Fish Creek Watershed Plan

Teton County, Wyoming
2026

Prepared by:
Teton Conservation District
Alder Environmental, LLC
Wyoming Department of Environmental Quality

Fish Creek Watershed Plan

Addressing *E. coli* and Nutrient Impairments in the Fish Creek Watershed

May 2026

Teton Conservation District
Est. 1946

Prepared by:
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Addressing *E. coli* and Nutrient Impairments in the Fish Creek Watershed

In Collaboration with:

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EXECUTIVE SUMMARY

The Fish Creek watershed is located in Teton County, Wyoming and covers approximately 124 square miles. Fish Creek originates near Teton Village, WY and travels 14.7 miles to its confluence with the Snake River. Fish Creek was designated as an impaired waterbody by Wyoming Department of Environmental Quality (WDEQ) for *E. coli* in 2020 along the entire stream length and for nutrient enrichment due to nitrogen and phosphorus in its uppermost 9.6 miles in 2025. These impairments are summarized in Wyoming's 2022/2024 Integrated 305(b) and 303(d) Report. This watershed-based plan addresses both current impairments.

At a minimum, this plan contains the nine elements required by the Environmental Protection Agency (EPA) including pollutant source characterization, load reduction estimates, management measures, an education component, monitoring program, and others. In addition, this plan may serve as an Advance Restoration Plan that gives an implementation schedule and interim measurable milestones with the goal of achieving water quality standards in Fish Creek. This watershed-based plan identifies four goals: 1) improve water quality in Fish Creek to meet existing water quality criteria, 2) protect and restore riparian habitat along the Fish Creek corridor, 3) improve aquatic habitat in Fish Creek, and 4) minimize impacts on Fish Creek's ecological functions from human uses and development.

A summary of data collected to date by multiple partnering organizations is provided in this watershed-based plan. *E. coli* concentrations in Fish Creek in 2017 and 2023-2025 exceeded single-sample and five-sample geometric mean water quality criteria, primarily in June and July. The sources of fecal pollution in Fish Creek include livestock manure, failing septic systems along the waterbody, wildlife, and dogs. Load reduction estimates were determined using a load duration curve. To meet existing water quality criteria, *E. coli* loads would need to be reduced by an average of 50%.

Median total nitrogen and total phosphorus concentrations in Fish Creek exceed reference-based thresholds identified in the Fish Creek Nutrient Assessment. These exceedances occur primarily in upper Fish Creek near Teton Village, WY. Insufficient streamflow data exists to perform load calculations. The sources of nitrogen and phosphorus in Fish Creek have been well-studied and include livestock, septic systems, wastewater treatment facilities, fertilizer application, atmospheric deposition, and potential natural sources in spring-fed tributaries to Fish Creek.

Nutrient enrichment in Fish Creek is also documented by its indirect effects on the waterbody, including observed changes in the macroinvertebrate community, periphyton composition and benthic chlorophyll-a concentrations indicative of accelerated macrophyte and nuisance algal growth, and changes in dissolved oxygen and pH dynamics. These effects are documented in this plan.

Four critical areas in Fish Creek have been identified where management measures will have the greatest water quality benefit. These areas are 1) residential and developed areas in upper Fish Creek near Teton Village, 2) areas of livestock grazing along Fish Creek and Lake Creek, 3) areas where septic systems may be adjacent to Fish Creek or its tributaries, and 4) impervious surfaces and snow storage locations near Fish Creek.

This watershed-based plan identifies 38 best management practices (BMPs) to improve water quality in Fish Creek, a subset of which can be implemented within the next five years given landowner permission and available funding. These projects include riparian fencing and virtual fencing options, a septic replacement program for failing septic systems, and expanded sewer connections in areas adjacent to existing sewer lines.

This plan reviews the previous monitoring and restoration efforts that have been completed in the watershed to date. It also recommends 24 additional monitoring efforts or studies to address existing data gaps in Fish Creek. These data gaps include quantifying *E. coli* transport in Lake Creek, characterizing nutrient transport from groundwater to Fish Creek in Teton Village using tracers, characterizing a potential natural source of nitrogen in the headwater tributaries of Fish Creek in Teton Village, and others.

Implementation of the watershed-based plan is the responsibility of Teton Conservation District and Fish Creek Stakeholders identified in the plan. As the impairments in Fish Creek are non-point in origin, voluntary strategies led by the stakeholder group are essential to achieving water quality standards in Fish Creek.

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1 INTRODUCTION

This document provides a strategic restoration and implementation plan to address impairments of the Recreation and Aquatic Life designated uses due to *E. coli* and nutrient concentrations in Fish Creek near Wilson, Wyoming. The plan provides background information on watershed planning and watershed characterization, summarizes water quality and habitat data, recommends general and specific best management practices to reduce *E. coli* and nutrient concentrations in Fish Creek. It includes timelines and load reduction estimates and outlines a monitoring program to continue assessing water quality changes in Fish Creek as new projects are implemented.

1-1 Need for Watershed Planning

Since the 1990s, residents of the Fish Creek watershed have reported changes to Fish Creek, including increased growth of algae and vascular aquatic plants and changes to the macroinvertebrate community (Eddy-Miller et al., 2013). In 2004, the United States Geological Survey (USGS), in partnership with Teton Conservation District (TCD), began conducting a multi-phase study to describe the interaction of surface water and groundwater and to determine the extent of algal growth, nutrient concentrations, and biological community composition in Fish Creek. Publications from this multi-phase study have determined that aquatic plant productivity is higher in Fish Creek than in other related streams of its size and geographic location, which has resulted in shifts in the aquatic macroinvertebrate community (USGS Wyoming-Montana Water Science Center, 2018). Additionally, *E. coli* concentrations exceed Wyoming's surface water quality standards, and total nitrogen and total phosphorus concentrations exceed reference-based thresholds identified by Wyoming Department of Environmental Quality's Water Quality Division (WDEQ/WQD et al., 2023). More recently, changes in observed fisheries populations in Fish Creek have been documented, including decreases in observations of Snake River fine-spotted cutthroat trout (*Oncorhynchus clarkii behnkei*), which are especially significant in younger age classes (D. Miller, oral commun., 2023; Figure B-28).

Compliance with Federal and State Regulations

Section 305(b) of the Clean Water Act (CWA) requires states to assess and report on the overall condition of aquatic resources, and Section 303(d) of the CWA requires states to develop lists of impaired waterbodies and prioritize these waters for restoration (Federal Water Pollution Control Act, 1972). The State of Wyoming is responsible for disseminating a biennial report to EPA that integrates information required by both Section 303(d) and 305(b) of the Clean Water Act, referred to as the "Integrated Report". See Section 3 – Waterbody and Watershed Conditions for more information on Fish Creek's assessment and impairment status.

Section 319 of the CWA provides grants and technical assistance to states, territories, and tribes to control nonpoint source water pollution. Since Fish Creek is a state-designated impaired waterbody under Section 303(d) of the CWA, nonpoint source pollution control implementation projects are eligible for CWA Section 319 grant funds.

Community Values

Fish Creek, as the name implies, is named and known for its historic populations of fish species, which brought attention from anglers since settlement of the region in the late 1800s. Fish Creek is a valuable community resource known for its population of Snake River fine-spotted cutthroat trout (*Oncorhynchus clarkii behnkei*), fly fishing, scenery, and riparian vegetative community. Fish Creek predominantly flows through private land and residents enjoy scenic values and wildlife presence along the creek. Fish Creek and the riparian habitat located near Wilson provide crucial wildlife habitat and movement corridors for many species, including moose, elk, mule deer, black bears, grizzly bears, and mountain lions. Over the past several decades, recreators on Fish Creek have reported a decrease in aesthetic value due to the increased growth of nuisance algae and vascular aquatic plants on the streambed. The degradation of Fish Creek's aquatic resources and complex private land ownership demonstrates the need for collaborative planning in the restoration of the Fish Creek watershed.

Local government has played a role in developing strategic and long-range plans that address and conserve natural resources. The Jackson/Teton County Comprehensive Plan addresses Fish Creek in several instances, including in its policies referring to runoff filtration, natural feature enhancement, wildlife presence and migration, and the protection of tributaries, including Edmiston Spring, and adjacent wetlands from degradation (Jackson/Teton County Long-Range Planning, 2020).

1-2 Watershed Planning Authority

Local conservation districts have statutory authority, Wyoming State Stat. §11-16-103 and 11-16-122(b)(xvi), to develop and implement comprehensive resource use and management plans related to water resources, including watershed-based plans, and to provide the technical expertise related to natural resource management issues. Third parties, including conservation districts, non-profit organizations, watershed groups, consultants, universities, and private citizens, can and frequently do develop watershed-based plans. For a third-party plan to be eligible for federal implementation funding, it must meet EPA guidelines, which typically require acceptance by state or federal environmental agencies.

Local conservation districts in Wyoming have developed Watershed Based Plans in collaboration with WDEQ for waterbodies designated as impaired on the CWA 303(d) impaired waterbodies list, including:

- Bitter Creek Watershed Based Plan – Sweetwater County Conservation District (2021)
- Middle Fork Popo Agie Watershed Based Plan – Popo Agie Conservation District (2020)
- Flat Creek Watershed Management Plan (revision) – Teton Conservation District (2019)
- Sediment Watershed Plan for the Shoshone River from Buffalo Bill Reservoir to Willwood Dam – Willwood Working Group #3, including Powell-Clarks Fork Conservation District and Cody Conservation District (2019)
- Little Powder River Watershed Restoration Plan – Little Powder River Watershed Steering Committee and Campbell County Conservation District (2019)

1-3 Nine Minimum Elements of an EPA Watershed Restoration Plan

The Watershed Planning Process is guided by the Environmental Protection Agency's Handbook for Developing Watershed Plans to Restore and Protect Our Waters (USEPA, 2008). Watershed plans that are funded by the CWA Section 319 funds are required by EPA to contain a minimum of nine critical elements (USEPA, 2008). These elements are summarized below along with their location within this Watershed Plan:

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions (Section 3-5 and 3-6).
2. An estimate of the load reductions expected from management measures (Section 5-2).
3. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in item 2, and a description of the critical areas in which those measures will be needed to implement this plan (Section 4-4 and 4-5).
4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan (Section 5-3 and 5-4).
5. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented (Section 5-5).
6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious (Section 4-5).
7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented (Section 4-5 and 6-2).
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards (Section 6-2).
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item 8 immediately above (Section 6-3).

1-4 Advance Restoration Plan Requirements

This plan may be determined to serve as an Advance Restoration Plan (ARP) by the State of Wyoming and EPA. Following EPA guidance (Best-Wong, 2015), the ARP will, at a minimum, include the following elements:

1. Identification of specific impaired water segments or waters addressed by the alternative restoration approach and identification of all significant sources contributing to the impairment.
2. Analysis to support why the State believes that the implementation of the alternative restoration approach is expected to achieve water quality standards (WQS).

3. An Action Plan or Implementation Plan to document: a) the actions to address all significant sources—both point and nonpoint sources, as appropriate—necessary to achieve WQS (this may include e.g., commitments to adjust permit limits when permits are re-issued or a list of nonpoint source conservation practices or best management practices (BMPs) to be implemented, as part of the alternative restoration approach); and, b) a schedule of actions designed to meet WQS with clear milestones and dates, which includes interim milestones and target dates with clear deliverables.
4. Identification of available funding opportunities to implement the alternative restoration plan.
5. Identification of all parties committed, and/or additional parties needed, to take actions that are expected to meet WQS.
6. An estimate or projection of the time when WQS will be met.
7. Plans for effectiveness monitoring to demonstrate progress made toward achieving WQS following implementation, identify needed improvement for adaptive management as the project progresses, and evaluate the success of actions and outcomes.
8. Commitment to periodically evaluate the alternative restoration approach to determine if it is on track to be more immediately beneficial or practicable in achieving WQS than pursuing the Total Maximum Daily Load (TMDL) approach in the near-term; and if the impaired water should be assigned a higher priority for TMDL development.

1-5 Stakeholder Participation Process

Stakeholder engagement and participation are key components of the watershed planning and implementation process. Stakeholder input was gathered by hosting a public meeting, soliciting feedback from an online survey, and receiving written comments through in-person meeting handouts and email correspondence. Advertising and outreach occurred at strategic times in early 2023 leading up to the stakeholder meetings and included informational emails and reminders to agency and public stakeholder groups, digital and print newspaper advertisements, social media posts, and information hosted on the Jackson Hole Clean Water Coalition website.

A hybrid meeting was held on June 7, 2023, at the Old Wilson Schoolhouse Community Center and virtually hosted on Zoom. The meeting was divided into an agency meeting followed by a public meeting. Teton Conservation District and Alder Environmental staff recorded notes during the discussion portions of both events. Summaries of notes and stakeholder feedback gathered during the meetings are included in Appendix C. The presentation portions of the stakeholder meetings were recorded through Zoom, and the full recording is available on the Teton Conservation District YouTube channel. A complete summary of the stakeholder processes including advertising and outreach efforts is included in Appendix C, Summary of 2023 Stakeholder Process.

In order to gain maximum input during plan development, additional stakeholder input was solicited in 2025. The best management practices included in this plan were shared with current Fish Creek stakeholders. Partners identified additional best management practices, refined existing practices, and provided information on additional funding avenues for proposed practices.

1-6 Adaptive Management Strategy

TCD and WDEQ will utilize an adaptive management strategy to implement the watershed management practices identified in this plan. If adapting the plan and management practices does not improve water quality in Fish Creek and achieve the watershed goals, additional management practices may be implemented and watershed protection policies modified. Monitoring in Fish Creek will guide changes to the management practices identified in the plan. TCD and WDEQ will be responsible for making future decisions to change and improve management practices found in this plan for Fish Creek water quality improvement and protection. In addition, the monitoring plan presented in this plan (Section 6-3) is subject to change based on watershed progress, funding/staffing limitations, or changes in watershed health that require revisions to the monitoring plan.

2 GOALS AND OBJECTIVES

The development of goals and objectives for the Fish Creek Watershed Plan was guided primarily by the engagement of stakeholders and public comment. Feedback provided in the stakeholder meetings, public comment period, and online survey were synthesized to determine shared priority goals for the community. Using the community goals as a baseline for the Watershed Plan, additional goals and objectives were identified based on the watershed characterization process and review of existing data sources and data gaps. These objectives provide targets to determine if the implementation of management practices is effective in achieving the watershed goals.

2-1 Water Quality

Goal 1 Restore water quality in Fish Creek to meet the WDEQ's water quality criteria to support designated uses for Fish Creek, including recreation and aquatic life.

Objective 1 Reduce geometric mean values for *E. coli* in designated sampling locations on Fish Creek to below 126 organisms per 100 mL to meet the State of Wyoming's water quality criteria supportive of the Recreation designated use.

Objective 2 Reduce total nitrogen and total phosphorus concentrations in Fish Creek to match reference-based thresholds established in the Fish Creek Nutrient Assessment.

Objective 3 Reduce average and maximum benthic algal biomass and periphyton composition to match reference-based thresholds established in the Fish Creek Nutrient Assessment.

Objective 4 Maintain dissolved oxygen concentrations and pH values from Fish Creek monitoring sites to comply with Wyoming Surface Water Quality Standards and to match conditions at reference sites established in the Fish Creek Nutrient Assessment.

2-2 Riparian Habitat

Goal 2 Protect and restore riparian habitat along the Fish Creek corridor.

Objective 1 Utilize aerial imagery to identify degraded riparian habitat areas along Fish Creek and work with private landowners to implement restoration projects for reestablishing native riparian vegetation along approximately 3,000 linear feet of the Fish Creek corridor.

Objective 2 Establish riparian fencing and water management to decrease the impact of cattle and horses on Fish Creek.

2-3 Aquatic Habitat

Goal 3 Improve aquatic habitat in Fish Creek to result in full support of the state-designated use Aquatic Life.

Objective 1 Improve trout spawning and rearing conditions to maintain a sustainable long-term population of Snake River cutthroat trout.

Objective 2 Promote restoration of aquatic habitat to support healthy macroinvertebrate populations, meeting the multi-metric index scores outlined in the WDEQ's Fish Creek Nutrient Assessment.

2-4 Human Uses

Goal 4 Minimize impacts of human uses and development on Fish Creek's ecological functions.

Objective 1 Recommend inspections of septic systems in the Fish Creek watershed.

Objective 2 Connect parcels within a 150-ft buffer to Fish Creek and its tributaries to sewer collection systems where possible.

Objective 3 Implement stormwater filtration systems in areas with surface disturbance and development density like the Wilson urban corridor and Teton Village to reduce suspended sediment load during runoff events.

Objective 4 Promote best practices for landscaped areas that benefit habitat and water quality in Fish Creek.

3 WATERSHED CHARACTERIZATION

3-1 Watershed and Jurisdictional Boundaries

The Fish Creek watershed is located in western Wyoming and is a tributary to the Snake River. The entire watershed lies within Teton County, WY. The headwaters of Fish Creek are in Teton Village, where several groundwater springs and irrigation ditches converge to form the upper reach of Fish Creek. Fish Creek flows generally to the south prior to converging with the Snake River approximately 4.2 miles south of Wilson, WY. The largest tributary to Fish Creek is Lake Creek, an intermittent stream largely controlled by irrigation diversions. Several other tributaries enter Fish Creek from the west, including Trail Creek and Mosquito Creek, flowing from the southern end of the Teton Range and the northern end of the Snake River Range prior to their confluence with Fish Creek. Groundwater contributions account for a significant portion of the inputs to Fish Creek, as there are many springs upwelling in the watershed between Teton Village and Fish Creek's terminus in the Snake River (Eddy Miller et al., 2009).

The Fish Creek watershed (HUC 170401030103) is a sub-watershed of the Greys-Hoback watershed (HUC 17040103). The Fish Creek watershed covers an area of 124 square miles. Fish Creek flows for approximately 15 miles before it enters the Snake River. Teton Village and Wilson, both census-designated places in Wyoming, are the two largest urban areas within the watershed. The land management of the Fish Creek watershed is a mix of privately held lands and government management units. The Bridger-Teton National Forest, National Park Service, Bureau of Land Management, Teton County, and the State of Wyoming all manage parcels of land within the Fish Creek watershed.

3-2 Physical and Natural Features

Climate

The Fish Creek watershed experiences a seasonally variable climate, with cold winters and warm summers. Seasonal temperatures vary with elevation, as the study area includes both semi-arid valley floor and high alpine environments. The Jackson, WY weather station was used to characterize weather and climate trends for the Fish Creek watershed, being the closest weather station to the study area available through the National Weather Service. Monthly mean maximum daily temperatures for the Jackson Hole valley vary from 26.1°F in January to 79.1°F in July (National Weather Service, 2024).

Precipitation in the Fish Creek watershed also varies with elevation. The valley floor receives an average of 17.64 inches of precipitation based on data from 2000- 2023 at the Jackson Hole weather station (National Weather Service, 2024). The precipitation total increases with elevation, as higher elevations within the Fish Creek watershed receive significantly greater levels of precipitation. The Phillips Bench SNOTEL records, accessed through the National Oceanic and Atmospheric Administration online weather data portal, show an annual mean of 40.72 inches of precipitation (Map 5).

Vegetation

The Fish Creek watershed is bounded to the west by the Teton and Snake River Ranges and to the east by the Snake River. The vegetative cover types in the higher elevations within the watershed consist of conifer and mixed conifer-aspen forests, subalpine meadows, and sparsely vegetated areas with minimal development, excluding the Jackson Hole Mountain Resort ski area. The dominant vegetative cover types at lower elevations and on the valley floor include agricultural fields, aspen forests, sagebrush shrublands, riparian (including cottonwood and mixed cottonwood-spruce forest and willow shrublands), and disturbed/developed pervious and impervious surfaces (Map 7).

Geology

The Fish Creek watershed has a complex geologic history related to multiple orogenic events and depositional environments. The western margin of the watershed is bounded to the north by the Teton Range and to the south by the Snake River Range. The Teton Range is an upthrown fault block consisting of a core of Precambrian metamorphic and igneous rocks overlain by Paleozoic sedimentary rocks (Love and Reed, 1968). The Snake River Range represents the southwestern boundary of the Fish Creek watershed and is associated with the Wyoming Thrust Belt (Nolan and Miller, 1995). The valley floor of the Fish Creek watershed is composed of unconsolidated surficial alluvial deposits of the Quaternary age. The valley floor deposits are attributed to outwash from Pleistocene-age valley floor glaciation, as well as postglacial fluvial deposition (Nolan and Miller, 1995). The Snake River represents the eastern boundary of the Fish Creek watershed, which flows roughly parallel to Fish

Creek through Quaternary surficial deposits in the Jackson Hole structural basin. The Teton fault zone, located along the eastern margin of the Teton Range, has caused westward tilting of the Jackson Hole basin to the point where Fish Creek is typically at a lower elevation than the Snake River throughout its course despite being a tributary to the Snake River.

Hydrology

The hydrology of Fish Creek is seasonally variable and dependent on inputs including snowmelt runoff, hyporheic exchange, irrigation diversion return flows from the Snake River to Lake Creek and Fish Creek, and other tributary inputs. Due to the strong influence of relatively warm groundwater (compared to surface water) it remains ice-free in the winter months. Groundwater exchange with the Snake River alluvial aquifer varies seasonally and longitudinally, with the most significant groundwater-surface water exchanges occurring in the upstream reach of Fish Creek near Teton Village (Eddy-Miller et al., 2009). This upper reach exhibits intermittent flow, and Fish Creek becomes a perennial flowing stream several miles south of Teton Village. Groundwater exchange with Fish Creek surface water is dependent on multiple factors including increased aquifer recharge from Snake River flows, rapid infiltration of snowmelt, and recharge from flood irrigation (Eddy-Miller et al., 2009). Flood irrigation practices in hay meadows and irrigation ditch return flows both contribute seasonally to the hydrology of Fish Creek. Several tributaries enter Fish Creek prior to its confluence with the Snake River, including Lake Creek, Phillips Creek, Trail Creek, Mosquito Creek, and others. Snowmelt from the Teton Range and Snake River Range also contribute to Fish Creek, particularly in the spring and early summer months. The USGS operates a gaging station on Fish Creek in Wilson, WY (USGS 13016450). The median annual peak streamflow for Fish Creek in Wilson, based on data collected from 1994-2025, is 904 cubic feet per second. Flows peak on Fish Creek between early June to early July, when the hydrology of Fish Creek is primarily driven by high-elevation snowmelt. The hydrology of Fish Creek is influenced by irrigation on the west bank of the Snake River, which in turn depends on the hydrology of the Snake River. In late September to early October, the Bureau of Reclamation ramps down its releases from Jackson Lake Dam to its target winter releases, which marks the end of the irrigation season. After this point, flows in Fish Creek decrease significantly (Figure 1). For a comprehensive hydrological summary, refer to Appendix B.

Aquatic, Riparian, and Terrestrial Ecology

Fish Creek contains a riparian corridor that is home to several species of plants that serve critical roles to the ecological function of the watershed. In addition to a host of other riparian species, willow species, including Coyote willow (*Salix exigua*), Bebb's willow (*Salix bebbiana*), and Booth's willow (*Salix boothii*) are present along the riparian corridor in Fish Creek. Narrowleaf cottonwood (*Populus angustifolia*) is also present in Fish Creek, particularly in the southern reaches and increasing in prevalence near the confluence with the Snake River.

In addition to its population of Snake River fine-spotted cutthroat trout, Fish Creek is also home to a number of other native fish species, including speckled dace (*Rhinichthys osculus*), longnose dace (*Rhinichthys cataractae*), Utah sucker (*Catostomus ardens*), Paiute sculpin (*Cottus beldingii*), mottled sculpin (*Cottus bairdii*) and mountain whitefish (*Prosopium williamsoni*). Non-native fish are also present in the Fish Creek watershed. Brook trout (*Salvelinus fontinalis*) are virtually ubiquitous throughout Fish Creek, and lake trout (*Salvelinus namaycush*) are prevalent in Phelps Lake, which is located in the headwaters of the Fish Creek watershed.

The Fish Creek watershed provides habitat for wildlife species classified as threatened by the U.S. Fish and Wildlife Service (Table 1). These species are also listed in the Wyoming Natural Diversity Database (WYNDD) and are, therefore, known to occur in the area.

Other important game and non-game wildlife species in the Fish Creek watershed include bald eagles, trumpeter swans, elk, mule deer, and moose, as well as other bird, amphibian, and mammal species that rely on the habitat types provided by the watershed. Beavers are present, particularly on tributaries to Fish Creek.

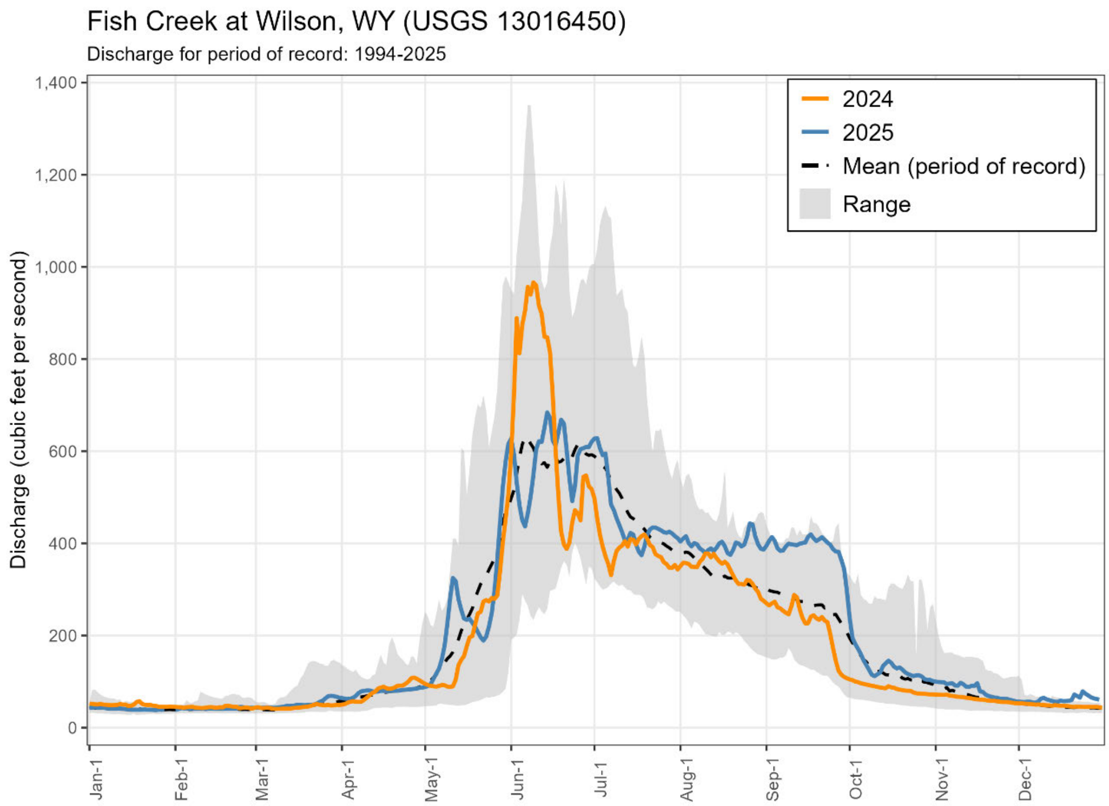


Figure 1. Fish Creek daily mean streamflow in 2024 and 2025.

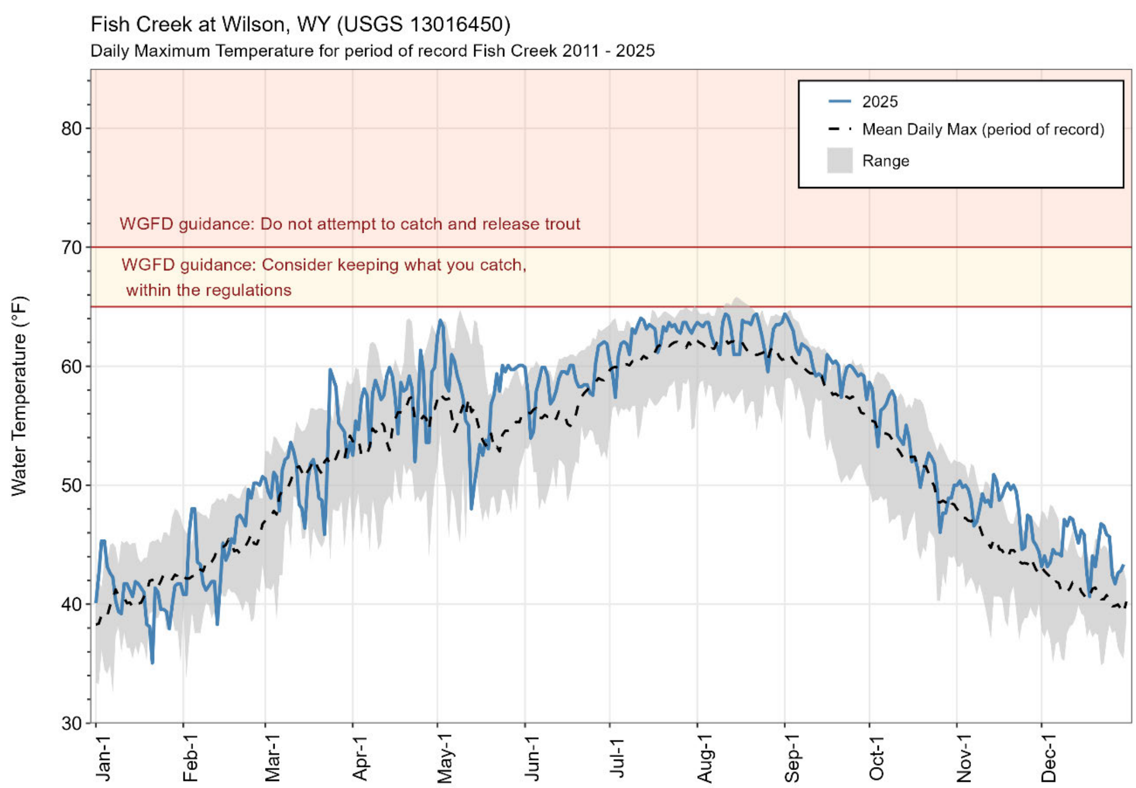


Figure 2. Fish Creek daily maximum temperature in 2025.

Table 1. Threatened wildlife species in the Fish Creek watershed.

Status	Common Name	Scientific Name
Threatened	Canada Lynx	*Lynx canadensis*
Threatened	Grizzly Bear	*Ursus arctos horribilis*
Threatened	North American Wolverine	*Gulo gulo luscus*
Threatened	Yellow-billed Cuckoo	*Coccyzus americanus*
Candidate	Monarch Butterfly	*Danaus plexippus*
Threatened	Western Glacier Stonefly	*Zapada glacier*

3-3 Land Use and Population Trends

Major types of land use in the Fish Creek watershed include natural/undeveloped spaces, agricultural areas, and developed parcels (Map 7). Much of the western half of the watershed is comprised of U.S. Forest Service land and is managed as a National Forest with minimal levels of development. The northern portion of the watershed is managed by the National Park Service, as well as a large summer and winter resort area operated by Jackson Hole Mountain Resort and the Bridger-Teton National Forest (Teton County GIS Hub, 2024). The region between Teton Village and Wilson contains a mix of agricultural and residential parcels and two golf courses. While there are no incorporated areas within the Fish Creek watershed, Teton Village, the census-designated place of Wilson, and the Aspens/Pines subdivision are the largest urban centers in the watershed and include a mix of single-family homes, condos, and businesses. South of Wilson, the land is primarily zoned as Rural and contains a mix of agricultural properties and residences.

The United States Census Bureau reported a population of 23,331 for Teton County, Wyoming in the 2020 census. The 2020 population represents nearly a 10% growth in population compared to the 2010 census of 21,294 (United States Census Bureau, 2024). The census-designated place of Teton Village was estimated to have a population of 906 in 2020, while Wilson was estimated to have a population of 1,303. These population trends do not account for the sizable amount of tourism and its impact on the natural resources of the region, as Wilson and Teton Village are both gateway communities to the popular tourism destinations of Grand Teton National Park, Yellowstone National Park, and Jackson Hole Mountain Resort.

3-4 Waterbody and Watershed Conditions

Classification, Designation, and Protection

As of 2026, the Wyoming Water Quality Rules establish designation and protection of Fish Creek based on its surface water quality standards, groundwater quality standards, and designated uses. Refer to the Wyoming Rules for more information (WDEQ/WQD 2025b).

Fish Creek is designated by WDEQ as an Outstanding Resource Water according to Chapter 1 of the Wyoming Water Quality Rules (WDEQ/WQD 2025b). WDEQ defines Outstanding Resource Waters as follows:

"'Outstanding Resource Water' means those Surface Waters of the State designated as such in this Chapter and formerly known as 'Class 1' waters."

Chapter 1 of the Wyoming Water Quality Rules (WDEQ/WQD 2025b) also state that WDEQ *"shall maintain and protect the existing quality of Outstanding Resource Waters*" and that "*Existing quality' means the chemical, physical, and biological water quality, and associated temporal variability, of an Outstanding Resource Water as of the date the specific waterbody segment was designated*." All surface waters of the State within the Fish Creek drainage were designated as Outstanding Resource Waters on July 17, 1979 (WDEQ/WQD 2025b).

Section 13 in Chapter 1 of the Wyoming Water Quality Rules (WDEQ/WQD 2025b) specifies provisions that the WDEQ must take "*to maintain and protect the existing quality and existing uses of Outstanding Resource Waters."*

Groundwater is classified by WDEQ by its ambient water quality according to its suitability for designated uses. The groundwater in the Fish Creek watershed is designated by the WDEQ as a Class 1 Groundwater, according to Chapter 8 of the Wyoming Water Quality Rules (WDEQ/WQD 2025c). WDEQ defines Class 1 Groundwater as follows:

"Class I Groundwater of the State - This water is suitable for domestic use. The ambient quality of underground water of this suitability does not have a concentration in excess of any of the standards for Class I Groundwater of the State."

"Underground water of Class I, II, III or Special (A) shall not contain biological, hazardous, toxic or potentially toxic materials or substances in concentrations or amounts that exceed maximum allowable concentrations based upon information of the EPA in the Federal Register for December 24, 1975 (Part IV), Water Programs, National Interim Primary Drinking Water Regulations; and in the Federal Register for March 13, 1978 (Part II), Water Programs, Hazardous Substances. In addition, underground water of Class I, II, III or Special (A) shall not contain any biological, hazardous, toxic or potentially toxic materials or substances in concentrations or amounts that, based upon the latest available scientific information and as determined by the Administrator, will impair this water for its use suitability or that may contribute to a condition in contravention of groundwater quality standards or to any toxic or hazardous effect on natural biota."

"A discharge into an aquifer containing Class I, II, III or Special (A) Groundwater of the State shall not result in variations in the range of any parameter, or concentrations of constituents in excess of the standards of these regulations at any place or places of withdrawal or natural flow to the surface. A discharge that results in concentrations in excess of standards shall be permitted if post-discharge water quality can be returned to a quality of use equal to, or better than, and consistent with the uses for which the water was suitable prior to the operation." (WDEQ/WQD 2025c).

WDEQ has assigned the following designated uses to Fish Creek: aquatic life (coldwater aquatic life), drinking water, human consumption of fish, recreation, livestock, irrigation, industry, terrestrial wildlife, and scenic value uses (WDEQ/WQD 2024).

Wyoming's Integrated 305(b) Report and 303(d) List

Wyoming's 2022/2024 Integrated 305(b) and 303(d) Report lists Fish Creek as impaired due to two causes: 1) *E. coli* bacteria and 2) nutrient enrichment (total nitrogen and total phosphorus). A summary follows:

"Fish Creek (WYSR170401030101_01): Multiple lines of evidence from nutrient and aquatic life data collected at multiple locations throughout Fish Creek from 2014-2018 indicated that the Aquatic Life Other than Fish designated use is impaired due to nutrients (total nitrogen and total phosphorus). In the 2020 IR, Fish Creek was also listed as impaired for the Recreation designated use due to high concentrations of E. coli" (WDEQ/WQD 2025a).

Table 2. Overview of impaired segments of Fish Creek.

Waterbody Name	Waterbody ID	Location Description	Length (mi)	Cause of Impairment	First Listed	Supporting Documentation
Fish Creek	WYSR170401030101_01	Fish Creek upstream of WY Hwy 22 to headwaters	9.6	Nutrients (Total Nitrogen, Total Phosphorus)	2024	Fish Creek Nutrient Assessment
Fish Creek	WYSR170401030101_01	Fish Creek upstream of WY Hwy 22 to headwaters	9.6	*E. coli*	2020	Wyoming's 2020 Integrated 305(b) and 303(d) Report
Fish Creek	WYSR170401030101_02	Fish Creek downstream of WY Hwy 22 to Snake River confluence	5.1	*E. coli*	2020	Wyoming's 2020 Integrated 305(b) and 303(d) Report

Table 3. Existing water quality and habitat assessment data collection and reporting in the Fish Creek watershed.

Year	Waterbody	Data Category	Title	Responsible Organization	Supporting Documentation
1992	Fish Creek	Hydrogeological	*Teton County Westbank Groundwater Study*	Nelson Engineering	Nelson 1992 Report
2004-present	Fish Creek	Biological (fisheries)	Fish Creek fisheries surveys (ongoing)	Wyoming Game and Fish Department	--
2005	Fish Creek	Hydrogeological	*West Bank Snake River Hydrology Study*	Wyoming State Engineer's Office	SEO 2005 Report
2005	Fish Creek, Flat Creek	Microbiological	*Microbial Source Tracking for Escherichia coli in Two Upper Snake River Basins*	Teton Conservation District	MST 2005 Final Report
2004	Fish Creek	Physical hydrology	*Seepage Investigation on Selected Reaches of Fish Creek, Teton County, Wyoming, 2004*	US Geological Survey	USGS 2005 Report
2004-2006	Fish Creek	Physical hydrology	*Characterization of Interactions between Surface Water and Near-Stream Groundwater along Fish Creek, Teton County, Wyoming, by Using Heat as a Tracer*	US Geological Survey	USGS 2009 Report
2007-2011	Fish Creek	Water quality, biological	*Characterization of water quality and related biological communities*	US Geological Survey	USGS 2013 Report
2014-2018	Fish Creek	Water quality, biological	Fish Creek nutrient sampling	Teton Conservation District	--
2015-2016	Fish Creek	Water quality	Fish Creek nutrient sampling	Teton Conservation District, Teton Village Water and Sewer District	--
2016	Fish Creek	Water quality, geospatial	*Estimation of nitrogen and phosphorus inputs to the Fish Creek watershed*	US Geological Survey	USGS 2016 Report
2017	Fish Creek, Flat Creek, Snake River	Microbiological	*Recreation Use Support Determination for Flat and Fish Creeks, Teton County, WY*	Wyoming Department of Environmental Quality	Wyoming's 2020 Integrated 305(b) and 303(d) Report
2021	Fish Creek, Flat Creek	Microbiological	*Understanding the contribution of different microbial sources to surface water for informed management of waterborne pathogens in Wyoming*	University of Wyoming	UW Water Research Project 2022 Report
2022	Fish Creek, Teton County	Water quality, microbiological	*Teton County Septic System Effluent Monitoring Report*	Nelson Engineering, Teton Conservation District	Nelson Report
2023	Fish Creek	Water quality, biological	*Fish Creek Nutrient Assessment*	Wyoming Department of Environmental Quality, Tetra Tech	Fish Creek Nutrient Assessment
2023	Fish Creek, Flat Creek	Microbiological	*E. coli* and microbial source tracking data collection	Protect Our Water Jackson Hole, Alder Environmental, Teton Conservation District	--
2024 - present	Fish Creek, Flat Creek	Water quality, biological, microbiological	Fish Creek nutrient and *E. coli* data collection	Teton Conservation District	--
2025	Fish Creek	Water quality, biological	*Aquatic Life Other Than Fish Use Support Determination for Fish Creek, Teton County, WY*	Wyoming Department of Environmental Quality	Wyoming's 2024 Integrated 305(b) and 303(d) Report

3-5 Water Quality Summary

Water Quality Data Overview

Water quality monitoring data in Fish Creek consists of both continuous monitoring at a permanent streamgage location in Wilson, WY (USGS 13016450) and discrete sampling locations at multiple locations along the entire reach between Teton Village, WY and the Snake River. At the permanent streamgage in Wilson, both continuous discharge and continuous temperature are collected, year-round (Figure 2). As Fish Creek is spring-driven, lower overall maximum temperatures are observed during the warm summer months compared to the Snake River and similar Snake River tributaries. These other waterbodies regularly see maximum daily temperatures above 65 degrees Fahrenheit, and even above 70 degrees Fahrenheit. Several historical and seven current discrete sampling locations are present on Fish Creek. At current discrete sampling locations, physical/chemical data, including nutrient concentrations, dissolved oxygen, specific conductance, pH, and temperature are collected (Figure 3). Biological data including macroinvertebrate data, algae/periphyton, and benthic chlorophyll data are also collected at these discrete sites. To view a summary of the water quality data collected directly involved with determining the formal impairments in Fish Creek, refer to the rest of Section 3-5 and Appendix B.

E. coli Data

E. coli data have been collected in Fish Creek as part of microbial source tracking studies beginning as early as 1999. An *E. coli* source tracking study was completed in 2003 by Teton Conservation District (Remlinger, 2005). More recently, WDEQ collected *E. coli* data in Fish Creek in 2017 and determined that Fish Creek was not supporting its designated use of recreation in the 2020 Integrated Report (WDEQ/WQD 2020, Appendix B). As a result, Fish Creek was listed as impaired due to *E. coli* bacteria in 2020. To assess trends and inform recreators using the Wyoming Waterborne Pathogen Notification Process, Teton Conservation District began collaborating with *E. coli* data collection in 2023 in partnership with Protect Our Water Jackson Hole and Alder Environmental. TCD assumed sampling responsibility for *E. coli* in 2024 and continues to collect data currently.

E. coli data were collected at five sites on Fish Creek in 2017 and 2023-2025. All *E. coli* data presented have been collected under Sampling and Analysis Plans (SAPs) which have been reviewed and approved by WDEQ. Sampling methodology utilized the IDEXX Colilert method of total coliform bacteria and *E. coli* enumeration, outlined in the Standard Operating Procedures for Sample Collection and Analysis (WDEQ/WQD, 2025). *E. coli* data are reported in the most probable number of organisms per 100 mL, or MPN/100 mL. This unit is equivalent to colony forming units (cfu) per 100 mL. Data is available for sites A_R1D, A_RB, A_R3D, A_Wck, and A_R7 for the 2017, 2023, 2024, and 2025 recreation seasons. A summary of data collected since 2017 is provided below (Figure 4).

Microbial Source Tracking

In 2023, Protect Our Water Jackson Hole, in collaboration with Alder Environmental, Teton Conservation District, and the Wyoming Public Health Department, conducted a study to measure source contributions of fecal indicator bacteria in Fish Creek and Flat Creek in Teton County, WY. This study used microbial source tracking methods to evaluate *Bacteroides* markers from known host species and compared these signatures to those present in water samples. *Bacteroides*, a genus of bacteria associated with fecal pollution in waterbodies, was identified as a candidate for microbial source tracking work based on the large volume of study established in the literature (Reischer et al., 2013; Jang et al., 2017; Bae and Wuertz, 2009; Kim and Wuertz, 2015; Ahmed et al., 2016).

Water samples were collected during twelve independent sampling events at five sites on Fish Creek between May 1 and September 30, 2023. Upon receipt, samples were processed and analyzed using Traditional Real-Time Polymerase Chain Reaction (RT-PCR) methods which provided presence/absence results of *Bacteroides* markers within the sample. Samples were then filtered and frozen until the end of the sampling season, when Digital Polymerase Chain Reaction (dPCR) methods were utilized on positive detections to provide enumeration results for *Bacteroides* markers.

Markers identified for study within the Fish Creek watershed were AllBac (non-specific universal maker), HF-183 (human), HumM2 (human), HumM3 (human), RumBacB2 (ruminant-specific), CowM2 (cattle-specific), CowM3 (cattle-specific), BacCow (ruminant), BoBac (cattle-specific), and BacCan (canine-specific). These markers were chosen because of the presence of their hosts within the Fish Creek watershed. Additionally, these markers were present and available within the current genetic library of the Wyoming Public Health Laboratory in 2023. Avian and rodent sources were not quantified due to the lack of existing genetic information at the Wyoming Public Health Laboratory at the time. Positive detections from RT-PCR analysis for markers AllBac, BacCan, BacCow, CowM3, and HF-183 were run using dPCR to determine quantification of sources of fecal pollution in Fish Creek.

RT-PCR results from samples collected in 2023 demonstrated that at least one ruminant marker was detected in 100% of sampling events in Fish Creek (Figure 5). The human marker, HF-183, was detected primarily in upper Fish Creek, within and just downstream of Teton Village (eight of 12 sampling events). Lower Fish Creek also exhibited detections of HF-183 in six of 12 sampling events.

Digital-PCR results demonstrated that the largest contribution of *Bacteroides* in Fish Creek among those studied was from the ruminant-specific marker, BacCow, followed by the canine-specific marker, BacCan (Figure 5). The cattle-specific marker, CowM3, exhibited low enumeration throughout the watershed. The human-specific marker, HF-183, also exhibited low enumeration and was primarily localized in the upper watershed at site A_R1D.

Results from this study suggest that ruminant-specific markers are significantly present in Fish Creek. Ruminant-specific markers were both the most frequently detected marker using presence-absence methodology (RT-PCR) and the largest levels using the enumeration method (dPCR). Canine markers were also frequently detected in Fish Creek (up to 7 of 12 sampling events). The human marker (HF-183) was detected more frequently in upper Fish Creek, especially near Teton Village. Due to the low sensitivity of the cattle-specific CowM3 marker (Table B-2), it is difficult to determine whether the high presence of the ruminant-specific marker is due to the presence of cattle or due to non-bovine ruminants including elk, moose, and deer.

Nitrogen and Phosphorus

Median total nitrogen (TN) and total phosphorus (TP) concentrations from samples collected in Fish Creek between 2007 and 2025 exceeded reference-based thresholds identified in the Fish Creek Nutrient Assessment (WDEQ/WQD et al., 2023). The majority of TN collected in Fish Creek is in the form of nitrate (Figure B-15). TN and TP concentrations are highest in upper Fish Creek sites and decrease with downstream distance (Figure 6). Nitrate concentrations in Fish Creek surface water are highest in April and May, decrease throughout the growing season, and are lowest in October (Figure B-16). This consistent decrease in nutrient concentrations in both downstream distance and time is presumably due to the negative correlation established between nitrate concentrations and aquatic macrophytes, suggesting vegetative uptake of nitrogen during the growing season (Eddy-Miller et al., 2013).

Dissolved Oxygen and pH

Dissolved oxygen and pH dynamics can differ in streams experiencing nutrient enrichment compared to streams not experiencing nutrient enrichment due to the increased rate of primary production by aquatic vegetation (WDEQ/WQD et al., 2023).

The lower Fish Creek site (A_R7) exhibited greater daily dissolved oxygen maxima, daily dissolved oxygen range, and daily pH range than the upper site (A_R1D). Refer to Appendix B for more information on dissolved oxygen and pH dynamics in Fish Creek.

Macroinvertebrates

Taxa richness of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly), commonly referred to as EPT richness, is a common indicator of stream health as these taxa are generally sensitive to water quality degradation and important prey for fish (WDEQ/WDQ et al., 2023). EPT richness is higher in Fish Creek in April and May than in August (Figure B-24). EPT density, in individuals per m^2, is highest at the upstream site A_RB and lowest at the downstream site A_R7 (Figure B-25). A lower EPT percent, or proportion of EPT density compared to total macroinvertebrate density, in Fish Creek in 2024 suggests an increase in nutrient tolerant taxa. Macroinvertebrate data at A_RB and A_Wck were consistent with a combined model rating of “Non- or Partial Support” using Wyoming’s RIVPACS and WSII macroinvertebrate models (WDEQ/WQD et al., 2023).

Refer to Appendix B for comprehensive summaries of water quality and biological data collected from Fish Creek.

