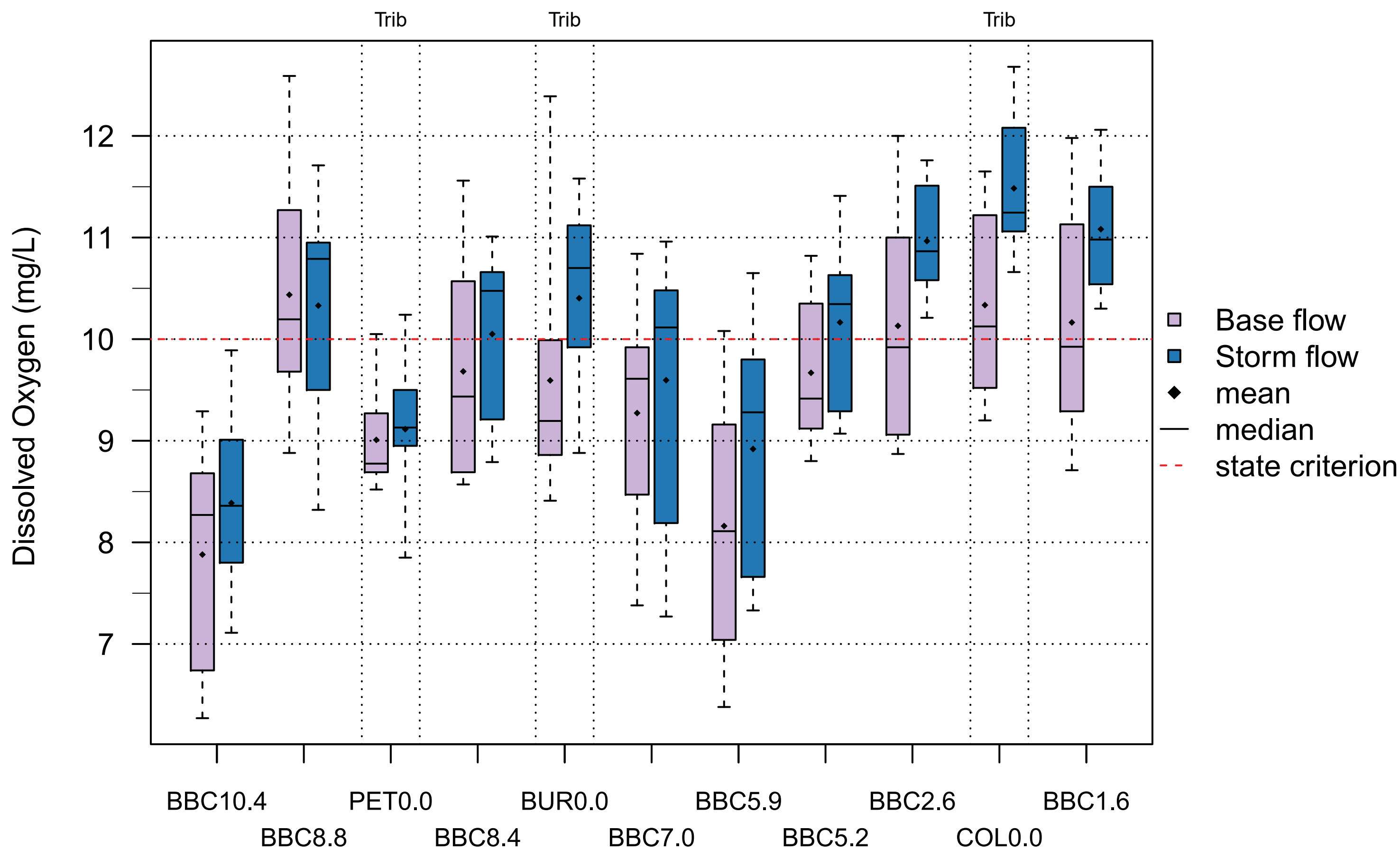
Trib
Trib
Trib
Temperature (deg C)
16
14
12
10
8
6
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median
state criterion

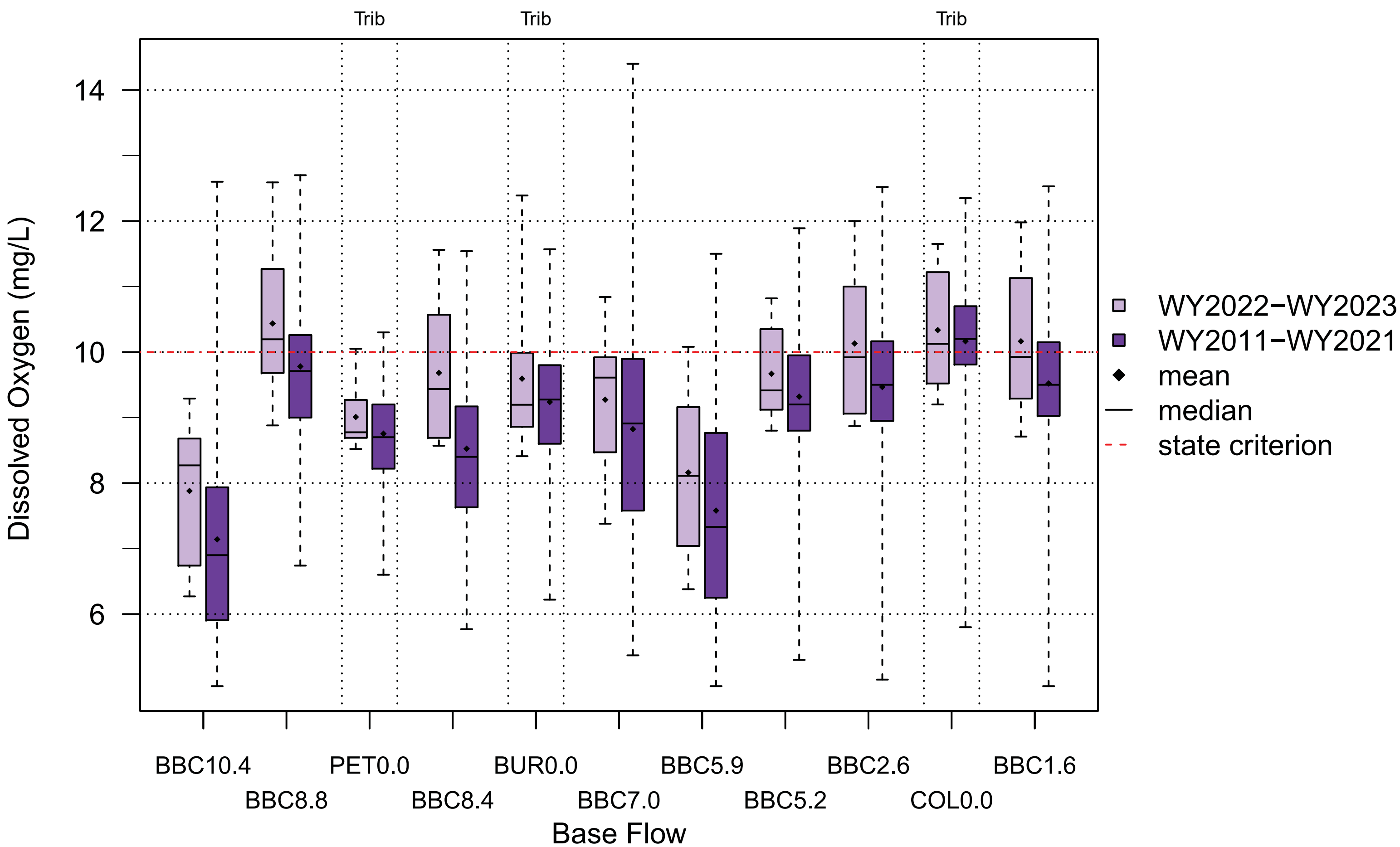


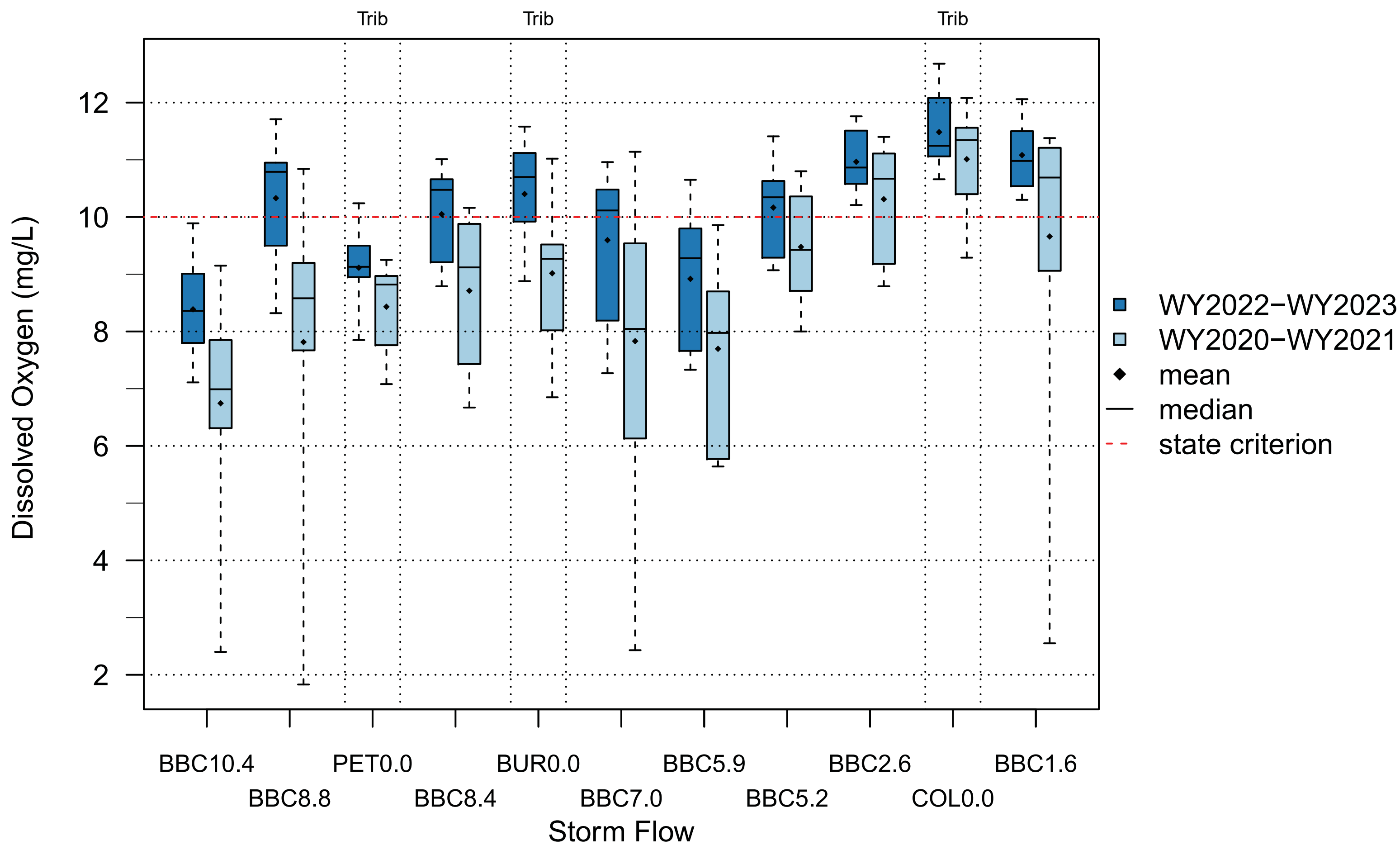
Temperature − WY 2022
Temperature (deg C)
20
15
10
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
state criterion

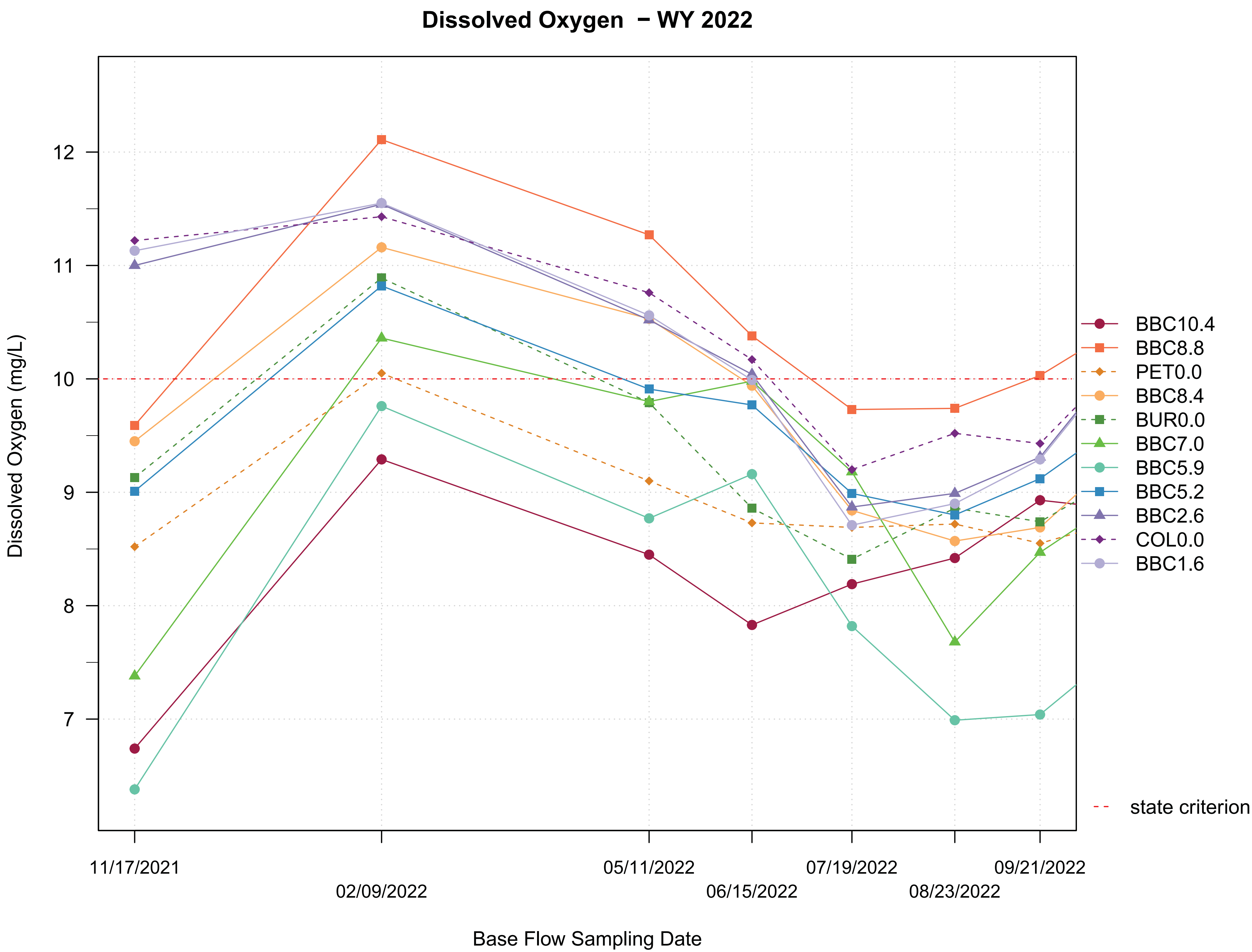


Temperature − WY 2023
Temperature (deg C)
20
15
10
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
state criterion

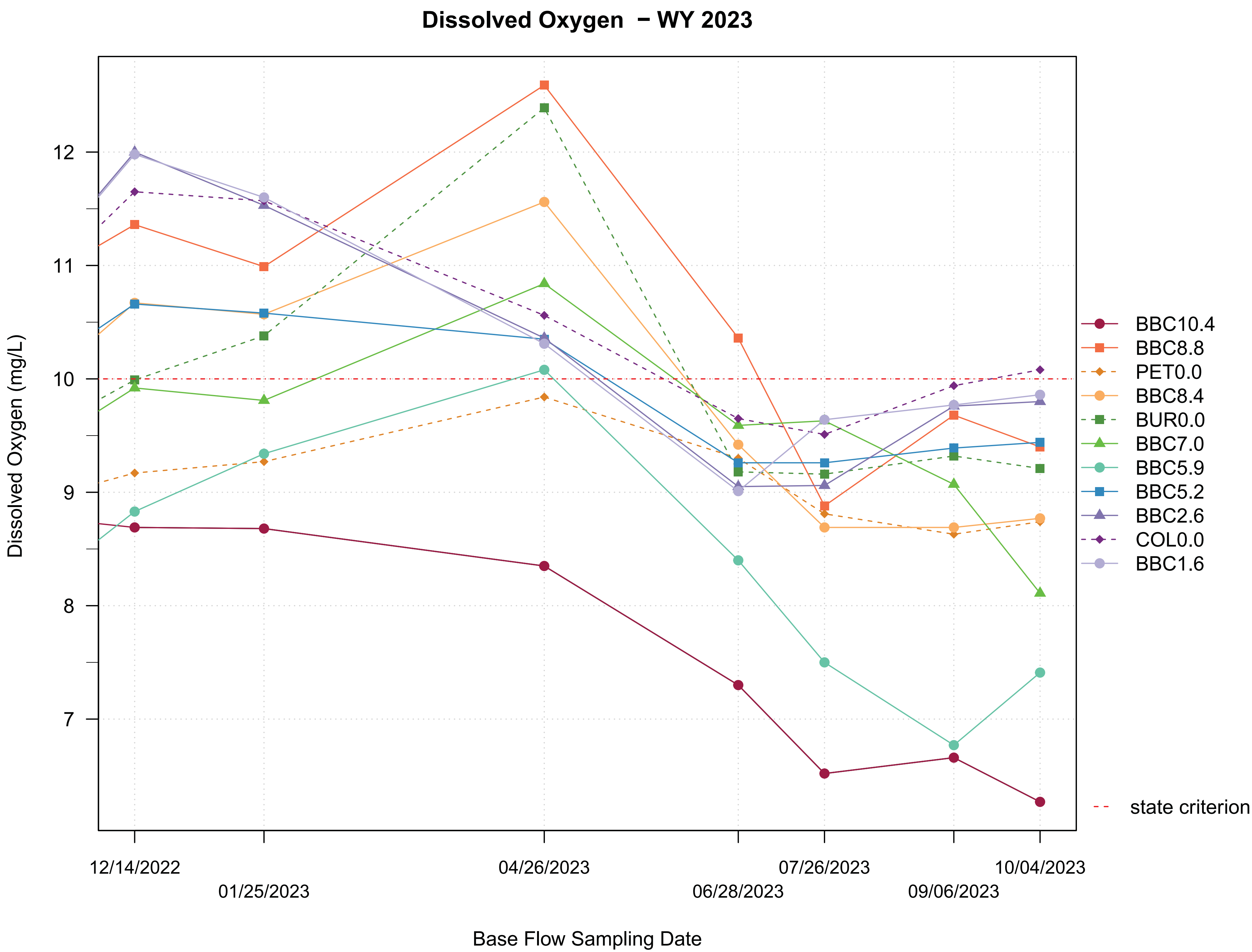

Trib
Trib
Trib
Dissolved Oxygen (mg/L)
12
11
10
9
8
7
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median
state criterion

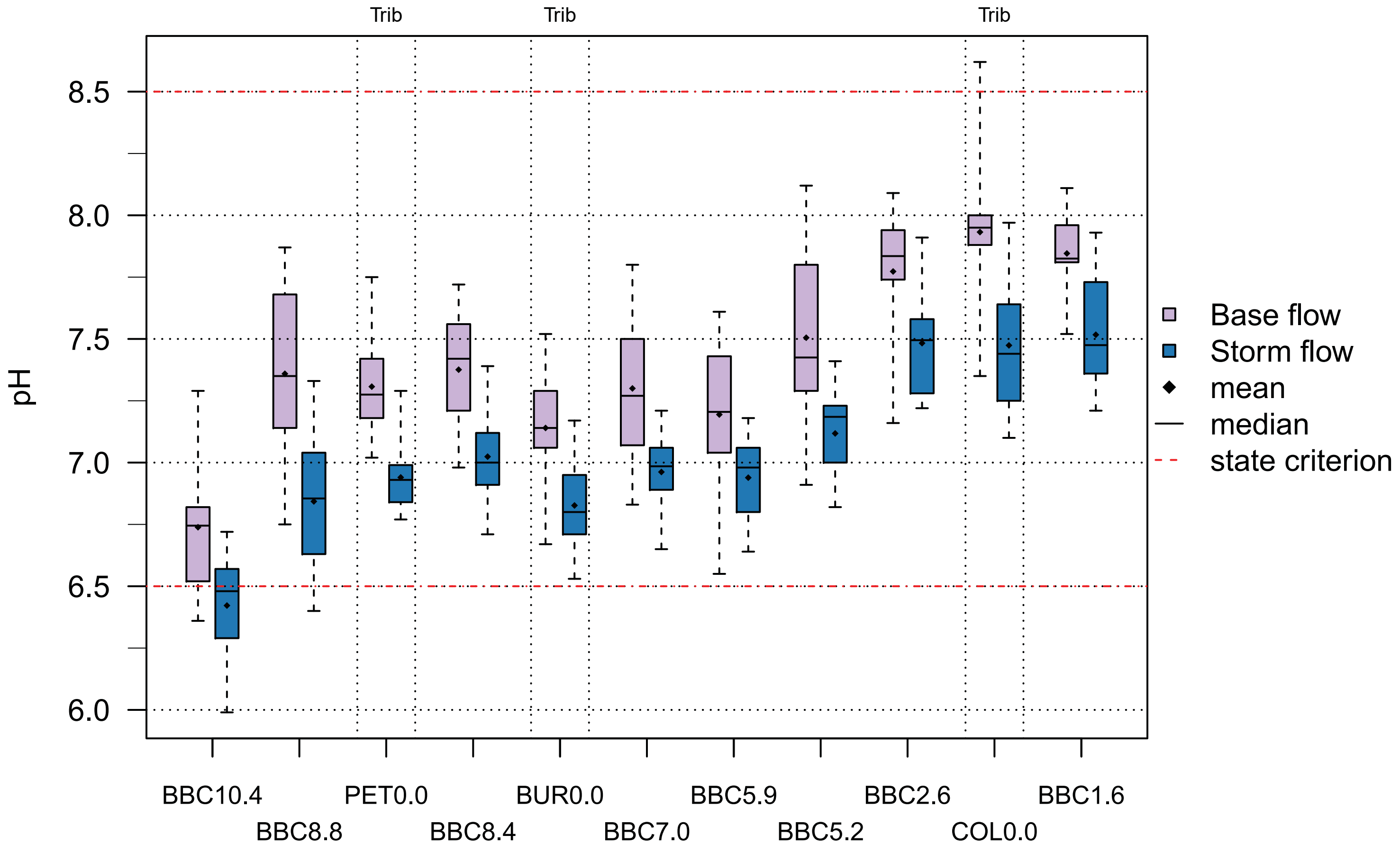

Trib
Trib
Trib
Dissolved Oxygen (mg/L)
14
12
10
8
6
WY2022−WY2023
WY2011−WY2021
mean
median
state criterion
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow


Trib
Trib
Trib
Dissolved Oxygen (mg/L)
12
10
8
6
4
2
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median
state criterion

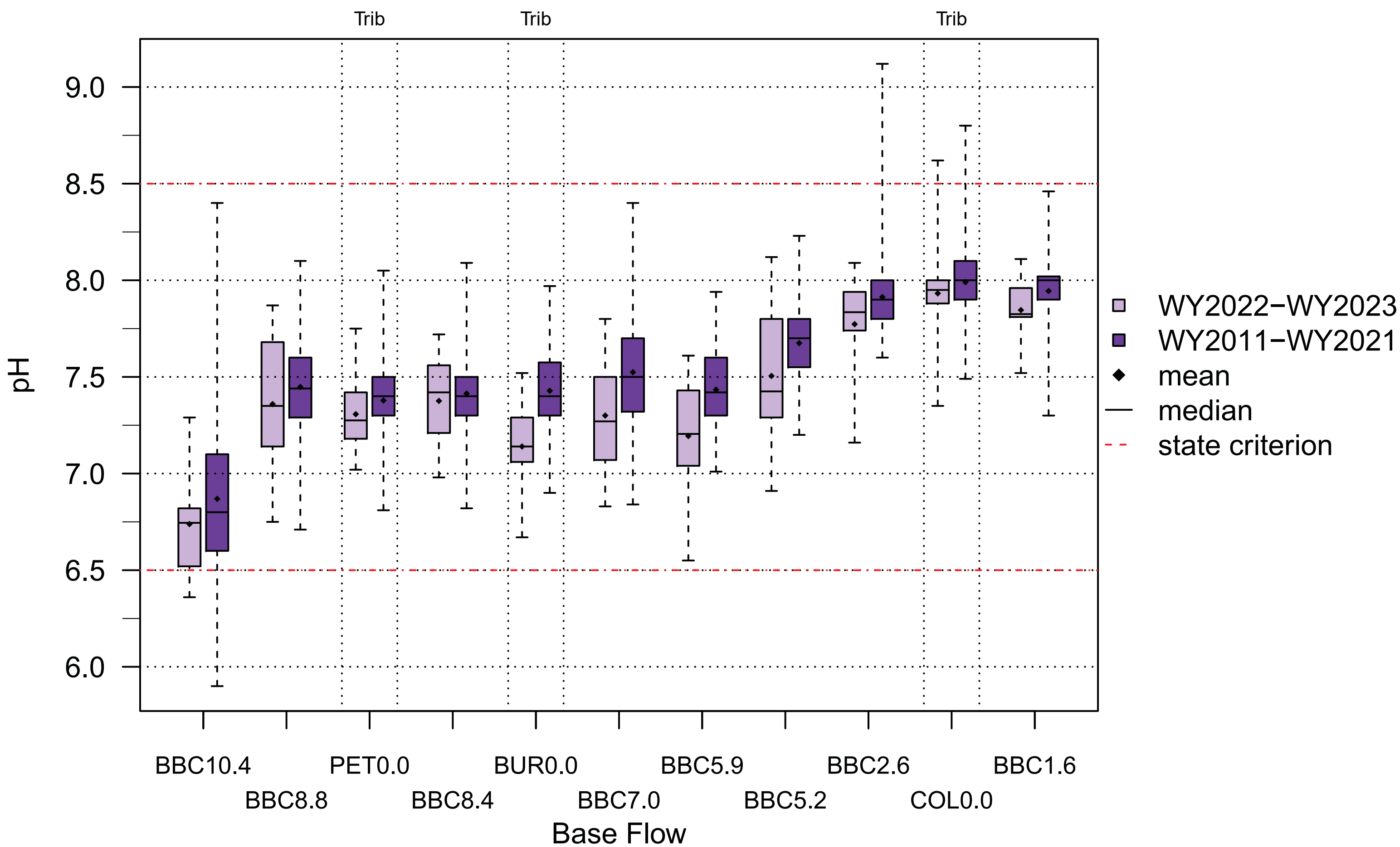


Dissolved Oxygen − WY 2022
Dissolved Oxygen (mg/L)
12
11
10
9
8
7
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
state criterion

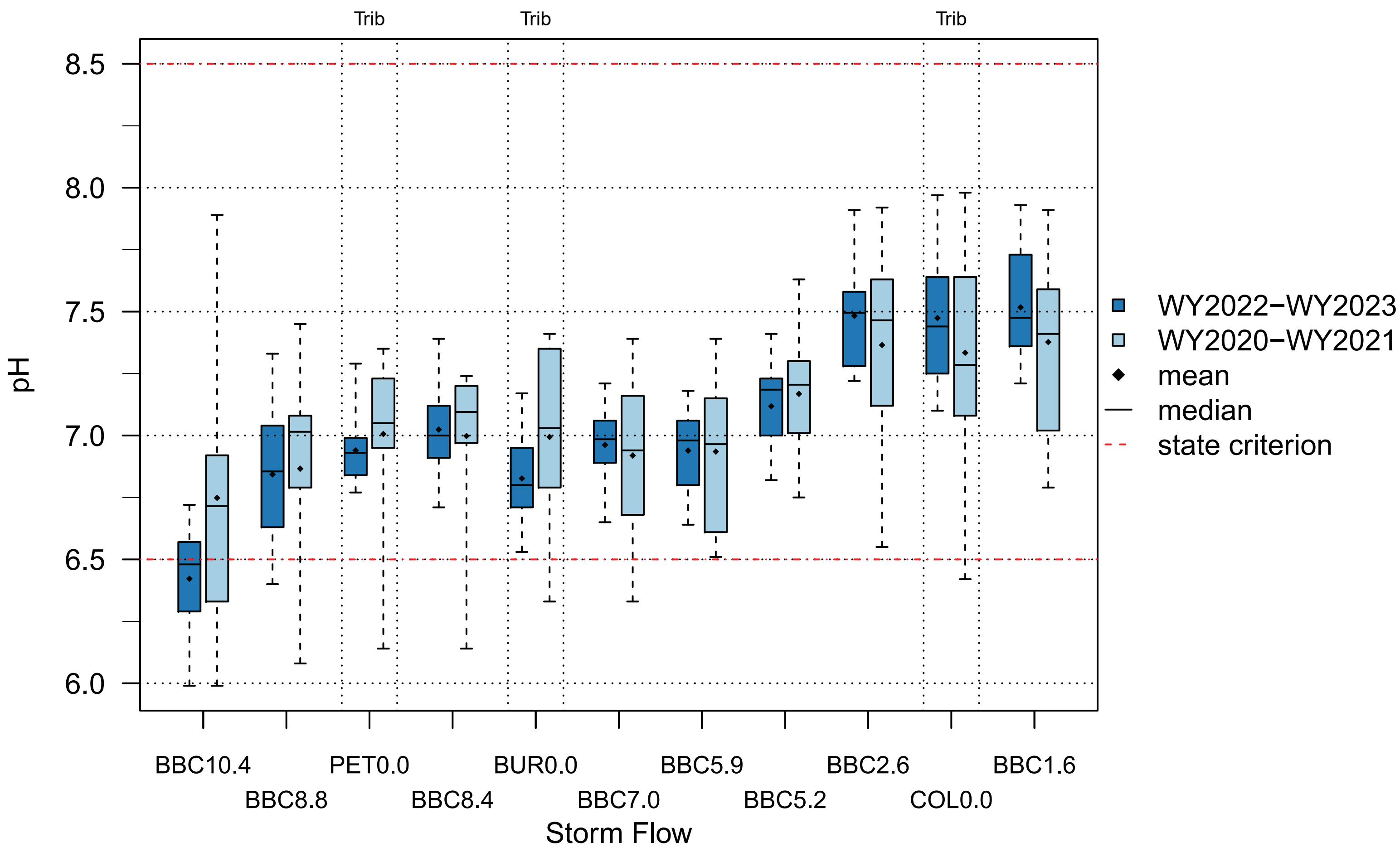

Dissolved Oxygen − WY 2023
Dissolved Oxygen (mg/L)
12
11
10
9
8
7
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
state criterion



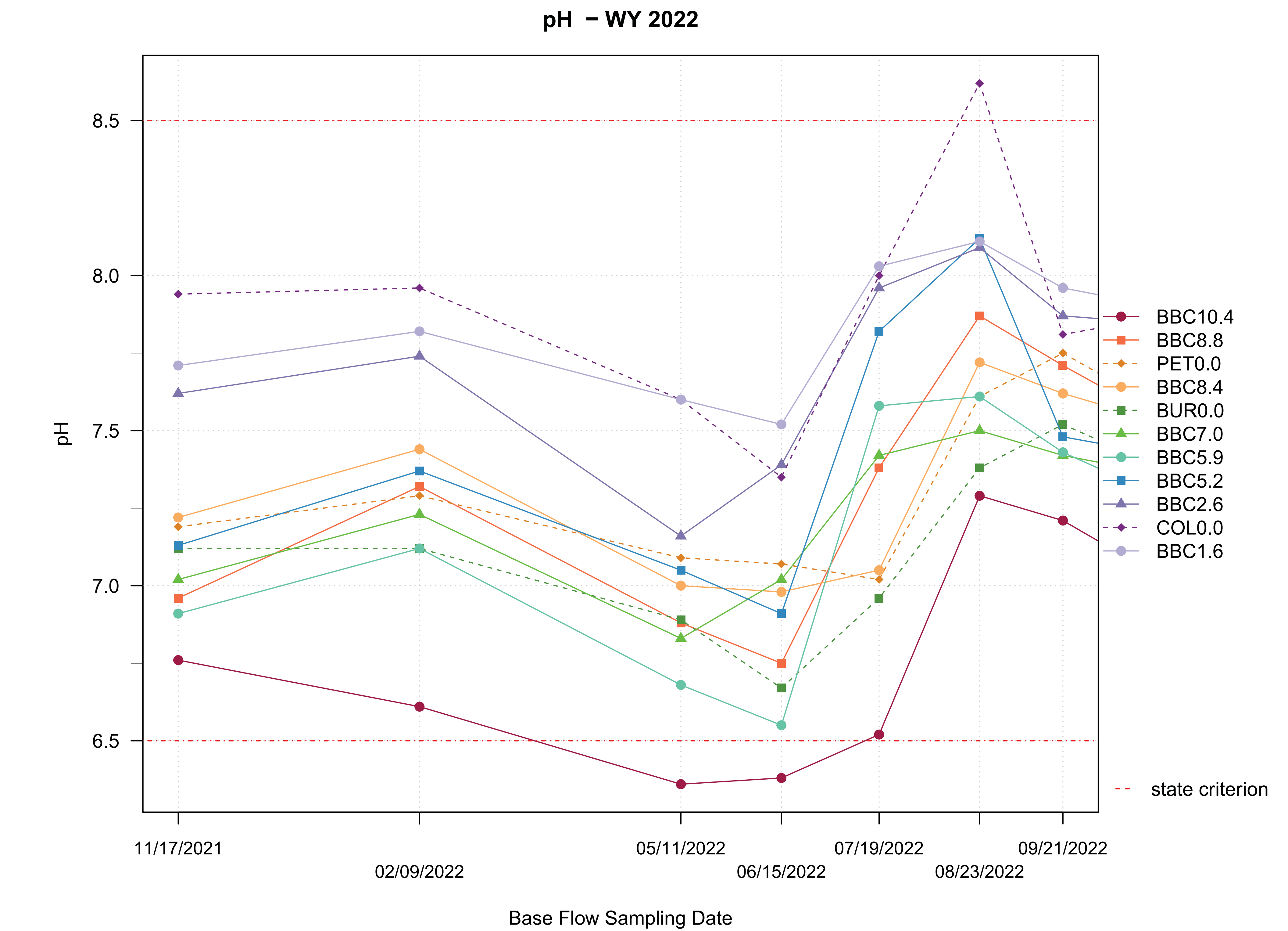
Trib
Trib
Trib
8.5
8.0
7.5
7.0
6.5
6.0
pH
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median
state criterion



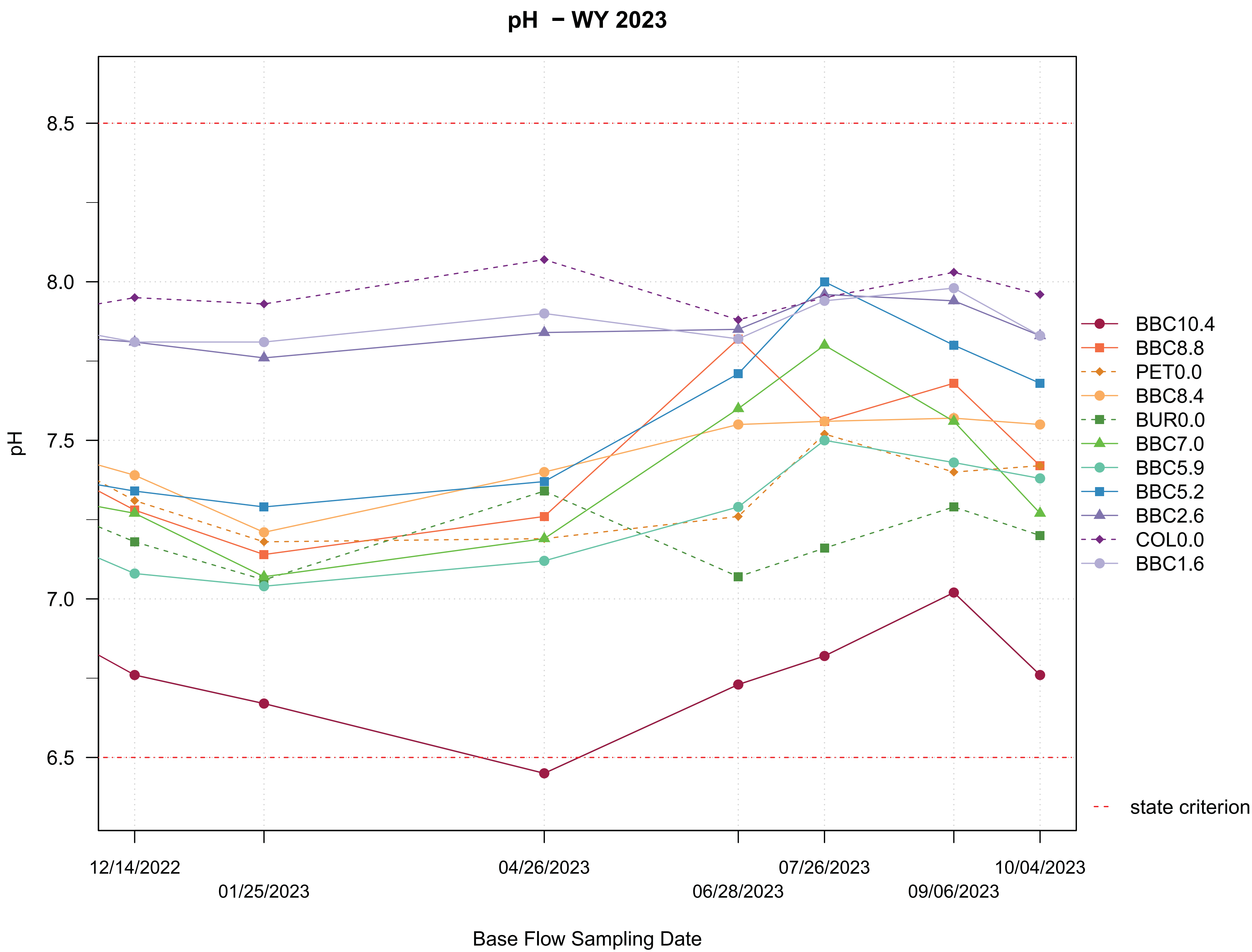
Trib
Trib
Trib
9.0
8.5
8.0
7.5
7.0
6.5
6.0
pH
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2011−WY2021
mean
median
state criterion

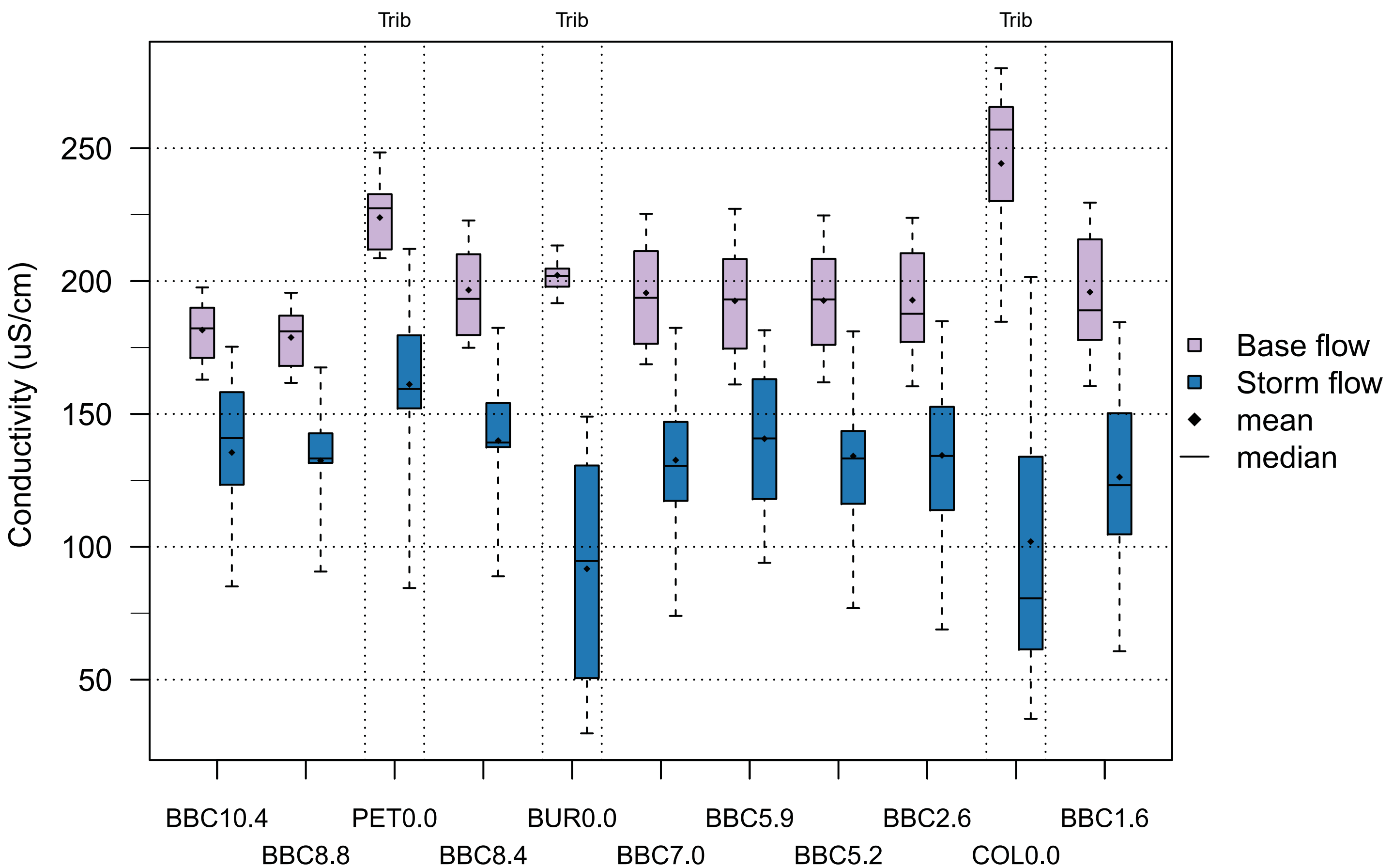


Trib
Trib
Trib
8.5
8.0
7.5
7.0
6.5
6.0
pH
WY2022−WY2023
WY2020−WY2021
mean
median
state criterion
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow