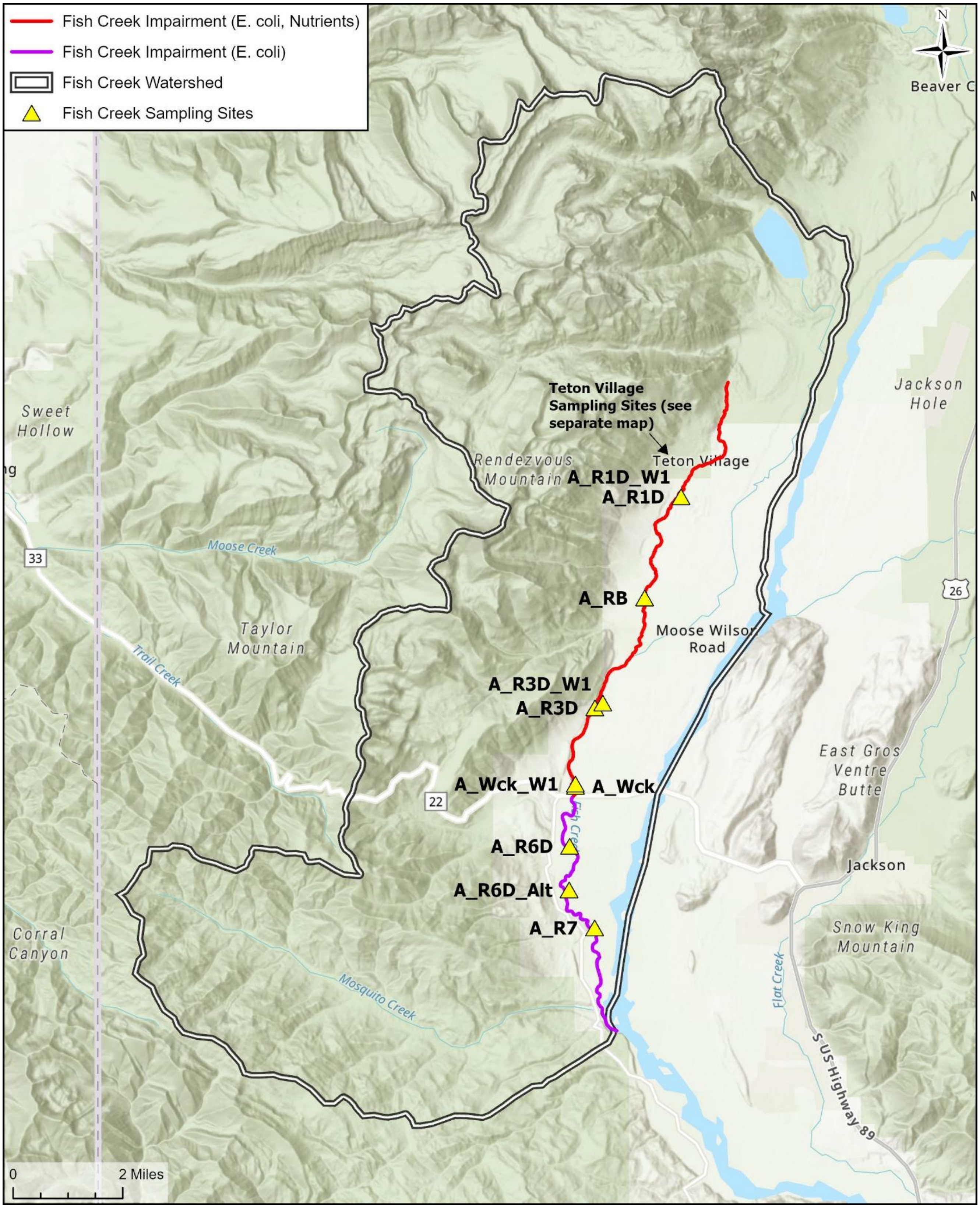


Figure 3. Fish Creek watershed, impaired segments, and surface water sampling sites.

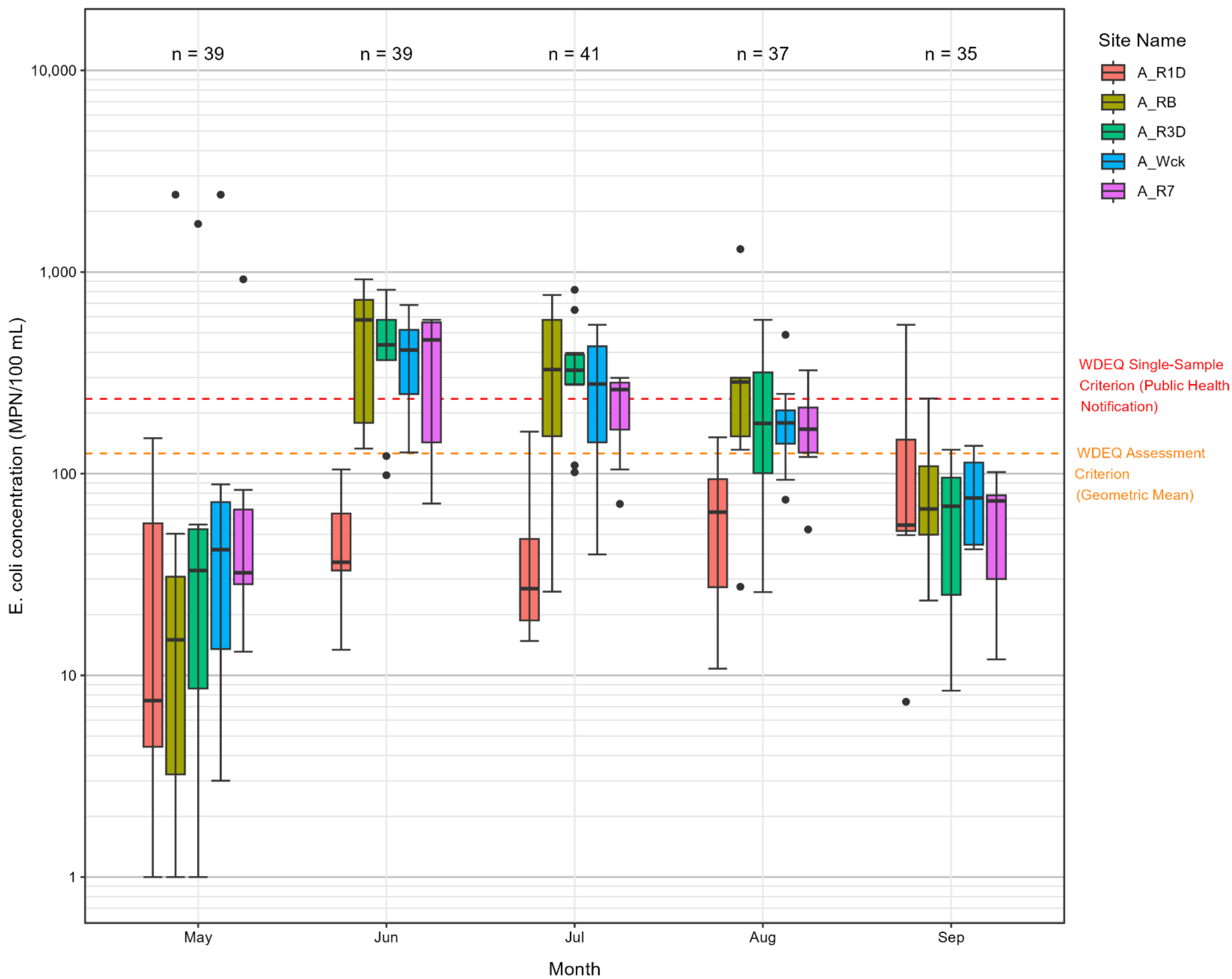
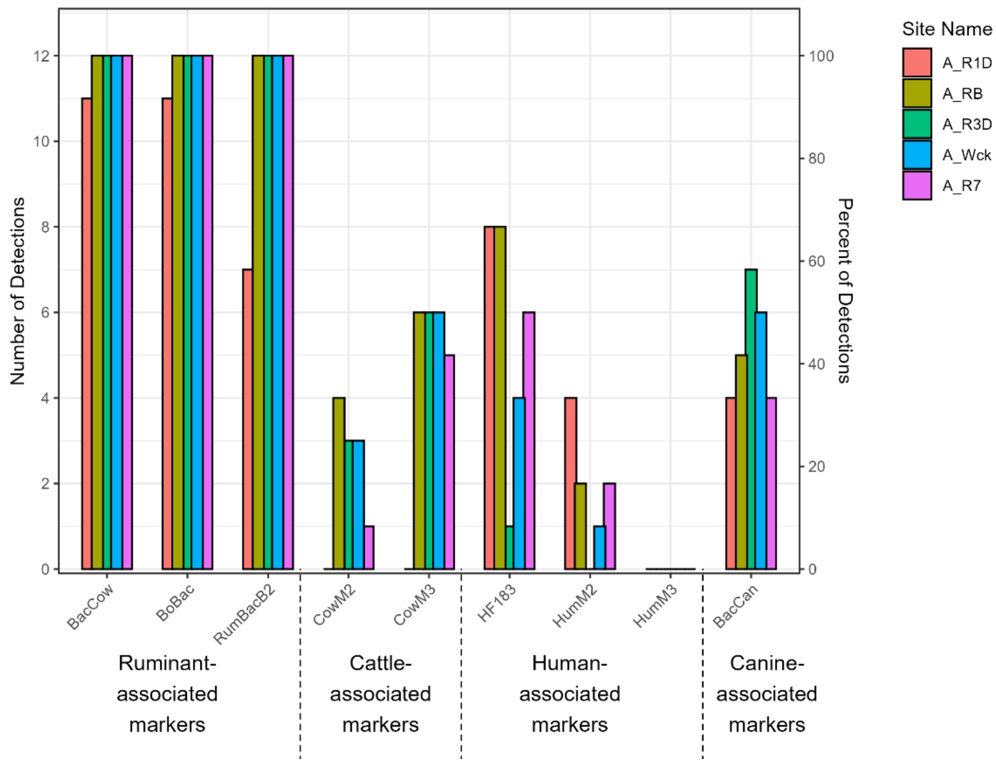


Figure 4. *E. coli* concentrations at regularly sampled Fish Creek sites. Samples collected during the 2017 and 2023-2025 primary recreation seasons. The red line represents the 235 organisms/100 mL single-sample criterion that is used in the public health notification process. The orange line represents Wyoming's numeric water quality criterion of a geometric mean of 126 organisms/100 mL protective of full body contact water recreation during the summer recreation season. Dots represent outliers outside of 1.5 times the interquartile range. Non-detects, or samples collected with <1 MPN/100 mL, are represented as 1.0 on a log-axis plot. The number of samples collected (n) is shown across the top of the plot.



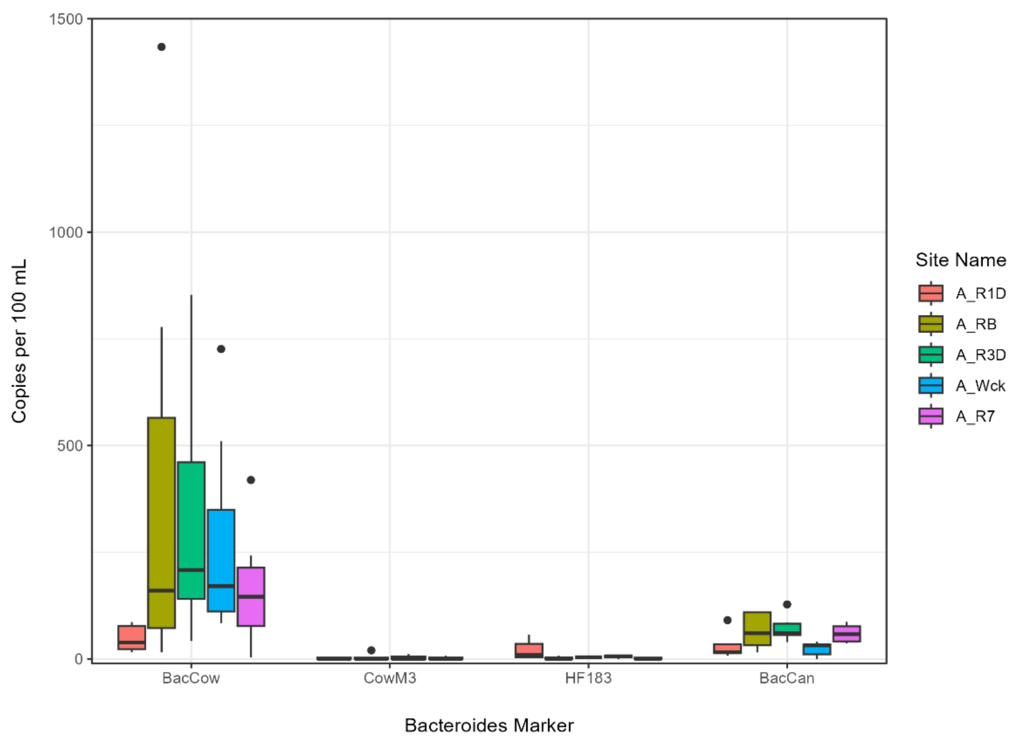
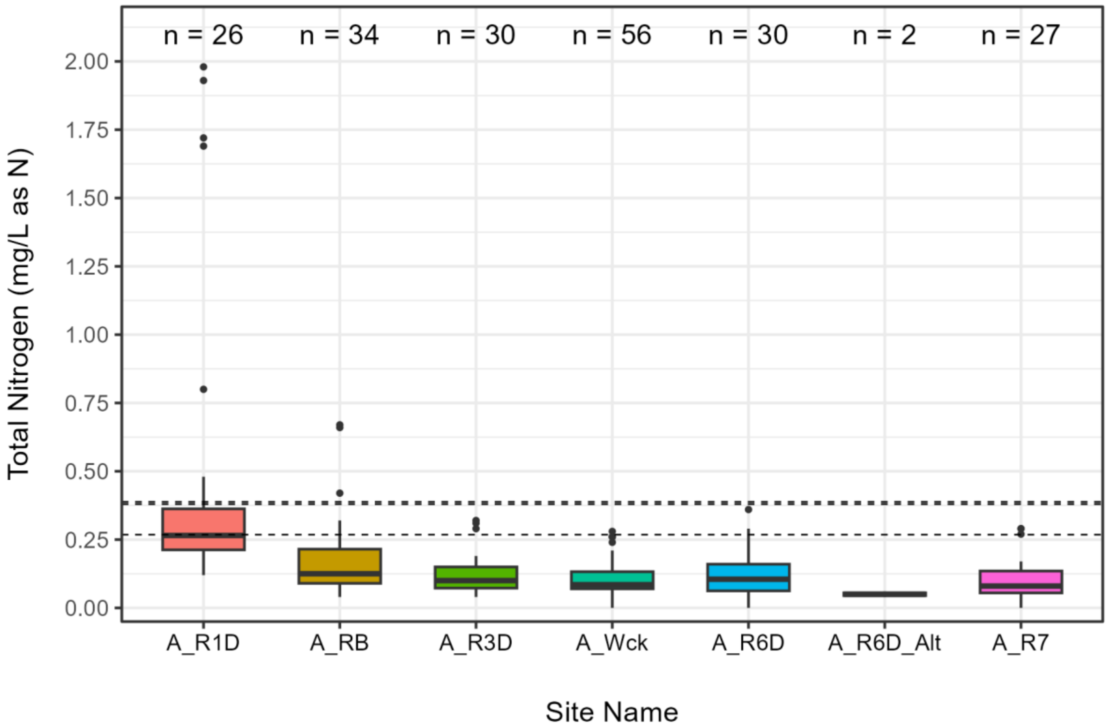


Figure 5. *Bacteroides* microbial source tracking results in Fish Creek. Presence-absence results from real-time PCR (top) and enumeration results from digital PCR (bottom) from samples collected during the 2023 primary recreation season. Dots represent outliers outside of 1.5 times the interquartile range.



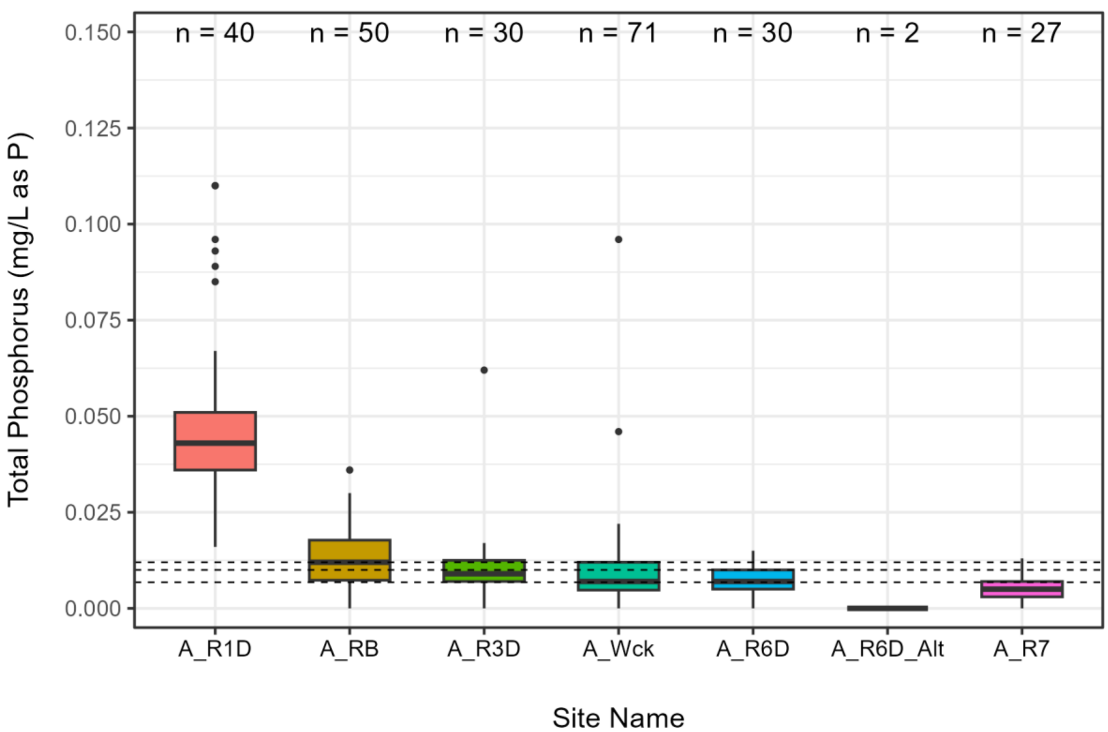


Figure 6. Total nitrogen (top) and total phosphorus (bottom) concentrations in Fish Creek between 2007-2011, 2014-2018, and 2024-2025. Dots represent outliers outside of 1.5 times the interquartile range. Dashed lines represent reference-based criteria identified in the Fish Creek Nutrient Assessment. EPA 25th percentile, Wadeable Streams Assessment (WSA) 25th percentile, and WSA 75th percentile (WDEQ/WQD et al., 2023). For total nitrogen, EPA 25th and WSA 75th percentiles are overlapping. The number of samples collected (n) is shown across the top of the plots.

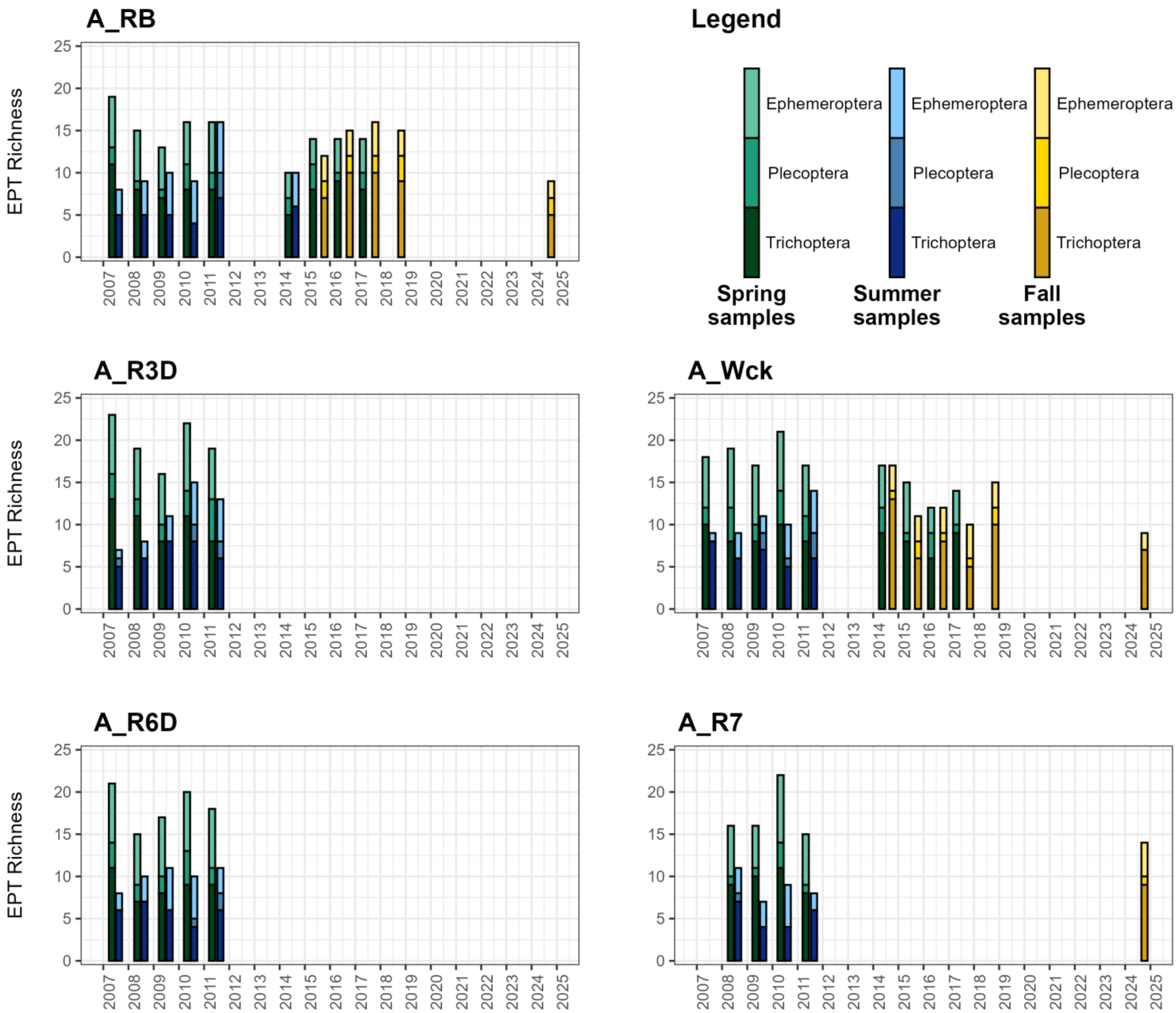


Figure 7. Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) richness in Fish Creek, 2007-2024.

WDEQ Fish Creek Nutrient Assessment

The following is a subset of nutrient-related data collected in Fish Creek. The subset refers to data accepted by WDEQ and utilized in a formal assessment of Fish Creek for nutrient impairment (WDEQ/WDQ et al., 2023). This Fish Creek Nutrient Assessment utilized a multiple lines of evidence approach to address the potential nutrient impairment. The basis for nutrient impairment is summarized below:

"This assessment was conducted using a lines of evidence approach, using a suite of indicators for the aquatic life designated use derived from the simple question:

> *If nutrients are causing an impact on Fish Creek, what would be the expected responses in terms of physical, chemical, and biological condition?*

The lines of evidence that would support a conclusion of use impairment due to nutrients include the following suite of indicators:

*1. **Nutrient Concentrations**: Nutrient concentrations would be elevated compared to sites without nutrient enrichment. Nutrient concentrations proximate to sources would be highest, and would decrease downstream, absent additional enrichment, as nutrients are taken up by algae and stored in benthic (or stream bottom) biomass.*

*2. **Benthic Algal Biomass:** Benthic chlorophyll would be elevated compared to sites without nutrient enrichment. Benthic chlorophyll would increase downstream until an equilibrium between uptake and release is reached. Nutrients flow downstream and the location of algal response can be displaced from the point of loading as it can take time (and thus space) for nutrient uptake to occur. Eventually, uptake and release rates may equilibrate, and no further increases in benthic chlorophyll are noted unless additional nutrients enter the system.*

*3. **Periphyton Composition:** Nutrient enrichment would cause a shift in the composition of benthic primary producers to more nutrient tolerant and nuisance algal species, including filamentous green algae, compared to sites without nutrient enrichment.*

*4. **Dissolved Oxygen and pH**: With greater primary producer biomass, greater daily variation in dissolved oxygen (DO) percent saturation, DO concentration, and pH are expected compared to sites without nutrient enrichment. This occurs because increased primary producer photosynthesis during the day would produce increased daytime oxygen and pH and then respiration of greater benthic biomass at night would produce larger decreases in nighttime oxygen and pH.*

*5. **Macroinvertebrates:** With a shift in habitat conditions to excess benthic biomass, a shift in the types of primary producers used as food, and changes in DO and pH, one would expect to lose some sensitive macroinvertebrate (especially aquatic insect) taxa.*

Available data on all of these measures were compiled from Fish Creek sampling sites and from regional reference sites. Additional reference values were obtained from the United States Environmental Protection Agency (EPA), other nearby states, and literature to provide additional perspective. Fish Creek sample values were then compared to reference values, which set expectations for conditions expected in the absence of nutrient enrichment.

In Fish Creek, total nitrogen (TN) and total phosphorus (TP) concentrations exceeded reference-based thresholds at one Fish Creek location (A-R1D). In addition, average and maximum benthic chlorophyll exceeded reference-based conditions as well as eutrophic thresholds at all Fish Creek sites. Periphyton composition was different from reference and included a proliferation of known nuisance taxa. DO and pH concentrations generally met water quality criteria, however observed increased diurnal fluxes are consistent with enhanced rates of primary productivity. Lastly, the macroinvertebrate assemblage was substantially altered from those that occur at reference sites. These results lead to the conclusion that nutrients are impairing the aquatic life designated use of Fish Creek." (WDEQ/WQD et al., 2023).

Refer to Appendix B and WDEQ/WQD et al. (2023) for a synopsis of data included in the Fish Creek Nutrient Assessment.

3-6 Pollutant Sources and Pathways

Sources of nutrients in the Fish Creek watershed have been compiled based on water quality and biological data collection and reporting efforts in Fish Creek from 2003-2025 (Table 3). Potential sources and pathways of *E. coli* and nutrients in the Fish Creek watershed include the following and are prioritized in order of importance. Importantly, this study was not able to account for wildlife as a nutrient source. A USGS report identified and quantified nitrogen and phosphorus sources and inputs to the Fish Creek watershed (Eddy-Miller at al., 2016). Sources and inputs of nitrogen and phosphorus to the Fish Creek watershed are summarized in Table 4 below. While this study helped quantify nutrient sources to the Fish Creek watershed, it does not account for vegetative uptake and transformation of nitrogen species between deposition locations and the creek, which could be separated by several miles.

Livestock and Agricultural practices (*E. coli* and nutrients)

One of the most significant land uses in the Fish Creek watershed when considering water quality impairments is agricultural land and livestock management operations. Multiple large ranches exist in the watershed, which manage cattle and horses in addition to cultivating hay. Several publications reviewed during this assessment indicate that livestock and agricultural operations contribute significantly to the *E. coli* and nutrient impairments on Fish Creek.

Cattle waste was identified as the second highest contributing source of nitrogen to the Fish Creek watershed at 28%, behind only atmospheric deposition (Eddy-Miller et al., 2016). Regarding phosphorus inputs, cattle waste was ranked as the primary contributing source to Fish Creek at 41% (Eddy-Miller et al., 2016).

Analysis of nitrogen isotopes and a comparison to literature values is another method to determine source contributions in the Fish Creek watershed. The USGS analyzed nitrogen isotope samples from surface water and groundwater samples throughout the watershed to determine likely sources of nitrogen. Nitrogen isotope values from water samples from the upper and lower reaches of Fish Creek were attributed primarily to manure and septic/sewage effluent (Eddy- Miller et al., 2013, Appendix B). The middle reach of Fish Creek contained isotope values indicating mixed sources of nitrogen. The upper and lower reaches of Fish Creek, which had nitrogen isotope values consistent with manure-derived nitrates, corresponded to areas where agriculture is the primarily land use.

Elevated concentrations of *E.coli* in Fish Creek are partially linked to fecal bacteria markers of cattle. In 2021, *E. coli* quantification methods were compared with community-based microbial source tracking (MST) results to assess sources of fecal bacteria contributing to the impairment of Fish Creek. Cattle waste was cited as the second largest contributor to aquatic bacterial communities behind wastewater (Ruehling, 2022).

Wastewater Effluent from Septic Systems (*E. coli* and nutrients)

Approximately 1,000 small wastewater facilities (septic systems) are located in the Fish Creek watershed, over 450 of which are buried leachfield systems (Teton Conservation District, 2018). In the Fish Creek watershed, high seasonal groundwater reduces the effectiveness of buried leachfield systems and the cold winter air temperatures reduce effectiveness of raised leachfields in the winter. This issue is compounded in locations where septic systems are located relatively close to a waterbody (see Section 4-4, Critical Areas). In collaboration with Teton Conservation District and Teton County, Nelson Engineering and Alder Environmental performed a monitoring study on septic system effluent from 2020-2022 and determined that, while nitrogen removal was effective in summer months, septic systems have decreased efficiencies in treating nitrogen in wastewater during winter months (Nelson Engineering, 2022).

Wastewater Treatment Plants (nutrients)

Two wastewater treatment plants are located within the Fish Creek watershed: Teton Village Water and Sewer District (TVWSD) and Aspen-Pines Water and Sewer District (APWSD). Both facilities inject treated effluent into Class 1 groundwater specified by WDEQ. In addition, one large capacity septic system with effluent discharge above 2,000 gallons of wastewater per day is present in the Fish Creek watershed. Both wastewater treatment plants and septic systems above 2,000 gallons of wastewater effluent per day are subject to WDEQ's Underground Injection Control permit program. The UIC program regulates both wastewater treatment plants to the following standards:

- Ammonia (as N): 0.5 mg/L
- Nitrate (as N): 10 mg/L
- Fecal coliform: 2 colonies per 100 mL – APWSD only
- *E. coli*: Absent – TVWSD only

The TVWSD treatment plant operates a mechanical wastewater treatment plant that is permitted for 1.170 MGD (million gallons per day) maximum flow and 0.7 MGD average flow and is responsible for the collection and treatment of wastewater within the TVWSD. The screening depth of the injection wells at TVWSD facility is between 15 and 25 feet below ground surface (TVWSD UIC Permit # 2024-0001). The TVWSD wastewater treatment facility discharges between 0.5-7 mg/L nitrate (as N) into the groundwater in the upper Fish Creek watershed (Trihydro Corporation, 2024). As of 2024, there is no current land application of biosolids from the TVWSD facility, and biosolids are trucked to Bonneville County, ID.

The APWSD operates a mechanical wastewater treatment plant that is permitted for 0.40 MGD maximum flow and 0.24 MGD average flow. The screening depth of the injection wells at APWSD is between 10 and 102 feet below ground surface (APWSD UIC Permit #15-370). The APWSD wastewater treatment facility discharges between 0.5-6 mg/L nitrate (as N) into the groundwater in the Fish Creek watershed (Trihydro, 2024). As of 2024, biosolids are stored and treated in an onsite lined wetland or trucked to the Teton County Integrated Solid Waste and Recycling facility (Trihydro, 2024).

Both wastewater treatment facilities are the largest sources of both nitrogen and phosphorus, per acre, in the Fish Creek watershed (Eddy-Miller et al., 2016).

Available data do not suggest that wastewater treatment plants or other point source discharges are a significant source of *E. coli* in the Fish Creek watershed (see Appendix A).

Wildlife (*E. coli* and nutrients)

Wildlife may be significant sources of both *E. coli* and nutrients to the Fish Creek watershed. Elk, mule deer, moose, birds, bear, beavers, and other wildlife are prevalent in and near Fish Creek throughout the year. Controlling true wildlife impact on water quality is not in the scope of this plan and is also in conflict with the progress this community and others have made in implementing wildlife-friendlier fencing. The goal of this plan is to achieve water quality standards by controlling influences by humans and human development. However, by maintaining and enhancing the health of wetlands and riparian areas, we also reduce the potential for wildlife feces to enter surface waters.

Atmospheric Deposition (nutrients)

Atmospheric deposition is a significant source of both nitrogen and phosphorus to the landscape. Nitrogen can enter the atmosphere from anthropogenic sources including agriculture, fire, industry, wastewater treatment, coal combustion, or transportation and can be deposited via wet or dry deposition (Eddy-Miller et al., 2016). The mobilization of sediment from agricultural areas is one of the largest sources of phosphorus deposition nationwide (Sabo et al., 2021), and areas like the Snake River Plain in southern Idaho could be a source of phosphorus to the Fish Creek watershed due to a prevailing west wind. Across the entire land area of the Fish Creek watershed, atmospheric deposition contributed the largest input of nitrogen (Eddy-Miller, et al., 2016, Table 4).

Fertilizer Applied to Lawns, Trees, and Golf Courses (nutrients)

Potential sources of fertilizer application in the Fish Creek watershed include golf courses, lawns, parks, agricultural crops, and planted/ornamental woodlands. Application rates and frequency of application varies with land use. Golf courses were found to have a mean nitrogen application rate of 92 lb/acre/yr. Phosphorus application rates from fertilizer average 2.4 lb/acre/yr (Eddy-Miller et al., 2016).

Humans, Non-Wastewater (*E. coli*)

Humans can be a source of *E. coli* both directly as a fecal contributor and indirectly through their pets. Of domestic (human) sources, dog waste was found to be the largest source of *E. coli* in the Fish Creek watershed (Remlinger 2005, Appendix B). Recreation in and near waterbodies, including wading, floating, tubing, and swimming, can be a source of *E. coli* to the Fish Creek watershed through direct or indirect fecal deposition. Stormwater discharge from impervious developed areas in the watershed can also directly contribute to elevated *E. coli* concentrations in Fish Creek and its tributaries (Shanks et al., 2024).

Other Natural Sources (nutrients)

Other natural sources of nutrients could include a geologic source within the upper watershed as well as nitrogen fixation, or the process of converting nitrogen gas to biologically available nitrogen. Studies have identified geological-derived nitrogen and phosphorus as drivers of nutrient concentrations in surface water in the western US (Deas et al., 2024). As Fish Creek is closely tied to its adjacent groundwater, a natural geologic source of nitrogen or phosphorus could have significant impact on nitrate concentrations in Fish Creek. The Teton County Water Quality Management Plan recommended assessing the contribution of geologic nutrient sources in the Fish Creek watershed as a need within the monitoring section of this plan (Trihydro, 2024).

While Eddy-Miller et al. (2016) identified and characterized sources of nutrients in the Fish Creek watershed, we are presently unable to accurately quantify the loading rate of nutrients from all assessed land uses into Fish Creek directly. Pathways along the land surface and through shallow groundwater provide opportunities for nutrients to be taken up by vegetation or transformed into other species. The nutrient sources from this study should be characterized as potential sources until further tracing studies are performed in Fish Creek to identify the fate of nutrients in the stream (see Section 3-7).

Table 4. Fish Creek nitrogen and phosphorus sources, adapted from Eddy-Miller et al. (2016).

Source	Maximum nitrogen input (lb/10 acres)	Total annual nitrogen input into watershed (lb)	Percentage of total nitrogen input from source	Maximum phosphorus input (lb/10 acres)	Total annual phosphorus input into watershed (lb)	Percentage of total phosphorus input from source
Atmospheric deposition	63	280,000	46%	2.8	19,000	23%
Fertilizer (golf courses)	840	20,000	3%	42	520	0.7%
Fertilizer (lawns and parks)	660	66,000	11%	45	4,600	6%
Fertilizer (planted/ornamental woodlands)	20	1,400	0.2%	8.8	620	0.8%
Septic Systems	270	28,000	4%	39	3,900	5%
Wastewater treatment plants (injectate)	3,900	4,800	0.8%	2,100	3,100	4%
Wastewater treatment plants (biosolids land application)	360	3,200	0.5%	140	1,300	2%
Livestock (horses)	3,220	36,000	6%	1,200	13,000	16%
Livestock (cattle)	390	174,000	28%	72	32,000	41%
Snake River diversions	31	940	0.2%	57	1,700	2%
Explosives used for avalanche control	43	43	0.01%	NA	NA	NA

3-7 Data Gaps

A summary of existing data collected in Fish Creek is provided in Section 3-5 and Appendix B. While these sections attempt to be comprehensive and provide summaries of multiple categories (biological, chemical, physical) of data across two decades, questions remain regarding the location and transport of nutrient sources in Fish Creek.

Fish Creek near Teton Village, WY has been shown to be sensitive to seasonal fluctuations in groundwater level due to snowmelt (Eddy-Miller et al., 2009). In addition, nutrient concentrations in Fish Creek are highest in upstream sites, decreasing with downstream distance, and highest during the time where the groundwater level is rising due to snowmelt (Eddy-Miller et al., 2013). These two concepts lead us to believe that a significant portion of Fish Creek's nutrient sources are in upper Fish Creek, but we do not yet know the fate and transport of nutrients between groundwater and surface water. A tracer study that characterizes nutrient transport, especially from injected wastewater effluent, from shallow groundwater to Fish Creek and Lake Creek has been recommended to answer this question.

While ponds have been identified as a non-priority watershed issue in this plan, pond development in the Fish Creek watershed and Teton and Lincoln counties has seen a sharp increase over the last 10-15 years. In 1994, a study was performed to address the groundwater impacts from ponds on the west bank of the Snake River and found "a very small impact" (Hinckley and Jorgensen, 1994). While recent land development regulation updates in Teton County have sought to address pond development and management, a study identifying existing ponds in the Fish Creek watershed that are surficially connected to Fish Creek and their resulting impact on stream temperature, aquatic ecology, and nutrient transport is warranted.

Nutrient concentrations in surface waters can be affected by natural geologic sources. High nutrient concentrations have been observed in groundwater and surface water in sites in and near Teton Village, WY, upstream and downstream of the Teton Village wastewater treatment plant (Appendix B). Further investigation is needed to determine if there is a potential natural geologic source of nitrogen or phosphorus in the Fish Creek watershed.

The potential link between Teton Village wastewater effluent injectate and the higher concentrations of nutrients found in upper Fish Creek also needs to be studied. A tracer study investigating the flow direction and surficial connectivity of injectate to Fish Creek could differentiate natural versus injectate nutrient loading to Fish Creek in the Teton Village area.

While *E. coli* concentrations have been quantified in Fish Creek over a few seasons, documenting the extent of their source has not fully been possible due to the lack of sampling for *E. coli* in Lake Creek. Further study is needed to quantify sources in Fish Creek tributaries (Granite Creek and Lake Creek) to prioritize projects that reduce *E. coli* loads upstream of their Fish Creek confluence. Standardizing methodology for future microbial source tracking studies, concurrent with existing *E. coli* data collection, is also being explored.

Table 5 below provides a list of identified data gaps and recommended monitoring and data collection studies or objectives, along with the source of the identified data gap or suggested study. The monitoring and data collection efforts proposed support the planning process and are targeted to monitor/address data gaps and pollutant transport. The list of studies was developed from the input received in the stakeholder meetings, as well as additional ideas from Teton Conservation District.

Identified data gaps in Table 5 are prioritized in order of importance and should be addressed in the order they are presented when feasible. Teton Conservation District and its partners will move forward with addressing these data gaps using existing funding mechanisms in Section 5-4, given stakeholder interest and capacity.

Table 5. Identified data gaps in monitoring to support the planning process.

Monitoring Objective		Input Source
1	Conduct wastewater effluent discharge tracer study	Agency Meeting Input
2	Conduct groundwater modeling study to identify the direction and magnitude of groundwater entering Fish Creek	Crescent H Stream and Trail Committee
3	Collect additional groundwater samples at spring sources in Fish Creek headwaters to investigate a potential natural geologic source of nutrients	TCD
4	Study water quantity and water quality impacts from ponds to understand cumulative impact of pond construction on Snake River alluvial aquifer	Public Meeting Input
5	Map the headwaters of Fish Creek in Teton Village	TCD
6	Identify unmaintained, failing, or unused septic systems	Public Meeting Input
7	Continue microbial source tracking study with direct fecal sample collection to aid genetic marker verification	TCD
8	Quantify stormwater runoff and snowmelt hotspots along Fish Creek corridor	Public Meeting Input
9	Establish long-term trend monitoring for groundwater quality	TCD
10	Perform inventory of sewer lines in Fish Creek watershed and identify potential infiltration/exfiltration	TCD
11	Study alternative discharge options for wastewater treatment plants in the Fish Creek watershed	TCD
12	Conduct additional discharge monitoring in Upper Fish Creek to estimate nutrient (N,P) loads	TCD
13	Study riparian soil and vegetation condition, before and after riparian exclusion (fence), using Multiple Indicator Monitoring of Stream Channels and Streamside Vegetation protocol	TCD
14	Study impact of reducing land application of biosolids on Fish Creek water quality	Aspens Pines Water & Sewer District
15	Conduct continued surface water monitoring for pesticides with partner agencies	Agency Meeting Input
16	Study on permeability and exchange of bacteria between Fish Creek surface water and shallow groundwater of Snake River alluvial aquifer	Public Meeting Input
17	Implement high-frequency nutrient concentration data collection in Fish Creek	TCD
18	Conduct full watershed assessment of riparian habitat condition; identify bank stabilization sites and riparian planting areas	Public Meeting Input
19	Fish population monitoring to determine if BMPs have resulted in a biological response in Fish Creek	Trout Unlimited
20	Temperature monitoring to determine if riparian BMPs and stormwater improvements are effective in maintaining low stream temperature	Trout Unlimited
21	Habitat Condition Monitoring to determine erosion potential and ability for streams to retain and process nutrients	Trout Unlimited
22	Post-project water quality assessment for fencing, vegetation plantings/habitat treatments, diversions/irrigation improvements	Trout Unlimited
23	Continue use support determination data collection on nutrients and *E. coli*	TCD
24	Study of rooted macrophyte and cobble embeddedness trends in Fish Creek	Public Meeting Input

4 WATERSHED ISSUES, PREVIOUS WORK, AND CRITICAL AREAS

4-1 Past and Present Best Management Practices in Fish Creek

Existing watershed improvement and protection measures were identified prior to developing a management strategy for the Fish Creek watershed (Table 6). The list of completed and ongoing programs, policies, and studies was developed from the input received in the stakeholder meetings and from knowledge of public and private projects within the watershed. These existing management practices are grouped into three categories:

1. *Structural Management Practices*
   These practices involve construction, installation, and maintenance to capture pollutants, improve or enhance habitat, and eliminate erosion.

2. *Non-Structural Management Practices*
   These practices involve changes to activities or behavior and focus on controlling pollutants at their source and preventing degradation of habitat.

3. *Administration and Monitoring*
   Involves administration of watershed plan implementation, annual evaluations and reporting, monitoring of management practice success, and revisions to the plan.

4-2 Priority Watershed Issues

Priority watershed issues identified by Teton Conservation District and project partners relate to the Fish Creek goals and objectives outlined in Section 2 of this Plan.

1. Nutrient and *E. coli* loading from livestock use adjacent to Fish Creek
2. Nutrient loading from Underground Injection Control (UIC) facilities that discharge to shallow groundwater (less than 30 ft)
3. Loss of riparian vegetation and habitat along Fish Creek
4. Hydrological flow alterations in Fish Creek from irrigation conveyed from the Snake River
5. Nutrient loading from septic systems adjacent to Fish Creek
6. Eutrophic processes increasing aquatic plant biomass on the streambed of Fish Creek, impacting fish spawning and aquatic invertebrate habitat
7. Stormwater influence on Fish Creek from developed areas, including Wilson and Teton Village
8. Clean Water Action Section 303(d) listing status

4-3 Non-Priority Watershed Issues

Non-priority watershed issues were identified by project partners and the public but will be addressed minimally by management practices in this watershed plan.

1. Recreational floaters trespassing on private land and impacting fish and wildlife
2. Litter from stormwater and developed areas in Fish Creek
3. Pesticides from public agency invasive species control efforts entering water resources
4. Impact of ponds and manmade watercourses
5. Road and pathway infrastructure adjacent to waterways

Table 6. Past and present best management practices in Fish Creek.

	Structural Management Practices	Status
1	Shooting Star Golf Course and subdivision grading and erosion control	Completed
2	Shooting Star West pond outfall – gravel bed wetland	Completed
3	Teton Village stormwater retention facility	Completed
4	Teton Village Water & Sewer District – improvements to wastewater treatment facilities, treatments for nitrate and ammonia	Completed
5	Aspens-Pines Water and Sewer District – reduce/eliminate land application of biosolids	Completed
6	Teton Pines - reduced fertilizer use	Completed
7	Wilson Sewer pre-Phase IV installation	Completed
8	Private creek restoration and enhancements	Completed
9	Private wastewater treatment wetland - Pomeroy residence	Completed
10	Riparian area fencing on Fish Creek on Snake River Ranch	Ongoing
11	Trout Unlimited bank stabilization projects to reduce sediment loads	Completed
12	Improvements to water flow control infrastructure on ditches on Snake River Ranch	Completed
	Non-Structural Management Practices	
13	Edmiston Spring snowmelt mitigation with Hungry Jacks General Store, Jackson Hole Land Trust, and Teton Conservation District	Completed
14	Protect Our Water Jackson Hole (formerly Friends of Fish Creek) and Jackson Hole Clean Water Coalition Outreach and Education	Ongoing
15	JH Clean Water Coalition - Trout Friendly Lawns Program	Ongoing
16	Trout Unlimited Adopt-a-Trout program	Ongoing
17	Protect Our Water Jackson Hole Rally for Clean Water	Completed
18	TCD/Protect Our Water Jackson Hole Septic System Maintenance Cost Share Program (2019)	Completed
19	Protect Our Water Jackson Hole Septic System Maintenance Cost Share Program (2024)	Completed
	Administration and Monitoring	
20	Shooting Star Golf Course Natural Resources Management Plan	Completed
21	Teton County Westbank Groundwater Study (Nelson Engineering, 1992)	Completed
22	West Bank Snake River Hydrology Study (Wyoming State Engineer's Office, 2005)	Completed
23	Snake / Salt River Basin Water Plan Update Groundwater Study (Wyoming State Geological Survey, 2014)	Completed
24	Shooting Star Golf Course Water Quality Monitoring	Ongoing
25	Friends of Fish Creek Teton Pines Golf Course Water Quality Monitoring	Completed
26	Friends of Fish Creek, Protect Our Water JH, & Teton Conservation District Water Quality Monitoring and Assessment	Ongoing
27	Teton Conservation District Septic System Water Quality Assessment (2022)	Completed
28	Adoption of water quality measures in Jackson Teton County Comprehensive Plan Update (2020)	Completed
29	Teton Conservation District Septic and Sewer Mapping (2018)	Completed
30	Wyoming Game & Fish Department - Fish Population Surveys	Ongoing
31	Teton County Water Quality Management Plan (2024)	Completed
32	Teton Pines Golf Course Audit by EnviroLogic Resources, LLC	Completed
33	TCD Surface Water Inventory (2019)	Completed
34	Upper Snake River Basin Level 1 Watershed Study (2016) – Wyoming Water Development Office	Completed
35	Teton County Land Development Regulations update regarding setbacks from surface waterbodies	Completed

4-4 Critical Areas

The impaired reach of Fish Creek, extending from its headwaters near Teton Village to the WY-22 crossing near Wilson is of the highest management priority. This reach extends for 9.6 miles and incorporates the Fish Creek, Lake Creek, Granite Creek, and Phillips Canyon watersheds. Critical areas in Fish Creek are defined below. Refer to Map 9 for a spatial representation of critical areas in Fish Creek.

1. *Upper Fish Creek, including Teton Village and Shooting Star subdivision*
   Upper Fish Creek is known to be more closely connected to its adjacent groundwater than downstream reaches, making it more susceptible to contaminant transport via groundwater (Eddy-Miller et al., 2013). As such, the introduction of nutrients to Fish Creek is facilitated by that connection to groundwater, particularly in April and May when the groundwater table is rising from snowmelt. A significant amount of development has occurred recently and will continue based on the zoning in this resort district. This area of Fish Creek is identified as a critical area as it may have a more significant effect on nutrient concentrations and associated algal biomass growth observed in downstream reaches.

2. *Areas of livestock grazing along Fish Creek and Lake Creek between Teton Village and Wilson, WY.*
   Riparian restoration efforts should be focused primarily on this reach of Fish Creek and Lake Creek. Although some fencing has occurred in the riparian area, especially on Fish Creek, the lack of existing riparian buffer in some locations and the impact of livestock on the riparian corridor highlights the need to continue to implement riparian fencing on Fish Creek, Lake Creek, and areas where irrigation return flows travel to Fish Creek.

3. *Areas of Fish Creek where septic systems may be within 100ft of the waterbody.*
   A prioritization of areas where septic systems, particularly systems that were permitted decades ago, may be located within 100 ft of the waterbody. As of 2024, the Teton County Small Wastewater Facility regulations require a 50 ft horizontal setback to surface water from both a septic tank (or equivalent) and a soil absorption system (leachfield) (Teton County, 2022). Particularly in locations where sewer connection is possible, these areas are identified as critical areas for their need for more focused attention to either maintenance/replacement or sewer connection.

4. *Impervious surfaces and snow storage locations near Fish Creek, including areas near Wilson, WY, and Teton Village, WY.*
   Impervious surfaces are known to promote stormwater runoff, both in the snowmelt season (Apr-May) and during summer storm events. While a very small percentage of the Fish Creek watershed is covered by impervious surface, there are some areas that have little riparian buffer between the impervious surface and Fish Creek (or its tributaries, including Edmiston Spring). Additionally, some areas of the Fish Creek watershed are used as snow storage locations throughout the winter season. These areas should be prioritized for future long-term best management practice implementation through riparian buffer expansion, stormwater detention, and other practices.

5 IMPLEMENTATION PLAN

5-1 Future Best Management Practices in Fish Creek

Management practices were chosen to achieve the watershed management goals identified in Section 2 of this plan and to achieve water quality criteria in Fish Creek. Tables 7 and 8 (below) provide a summary of the recommended management practices. The list of programs, policies, and studies to protect and improve the watershed was developed from the input received in the stakeholder meetings, as well as additional recommendations from Teton Conservation District.