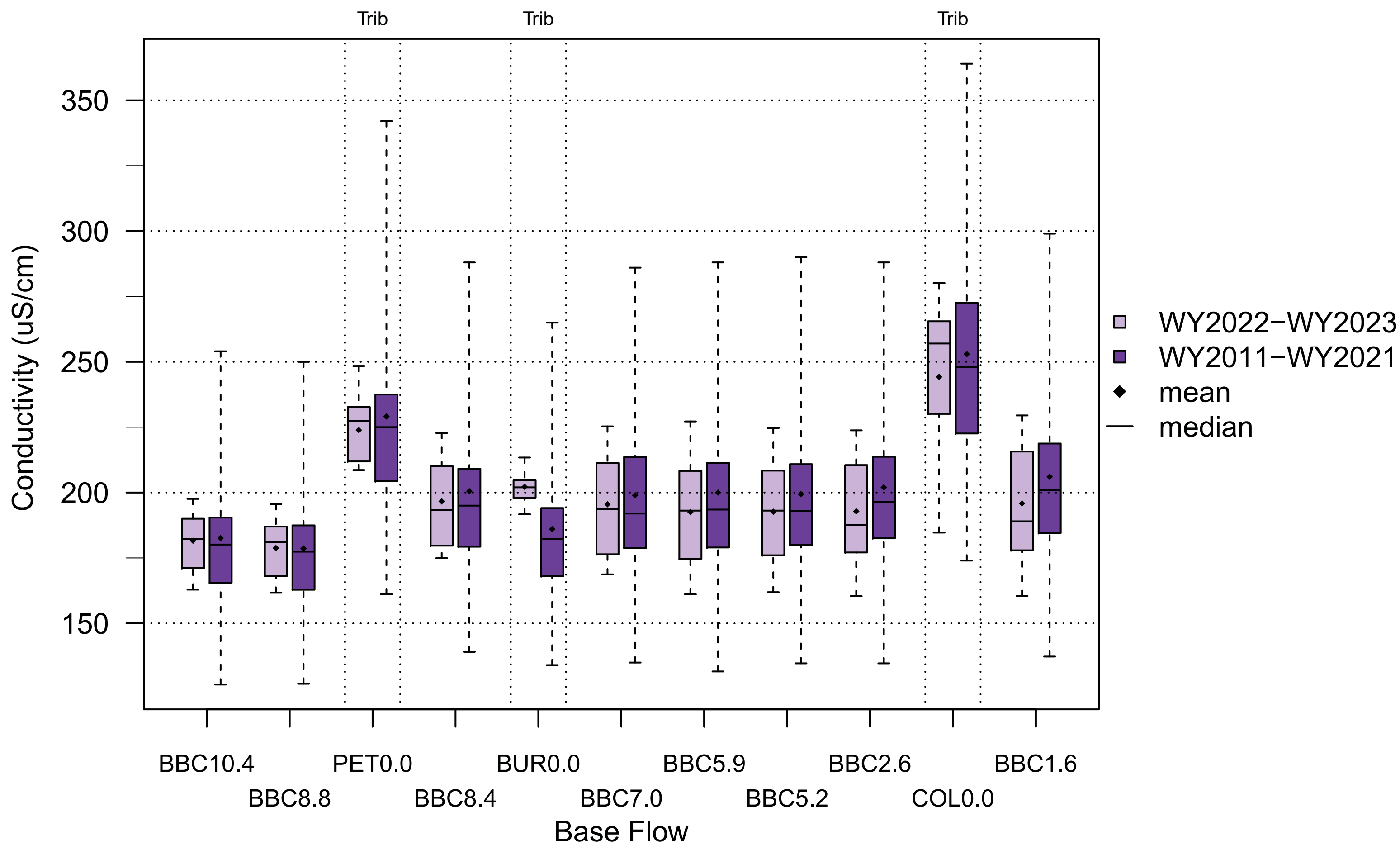


pH − WY 2022
pH
8.5
8.0
7.5
7.0
6.5
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
state criterion

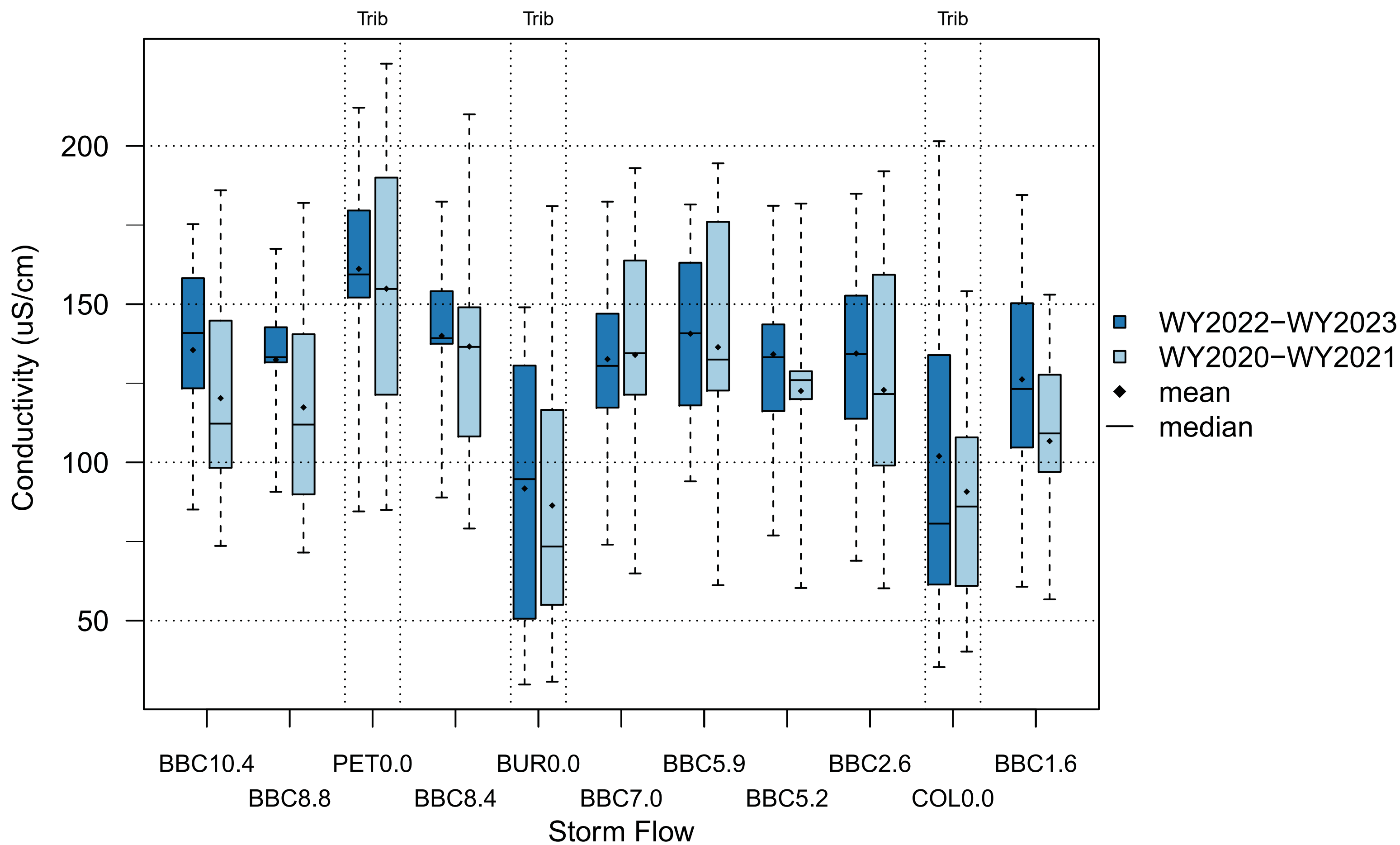

pH – WY 2023
pH
8.5
8.0
7.5
7.0
6.5
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
state criterion



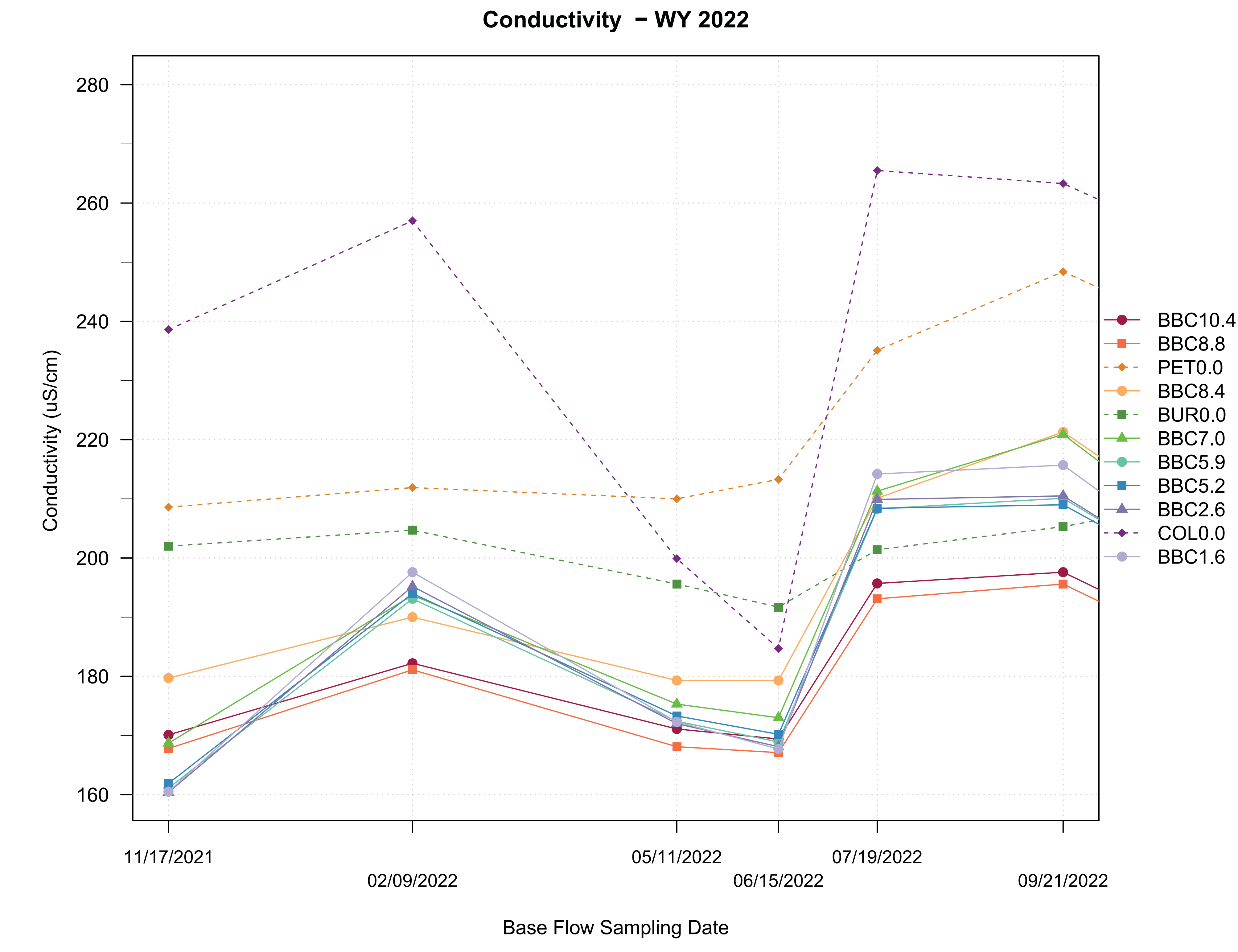
Trib
Trib
Trib
Conductivity (uS/cm)
250
200
150
100
50
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median



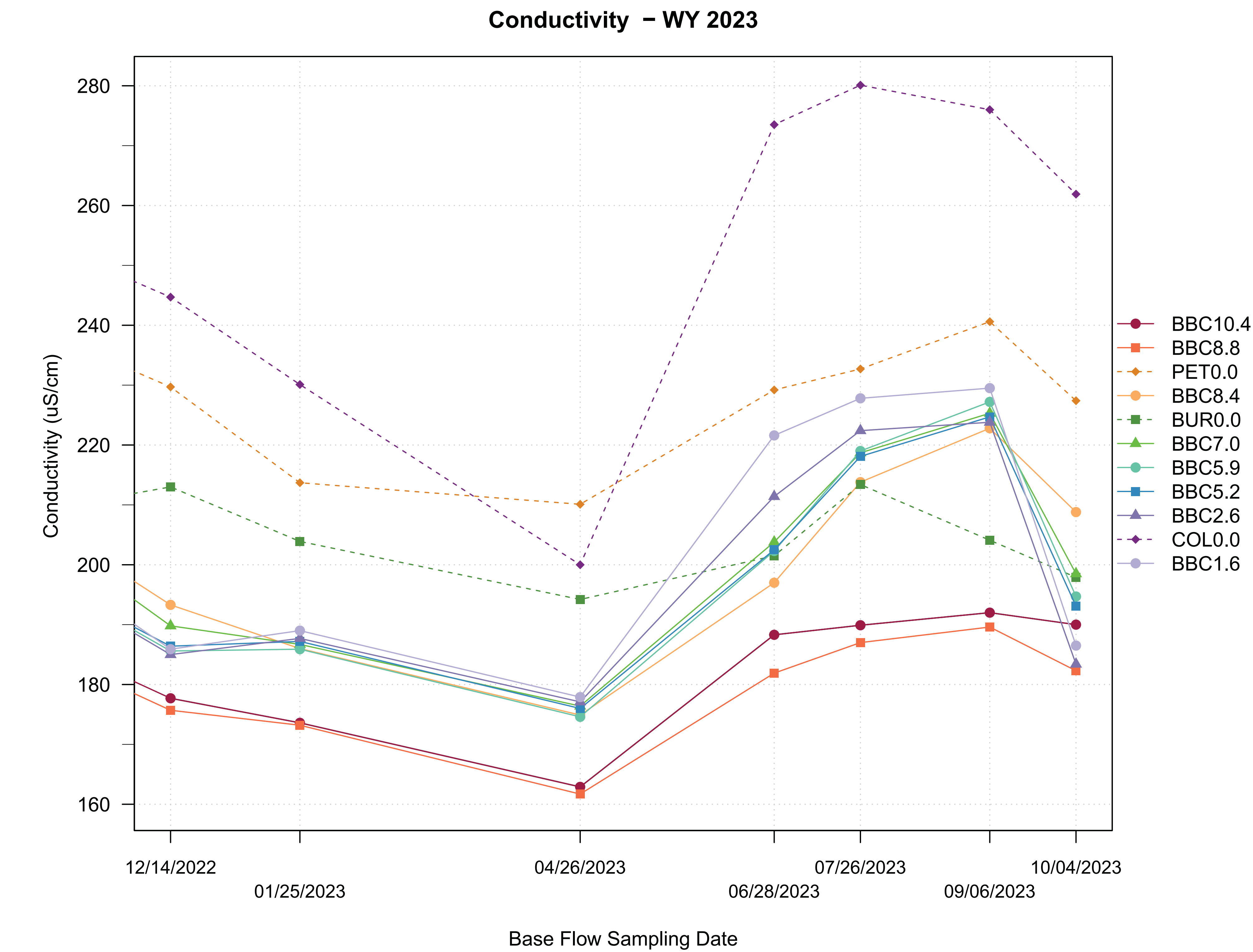
Trib
Trib
Trib
350
300
250
200
150
Conductivity (uS/cm)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2011−WY2021
mean
median



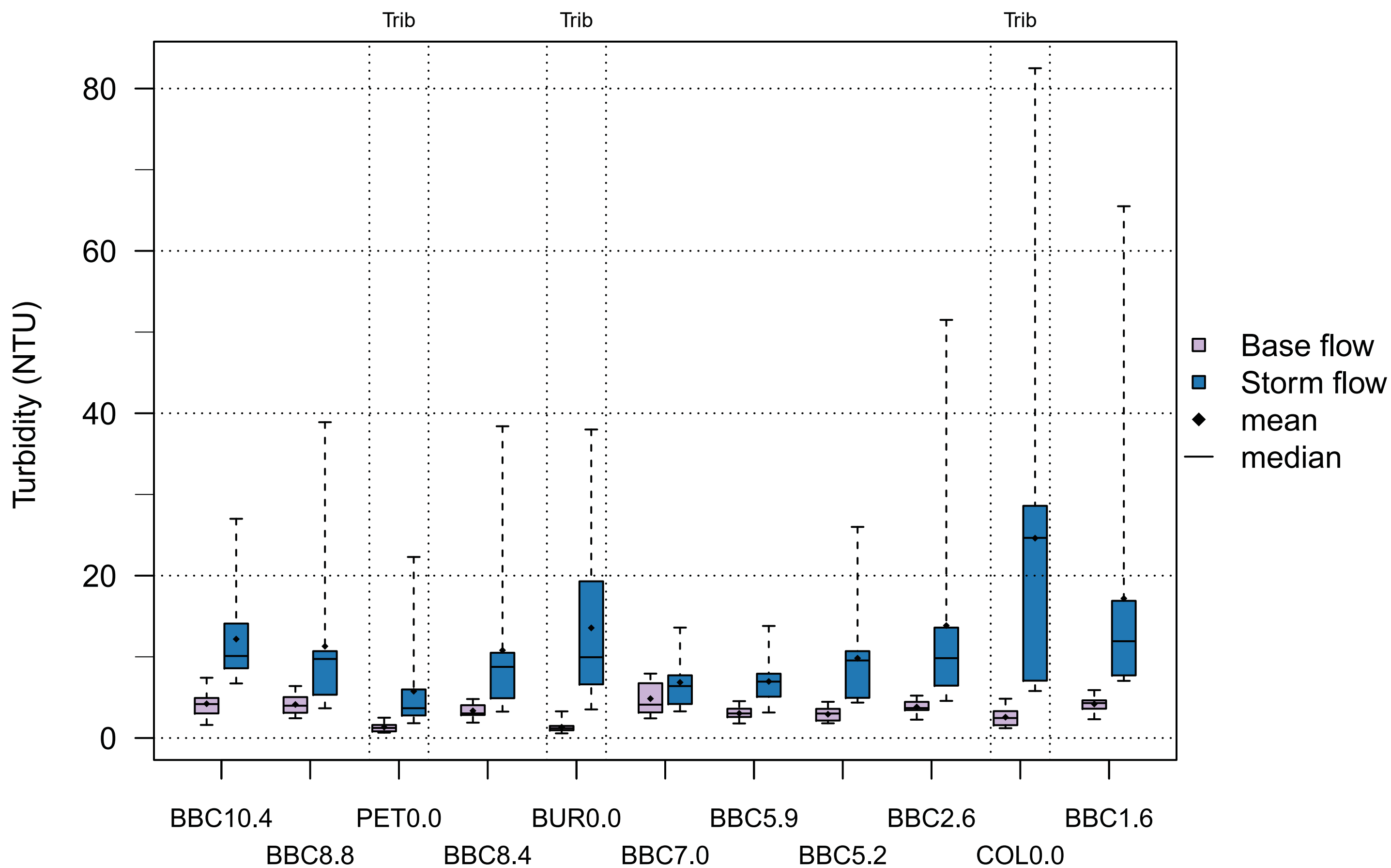
Trib
Trib
Trib
200
150
100
50
Conductivity (uS/cm)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median



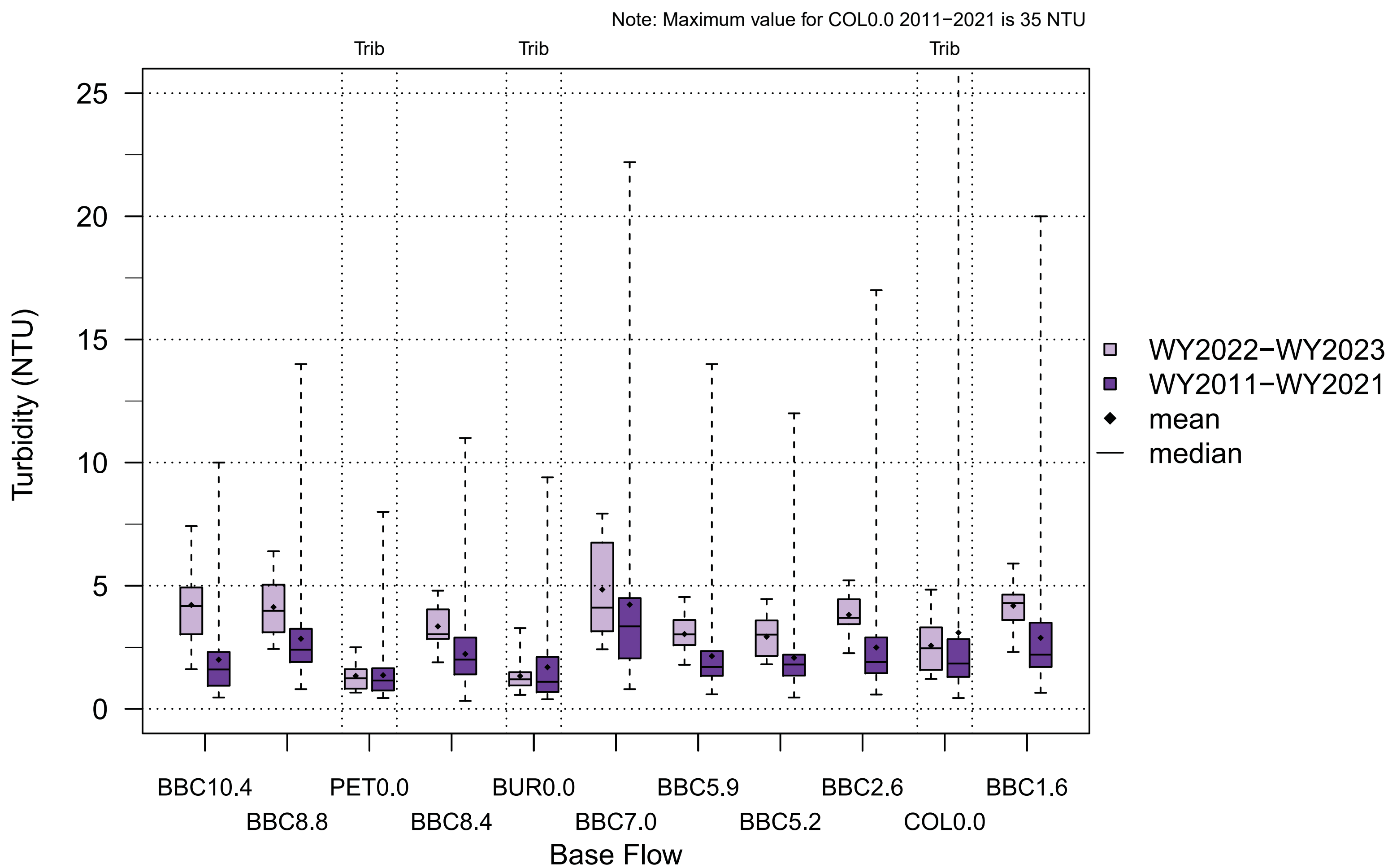
Conductivity − WY 2022
Conductivity (uS/cm)
280
260
240
220
200
180
160
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

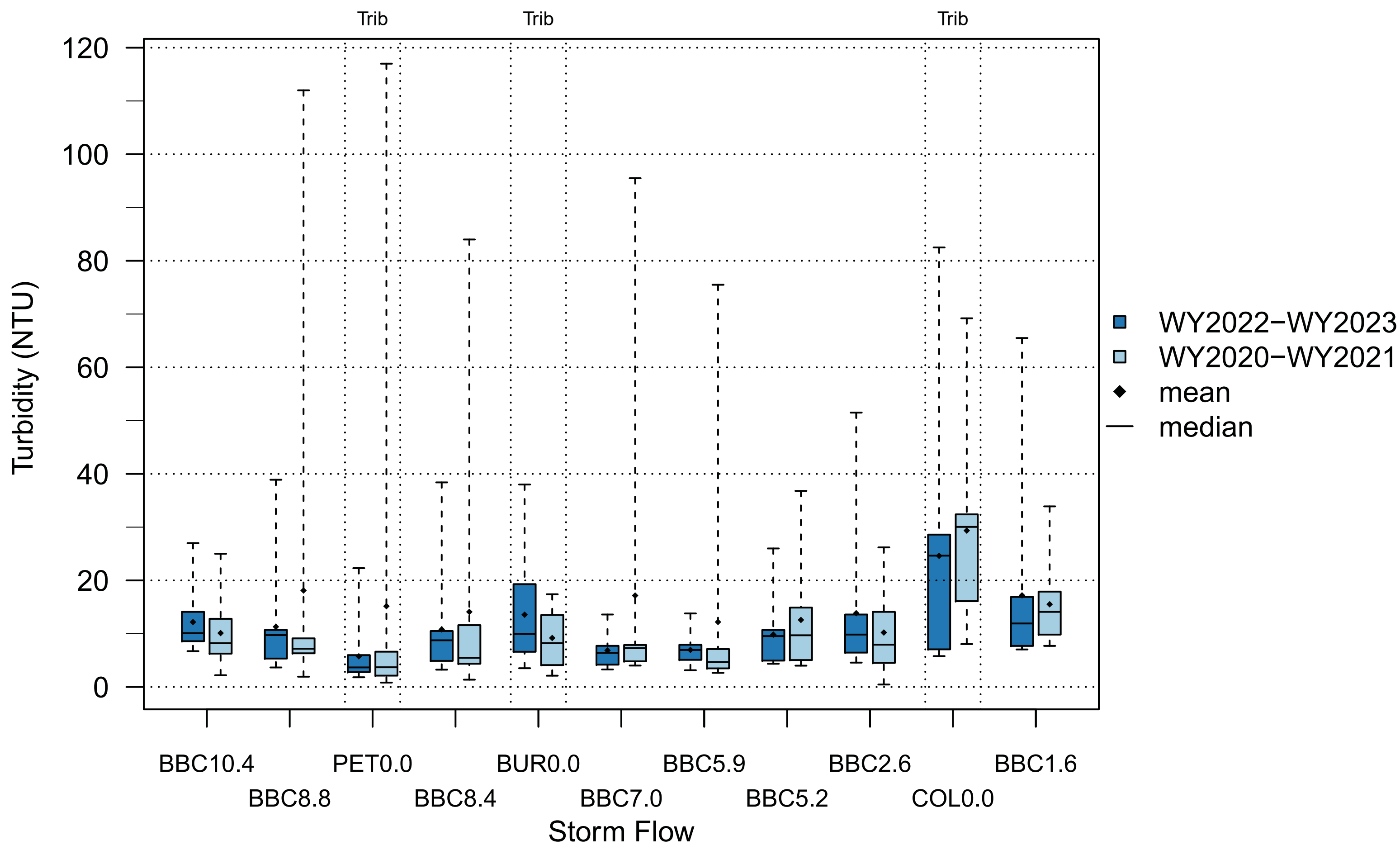


Conductivity − WY 2023
Conductivity (uS/cm)
160
180
200
220
240
260
280
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

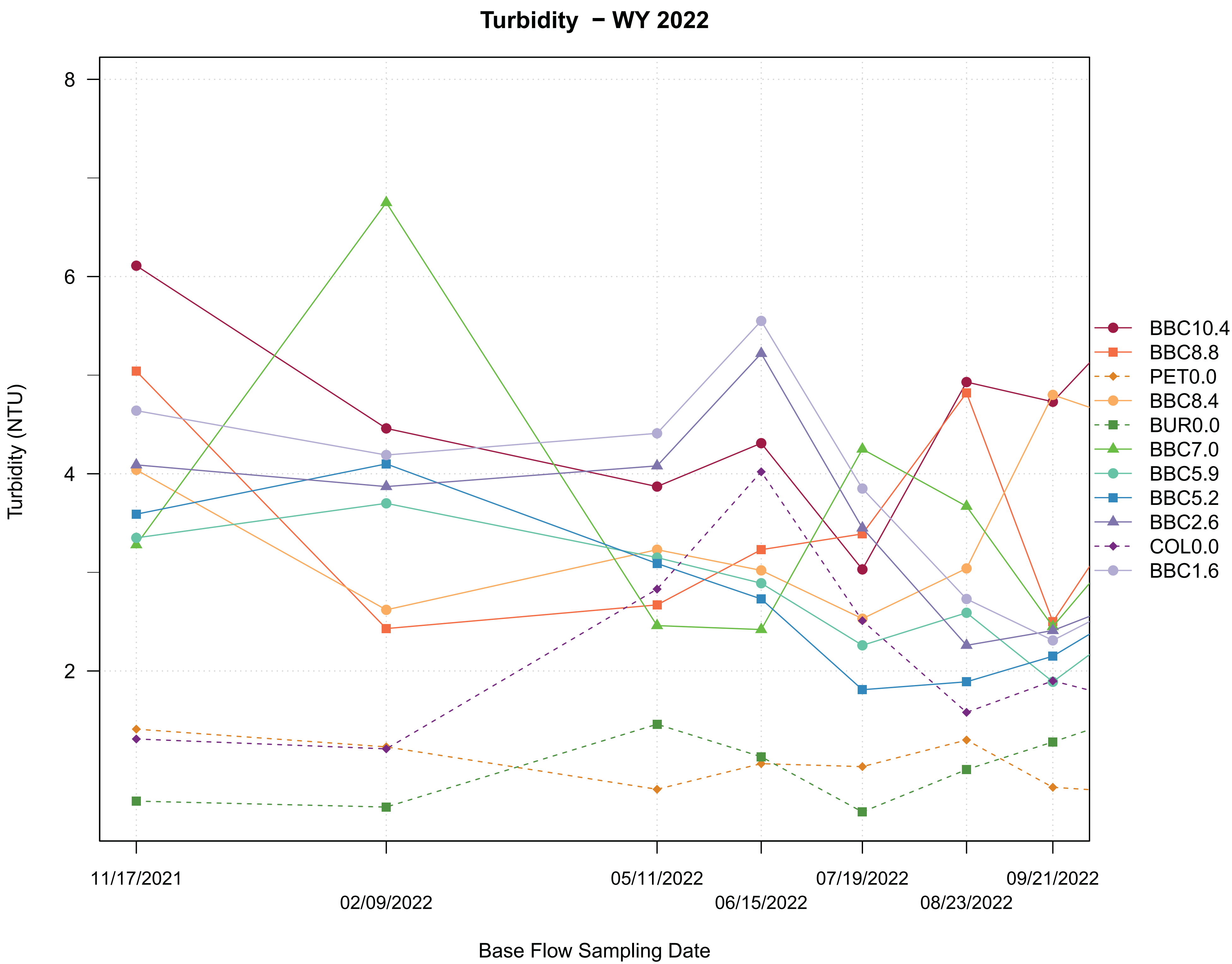


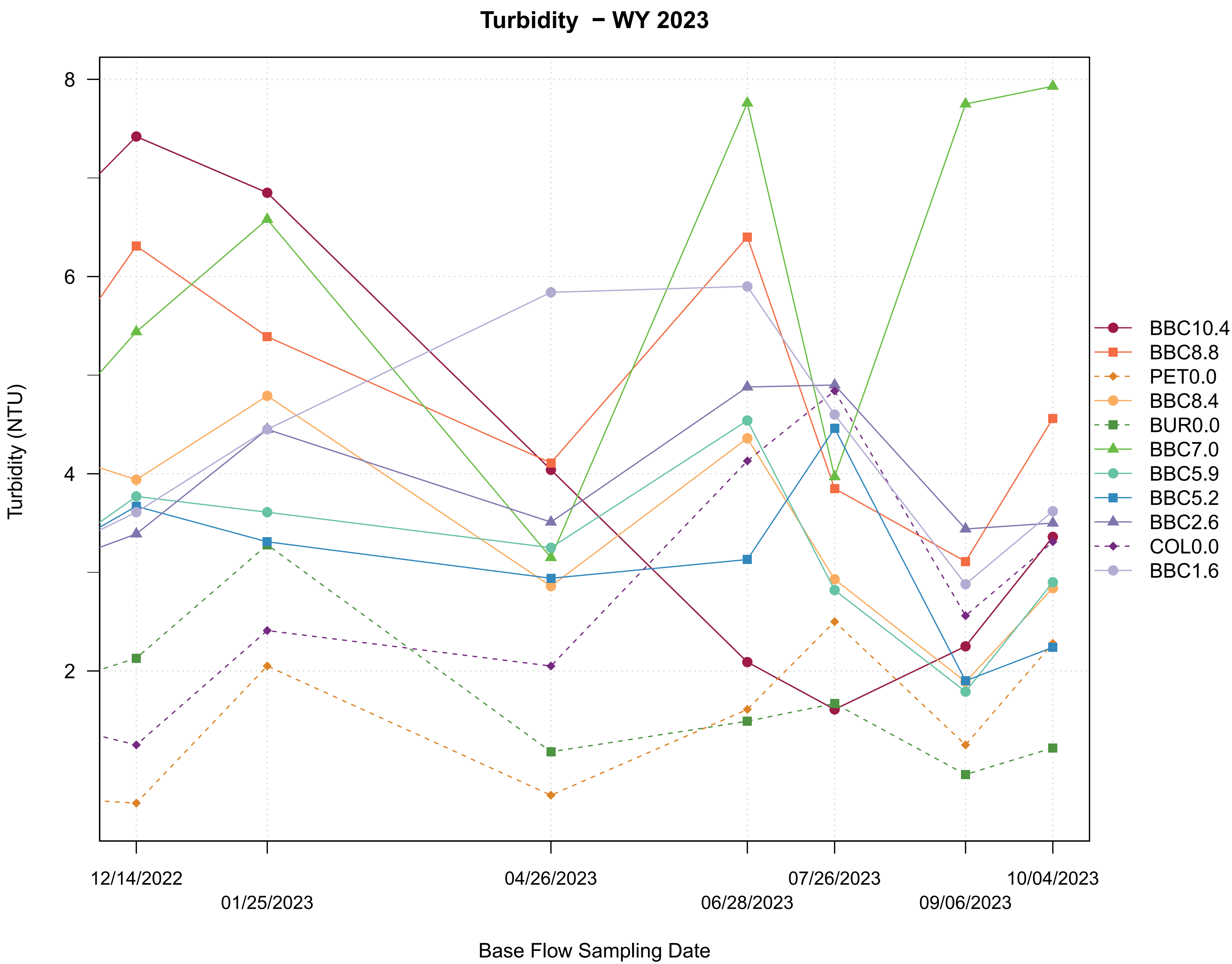
Trib
Trib
Trib
80
60
40
20
0
Turbidity (NTU)
Base flow
Storm flow
mean
median
BBC10.4
PET0.0
BUR0.0
BBC5.9
BBC2.6
BBC1.6
BBC8.8
BBC8.4
BBC7.0
BBC5.2
COL0.0


Note: Maximum value for COL0.0 2011−2021 is 35 NTU
Trib
Trib
Trib
Turbidity (NTU)
25
20
15
10
5
0
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2011−WY2021
mean
median

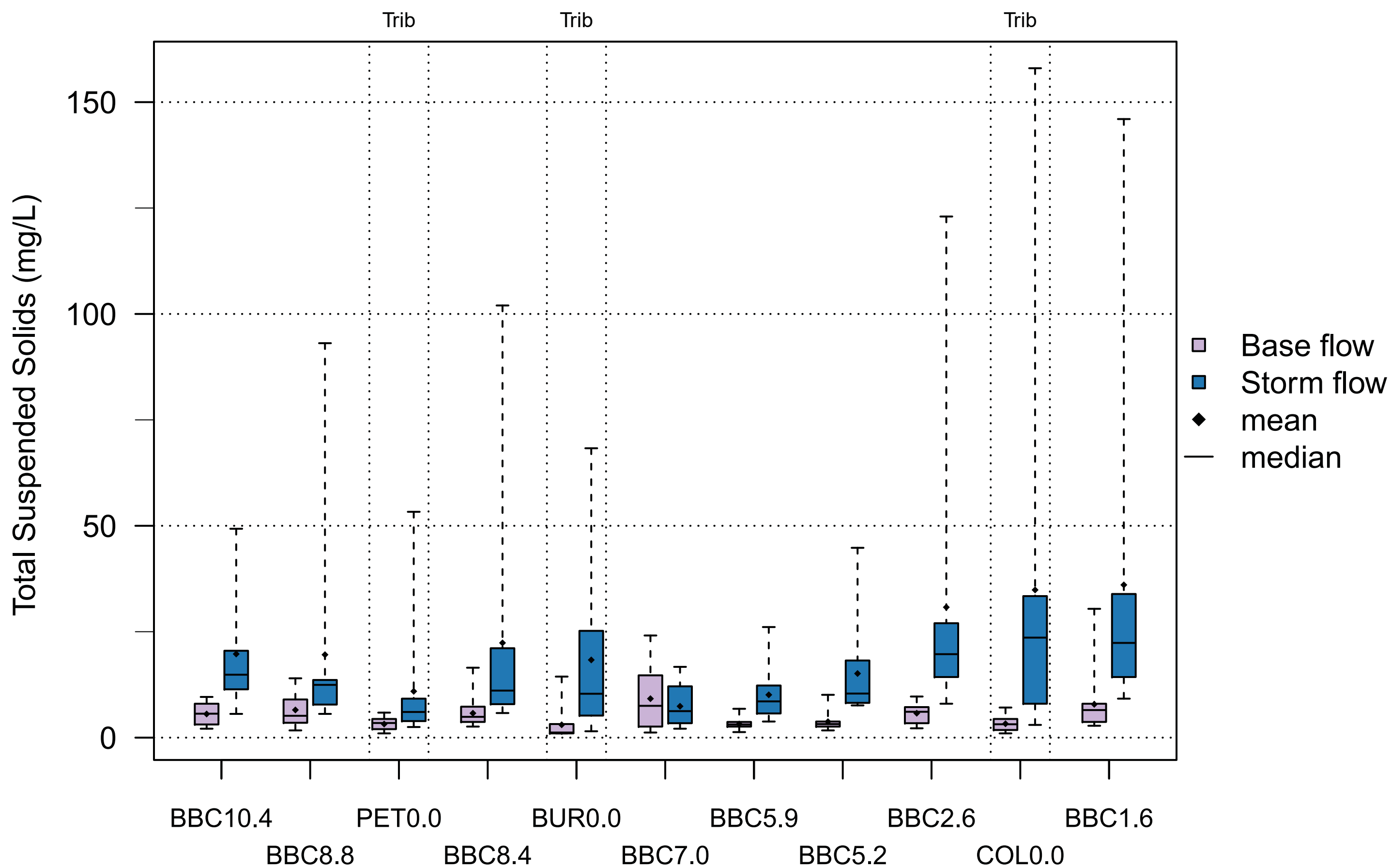


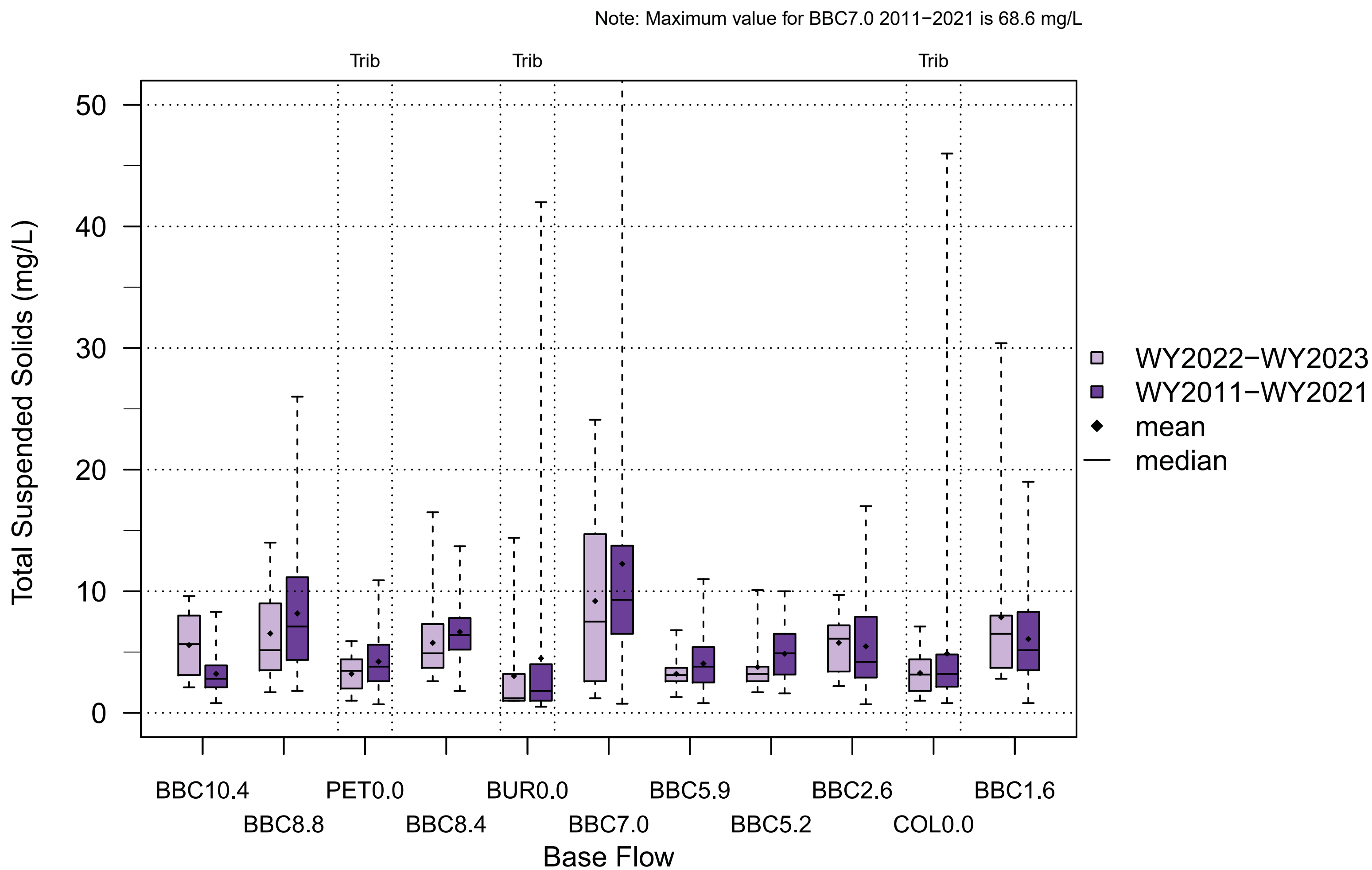
Trib
Trib
Trib
120
100
80
60
40
20
0
Turbidity (NTU)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median


Turbidity − WY 2022
Turbidity (NTU)
8
6
4
2
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

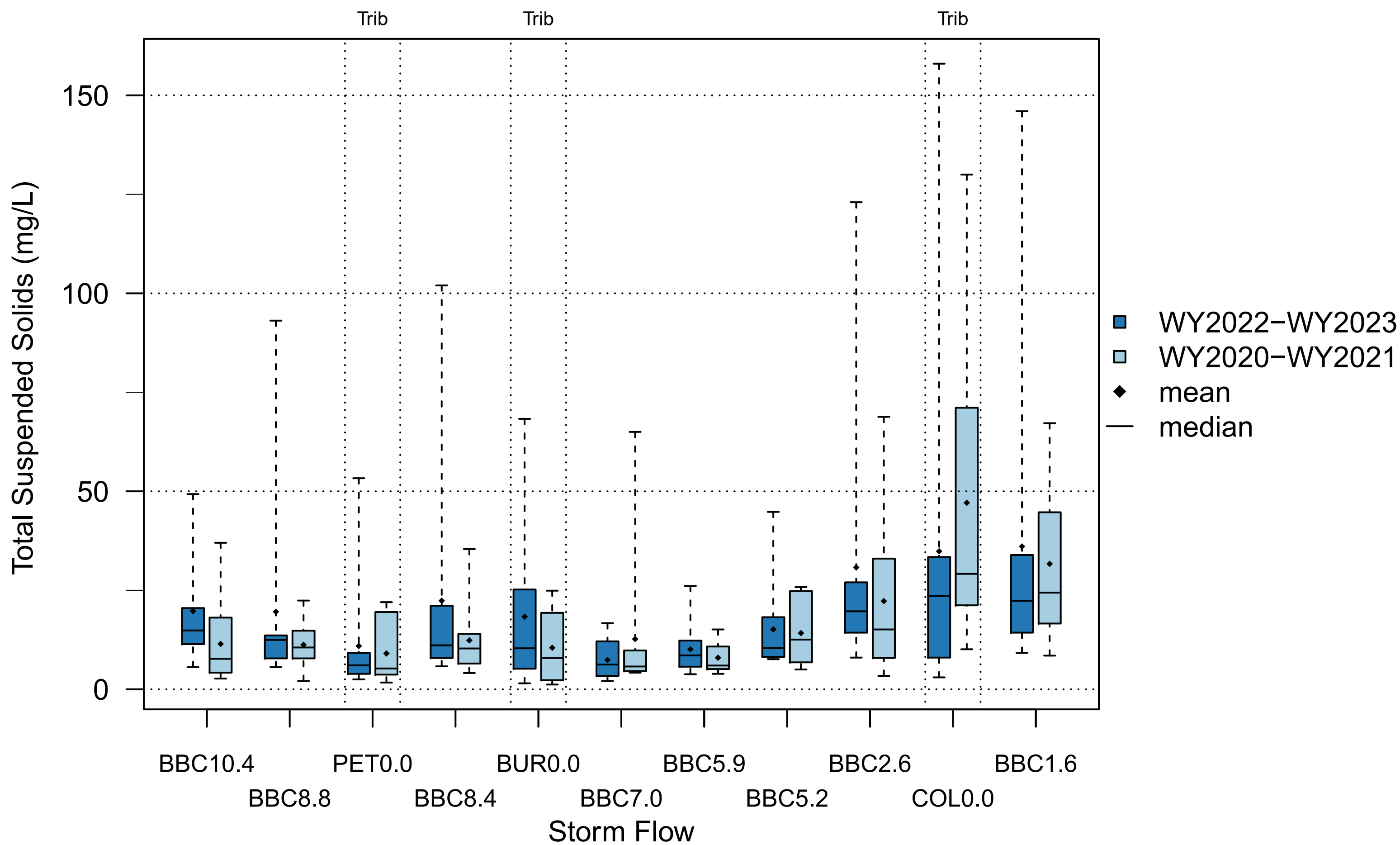


Turbidity − WY 2023
Turbidity (NTU)
8
6
4
2
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

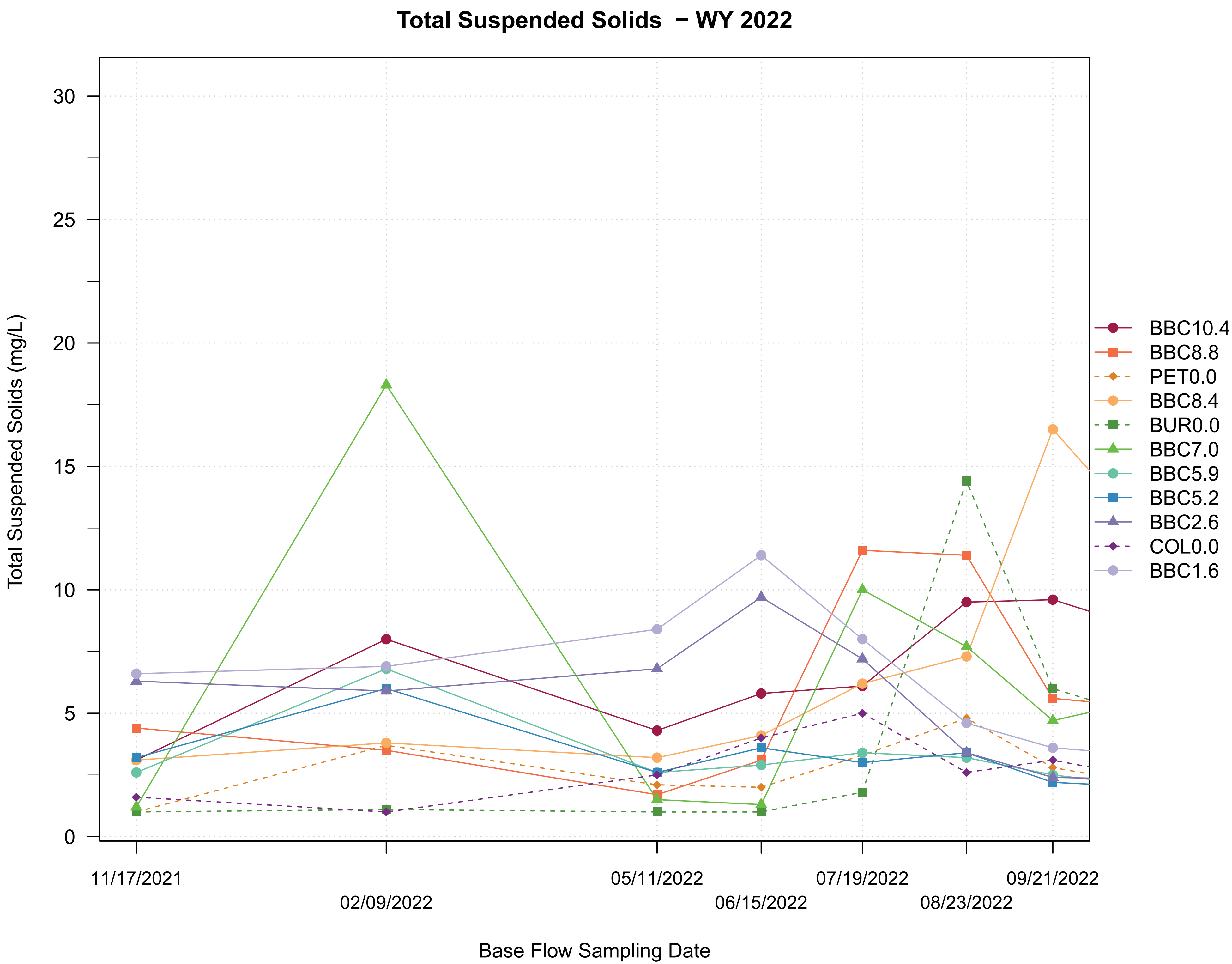

Trib
Trib
Trib
Total Suspended Solids (mg/L)
150
100
50
0
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median



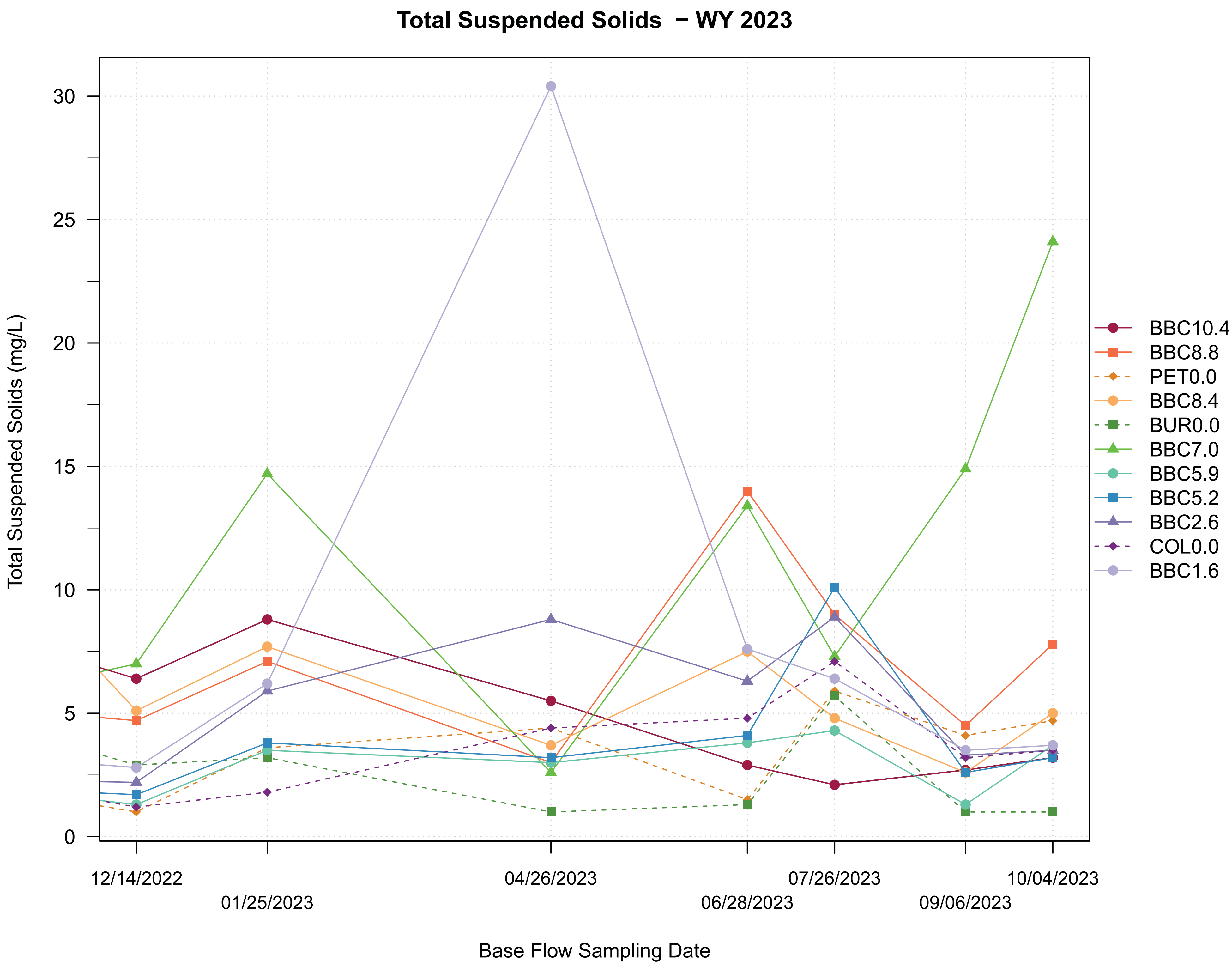
Note: Maximum value for BBC7.0 2011−2021 is 68.6 mg/L
Trib
Trib
Trib
Total Suspended Solids (mg/L)
0
10
20
30
40
50
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2011−WY2021
mean
median



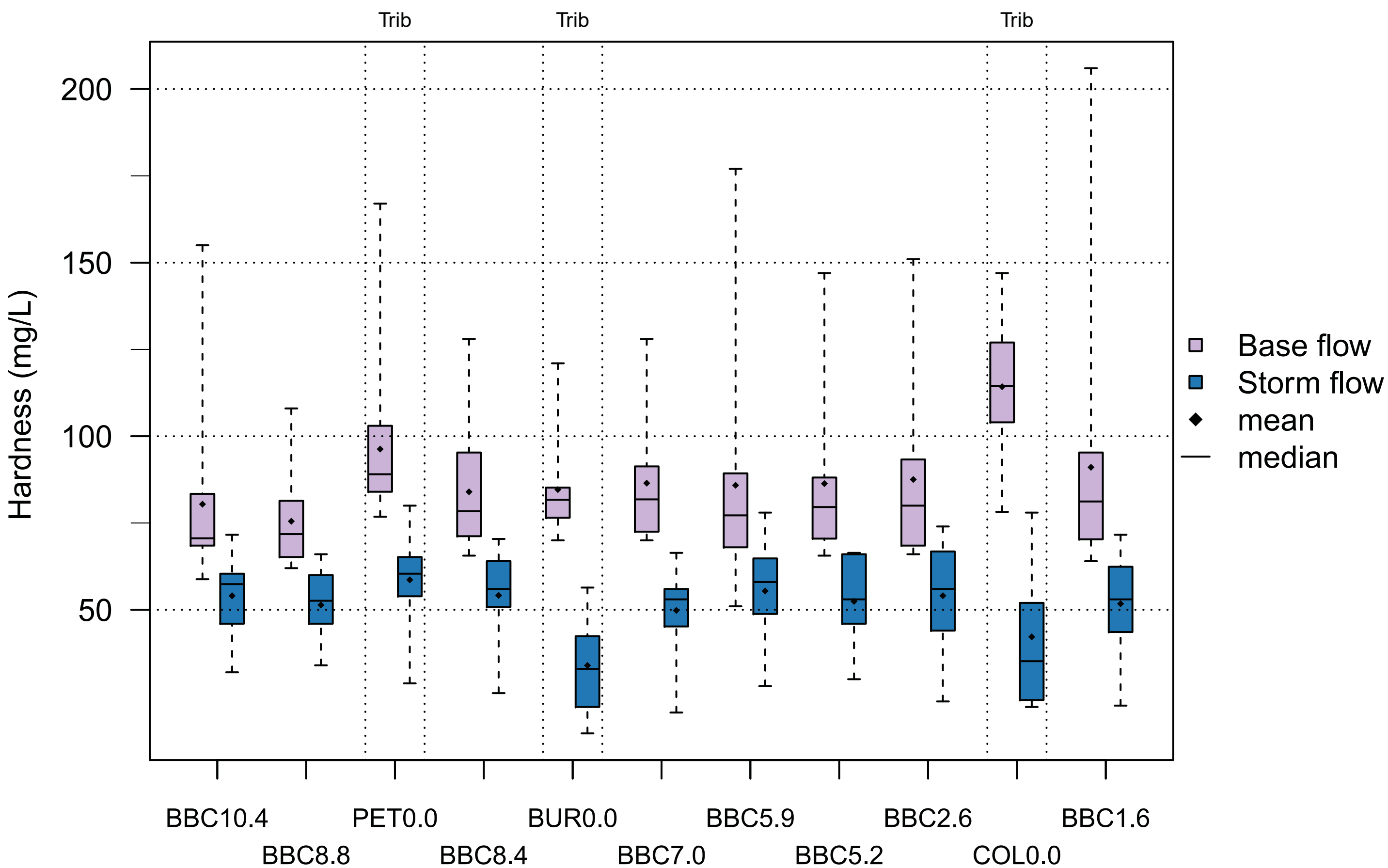
Trib
Trib
Trib
Total Suspended Solids (mg/L)
150
100
50
0
WY2022−WY2023
WY2020−WY2021
mean
median
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow



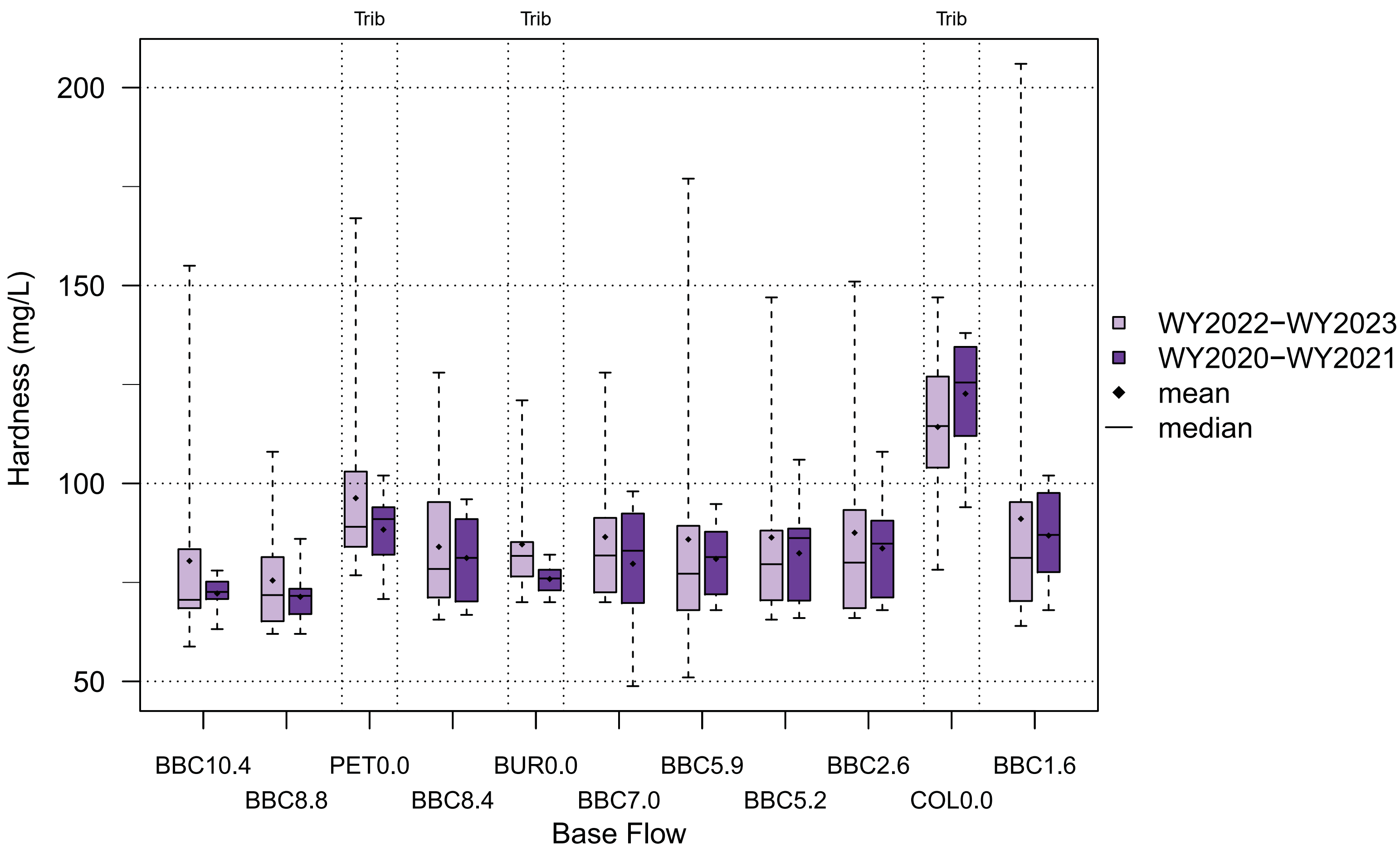
Total Suspended Solids − WY 2022
Total Suspended Solids (mg/L)
0
5
10
15
20
25
30
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

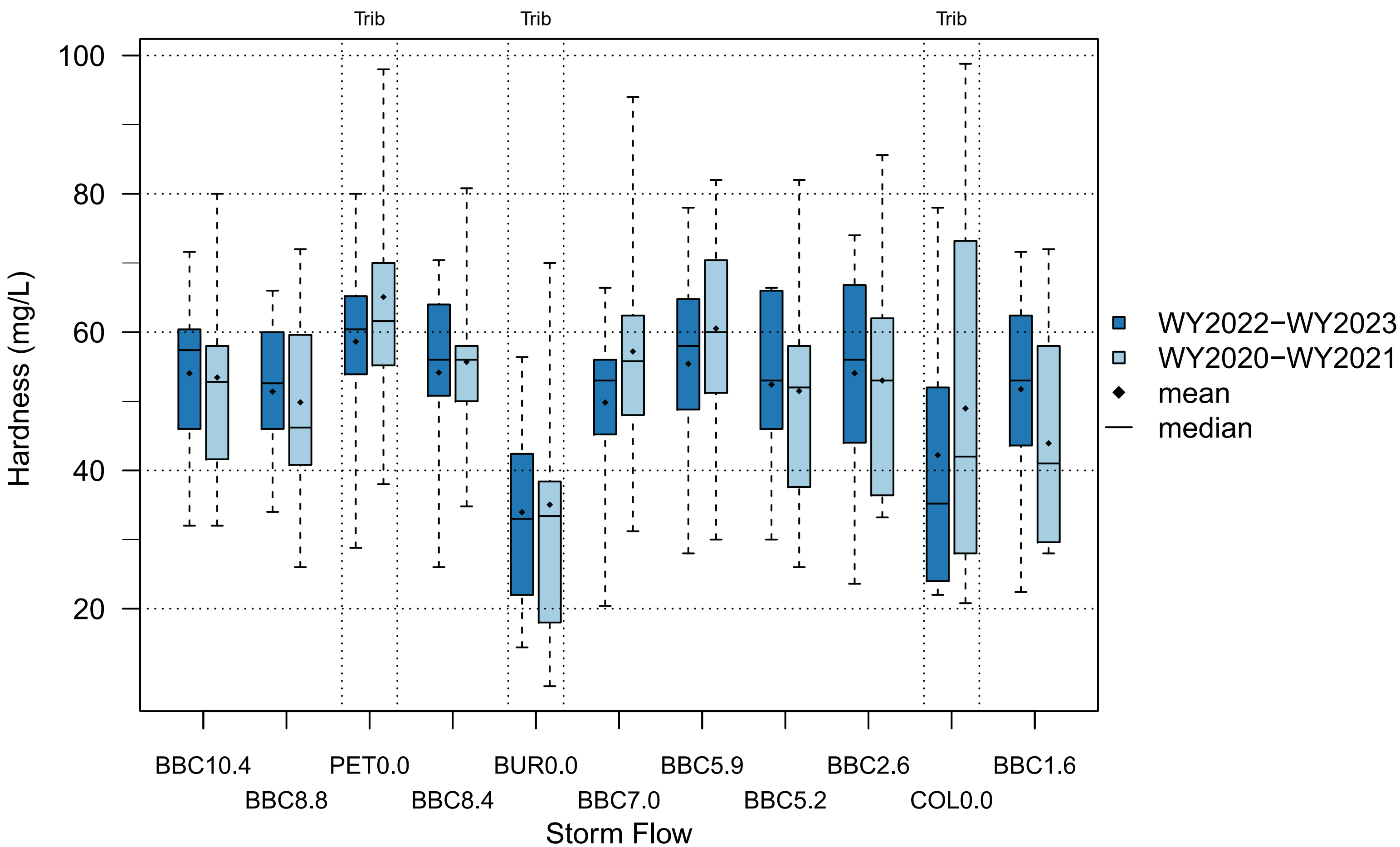


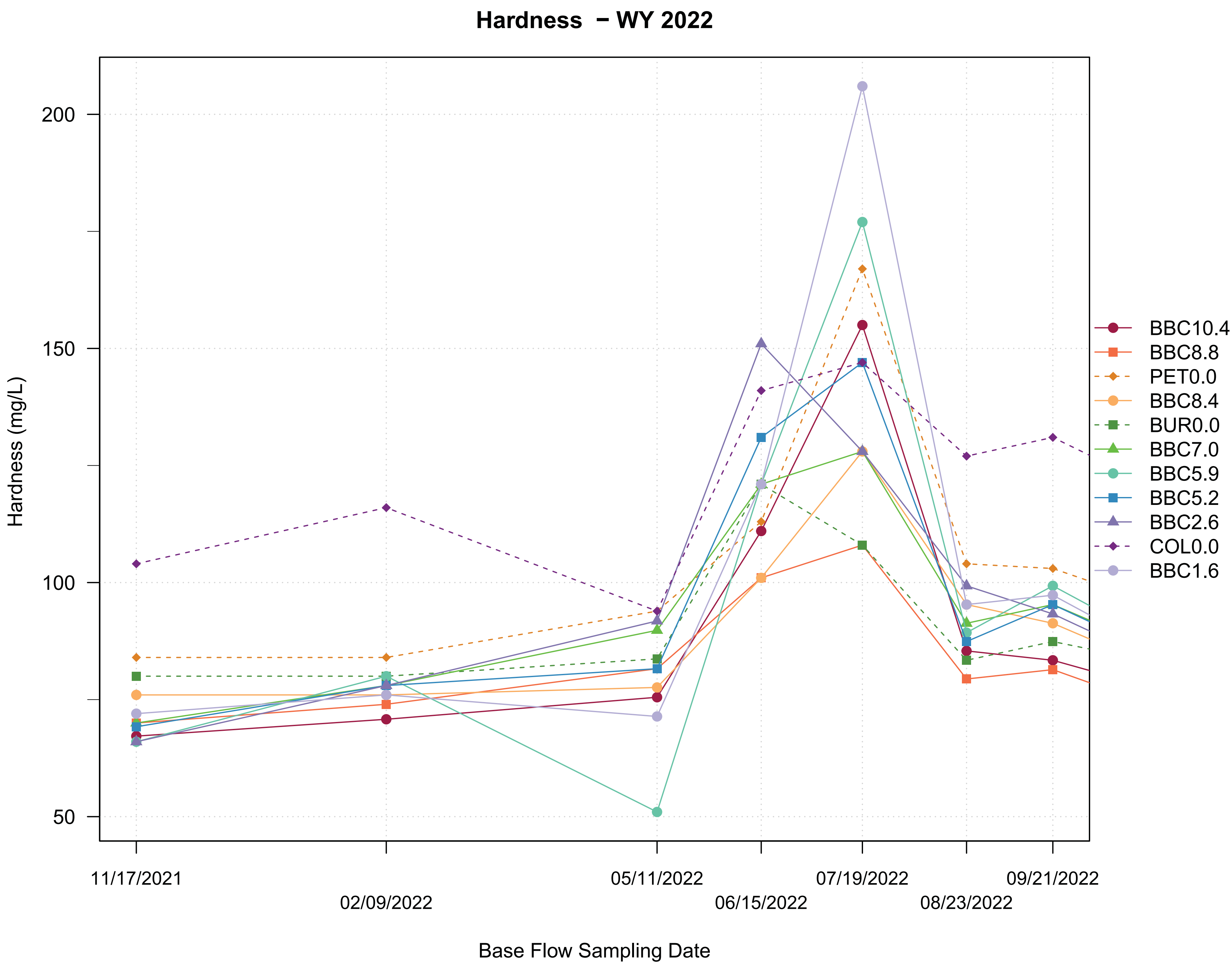
Total Suspended Solids − WY 2023
Total Suspended Solids (mg/L)
0
5
10
15
20
25
30
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6



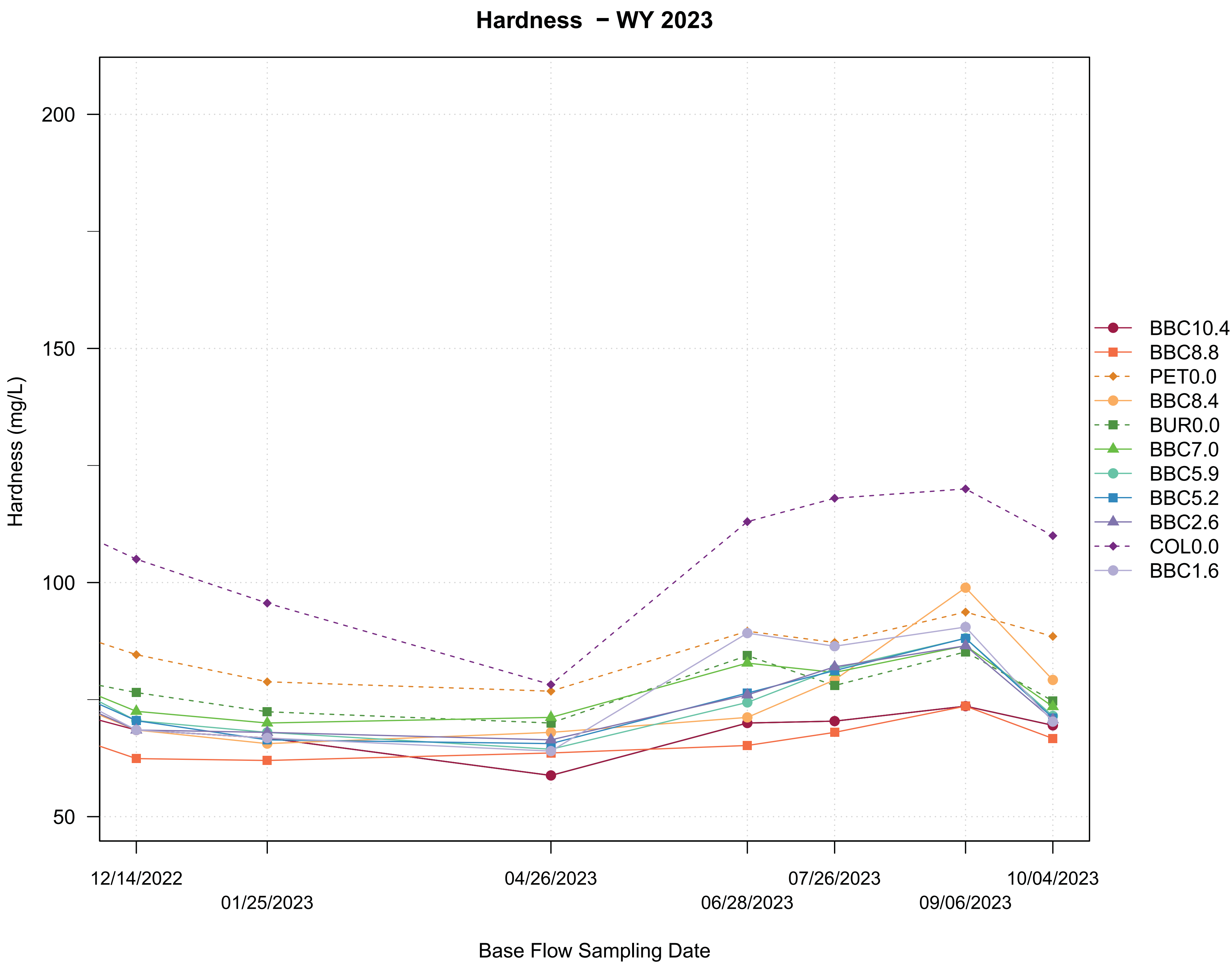
Trib
Trib
Trib
200
150
100
50
Hardness (mg/L)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median


Trib
Trib
Trib
200
150
100
50
Hardness (mg/L)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2020−WY2021
mean
median

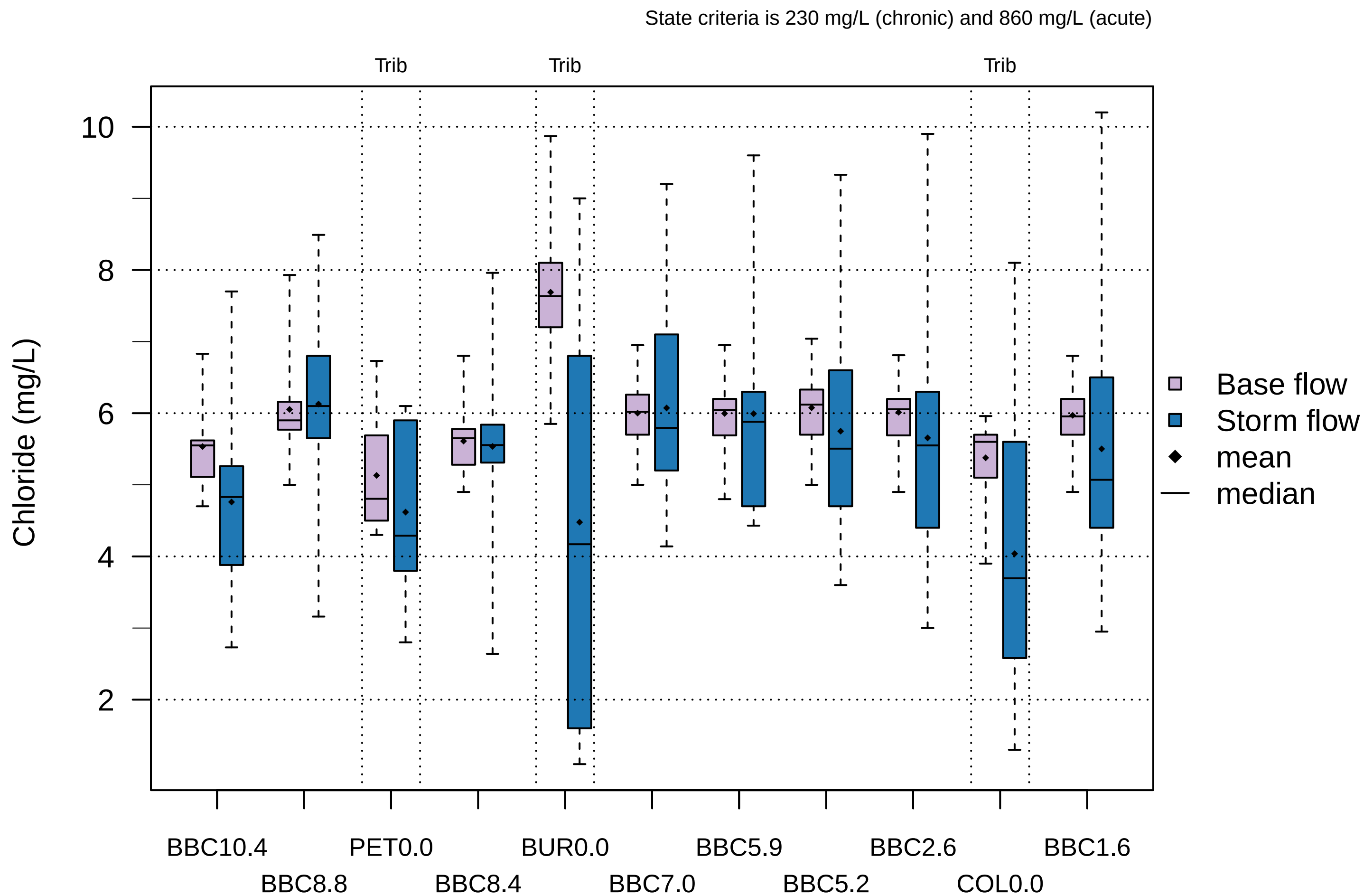

Trib
Trib
Trib
100
80
60
40
20
Hardness (mg/L)
WY2022−WY2023
WY2020−WY2021
mean
median
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow



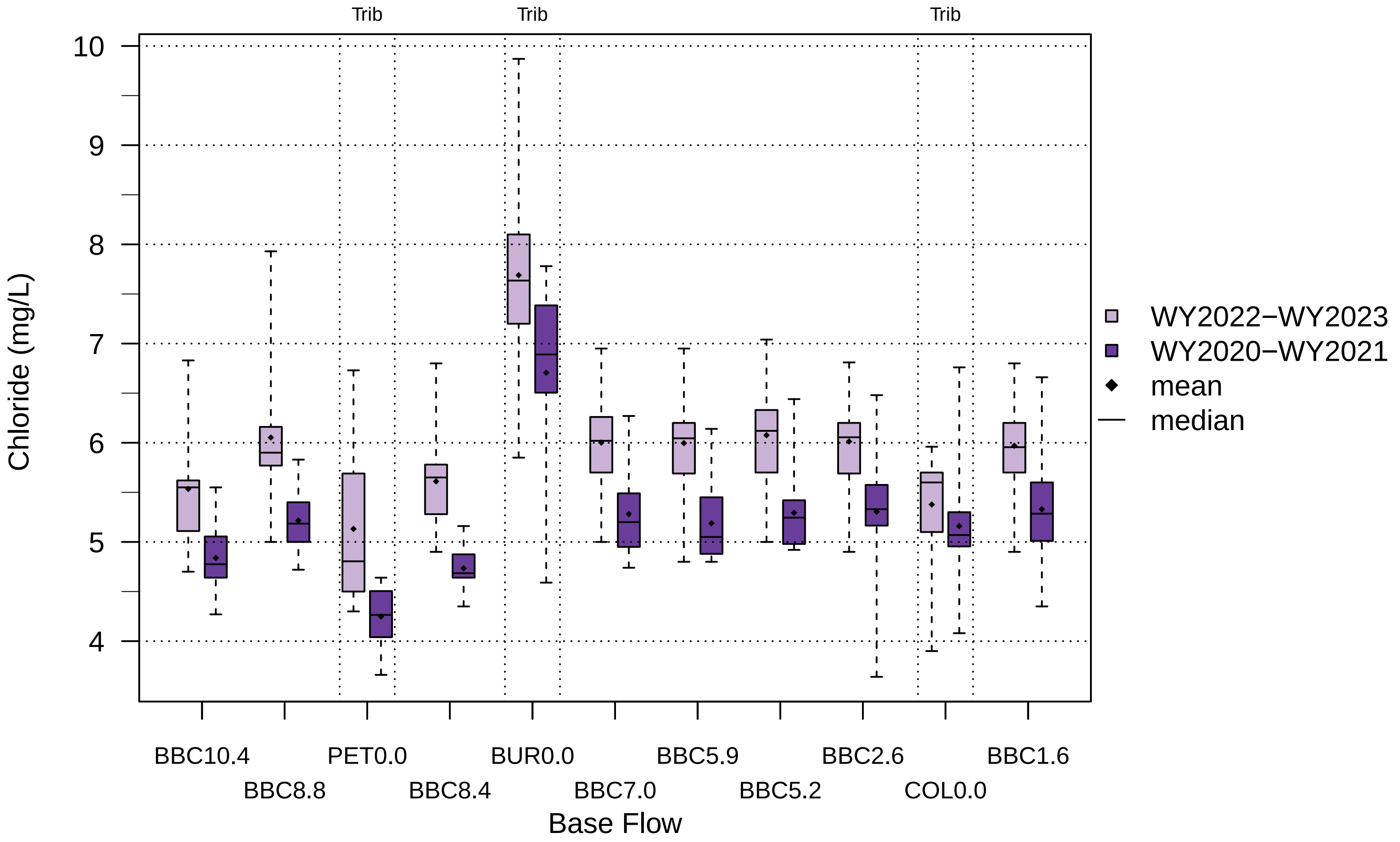
Hardness − WY 2022
Hardness (mg/L)
200
150
100
50
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6



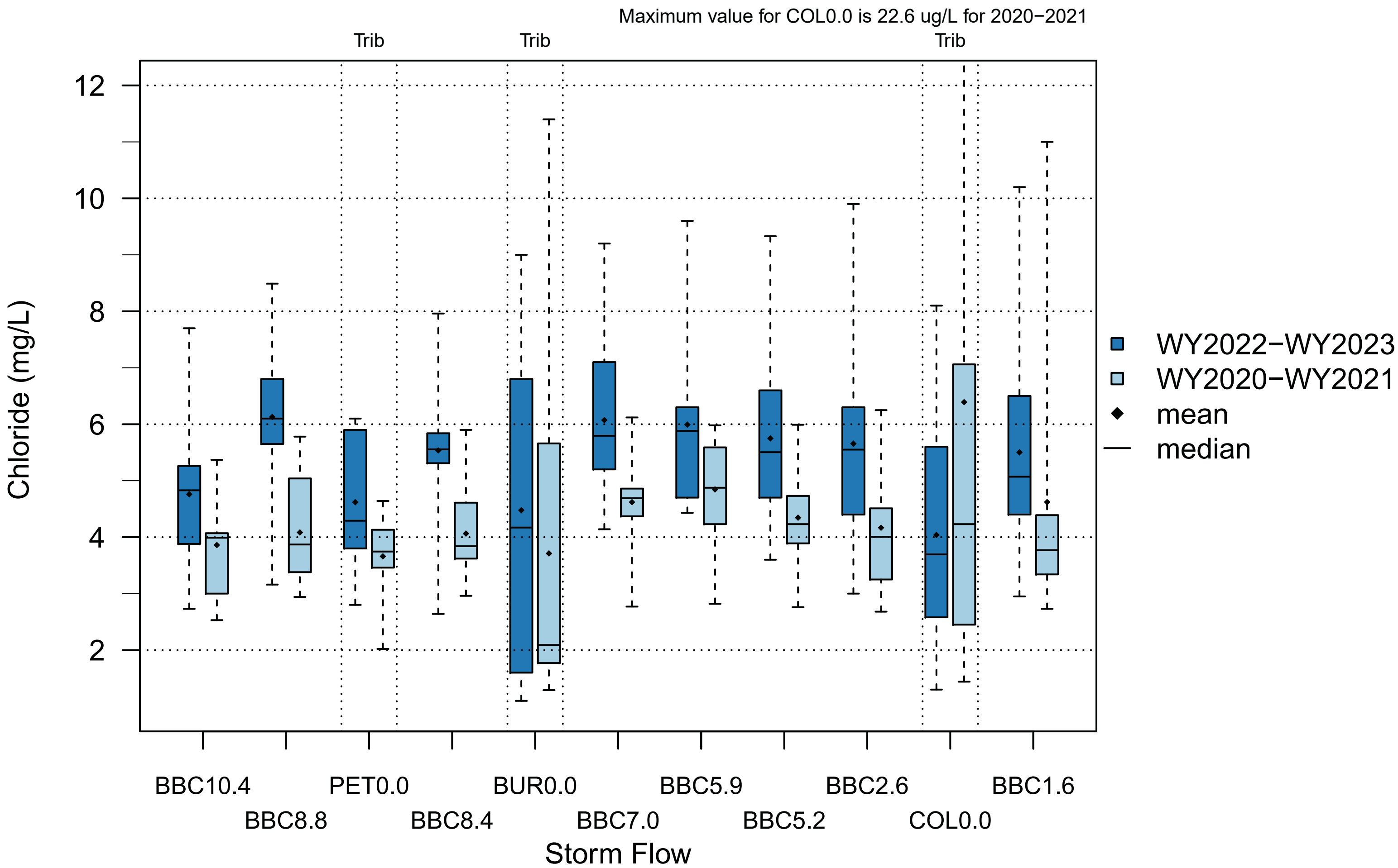
Hardness − WY 2023
Hardness (mg/L)
200
150
100
50
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