This plan identifies a large number of projects, which are split into two phases. Phase 1 projects (Table 7) are high priority projects that can be implemented within the next five years. Specifically, exclusion of livestock from riparian areas, planting, and voluntary grazing management projects can be implemented on a short time scale with approval and support of agricultural landowners in the watershed. Partnerships currently exist between these landowners and water quality stakeholders in the Fish Creek watershed, and continued outreach and meetings will be the key to implementing these projects in a timely manner. These high priority Phase I BMPs are key projects to improve water quality in Fish Creek and are listed in Table 7. Table 7 lists the critical area addressed, the pollutant source addressed, the estimated implementation timeline, cost, and funding source for each proposed BMP. BMPs were chosen based on their effectiveness in reducing water quality impacts to waterbodies from human activities, both in peer-reviewed literature and prior watershed plan implementation in Wyoming.

Agricultural sources of *E. coli* and nutrients can be reduced by the implementation of best management practices that control direct waste deposition and surface water runoff to Fish Creek and its tributaries. These practices should be designed to control the location of waste deposition and to create or increase the buffer distance between livestock activity and a waterbody. In the Fish Creek watershed, this can be challenging as the majority of land area on the west bank of the Snake River sees very high groundwater tables during the runoff months that lead to ponding of water in locations where livestock grazing occurs, resulting in the connection of a large portion of the land surface and Fish Creek for weeks to months at a time. Care must be taken to collaborate with local irrigators whose voluntary irrigation water use strategies can have a significant positive impact on water quality. WDEQ's Livestock/Wildlife Best Management Practices Manual is a valuable resource for determining strategies to reduce contribution of fecal waste from livestock to surface waters (WDEQ/WQD, 2013).

Phase 2 projects are longer-term projects and are listed and described in Table 8. These proposed projects are related to wastewater infrastructure, erosion control, pet waste, snow storage, and other sources of pollution.

Small wastewater facility regulations in Teton County were revised in 2021 and incorporated the need for new systems to have four feet of separation between the leachfield and the groundwater table (Teton County, 2022). While this is a good step forward, most systems in the Fish Creek watershed are older systems not subject to new regulations. Septic system maintenance and replacement in locations where sewer connection is impossible remains a significant strategy to maximize the treatment efficacy of septic systems. While connection of aging/failing septic systems to a local sewer system remains a goal to reduce *E. coli*/nutrient loading, it remains a fact that some septic systems will remain present in Teton County, WY for the foreseeable future.

Continued best management practice implementation at golf courses and residential areas, including increased outreach for the Trout Friendly Lawns Program (see Section 5.6) can balance aesthetic quality with reduced nutrient application rates, and incorporate larger riparian buffers for uptake before surface water discharge.

Table 7. Proposed Phase I best management practices to improve water quality and riparian habitat in Fish Creek.

Phase I BMPs (High Priority, Short Term Projects)							
	Project Description	**Critical Area Addressed**	**Pollutant Source Addressed**	**Implementation Timeline**	**Cost Estimate**	**Lead Organization**	**Funding Source**
1	Plant temporarily excluded riparian vegetation filter strips on livestock access areas on WYOSLI parcel in Teton Village	2	Livestock and agricultural practices (*E. coli* and nutrients)	2027 - 2032	$50,000-$100,000	TCD, TU, WGFD	WDEQ, NRCS, WDA, TCD
2	Establish riparian area exclusion fencing or utilize virtual fencing on livestock access areas on WYOSLI parcel	2	Livestock and agricultural practices (*E. coli* and nutrients)	2027 – 2032	$15,000-$50,000	TCD, TU, WGFD	WDEQ, NRCS, WDA, TCD, Ricketts Conservation Foundation, JHOF
3	Plant temporarily excluded riparian vegetation filter strip on livestock access areas along Fish Creek upstream of Wilson	2	Livestock and agricultural practices (*E. coli* and nutrients)	2027 – 2032	$50,000-$100,000	TCD, TU, WGFD	WDEQ, NRCS, WDA, TCD
4	Establish riparian area exclusion fencing or utilize virtual fencing on livestock access areas upstream of Wilson	2	Livestock and agricultural practices (*E. coli* and nutrients)	2027 - 2032	$15,000-$50,000	TCD, TU, WGFD	WDEQ, NRCS, WDA, TCD, Ricketts Conservation Foundation, JHOF
5	Plant temporarily riparian vegetation filter strip on livestock access areas along Fish Creek downstream of Wilson	NA	Livestock and agricultural practices (*E. coli* and nutrients)	2027 – 2032	$50,000-$100,000	TCD, TU, WGFD	WDEQ, NRCS, WDA, TCD
6	Establish riparian area exclusion fencing or utilize virtual fencing on livestock access areas downstream of Wilson	NA	Livestock and agricultural practices (*E. coli* and nutrients)	2027 - 2032	$15,000-$50,000	TCD, TU, WGFD	WDEQ, NRCS, WDA, TCD, Ricketts Conservation Foundation, JHOF
7	Design and construct off-channel stockwater facilities	1, 2	Livestock and agricultural practices (*E. coli* and nutrients)	2027 – 2032	$0 - $15,000	TCD	WDEQ, NRCS, WDA, TCD, SWPP
8	Design and construct hardened stream crossings and water gaps in high use and degraded areas	All	Livestock and agricultural practices (*E. coli* and nutrients)	2027 - 2032	$50,000-$100,000	TCD	WDEQ, NRCS, WDA, TCD
9	Implement erosion control, riparian buffers, and other BMPs between corrals and waterbodies adjacent to Fish Creek and its tributaries	1, 2	Livestock and agricultural practices (*E. coli* and nutrients)	2027 – 2032	$15,000-$50,000	Private landowner	TCD/Private
10	Implement regulations for fertilizer use as recommended in the Teton County WQMP	All	Fertilizer application (nutrients)	2027 – 2028	$0 - $15,000	Teton County	NA
11	Implement septic system replacement cost-share program for failing systems with Teton County	All	Wastewater effluent from septic systems (*E. coli*, nutrients)	2027 – 2032	$100,000+	Teton County	TCD/Private
12	Outreach/education campaigns to inform public on Fish Creek issues and pollutant sources	All	Wastewater sources, fertilizer application (*E. coli* and nutrients)	2026 - 2027	$15,000-$50,000	All	All
13	Implement sewer connection to wastewater treatment immediate priority areas in the Fish Creek watershed listed in the WQMP	All	Wastewater effluent from septic systems (*E. coli* and nutrients)	2027 – 2032	$1,000,000+	Private landowner, sewer districts, Teton County	TCD/Private

Table 8. Proposed Phase II best management practices to improve water quality and riparian habitat in Fish Creek.

Phase II BMPs (Medium to Low Priority/Long-term Projects)				
	Project Description	**Critical Area Addressed**	**Pollutant Source Addressed**	**Cost Estimate**
1	Increase riparian buffers on ditches and tributaries to Fish Creek	All	Livestock and agricultural practices, wildlife, fertilizer, humans (*E. coli* and nutrients)	$0 - $15,000
2	Implement sewer connection to wastewater treatment short-term and long-term priority areas in the Fish Creek watershed listed in the WQMP to sewer	All	Wastewater effluent from septic systems (*E. coli* and nutrients)	$1,000,000+
3	Expand existing wastewater collection systems in the Fish Creek watershed	All	Wastewater effluent from septic systems (*E. coli* and nutrients)	$1,000,000+
4	Revise the Teton County Small Wastewater Facility Regulations regarding maintenance and inspection	All	Wastewater effluent from septic systems (*E. coli* and nutrients)	$0 - $15,000
5	Design and construct improved irrigation systems to reduce pollution from irrigation return flows to Fish Creek	All	Livestock and agricultural practices (*E. coli* and nutrients)	$100,000-$500,000
6	Incorporate improvements to existing wastewater treatment facilities, including sewer line maintenance	All	Wastewater treatment plants (nutrients)	$100,000+
7	Perform continued outreach/education on septic system operation and maintenance and support a cohesive maintenance and inspection program	All	Wastewater effluent from septic systems (*E. coli* and nutrients)	$15,000-$50,000
8	Develop options for alternative usage of biosolids that originate from wastewater treatment plants	1	Wastewater treatment plants (nutrients)	$15,000-$50,000
9	Erosion control implementation on earthwork projects in the Fish Creek watershed	All	NA	$15,000-$50,000
11	Assess opportunities for Land Development Regulation Amendments that address ponds, snow storage, and other categories related to water quality	All	Humans, other natural sources (nutrients)	
12	Increased review of stream-altering projects at Jackson Hole Mountain Resort by collaborating natural resources stakeholders including land management agencies	1	Humans, non-wastewater, and other natural sources (*E. coli* and nutrients)	$15,000-$50,000
13	Implement snow storage buffers from waterbodies in the Fish Creek watershed	All	Humans, other natural sources (nutrients)	$50,000-$100,000
14	Protect existing wetlands from dredge/fill operations and/or development	All	Humans, other natural sources (nutrients)	$15,000-$50,000
15	Add native vegetation and wetland components to stream habitat projects	All	Livestock and agricultural practices, wildlife, fertilizer, humans (*E. coli* and nutrients)	$15,000-$50,000

16	Eliminate future development on and restore ecological function of Crystal Springs and adjacent Fish Creek headwater tributaries in Teton Village	1	Humans, non-wastewater, and other natural sources (*E. coli* and nutrients)	$50,000-$100,000
17	Establish treatment wetlands to improve water quality of irrigated return flow on WYOSLI parcel and similar areas, and, where applicable, coordinate with other BMPs to improve quality of conveyed water.	1, 2	Livestock and agricultural practices (*E. coli* and nutrients)	$50,000-$100,000
18	Implement additional BMPs at golf courses to reduce runoff (reconfigurations with bioswales, equipment clean stations, drainage)	All	Fertilizer applied to lawns, trees, and golf courses (nutrients)	$50,000-$100,000
19	Implement stormwater quality BMPs (maintain existing vaults, add green infrastructure, identify areas with impervious surfaces)	4	Humans, other natural sources (nutrients)	$100,000+
20	Plan, implement, and incentivize regenerative agriculture practices that maximize biodiversity, minimize soil disturbance, maximize presence of living roots, and maximize soil cover.	2	Livestock and agricultural practices (*E. coli* and nutrients)	$15,000-$150,000
21	Cooperate with WYOSLI to understand opportunities and constraints for improvements to OSLI lands, and improvements to permitted activities on OSLI lands	2	Livestock and agricultural practices (*E. coli* and nutrients)	--
22	Add trailhead/park dog-waste stations, bins, signage at pathway nodes, Teton Village corridor, Fish Creek access points on public land and in Wilson	All	Humans, non-wastewater, and other natural sources (*E. coli* and nutrients)	$15,000-$50,000
23	Targeted manure management education at equestrian & small-acreage properties	2	Livestock and agricultural practices (*E. coli* and nutrients)	$0-$15,000
24	Riparian buffer establishment at snow storage sites in Wilson and other developed areas of the Fish Creek watershed	4	Humans, non-wastewater, and other natural sources (*E. coli* and nutrients)	$15,000-$50,000
25	Permit/education program to eliminate pool/spa discharges to waterbodies	4	Humans, non-wastewater, and other natural sources (nutrients)	$0-$15,000

5-2 Roles and Responsibilities

A diverse group of stakeholders are poised to influence water quality and aquatic habitat in the Fish Creek watershed. Relatively few groups, however, can contribute significantly through funding and administration of large projects. These groups will be responsible for the implementation of large projects and for the outreach required to produce watershed-scale benefits completed at the parcel scale. Table 7 (above) provides a link between projects and parties who can collaborate and accomplish these projects. Actions taken outside of this framework are also encouraged, while noting that engaging TCD or other stakeholders will help track the progress of watershed projects.

- Teton Conservation District (TCD) will remain a lead partner by convening stakeholders, providing technical expertise, working with the Wyoming Department of Environmental Quality (WDEQ), and providing available funding.

- The Wyoming Game and Fish Department (WGFD) has been a primary lead on riparian and aquatic habitat enhancement projects and fisheries monitoring. Trout Unlimited (TU) serves the role of project lead/support on riparian and aquatic habitat enhancement, as well as education and outreach.

- Agriculture producers own a significant portion of the land along Fish Creek. Agriculture property owner engagement and support of riparian and aquatic enhancement shall remain a priority. These actions may be initiated by landowners with support from other entities.

- The engagement of non-agricultural private landowners in riparian enhancement and other projects is important due to the proximity of wastewater systems to Fish Creek and its tributaries.

- Local non-profit organizations, along with TCD, have been major conduits for outreach and community education and funding for water quality monitoring and infrastructure improvement programs. Additionally, local non-profit organizations have helped take on part of the workload for managing projects.

- The Bridger Teton National Forest (BTNF) has led riparian and aquatic habitat enhancement projects on streams in the area. The BTNF manages a small portion of land adjacent to Fish Creek that includes a small recreation area near Hunt Bridge upstream of Wilson, WY.

- Teton County, Wyoming will assist with the planning and implementation of public infrastructure projects and activities. Teton County's role in septic system and development permitting is essential to the success of this plan. Additionally, it is responsible for zoning and building requirements, with revisions at times focusing on the protection of riparian habitat and water quality.

- Continued partnership and engagement with golf courses and HOAs within the Fish Creek watershed is critical to implement additional best management practices designed to reduce nutrient/sediment runoff to Fish Creek.

- The wastewater utilities in the Fish Creek watershed (Teton Village Water and Sewer District, Aspens-Pines Water and Sewer District, Wilson Sewer District, etc.) will be valuable partners to continue to improve the detention and treatment of wastewater for residents in the watershed. While many great improvements have been made, additional practices could be valuable to reduce nutrient transport.

- Jackson Hole Mountain Resort (JHMR) and Teton Village manage a significant development location in the upper stretches of Fish Creek. Continued outreach, engagement, and support will allow for opportunities for input on recreation projects that may impact the watershed.

- Wyoming Department of Transportation (WYDOT) maintains Wyoming State Highways 22 and 390, which run through the Fish Creek watershed.

- Grand Teton National Park (GTNP) owns and manages part of the watershed at and around the headwaters.

5-3 Load Reduction Estimates

To estimate the load reductions needed, and expected, to achieve water quality goals outlined in the Watershed Plan, monitoring data and literature values were compared with water quality standards established by the WDEQ.

E. coli Load Reduction Estimates

Load duration curves are among the most frequently used methods in watershed planning efforts to estimate load reductions needed to achieve water quality criteria. The EPA's guidance on load duration curves, "An Approach for Using Load Duration Curves in the Development of TMDLs" provides guidance for developing and interpreting these curves to assess water quality (USEPA, 2007). The development of a load duration curve relies on the collection of ambient water quality data with a stream discharge measurement taken at the time of sampling (USEPA, 2007). Teton Conservation District used this information and other load duration curve examples from existing watershed plans to develop a load duration curve for *E. coli* to characterize load reduction needs in Fish Creek using data collected during the 2017, 2023, 2024, and 2025 primary recreation seasons (Campbell County Conservation District, 2019; Popo Agie Conservation District; 2020).

E. coli daily loads were calculated by multiplying the instantaneous streamflow measurements at the streamgage by the *E. coli* concentration collected from site A_Wck, adjacent to the USGS streamgage 13016450 on Fish Creek and applying a conversion factor. Load duration curves require the development of a "target" load, or maximum allowable load using the existing water quality criteria for *E. coli* for a given flow condition. The target load in Fish Creek was developed using the target *E. coli* concentration of 126 MPN/100 mL. Flow duration curves are commonly broken up into intervals of flow conditions (USEPA, 2007). For the Fish Creek flow duration curve, duration curve intervals were categorized by "high flows" (0-10% exceedance), "moist conditions" (10-40%), "mid-range flows" (40-60%), "dry conditions" (60-90%), and low flows (90-100%). For specific methodology on load reduction curve development and calculated *E. coli* loads, refer to Appendix A.

Calculated loads that plot above the duration curve indicate water quality impairment and loads that plot below the duration curve indicate water quality compliance (USEPA, 2007). In Fish Creek, 25 of 43 calculated *E. coli* loads were above the target *E. coli* load, and 18 of 43 calculated *E. coli* loads were below the target *E. coli* load (Figure 8). All but one (24 of 25) *E. coli* load exceedance occurred during high flows, moist conditions, and mid-range flows. Both concentrations of *E. coli* from collected samples and calculated *E. coli* loads are highest in June and July when Fish Creek streamflow is elevated (Figure 4, Figure 8).

Load reductions needed to achieve water quality standards were calculated by subtracting the difference between calculated loads that plot above the load duration curve and the target load (see Appendix A). "High flow" conditions (4 of 25) were excluded from load reduction estimates because these extreme flows are not representative of typical conditions (USEPA, 2007). On average, an estimated 49.7% reduction in *E. coli* loads is required to meet existing water quality standards for *E. coli* in Fish Creek across all flow conditions outside of these extreme flows (Appendix A).

As load reductions can vary depending on type, quantity, and spatial extent of treatment, individual estimates are difficult to make before implementation. In general, riparian buffer establishment and expansion, coupled with grazing management, has been shown to significantly reduce *E. coli* concentrations in streams (Coyne et al., 1995; USFWS, 2006; Zeckoski et al., 2012; Lim et al., 2022). It should be expected that *E. coli* concentrations could be significantly reduced in Fish Creek after implementation of Phase I best management practices. Other watershed planning efforts addressing impaired streams due to *E. coli* loads, including the Salt River in Lincoln County, WY, have estimated expected load reductions from best management practices (Tetra Tech, 2015). It is important to note that the proposed best management practices for *E. coli* also have co-benefits of reducing nutrient concentrations depending on pollutant source category (Richkus et al., 2023). See Table 9 for estimated load reductions due to implementation of proposed best management practices.

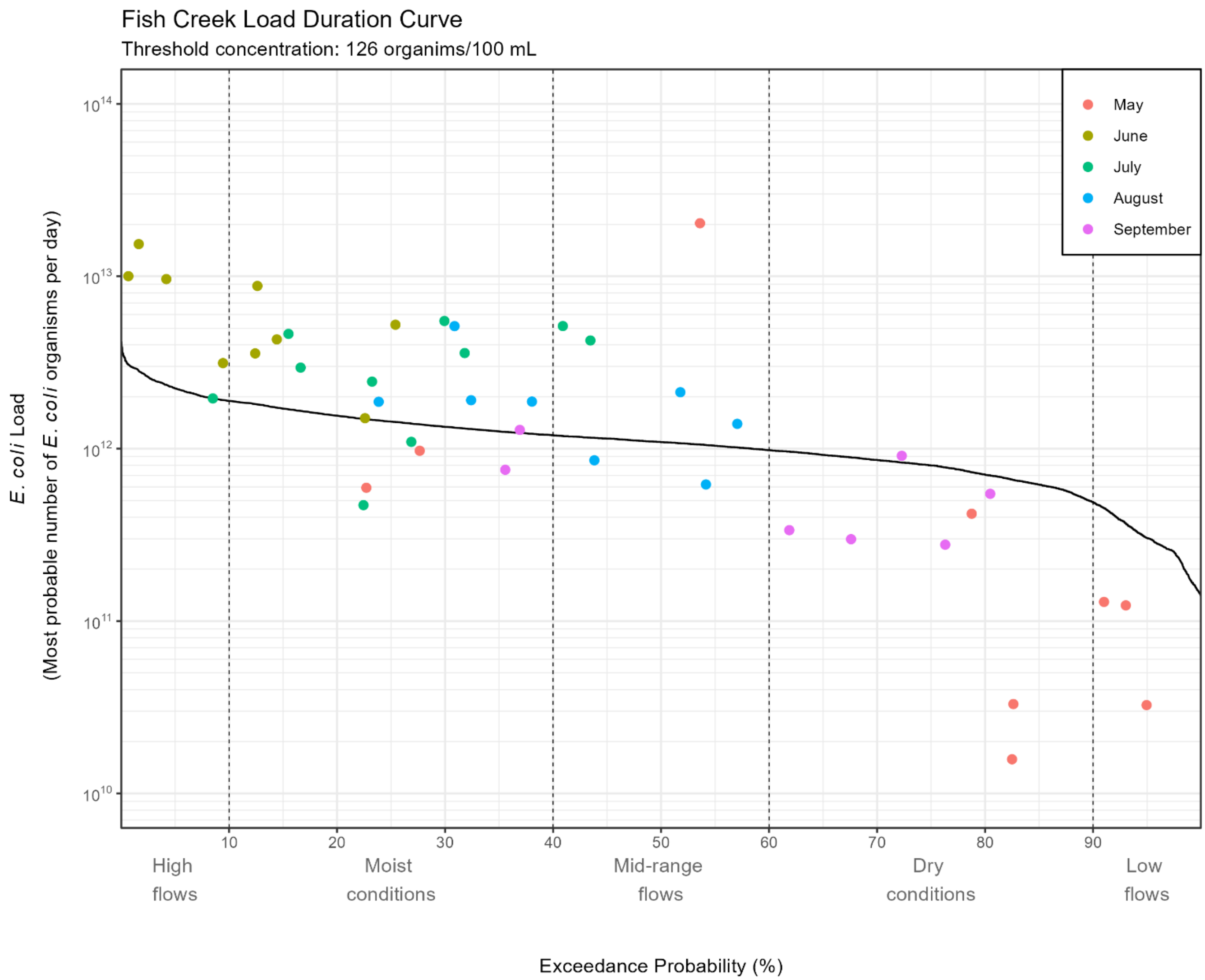


Figure 8. *E. coli* Load Duration Curve for Fish Creek developed with data collected from site A_Wck during the 2017, 2013, and 2024 primary recreation seasons coupled with continuous streamflow data collected from USGS streamgage 13016450 (Fish Creek at Wilson, WY). Calculated loads that plot above the duration curve indicate water quality impairment and loads that plot below the duration curve indicate water quality compliance (USEPA, 2007).

Nutrient Load Reduction Estimates

A nutrient load reduction curve was not prepared for Fish Creek. Adequate discharge data where nutrient concentrations are above instrument reporting limits (upper Fish Creek sites) are currently unavailable.

To achieve interim water quality targets which have been established based on the Fish Creek Nutrient Assessment, concentrations would need to be reduced for total nitrogen for total phosphorus. These reductions would need to primarily occur in upper Fish Creek near Teton Village (Section 3-5, Appendix B).

As nutrient concentrations in Fish Creek are already low in most locations aside from its headwaters, a small reduction in nutrient input in upper Fish Creek may have a substantial impact on the observed biological response in Fish Creek (Eddy-Miller, 2013). Reducing surface or groundwater transport of nitrogen and phosphorus input to upper Fish Creek by grazing management, riparian buffer establishment and expansion, and continued wastewater improvements can reduce nitrogen and phosphorus concentrations below thresholds identified in the Fish Creek Nutrient Assessment (Agouridis, et al., 2005; McCormick and Campbell, 2007; Line et al., 2016). See Table 9 for estimated nutrient load reductions due to implementation of proposed best management practices.

Table 9. Estimated load reductions from best management practices (BMPs) by source category *

Source Category	Proposed BMPs	Estimated *E. coli* Load Reduction (%)	Estimated Combined Nutrient (N, P) Load Reduction (%)
Livestock and agricultural practices	Fencing, riparian buffers, grazing management, off-channel water projects	50-95[1,5]	30-80[2,3,4]
Wastewater effluent from septic systems	Sewer connections, septic system inspection and maintenance	Up to 100% (for repair/replacement of failing systems)[1]	30-80[6]
Wastewater treatment plants	Sewer line maintenance, plant upgrades, treatment wetland expansions	--	50-90[7]
Humans (non-wastewater)	Education/outreach, stormwater treatment improvements	0-50[1]	10-50[8]

*Table generated using estimates from published watershed restoration plans and peer reviewed literature: 1: Tetra Tech, 2015; 2: Line et al., 2016; 3: Agouridis, et al., 2005; 4: McCormick and Campbell, 2007; 5: Malan, et al., 2018; 6: Erban et al., 2024; 7: USEPA, 2010; 8: Davis et al., 2006.

5-4 Funding Opportunities

The list of recommended best management practices within this plan will require significant sums of funding for design and implementation. Most of the projects within this plan will involve significant technical and financial collaboration between multiple entities, including TCD, WGFD, Teton County, and local non-profit organizations including Trout Unlimited and Protect Our Water Jackson Hole. Major sources of funding include:

- Bureau of Reclamation WaterSMART funding
- Environmental Protection Agency funding
- Local funding (non-profit organizations)
- Natural Resources Conservation Service (NRCS) funding
- Teton County funding
- Wyoming Department of Agriculture funding
- WDEQ Nonpoint Source Grant funding (Clean Water Act Section 205(j) and Section 319)
- Wyoming Game and Fish Department funding
- Wyoming Water Development Commission – Small Water Project Program funding
- Wyoming Wildlife Natural Resource Trust

Teton Conservation District received $20,000 in WDEQ Section 205(j) funding in 2023 to draft this watershed plan. Completion of this watershed plan results in Fish Creek becoming eligible to apply for Clean Water Act Section 319 funding for implementation of projects included in this plan (and others). Additionally, Section 205(j) funding is available for best management practice implementation monitoring and additional planning projects.

5-5 Administration and Work Plan

Teton Conservation District will provide the administration of the watershed management plan including the following:

- Organize and store watershed-related data
- Assist other agencies and organizations with pursuing grant funding and technical assistance when needed

Teton Conservation District will track watershed health and make information available upon request. This includes:

- Progress made on individual management practices
- Monitoring results and effectiveness of current management practices
- Consideration of major external influences and conditions affecting the watershed
- Revisions to the watershed management plan
- Facilitate stakeholder activities
- Ensure progress is being made to achieve the watershed goals
- Monitor watershed management plan progress

5-6 Education and Outreach

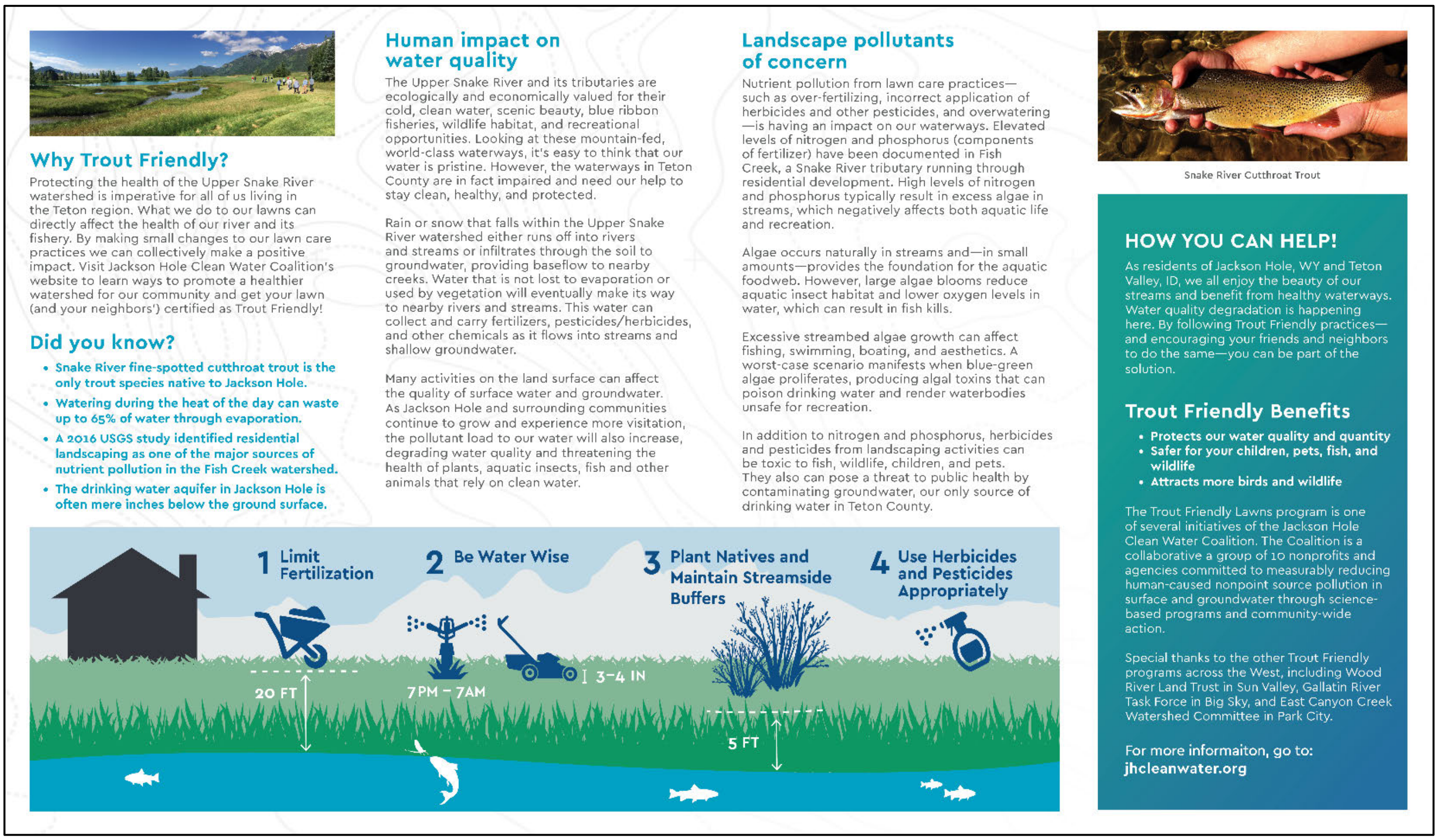
An education and outreach component of watershed restoration is a critical step to raising community awareness of water quality issues and generating/maintaining relationships with collaborators and stakeholders in the watershed. Teton Conservation District has led or participated in the majority of education and outreach activities centered around Fish Creek.

Teton Conservation District is a founding member of the Jackson Hole Clean Water Coalition (JHCWC), formed in 2018. The Jackson Hole Clean Water Coalition is a collaborative entity whose members included:

- Flat Creek Water Improvement District
- Friends of the Teton River
- Jackson Hole Land Trust
- LegacyWorks Group (facilitator)
- PAWS of Jackson Hole
- Protect Our Water Jackson Hole (former member)
- Snake River Fund
- Teton Conservation District
- Trout Unlimited
- Teton County Weed and Pest District
- Wyoming Nature Conservancy
- Wyoming Ducks Unlimited

At the time of the JHCWC's formation, there was little outreach occurring locally regarding water quality. The JHCWC summarized outreach materials regarding nutrient and *E. coli* impairment issues in Fish Creek years before a formal assessment was made. The Trout Friendly Lawns Program is the largest community outreach program formed under the JHCWC and involves incentivizing residents and landscaping businesses to reduce their fertilizer input, conserve water, plant and maintain riparian buffers, and apply herbicide/pesticide appropriately (Figure 9). The program has grown to over 230 residential certifications and 15-25 recurring annual business certifications. The JHCWC also spearheaded a pet waste education program with PAWS of Jackson Hole, educating pet owners about the consequences of pet waste transport to surface water. As a result, signage was incorporated into many high-traffic locations in Teton County including trailheads and public land access points, and waste bag stations were incorporated and maintained by PAWS of Jackson Hole with Teton Conservation District support.

Since the JHCWC formation, local water quality awareness surrounding Fish Creek and Flat Creek impairments, drinking water quality degradation, and recreation impacts have increased substantially. In 2022, a much larger local effort was formed with Trout Unlimited's leadership: the Snake River Headwaters Watershed Group. This partnership attracted over 90 organizations and 200 individual members representing agencies, non-profit organizations, private businesses, ranchers and irrigators, and universities. The goal of the Snake River Headwaters Watershed Group is to improve communication across entity boundaries centered around several key projects: operation of and flows from the Jackson Lake Dam, surface and groundwater quality, riparian habitat degradation and restoration, and generating resiliency to drought and climate change. The JHCWC was incorporated into the Outreach and Community Engagement working group within the larger watershed group and will continue to provide community outreach regarding local water quality impacts.



Why Trout Friendly?

Protecting the health of the Upper Snake River watershed is imperative for all of us living in the Teton region. What we do to our lawns can directly affect the health of our river and its fishery. By making small changes to our lawn care practices we can collectively make a positive impact. Visit Jackson Hole Clean Water Coalition's website to learn ways to promote a healthier watershed for our community and get your lawn (and your neighbors') certified as Trout Friendly!

Did you know?

- Snake River fine-spotted cutthroat trout is the only trout species native to Jackson Hole.
- Watering during the heat of the day can waste up to 65% of water through evaporation.
- A 2016 USGS study identified residential landscaping as one of the major sources of nutrient pollution in the Fish Creek watershed.
- The drinking water aquifer in Jackson Hole is often mere inches below the ground surface.

Human impact on water quality

The Upper Snake River and its tributaries are ecologically and economically valued for their cold, clean water, scenic beauty, blue ribbon fisheries, wildlife habitat, and recreational opportunities. Looking at these mountain-fed, world-class waterways, it's easy to think that our water is pristine. However, the waterways in Teton County are in fact impaired and need our help to stay clean, healthy, and protected.

Rain or snow that falls within the Upper Snake River watershed either runs off into rivers and streams or infiltrates through the soil to groundwater, providing baseflow to nearby creeks. Water that is not lost to evaporation or used by vegetation will eventually make its way to nearby rivers and streams. This water can collect and carry fertilizers, pesticides/herbicides, and other chemicals as it flows into streams and shallow groundwater.

Many activities on the land surface can affect the quality of surface water and groundwater. As Jackson Hole and surrounding communities continue to grow and experience more visitation, the pollutant load to our water will also increase, degrading water quality and threatening the health of plants, aquatic insects, fish and other animals that rely on clean water.

Landscape pollutants of concern

Nutrient pollution from lawn care practices—such as over-fertilizing, incorrect application of herbicides and other pesticides, and overwatering—is having an impact on our waterways. Elevated levels of nitrogen and phosphorus (components of fertilizer) have been documented in Fish Creek, a Snake River tributary running through residential development. High levels of nitrogen and phosphorus typically result in excess algae in streams, which negatively affects both aquatic life and recreation.

Algae occurs naturally in streams and—in small amounts—provides the foundation for the aquatic foodweb. However, large algae blooms reduce aquatic insect habitat and lower oxygen levels in water, which can result in fish kills.

Excessive streambed algae growth can affect fishing, swimming, boating, and aesthetics. A worst-case scenario manifests when blue-green algae proliferates, producing algal toxins that can poison drinking water and render waterbodies unsafe for recreation.

In addition to nitrogen and phosphorus, herbicides and pesticides from landscaping activities can be toxic to fish, wildlife, children, and pets. They also can pose a threat to public health by contaminating groundwater, our only source of drinking water in Teton County.

Snake River Cutthroat Trout

HOW YOU CAN HELP!

As residents of Jackson Hole, WY and Teton Valley, ID, we all enjoy the beauty of our streams and benefit from healthy waterways. Water quality degradation is happening here. By following Trout Friendly practices—and encouraging your friends and neighbors to do the same—you can be part of the solution.

Trout Friendly Benefits

- Protects our water quality and quantity
- Safer for your children, pets, fish, and wildlife
- Attracts more birds and wildlife

The Trout Friendly Lawns program is one of several initiatives of the Jackson Hole Clean Water Coalition. The Coalition is a collaborative a group of 10 nonprofits and agencies committed to measurably reducing human-caused nonpoint source pollution in surface and groundwater through science-based programs and community-wide action.

Special thanks to the other Trout Friendly programs across the West, including Wood River Land Trust in Sun Valley, Gallatin River Task Force in Big Sky, and East Canyon Creek Watershed Committee in Park City.

For more informaiton, go to: jhcleanwater.org

Figure 9. Trout Friendly Lawns Program brochure.

6 EVALUATION OF PROGRESS

6-1 Evaluation Criteria

Evaluation criteria used to determine whether best management practices are being implemented and load reductions are being achieved include interim water quality targets (Section 6-2) and meetings between TCD and primary stakeholders in the Fish Creek watershed (Section 5-1). These meetings will be scheduled as needed and focused on generating collaborative technical and financial resources to implement the projects listed in this plan and to collaborate on BMP effectiveness monitoring.

All best management practices implemented in the watershed will be compared to the milestones set in Section 4 of this plan to identify their validity and potential vs. realized impact on water quality in Fish Creek. As data collection efforts continue in Fish Creek (Section 6-3), data will be analyzed for trends and potential deviation from historic trends. As management practices are implemented, new projects that are not currently in this plan may be recommended, at which point the Fish Creek Watershed Plan may be revised to incorporate these additional projects.

Stakeholder meetings will involve sharing data and collaboratively reporting results to the community, and individual reporting to the WDEQ and through Wyoming Association of Conservation Districts' Watershed Progress Reports.

6-2 Water Quality Targets

Targets for *E. coli*

Interim targets for *E. coli* in Fish Creek are chosen to match the existing criteria for single-sample and five-sample geometric mean *E. coli* concentrations established by WDEQ (Table 10).

Table 10. Water quality targets for *E. coli* in Fish Creek.

Indicator	Interim Target	Description
E. coli geometric mean of five samples collected within a 60-day period (12-day sampling blocks)	< 126 MPN/100 mL	WY Surface Water Quality Standards target (WDEQ/WQD, 2024)
E. coli single sample concentration for high-use swimming areas	< 235 MPN/100 mL	WY Surface Water Quality Standards target (WDEQ/WQD, 2024)

Interim Targets for Nutrients

As the state of Wyoming does not have numeric nutrient criteria, WDEQ determined that Fish Creek was impaired for its Aquatic Life use due to excess nutrients using a weight-of-evidence approach to interpret its narrative water quality criteria, including chemical and biological indicators. Accordingly, interim nutrient-related water quality targets will also include those same indicators: nutrient concentrations, benthic algal biomass (chlorophyll-a concentrations), periphyton taxonomic composition, dissolved oxygen/pH dynamics, macroinvertebrate taxonomic composition, and related indicators. Interim nutrient-related water quality targets are shown below in Table 11. These targets may be revised as more data and information are gathered in the future.

Table 11. Interim nutrient targets for Fish Creek.

Indicator	Interim Target	Description	Current Interim Target Status
Total Nitrogen (as N)	< 0.38 mg/L	EPA recommended regional nutrient criteria based on the 25th percentile of available data as a surrogate for reference condition (USEPA 2000)	Not Attained
Total Phosphorus (as P)	< 0.01 mg/L	EPA recommended regional nutrient criteria based on the 25th percentile of available data as a surrogate for reference condition (USEPA 2000)	Not Attained
Reach Benthic Chlorophyll-a concentration (mean)	< 70 mg/m^2	Target chosen to reflect the mesotrophic-eutrophic trophic state boundary for streams (Dodds et al., 1998).	Not Attained
Reach Benthic Chlorophyll-a concentration (maximum)	< 200 mg/m^2	Target chosen to reflect the mesotrophic-eutrophic trophic state boundary for streams (Dodds et al., 1998).	Not Attained
Periphyton composition	Comparable to reference condition	-	NA
Dissolved Oxygen (7-day mean)	≥ 9.5 mg/L	WY Surface Water Quality Standards target (WDEQ/WQD 2024).	Attained
Dissolved Oxygen (1-day minimum)	≥ 8.0 mg/L	WY Surface Water Quality Standards target (WDEQ/WQD 2024).	Attained
pH	≥ 6.5 and ≤ 9.0 standard units	WY Surface Water Quality Standards target (WDEQ/WQD 2024).	Not Attained
Macroinvertebrates	"Fully Supporting" combined model rating using the two models WY-RIVPACS and WSII	WSII (Hargett 2011), WY RIVPACS (Hargett et al., 2005)	Not Attained

6-3 Monitoring Program

Teton Conservation District currently has two active Sampling and Analysis Plans (SAP) through WDEQ to collect both *E. coli* data (TCD, 2024a) and nutrient-related water quality data (TCD, 2024b). SAPs outline the study purpose, design, sampling frequency, parameter list and sampling methodology, quality assurance/quality control requirements, and other important descriptors. This ensures data is scientifically valid and, when applicable, meet requirements of Wyoming's Credible Data standard (WDEQ/WQD, 2025b).

In accordance with these SAPs, in 2026 Teton Conservation District will collect and analyze water samples for *E. coli* concentration at five sites along Fish Creek (Table 12) during the summer recreation season (May 1 – Sept 30) to inform the Waterborne Pathogen Notification Process and to submit to WDEQ for assessment and re-evaluation of designated use support. Additionally, nutrient related data (total nitrogen and total phosphorus concentrations, benthic chlorophyll-a, periphyton composition, macroinvertebrates, and dissolved oxygen/pH dynamics) will be collected at 3-4 sites at near-baseflow conditions annually (Table 12). Additional nutrient data may be collected as needed by either TCD or collaborating agencies/entities. In addition to data collected by TCD, fisheries-related data collected by WGFD and other entities will be collected and compared to existing datasets. For a comprehensive list of data collected to date by TCD and related partners, refer to Appendix B.

Table 12. Teton Conservation District Fish Creek monitoring program overview.

Waterbody	**Site Name**	**Parameters Sampled**							**Monitoring Site Selection Rationale**
		Nutrient concentrations (TN, TP)	*E. coli* concentrations	Benthic chlorophyll-a	Periphyton composition	Macroinvertebrates	Dissolved oxygen / pH / Continuous temperature	Streamflow	
Fish Creek	A_R1D	x	x	x*	x*		x	x	Upstream site; historical record; location of highest nutrients
Fish Creek	A_RB	x	x	x	x	x		x	Historical record; adequate conditions for biological sampling
Fish Creek	A_R3D	x	x					x	Historical record; land use change
Fish Creek	A_Wck	x	x				x	x	Historical record; active USGS gage
Fish Creek	A_Wck_Bio			x	x	x		x	Historical record; adequate conditions for biological sampling
Fish Creek	A_R6D_Alt	x						x	Historical record; land use change
Fish Creek	A_R7	x	x	x	x	x	x	x	Downstream site; historical record; adequate conditions for biological sampling

*If site suitability allows collection

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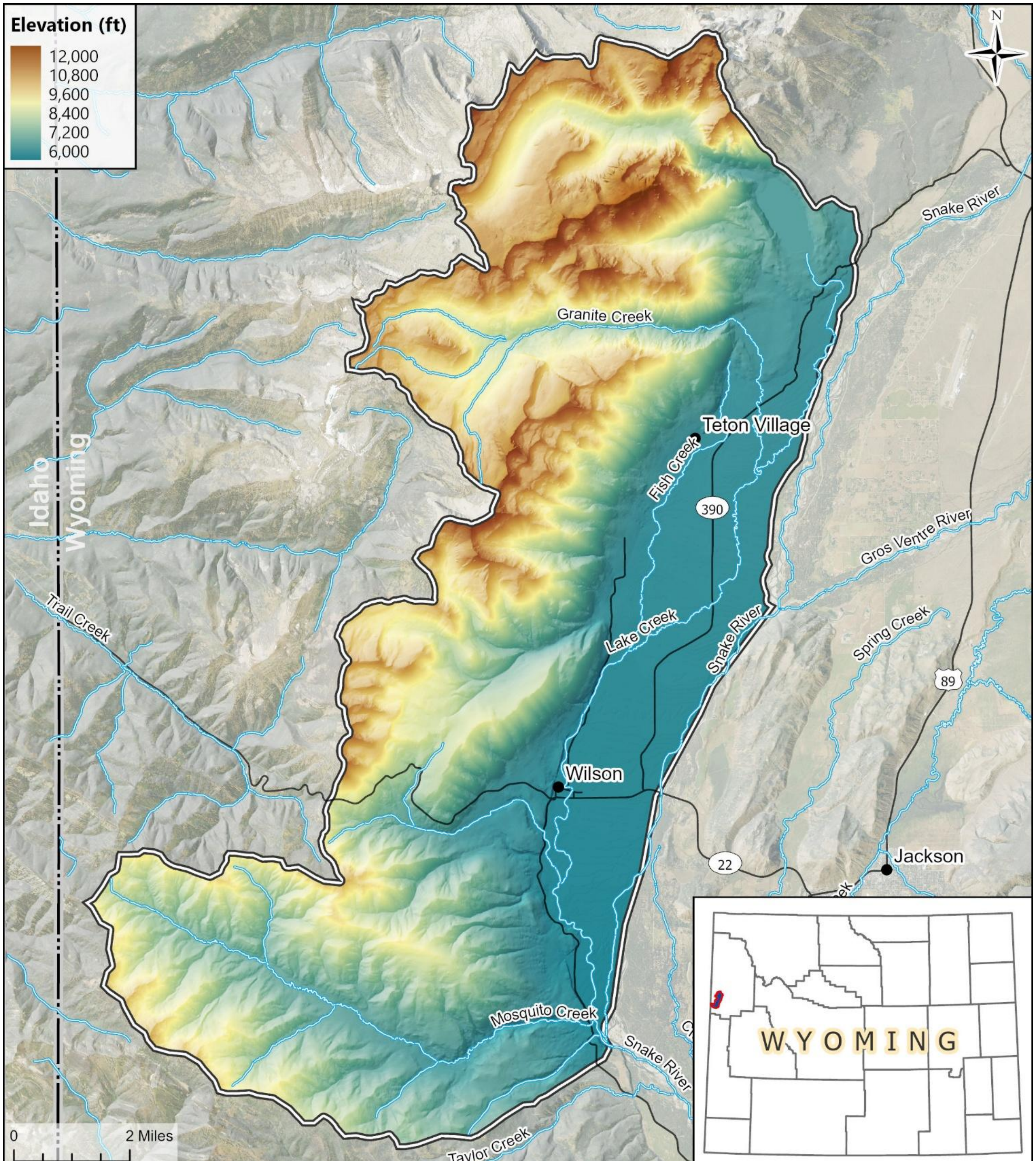
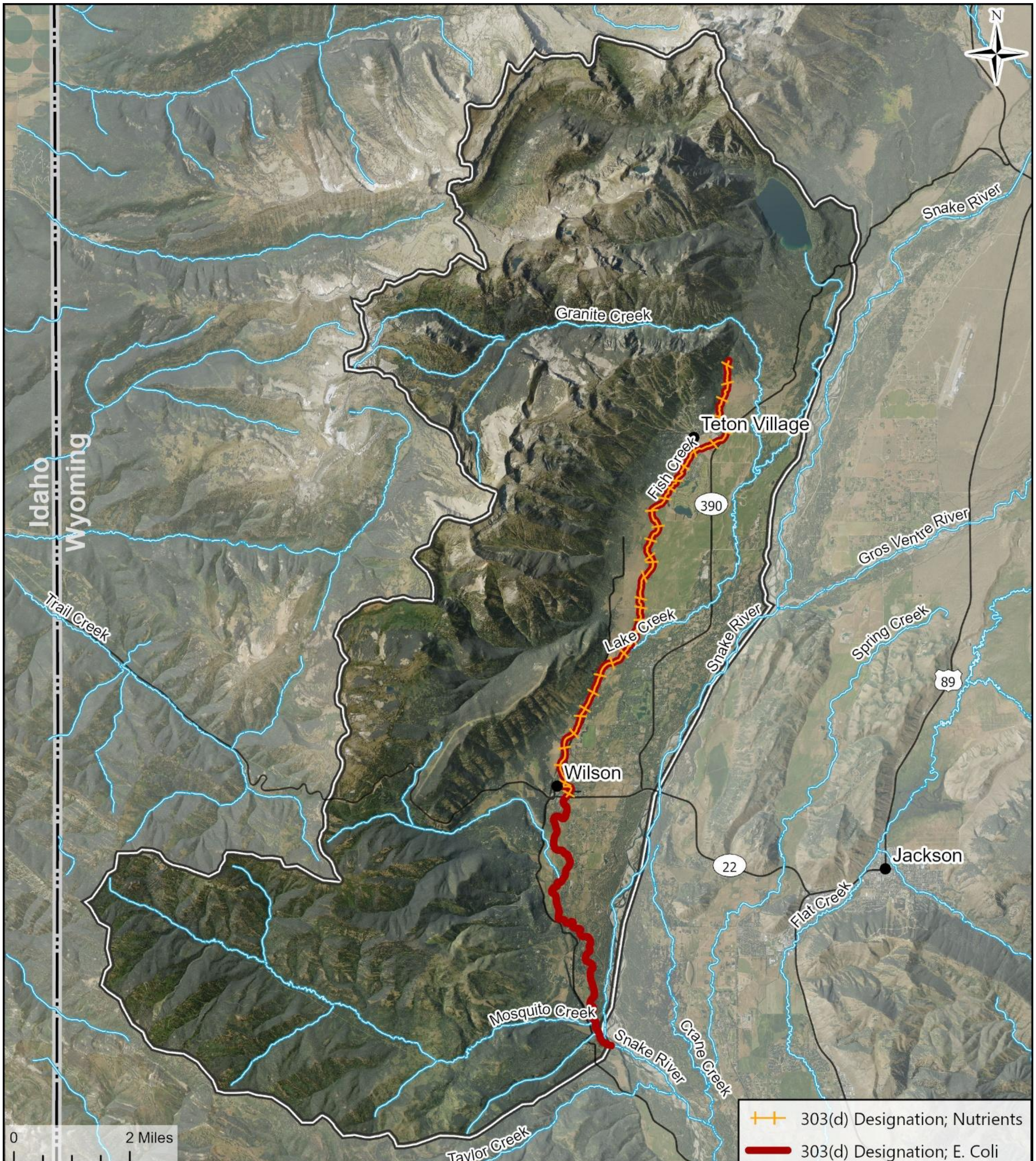
8 MAPS



Teton Conservation District Est. 1946

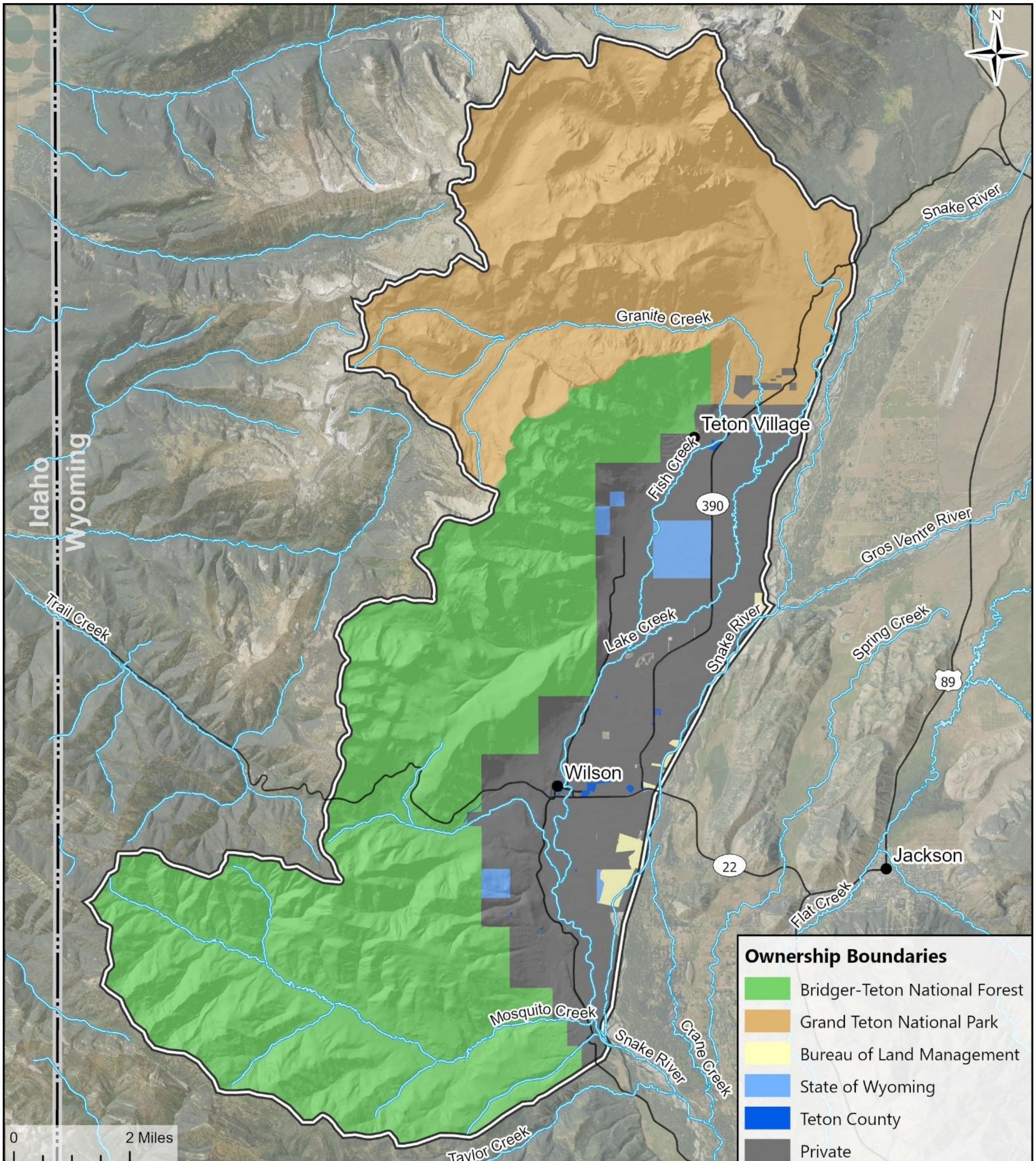
Map 1: Fish Creek Watershed Elevation

Elevation across the Fish Creek Watershed.



Map 2: 303(d) Designations

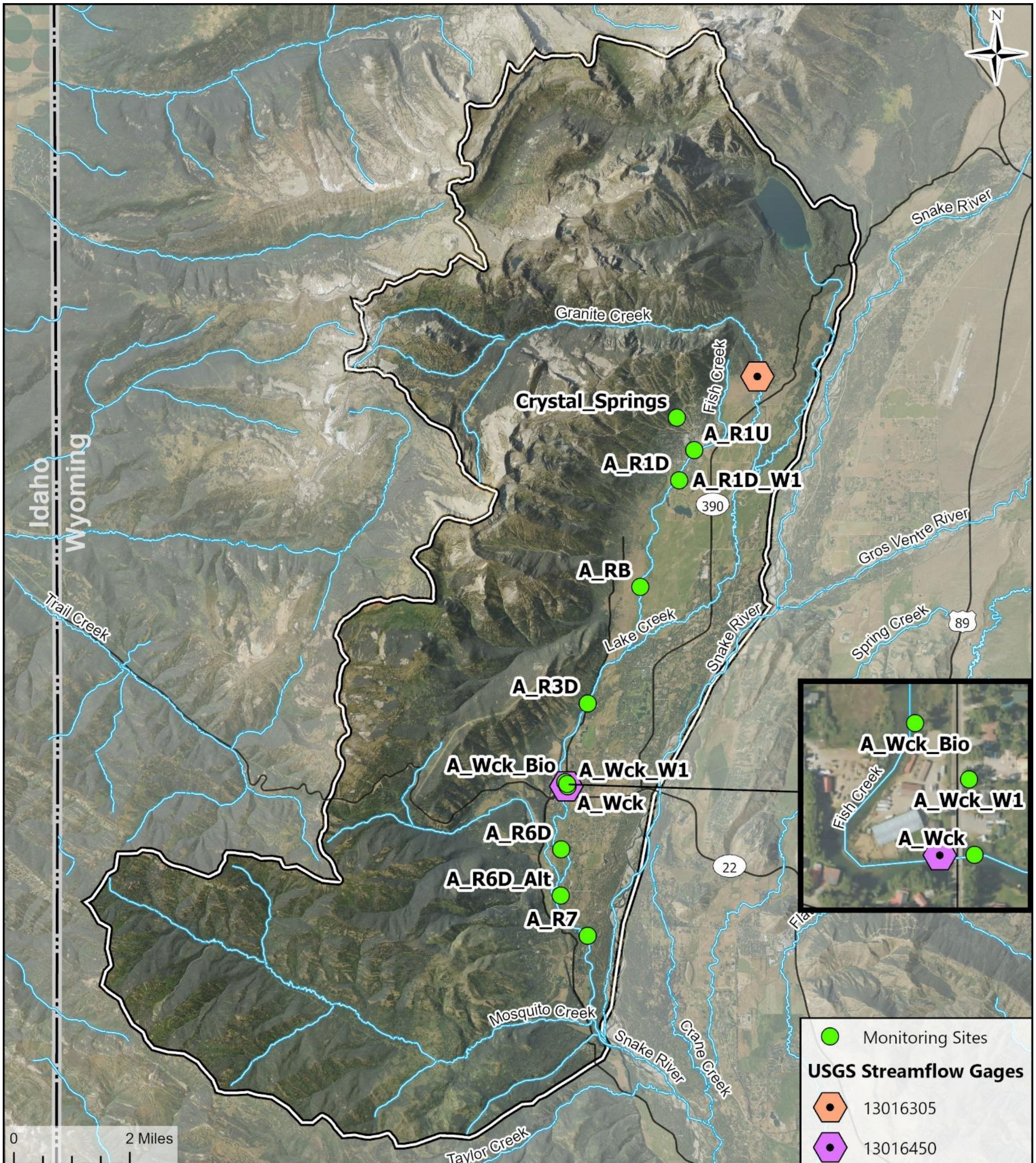
303(d) designations for nutrients and E.Coli within the Fish Creek Watershed based on the Wyoming Department of Environmental Quality's Wyoming 2024 Integrated 305(b) and 303(d) Report.



Teton Conservation District Est. 1946

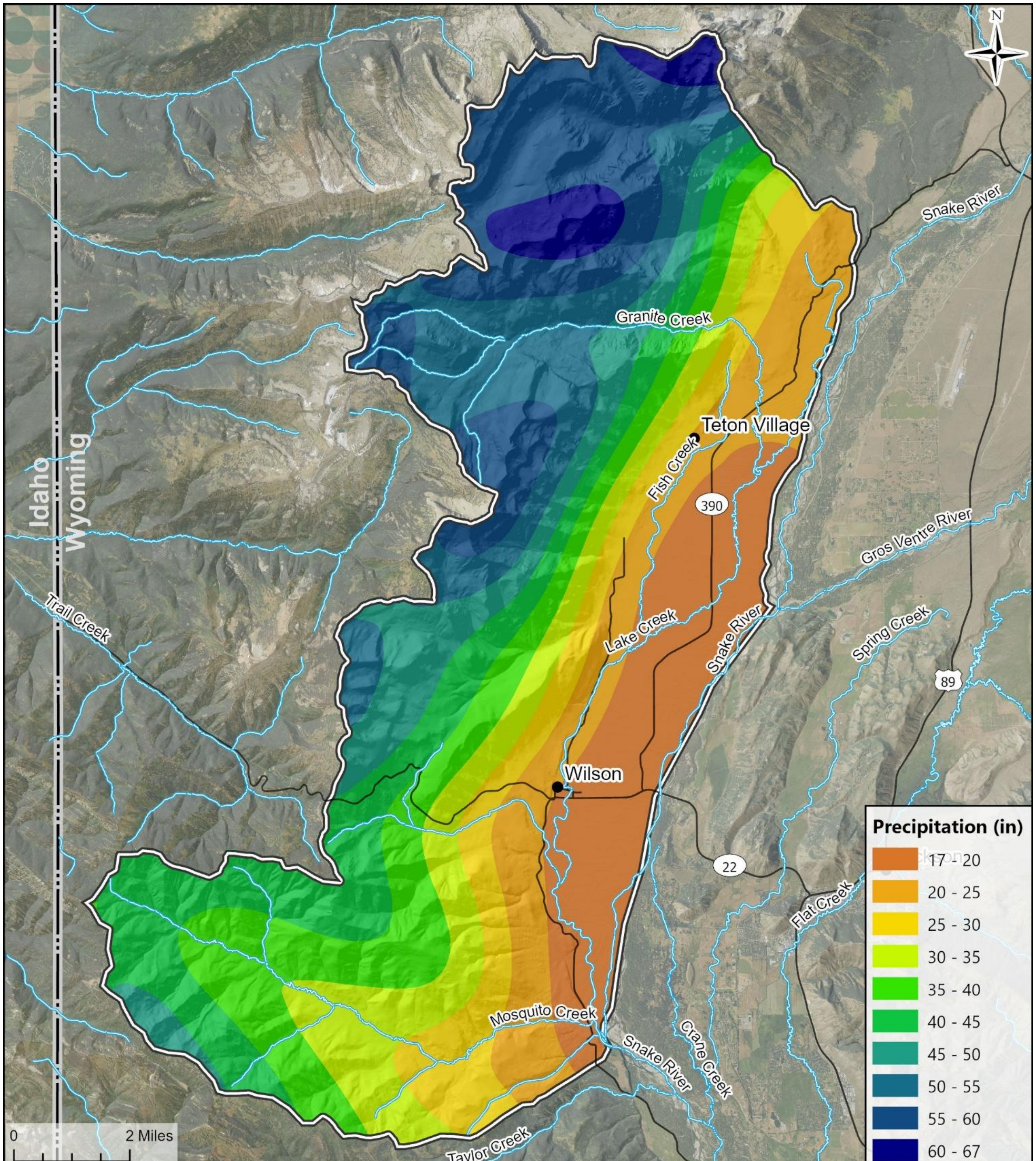
Map 3: Property Ownership

Property parcel boundaries within the Fish Creek Watershed.



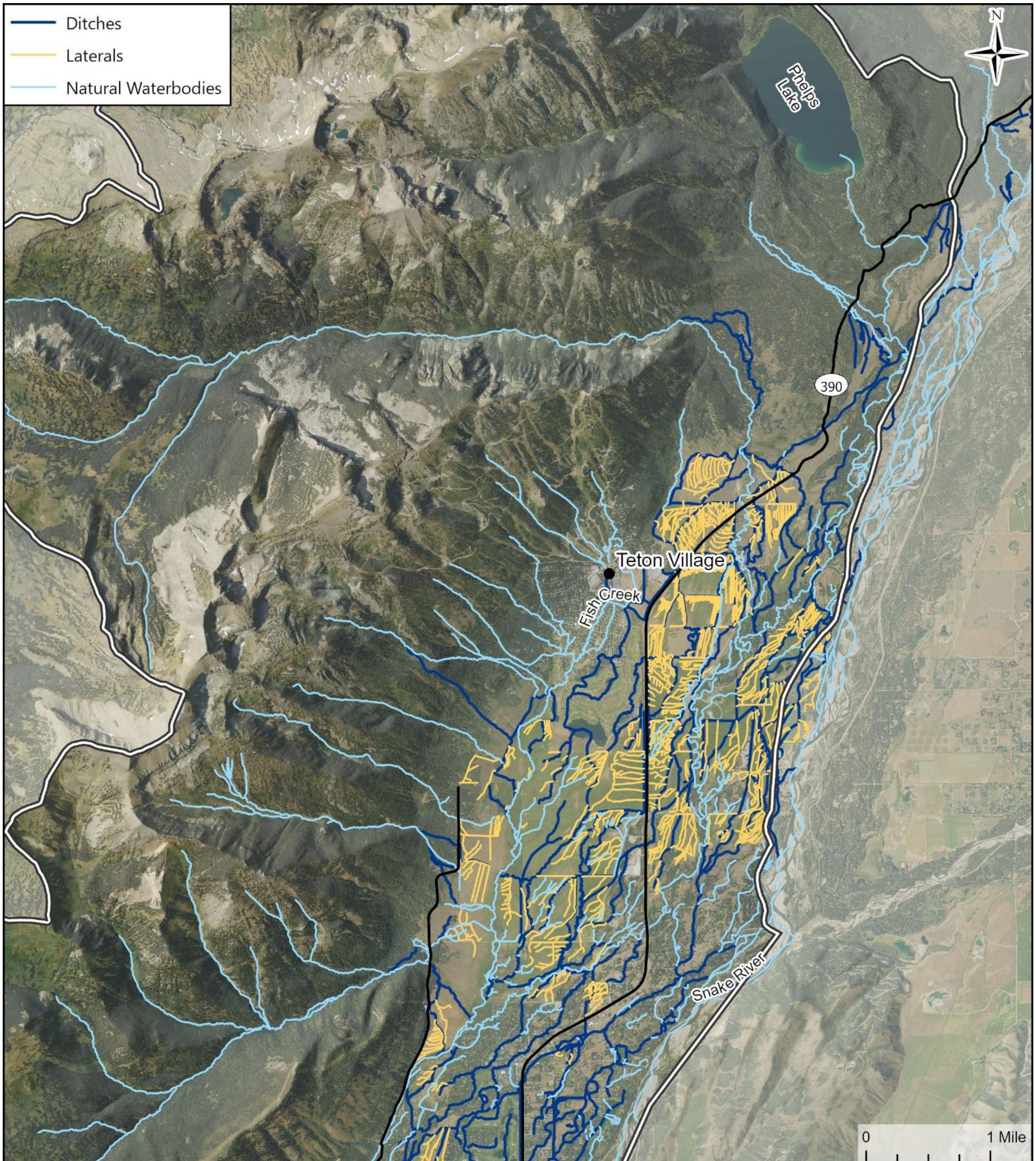
Map 4: Monitoring Sites & USGS Streamflow Stations

Monitoring sites & USGS streamflow stations within the Fish Creek Watershed.



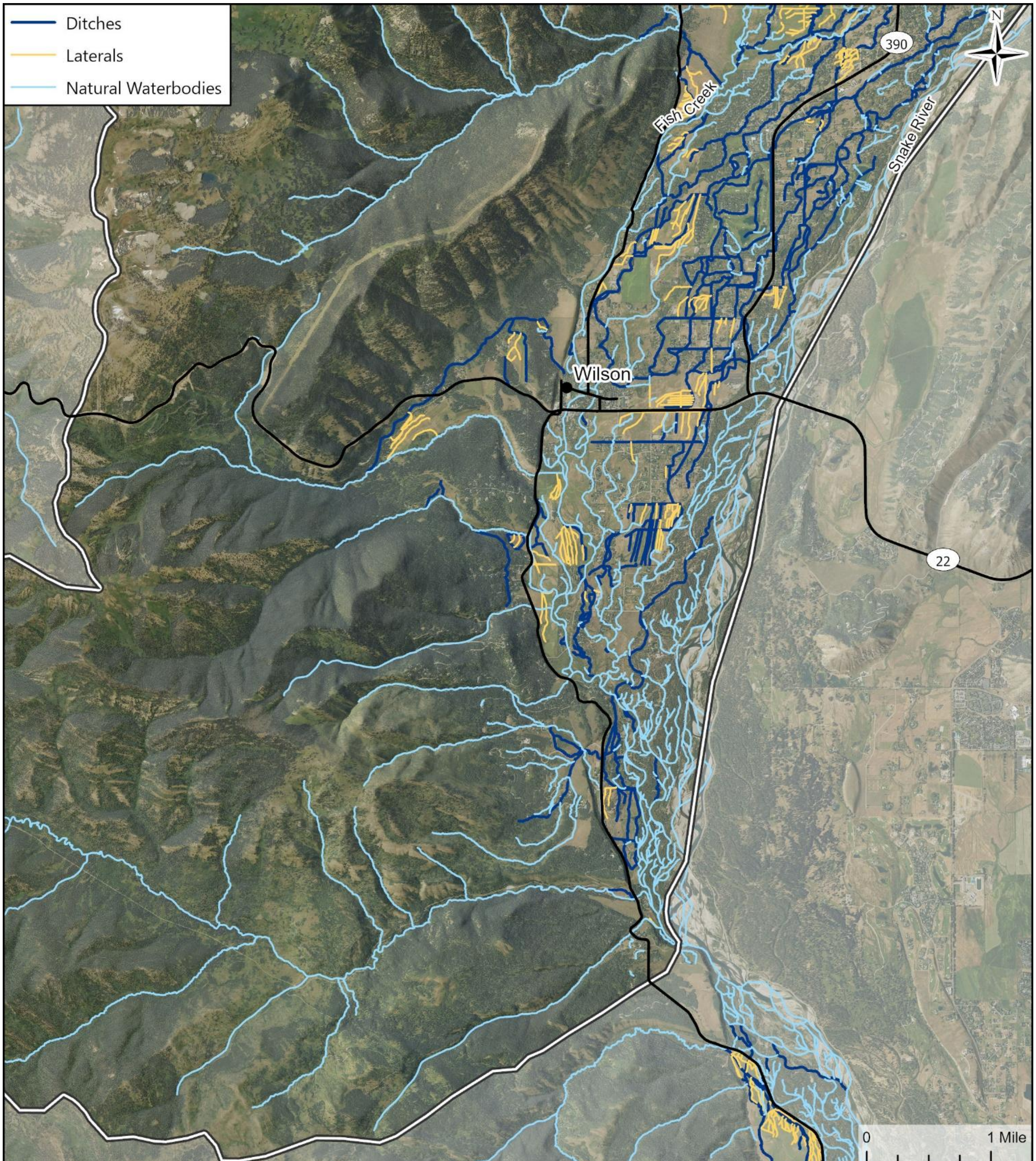
Map 5: Average Annual Precipitation

Average annual precipitation across the Fish Creek Watershed based on 30 year normal PRISM data for 1991-2020.



Map 6a: Ditches near Teton Village, WY

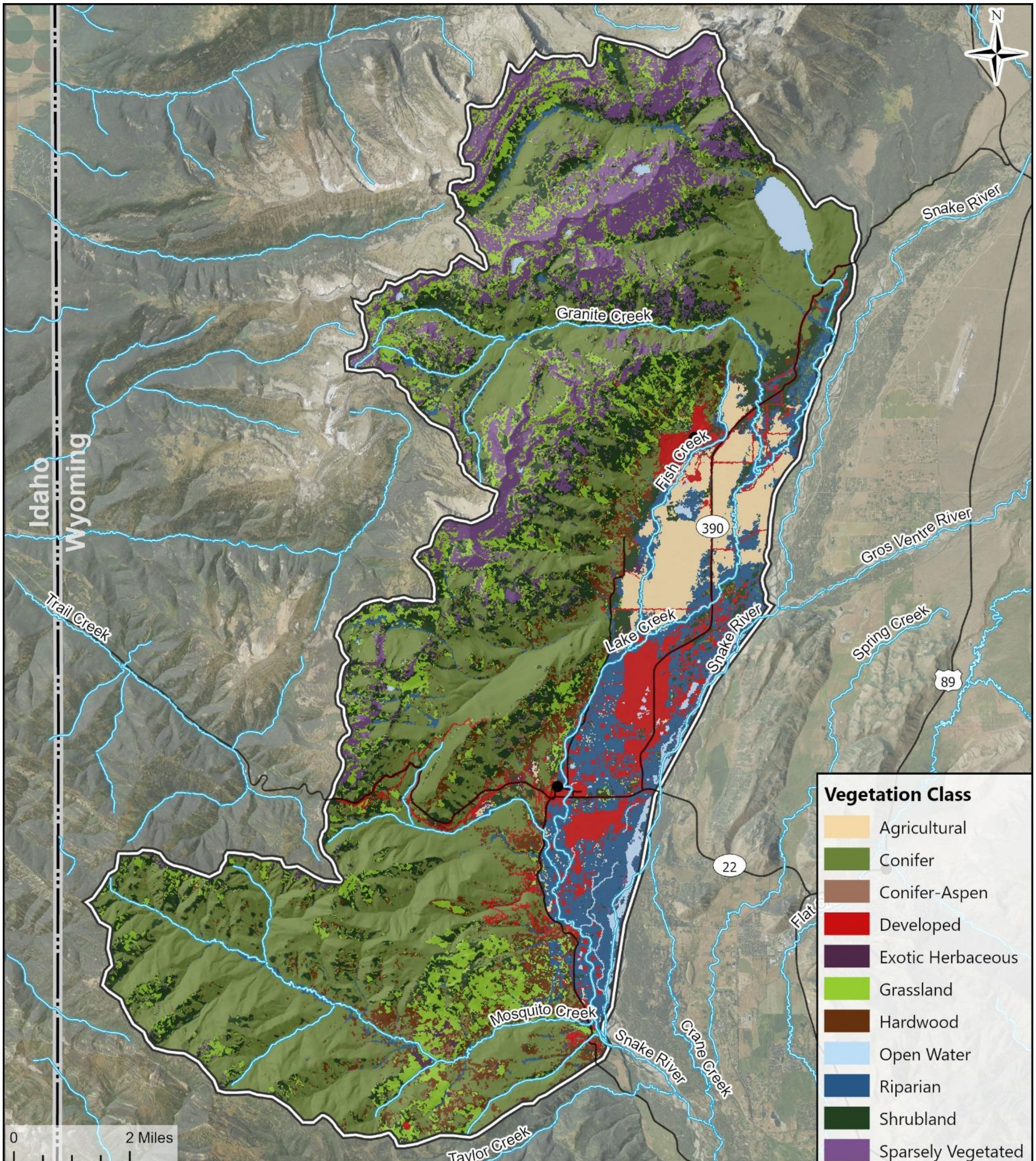
Ditches, laterals and natural waterbodies in the northern portion of Fish Creek Watershed.



Map 6b: Ditches near and South of Wilson, WY

Ditches, laterals and natural waterbodies in the southern portion of Fish Creek Watershed.

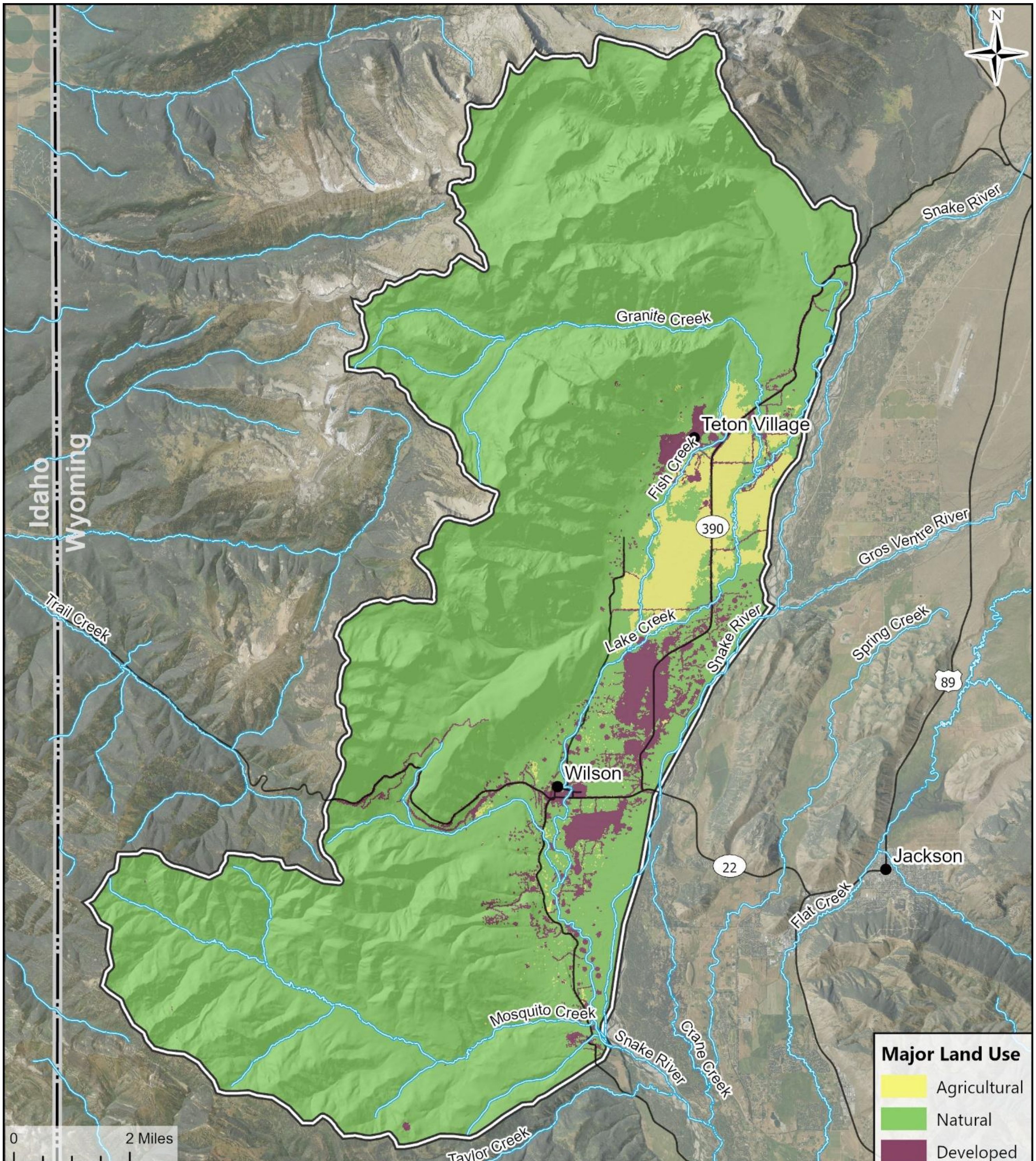
Teton Conservation District Est. 1946



Teton Conservation District Est. 1946

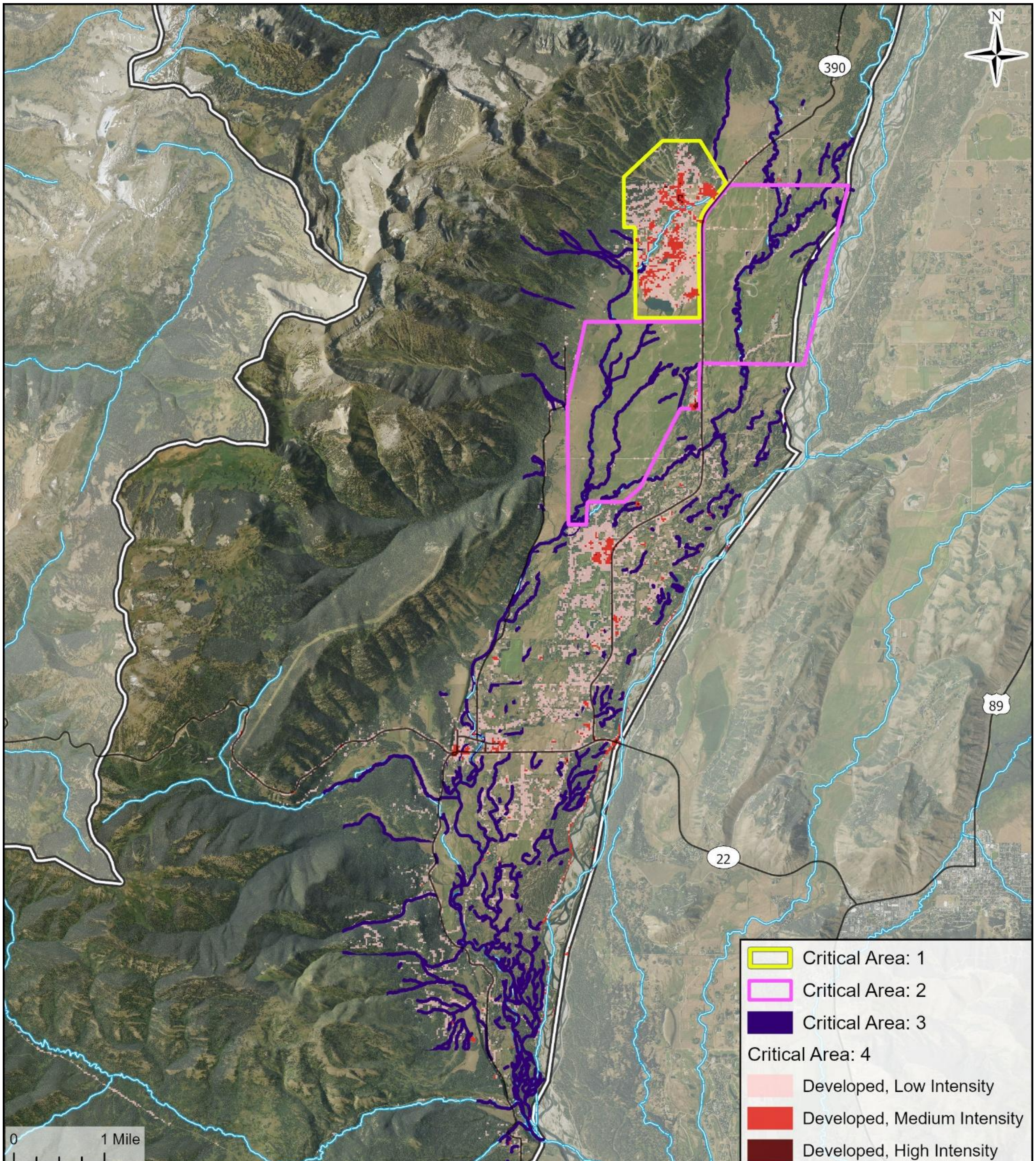
Map 7: Vegetative Covertypes

Vegetation covertypes within the Fish Creek Watershed from the US Department of Agriculture's 2022 LANDFIRE Existing Vegetation Type dataset.



Map 8: Major Land Use Types

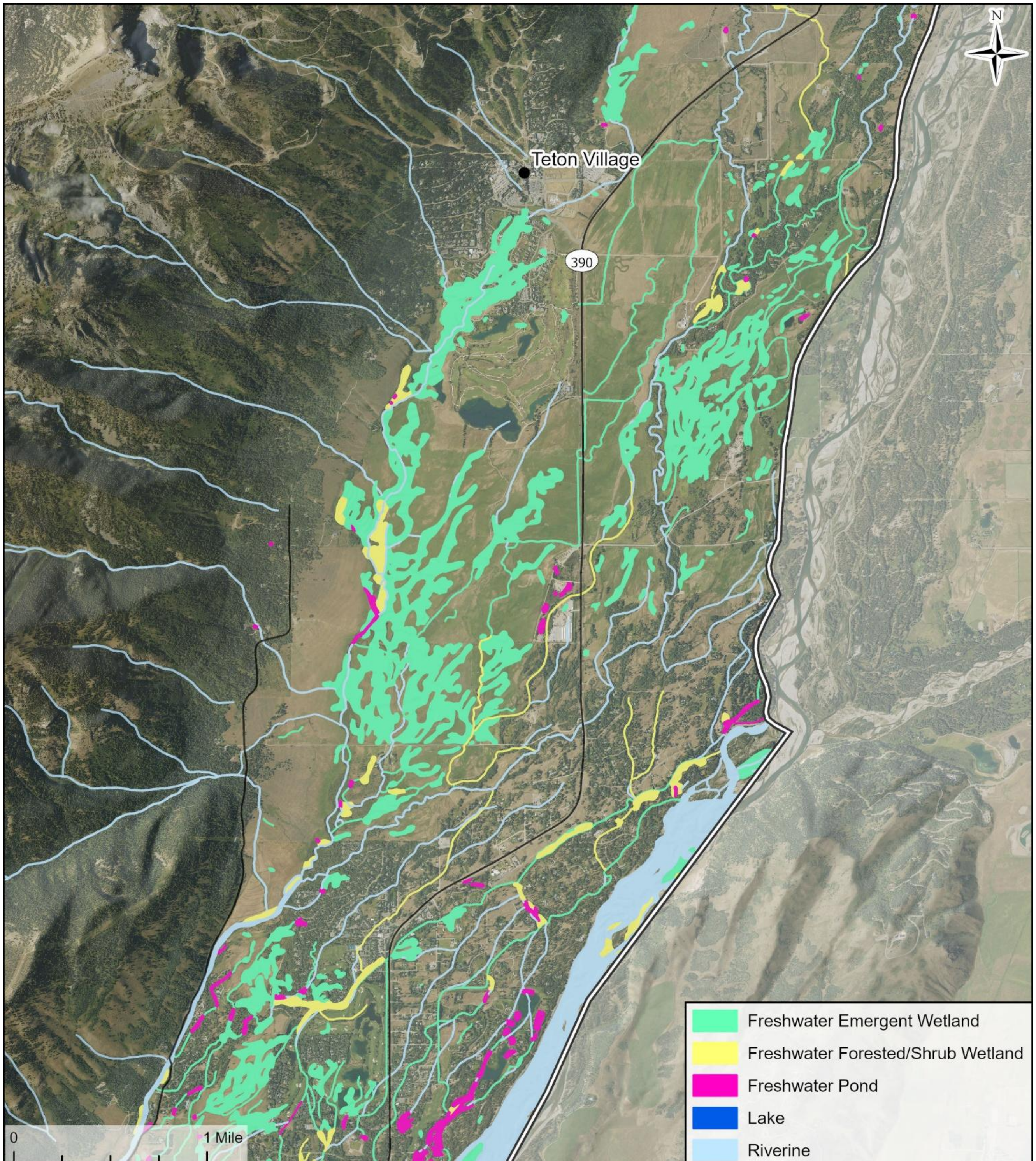
Major land use types within the Fish Creek Watershed from the US Department of Agriculture's 2022 LANDFIRE Existing Vegetation Type dataset.



Teton Conservation District Est. 1946

Map 9: Critical Areas

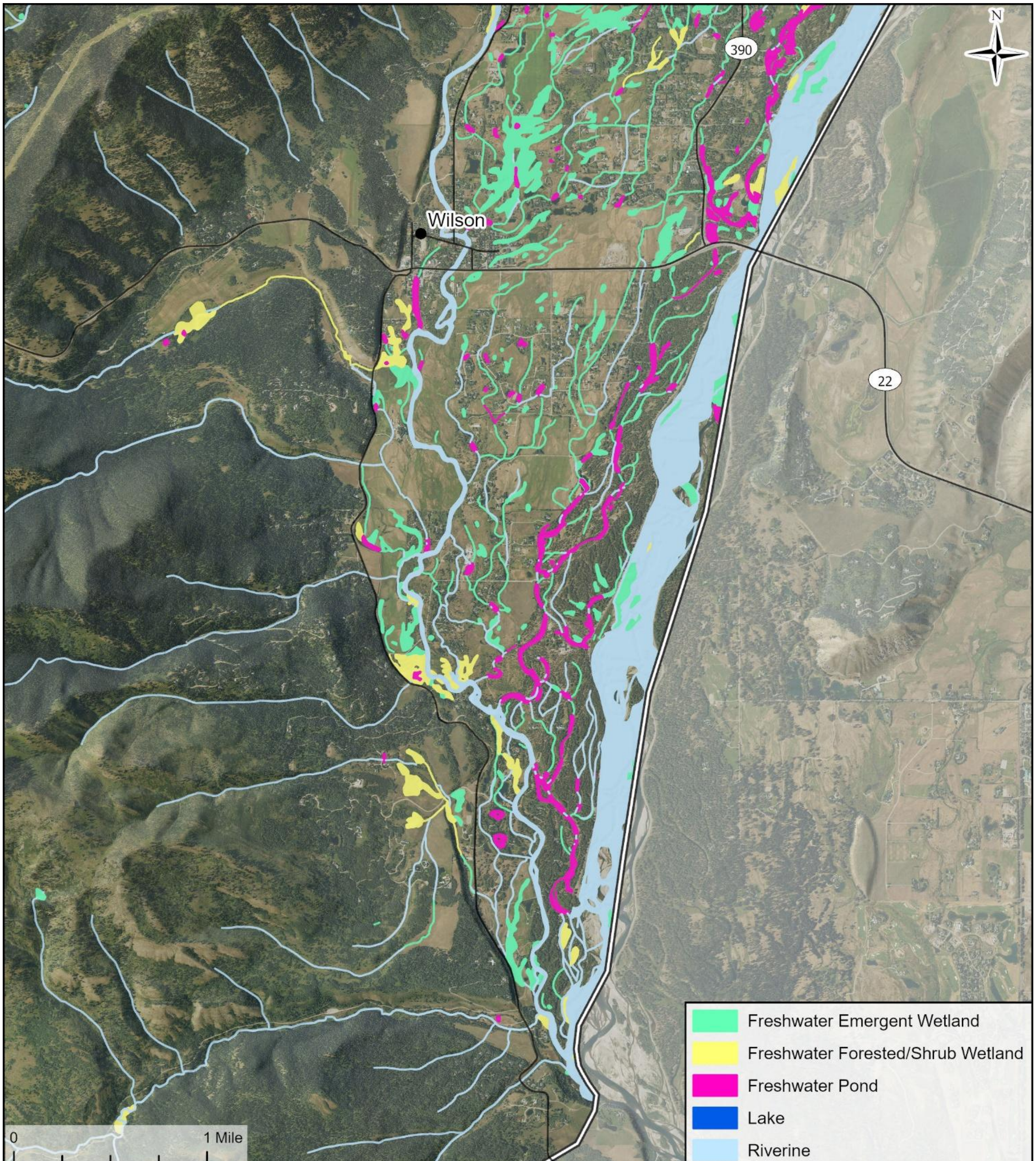
Critical areas within the Fish Creek Watershed, their descriptions can be found in Section 4-4.



Teton Conservation District Est. 1946

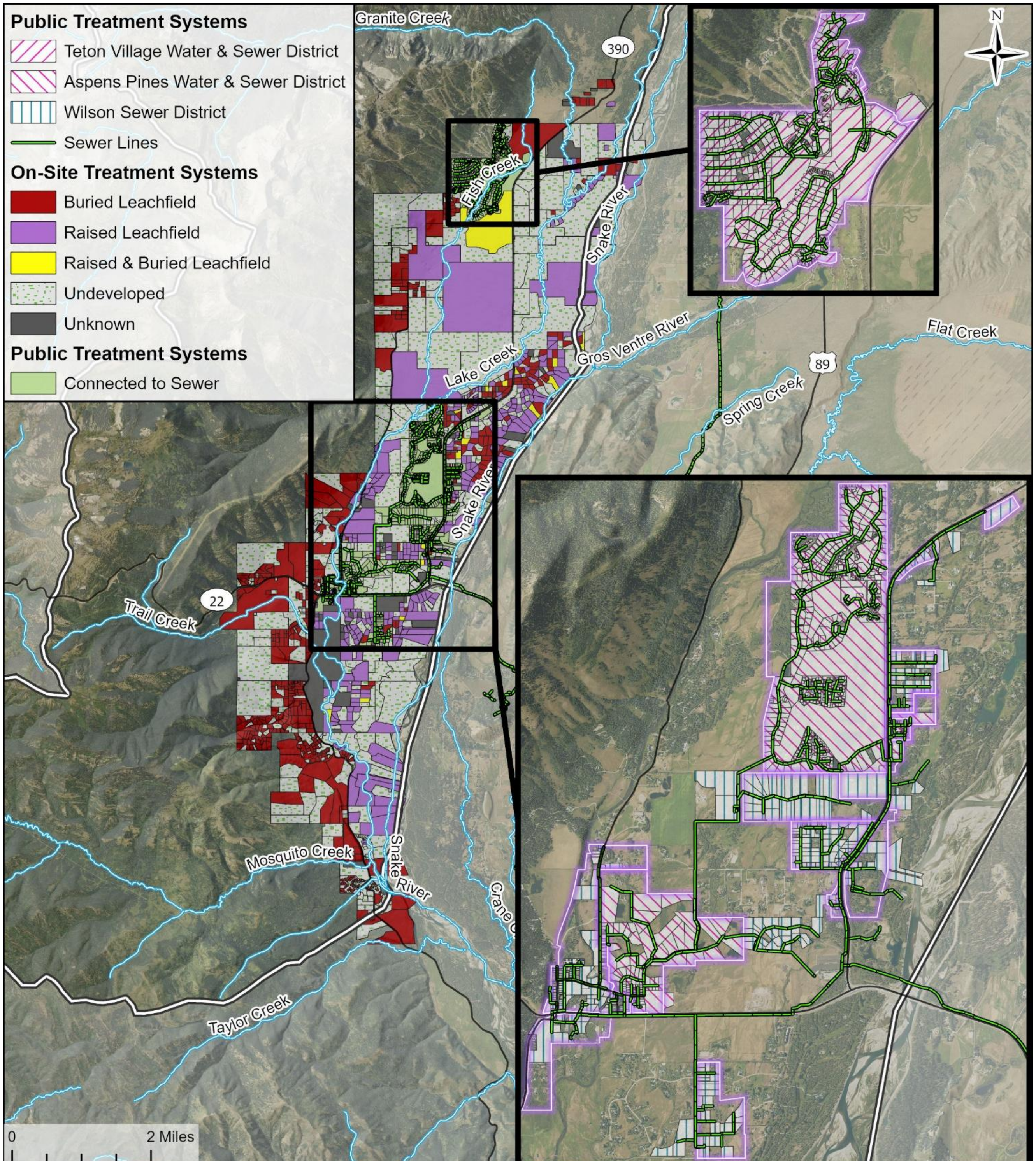
Map 10a: Wetlands and Waterbodies near Teton Village

Wetlands and waterbodies mapped as a part of the National Wetlands Inventory for the northern portion of the Fish Creek Watershed (USFWS, 1980s).



Map 10b: Wetlands and Waterbodies near Wilson

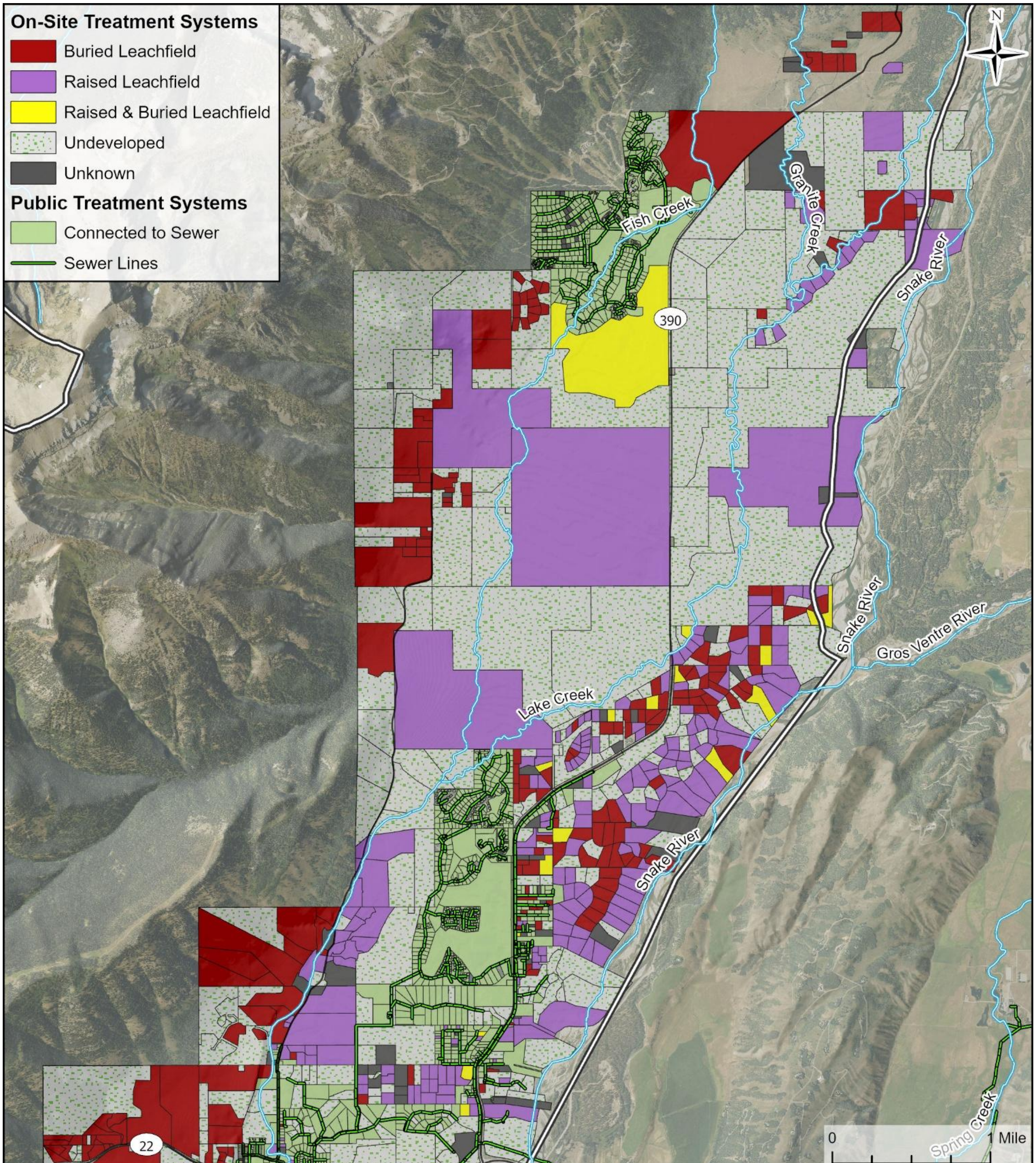
Wetlands and waterbodies mapped as a part of the National Wetlands Inventory for the southern portion of the Fish Creek Watershed (USFWS, 1980s).