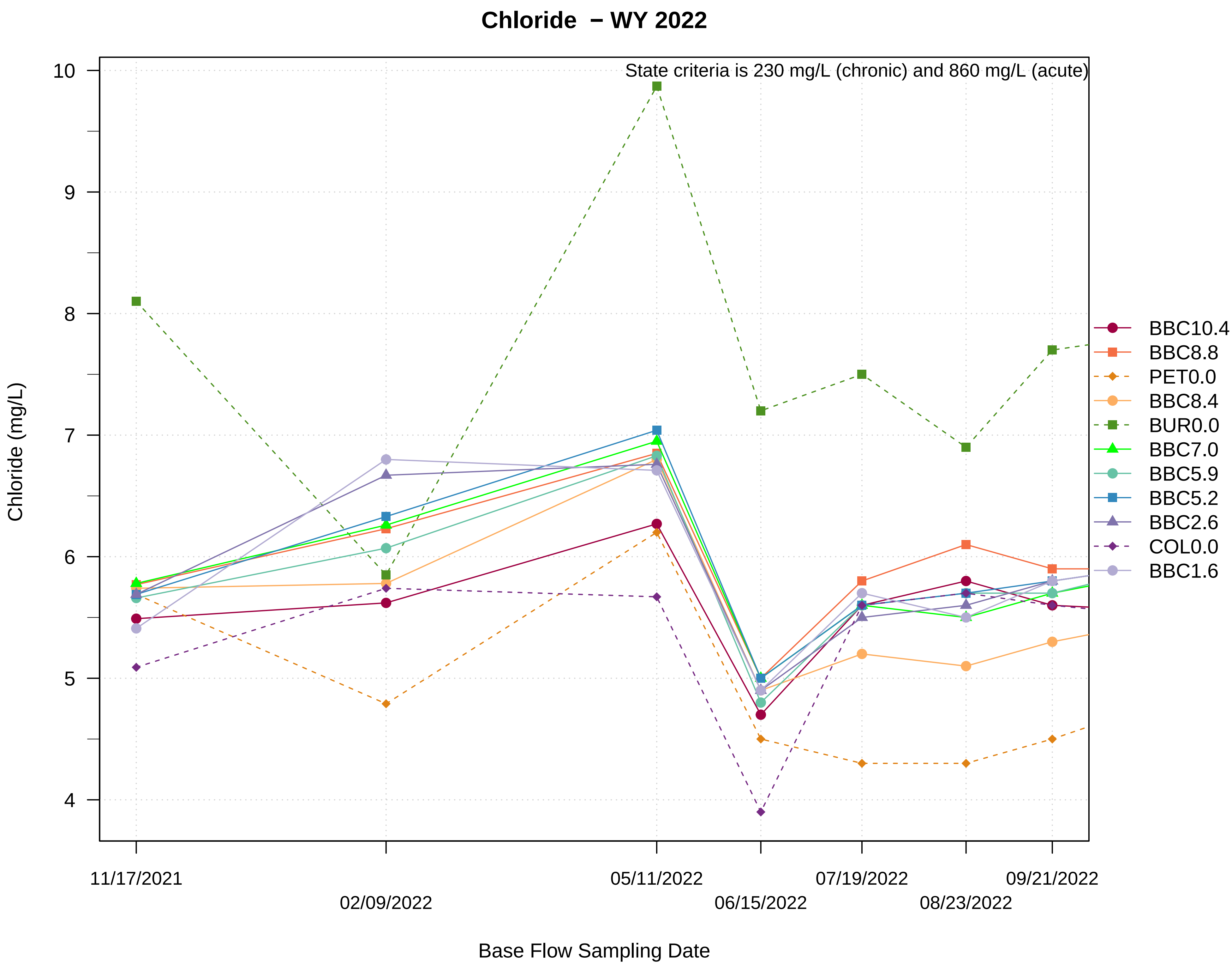


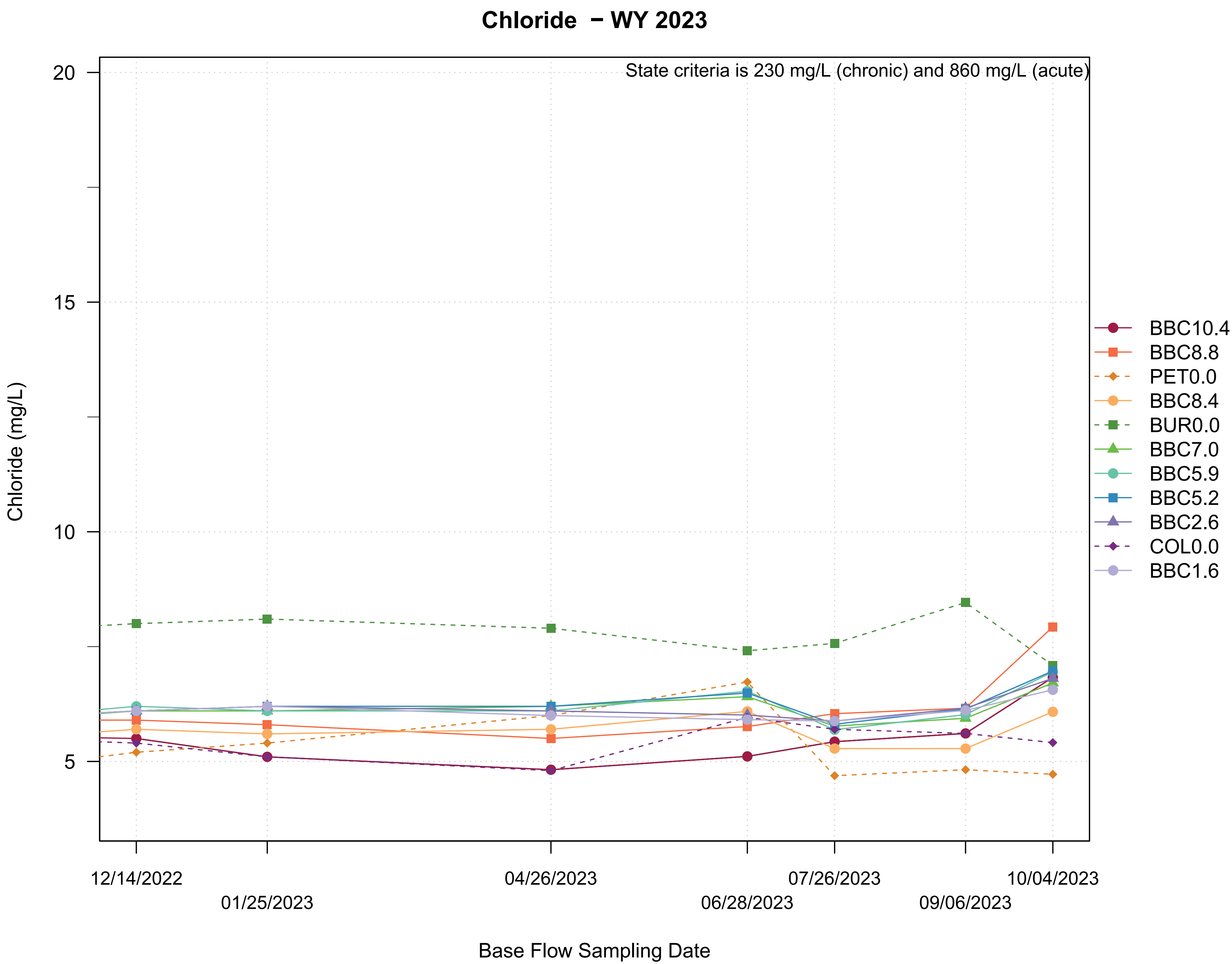
State criteria is 230 mg/L (chronic) and 860 mg/L (acute)
Trib
Trib
Trib
Chloride (mg/L)
10
8
6
4
2
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median



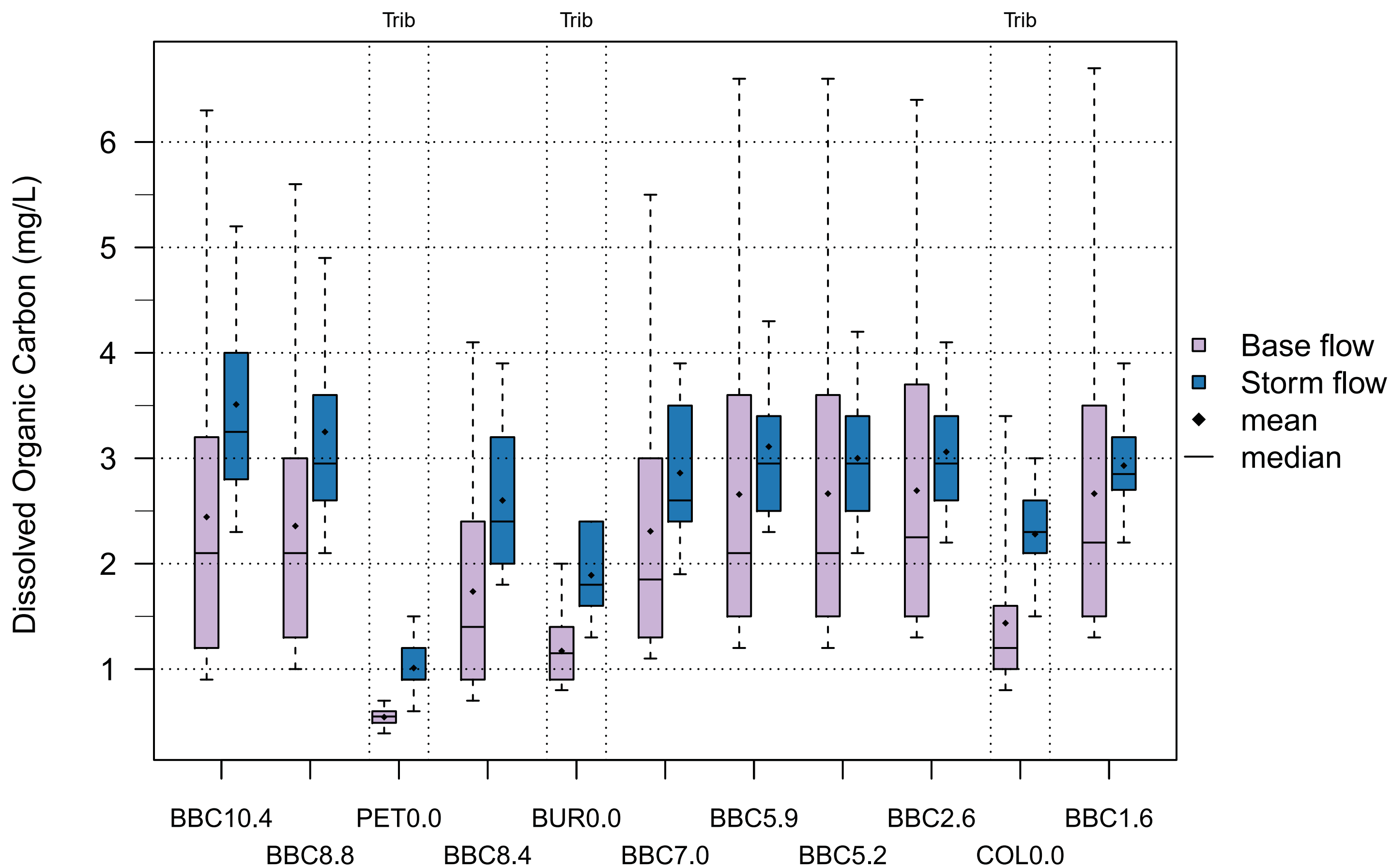
Trib
Trib
Trib
Chloride (mg/L)
10
9
8
7
6
5
4
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2020−WY2021
mean
median


Maximum value for COL0.0 is 22.6 ug/L for 2020−2021
Trib
Trib
Trib
Chloride (mg/L)
12
10
8
6
4
2
WY2022−WY2023
WY2020−WY2021
mean
median
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow

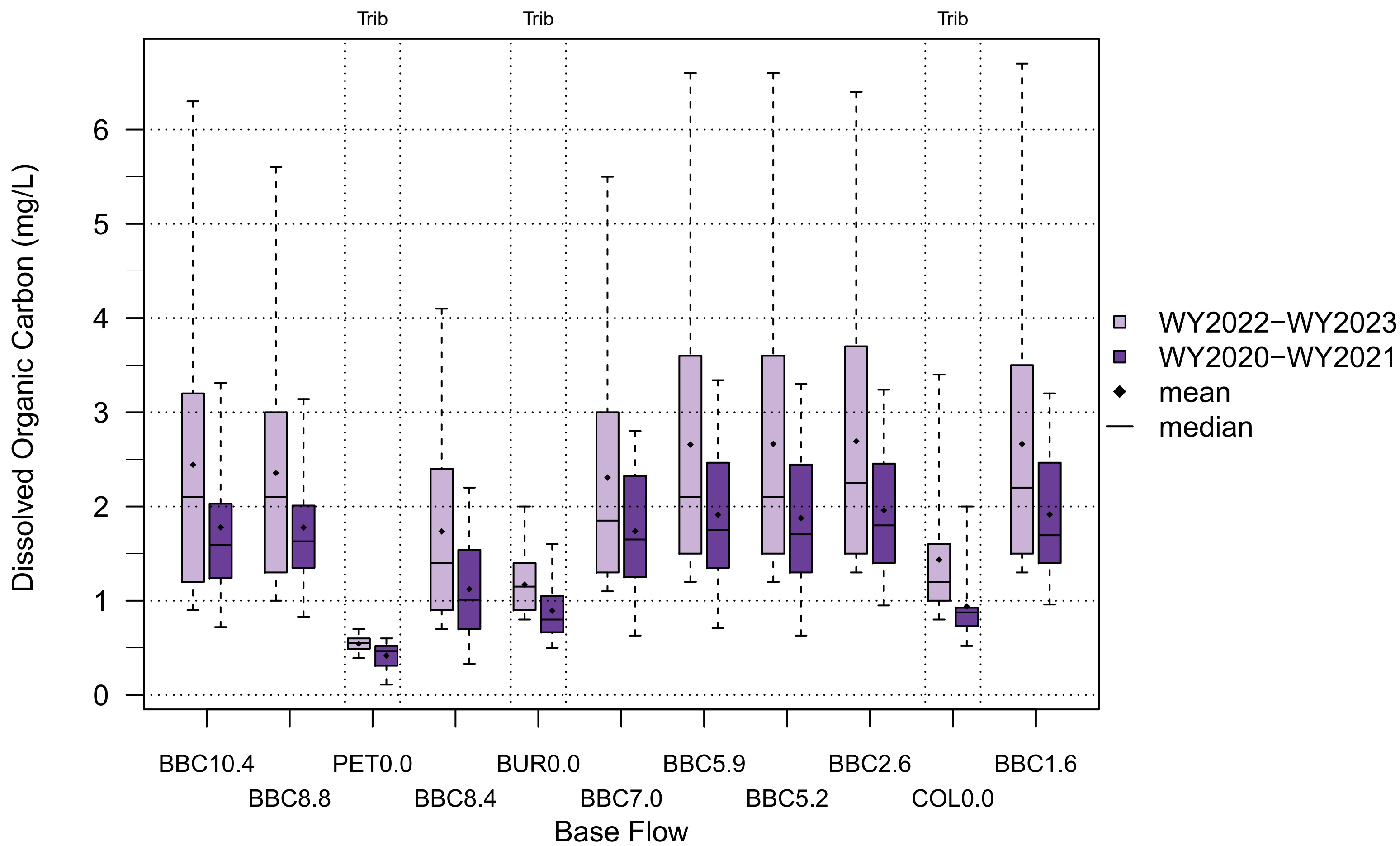

Chloride – WY 2022
State criteria is 230 mg/L (chronic) and 860 mg/L (acute)
Chloride (mg/L)
10
9
8
7
6
5
4
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6



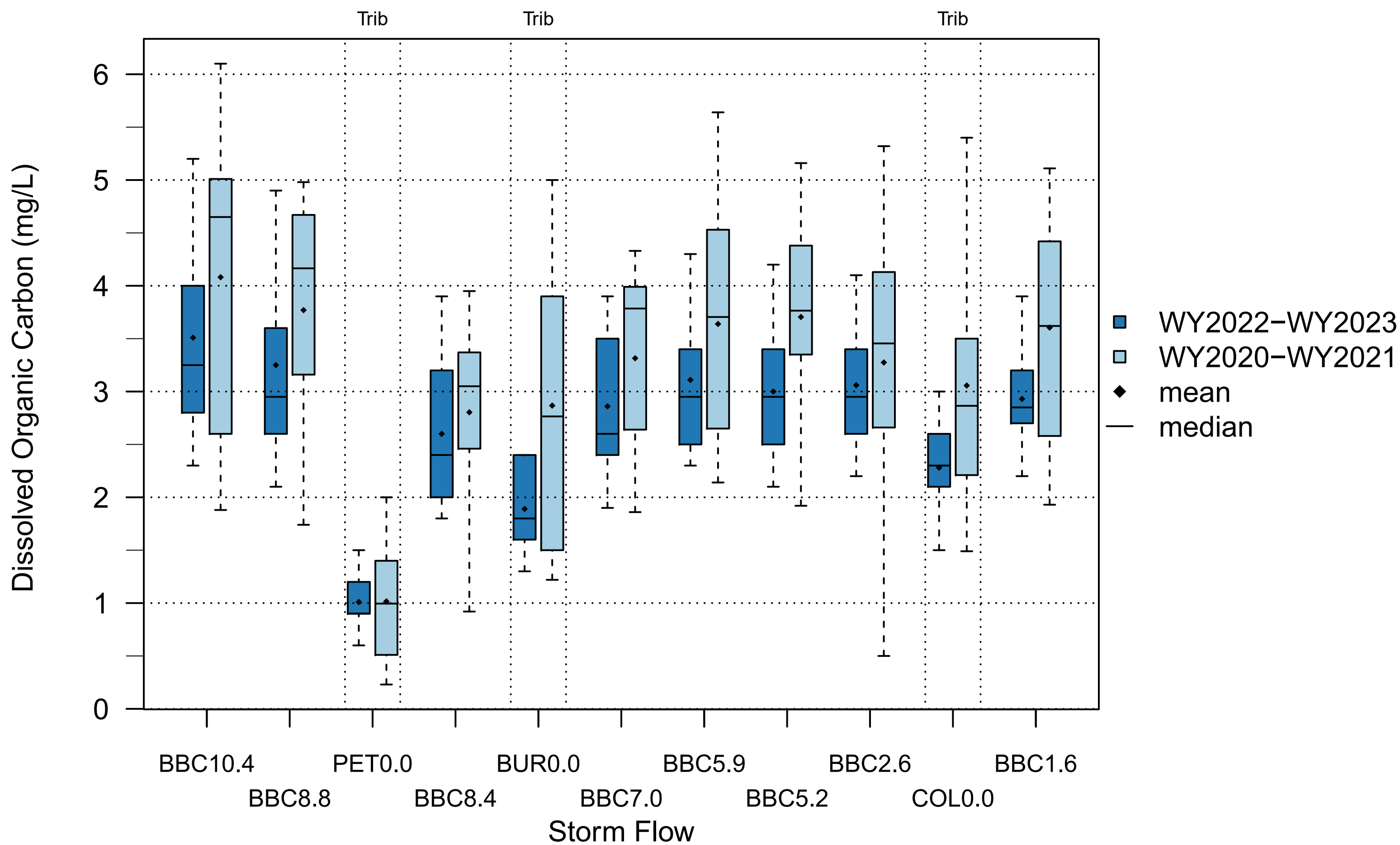
Chloride − WY 2023
State criteria is 230 mg/L (chronic) and 860 mg/L (acute)
Chloride (mg/L)
20
15
10
5
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

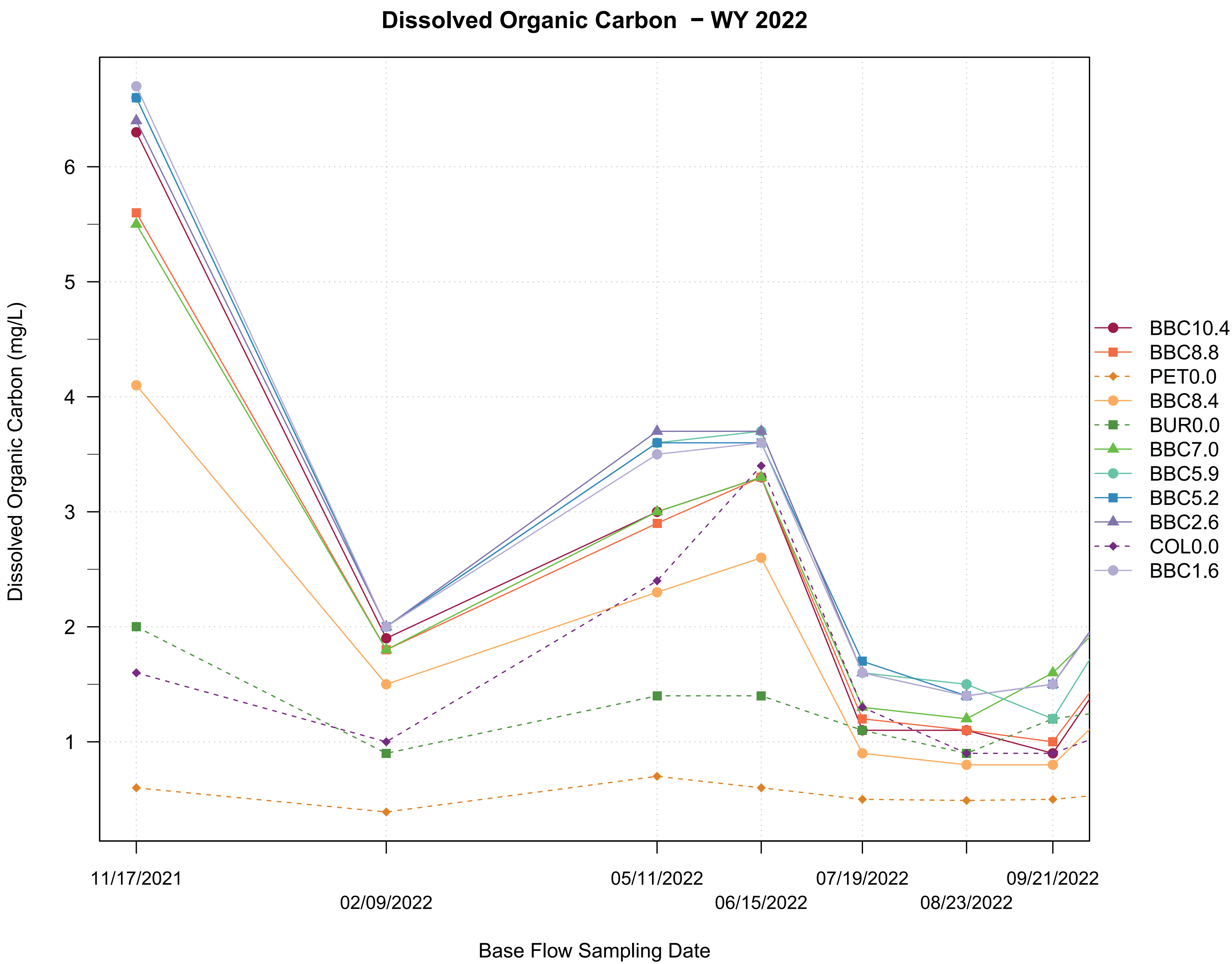


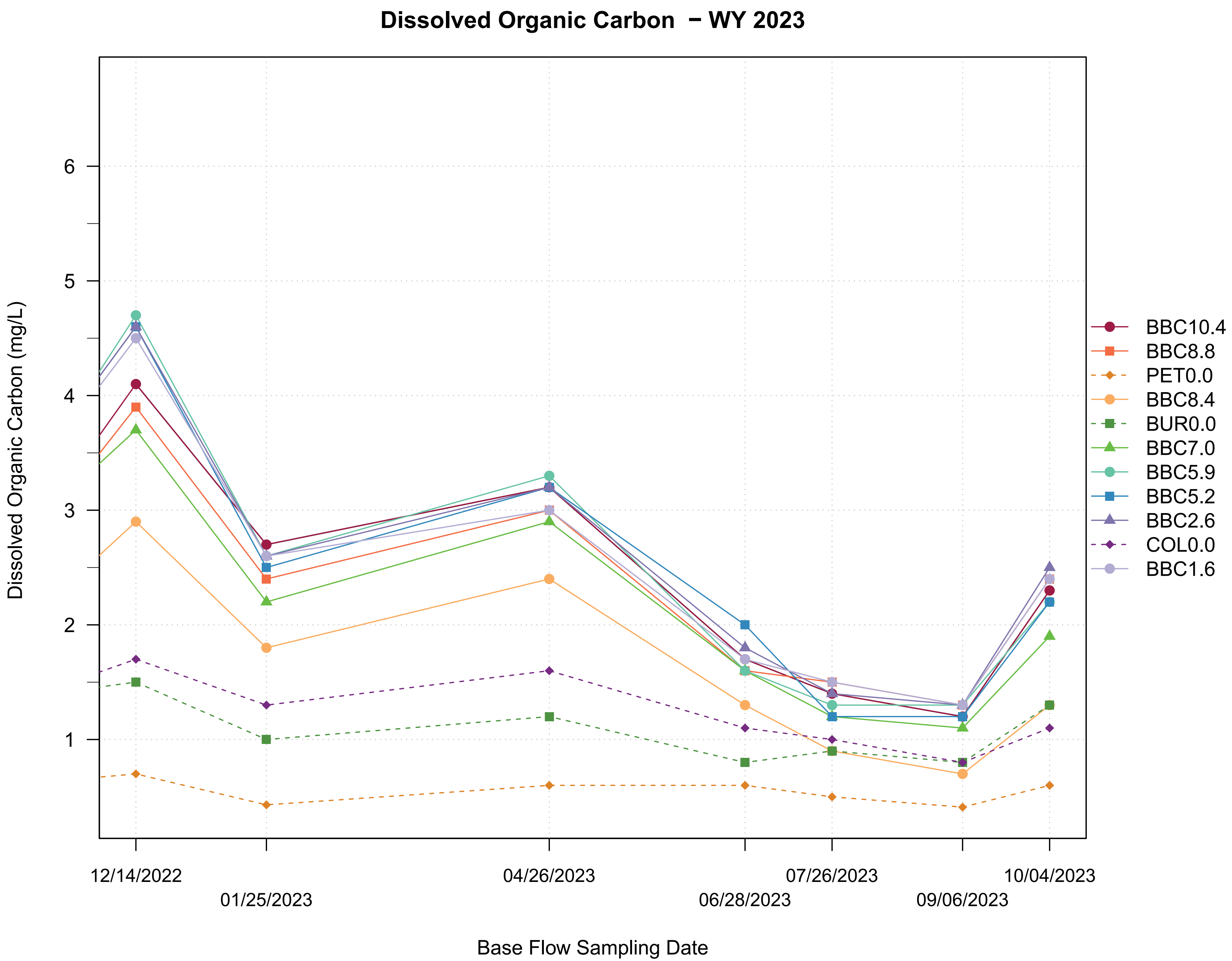
Trib
Trib
Trib
Dissolved Organic Carbon (mg/L)
1
2
3
4
5
6
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median

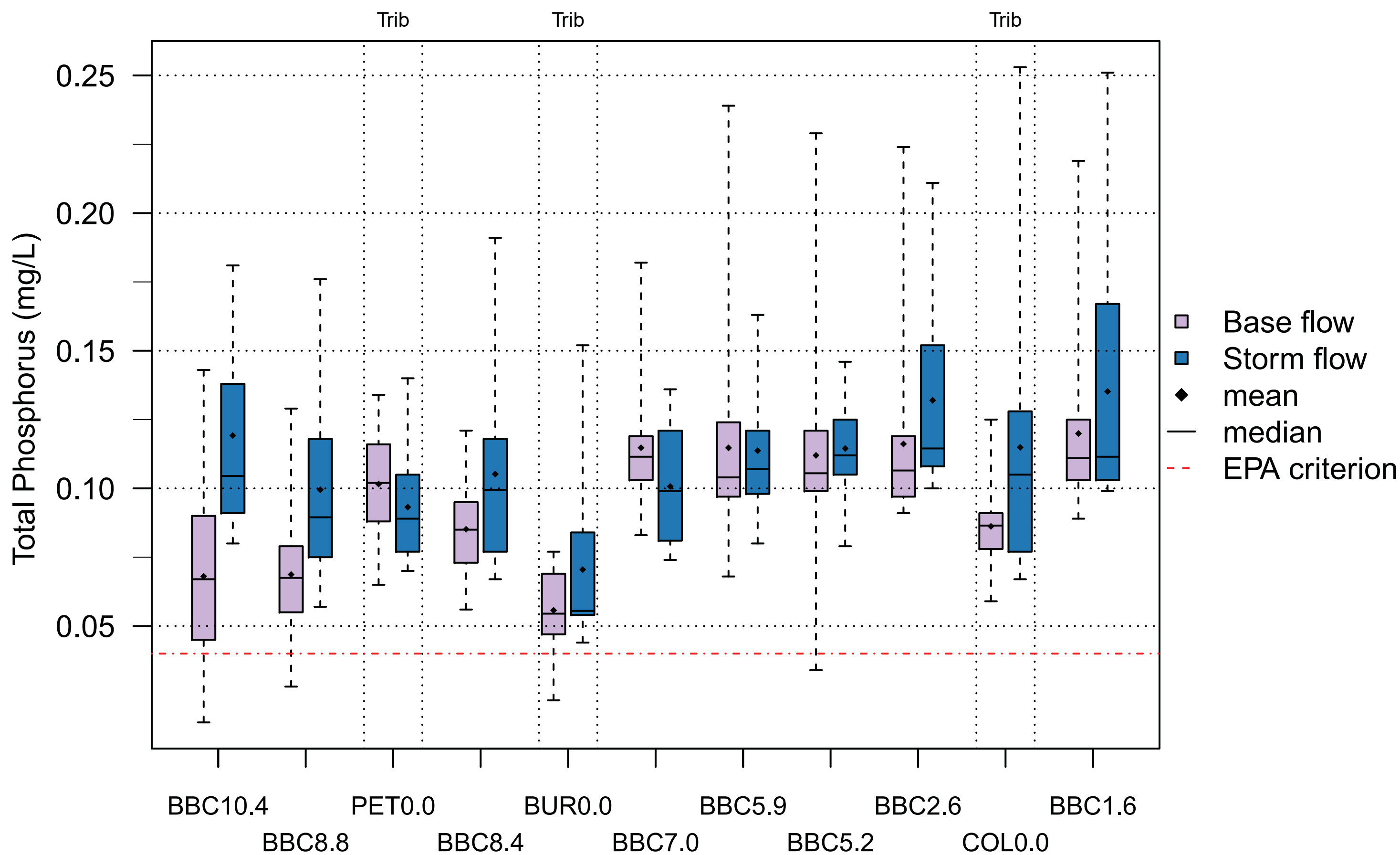


Trib
Trib
Trib
Dissolved Organic Carbon (mg/L)
0
1
2
3
4
5
6
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2020−WY2021
mean
median

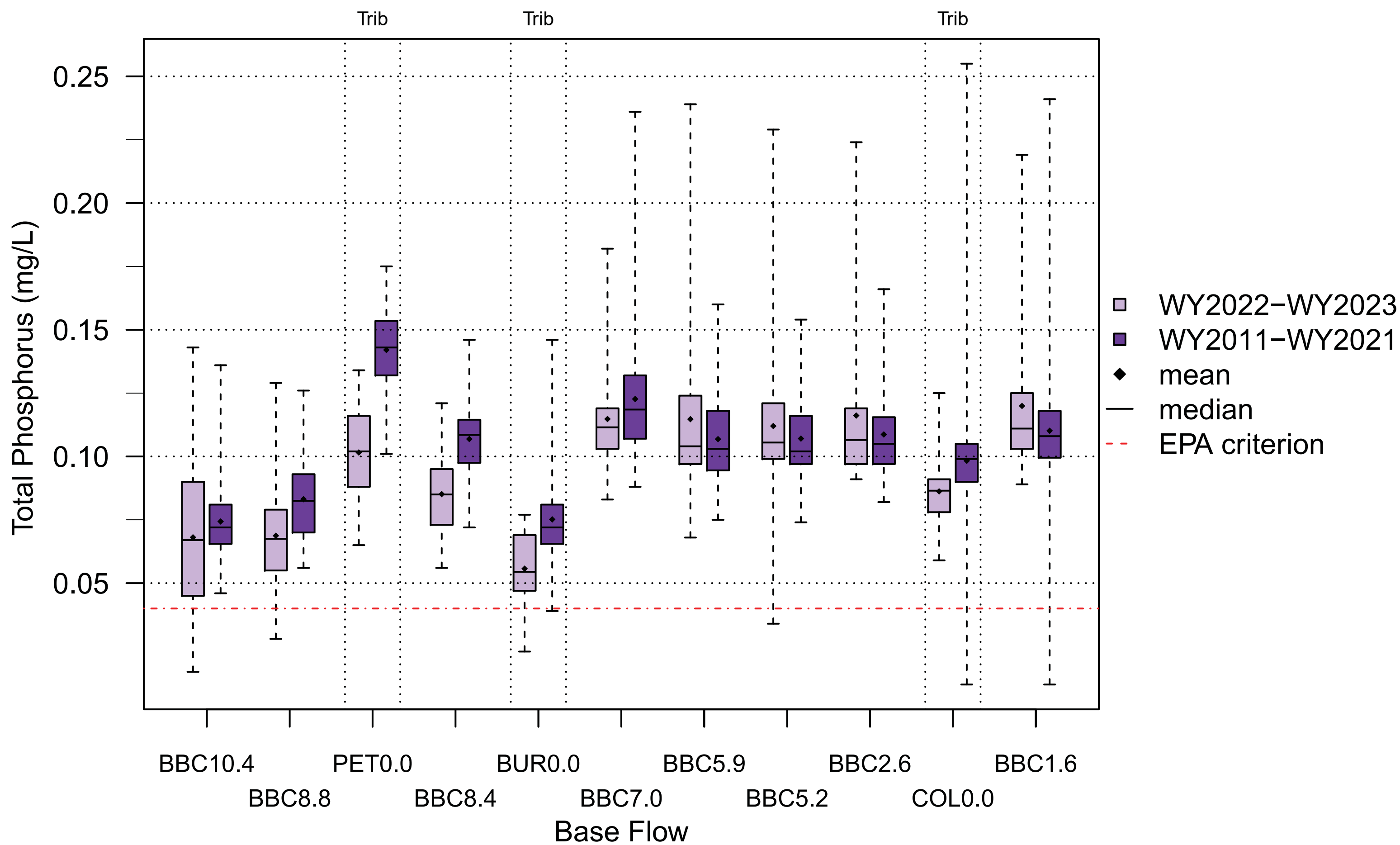

Trib
Trib
Trib
6
5
4
3
2
1
0
Dissolved Organic Carbon (mg/L)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median

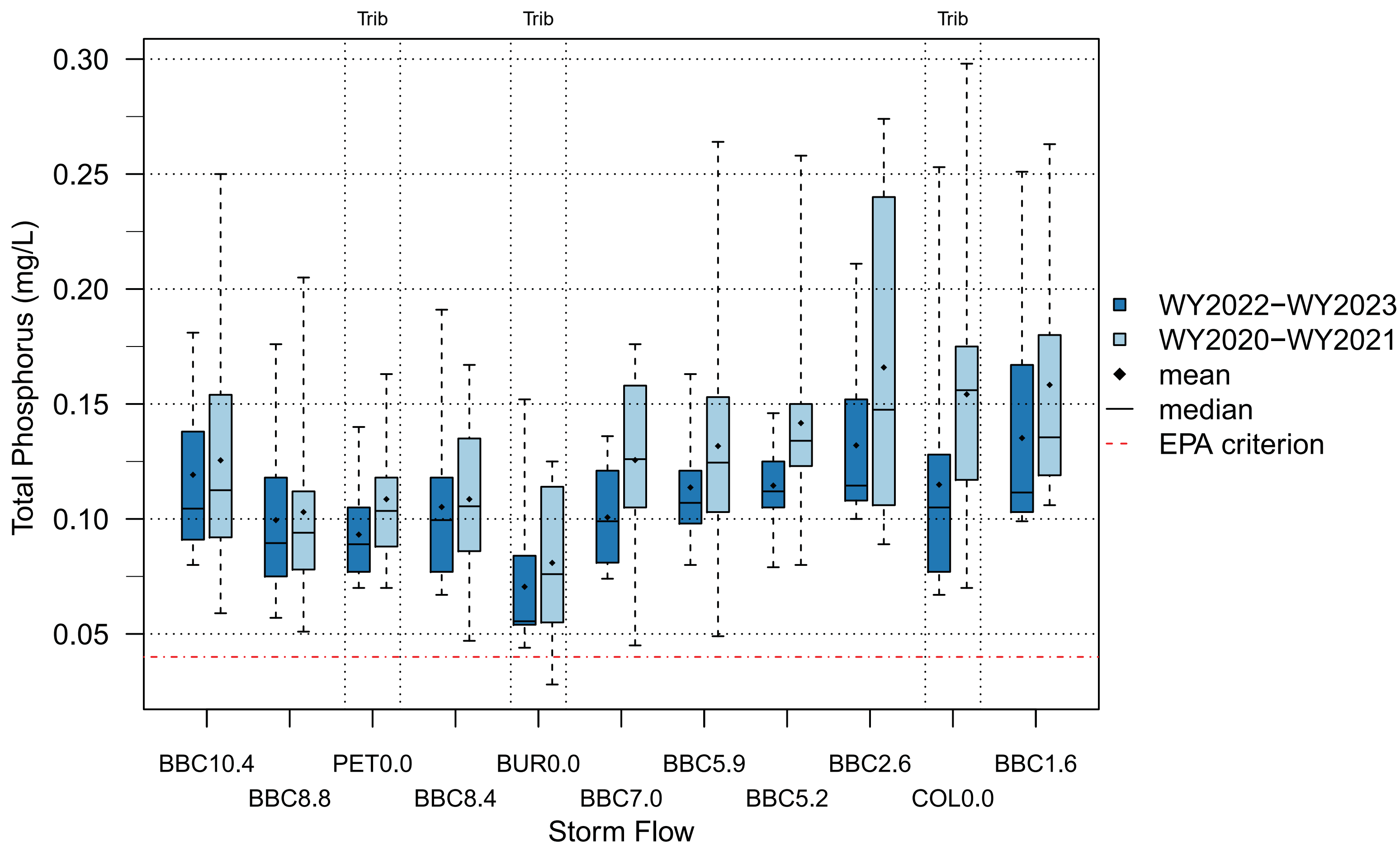

Dissolved Organic Carbon − WY 2022
Dissolved Organic Carbon (mg/L)
1
2
3
4
5
6
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6


Dissolved Organic Carbon − WY 2023
Dissolved Organic Carbon (mg/L)
1
2
3
4
5
6
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

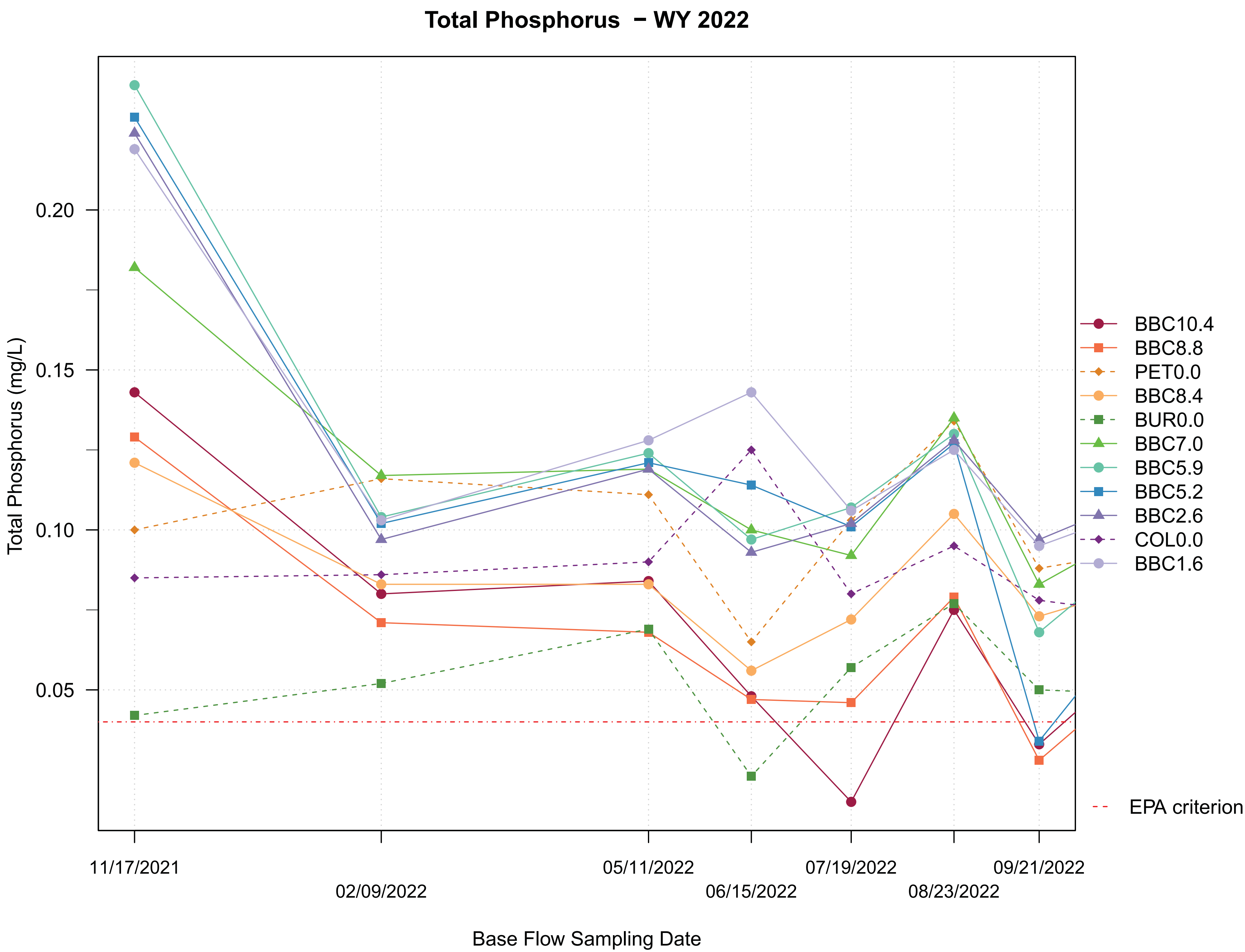


Trib
Trib
Trib
Total Phosphorus (mg/L)
0.25
0.20
0.15
0.10
0.05
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median
EPA criterion

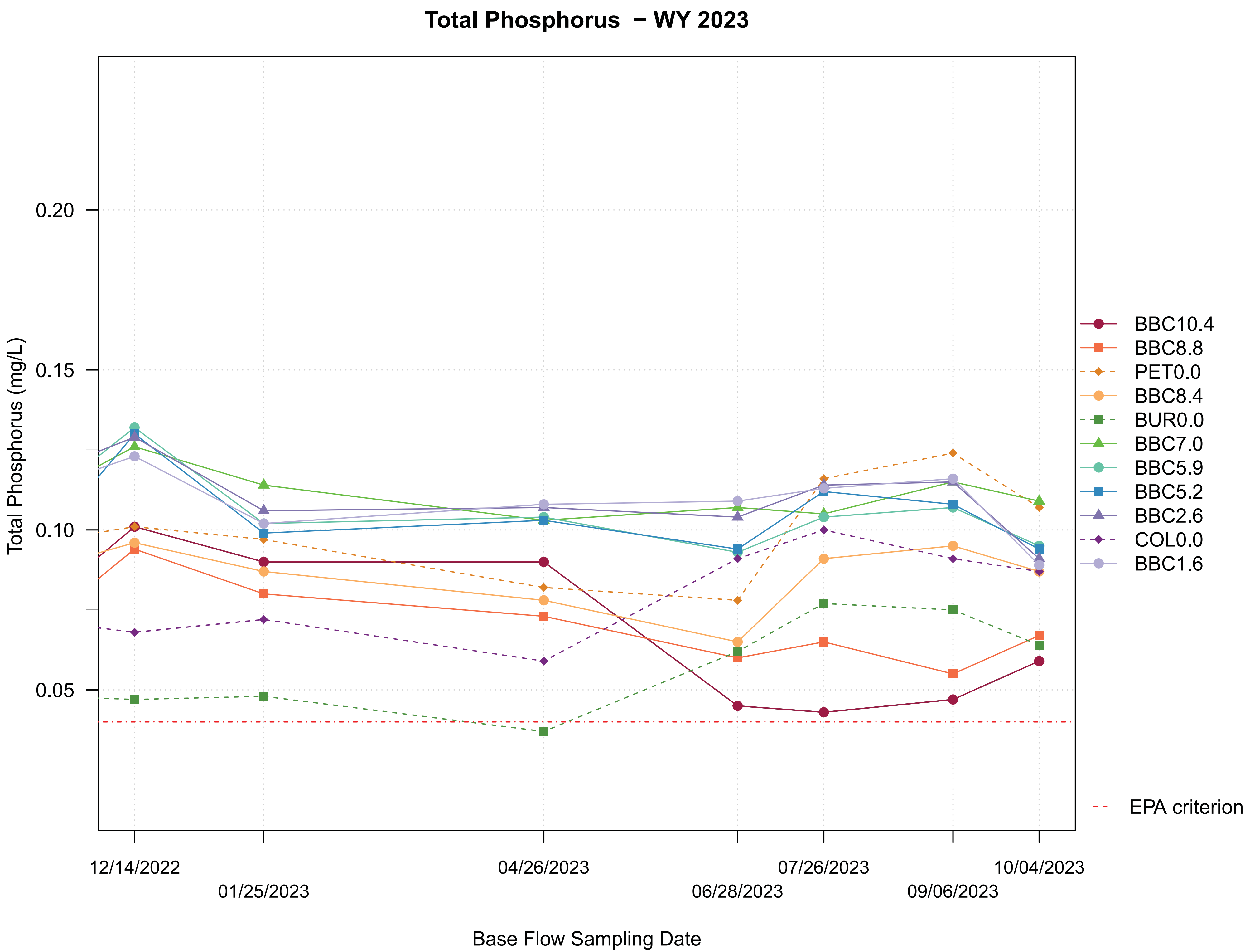

Trib
Trib
Trib
Total Phosphorus (mg/L)
0.25
0.20
0.15
0.10
0.05
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2011−WY2021
mean
median
EPA criterion



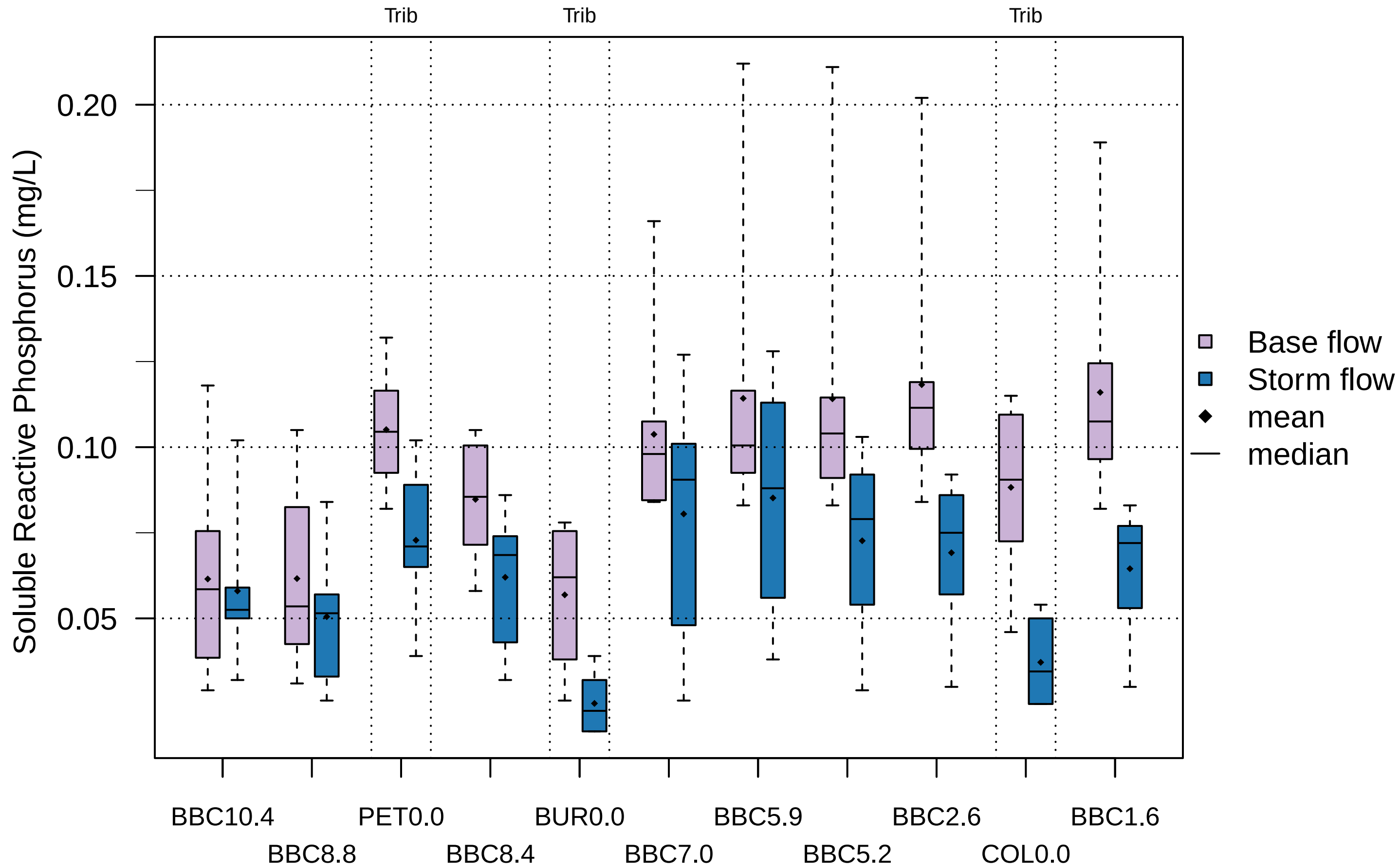
Trib
Trib
Trib
0.30
0.25
0.20
0.15
0.10
0.05
Total Phosphorus (mg/L)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median
EPA criterion



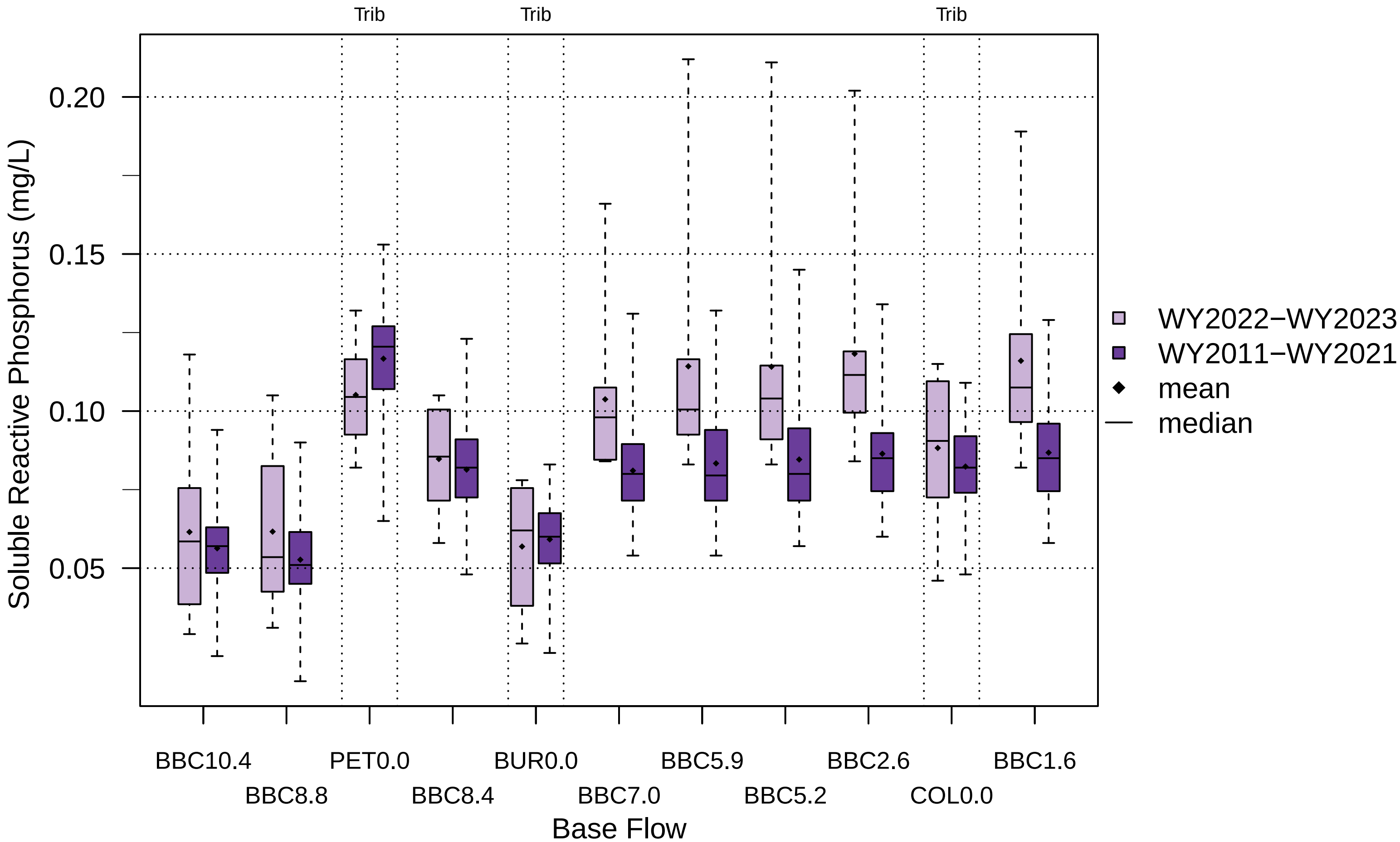
Total Phosphorus − WY 2022
0.20
0.15
0.10
0.05
Total Phosphorus (mg/L)
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
EPA criterion



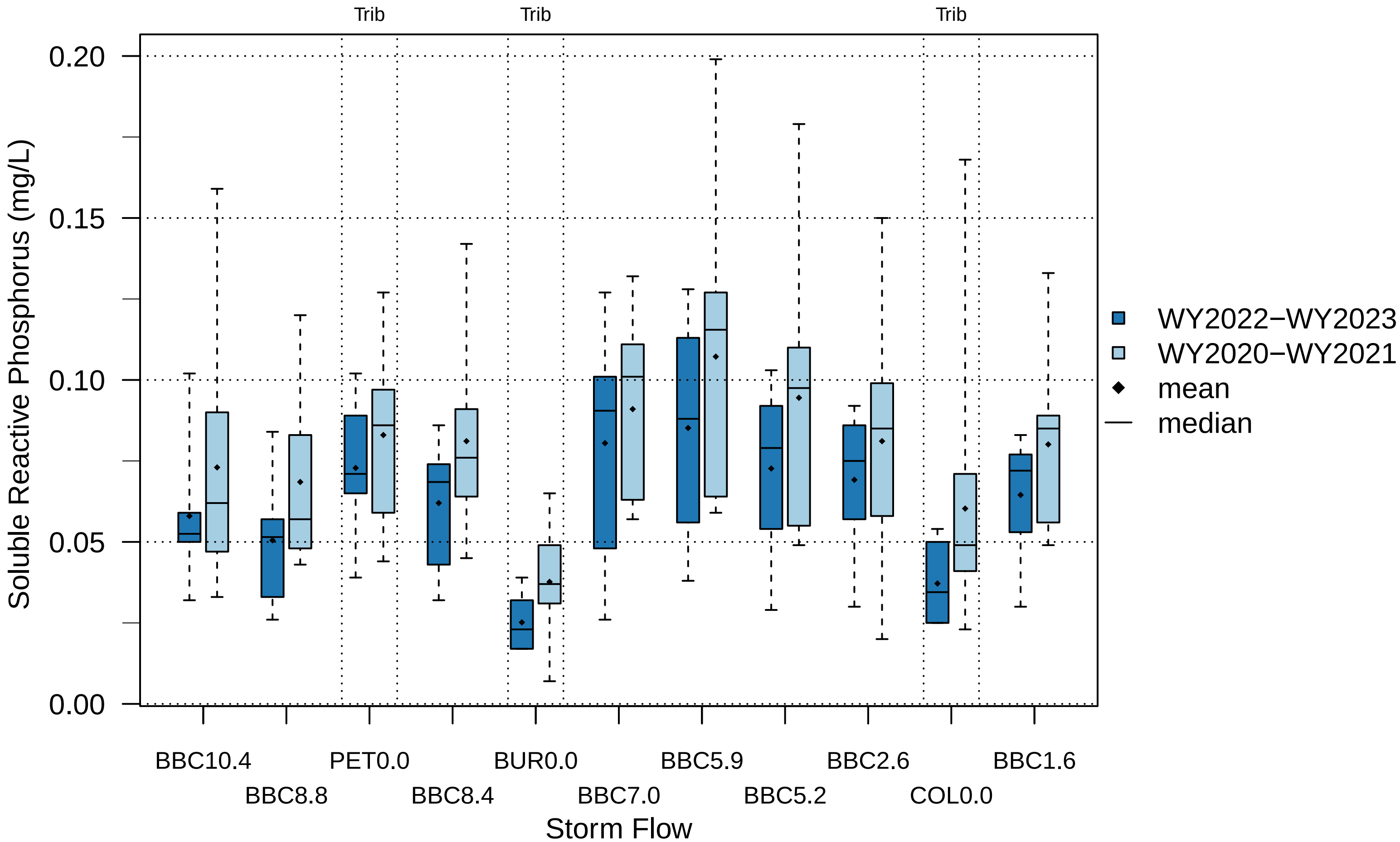
Total Phosphorus − WY 2023
Total Phosphorus (mg/L)
0.20
0.15
0.10
0.05
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
EPA criterion



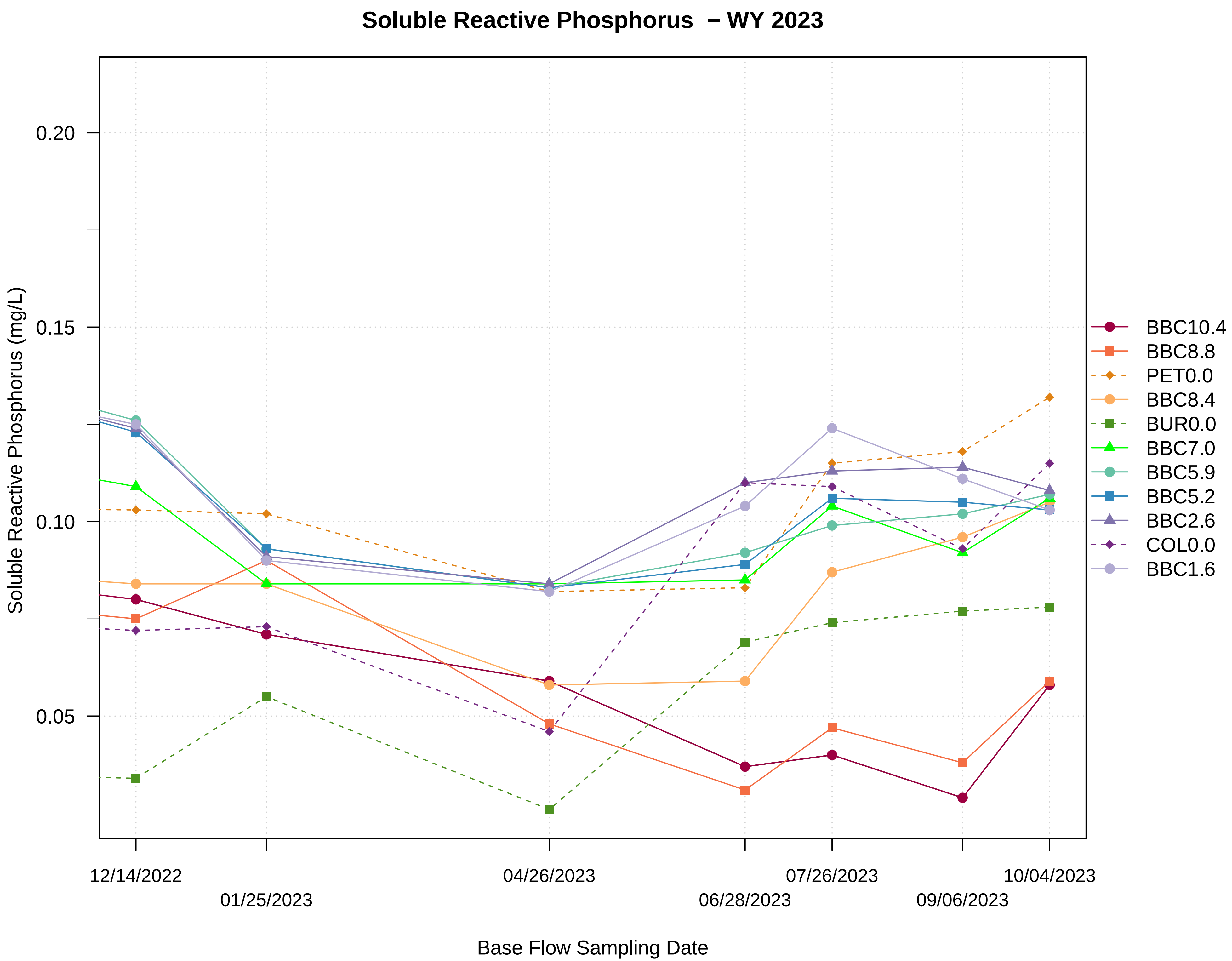
Soluble Reactive Phosphorus (mg/L)
0.05
0.10
0.15
0.20
Trib
Trib
Trib
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median



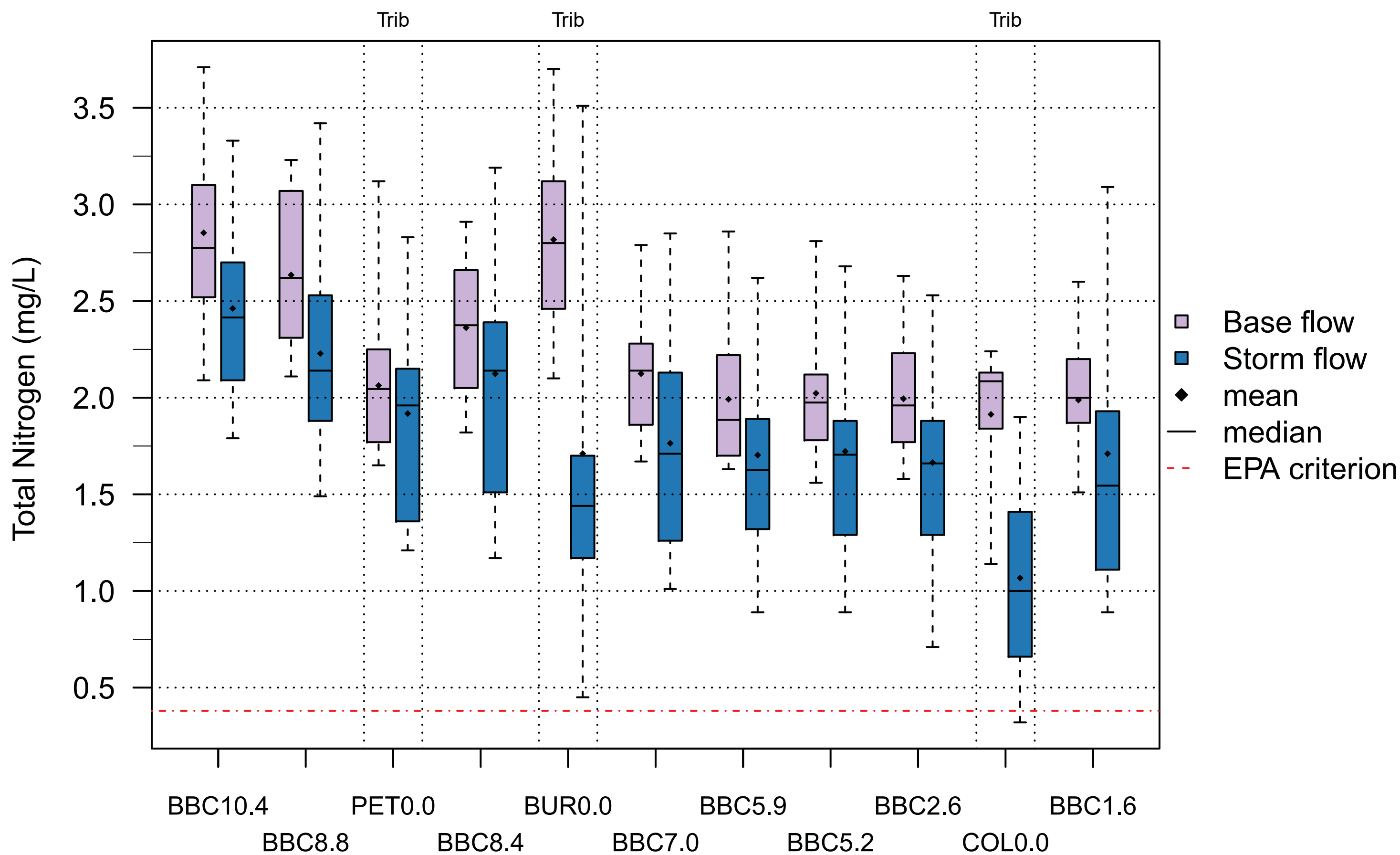
Trib
Trib
Trib
Soluble Reactive Phosphorus (mg/L)
0.20
0.15
0.10
0.05
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2011−WY2021
mean
median

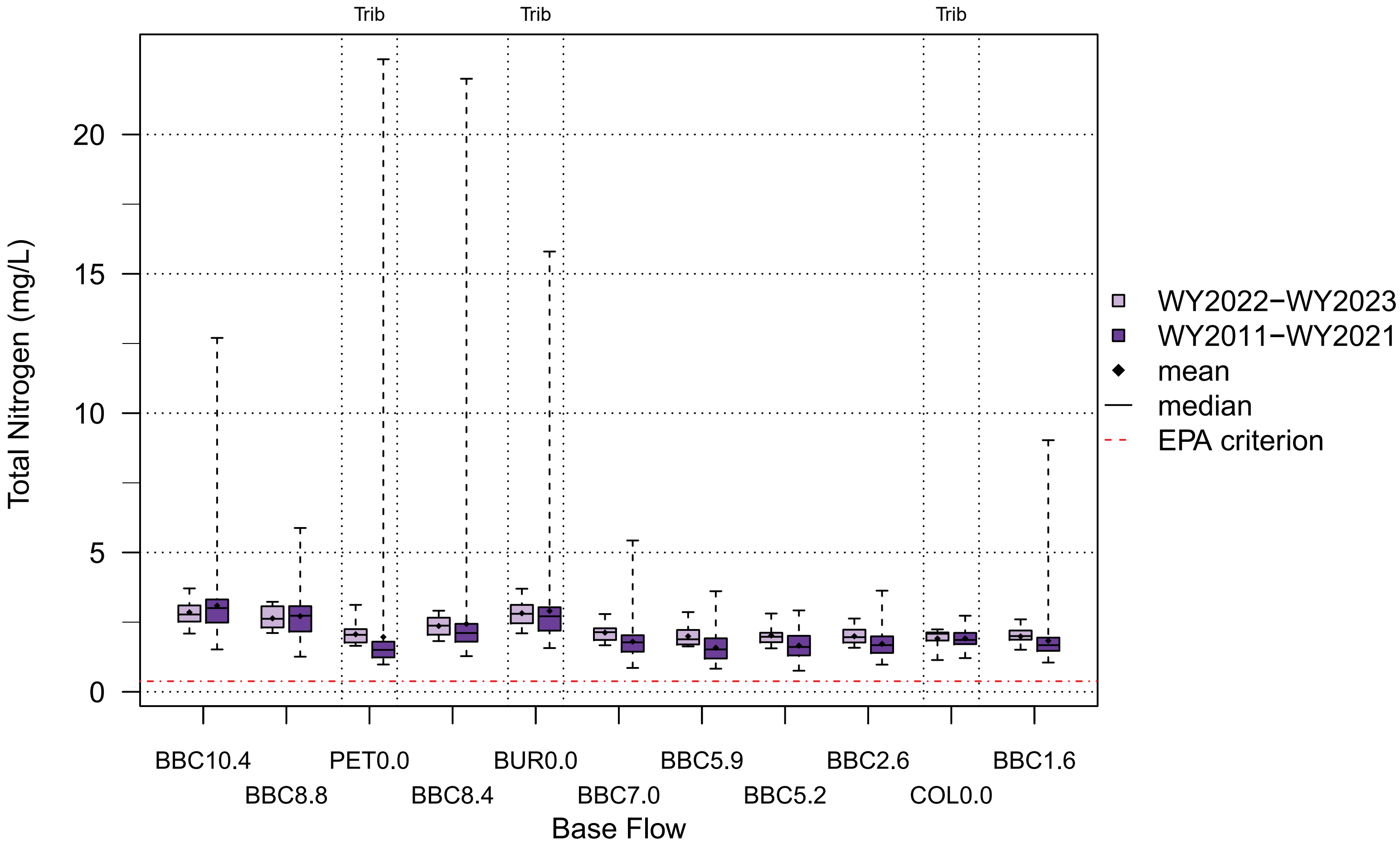


Trib
Trib
Trib
0.20
0.15
0.10
0.05
0.00
Soluble Reactive Phosphorus (mg/L)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median

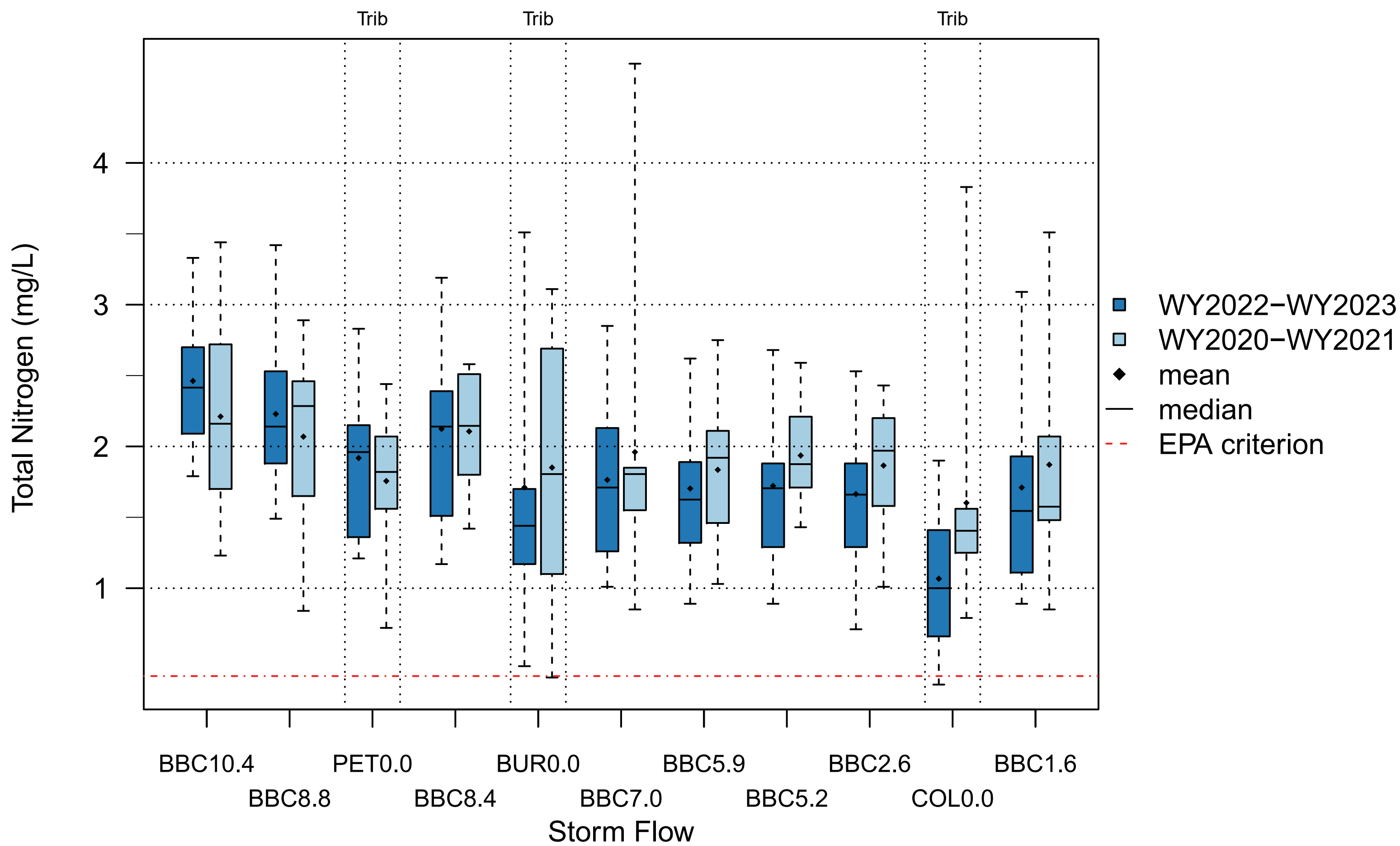


Soluble Reactive Phosphorus − WY 2023
Soluble Reactive Phosphorus (mg/L)
0.20
0.15
0.10
0.05
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

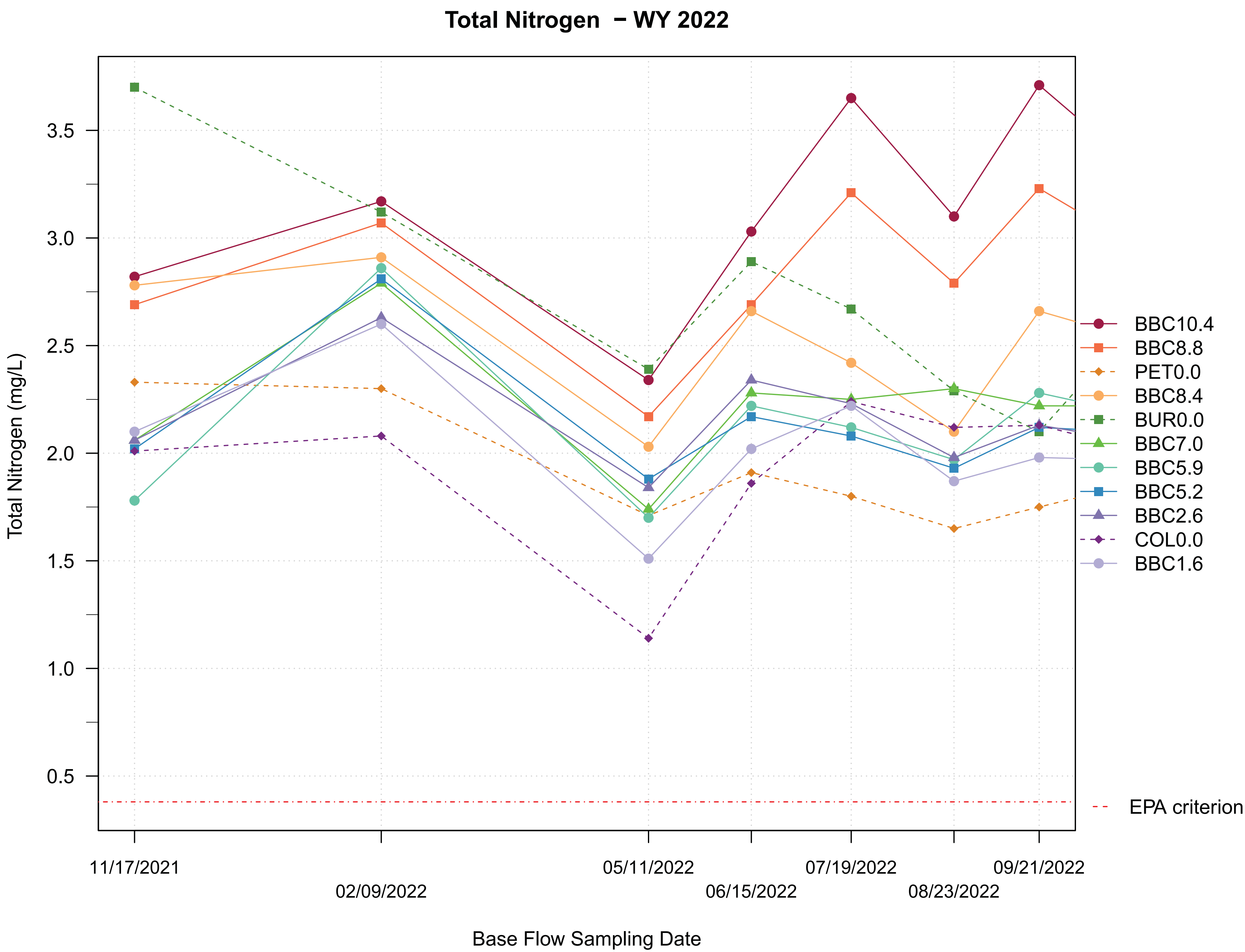

Total Nitrogen (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Trib
Trib
Trib
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median
EPA criterion

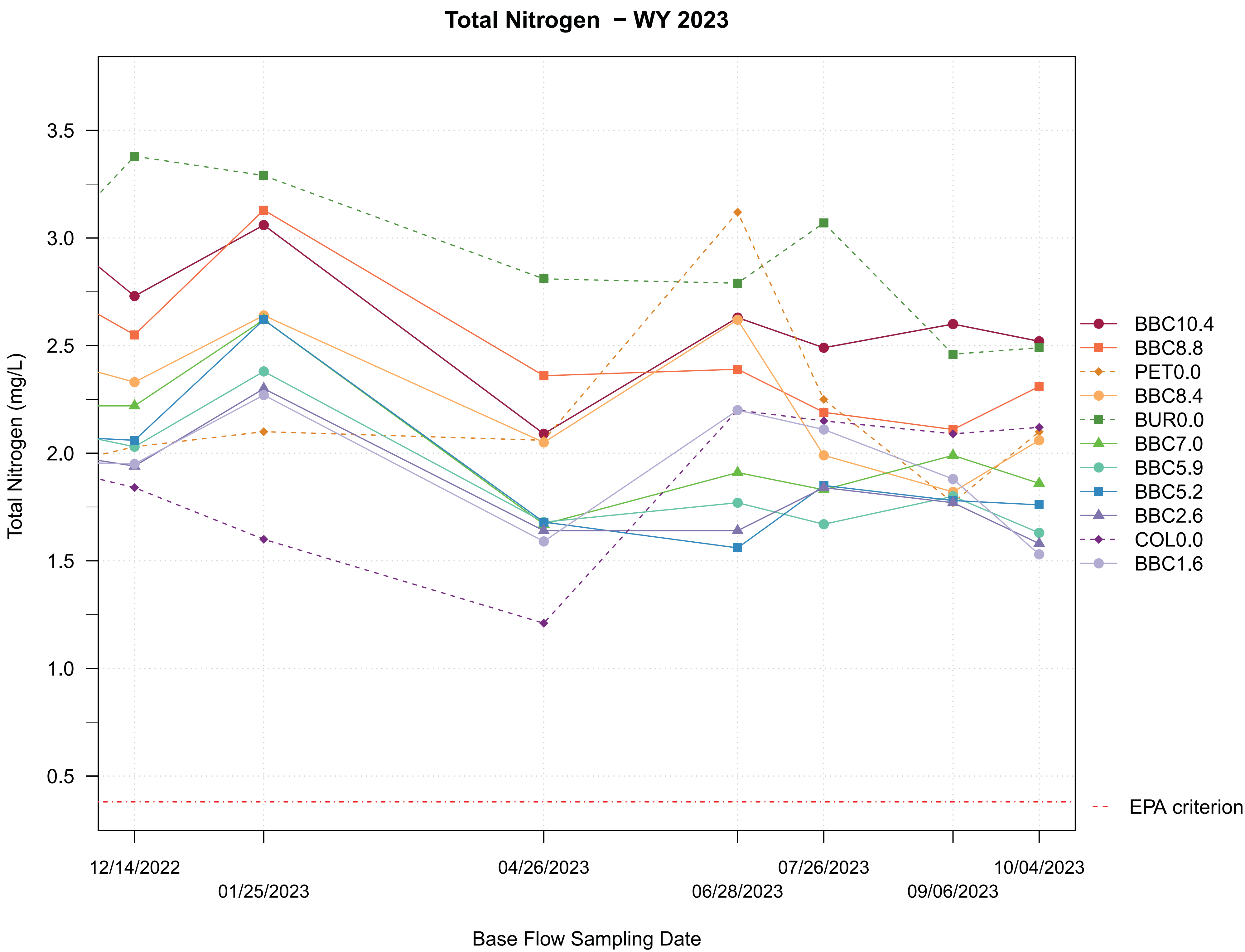


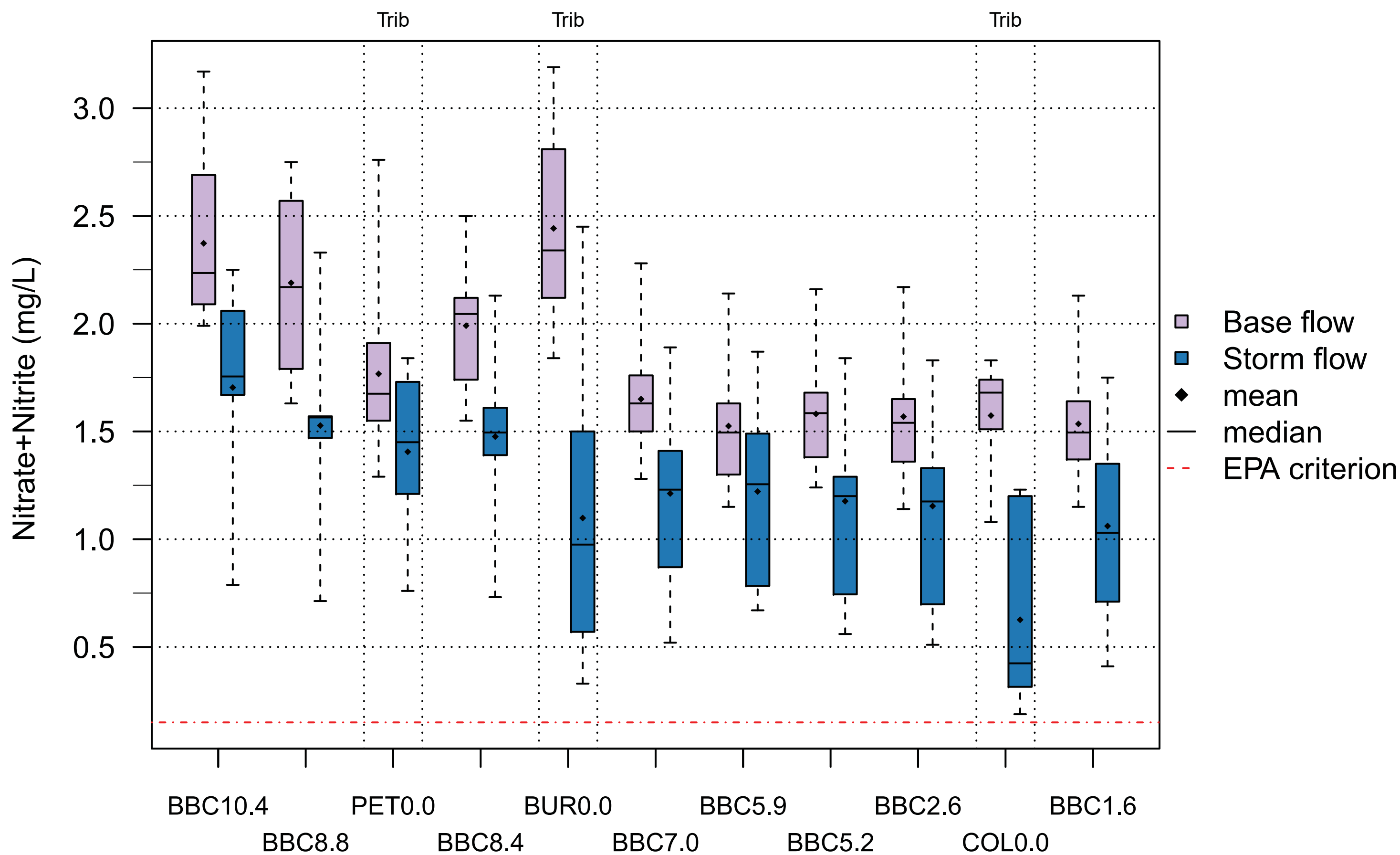
Trib
Trib
Trib
Total Nitrogen (mg/L)
20
15
10
5
0
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2011−WY2021
mean
median
EPA criterion



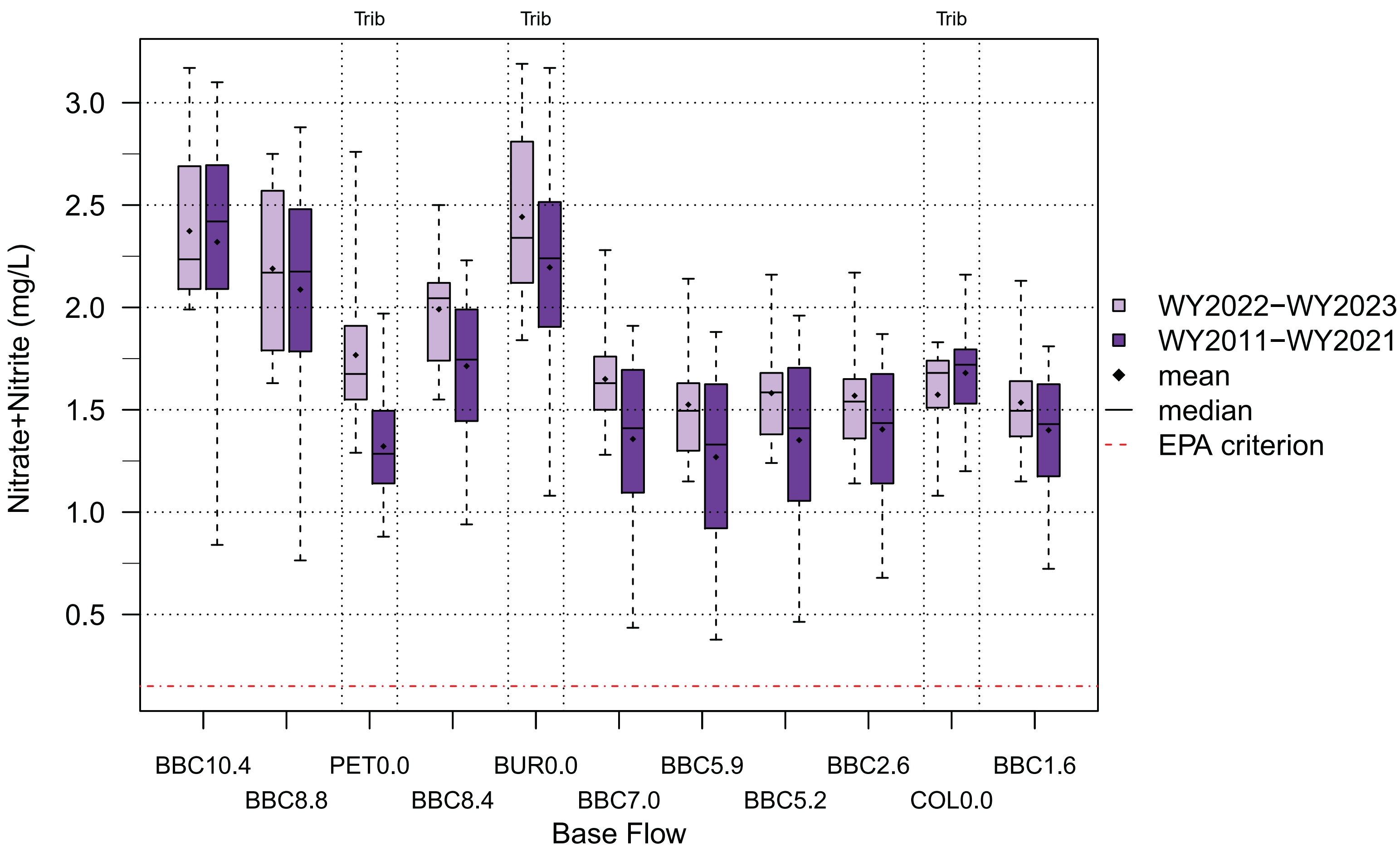
Trib
Trib
Trib
Total Nitrogen (mg/L)
4
3
2
1
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median
EPA criterion