Teton Conservation District Est. 1946

Map 11: Sewer Lines & Water and Sewer Districts as of 2015

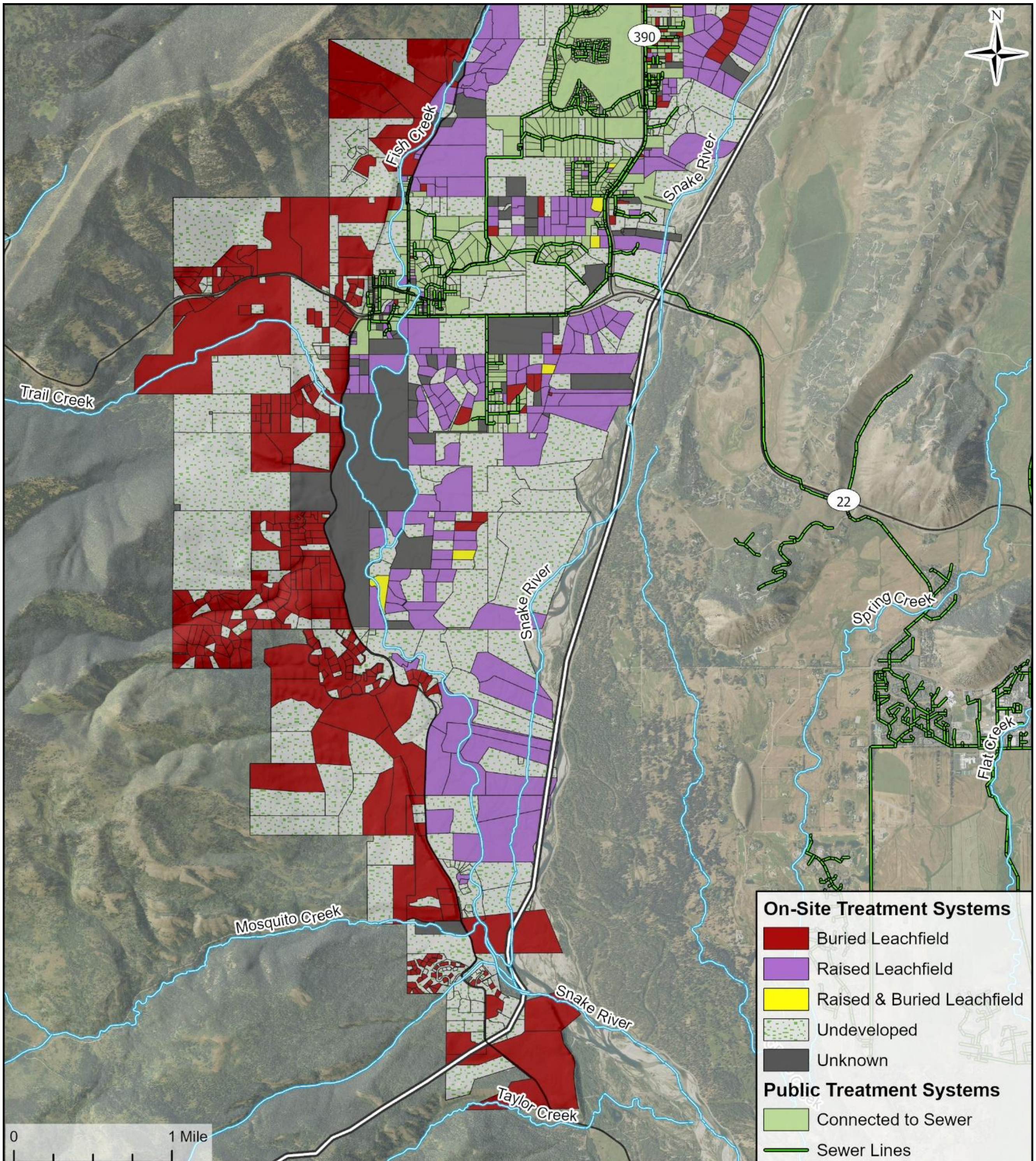
Sewer lines and wastewater treatment type within the Fish Creek Watershed, specifically Teton Village Water & Sewer District, Aspens Pines Water & Sewer District, and Wilson Sewer District.



Teton Conservation District Est. 1946

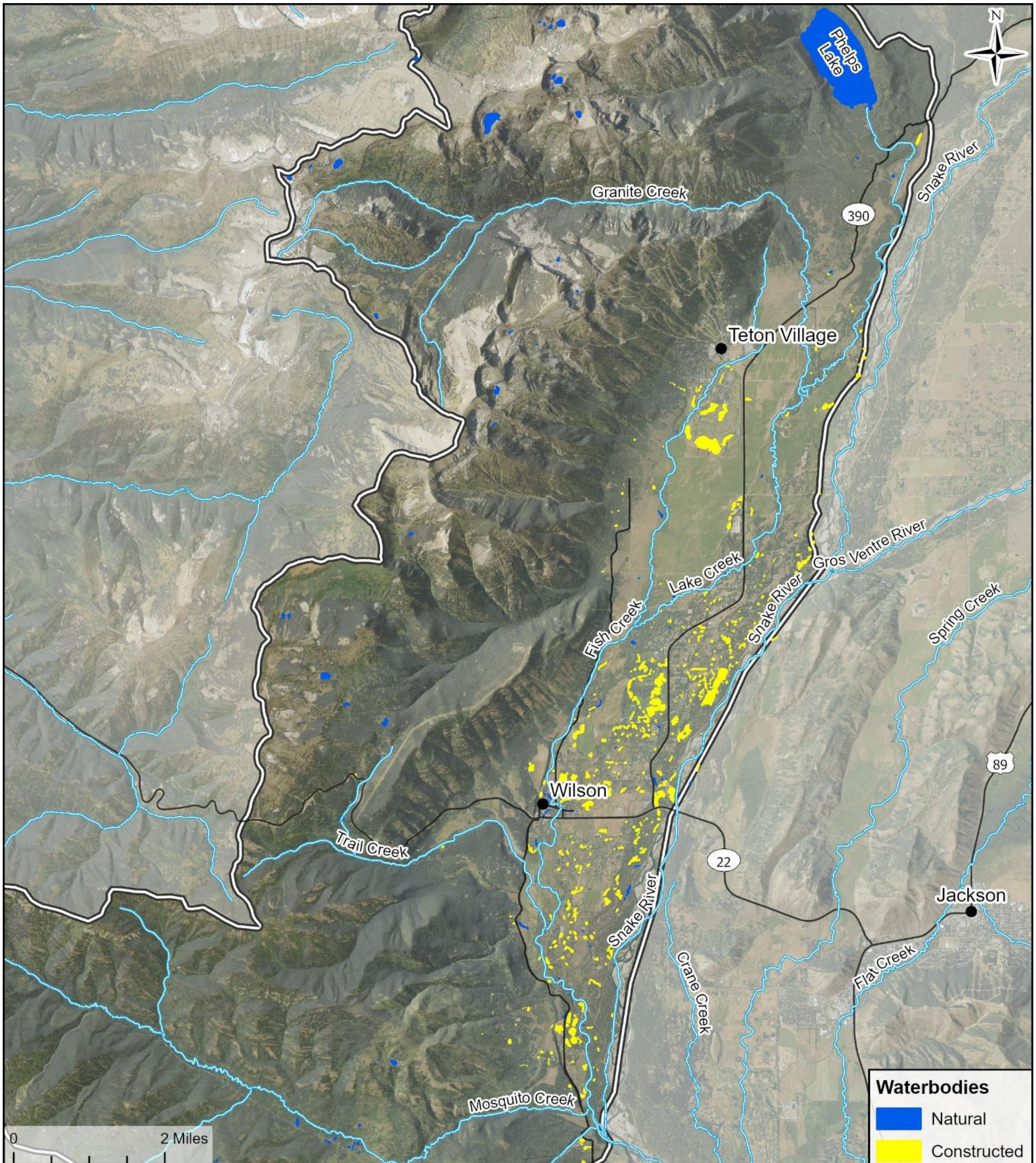
Map 11a: Sewer Lines & Wastewater Treatment near Teton Village, WY as of 2015

Sewer lines and waste water treatment systems within the Fish Creek Watershed.



Map 11b: Sewer Lines & Wastewater Treatment near and South of Wilson, WY as of 2015

Sewer lines and waste water treatment systems within the Fish Creek Watershed.



Map 12: Natural and Constructed Waterbodies

Lentic waterbodies within the Fish Creek Watershed (TCD, 2019).

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APPENDIX A: E. COLI LOAD REDUCTION CURVE METHOD

A-1 Introduction

A load duration curve provides an interpretation of the relationship between flow conditions and pollutant loading in a waterbody. A load duration curve is a tool used to both characterize sources depending on flow conditions in a waterbody and to identify load reductions needed to achieve water quality standards. Development of a load duration curve relies on the collection of ambient water quality data with a stream discharge measurement taken at the time of sampling (USEPA, 2007). The EPA's guidance on load duration curves, "An Approach for Using Load Duration Curves in the Development of TMDLs" (USEPA, 2007), provides guidance for developing and interpreting these curves to assess water quality:

"By displaying instantaneous loads calculated from ambient water quality data and the daily average flow on the date of the sample (expressed as a flow duration curve interval), a pattern develops, which describes the characteristics of the water quality impairment. Loads that plot above the curve indicate an exceedance of the water quality criterion, while those below the load duration curve show compliance.

The pattern of impairment can be examined to see if it occurs across all flow conditions, corresponds strictly to high flow events, or conversely, only to low flows. Impairments observed in the low flow zone typically indicate the influence of point sources, while those further left generally reflect potential nonpoint source contributions."

An *E. coli* load duration curve was developed for Fish Creek using *E. coli* data collected during the 2017, 2023, 2024, and 2025 summer recreation seasons to 1) provide insights into possible sources and pathways of *E. coli*, and 2) to characterize load reduction needs in Fish Creek.

A nutrient load reduction curve was not prepared for Fish Creek. Adequate discharge data where nutrient concentrations are above instrument reporting limits (i.e. upper Fish Creek sites) are currently unavailable.

A-2 *E. coli* Load Duration Curve Method

Flow Duration Curve Method

The development of an *E. coli* load duration curve begins with the development of a flow duration curve for the sample site where *E. coli* data is collected. A flow duration curve is a visual representation of the cumulative frequency distribution of stream discharge, with the x-axis representing exceedance probability, and the y-axis representing discharge (in cubic feet per second). For example, a discharge value on the flow duration curve at 40% exceedance probability would indicate that 40% of all observed daily average streamflow values exceed that discharge value.

Because the *E. coli* water quality criterion of 126 most probable number of organisms (MPN) per 100 mL applies only during the summer recreation season (May 1 – September 30), the critical flow conditions for this analysis were defined over that same period. A flow duration curve was developed using average daily flows from May 1 through September 30 to ensure consistency between the period of applicability of the water quality criterion and quantified hydrologic conditions.

Flow duration curves are commonly broken up into intervals of flow conditions (USEPA, 2007). For the Fish Creek flow duration curve, duration curve intervals were categorized by “high flows” (0-10% exceedance), “moist conditions” (10-40%), “mid-range flows” (40-60%), “dry conditions” (60-90%), and low flows (90-100%).

Discharge data was retrieved from USGS streamgage 13016450 (Fish Creek at Wilson, WY) within the May 1 – September 30 summer recreation season for the period of record 1994-2025. Daily average discharges (n=4,896) were ranked from highest to lowest, and percent exceedance values were calculated using the Weibull plotting position (Vogel and Fennessey, 1994):

$$Percent\ Exceedance = \frac{m}{n+1} * 100$$

m = daily average discharge rank, n = number of observations (4,896)

The curve was then generated with percent exceedance on the x-axis, and discharge on the y-axis. The flow duration curve for Fish Creek is displayed below in Figure A-1. The maximum observed average daily discharge in Fish Creek for the 1994-2025 period of record was 1,350 cfs on June 9th, 1997, and the minimum observed average daily discharge was 45.4 cfs on May 2nd, 2013.

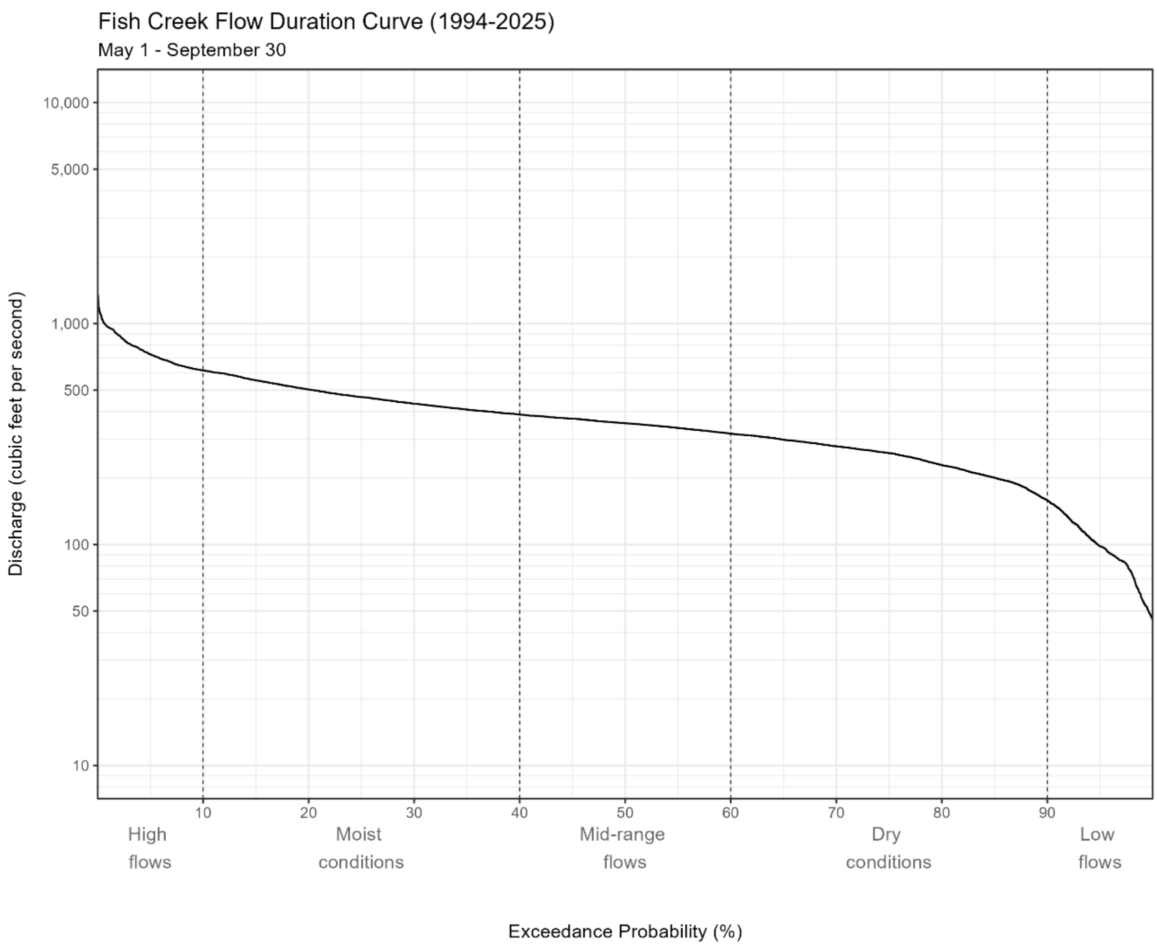

Figure A-1. Flow Duration Curve for Fish Creek developed using continuous streamflow data between May 1 and September 30 collected from USGS streamgage 13016450 (Fish Creek at Wilson, WY). Streamgage period of record: 1994-2025.

Load Duration Curve Method

An *E. coli* load duration curve is developed by multiplying the flow duration curve values by the target allowable *E. coli* load under existing water quality criteria and applying a conversion factor to account for a change in units (Table A-1). The load duration curve for Fish Creek was developed by multiplying the average daily discharge values in Fish Creek by the target allowable *E. coli* concentration of 126 MPN/100 mL and applying the conversion factor. This produces a load duration curve that represents the maximum target *E. coli* load to pass through location of USGS streamgage 13016450.

Table A-1. Conversion factor for *E. coli* load calculations.

***E. coli* concentration (MPN/100 mL)**	**Discharge (ft^3/second)**	**100 mL/ft^3**	**seconds/day**	***E. coli* load (MPN/day)**
x	y	283.168	86,400	$24{,}465{,}715.2(xy)$
126	y	283.168	86,400	$3{,}082{,}680{,}115.2(y)$

The load duration curve was generated with percent exceedance on the x-axis, and *E. coli* load (MPN/day) on the y-axis (Figure A-2). The range of target *E. coli* loads from the load duration curve development are displayed below and are calculated using the minimum and maximum daily average discharges observed in Fish Creek during the summer recreation season (Table A-2).

Table A-2. Target *E. coli* loads in Fish Creek.

E. coli concentration (MPN/100 mL)	**Discharge (ft^3/second)**	**Target *E. coli* load (MPN/day)**
126	45.4	$1.39 * 10^{11}$
126	1,350	$4.16 * 10^{12}$

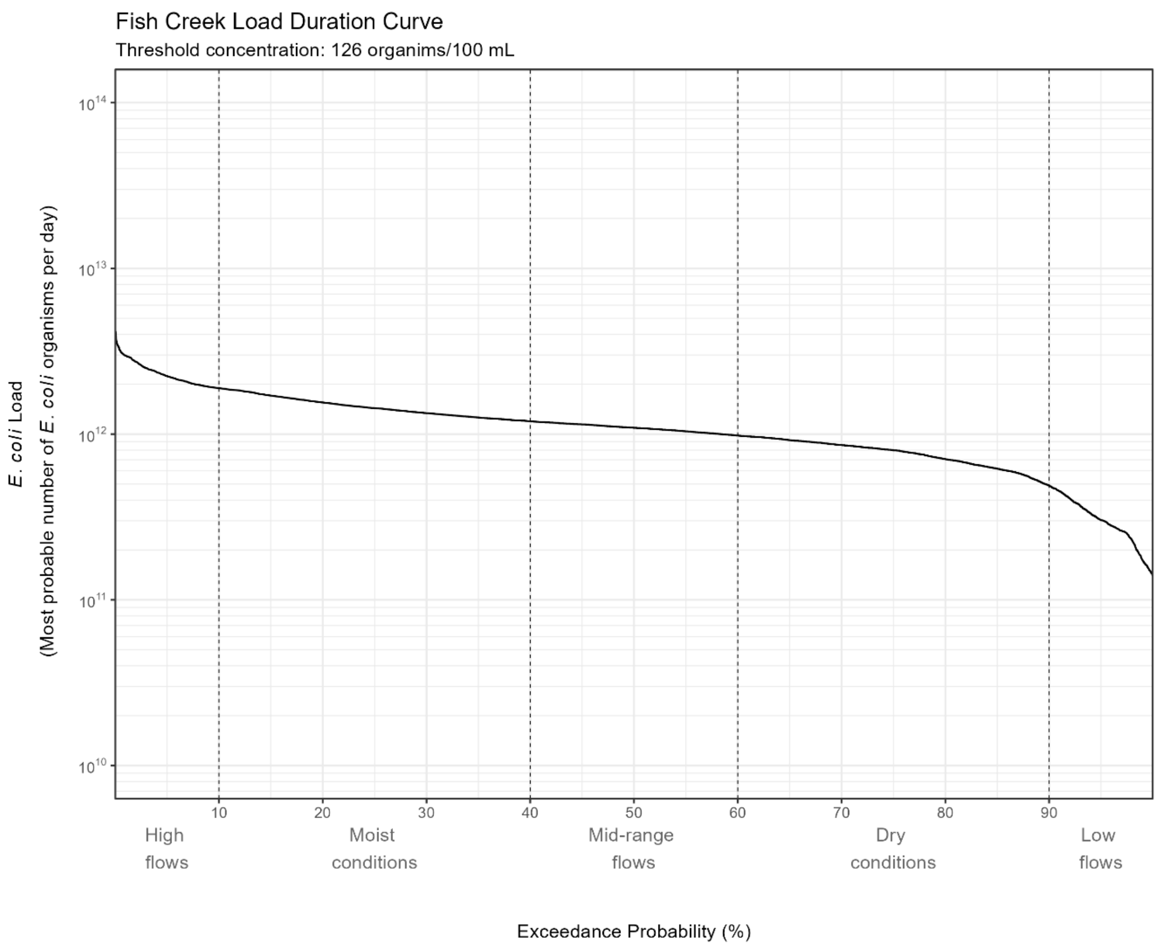

Figure A-2. Load Duration Curve for Fish Creek developed with target *E. coli* loads associated with target concentrations of 126 MPN/100 mL and continuous streamflow data collected from USGS streamgage 13016450 (Fish Creek at Wilson, WY).

Load Duration Curve with Estimated Pollutant Loads

E. coli daily loads were calculated by multiplying the *E. coli* concentration from water quality sampling events by the average daily discharge in Fish Creek during the day the sample was collected and applying the conversion factor from Table 1. *E. coli* data collected from site A_Wck during the 2017, 2023, 2024, and 2025 primary recreation seasons (n = 43) were used to calculate *E. coli* loads and compare them to the target *E. coli* loads associated with 126 MPN/100 mL and hydrologic conditions at USGS streamgage 13016450. *E. coli* loads above the load duration curve indicate water quality impairment, and *E. coli* loads below the load duration curve indicate water quality compliance (USEPA, 2007).

Once the load duration curve with estimated daily *E. coli* loads from sampling data is generated, critical flow conditions where the majority of the water quality standard exceedances occur can be determined (USEPA, 2007). Moist flow conditions are associated with snowmelt and heavy precipitation runoff conditions, when a larger percentage of the watershed is connected to the stream that drains it. Mid-range flow conditions are related to average streamflow and precipitation, while drier condition flows correspond with below-average streamflows and precipitation and suggest a more continuous contribution such as a point source discharge (Campbell County Conservation District, 2019).

In Fish Creek, 25 of 43 estimated *E. coli* loads were above the target *E. coli* load, and 18 of 43 estimated *E. coli* loads were below the target *E. coli* load (Figure A-3). All but one (24 of 25) *E. coli* load exceedance occurred during high flows, moist conditions, or mid-range flows. This suggests nonpoint sources are responsible for *E. coli* exceedances in Fish Creek, rather than point source discharges (USEPA, 2007). When Fish Creek streamflow is elevated in June and July, both concentrations of *E. coli* from samples (Figure 4 in Section 3-5) and estimated *E. coli* loads are highest compared with other flows and times of year.

Load Reduction Estimates

Load reductions needed to achieve water quality standards were calculated by subtracting the difference between estimated loads that plot above the load duration curve and the target load (Table A-3). "High flow" conditions (4 of 25) were excluded from load reduction estimates because these extreme flows are not representative of typical conditions (USEPA, 2007). On average, an estimated 49.7% reduction in *E. coli* loads is required to meet existing water quality standards for *E. coli* in Fish Creek across all flow conditions.

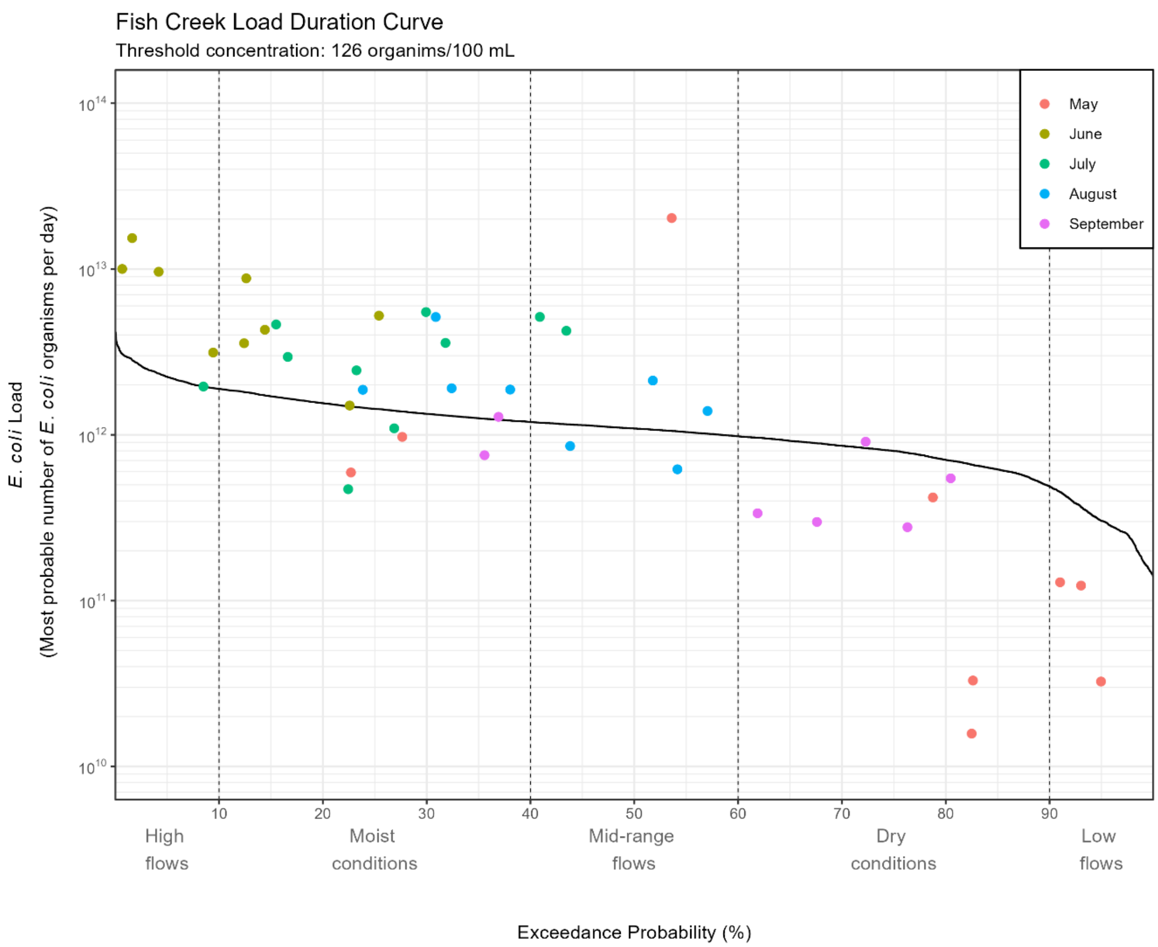

Figure A-3. Load Duration Curve for Fish Creek with estimated *E. coli* loads, developed with *E. coli* concentration data collected from site A_Wck and continuous streamflow data collected from USGS streamgage 13016450 (Fish Creek at Wilson, WY). Estimated loads that plot above the duration curve indicate water quality impairment and loads that plot below the duration curve indicate water quality compliance (USEPA, 2007).

Table A-3. Calculated *E. coli* loads and reduction estimates needed to achieve water quality standards in Fish Creek.

Date	Flow condition	Target E. coli Load (10^9 MPN/day)	Measured E. coli Load (10^9 MPN/day)	Load Reduction Needed (10^9 MPN/day)	Load Reduction Needed (Percent)
2024-05-29	Mid-range flows	1,057	20,305	19,247	94.8
2025-06-11	Moist conditions	1,806	8,790	6,984	79.4
2025-07-23	Moist conditions	1,341	5,504	4,163	75.6
2024-07-10	Mid-range flows	1,184	5,144	3,960	77.0
2025-08-27	Moist conditions	1,326	5,138	3,813	74.2
2024-06-26	Moist conditions	1,430	5,234	3,804	72.7
2024-07-24	Mid-range flows	1,159	4,242	3,083	72.7
2017-07-18	Moist conditions	1,692	4,631	2,939	63.5
2025-06-04	Moist conditions	1,732	4,304	2,571	59.7
2025-07-30	Moist conditions	1,310	3,585	2,275	63.5
2023-06-14	Moist conditions	1,813	3,569	1,757	49.2
2017-07-05	Moist conditions	1,655	2,952	1,297	43.9
2024-08-07	Mid-range flows	1,076	2,125	1,049	49.4
2025-07-09	Moist conditions	1,470	2,448	978	39.9
2025-08-13	Moist conditions	1,221	1,875	654	34.9
2023-08-02	Moist conditions	1,301	1,910	609	31.9
2017-08-10	Moist conditions	1,458	1,870	412	22.0
2024-08-21	Mid-range flows	1,017	1,393	375	27.0
2024-09-04	Dry conditions	832	909	77	8.4
2025-09-03	Moist conditions	1,236	1,284	48	3.7
2025-06-25	Moist conditions	1,486	1,502	17	1.1
2023-07-05	High flows	1,958	1,956	--	--
2023-07-19	Moist conditions	1,489	470	--	--
2023-05-31	Moist conditions	1,483	593	--	--
2017-07-31	Moist conditions	1,396	1,095	--	--
2023-05-24	Moist conditions	1,384	972	--	--
2025-09-17	Moist conditions	1,252	754	--	--
2023-08-23	Mid-range flows	1,156	856	--	--
2023-08-16	Mid-range flows	1,051	620	--	--
2023-09-06	Dry conditions	962	337	--	--

Date	Flow condition	Target E. coli Load (10^9 MPN/day)	Measured E. coli Load (10^9 MPN/day)	Load Reduction Needed (10^9 MPN/day)	Load Reduction Needed (Percent)
2023-09-13	Dry conditions	891	298	--	--
2023-09-27	Dry conditions	780	277	--	--
2017-05-09	Dry conditions	731	419	--	--
2024-09-17	Dry conditions	700	547	--	--
2017-05-23	Dry conditions	663	16	--	--
2025-05-21	Dry conditions	660	33	--	--
2024-05-15	Low flows	453	129	--	--
2025-05-07	Low flows	370	123	--	--
2024-05-01	Low flows	304	33	--	--

A-3 References

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APPENDIX B: FISH CREEK WATER QUALITY AND HYDROLOGY

B-1 Introduction

Teton Conservation District has collected water quality data in Fish Creek, alongside other entities, since 2007. In partnership with the US Geological Survey (USGS), Teton Village Water and Sewer District (TVWSD), Protect Our Water Jackson Hole (POWJH), and other partners, TCD has collected water quality and biological data from numerous surface water sites in Fish Creek and collected water quality data from groundwater sites adjacent to Fish Creek. Fifteen total sites have relevant data beginning in 2007. Six surface water sites and three groundwater sites on Fish Creek have a large record of data, and data from these sites pertaining to *E. coli* and nutrient enrichment are presented within this appendix. Where applicable, additional sites and monitoring efforts are presented where relevant to *E. coli* and nutrient impairment.

All data provided in this appendix were collected by either the USGS, TCD, or POWJH. Data collected by TCD and Friends of Fish Creek/POWJH were collected under Sampling and Analysis Plans that were approved by WDEQ (TCD 2015, TCD 2016, WDEQ 2016, WDEQ 2017, POWJH 2023a, POWJH 2023b, TCD 2024). A subset of these data was reviewed and published in the Fish Creek Nutrient Assessment (WDEQ/WQD et al., 2023).

Field audits were conducted by WDEQ staff in October 2016, October 2017 to confirm adherence to Sampling and Analysis Plan methodology for nutrient enrichment data collection. An additional field audit was conducted in July 2025 to determine adherence to Sampling and Analysis Plan methodology for *E. coli* data collection. In 2016, auditors made recommendations to address a few discrepancies between TCD and a consultant assisting with monitoring work. In 2017, these discrepancies were corrected (WDEQ/WQD et al., 2023). In 2025, the field audit confirmed that data collection methods were representative of environmental field conditions and were expected to yield scientifically defensible *E. coli* data (WDEQ/WQD 2025a).

The following data summary represents two major categories of sampling efforts. The first effort was designed to document nutrient enrichment in Fish Creek and includes monitoring data for nutrient concentrations, isotope ratios, macroinvertebrates, chlorophyll-a, periphyton composition, and other data between 2007-2011, 2014-2018, and 2024-present. The second effort was designed to assess the existing *E. coli* impairment in Fish Creek, including *E. coli* concentration data collected during 2017 and 2023-2025, and microbial source tracking data associated with the fecal indicator bacteria *Bacteroides spp* collected in 2023. A summary of all collected data is provided below in Table B-1.

Table B-1. Fish Creek data collection summary.

Parameter	Units	Period of Record	Number of sites	Number of records
Chlorophyll, benthic	mg/m^2	2014-2018, 2024-present	5	32
Discharge	cfs	2007-2011, 2016-2018,2024-present	8	106
Escherichia coli	MPN/mL	1999-2003, 2017, 2023-present	5	191
Macroinvertebrates	--	2007-2011, 2014-2018, 2024-present	6	71
Nitrogen, organic (as N)	mg/L	2007-2011, 2014-2018, 2024-present	9	271
$^{15}N/^{14}N$ ratio ($\delta^{15}N$ [NO_3])	per mil	2007-2011, 2016-2018	8	32
Nitrate (as N)	mg/L	2007-2011, 2014-2018, 2024-present	14	217
Nitrate + Nitrite (as N)	mg/L	2007, 2014-2018, 2024-present	13	125
Nitrite (as N)	mg/L	2007-2011, 2014-2018, 2024-present	14	217
Nitrogen, total Kjeldahl (as N)	mg/L	2014-2018, 2024-present	8	89
Nitrogen, Ammonia (as N)	mg/L	2007-present	14	217
Nitrogen, total	mg/L	2007-2011, 2015, 2024-present	9	202
Nitrogen, total inorganic	mg/L	2015-2018, 2024-present	8	69
$^{18}O/^{16}O$ ratio ($\delta^{18}O$ [NO_3])	per mil	2007-2011, 2016-2018	8	46
Orthophosphate (as P)	mg/L	2007, 2014-2017, 2024-present	8	37
Oxygen, dissolved (instantaneous)	mg/L, percent saturation	2007-2011, 2016-2018, 2024-present	14	92
Oxygen, dissolved (continuous)	mg/L, percent saturation	2016, 2024-present	2	--
Periphyton taxonomic composition	--	2007-2011, 2014-2018, 2024-present	5	93
pH (instantaneous)	standard units	2007-2011, 2016-2018, 2024-present	15	164
pH (continuous)	standard units	2024-present	2	--
Phosphate (as P)	mg/L	2007-2011	6	92
Phosphorus, total (as P)	mg/L	2007-2011, 2014-2018, 2024-present	9	274
Turbidity	NTU, FNU	2016-2018, 2024-present	9	37

B-2 *E. coli* Data

WDEQ assessed Fish Creek *E. coli* samples in 2017 and determined that geometric mean values for *E. coli* concentrations exceeded the summer recreation standard of 126 organisms/100 mL (applicable May 1 – September 30). This exceedance resulted in the entirety of Fish Creek obtaining a Category 5 impairment status in the 2020 Wyoming Integrated 305(b) and 303(d) report for failing to meet its Recreation designated use. A University of Wyoming Master's thesis study was completed in 2022 by Kelsey Ruehling titled *Understanding Contributions of Fecal Bacteria Sources in Wyoming Rivers to Inform Pollution Management* (Ruehling, 2022). This study provided an in-depth analysis of microbial source tracking and considered the wide range of sources contributing to fecal bacteria pollution in Fish Creek. Most recently, POWJH supported an *E. coli* and microbial source tracking study on Fish and Flat Creeks in the summer of 2023. The study aimed to collect geometric mean values for *E. coli* samples, as well as corresponding Microbial Source Tracking data, to determine the relative contributions of fecal bacteria to Fish Creek.

E. coli data has been collected at five sites on Fish Creek in 2017 and 2023-2025 (Figure B-1). All *E. coli* data presented have been collected under Sampling and Analysis Plans (SAPs) which have been reviewed and accepted by the WDEQ). Sampling methodology utilized the IDEXX Colilert method of total coliform bacteria and *E. coli* enumeration, outlined in the Standard Operating Procedures for Sample Collection and Analysis (WDEQ/WQD, 2025b). *E. coli* data provided here are reported in the most probable number of organisms per 100 mL, or MPN/100 mL. This unit is equivalent to colony forming units (cfu) per 100 mL.

Two independent water quality criteria exist in Wyoming's Surface Water Quality Standards (WDEQ/WQD 2025c) to assess *E. coli* concentrations in Fish Creek during the summer recreation season (May 1 – September 30). The lower criterion, 126 MPN/100 mL, is a calculated geometric mean and referred to hereafter as the *E. coli* assessment criterion because this is the criterion that WDEQ uses to determine whether the Recreation designated use is fully supported or not fully supported (i.e. impaired) for waters designated for Full Body Contact Recreation. For comparison with the *E. coli* assessment criterion, the geometric mean is calculated from five independent samples collected within a single 60-day period within a single recreation season (May 1 – September 30). If at least one five-sample geometric mean exceeds 126 MPN/100 mL, the stream is considered impaired by WDEQ (WDEQ/WQD, 2021). The geometric mean is calculated using Equation 1 below:

$$Geometric\ mean = \sqrt[5]{x_1 * x_2 * x_3 * x_4 * x_5} \tag{1}$$

The higher water quality criterion for *E. coli*, 235 MPN/100 mL represents the value from a single sample, rather than a geometric mean. This single-sample criterion represents a specific point in time and is primarily used for communicating risk of illness from waterborne pathogens to the public rather than assessing designated use support. Starting in 2023, *E. coli* samples were collected in Fish Creek in partnership with Teton County Health Department to coordinate participation in the Wyoming Waterborne Pathogen Public Notification Process (WDEQ, 2025d). This process provides procedural guidelines for timely notification of the public should the presence of unsafe levels of waterborne pathogens be suspected or confirmed in a waterbody.

E. coli concentration data from 2017, 2023, and 2024 at five sites along Fish Creek are provided in Figures B-2 through B-7 below. Concentrations at A_R1D are the lowest along Fish Creek. Concentrations substantially increase at A_RB and remain consistent throughout downstream sites. *E. coli* concentrations in Fish Creek are highest in June and July, when streamflows are highest and pasture in the watershed is actively being grazed.

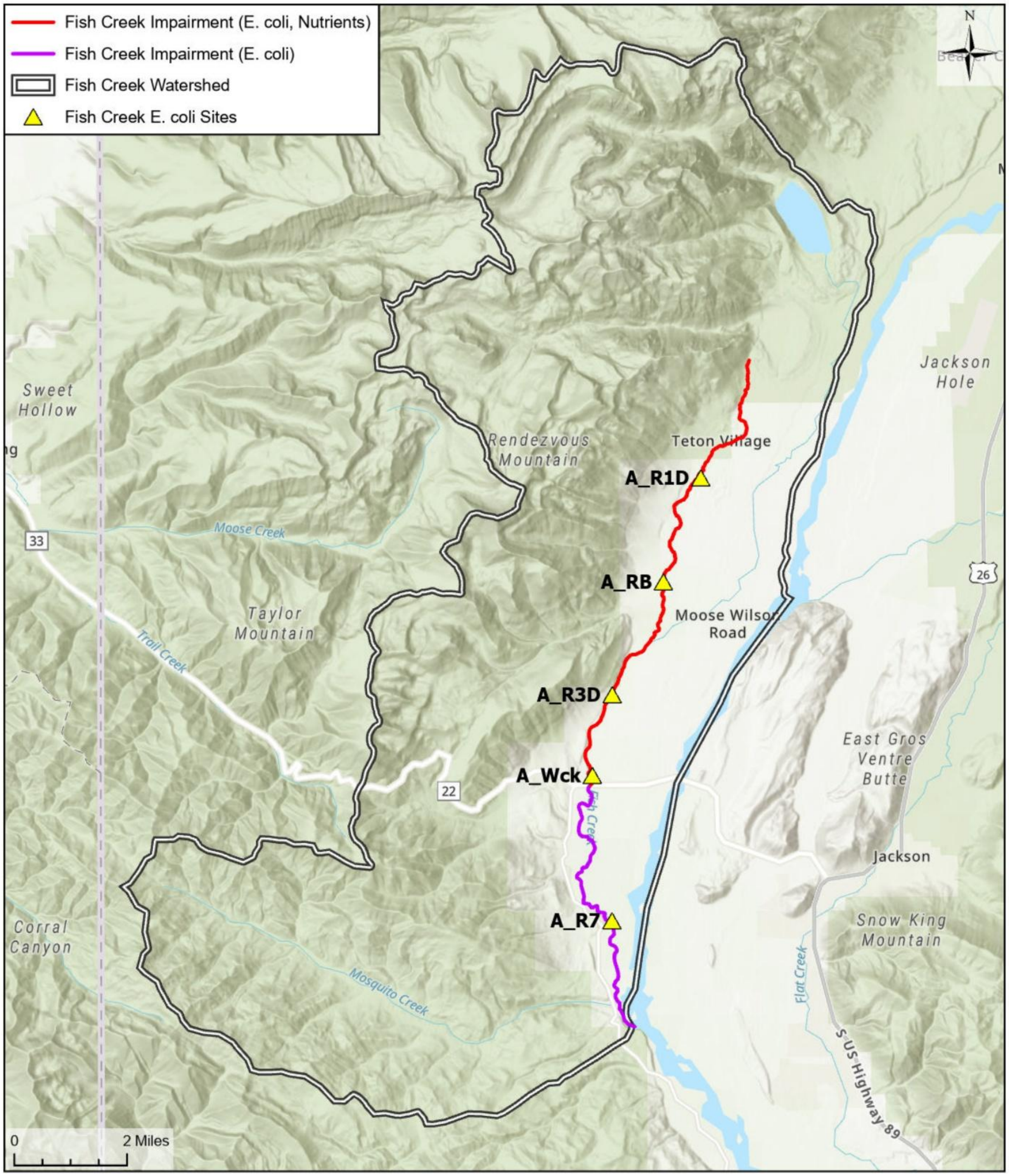


Figure B-1. *E. coli* sample collection sites in Fish Creek (2023-2025).

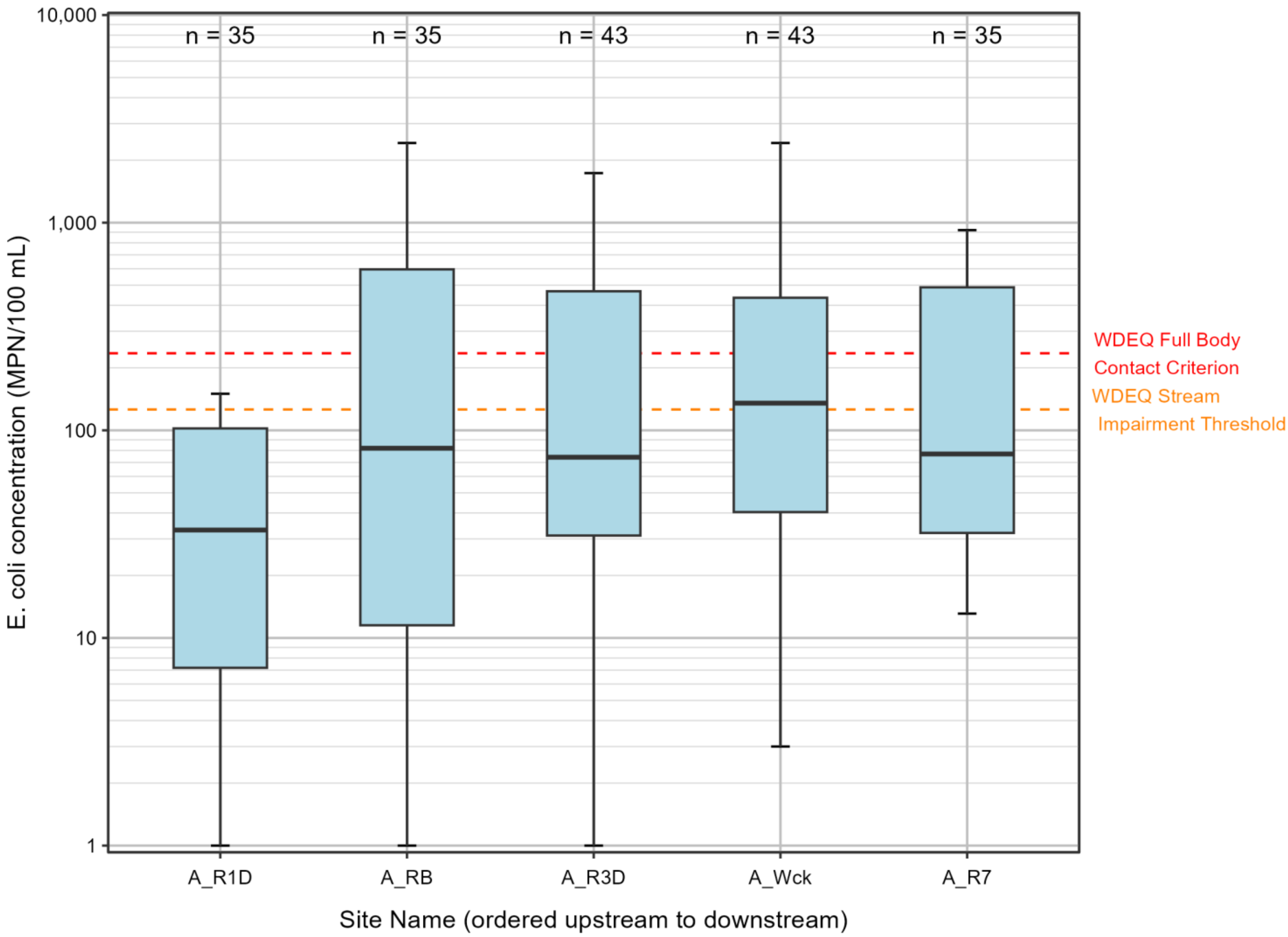


Figure B-2. *E. coli* concentrations at regularly sampled sites in Fish Creek from 2017 and 2023-2025. The red line represents the 235 organisms/100 mL single-sample criterion that is used in the public health notification process. The orange line represents Wyoming's numeric water quality criterion of a geometric mean of 126 organisms/100 mL protective of full body contact water recreation during the summer recreation season. Non-detects, or samples collected with <1 MPN/100 mL, are represented as 1.0 on a log-axis plot. The number of samples collected (n) is shown across the top of the plot.

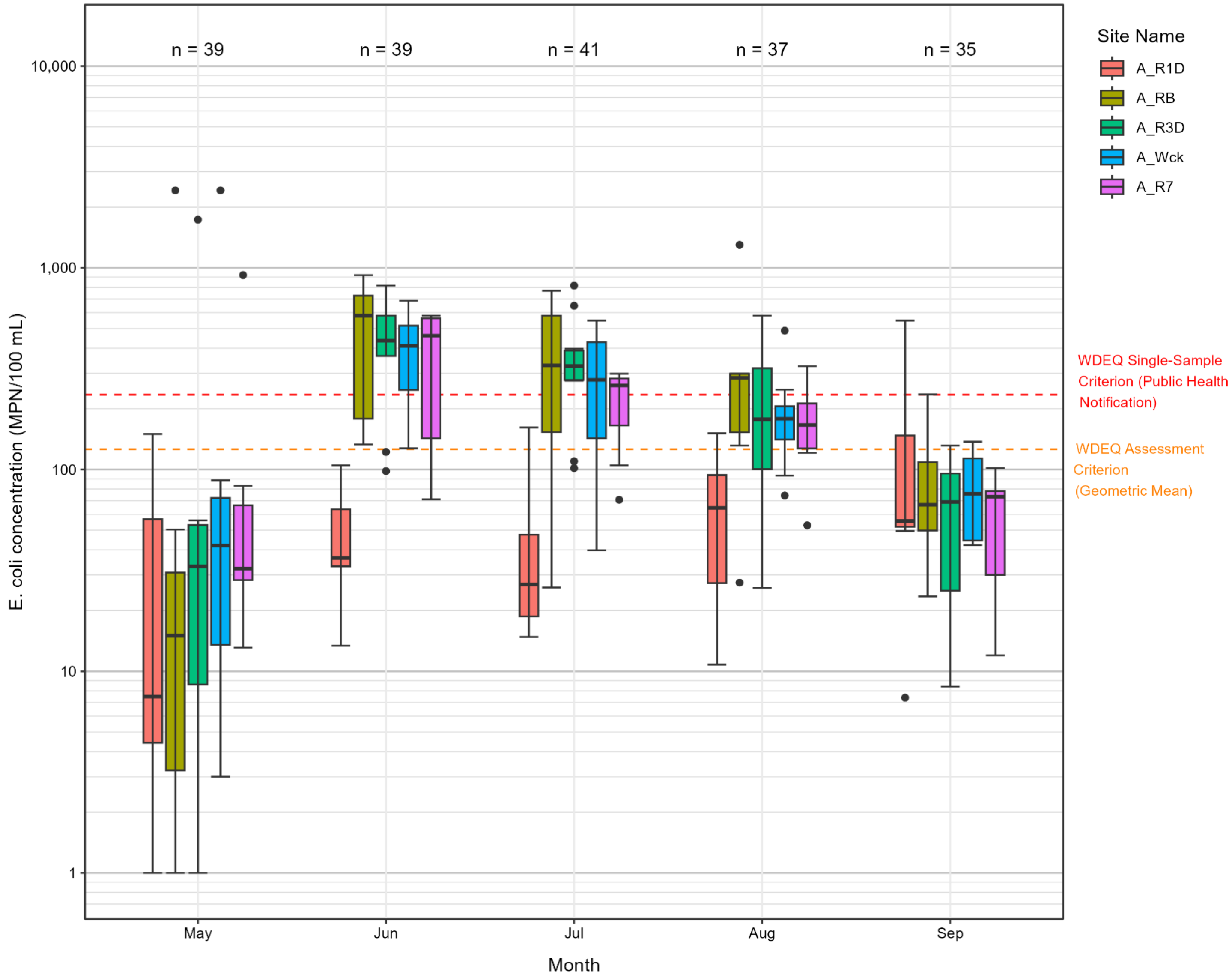


Figure B-3. *E. coli* concentrations at regularly sampled sites in Fish Creek separated by month from 2017 and 2023-2025. The red line represents the 235 organisms/100 mL single-sample criterion that is used in the public health notification process. The orange line represents Wyoming's numeric water quality criterion of a geometric mean of 126 organisms/100 mL protective of full body contact water recreation during the summer recreation season. Dots represent outliers outside of 1.5 times the interquartile range. Non-detects, or samples collected with <1 MPN/100 mL, are represented as 1.0 on a log-axis plot. The number of samples collected (n) is shown across the top of the plot.