Total Nitrogen − WY 2022
Total Nitrogen (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
EPA criterion

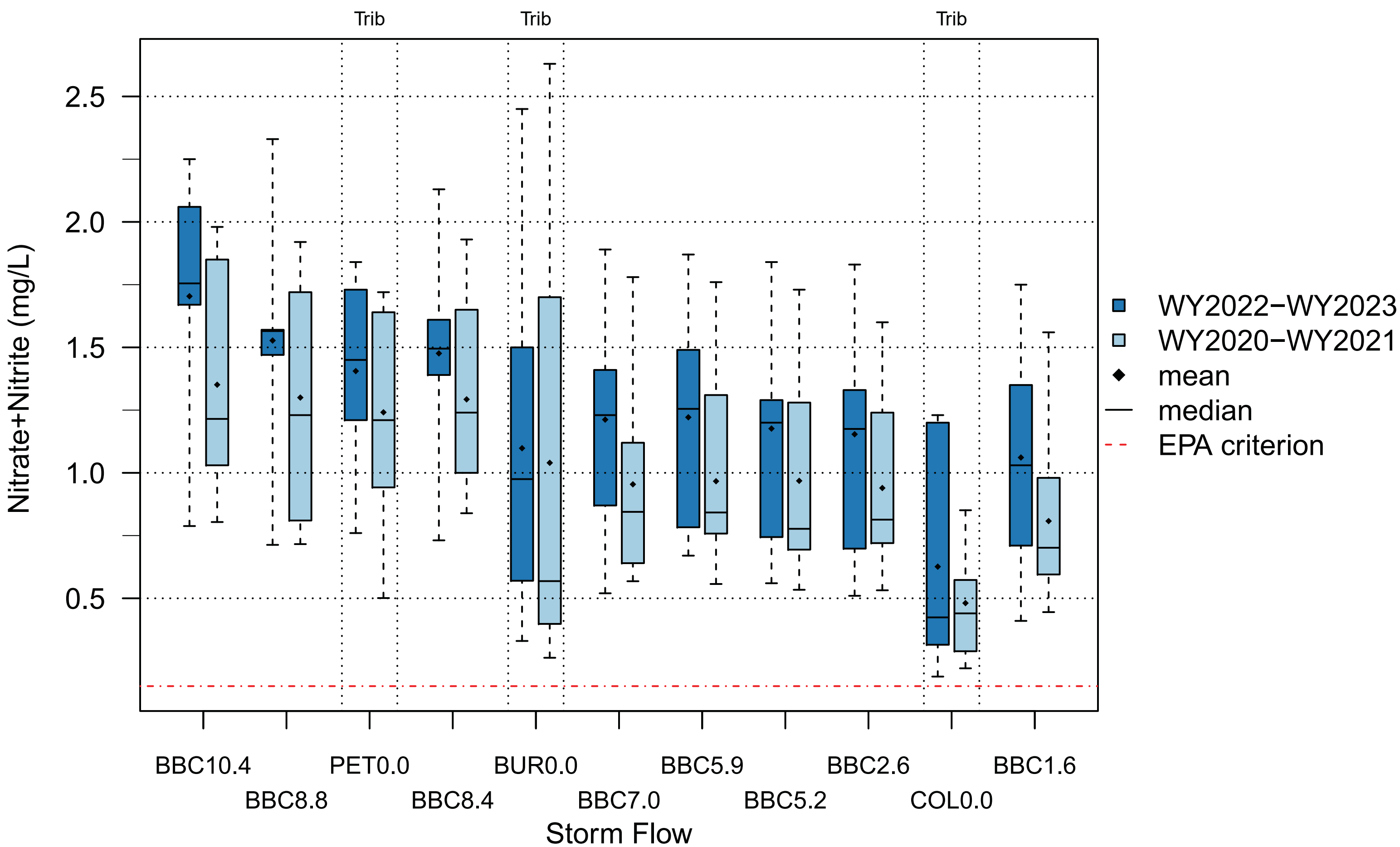

Total Nitrogen − WY 2023
Total Nitrogen (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
EPA criterion



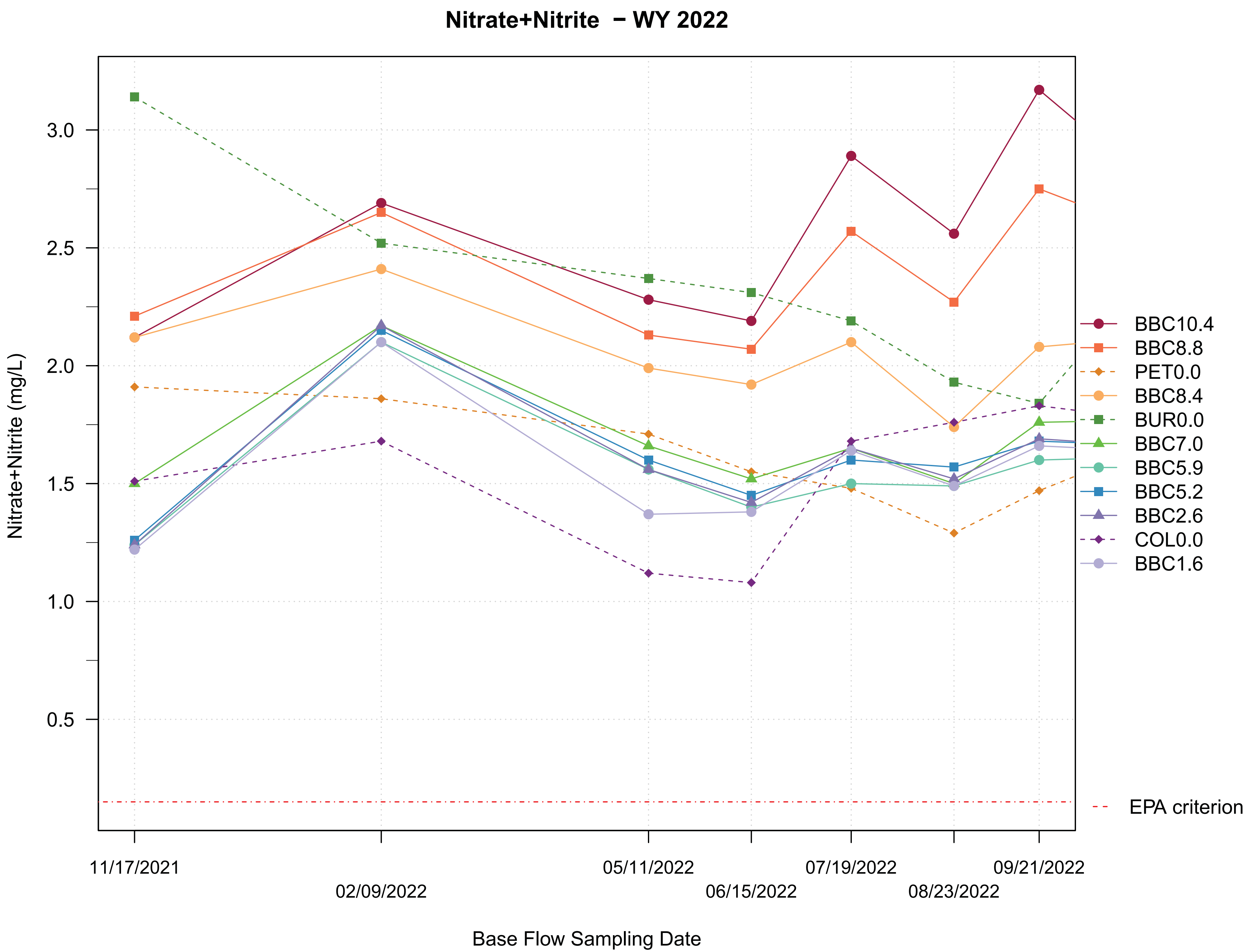
Trib
Trib
Trib
Nitrate+Nitrite (mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median
EPA criterion

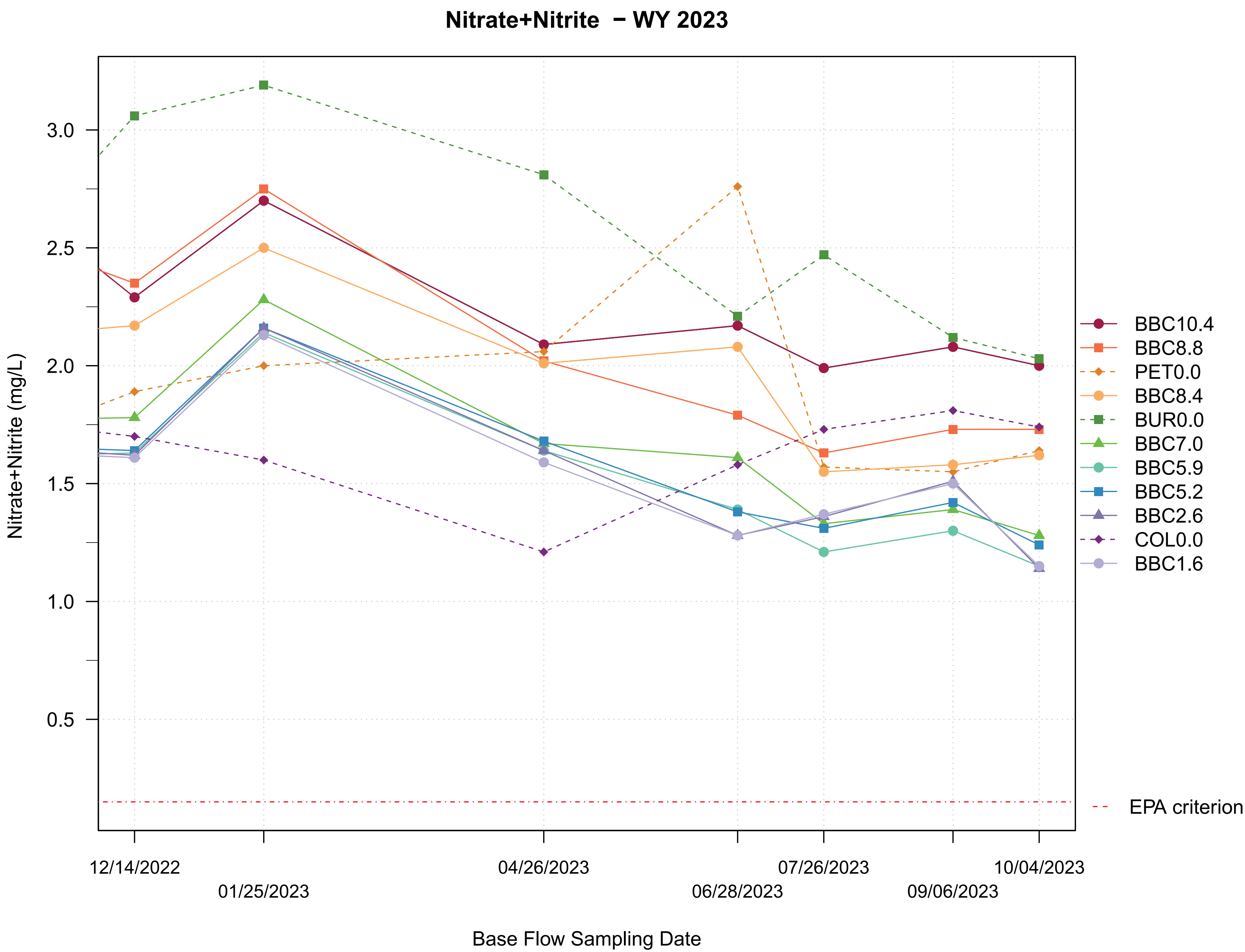


Trib
Trib
Trib
Nitrate+Nitrite (mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2011−WY2021
mean
median
EPA criterion

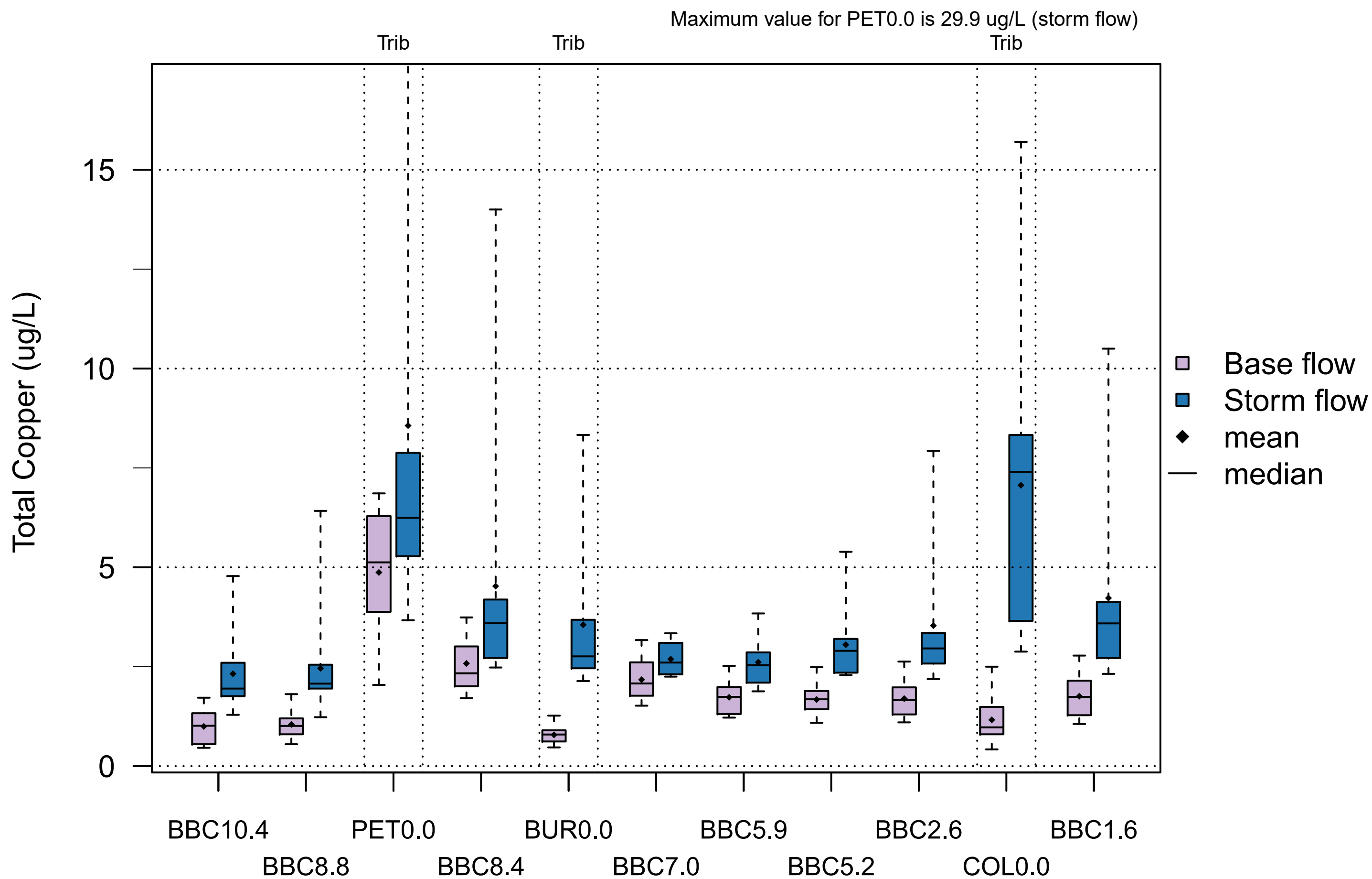


Trib
Trib
Trib
Nitrate+Nitrite (mg/L)
2.5
2.0
1.5
1.0
0.5
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median
EPA criterion

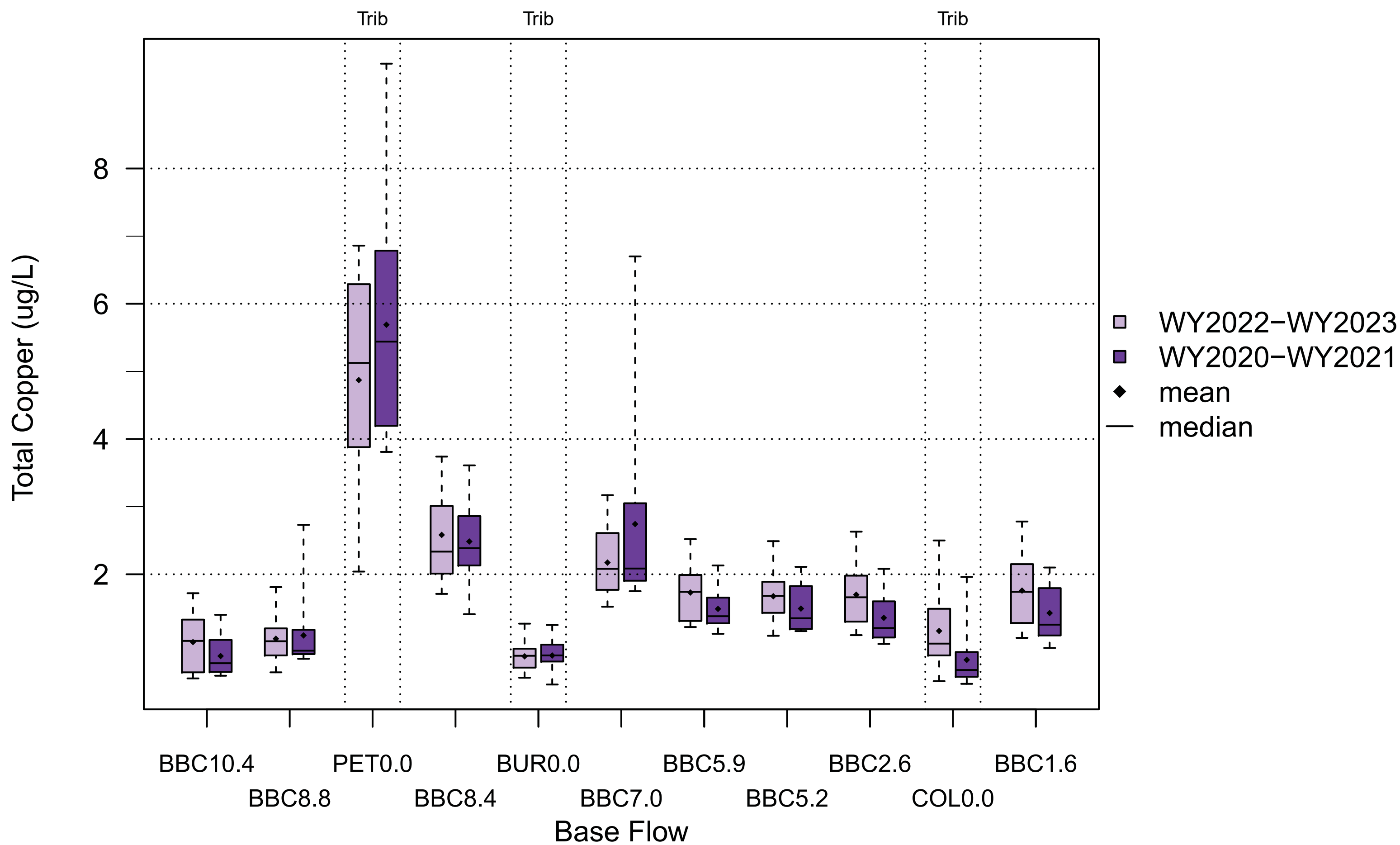

Nitrate+Nitrite − WY 2022
Nitrate+Nitrite (mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
EPA criterion



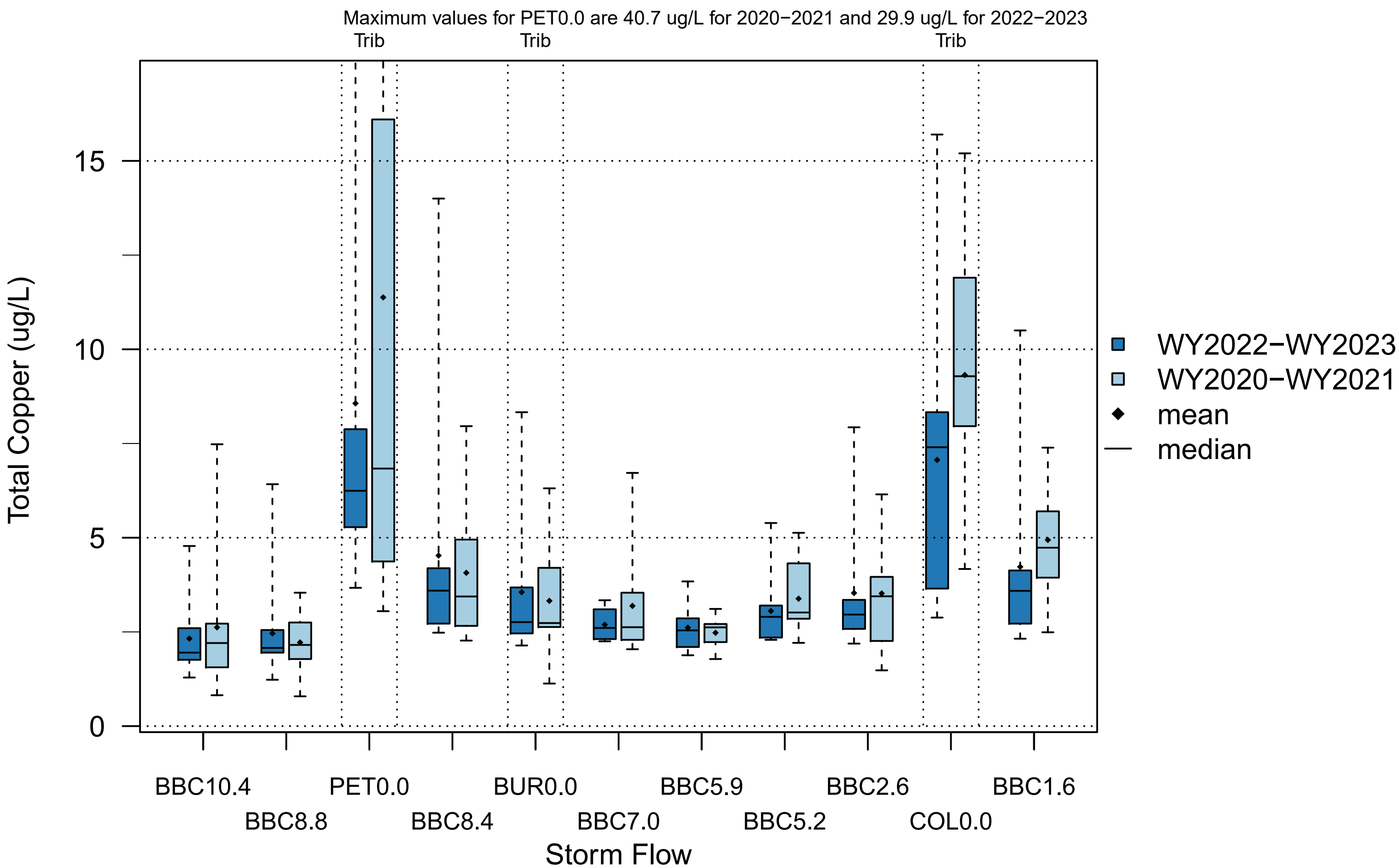
Nitrate+Nitrite − WY 2023
Nitrate+Nitrite (mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
EPA criterion



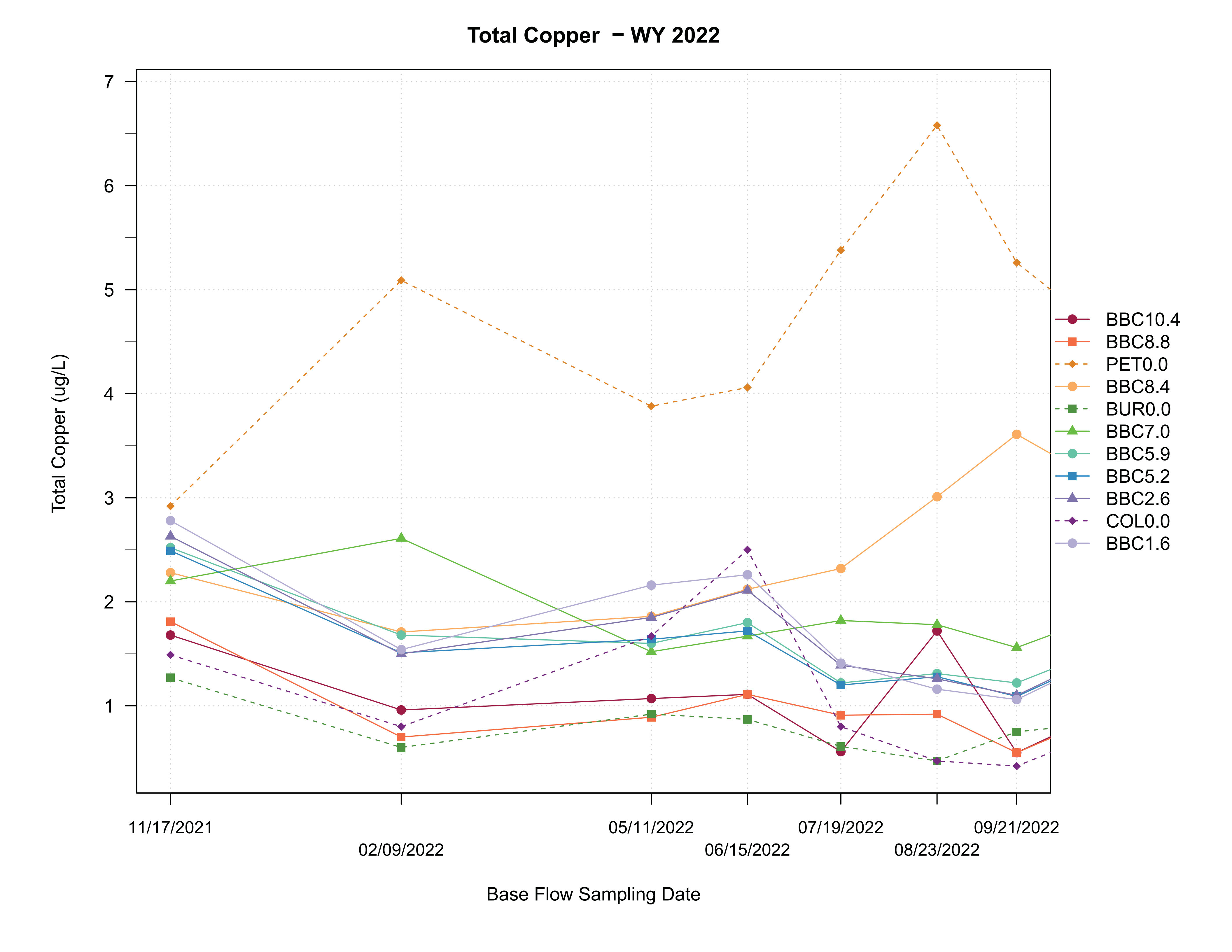
Maximum value for PET0.0 is 29.9 ug/L (storm flow)
Trib
Trib
Trib
Total Copper (ug/L)
0
5
10
15
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median

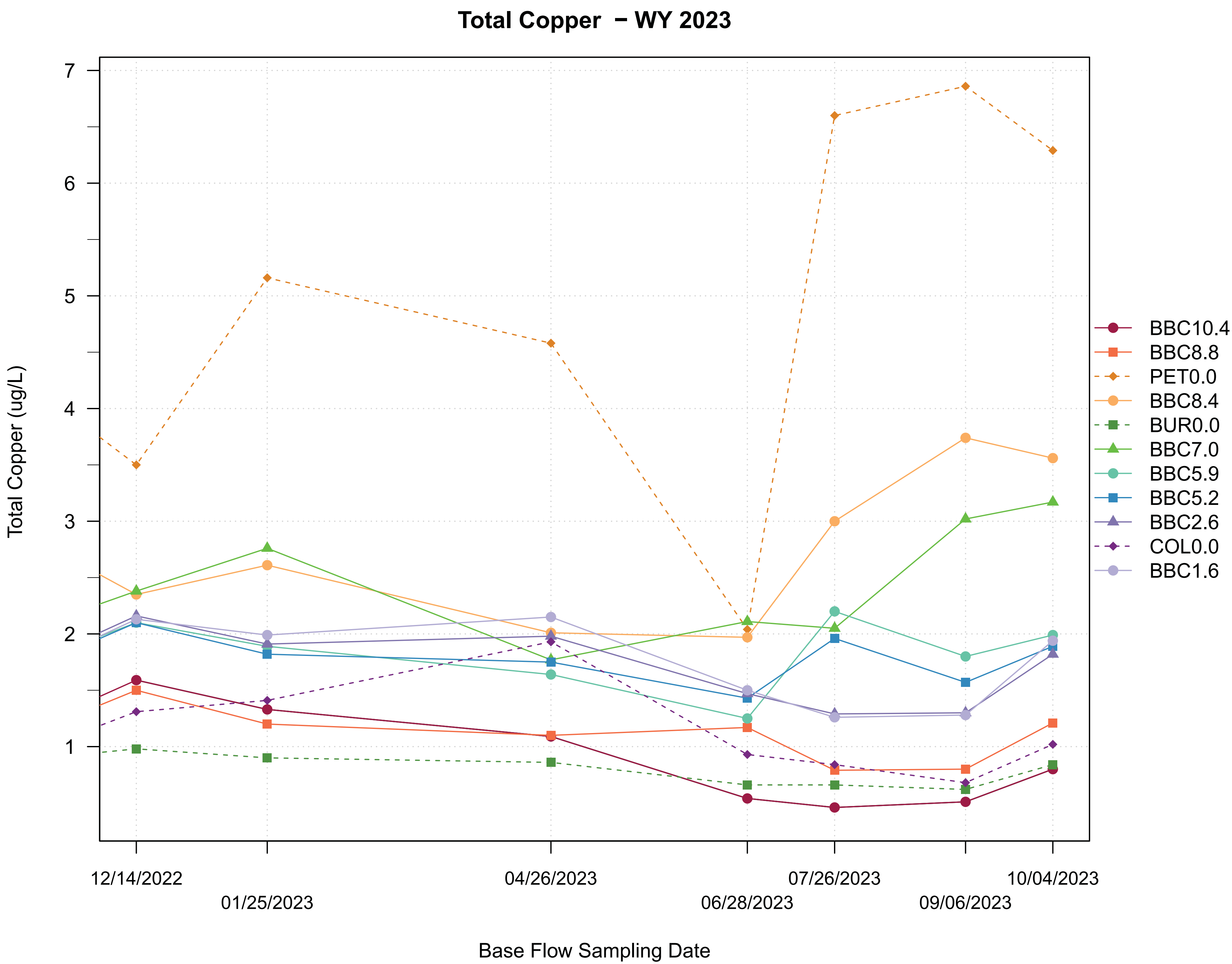


Trib
Trib
Trib
Total Copper (ug/L)
8
6
4
2
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2020−WY2021
mean
median

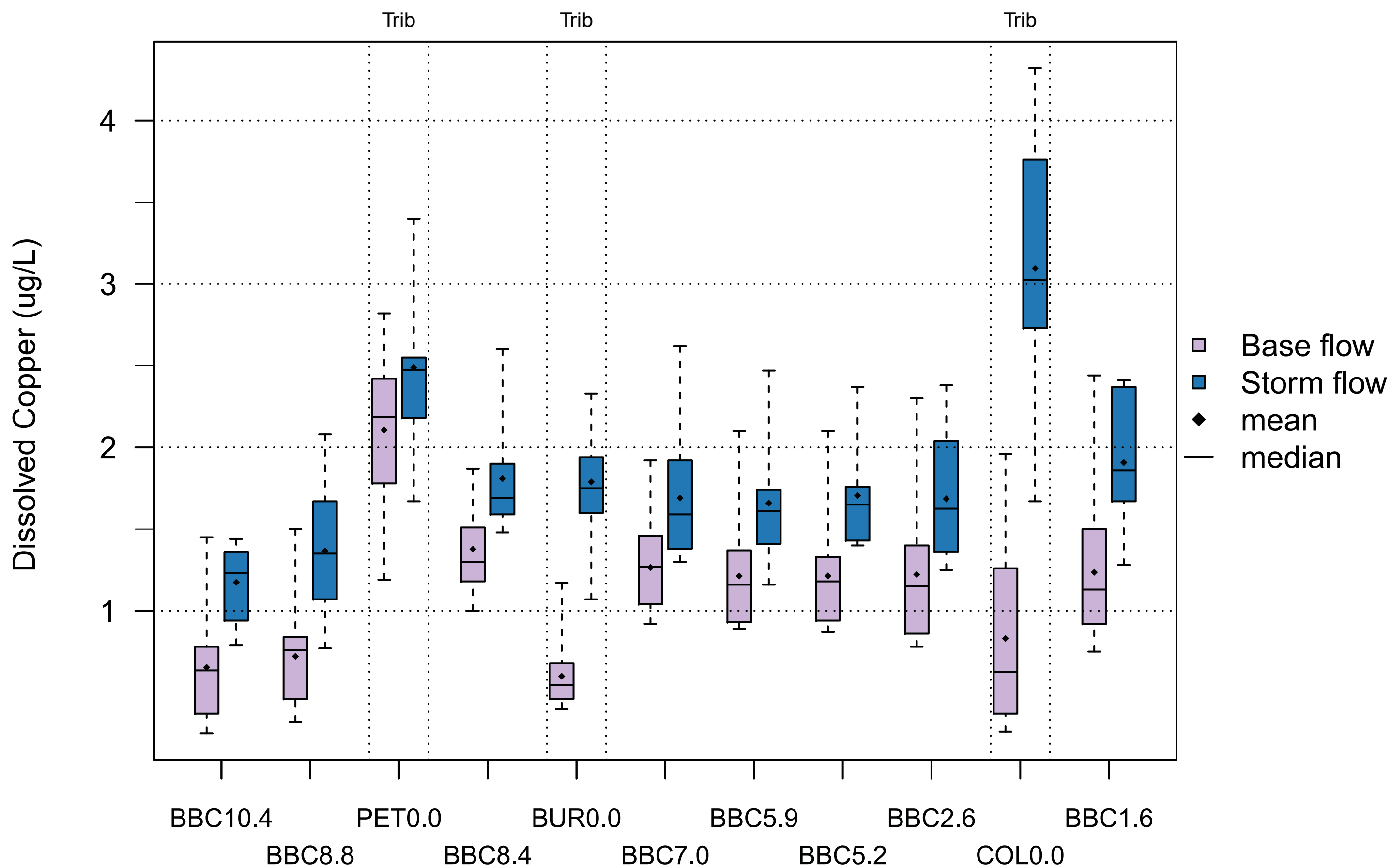


Maximum values for PET0.0 are 40.7 ug/L for 2020−2021 and 29.9 ug/L for 2022−2023
Trib
Trib
Trib
Total Copper (ug/L)
0
5
10
15
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median

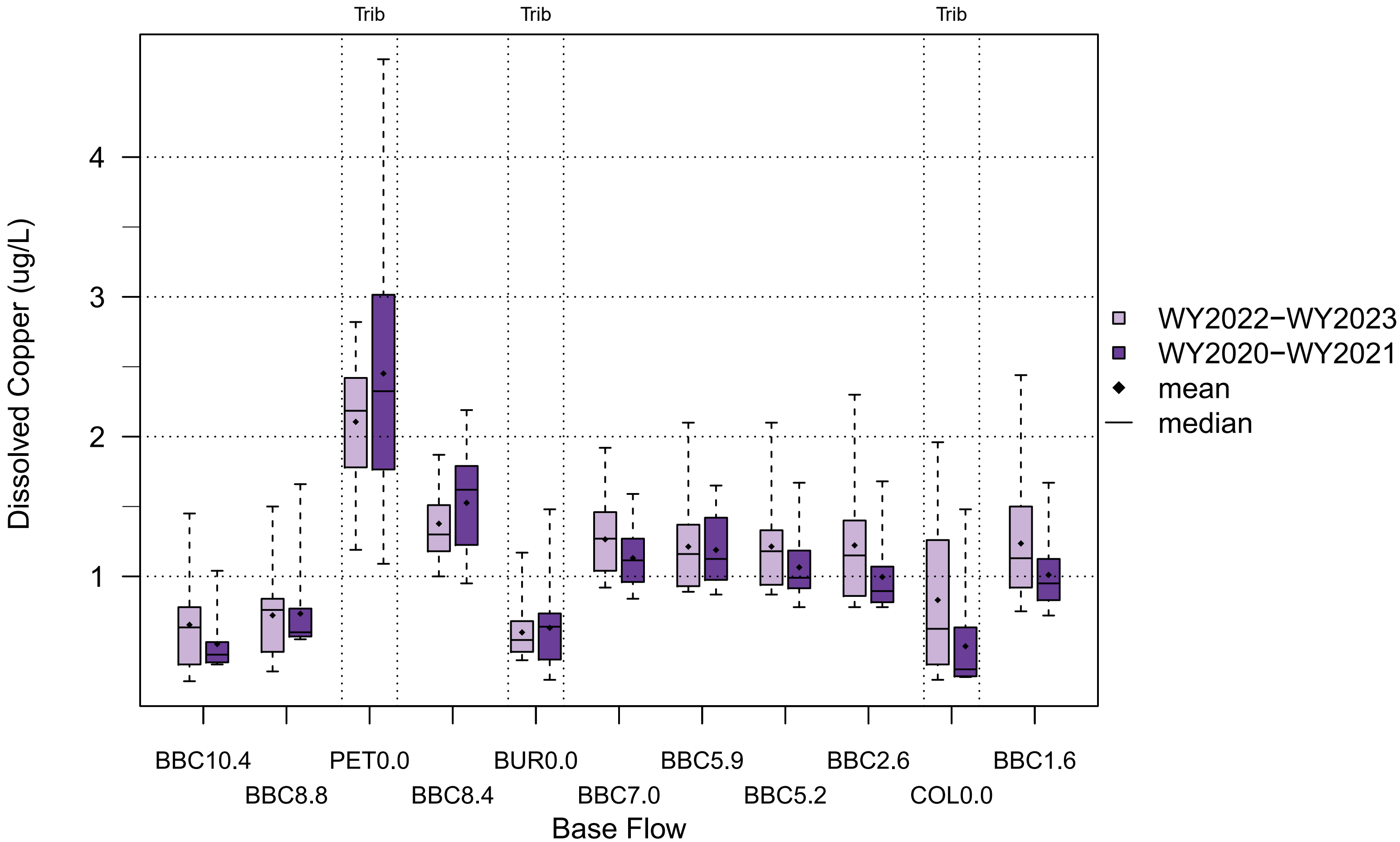

Total Copper − WY 2022
Total Copper (ug/L)
7
6
5
4
3
2
1
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6



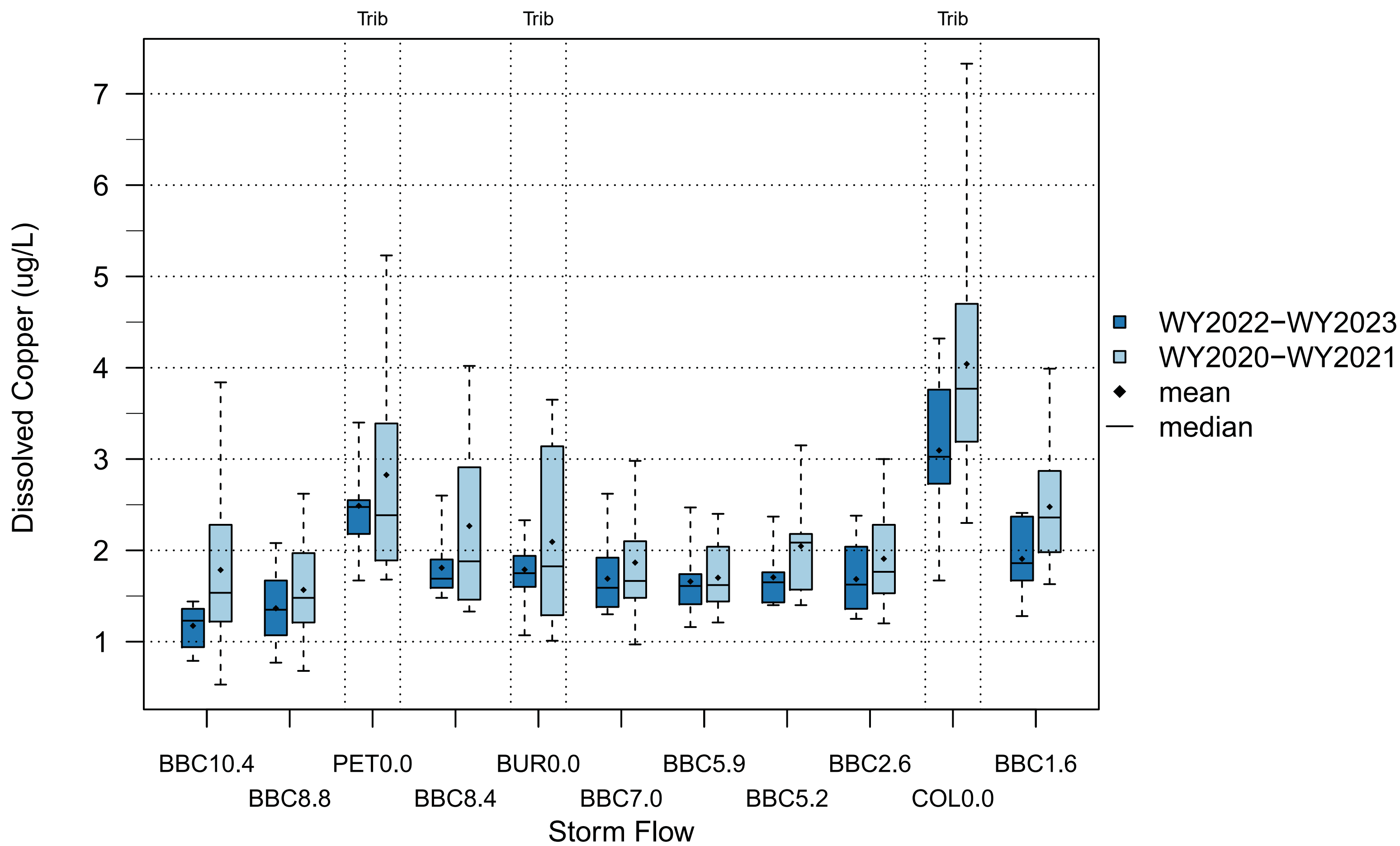
Total Copper − WY 2023
Total Copper (ug/L)
7
6
5
4
3
2
1
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6