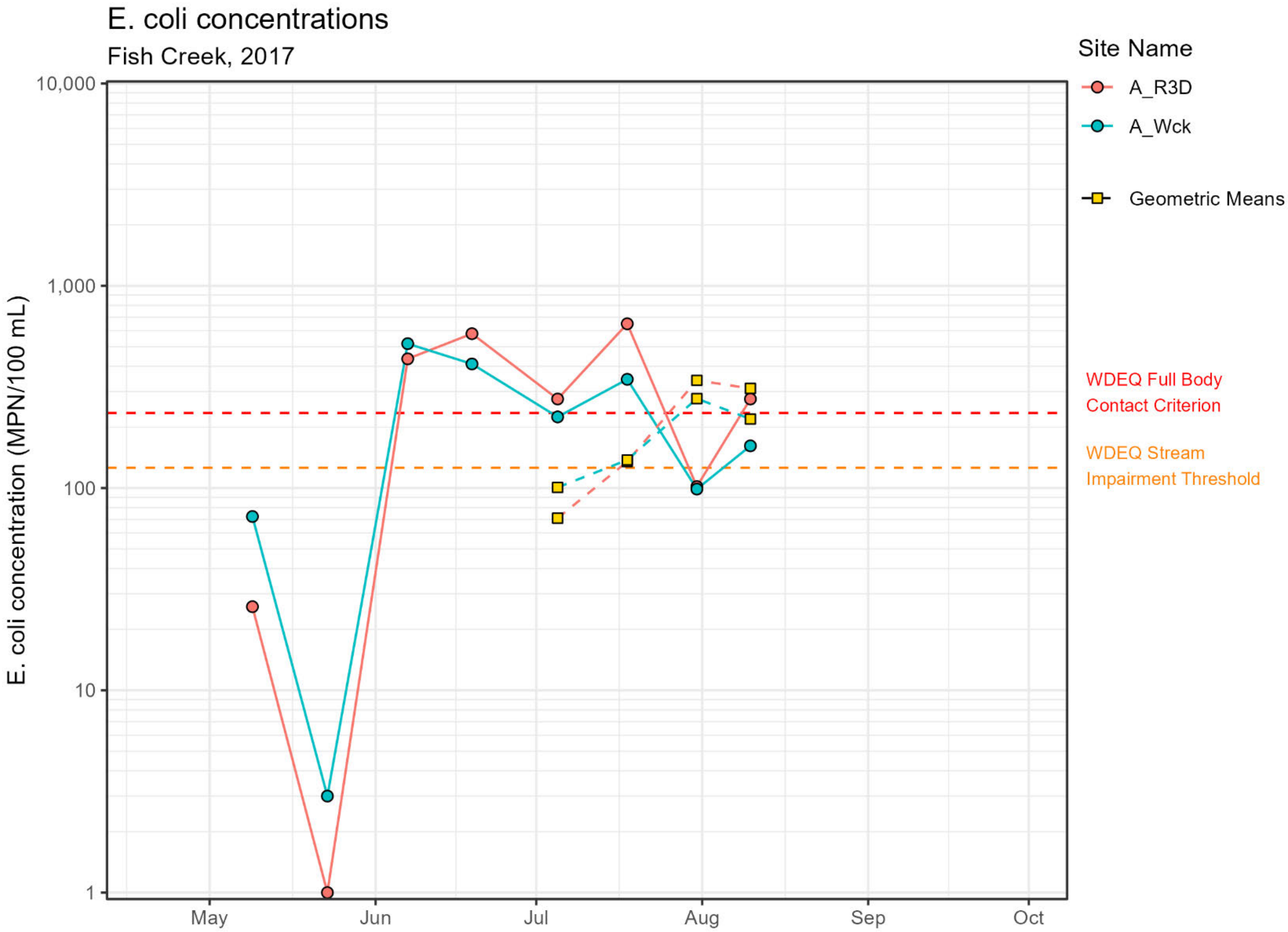


Figure B-4. *E. coli* concentrations at two Fish Creek sites 2017. Data collected by WDEQ. The red line represents the 235 organisms/100 mL single-sample criterion that is used in the public health notification process. The orange line represents Wyoming's numeric water quality criterion of a geometric mean of 126 organisms/100 mL protective of full body contact water recreation during the summer recreation season. Yellow squares are five-sample geometric means associated with each site. Non-detects, or samples collected with <1 MPN/100 mL, are represented as 1.0 on a log-axis plot.

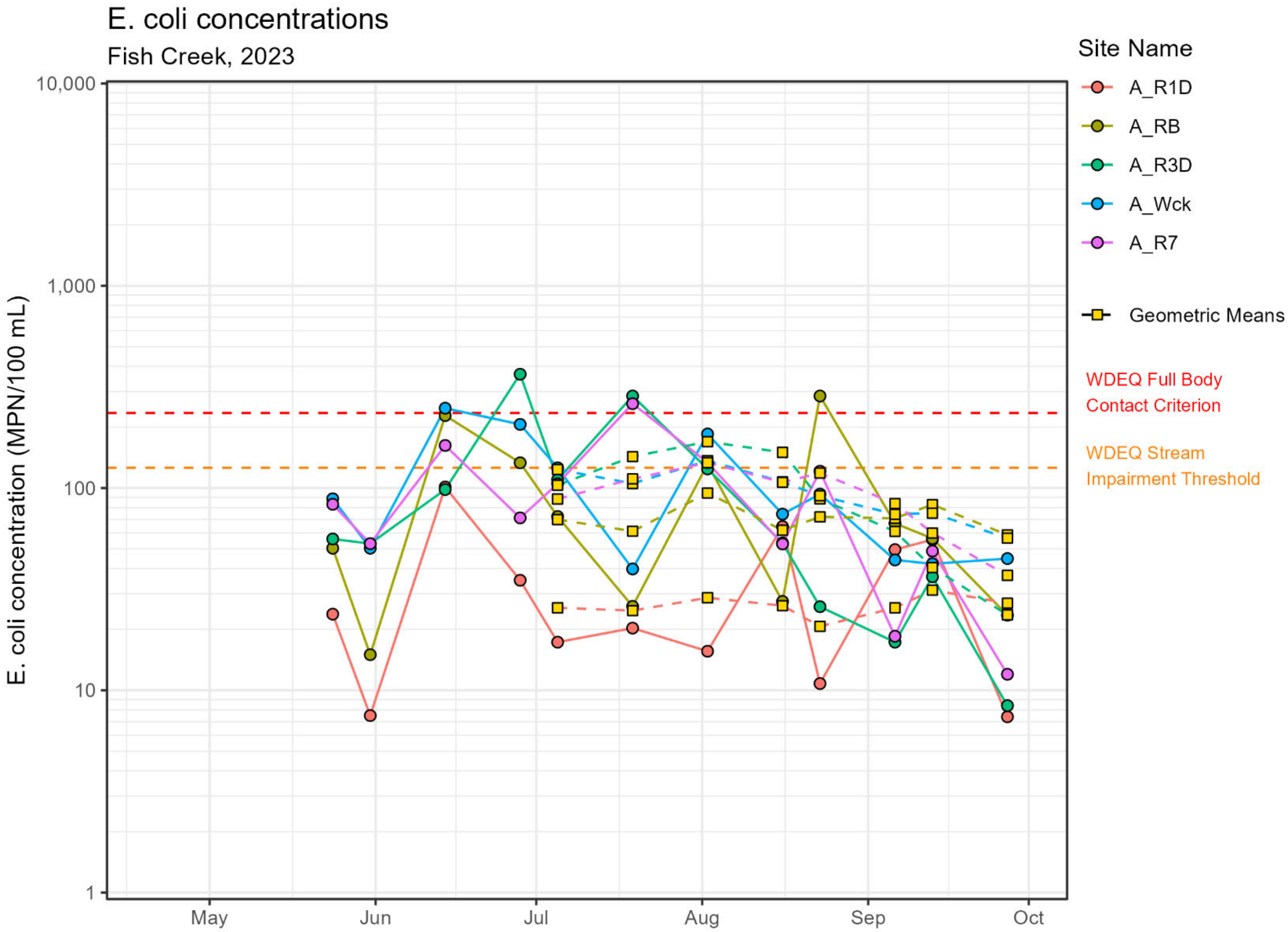


Figure B-5. *E. coli* concentrations in Fish Creek in 2023. The red line represents the 235 organisms/100 mL single-sample criterion that is used in the public health notification process. The orange line represents Wyoming's numeric water quality criterion of a geometric mean of 126 organisms/100 mL protective of full body contact water recreation during the summer recreation season. Yellow squares are five-sample geometric means associated with each site. Non-detects, or samples collected with <1 MPN/100 mL, are represented as 1.0 on a log-axis plot.

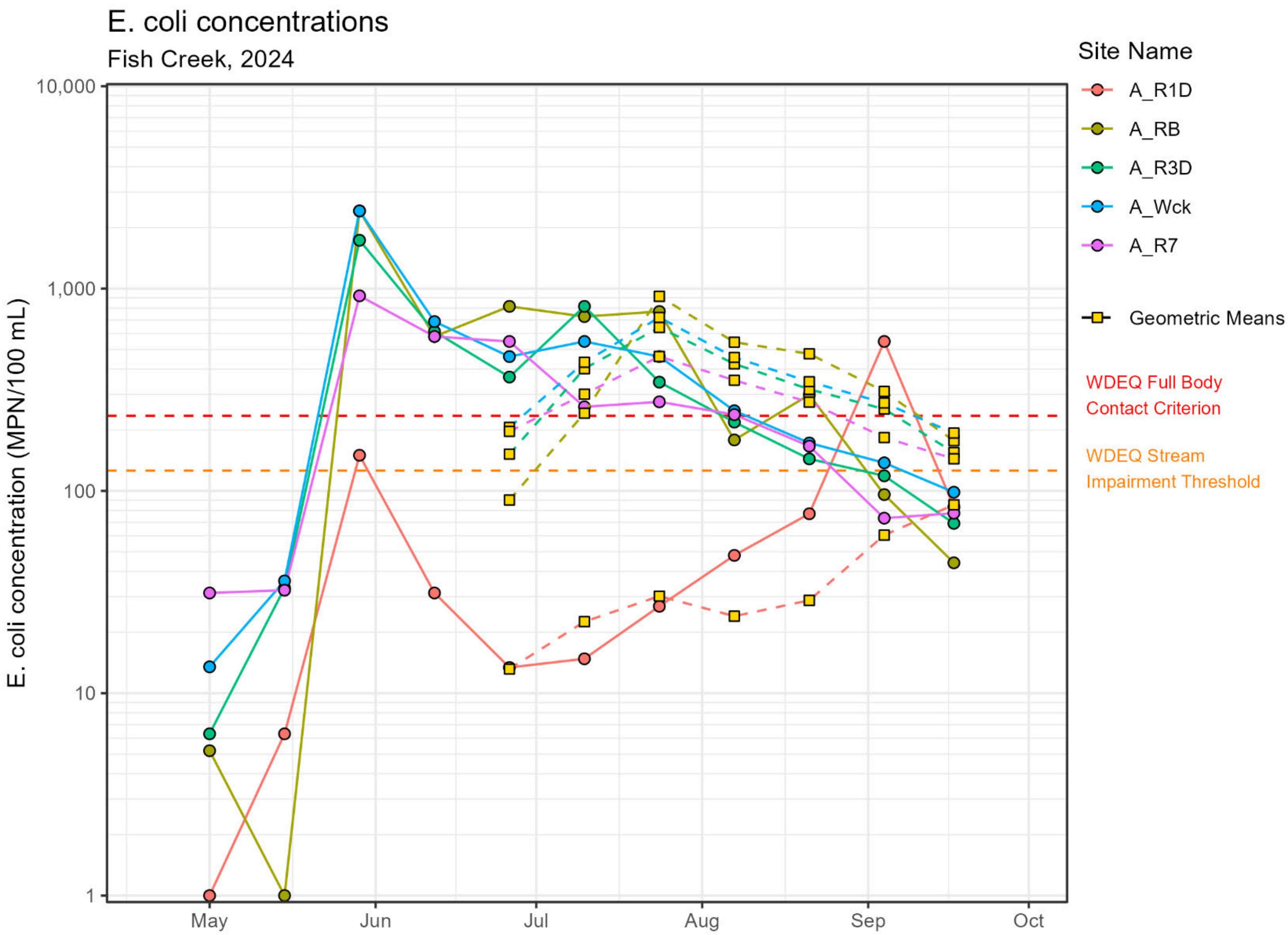


Figure B-6. *E. coli* concentrations Fish Creek in 2024. The red line represents the 235 organisms/100 mL single-sample criterion that is used in the public health notification process. The orange line represents Wyoming's numeric water quality criterion of a geometric mean of 126 organisms/100 mL protective of full body contact water recreation during the summer recreation season. Yellow squares are five-sample geometric means associated with each site. Non-detects, or samples collected with <1 MPN/100 mL, are represented as 1.0 on a log-axis plot.

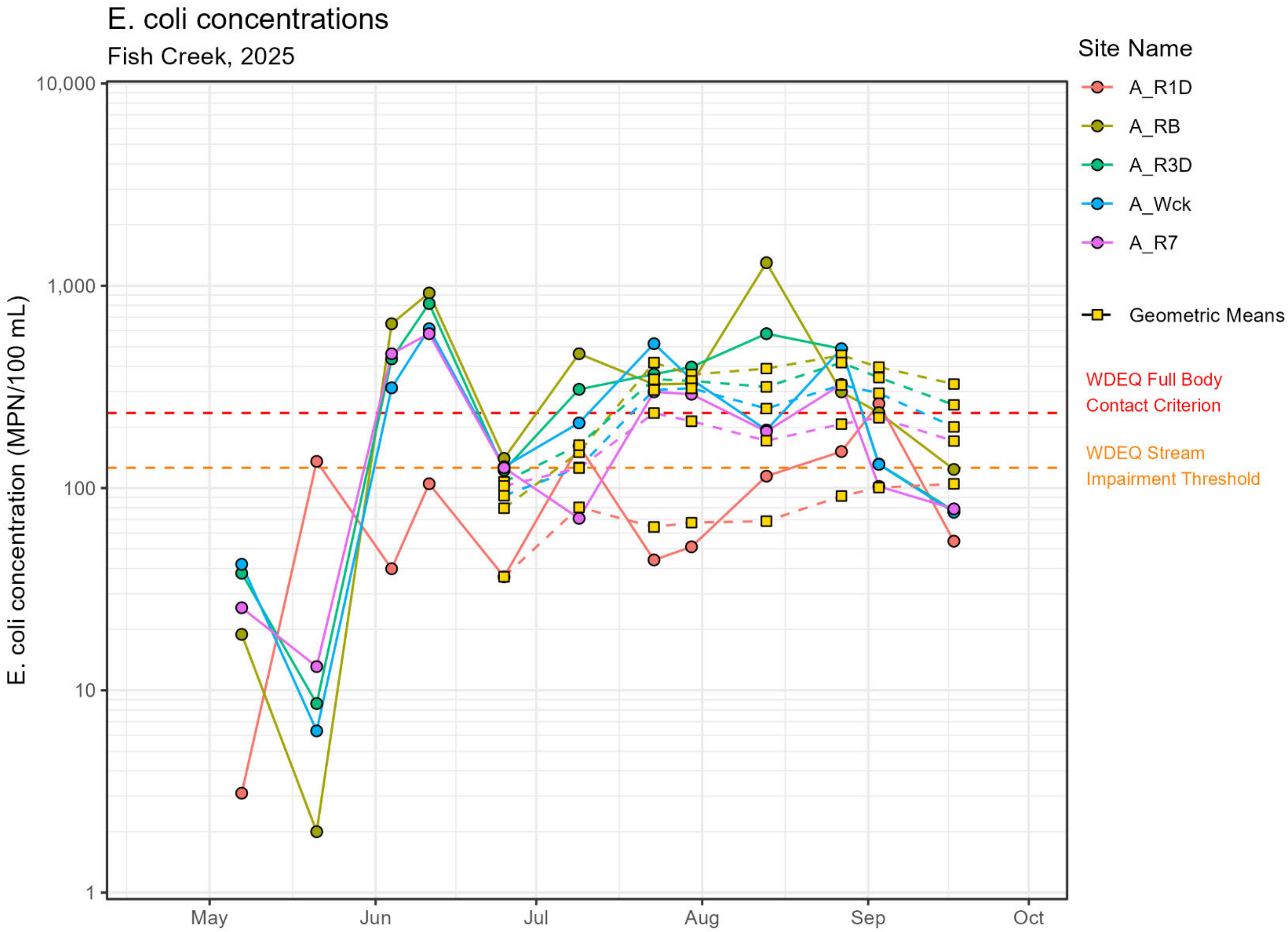


Figure B-7. *E. coli* concentrations in Fish Creek in 2025. The red line represents the 235 organisms/100 mL single-sample criterion that is used in the public health notification process. The orange line represents Wyoming's numeric water quality criterion of a geometric mean of 126 organisms/100 mL protective of full body contact water recreation during the summer recreation season. Yellow squares are five-sample geometric means associated with each site. Non-detects, or samples collected with <1 MPN/100 mL, are represented as 1.0 on a log-axis plot.

B-3 Microbial Source Tracking Data

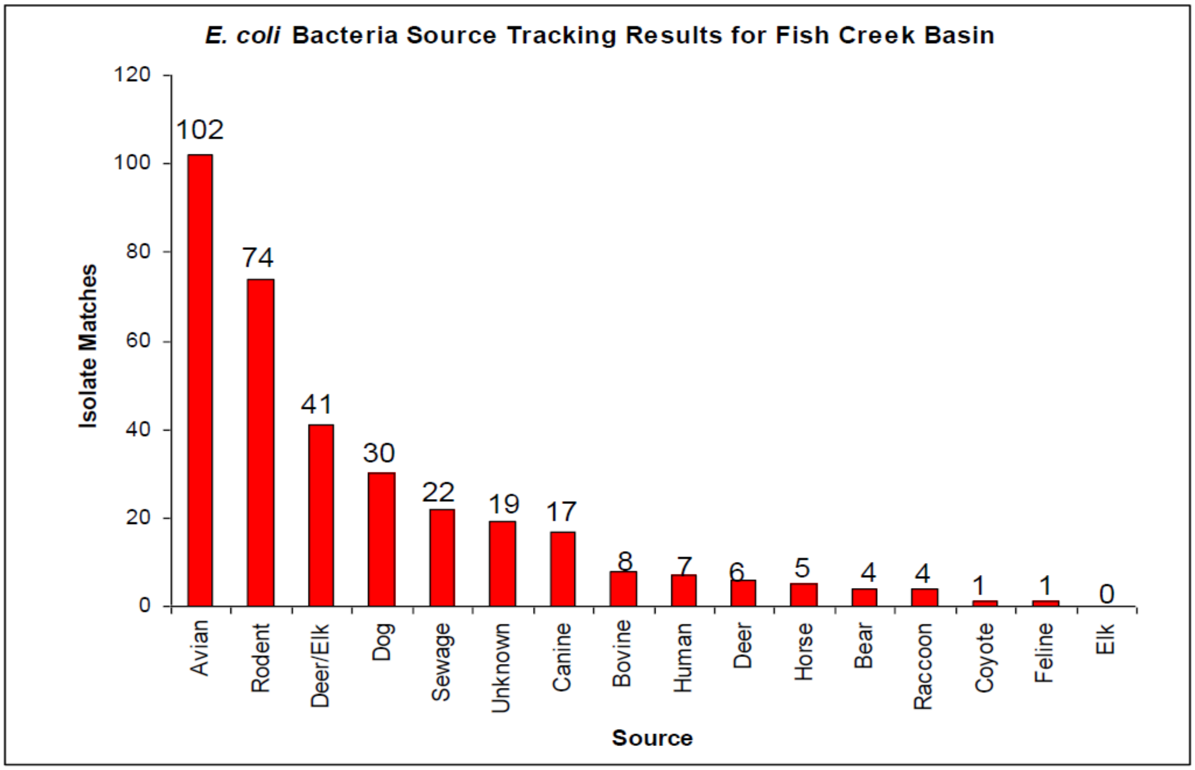
Microbial source tracking refers to an assessment of bacterial community evaluation in waterbodies. Fecal bacteria source tracking is of particular interest and has been studied extensively in waterbodies (Ahmed et al., 2009; Ahmed et al., 2013; Ahmed et al., 2016; Bae and Wuertz, 2009; Jang et al., 2017; Jesser et al., 2025; Kim et al., 2015; Odagiri et al., 2015; Reischer et al., 2013). Three microbial source tracking studies of interest have been conducted in Fish Creek.

E. coli Source Tracking Study (2003)

Heightened concern for bacteriological contamination of Fish Creek and Flat Creek began in the early 2000s with TCD's study on Microbial Source Tracking for *Escherichia coli* in Two Upper Snake River Basins, conducted in 2003 (Remlinger, 2005). Samples were collected in Fish Creek during the primary recreation season in 2003 and delivered to the Institute for Environmental Health (IEH) in Seattle, WA. Genetic ribotyping of *E. coli* DNA produced matches between collected samples and the species markers in the IEH genetic library. Avian sources comprised the largest number of isolate matches to Fish Creek samples (29.9%), followed by rodent (21.7%), deer/elk (12.0%), dog (8.8%), and sewage (6.5%) sources (Figure B-8).

Microbial Source Tracking Study (2021)

In 2021, a University of Wyoming Master's thesis study was conducted to identify and quantify sources of fecal pollution in Fish Creek and Flat Creek. Community-based microbial source tracking methods using high-throughput sequencing of water, fecal, and wastewater samples were utilized in Fish Creek and Flat Creek (Ruehling, 2022).The study indicated that increasing land development in the Fish Creek watershed has a negative effect on microbial diversity. In addition, 64% of the bacterial community analyzed was of unknown origin. Wastewater (17%), bovine (7%), canine (3.9%), and other sources (8%) comprised the identifiable portion of the bacterial community (Ruehling, 2022). The study found no correlation between fecal bacterial sources from microbial source tracking and standard *E. coli* enumeration, suggesting that *E. coli* could be a poor proxy for fecal pollution in waterbodies (Ruehling, 2022).



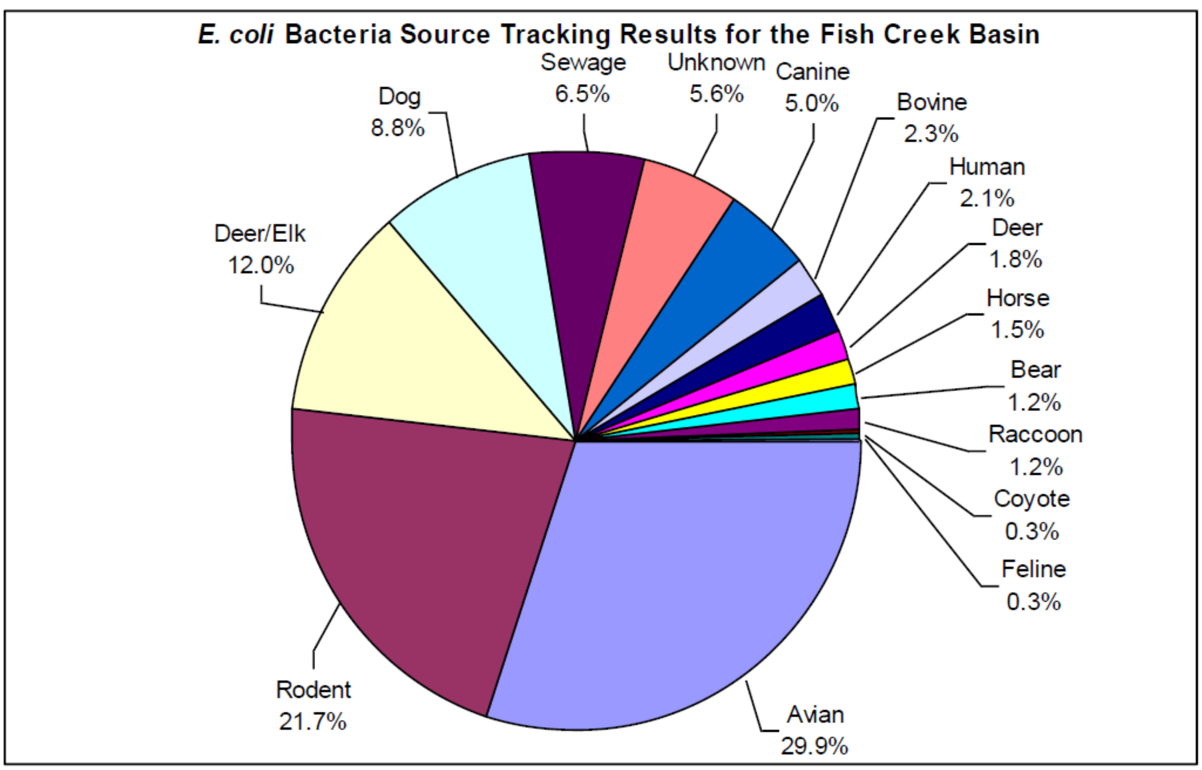


Figure B-8. *E. coli* source tracking results for the Fish Creek watershed, 2003. Taken from Remlinger, 2005.

Bacteroides Source Tracking Study (2023)

In 2023, Protect Our Water Jackson Hole, in collaboration with Alder Environmental, Teton Conservation District, and the Wyoming Public Health Department, conducted a study to measure source contributions of fecal indicator bacteria in Fish Creek and Flat Creek in Teton County, WY. This study used microbial source tracking methods to evaluate *Bacteroides* markers from known host species and compared these signatures to those present in water samples. *Bacteroides*, a genus of bacteria associated with fecal pollution in waterbodies, was identified as a candidate for microbial source tracking work based on the large volume of study established in the literature (Reischer et al., 2013; Jang et al., 2017; Bae and Wuertz, 2009; Kim and Wuertz, 2015; Ahmed et al., 2016).

While there was growing interest in repeating an *E. coli* source tracking project to compare results to what was collected and analyzed in Fish Creek in 2003, there was also a recent understanding in the literature that *E. coli* source tracking studies may not adequately characterize present fecal pollution sources in waterbodies. *E. coli*–based DNA source tracking may reflect historical or persistent fecal sources due to environmental survival and potential naturalization of *E. coli* populations, and therefore may not always indicate active, fecal inputs from present sources. *E. coli* can persist and grow outside of the gut of warm-blooded animals and can survive in environmental conditions present in streams (Jang et al 2017; Bae and Wuertz, 2009). Alternative fecal indicator bacteria have been studied extensively in microbial source tracking efforts over the past twenty years. *Bacteroides* decay rapidly outside of the gut and thus can serve well for identifying recent fecal pollution in environmental waters (Kim and Wuertz, 2015; Ahmed et al., 2016).

Water samples were collected during 12 independent sampling events at five sites on Fish Creek between May 1 and September 30, 2023. Samples were collected in 1.0-liter Nalgene sample bottles with no preservative. These bottles were provided by the Wyoming Public Health Laboratory. Bottles were triple rinsed with stream water prior to sample collection. Samples were cooled and shipped on ice to Wyoming Public Health Laboratory on the same day as sample collection. Upon receipt, samples were processed and analyzed using Traditional Real-Time Polymerase Chain Reaction (RT-PCR) methods which provided presence/absence results of Bacteroides markers within the sample. Samples were then filtered and frozen until the end of the sampling season, when Digital Polymerase Chain Reaction (dPCR) methods were utilized on positive detections to provide enumeration results for *Bacteroides* markers. This was performed by partitioning the sample into thousands of individual reactions that undergo PCR and assessing how many partitions are positive for that marker.

Markers identified for study were AllBac (non-specific universal maker used for positive controls), HF-183 (human-specific), HumM2 (human-specific), HumM3 (human-specific), RumBacB2 (ruminant-specific), CowM2 (bovine-specific), CowM3 (bovine-specific), BacCow (ruminant-specific), BoBac (ruminant-specific), and BacCan (canine-specific). These markers were chosen because of the presence of their hosts within the Fish Creek watersheds. Additionally, these markers were present and available within the current genetic library of the Wyoming Public Health Laboratory in 2023. Avian markers and beaver markers were not available to Wyoming Public Health Laboratory in 2023 and were not quantified. Positive detections from RT-PCR analysis for markers AllBac, BacCan, BacCow, CowM3, and HF-183 were run using dPCR to determine quantification of sources of fecal pollution in Fish Creek.

The effectiveness of *Bacteroides* markers for identifying sources of fecal pollution is described in the sensitivity and the specificity of the marker. The determination of marker sensitivity and specificity is not universally constant, and depends strongly on regionality, methodology, and local species variation. However, some literature has been produced on the topic and is summarized below (Table B-2).

> <u>Sensitivity</u>: Sensitivity represents the percentage of fecal or wastewater samples from the target host that test positive for the specific *Bacteroides* marker. Marker sensitivity is necessary for confidence that absence of the marker is indicative of the absence of the pollution source (Ahmed et al., 2016).
>
> <u>Specificity</u>: Specificity represents the percentage of fecal samples from all non-target hosts that test negative for the marker. "Host specificity is a paramount criterion for confidence that detection of a marker is a true indicator of the target host." (Ahmed et al., 2016).

Table B-2. *Bacteroides* genetic marker overview*.

Source Category	AllBac	HF-183	HumM2	HumM3	RumBacB2	CowM2	CowM3	BacCow	BoBac	BacCan
Sensitivity (%)	-	100[4]	49[1]	-	100[5]	50[1]	>80[6]	92[2]	82[2]	90[1]
Specificity (%)	-	99[3]	70[1]	-	88[5]	100[1,4]	>80[6]	57[2]	59[2]	96[1]

*Table generated using sensitivity and specificity values from peer-reviewed literature: 1: Odagiri, et al., 2015; 2: Reischer, et al., 2013; 3: Ahmed, et al., 2009; 4: Ahmed, et al., 2023; 5: Jesser, et al., 2025; 6: Ahmed, W., 2013.

RT-PCR results from samples collected in 2023 demonstrated that at least one ruminant marker was detected in 100% of sampling events in Fish Creek (Figure B-9). The human marker, HF-183, was detected primarily in upper Fish Creek, within and just downstream of Teton Village (eight of 12 sampling events). Lower Fish Creek also exhibited detections of HF-183 in six of 12 sampling events.

Digital-PCR results demonstrated that the largest contribution of *Bacteroides* in Fish Creek among those studied was from the ruminant-specific *Bacteroides* maker, BacCow, followed by the canine-specific marker, BacCan (Figures B-10, B-11). The cattle-specific marker, CowM3, exhibited low enumeration. The human-specific marker, HF-183, exhibited low enumeration and was primarily localized in the upper watershed at site A_R1D.

Results from this study suggest that ruminant-specific markers are significantly present in Fish Creek. Ruminant-specific markers were both the most frequently detected marker using presence-absence methodology (RT-PCR) and the largest levels using the enumeration method (dPCR). Canine markers were also frequently detected in Fish Creek (up to 7 of 12 sampling events). The human marker (HF-183) was detected more frequently in upper Fish Creek, especially near Teton Village. Due to the low sensitivity of the cattle-specific CowM3 marker (Table B-2), it is difficult to determine whether the high presence of the ruminant-specific marker is due to the presence of cattle or due to non-bovine ruminants including elk, moose, and deer.

Linear regressions between *E. coli* and *Bacteroides* marker levels provide insight into the relationship between particular fecal indicator bacteria sources (e.g. human, canine, ruminant) and *E. coli* pollution in the Fish Creek watershed. Linear regression analysis demonstrated a significant positive relationship ($p < 0.001$) between the BacCow marker concentrations and *E. coli* concentrations in the Fish Creek watershed (Figure B-12). Other relationships between BacCan (canine-specific), CowM3 (cattle-specific), and HF-183 (human-specific) were not statistically significant, demonstrating that *E. coli* concentrations do not correlate well to some microbial source tracking markers.

This study was a pilot to establish a methodology for identifying sources of fecal pollution. This study does not quantify all sources of fecal pollution in Fish Creek, but rather compares human sources of fecal pollution to commonly found animal sources of fecal pollution in Fish Creek. Opportunities exist to improve methodology for microbial source tracking to better characterize sources of fecal pollution to local waterbodies. Direct fecal samples were not collected in Fish Creek watersheds, and genetic markers were identified based on their similarity to the existing Wyoming Public Health genetic library. This can affect results by relying on a genetic library that is quantified by host species that may vary in their ability to exhibit a *Bacteroides* marker. While studied in previous microbial source tracking efforts in Teton County, avian and rodent markers were not analyzed due to the lack of these markers in the existing library at the time the study was performed. While creating a host library for watershed-specific species adds complexity and labor to the effort, it could significantly improve confidence in the results. In other words, a cattle marker specifically developed for cows that reside in the watershed may be able to directly quantify fecal pollution from cattle, rather than relying on a ruminant-specific marker or a cattle marker with low sensitivity. Teton Conservation District will continue to explore sampling methodologies for microbial source tracking studies.

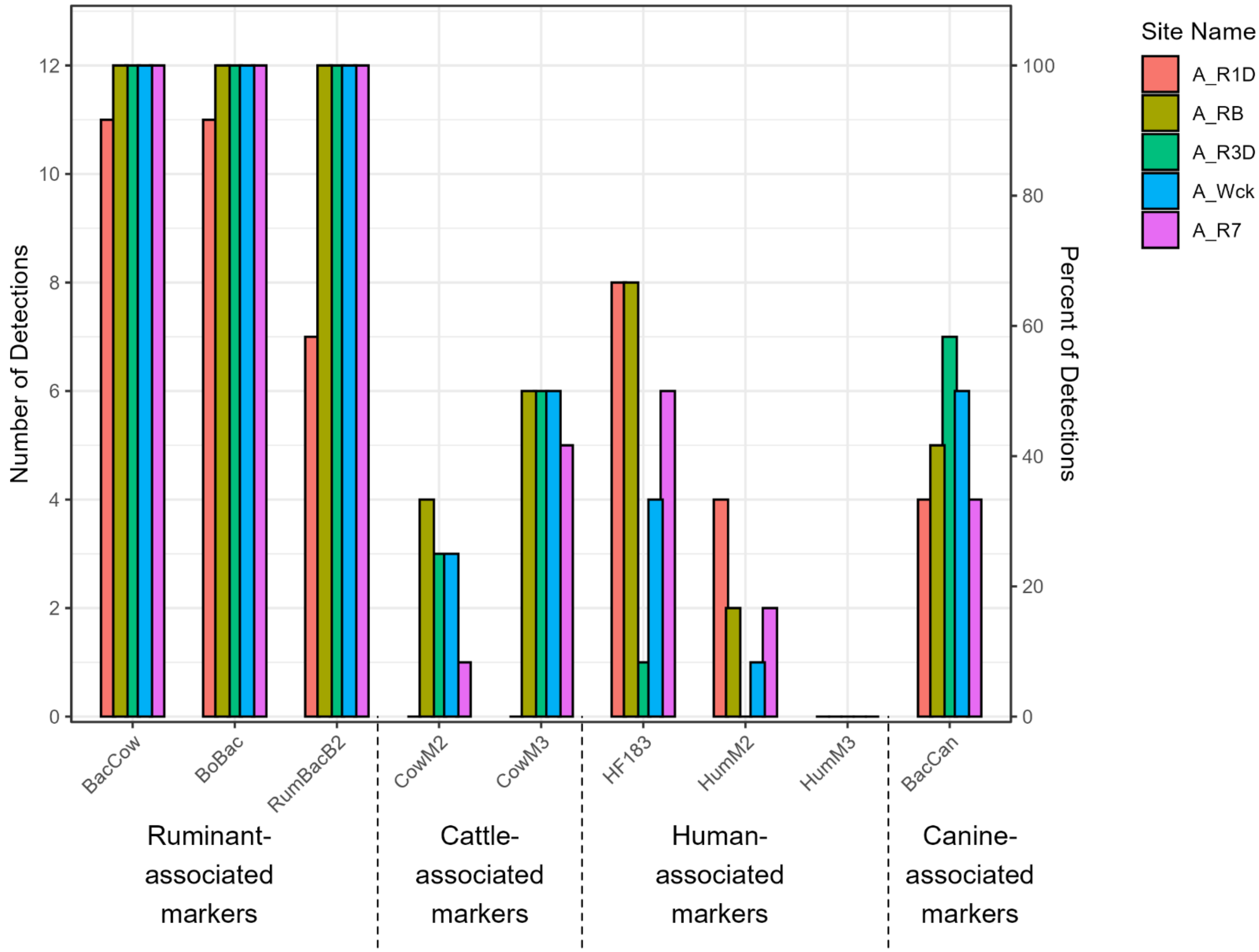


Figure B-9. *Bacteroides* marker detections from twelve sampling events in Fish Creek, 2023.

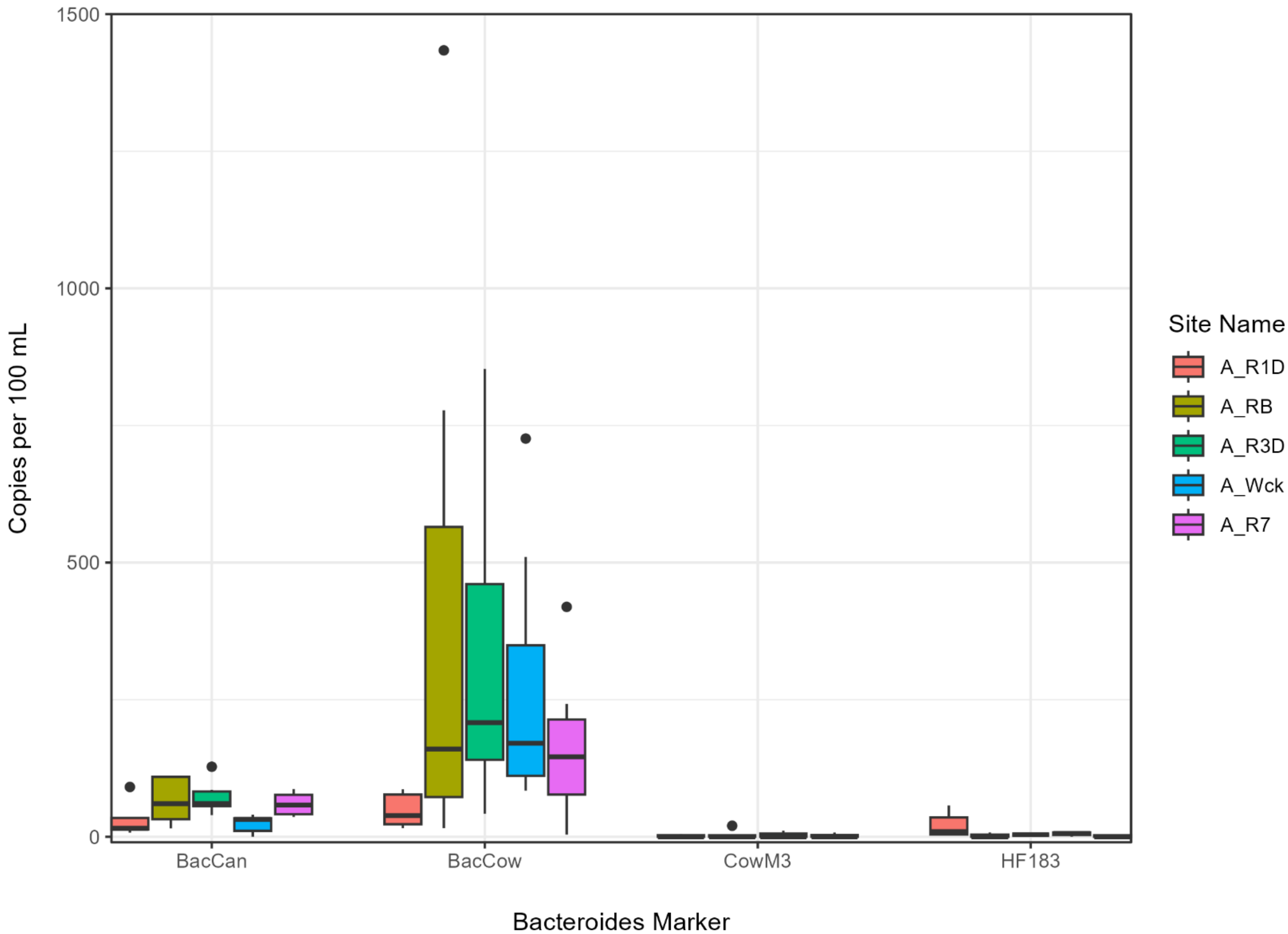


Figure B-10. *Bacteroides* marker levels, in copies per 100 mL, in samples collected from Fish Creek, 2023. Dots represent outliers outside of 1.5 times the interquartile range.

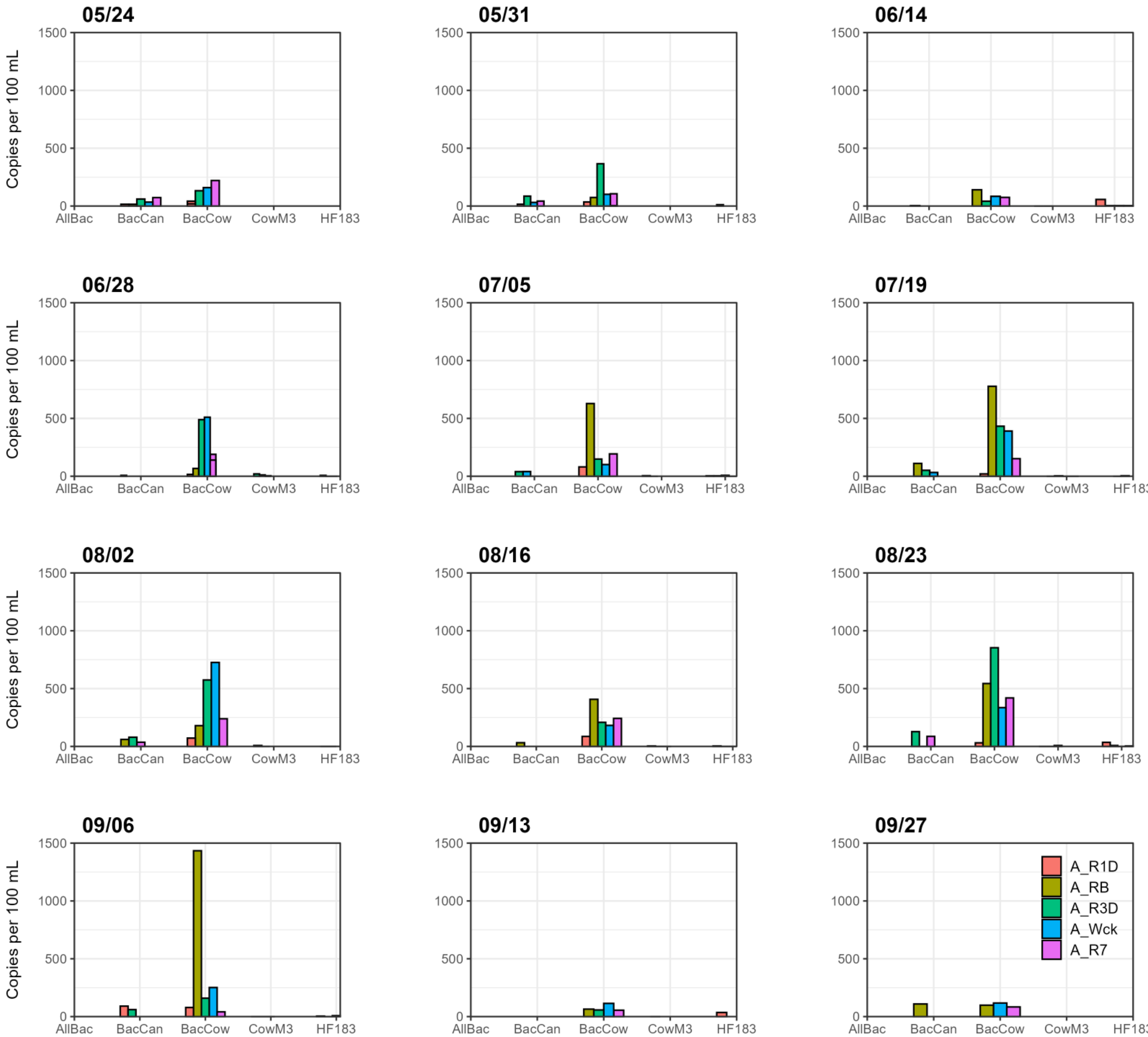


Figure B-11. *Bacteroides* marker levels, in copies per 100 mL, in samples collected from Fish Creek, 2023, separated by sampling event.

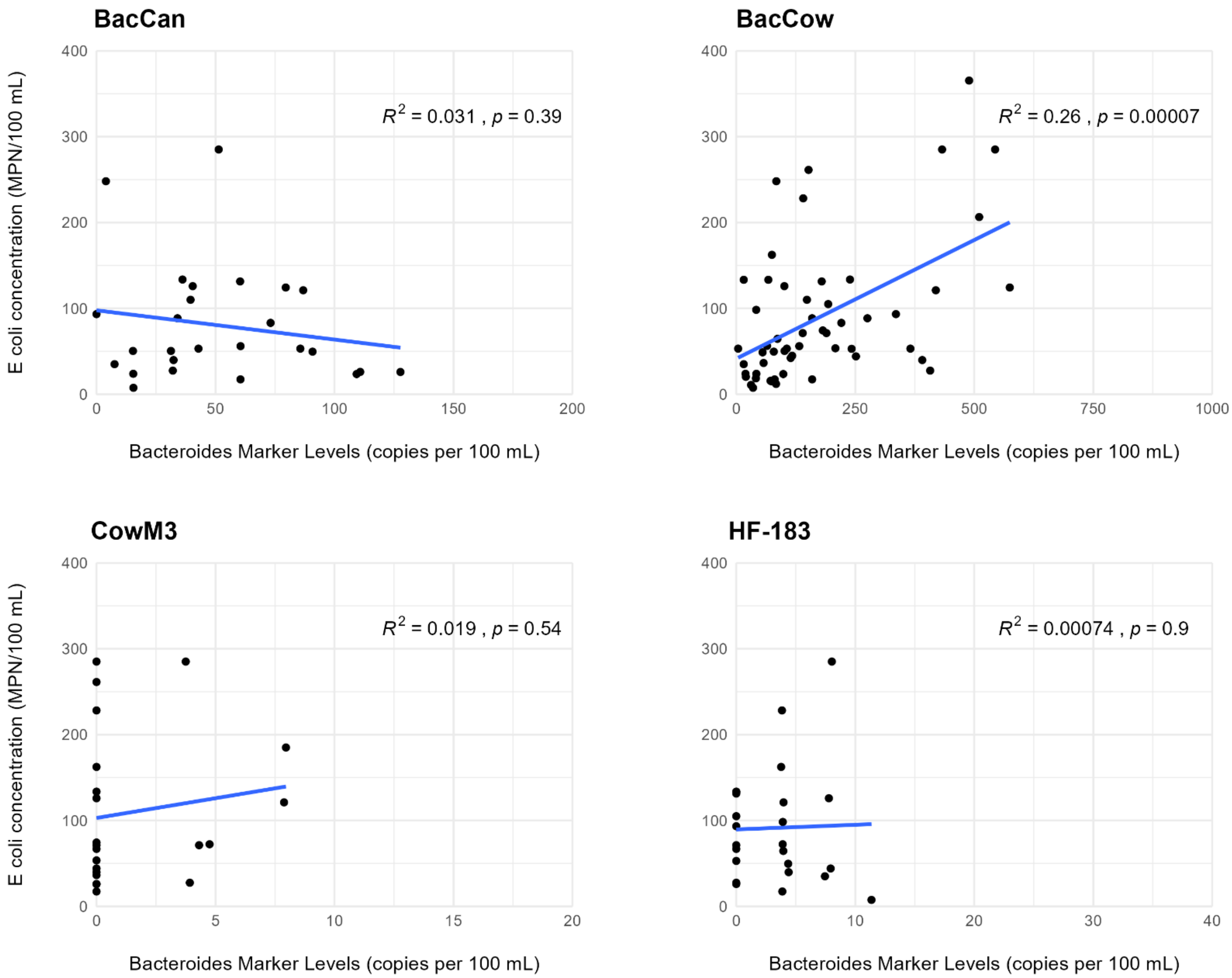


Figure B-12. Linear regressions between *Bacteroides* marker levels and *E. coli* concentrations collected in Fish Creek during the 2023 primary recreation season. Outliers outside of 1.5 times the interquartile range are removed from linear regressions. R^2 represents the coefficient of determination, with a value closer to 1.0 representing a stronger model fit. A p-value less than 0.05 represents statistically significant relationship.

B-3 Nutrient and Habitat Data

Observations of increased algal growth in Fish Creek in the early 2000s led to an increase in data collection regarding nutrients and water quality. The USGS, in tandem with TCD, designed and completed numerous studies from 2004- 2015 to characterize the hydrologic, biological, and water quality conditions of Fish Creek. These studies led to the conclusion that Fish Creek exhibits characteristics of a stream with high levels of nutrient contributions. Monitoring for nutrient concentrations in Fish Creek continued with funding from non-profit partners and TCD until 2018.

The WDEQ utilized existing datasets from 2014-2018 on nutrient and aquatic life data in Fish Creek and the surrounding groundwater to issue an assessment on nutrient enrichment, published in 2023. The 2023 assessment of nutrient enrichment in Fish Creek resulted in the WDEQ listing Fish Creek as impaired for its designated use of Aquatic Life for nutrients (total nitrogen and total phosphorus) in the 2022/2024 Wyoming Integrated 305(b) and 303(d) Report (WDEQ/WQD 2025e). Continued monitoring for nutrient enrichment on Fish Creek resumed in 2024 and continues currently. The following sub-sections describe the nutrient and habitat data referenced above.

Nitrogen and Phosphorus

Four field blanks had low but detectable concentrations of nitrate nitrogen, total nitrogen, total phosphorus, or orthophosphate phosphorus between 2015 and 2024. This resulted in the removal of 42 of 1,070 (3.9%) records from the data analysis.

Median total nitrogen (TN) and total phosphorus (TP) concentrations collected in Fish Creek between 2007 and 2025 exceeded reference-based thresholds identified in the Fish Creek Nutrient Assessment (Figure B-14) (WDEQ/WQD et al., 2023). TN and TP concentrations are highest in upper Fish Creek sites and decrease with downstream distance. The majority of TN collected in Fish Creek is in the form of nitrate (Figure B-15). Nitrate concentrations in Fish Creek surface water are highest in April and May, decrease throughout the growing season, and are lowest in October (Figure B-16). This consistent decrease in nutrient concentrations in both downstream distance and time is presumably due to the negative correlation established between nitrate concentrations and aquatic macrophytes, suggesting vegetative uptake of nitrogen during the growing season (Eddy-Miller et al., 2013).

The Fish Creek headwaters in Teton Village were sampled for nitrate in 2016 to characterize potential sources of nitrate to upper Fish Creek sites A_R1D and A_RB (Figure B-17). Three individual samples collected directly from the Crystal Spring emergence on Jackson Hole Mountain Resort in July, August, and September displayed consistently high nitrate concentrations of between 0.76 and 0.77 mg/L (Figure B-18).

As stated in previous publications on Fish Creek and not published in this appendix, molar ratios of total nitrogen to total phosphorus in Fish Creek are higher in April/May and lower in August and October, suggesting that phosphorus is the limiting nutrient in Fish Creek in the spring, while nitrogen is the limiting nutrient in the summer and fall (Eddy-Miller et al., 2013). Therefore, reductions of both total nitrogen and total phosphorus have the potential to reduce nutrient enrichment effects in Fish Creek.

Isotopes of Nitrate

Isotopes of nitrate, particularly δ15N [NO3] and δ18O [NO3], can be compared to values in peer-reviewed literature to determine the sources of nitrate in waterbodies (Kendall et al., 2007; Eddy-Miller et al., 2013). A study conducted in 2016 to determine sources of nitrogen and phosphorus to the Fish Creek watershed suggested that atmospheric deposition is the largest composition of nutrient sourcing to the watershed in its entirety (Eddy-Miller et al., 2016). However, isotopic compositions of nitrate from samples collected in Fish Creek between 2007-2011 and 2016-2018 suggest that the nitrate in the stream is primarily sourced a combination of manure and wastewater effluent (Figures B-19, B-20) (Kendall et al., 2007). This is corroborated further by the detection of wastewater chemicals in one upper Fish Creek site and one mid-reach groundwater site adjacent to Fish Creek in 2007 (Eddy-Miller et al., 2010).

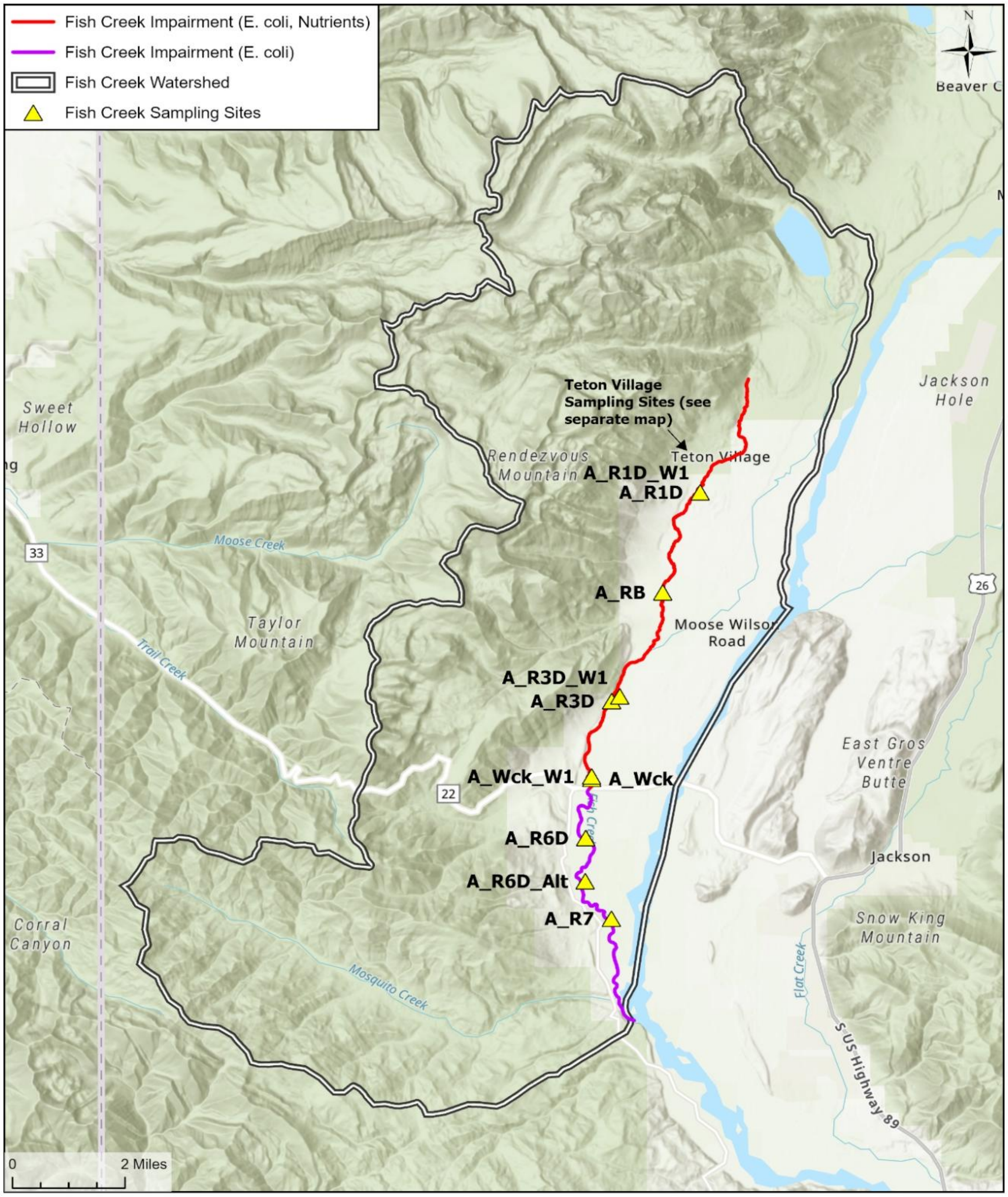


Figure B-13. Nutrient data collection sites in Fish Creek (2007-2011, 2014-2018, 2024-present). Sites that end in “W1” are groundwater sites.

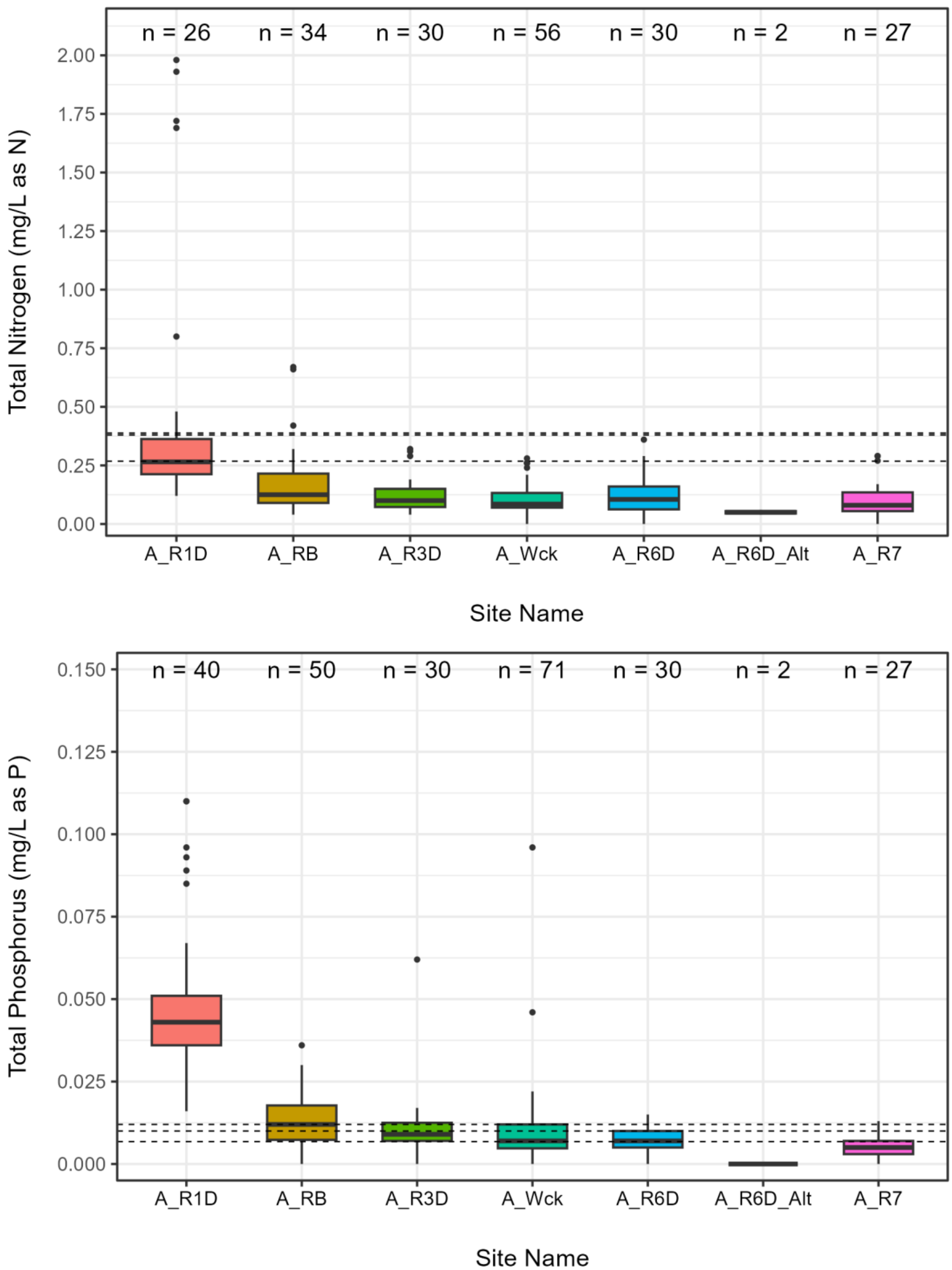
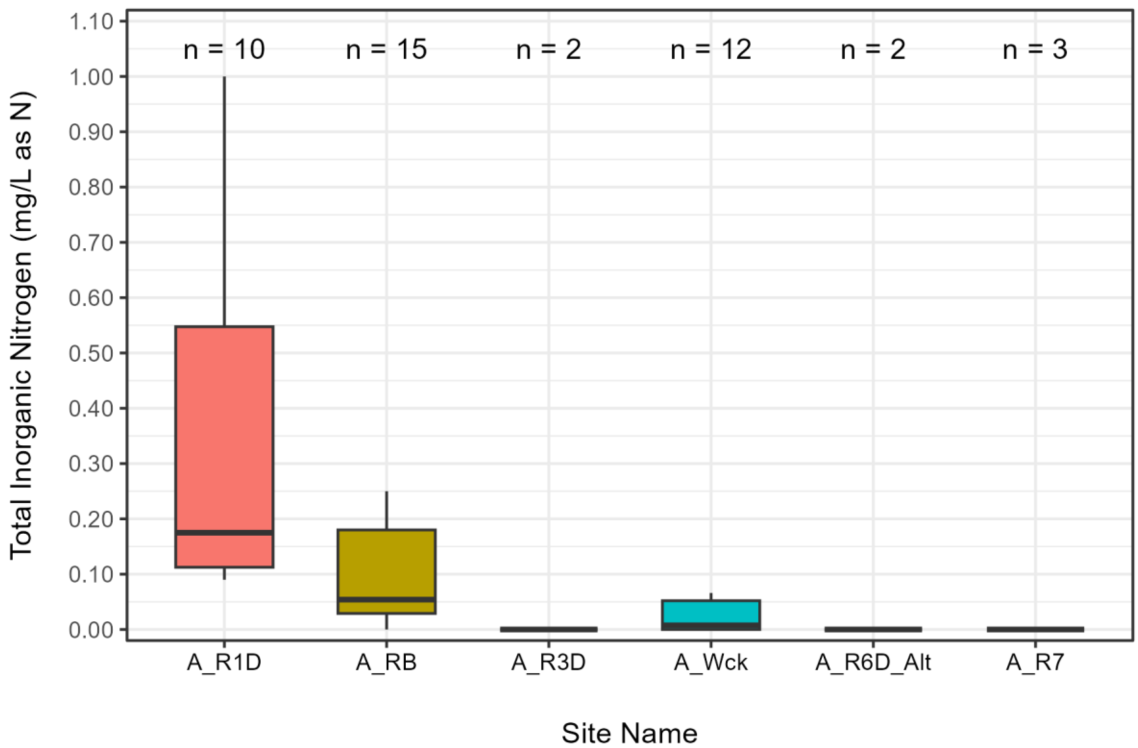


Figure B-14. Total nitrogen (top) and total phosphorus (bottom) data from Fish Creek between 2007-2011, 2014-2018, and 2024-2025. Dots represent outliers outside of 1.5 times the interquartile range. Dashed lines represent reference-based criteria identified in the Fish Creek Nutrient Assessment. EPA 25th percentile, Wadeable Streams Assessment (WSA) 25th percentile, and WSA 75th percentile (WDEQ/WQD et al., 2023). For total nitrogen, EPA 25th and WSA 75th percentiles are overlapping. The number of samples collected (n) is shown across the top of the plots.



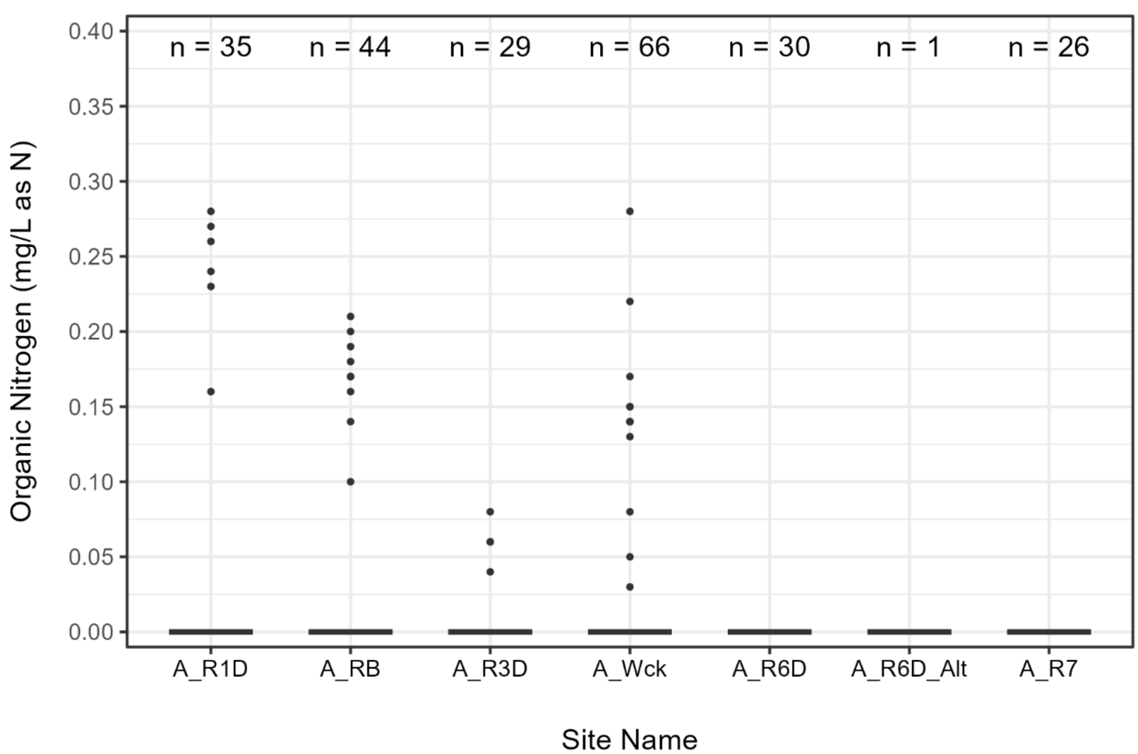


Figure B-15. Total inorganic nitrogen (top) and total organic nitrogen (bottom) data from Fish Creek. Total inorganic nitrogen collected between 2015-2018 and 2024-2025. Total organic nitrogen collected between 2007-2011, 2014-2018, and 2024-2025. Dots represent outliers outside of 1.5 times the interquartile range.

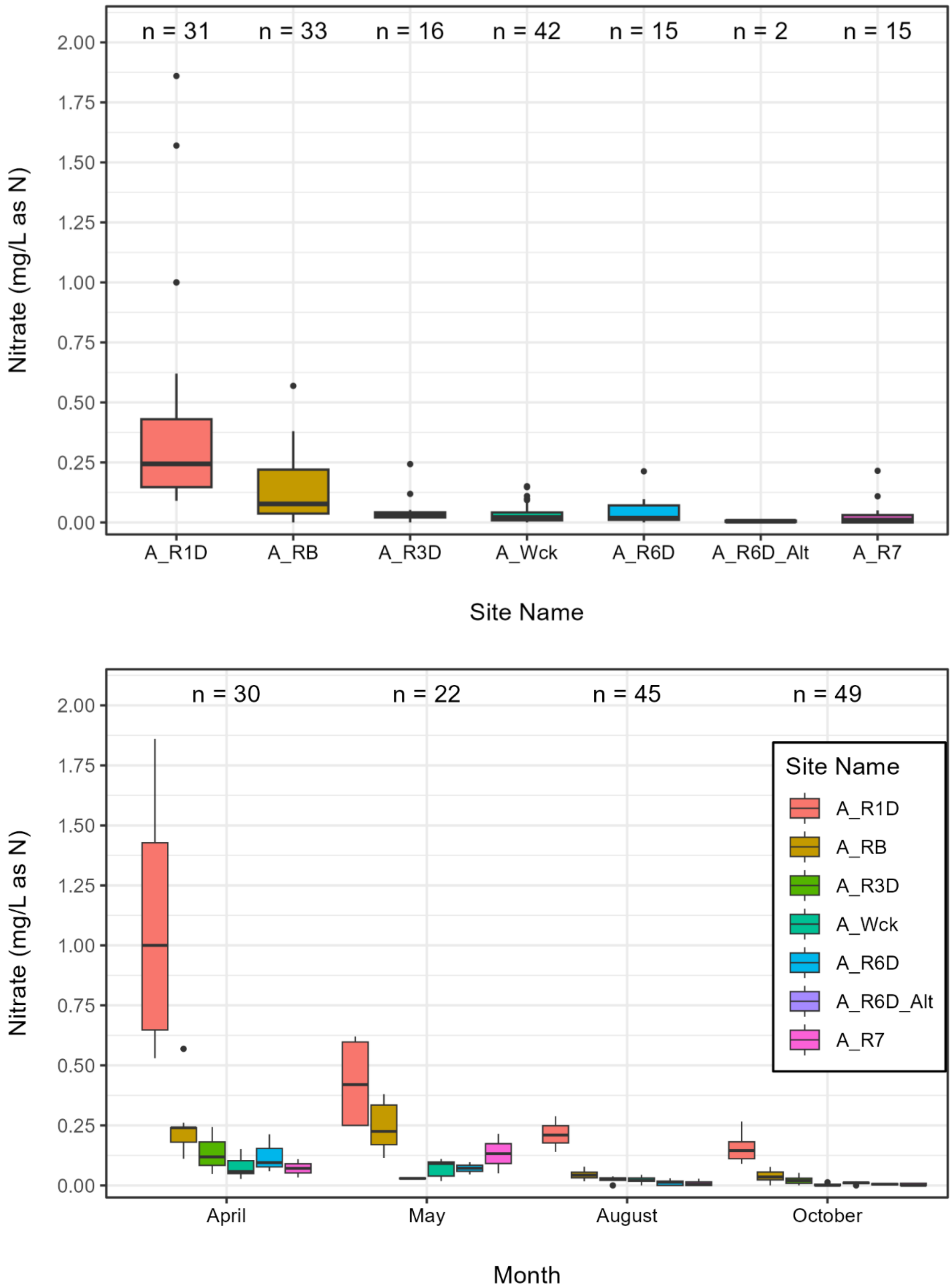


Figure B-16. Aggregated (top) and monthly-separated (bottom) nitrate data from Fish Creek between 2007-2011, 2014-2018, and 2024-2025. Dots represent outliers outside of 1.5 times the interquartile range. Dashed lines represent reference-based criteria identified in the Fish Creek Nutrient Assessment (WDEQ/WQD et al., 2023).

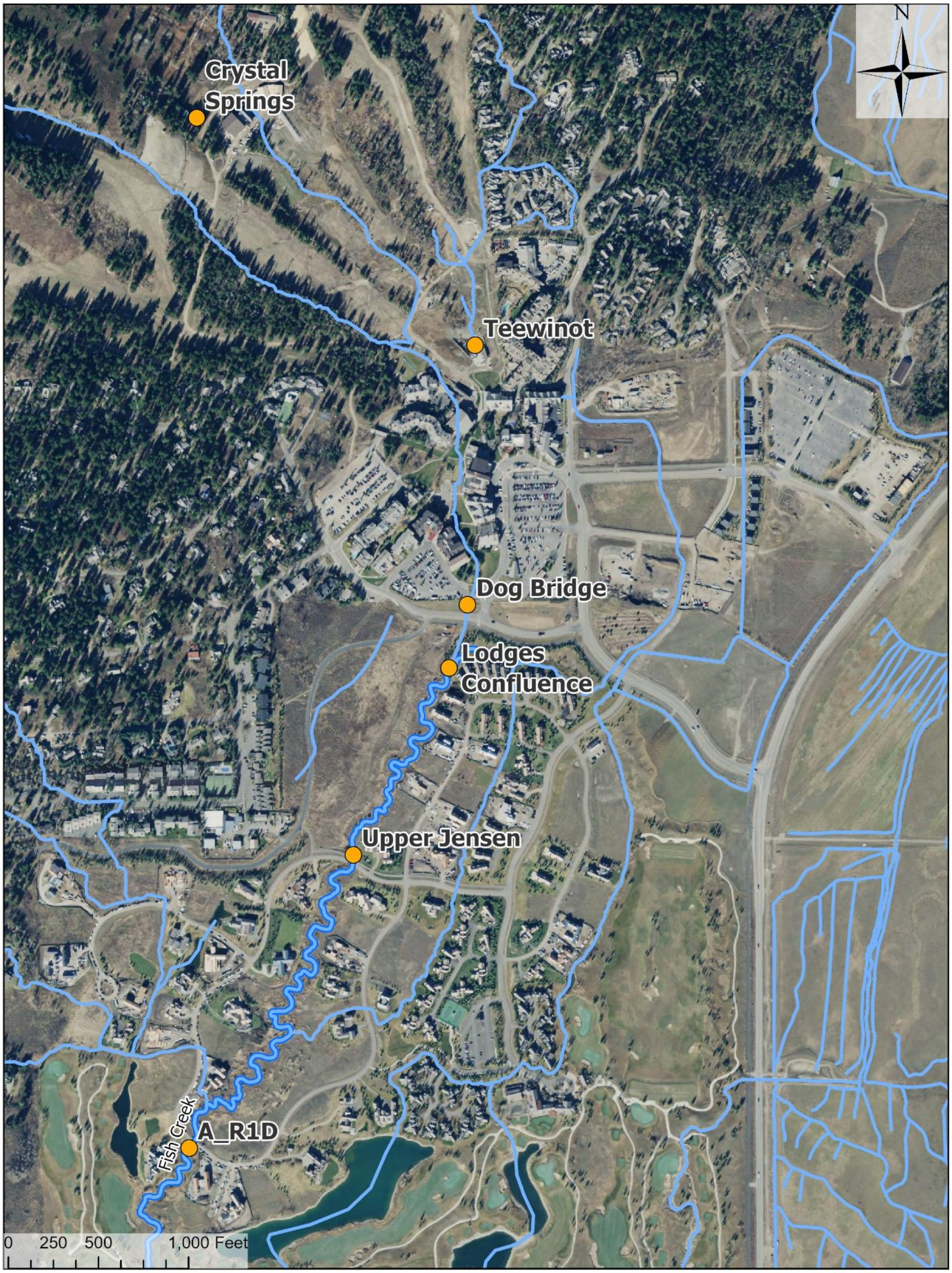


Figure B-17. Nitrate data collection sites in 2016 in Teton Village, WY.

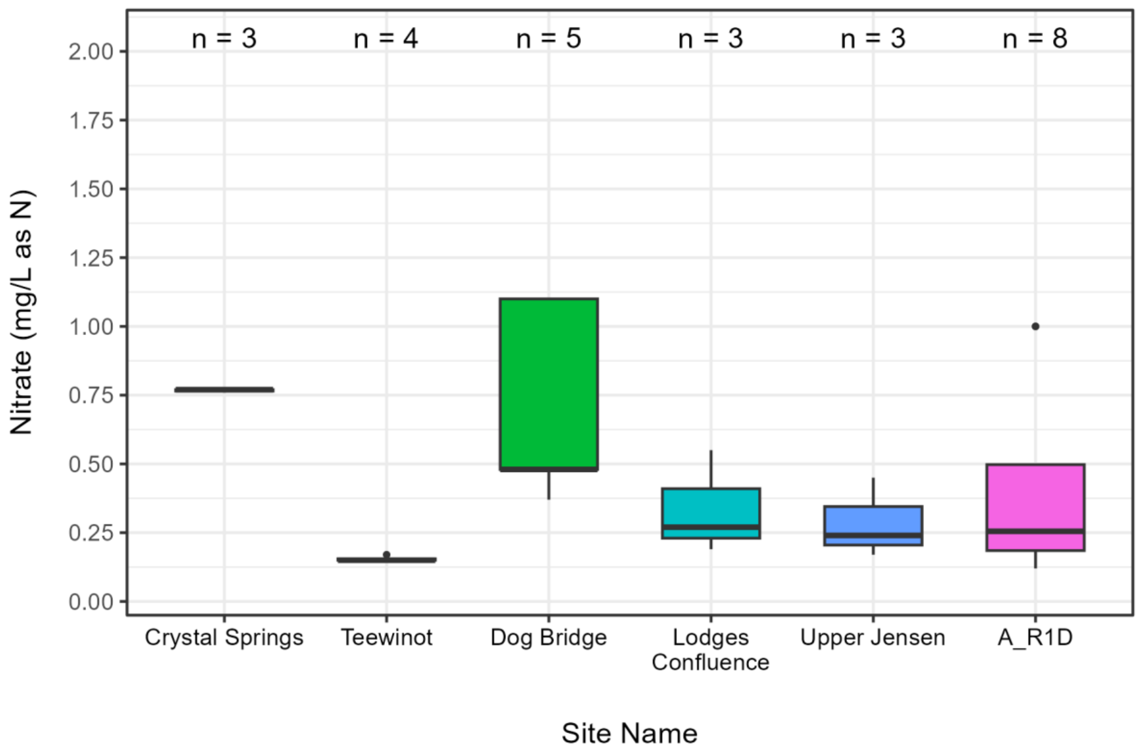


Figure B-18. Nitrate concentrations in Fish Creek headwater tributaries collected in 2016 in Teton Village, WY.

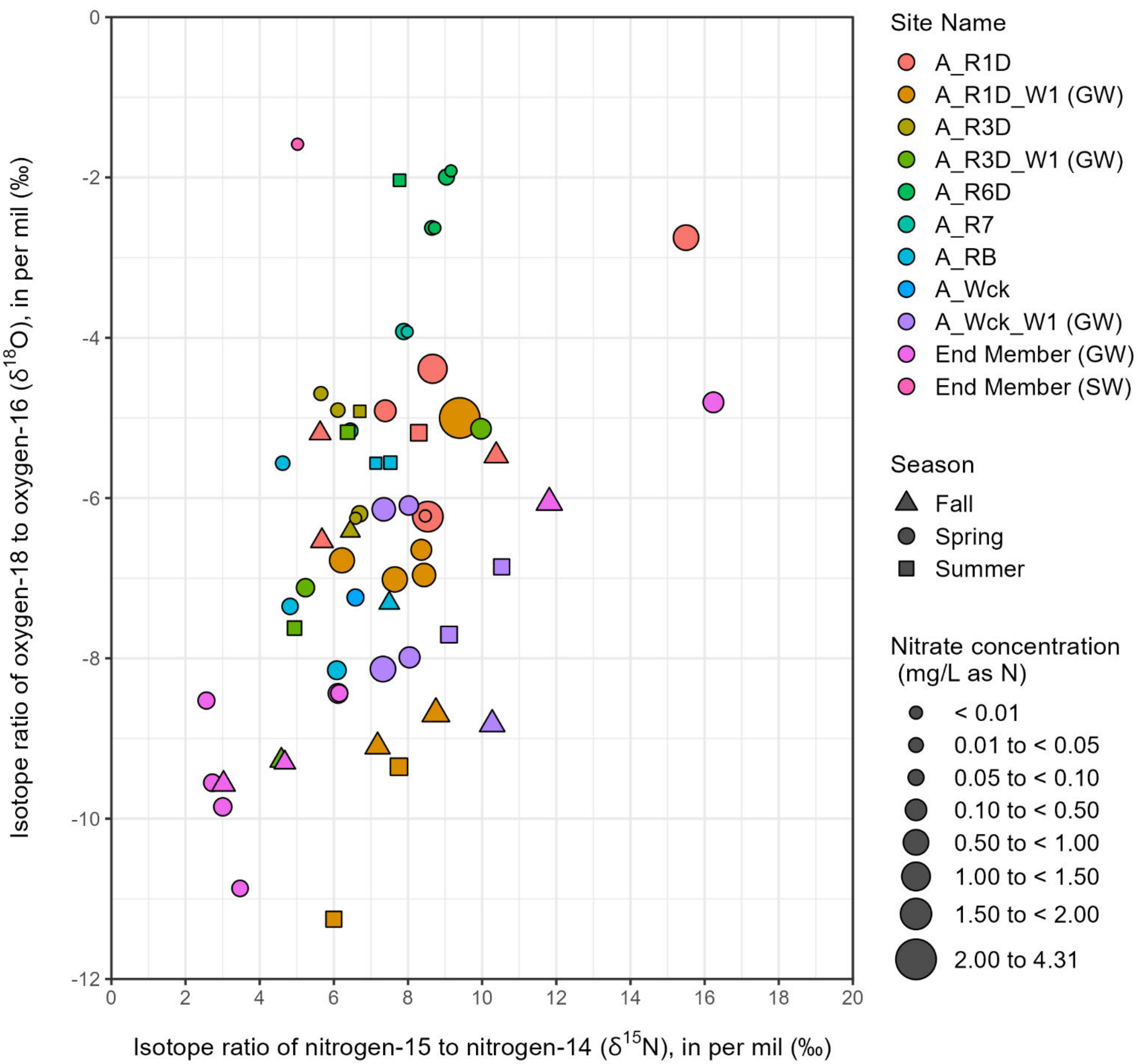


Figure B-19. Isotopic concentrations of nitrate in samples collected from surface water and nearby groundwater, Fish Creek, 2007-2018. Adapted from Eddy-Miller et al. (2013) and updated with recent data.

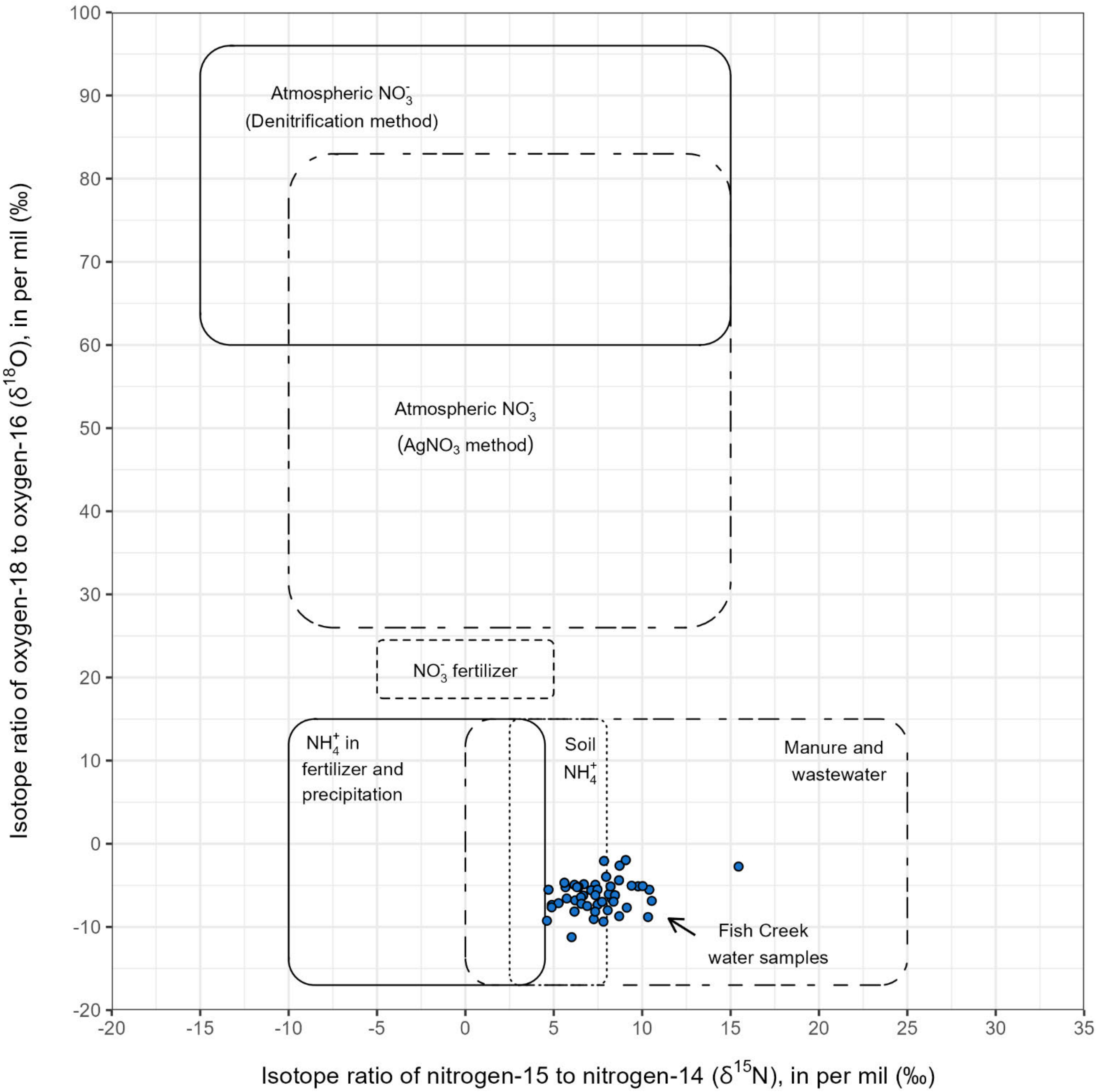


Figure B-20. Isotopic concentrations of nitrate in samples collected from surface water and nearby groundwater, Fish Creek, 2007-2018, compared to isotopic concentrations of various pollutant sources. Adapted from Kendall et al. (2007).

Dissolved Oxygen and pH

Dissolved oxygen and pH dynamics can differ in streams experiencing nutrient enrichment compared to streams not experiencing nutrient enrichment due to the increased rate of primary production by aquatic vegetation (WDEQ/WQD et al., 2023). As primary production increases during the day, dissolved oxygen concentrations can increase and pH can decrease. A larger daily variation in dissolved oxygen concentration, dissolved oxygen saturation, and pH is expected in streams experiencing nutrient enrichment (WDEQ/WQD et al., 2023). Continuous dissolved oxygen and pH data were collected at two sites in Fish Creek between August and October of 2024 to compare to data collected in 2016 and published in the Fish Creek Nutrient Assessment (WDEQ/WQD et al., 2023). Loggers were calibrated weekly during deployments to compensate for drift and to remove fouling from aquatic vegetation (TCD, 2024).

The lowest Fish Creek site, A_R7 exhibited greater daily dissolved oxygen maxima, daily dissolved oxygen range, and daily pH range than the uppermost site, A_R1D (Figures B-21 through B-23). The upper site is influenced directly by irrigation diversions from the Snake River and therefore receives supplemental Snake River water during the irrigation season. The influence of the annual rampdown of releases from Jackson Lake Dam into the Snake River each fall is reflected at the upper site by an increase in daily dissolved oxygen maxima, daily dissolved oxygen range, and daily pH range after the rampdown is complete.

In 2024, continuous dissolved oxygen and pH data collection and reporting was added to the USGS streamgage on Fish Creek (USGS 13016450), supported by Protect Our Water Jackson Hole. This location is approximately the midpoint between the upper site A_R1D and the lower site A_R7.

Macroinvertebrates

Statistically significant seasonal differences in macroinvertebrate community in Fish Creek have been documented (Eddy-Miller et al., 2013). Taxa richness of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly), commonly referred to as EPT richness, is a common indicator of stream health as these taxa are generally sensitive to water quality degradation and important prey for fish (WDEQ/WDQ et al., 2023). EPT richness is higher in April and May than in August (Figure B-24). Fall samples, collected beginning in October 2014, exhibited similar EPT richness to spring samples.

EPT density, in individuals per m^2, is highest at the upstream site A_RB and lowest at the downstream site A_R7 (Figure B-25). A lower EPT percent, or proportion of EPT density compared to total macroinvertebrate density, in Fish Creek in 2024 suggests an increase in nutrient tolerant species (Figure B-26).

Nutrient-tolerant taxa in Fish Creek are abundant. For example, *Chironomidae* (midge larvae) composed from 31 to 48% of sampled individuals in 2017 and 2018 (WDEQ/WQD et al., 2023). Macroinvertebrate data at A_RB and A_Wck were consistent with “Non- or Partial Support” using Wyoming’s combined RIVPACS and WSII macroinvertebrate models (WDEQ/WQD et al., 2023).

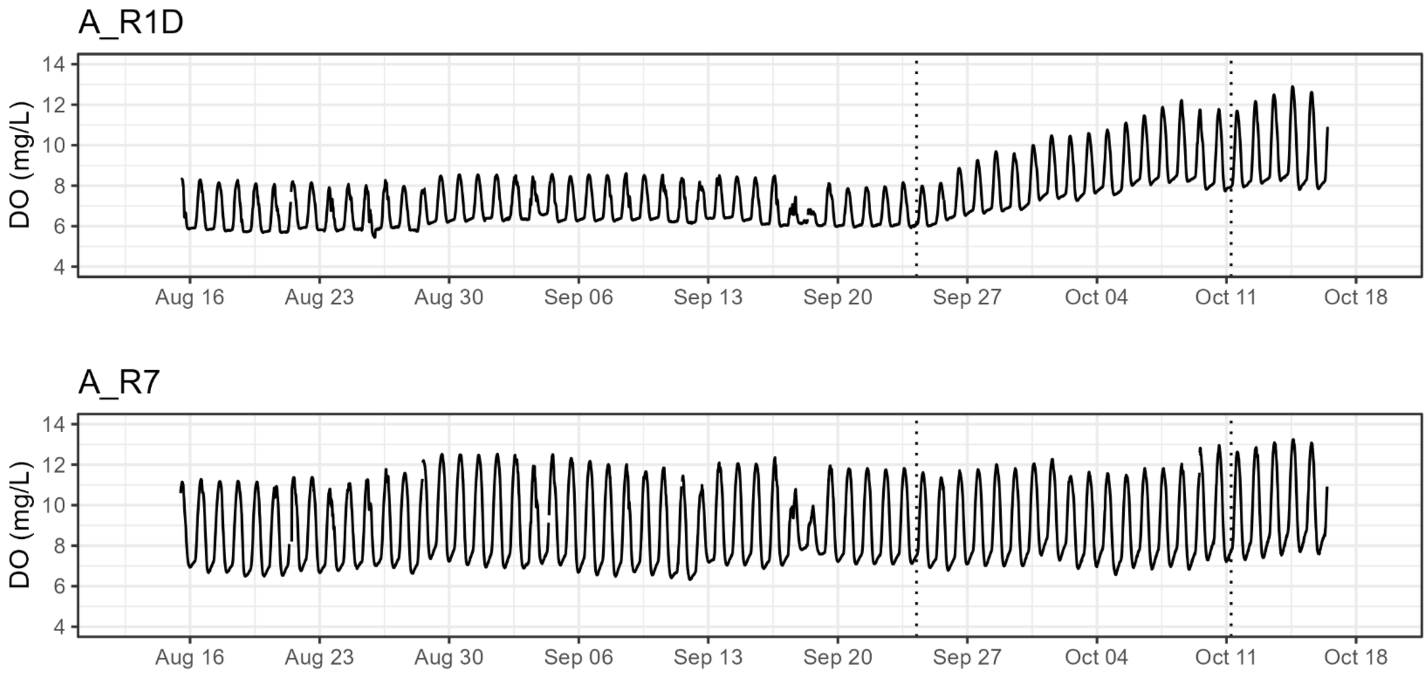


Figure B-21. Dissolved oxygen concentrations in upper (top) and lower (bottom) Fish Creek in 2024. Vertical dashed lines indicate the start (left) and end (right) of the rampdown of releases from Jackson Lake.

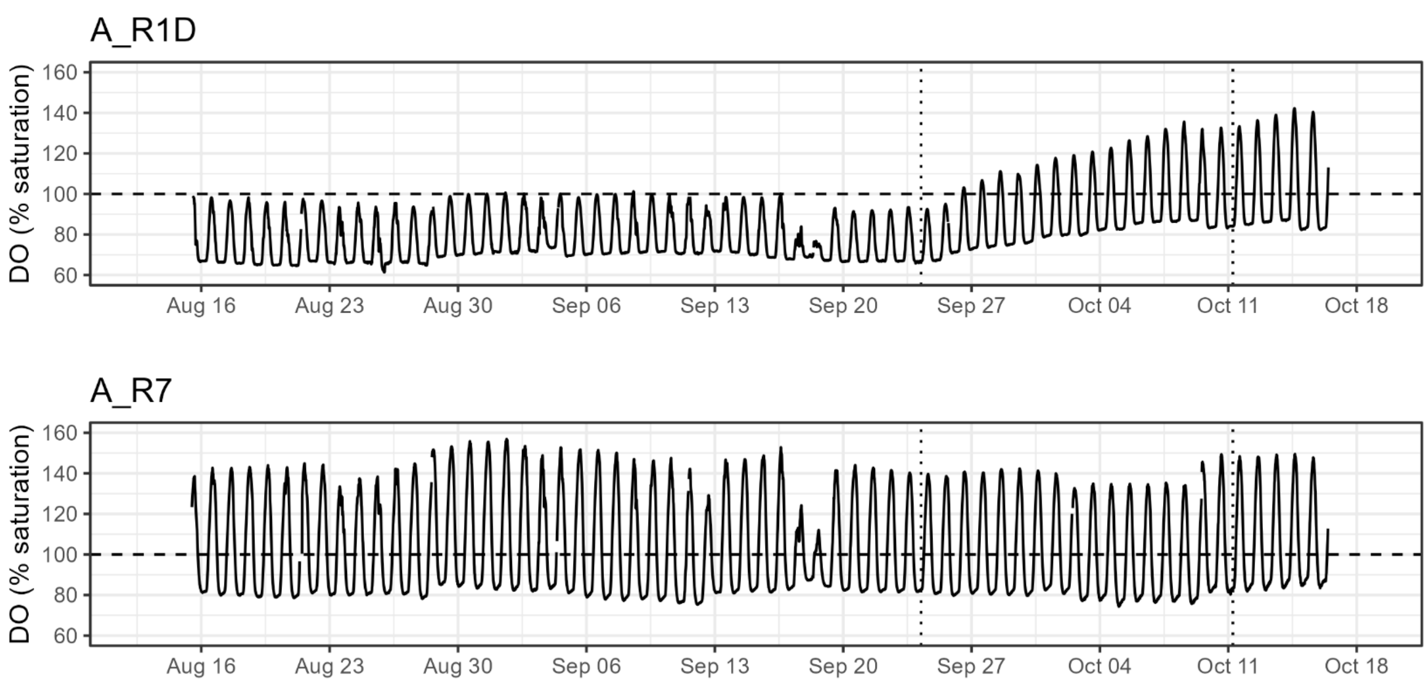


Figure B-22. Dissolved oxygen saturation in upper (top) and lower (bottom) Fish Creek in 2024. Vertical dashed lines indicate the start (left) and end (right) of the rampdown of releases from Jackson Lake. Horizontal dashed line indicates 100% saturation.

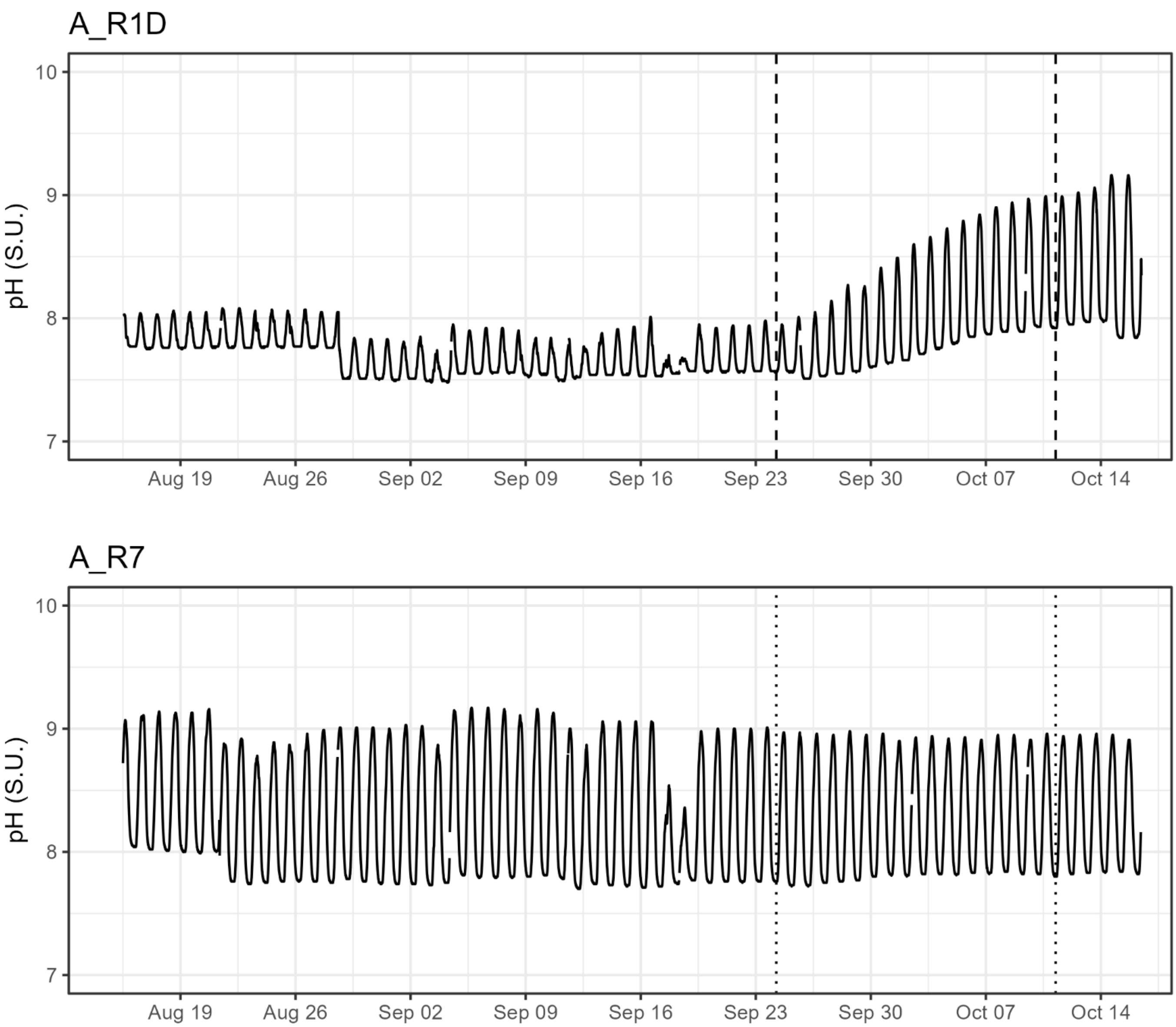


Figure B-23. pH in upper (top) and lower (bottom) Fish Creek in 2024. Vertical dashed lines indicate the start (left) and end (right) of the rampdown of releases from Jackson Lake.