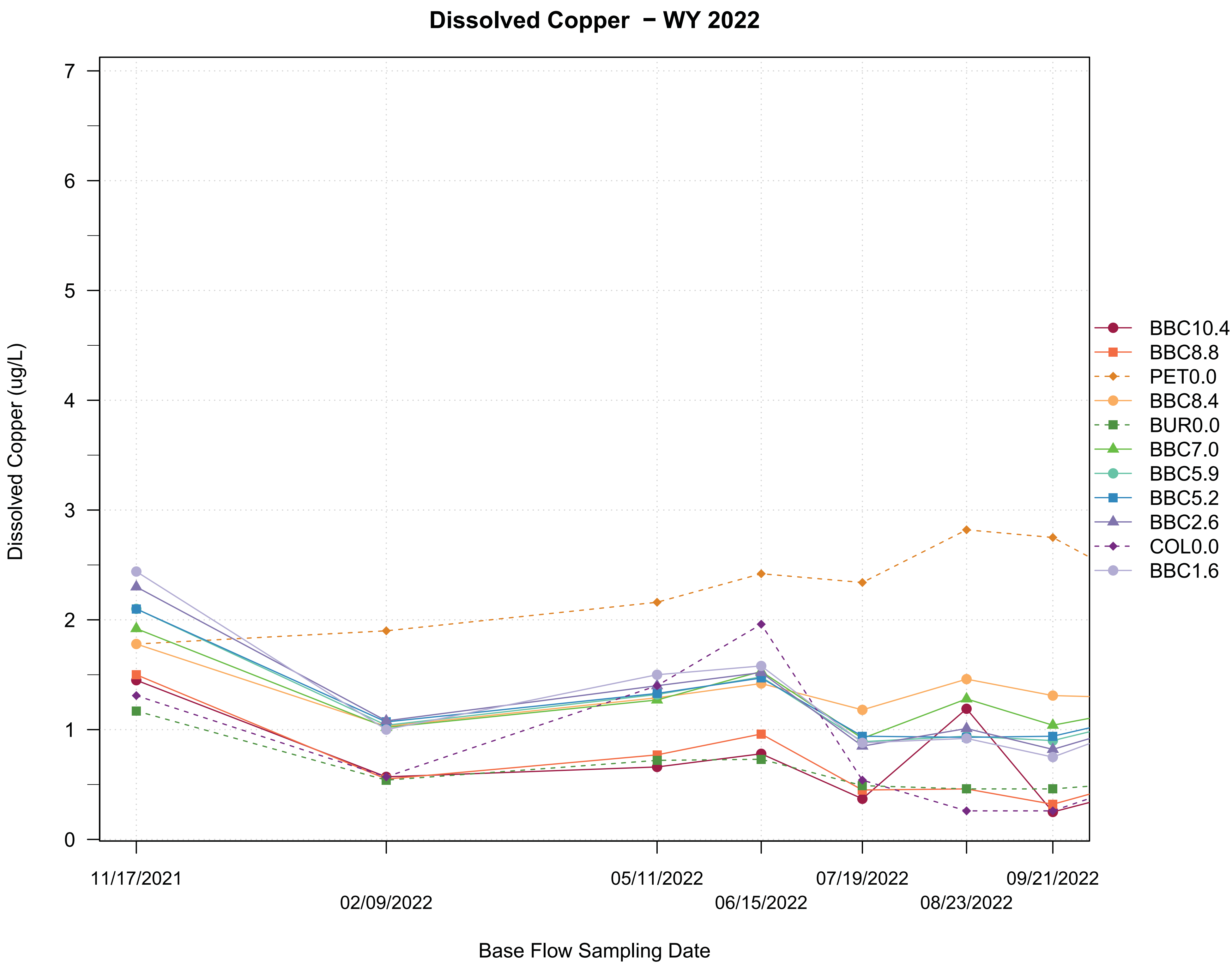
Trib
Trib
Trib
Dissolved Copper (ug/L)
4
3
2
1
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median



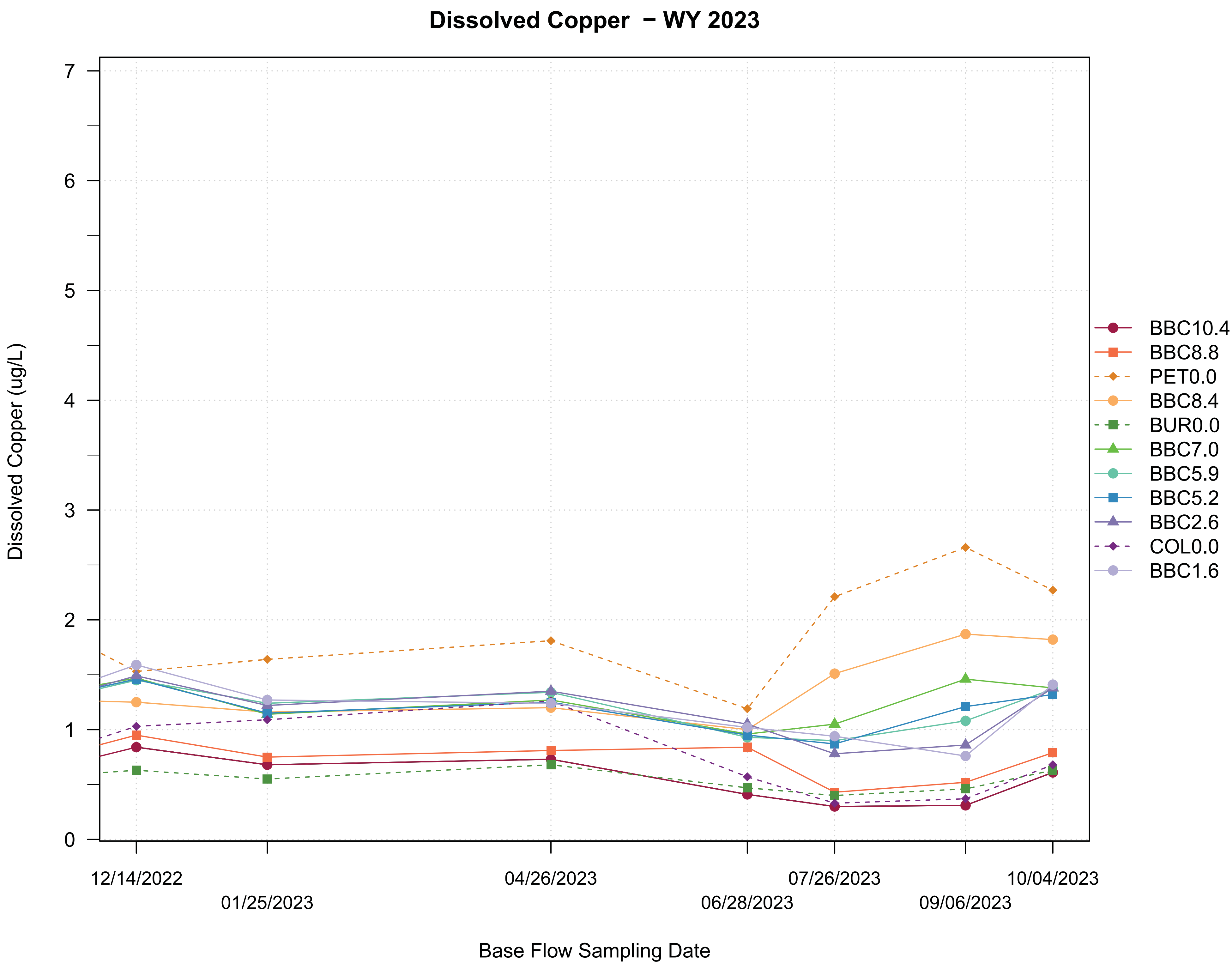
Trib
Trib
Trib
Dissolved Copper (ug/L)
4
3
2
1
WY2022−WY2023
WY2020−WY2021
mean
median
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow

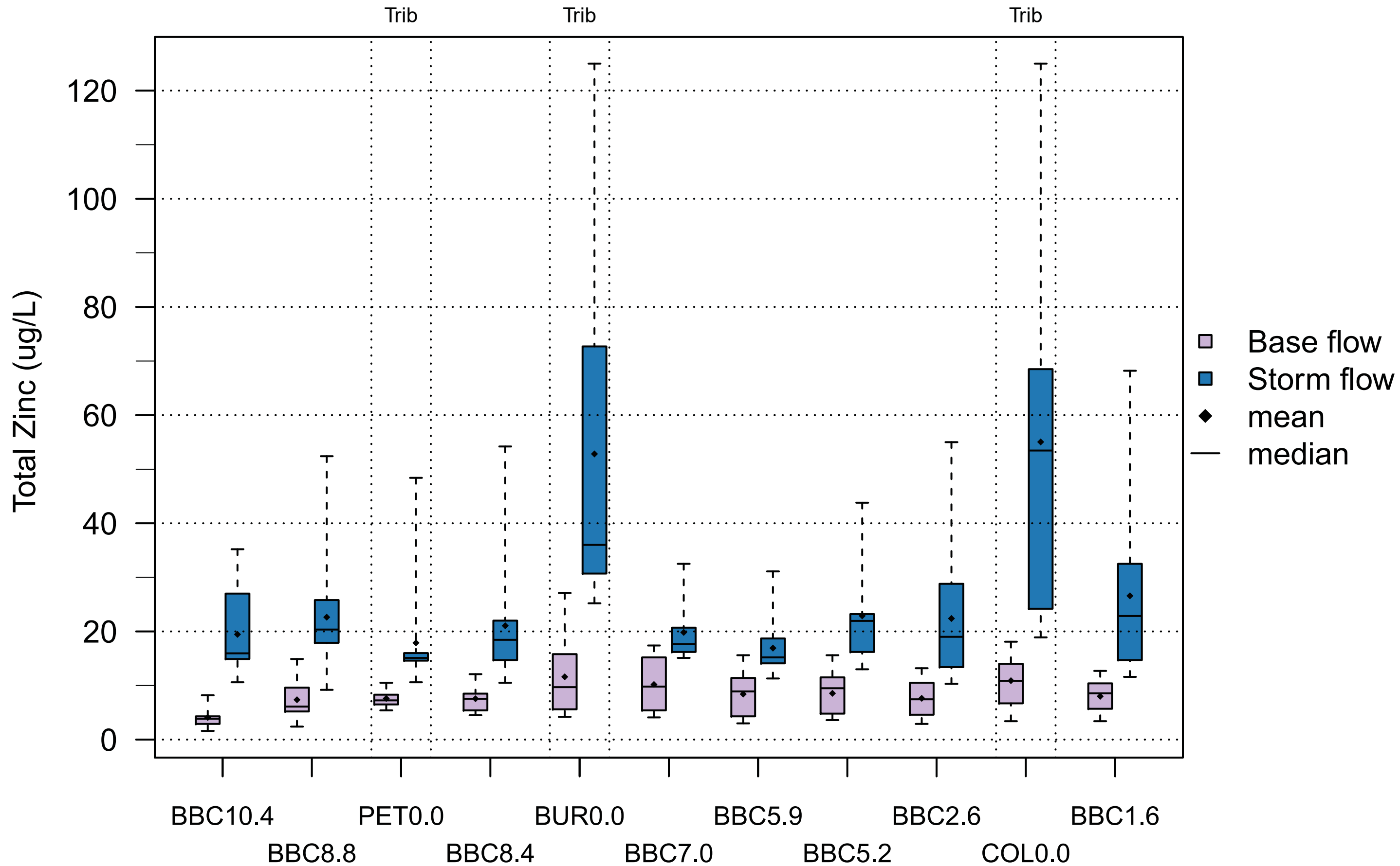


Trib
Trib
Trib
Dissolved Copper (ug/L)
7
6
5
4
3
2
1
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median

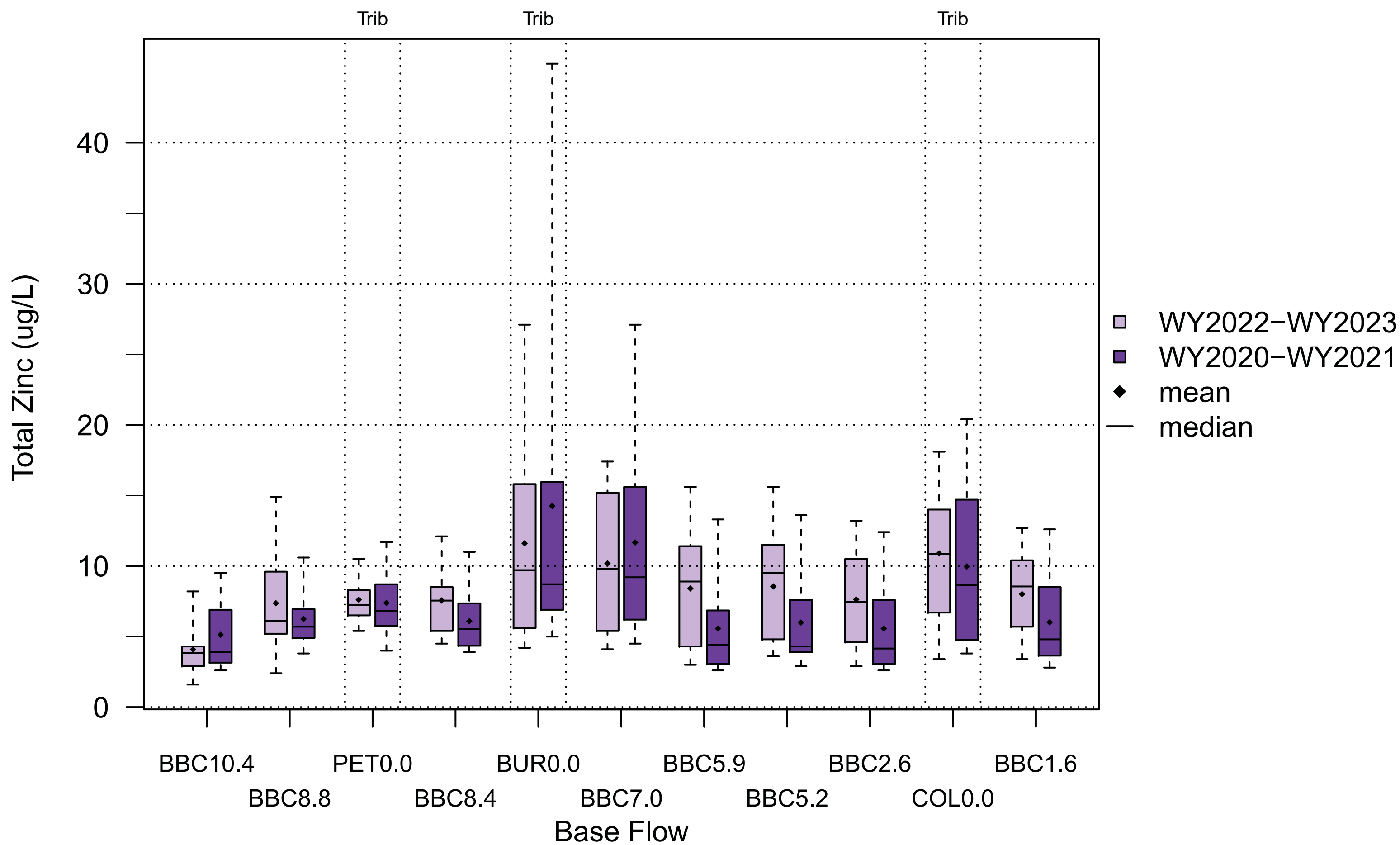


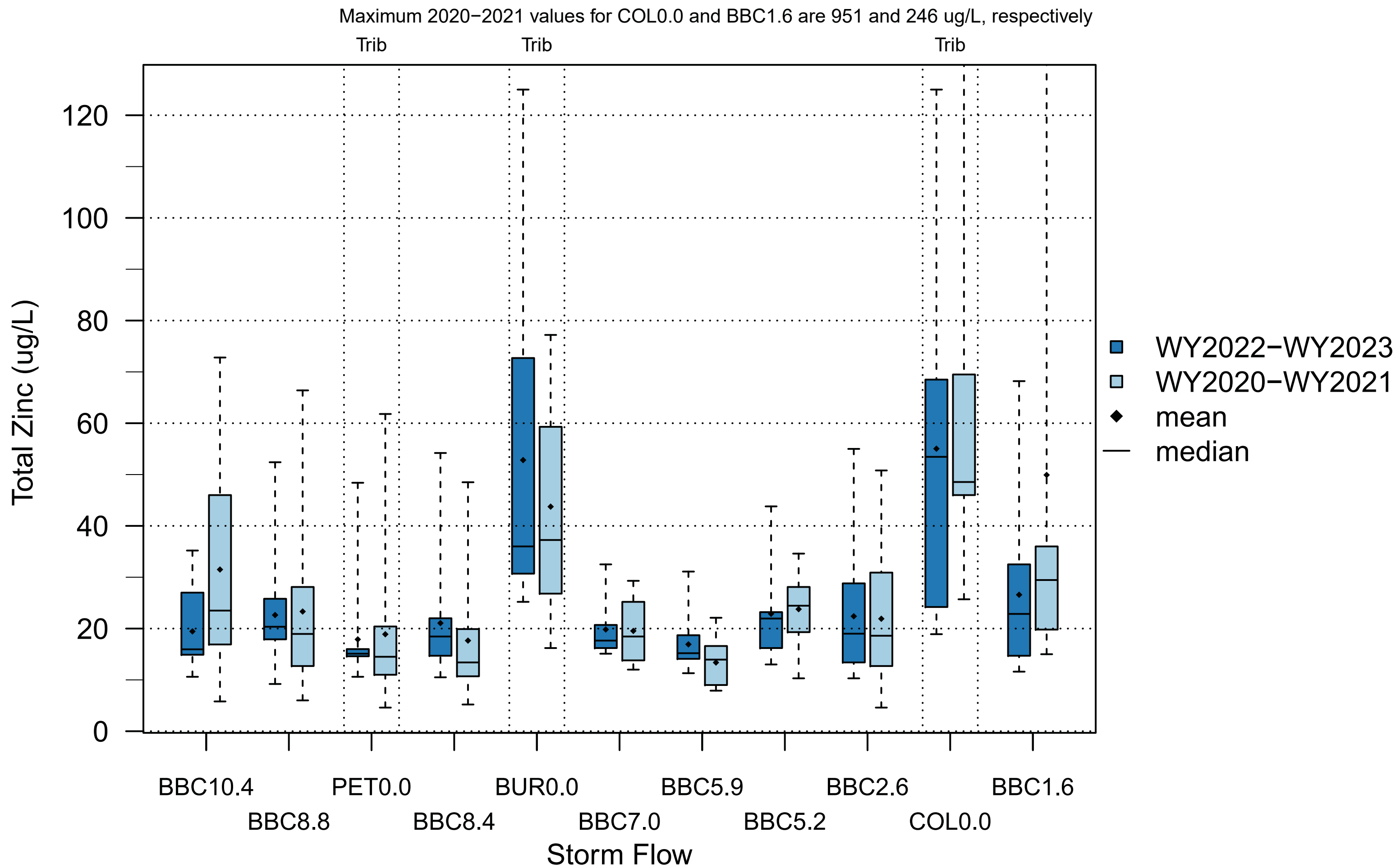
Dissolved Copper − WY 2022
Dissolved Copper (ug/L)
0
1
2
3
4
5
6
7
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6


Dissolved Copper − WY 2023
Dissolved Copper (ug/L)
0
1
2
3
4
5
6
7
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

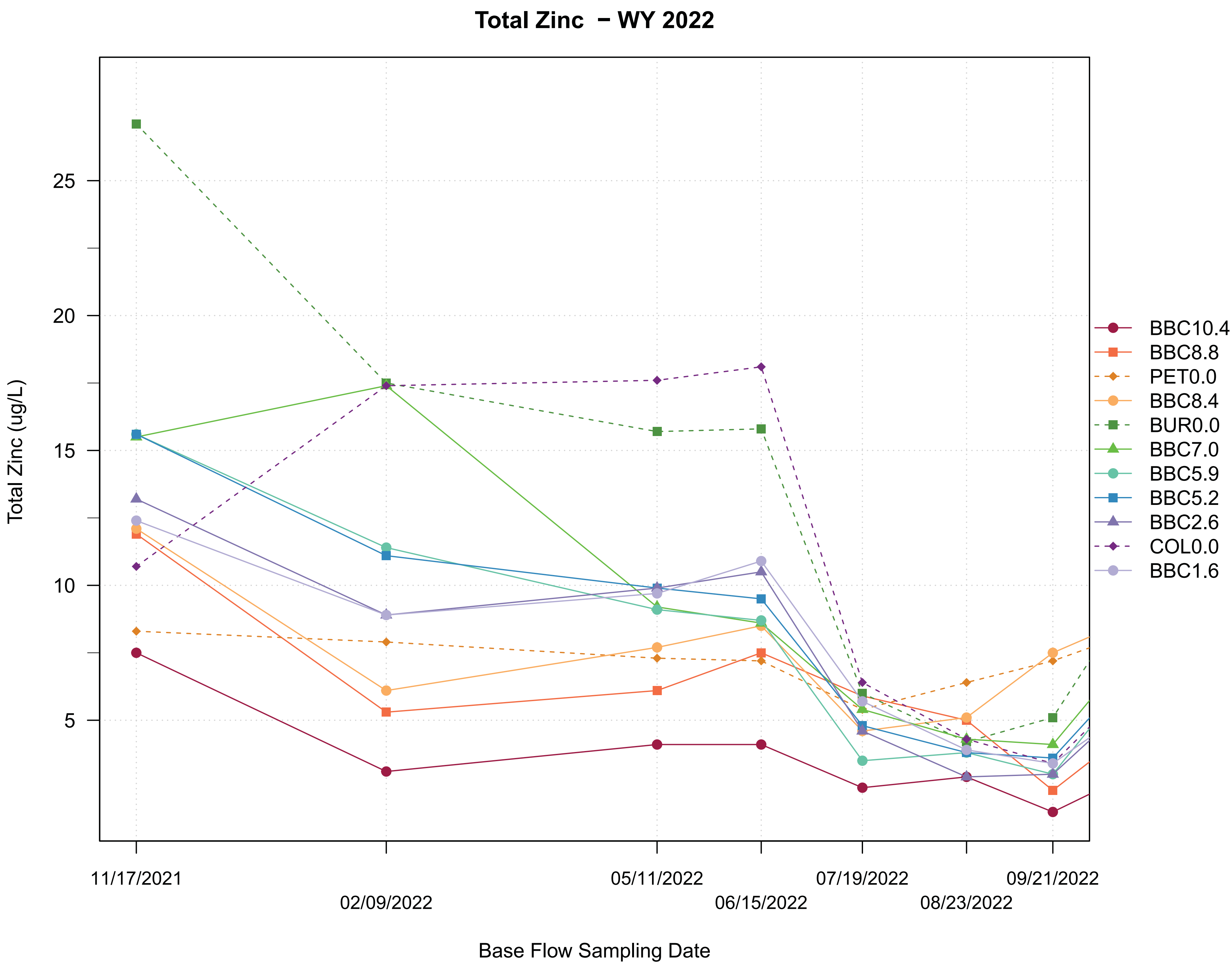


Trib
Trib
Trib
120
100
80
60
40
20
0
Total Zinc (ug/L)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median

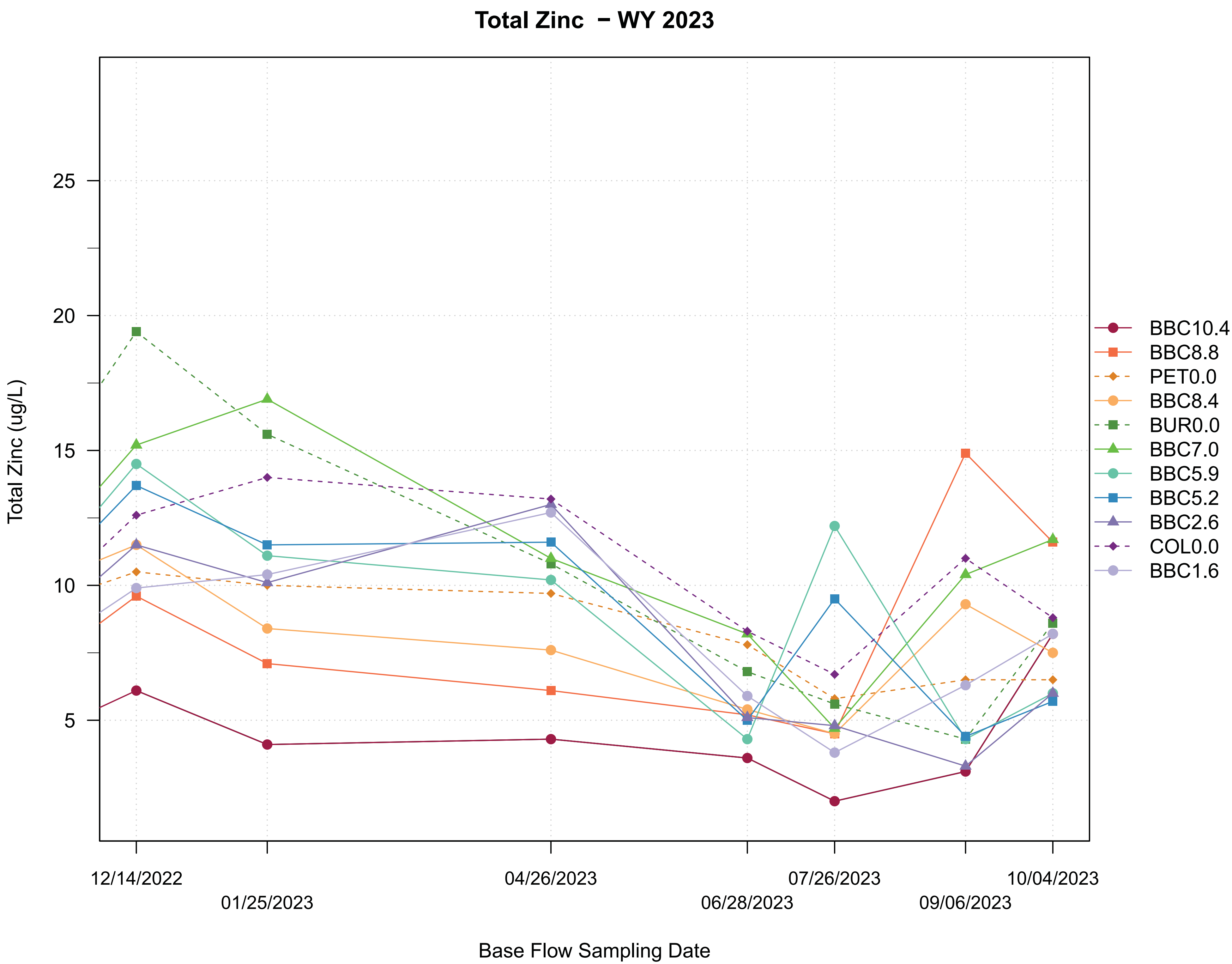

Trib
Trib
Trib
Total Zinc (ug/L)
0
10
20
30
40
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2020−WY2021
mean
median

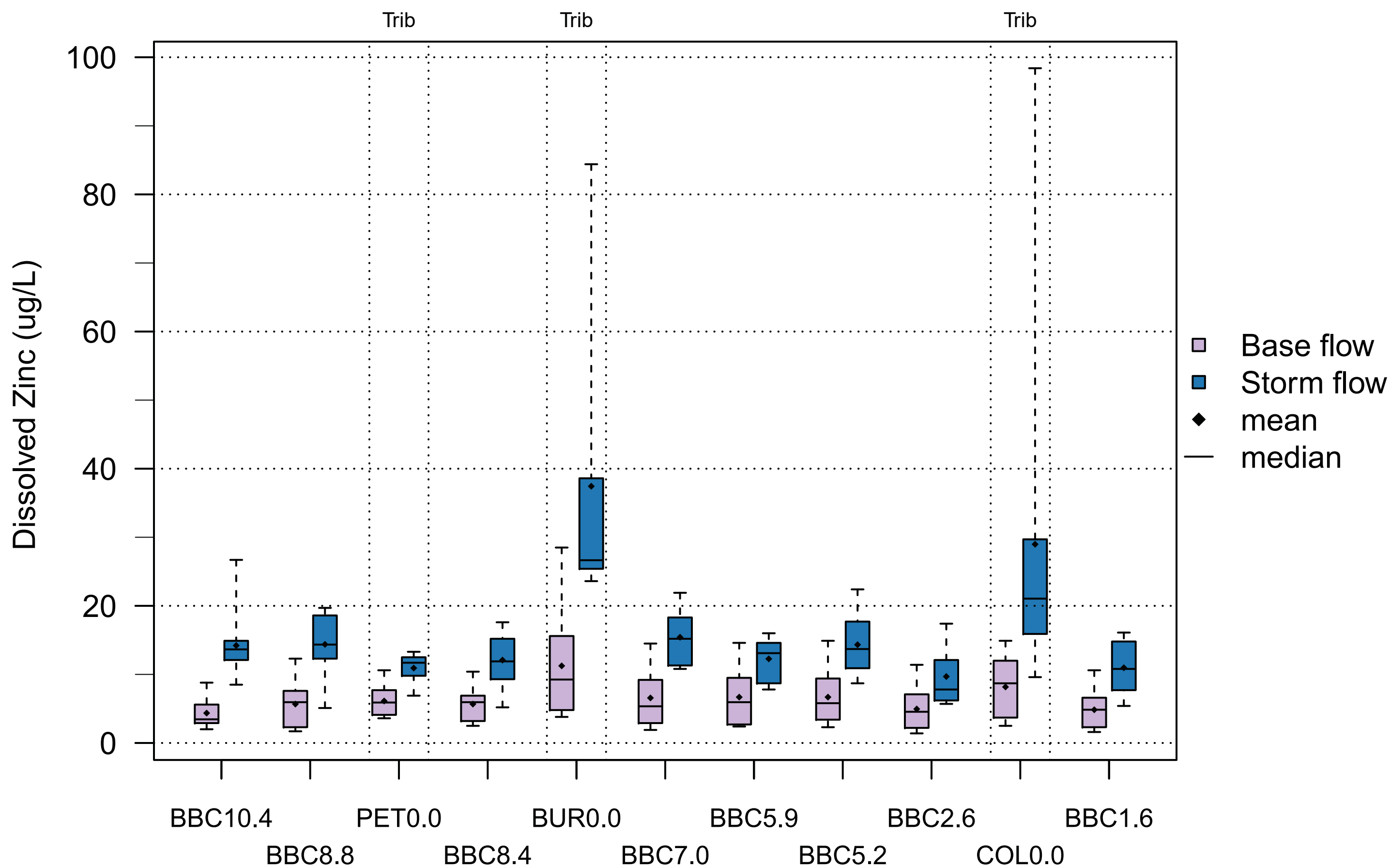


Maximum 2020−2021 values for COL0.0 and BBC1.6 are 951 and 246 ug/L, respectively
Trib
Trib
Trib
Total Zinc (ug/L)
0
20
40
60
80
100
120
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median

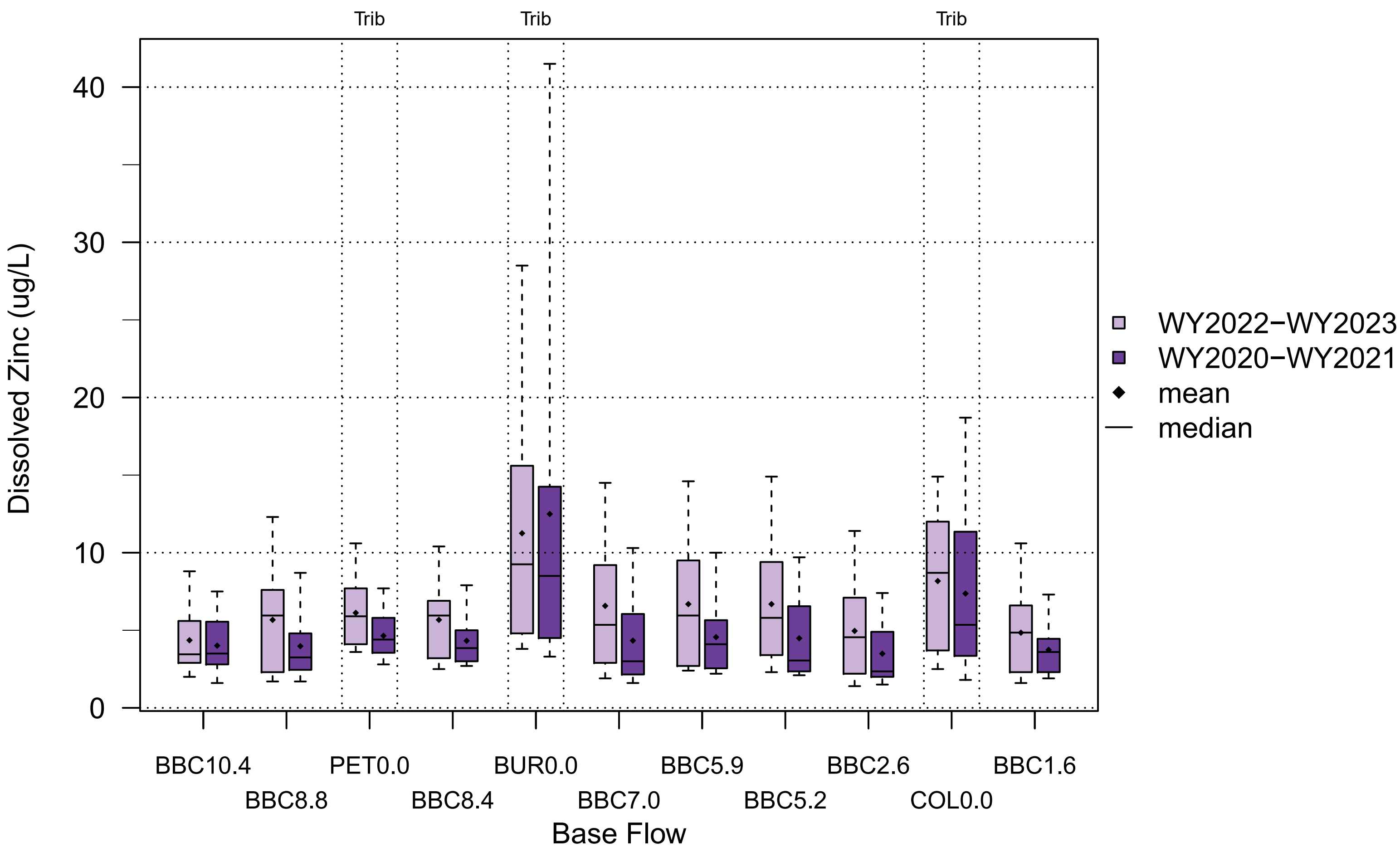


Total Zinc − WY 2022
Total Zinc (ug/L)
25
20
15
10
5
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6

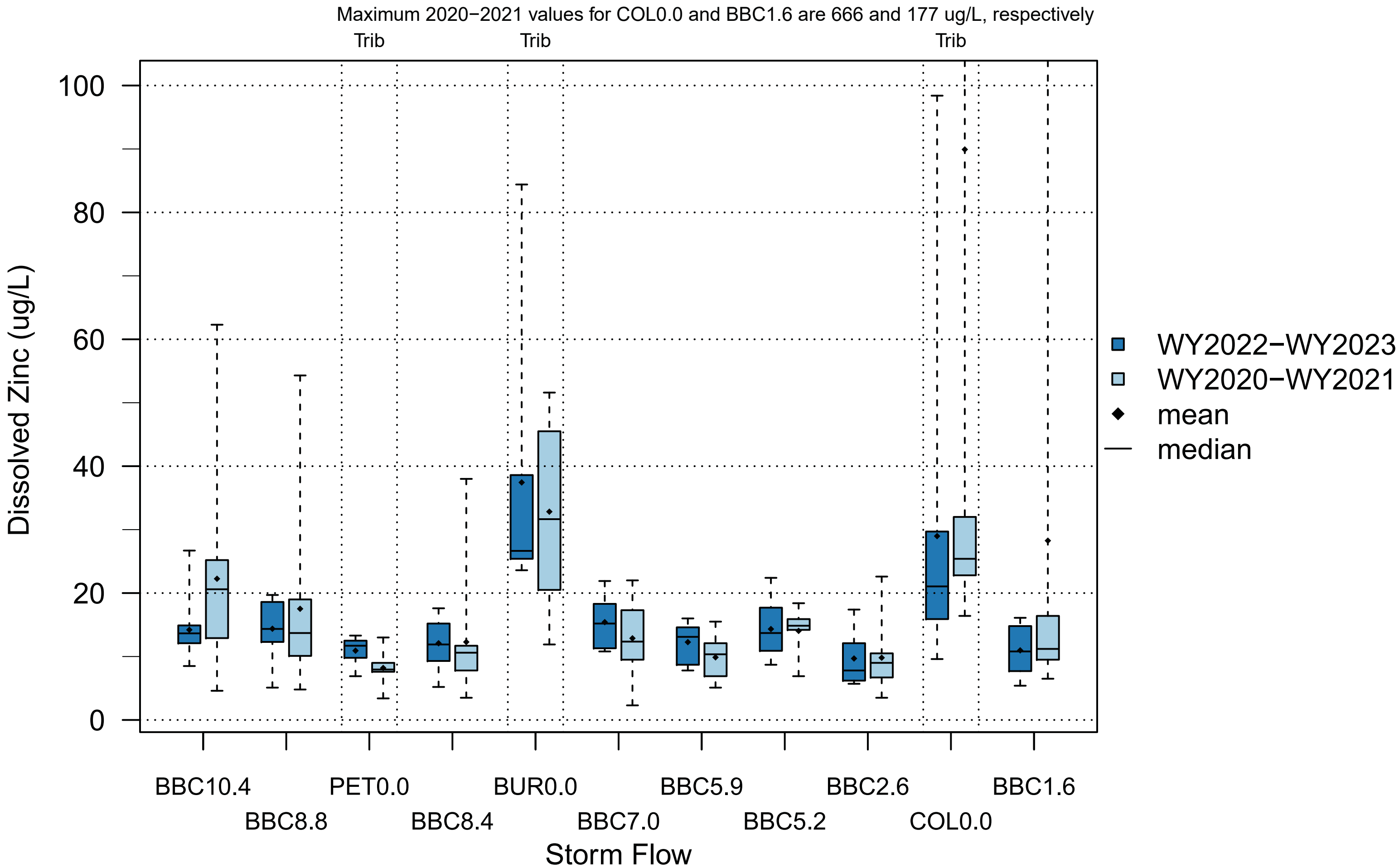

Total Zinc − WY 2023
Total Zinc (ug/L)
25
20
15
10
5
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6



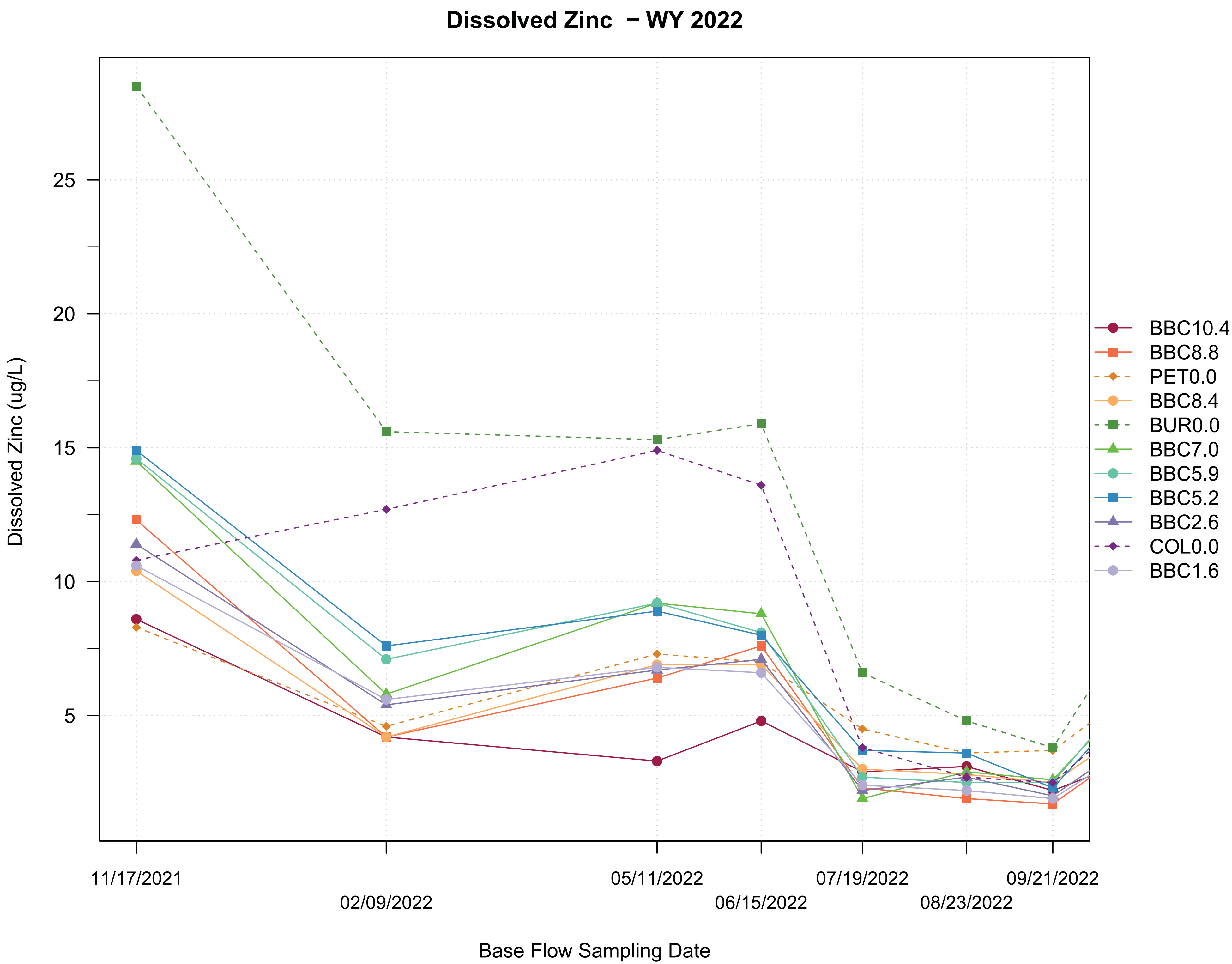
Trib
Trib
Trib
Dissolved Zinc (ug/L)
100
80
60
40
20
0
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
mean
median



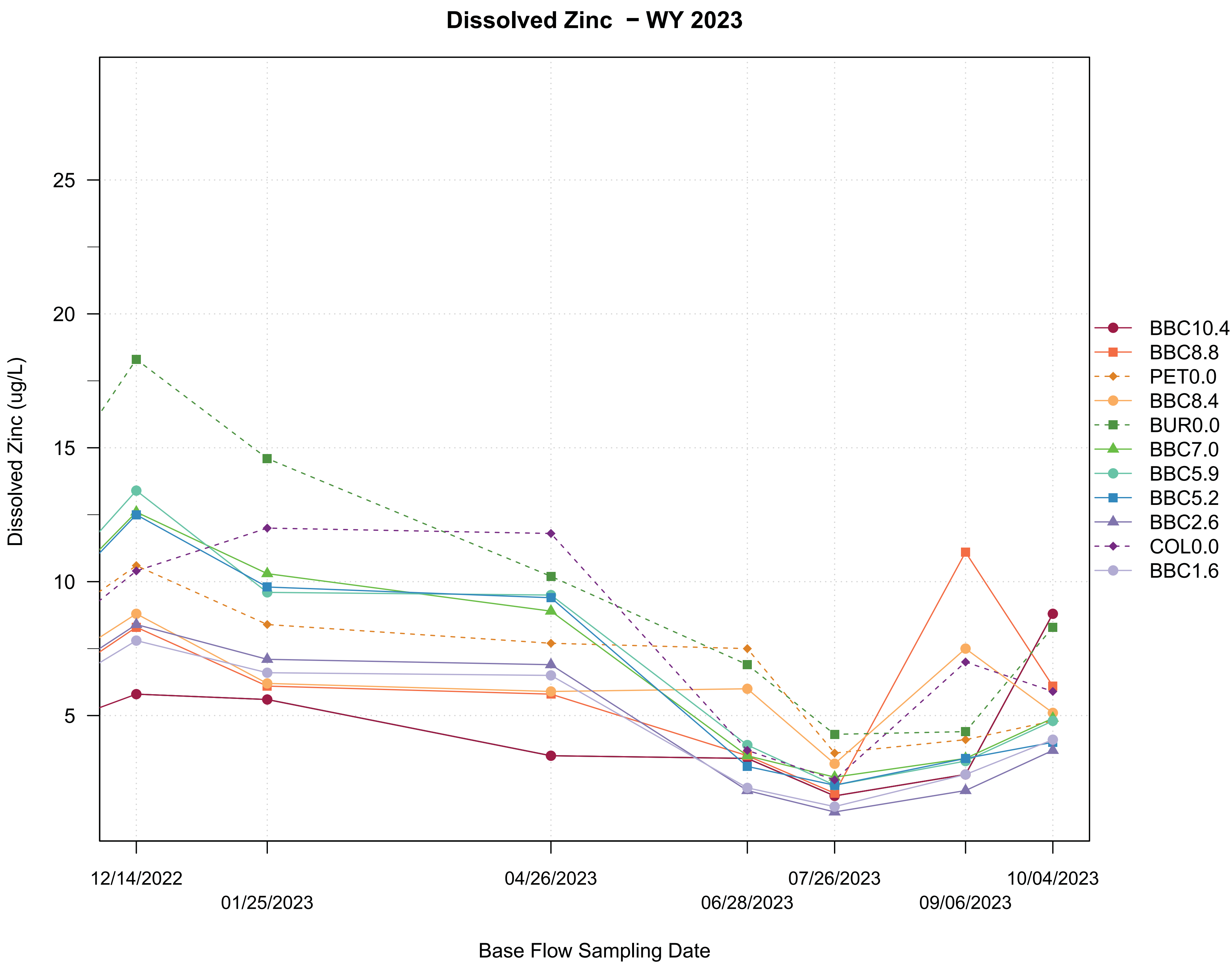
Trib
Trib
Trib
40
30
20
10
0
Dissolved Zinc (ug/L)
WY2022−WY2023
WY2020−WY2021
mean
median
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow



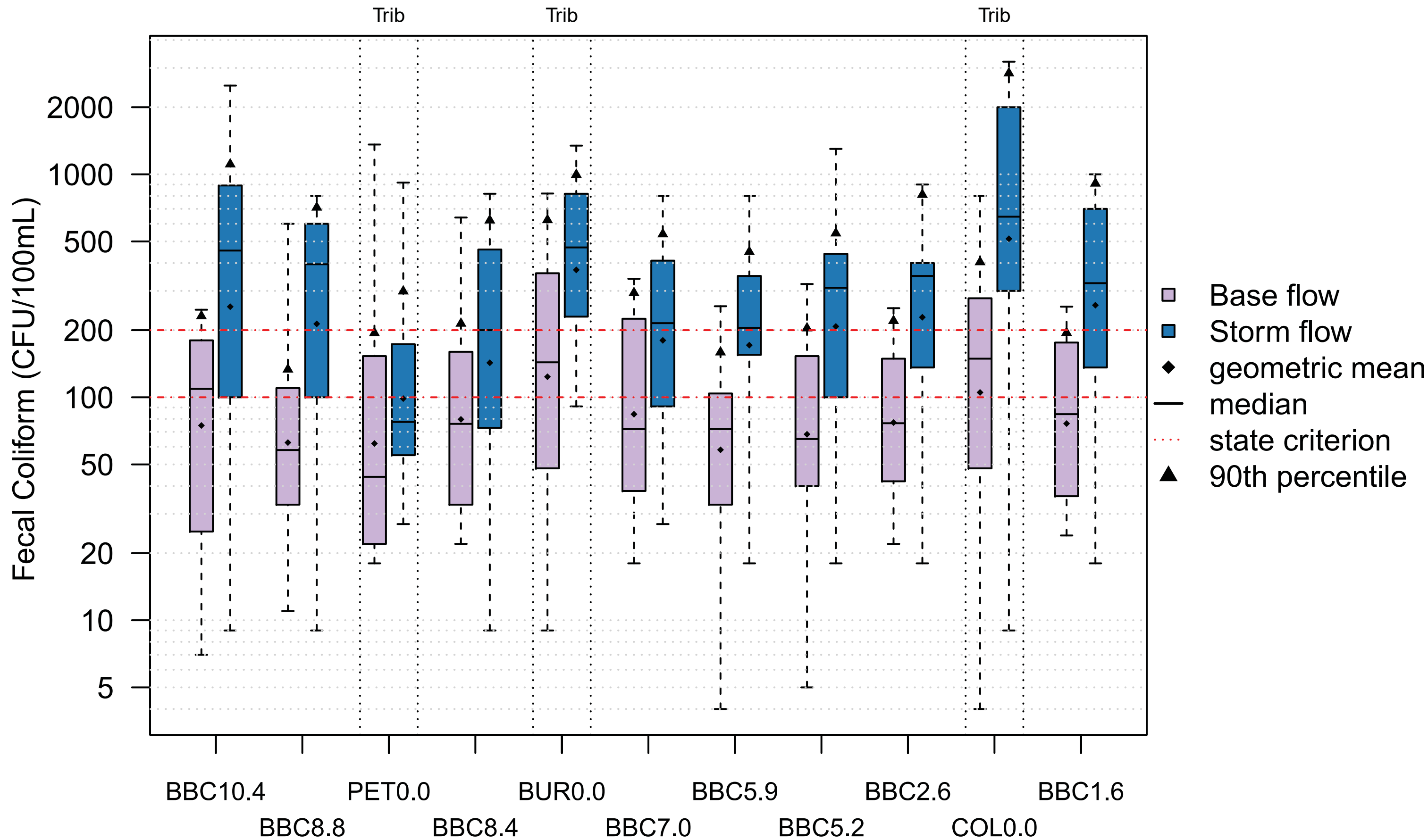
Maximum 2020−2021 values for COL0.0 and BBC1.6 are 666 and 177 ug/L, respectively
Trib
Trib
Trib
Dissolved Zinc (ug/L)
100
80
60
40
20
0
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
mean
median



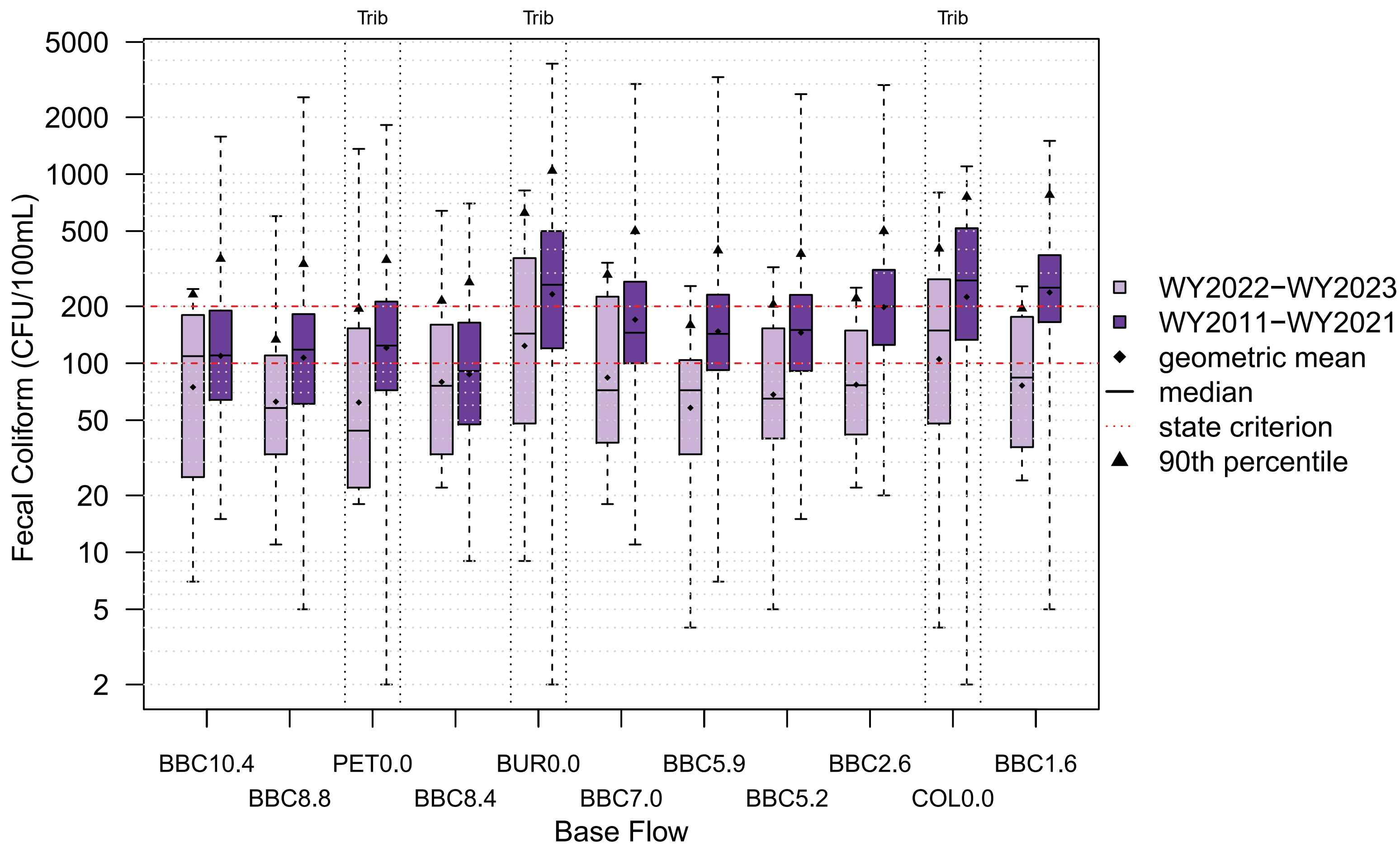
Dissolved Zinc − WY 2022
Dissolved Zinc (ug/L)
25
20
15
10
5
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6



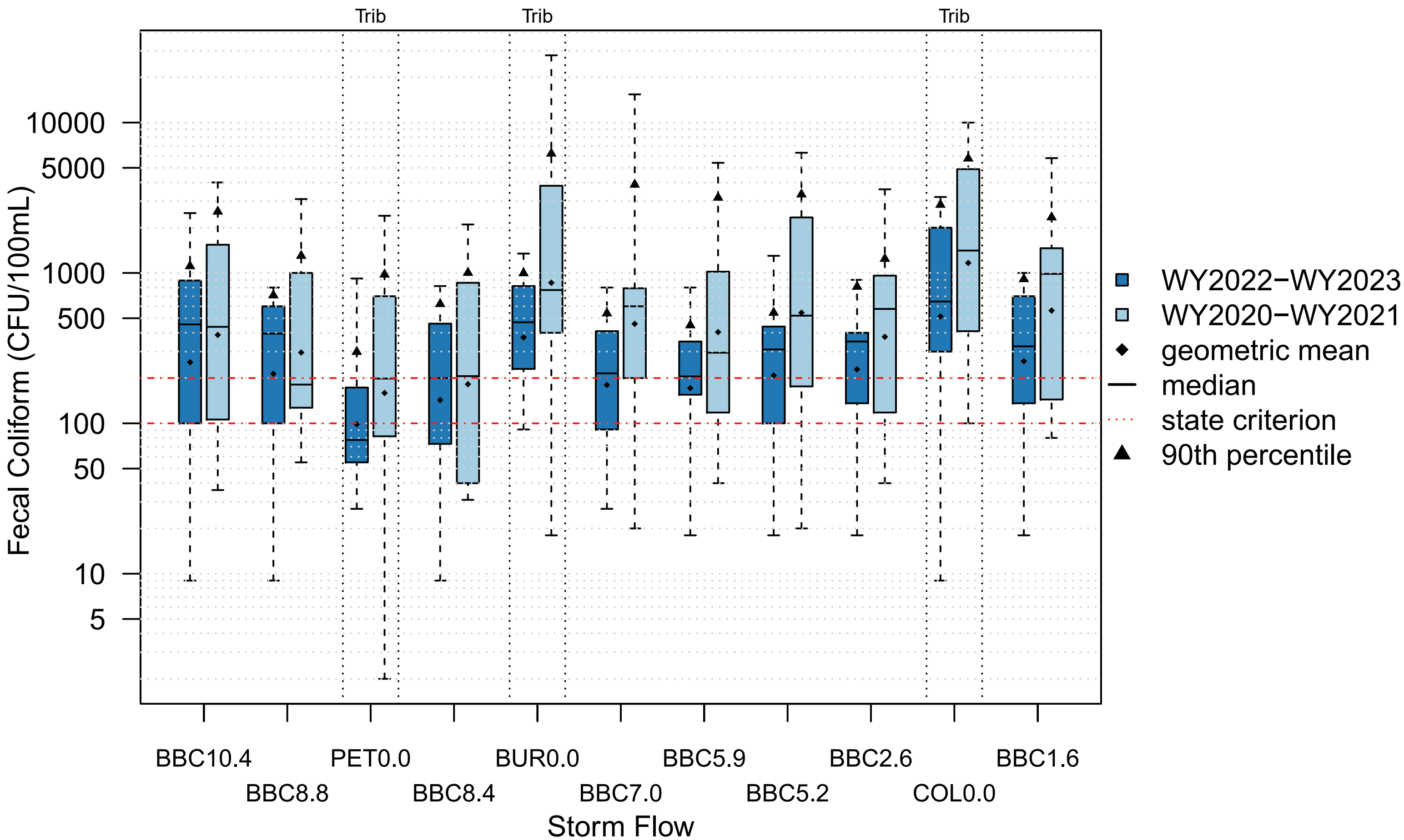
Dissolved Zinc − WY 2023
Dissolved Zinc (ug/L)
25
20
15
10
5
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6



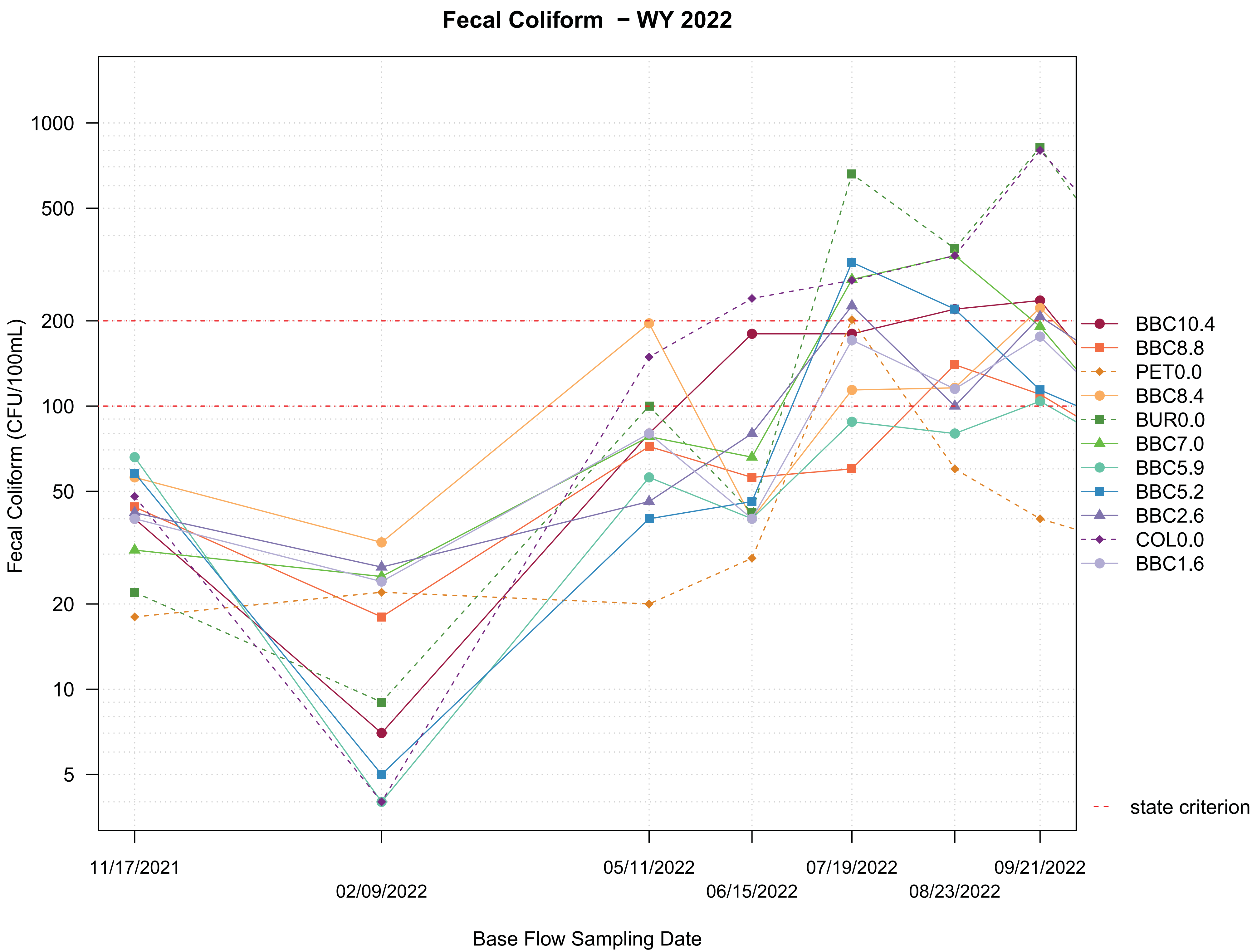
Fecal Coliform (CFU/100mL)
2000
1000
500
200
100
50
20
10
5
Trib
Trib
Trib
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
geometric mean
median
state criterion
90th percentile



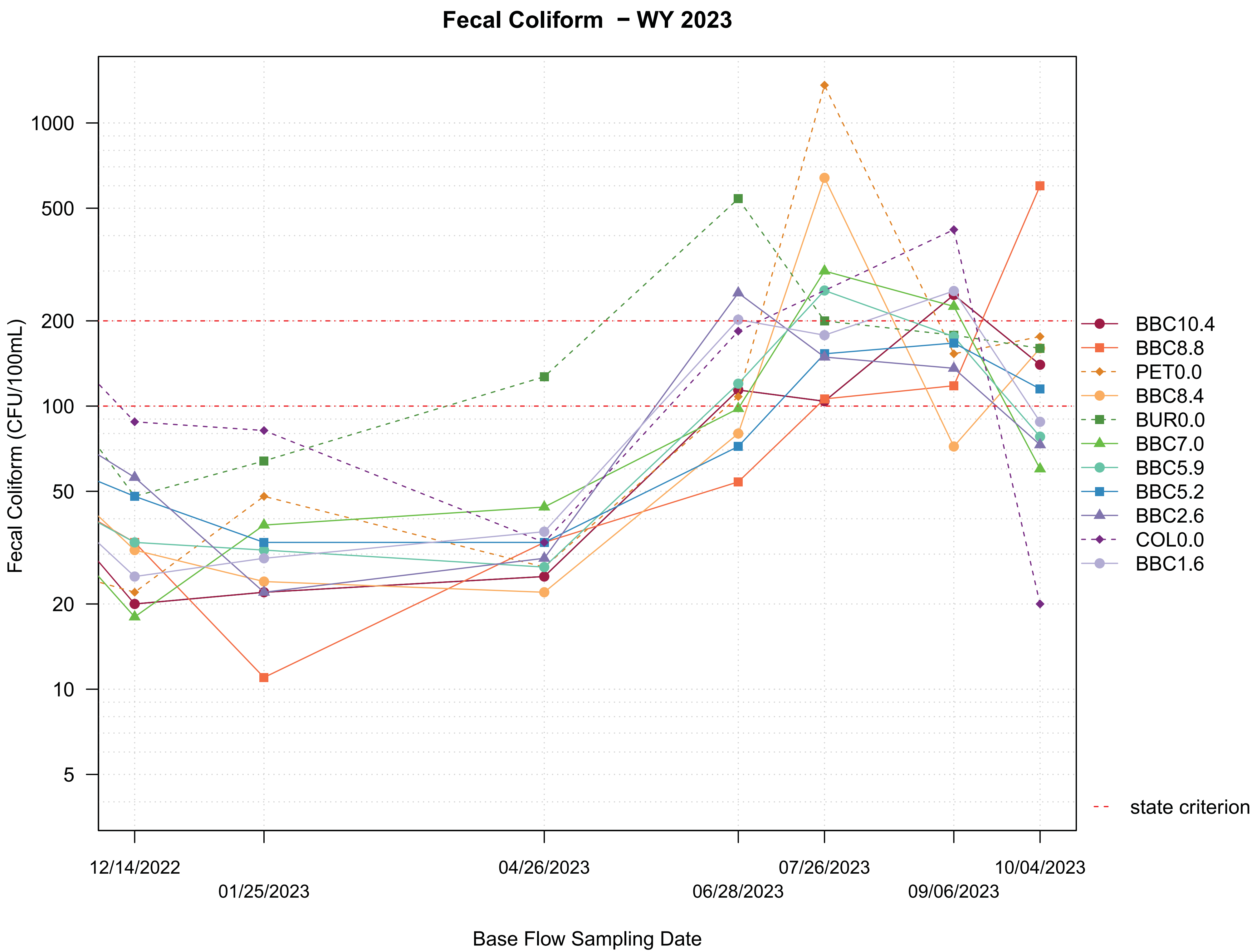
Trib
Trib
Trib
5000
2000
1000
500
200
100
50
20
10
5
2
Fecal Coliform (CFU/100mL)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2011−WY2021
geometric mean
median
state criterion
90th percentile



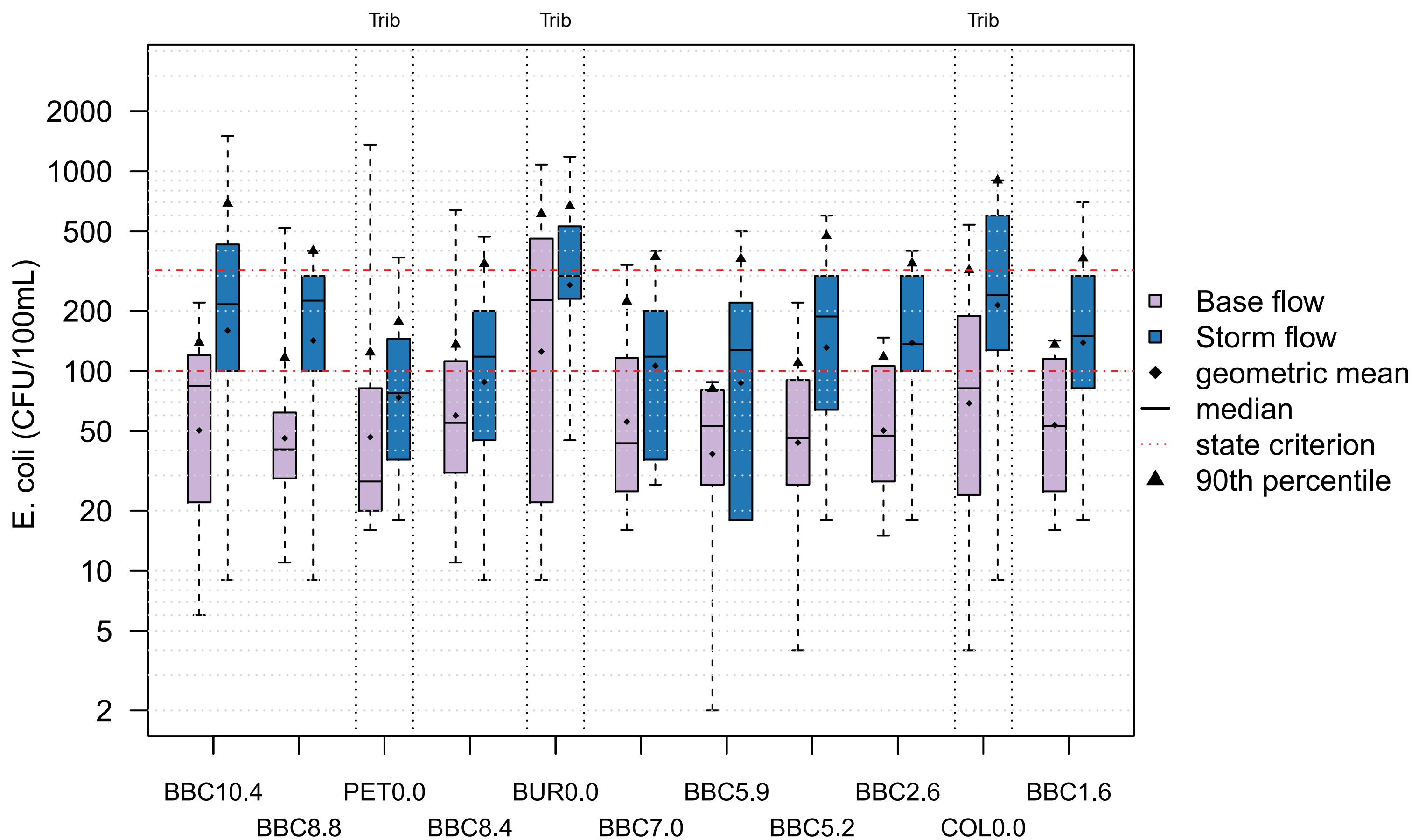
Trib
Trib
Trib
Fecal Coliform (CFU/100mL)
10000
5000
1000
500
100
50
10
5
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
geometric mean
median
state criterion
90th percentile



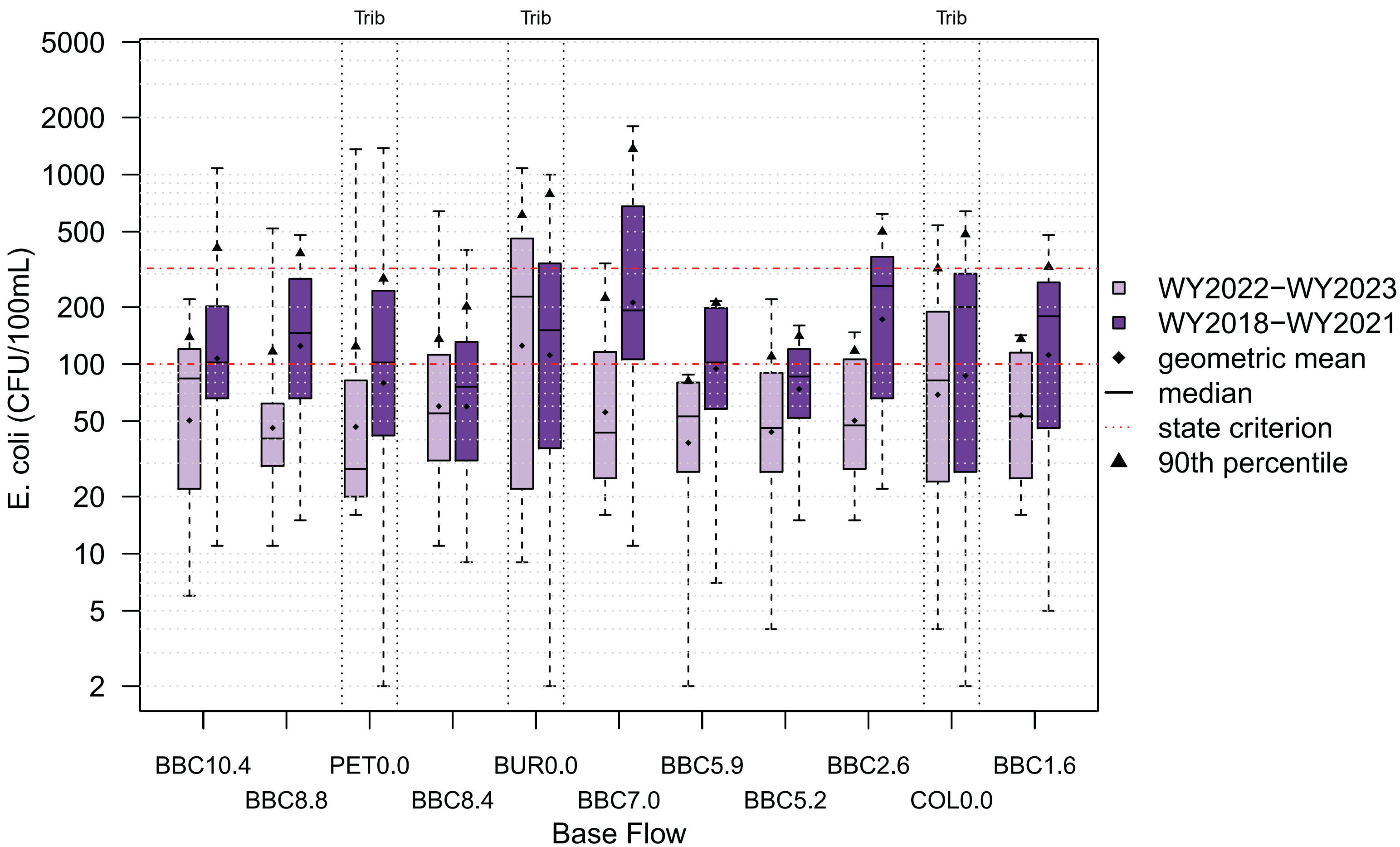
Fecal Coliform − WY 2022
Fecal Coliform (CFU/100mL)
1000
500
200
100
50
20
10
5
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
state criterion



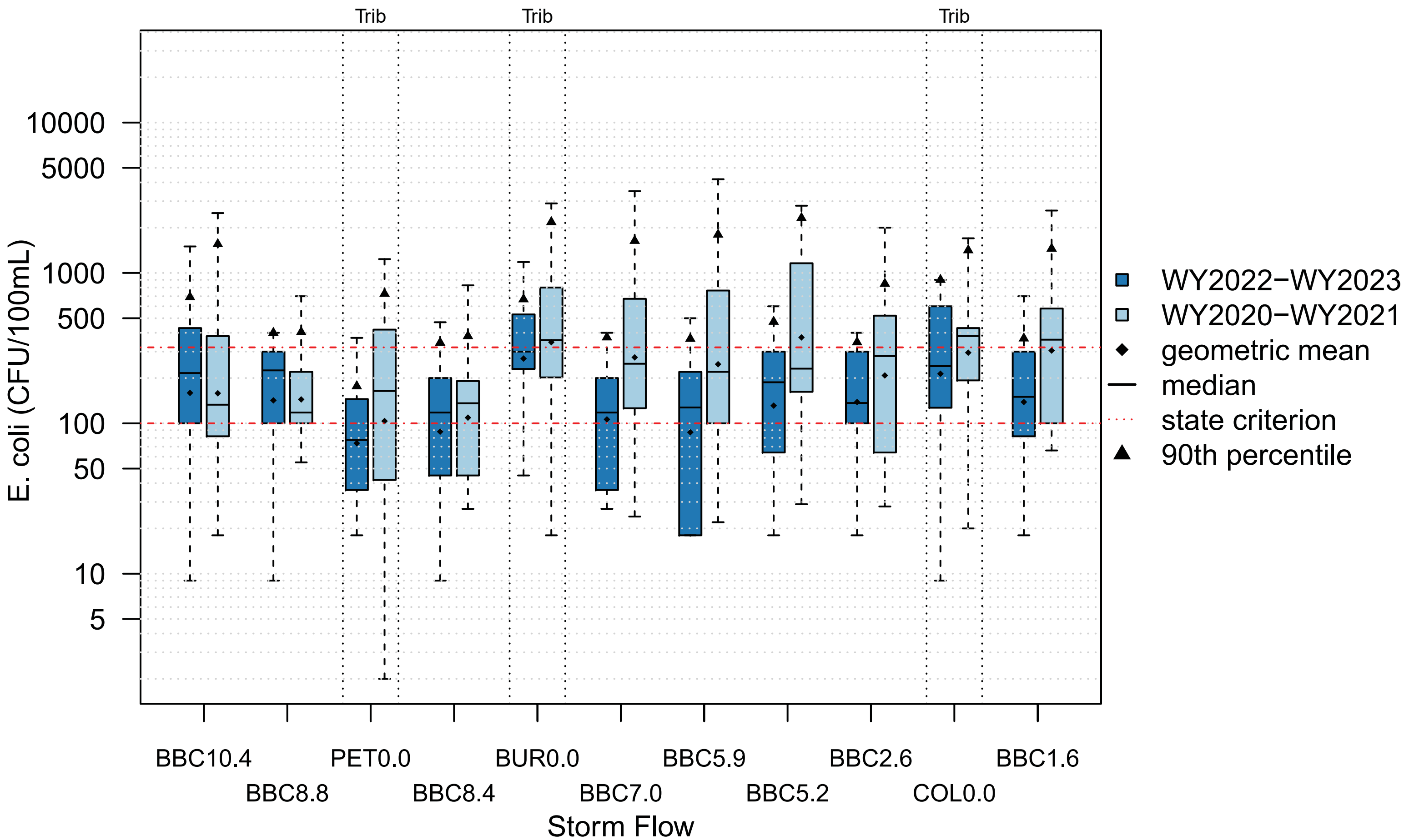
Fecal Coliform − WY 2023
Fecal Coliform (CFU/100mL)
1000
500
200
100
50
20
10
5
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
state criterion



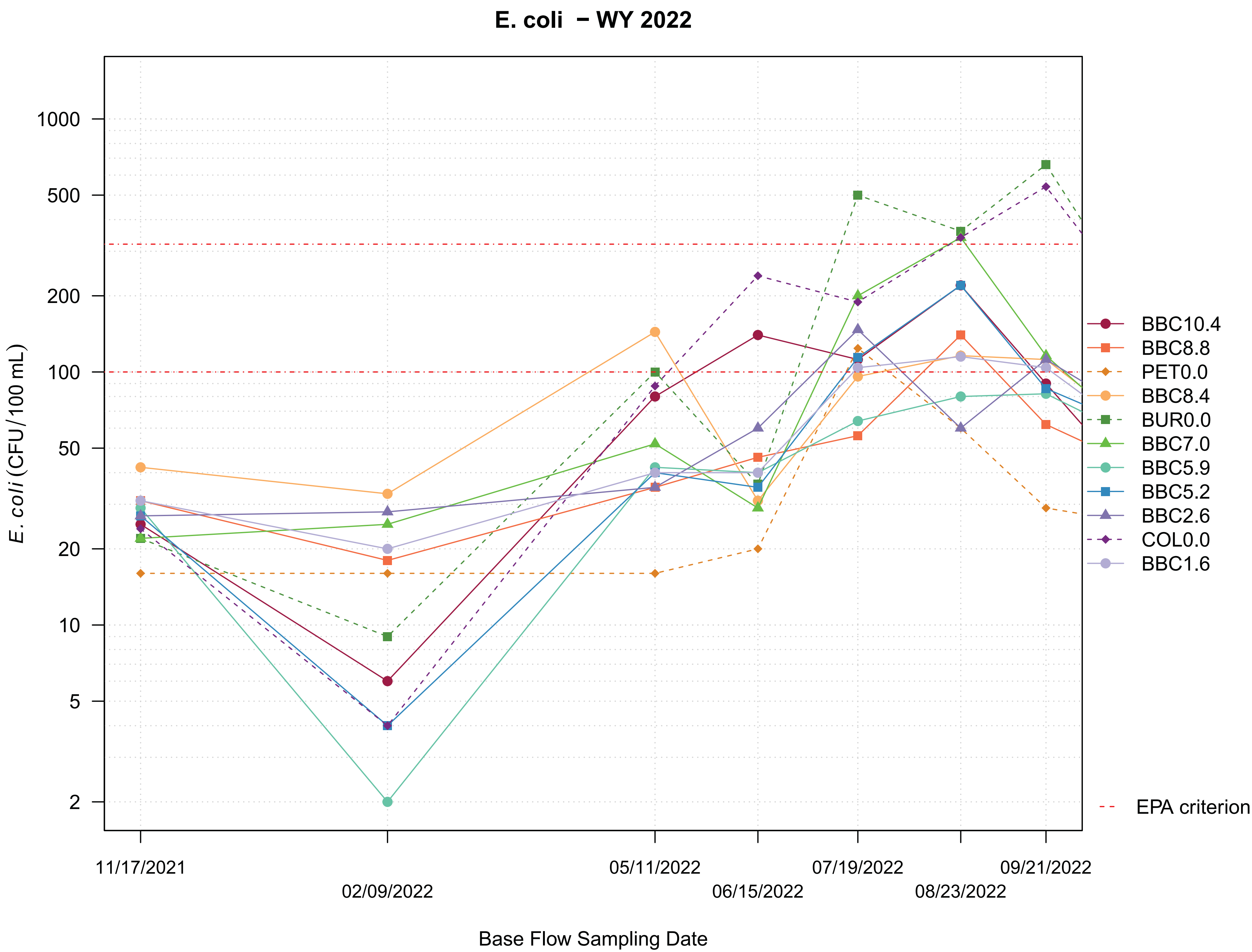
Trib
Trib
Trib
E. coli (CFU/100mL)
2000
1000
500
200
100
50
20
10
5
2
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base flow
Storm flow
geometric mean
median
state criterion
90th percentile



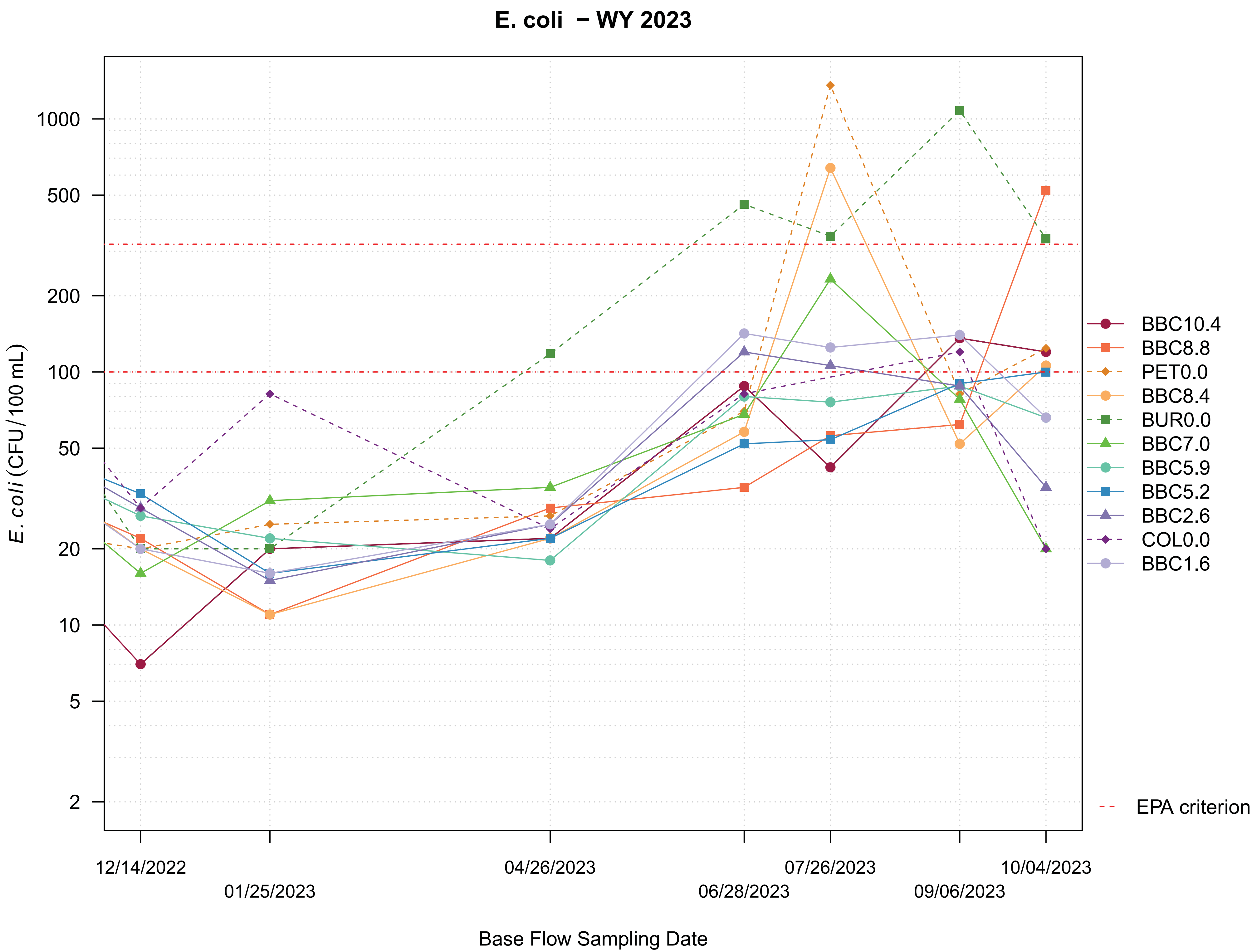
Trib
Trib
Trib
5000
2000
1000
500
200
100
50
20
10
5
2
E. coli (CFU/100mL)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Base Flow
WY2022−WY2023
WY2018−WY2021
geometric mean
median
state criterion
90th percentile



Trib
Trib
Trib
10000
5000
1000
500
100
50
10
5
E. coli (CFU/100mL)
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
Storm Flow
WY2022−WY2023
WY2020−WY2021
geometric mean
median
state criterion
90th percentile



E. coli – WY 2022
1000
500
200
100
50
20
10
5
2
E. coli (CFU/100 mL)
11/17/2021
02/09/2022
05/11/2022
06/15/2022
07/19/2022
08/23/2022
09/21/2022
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
EPA criterion



E. coli − WY 2023
E. coli (CFU/100 mL)
1000
500
200
100
50
20
10
5
2
12/14/2022
01/25/2023
04/26/2023
06/28/2023
07/26/2023
09/06/2023
10/04/2023
Base Flow Sampling Date
BBC10.4
BBC8.8
PET0.0
BBC8.4
BUR0.0
BBC7.0
BBC5.9
BBC5.2
BBC2.6
COL0.0
BBC1.6
EPA criterion