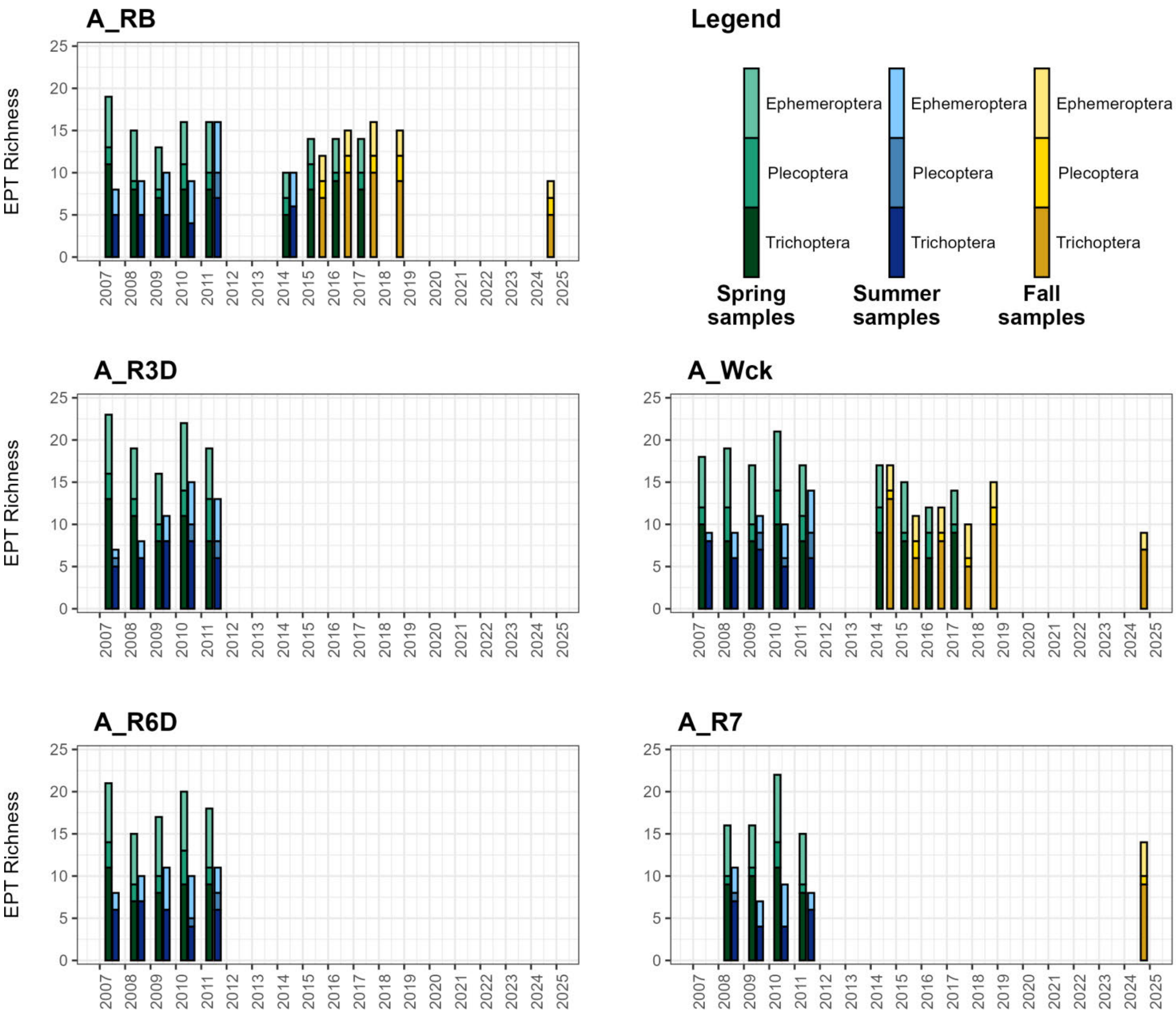


Figure B-24. Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) richness in Fish Creek, 2007-2024.

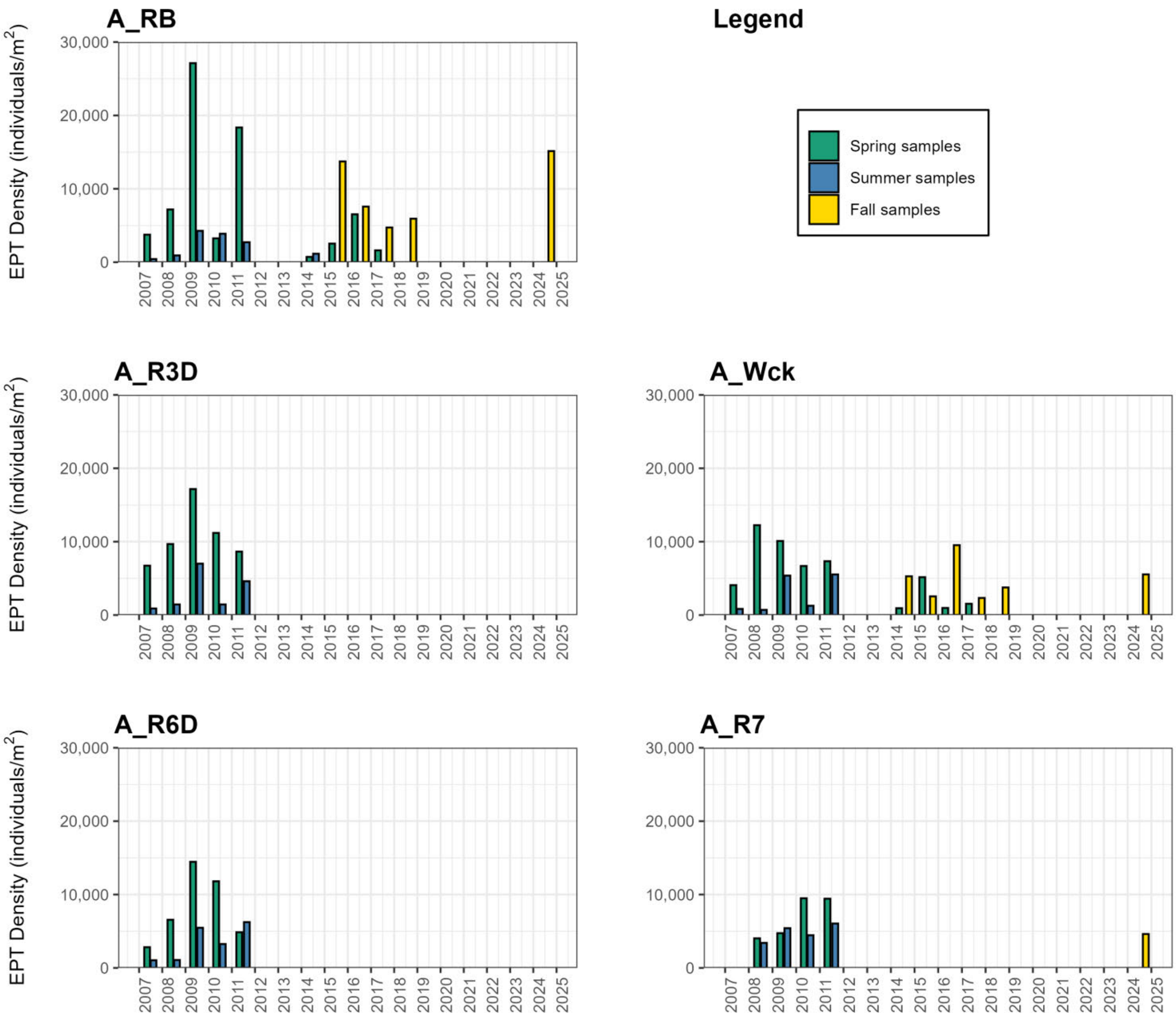


Figure B-25. Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) density in Fish Creek, 2007-2024.

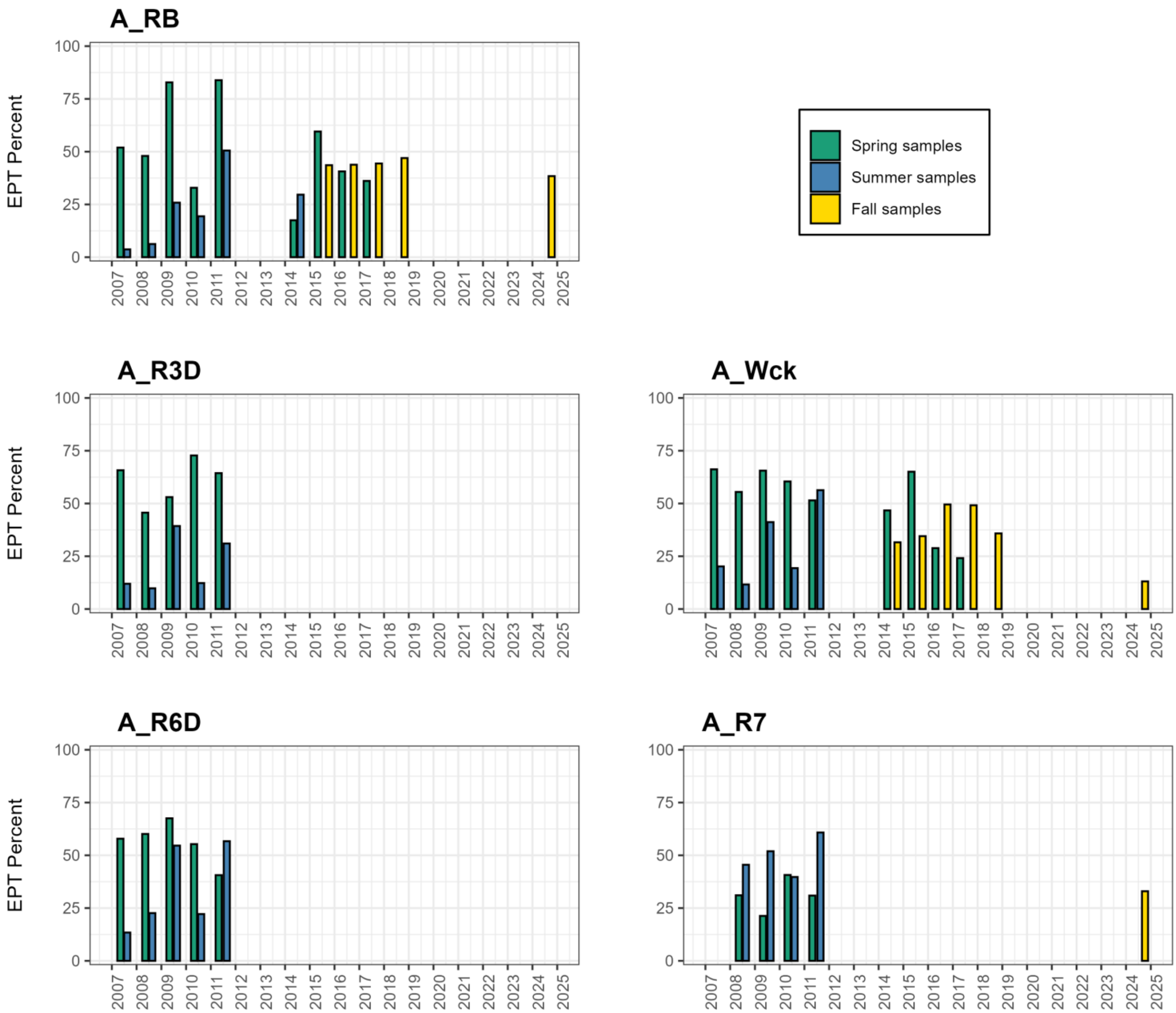


Figure B-26. Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) density, as percent of total macroinvertebrate density in Fish Creek, 2007-2024.

Benthic Chlorophyll-a

Concentrations of chlorophyll-a are indicators of algal growth in streams (Eddy-Miller et al., 2013; WDEQ/WQD et al., 2023). Benthic chlorophyll-a samples were collected in Fish Creek to determine algal productivity and spatial extent through Fish Creek. Chlorophyll-a concentrations are highest in downstream sites on Fish Creek (Figure B-27) and algae taxa richness increases with downstream distance in Fish Creek (Eddy-Miller et al., 2013). Chlorophyll-a concentrations are elevated compared to reference sites analyzed by WDEQ, and above reference-based thresholds for mean and maximum benthic chlorophyll-a concentrations for the mesotrophic-eutrophic boundary (Dodds et al., 1998; WDEQ/WQD et al., 2023).

Aquatic Plants

Fish Creek's prolific aquatic macrophyte community differs from most streams in Wyoming and is comprised of macroalgae (including *Cladophora*, a nuisance macroalgae), aquatic vascular plants, and moss, in addition to microalgae. Aquatic plants in Fish Creek can sometimes cover the entire streambed in a green mat at certain sites. Algae taxa richness in samples collected by USGS increases with downstream distance in Fish Creek (Eddy-Miller et al., 2013). *Cladophora* at times constituted almost 90% of periphyton biovolume in Fish Creek near Wilson (WDEQ/WQD et al., 2023). Periphyton samples analyzed by WDEQ were substantially different from reference sites not experiencing nutrient enrichment (WDEQ/WQD et al., 2023).

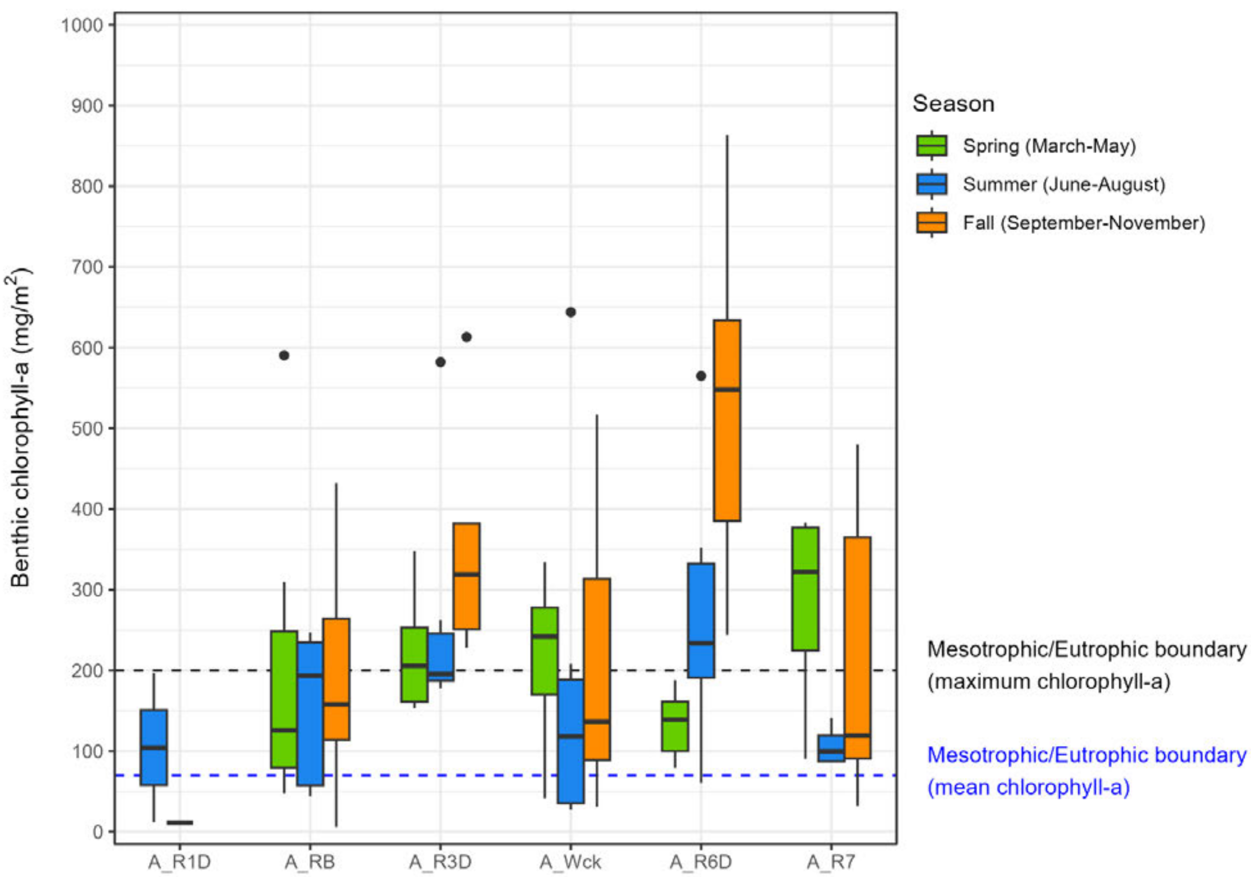


Figure B-27. Benthic chlorophyll-a concentrations in Fish Creek, 2007-2024.

Fisheries

The Wyoming Game and Fish Department has conducted several fisheries sampling efforts in Fish Creek, including spawning surveys and creel surveys. Population estimates using various electrofishing methodologies have been completed beginning in 2004 on upper Fish Creek, above Highway 22 (Figure B-28). Sampling was performed on a 1,000 ft reach from using a 2-pass estimate from shore in 2004 and from a towed cataraft electrofishing unit in 2008 and 2010. From 2017-2025, sampling was performed on a 0.54-mile reach using a 3-pass estimate from a raft. Error bars represent 95% confidence intervals.

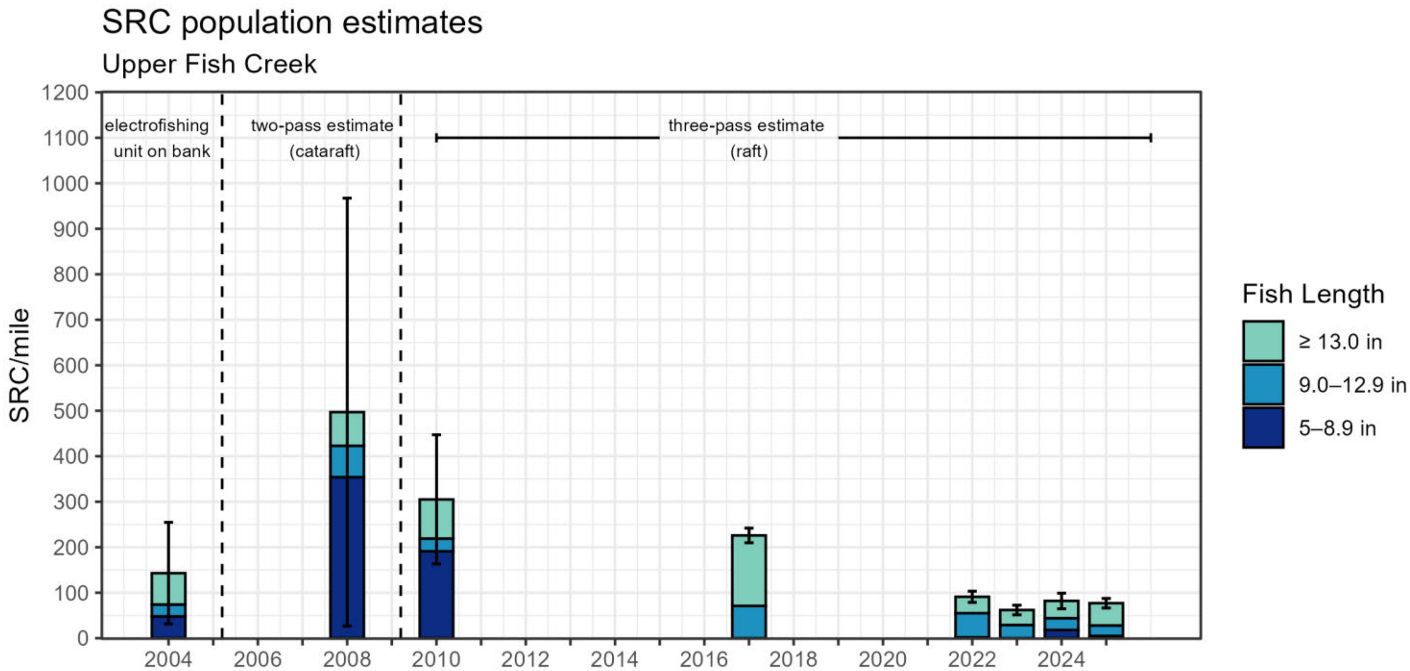
In upper Fish Creek, Snake River cutthroat trout (SRC) per mile estimates have varied from 143 fish per mile in 2004 to 305 fish per mile in 2010 and have recently declined to 77 fish per mile in 2025 (Figure B-28). Of note is the significant decline in smaller size class (5-8.9”) SRC. In 2023, no fish in that size class were sampled in upper Fish Creek. Brook trout (BKT) declines have also been documented in Fish Creek and they are intentionally removed for SRC conservation. Estimated BKT per mile decreased from 404 fish per mile in 2010 to 17 fish per mile in 2025.

In lower Fish Creek (downstream of highway 22), the period of record for fisheries population surveys is less extensive. Estimates have been completed in 2015, 2018, 2023, and 2024. SRC estimates were 276 fish per mile in 2015 and have decreased to 38 fish per mile in 2024 (Figure B-29). BKT estimates were not completed due to insufficient catch.

As sampling methodologies have changed over the course of the last twenty years of fisheries population surveys in Fish Creek, varying population estimates could be attributed, at least partially, to these changes in methods.

Substrate

Streambed substrate was measured by the USGS at five sites between 2008-2011. The smallest streambed substrate was sampled at A_RB and the largest substrate at A_R7 (Table B-3, Figure B-30). Substrate in Fish Creek is generally characterized as very coarse gravel to medium cobble substrate using the median particle size, D_{50} (Wentworth, 1922). Substrate data have not been collected in Fish Creek at all sites since 2011.



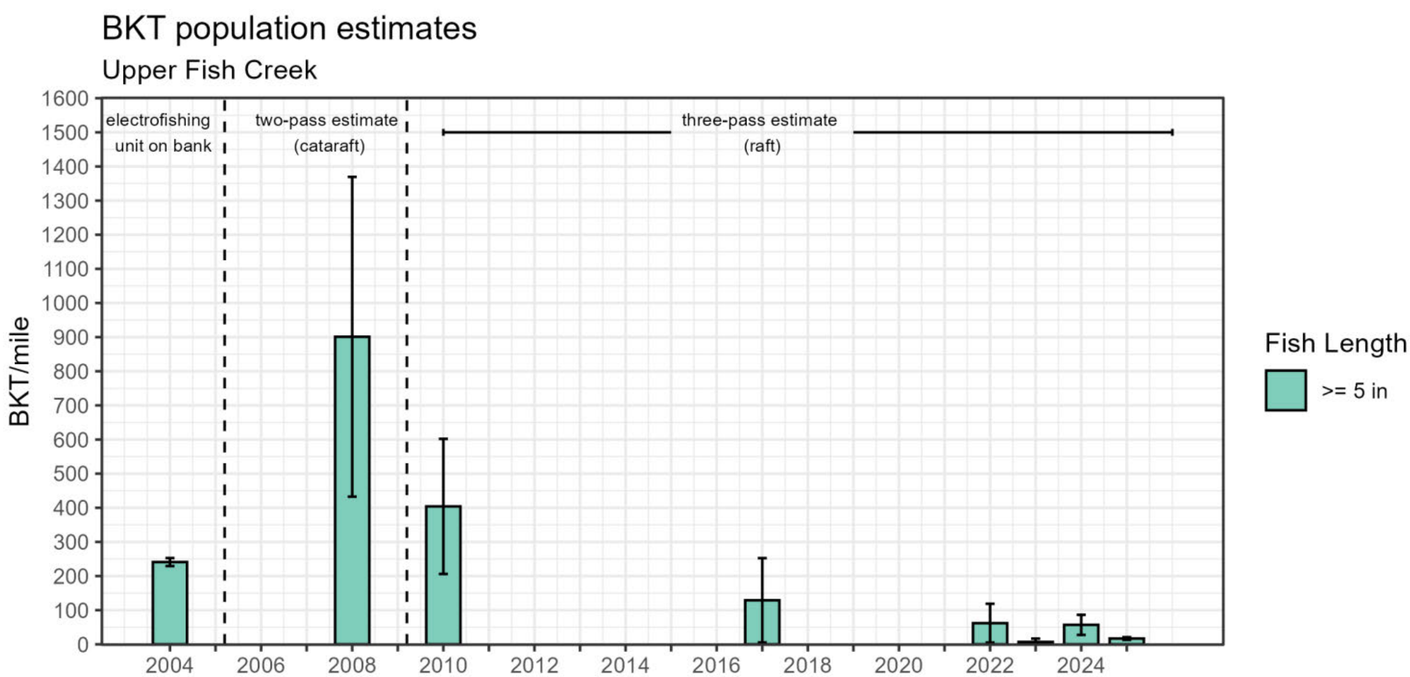


Figure B-28. Snake River cutthroat trout (top) and brook trout (bottom) population estimates in upper Fish Creek, 2004-2025.

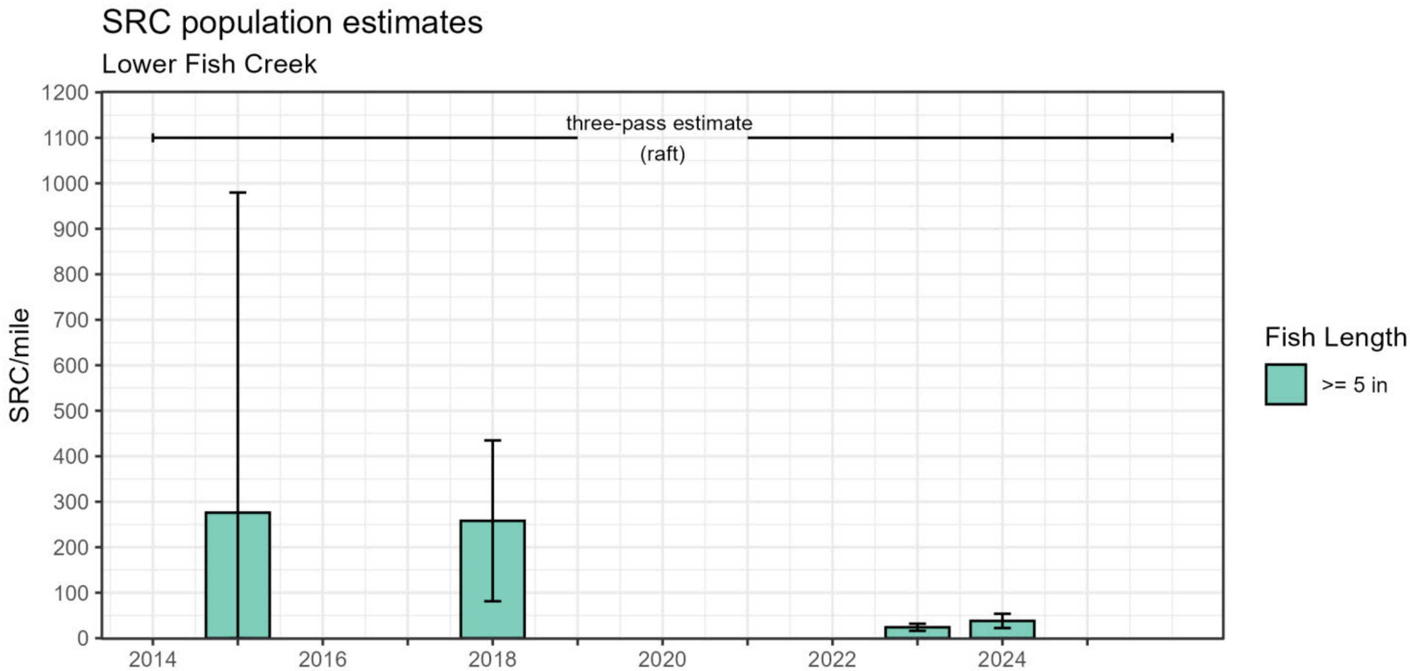


Figure B-29. Snake River cutthroat trout population estimates in lower Fish Creek, 2004-2025.

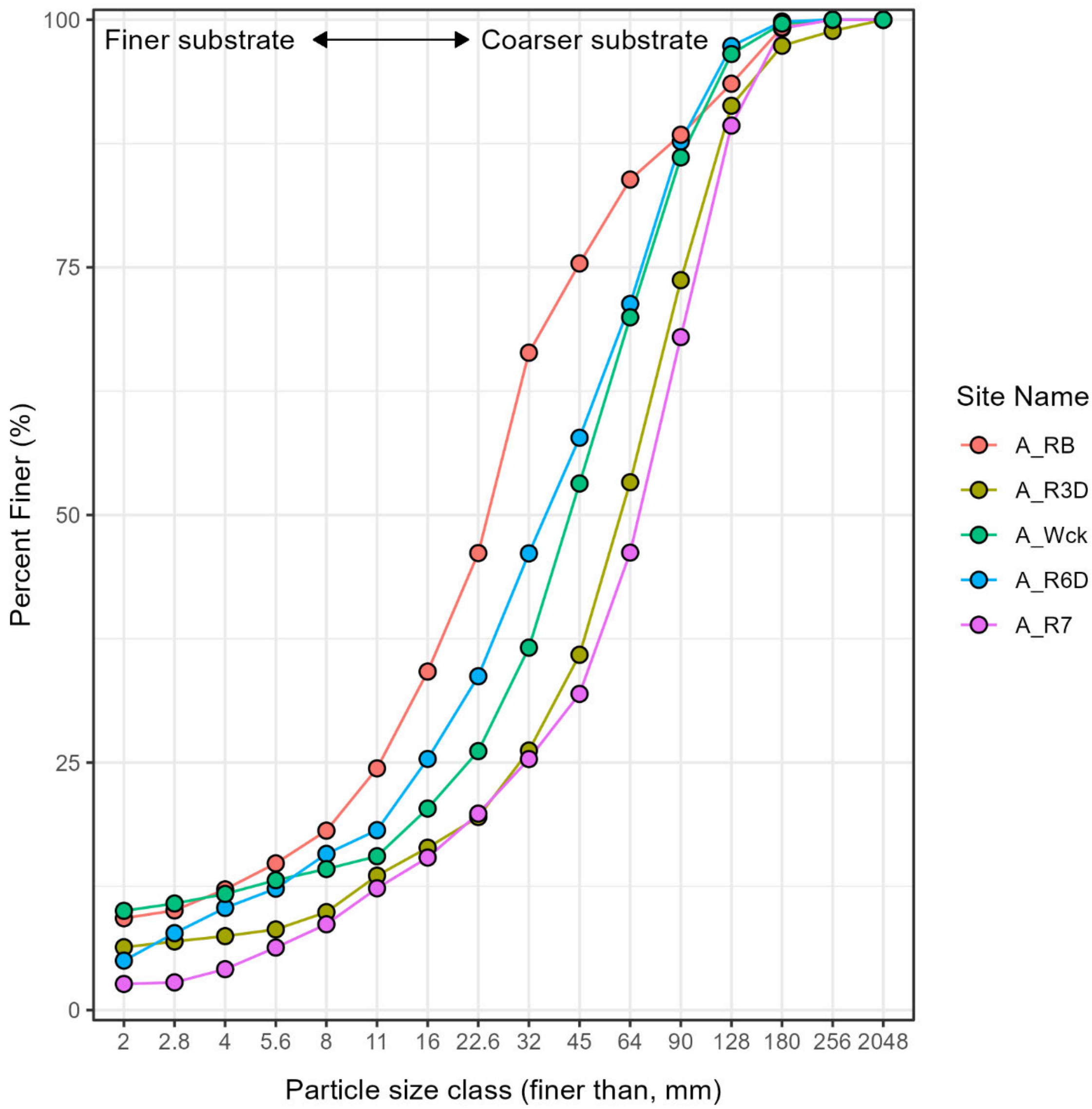


Figure B-30. Streambed substrate size distribution at Fish Creek sites, 2008-2011.

Table B-3. D_{50} and D_{84} values for Fish Creek streambed substrate.

Site Name	D_{50} (mm)	D_{84} (mm)
A_RB	24.4	64.8
A_R3D	60.4	112.2
A_Wck	56.7	104.2
A_R6D	36.3	84.1
A_R7	68.5	118.5

B-4 Streamflows and Generalized Flow Path Diagrams

Stream discharge in Fish Creek is monitored and reported continuously by the USGS 13016450 streamgage located in Wilson, WY. Discharge is provided for the period of record 1994-present.

Anecdotal reporting by the Fish Creek community prompted an analysis of discharge in Fish Creek to determine annual trends. It has been determined that annual cumulative discharge in Fish Creek through the USGS 13016450 streamgage is increasing by approximately 790 acre-feet per year on average ($p = 0.017$; Figure B-31). The trend is statistically significant and varies by season. Cumulative flow increases in summer are significant ($p < 0.05$) and represent a moderate increase, while increases in winter are highly significant ($p < 0.001$) and represent a smaller magnitude increase.

Generalized flow path diagrams have been produced for Fish Creek and its tributaries from prior USGS publications on Fish Creek (Eddy-Miller et al., 2013). The upstream site, A_R1D, is intermittent and strongly influenced by snowmelt upstream and large fluctuations in the water table, gaining an influx of groundwater to the stream in the spring throughout the season. The next site downstream of Teton Village, A_RB, is perennial and influenced by infiltration of valley snowmelt, recharge of the alluvial aquifer from high flows in the Snake River, snowmelt from the Tetons, and recharge from irrigation water infiltration. It is near-neutral (neither gaining nor losing streamflow to/from groundwater) in the summer, and gains streamflow from its groundwater in the fall. A_Wck, located in Wilson, is constantly supplied by a small input of groundwater and its streamflow fluctuations closely match fluctuations in the Snake River.

Figures B-32 through B-34 visualize the generalized flow paths of surface water and near-stream groundwater in Fish Creek (Eddy-Miller et al., 2013).

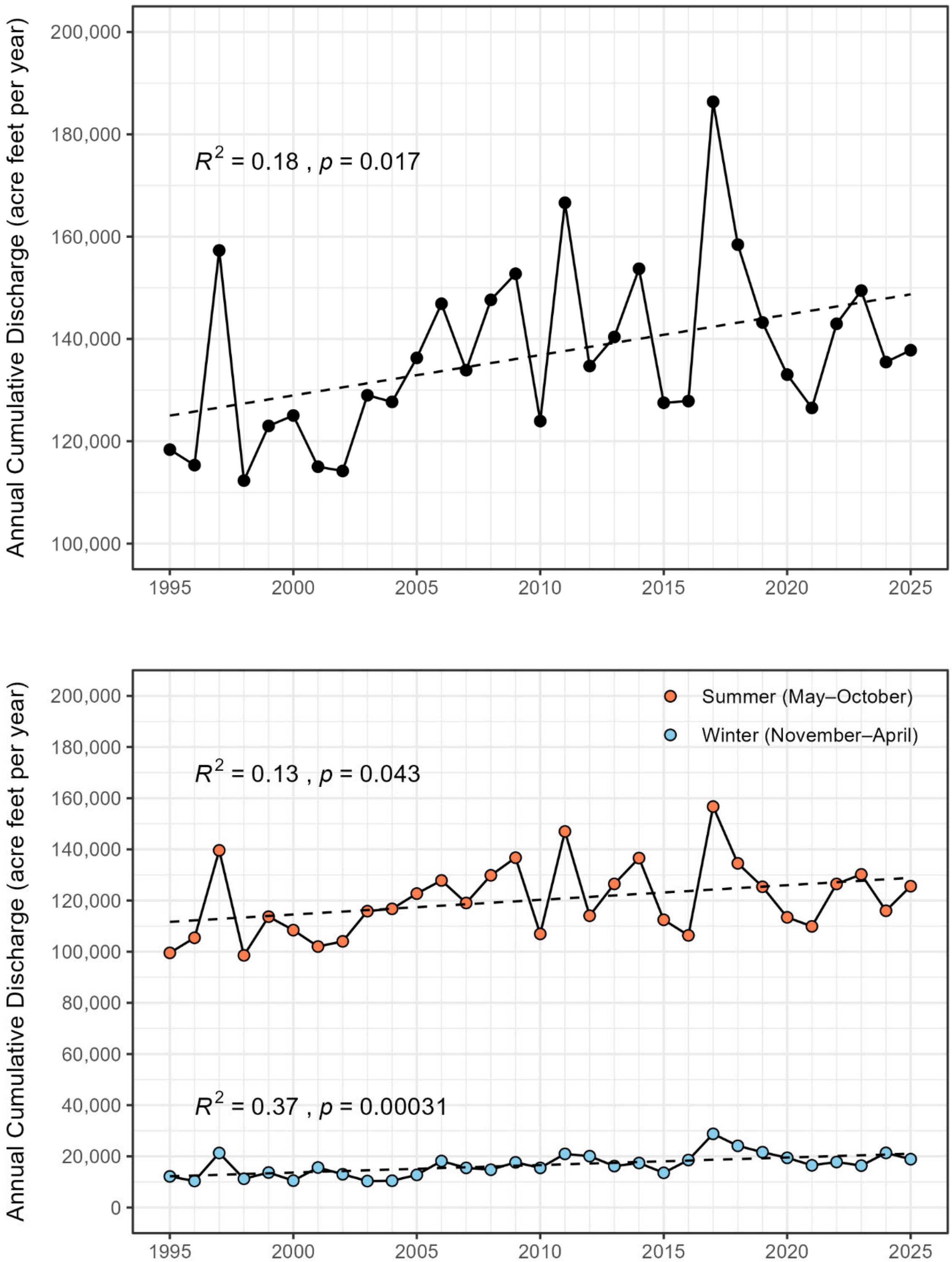


Figure B-31. Cumulative discharge annually (top) and separated by season (bottom) through the Fish Creek USGS 13016450 streamgage. Period of record 1994 – 2025.

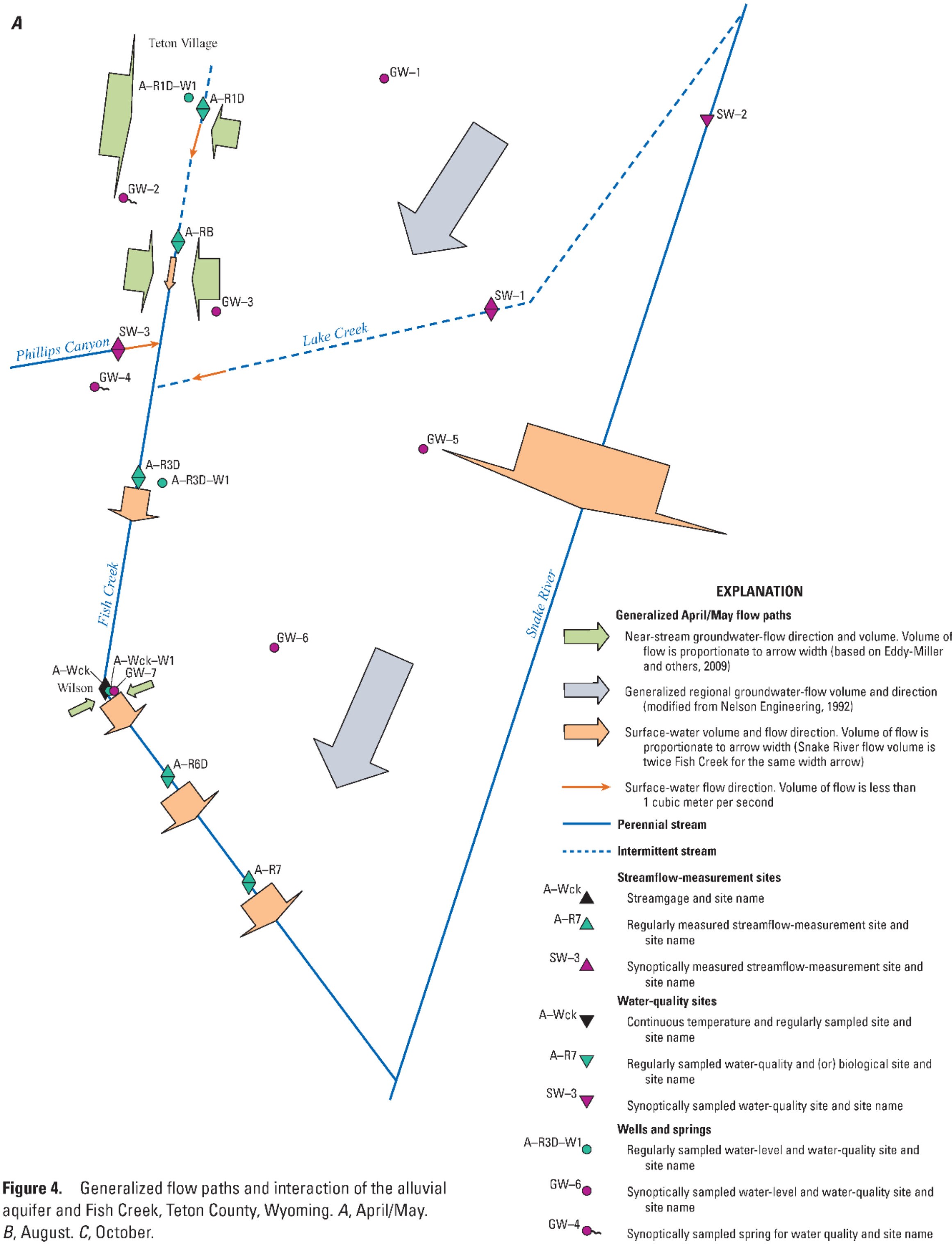


Figure 4. Generalized flow paths and interaction of the alluvial aquifer and Fish Creek, Teton County, Wyoming. *A*, April/May. *B*, August. *C*, October.

Figure B-32. Generalized flow paths and interaction of the alluvial aquifer and Fish Creek in April/May (taken from Eddy-Miller et al., 2009).

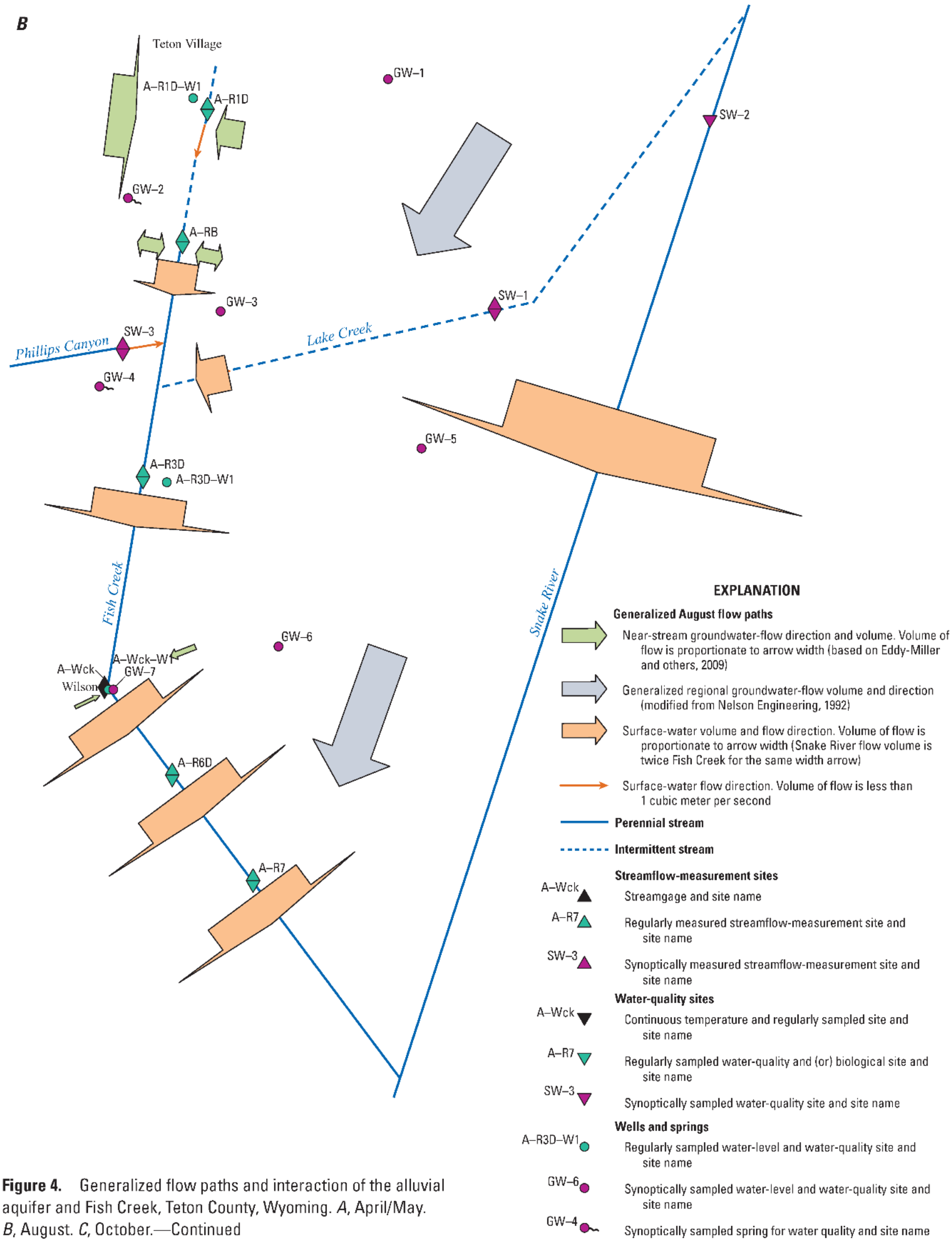


Figure 4. Generalized flow paths and interaction of the alluvial aquifer and Fish Creek, Teton County, Wyoming. *A*, April/May. *B*, August. *C*, October.—Continued

Figure B-33. Generalized flow paths and interaction of the alluvial aquifer and Fish Creek in August (taken from Eddy-Miller et al., 2009).

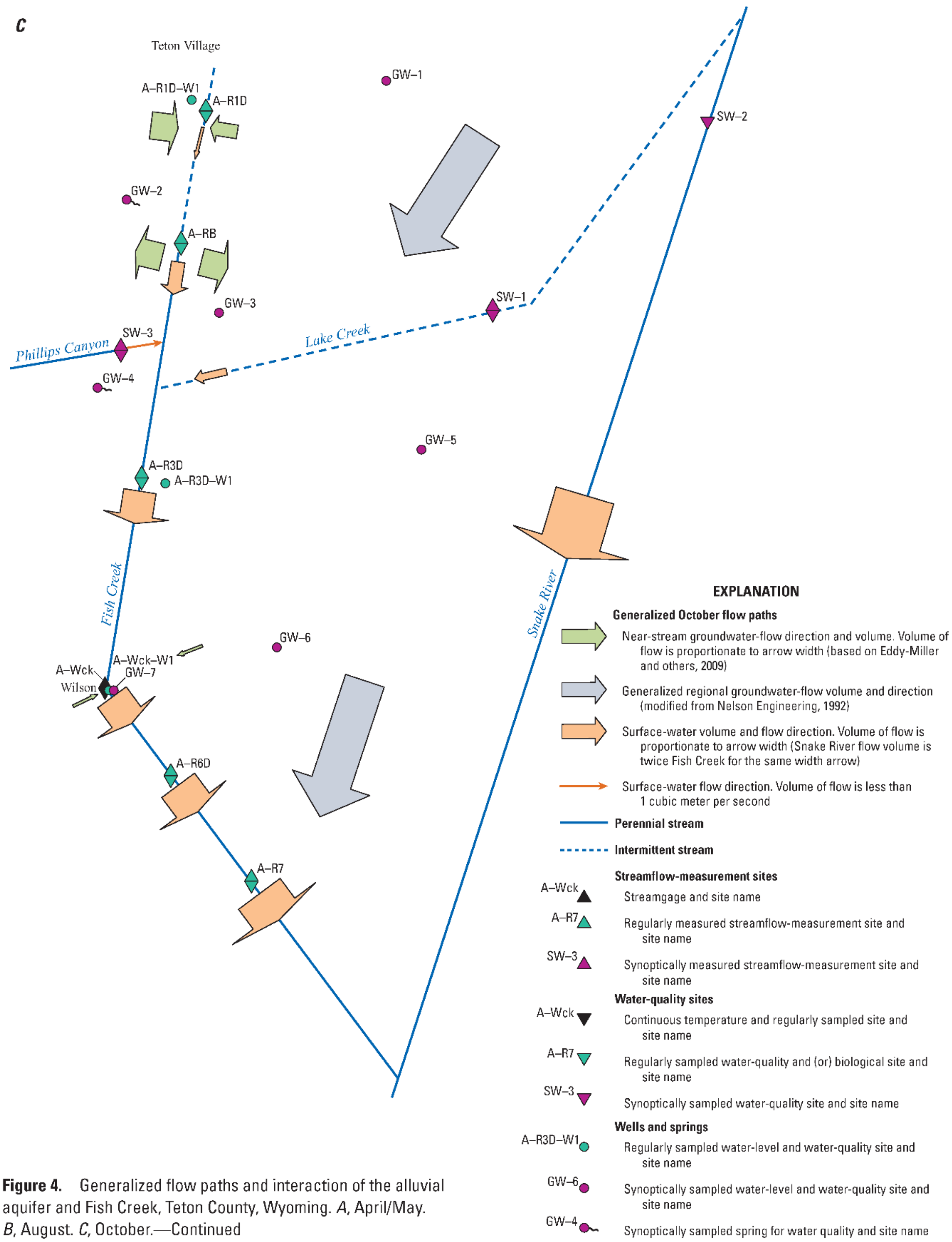


Figure 4. Generalized flow paths and interaction of the alluvial aquifer and Fish Creek, Teton County, Wyoming. *A*, April/May. *B*, August. *C*, October.—Continued

Figure B-34. Generalized flow paths and interaction of the alluvial aquifer and Fish Creek in October (taken from Eddy-Miller et al., 2009).

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APPENDIX C: SUMMARY OF STAKEHOLDER PROCESS

C-1 Introduction

Teton Conservation District and Alder Environmental designed an outreach and engagement campaign in 2023 to solicit feedback from stakeholders and the community regarding priority issues for the Fish Creek Watershed Plan. The following section summarizes the stakeholder collaboration and meeting process, the outreach and advertising methods, and the input gathered from stakeholder meetings.

C-2 Outreach and Advertisement

The following methods were used to advertise for participation in the Fish Creek Watershed Plan throughout 2023.

1. **Collaborator Websites**
    a. **Teton Conservation District**
        i. Link to Jackson Hole Clean Water Coalition website and store general project information.
        ii. Calendar event for June 7th, 2023 stakeholder meeting
    b. **Jackson Hole Clean Water Coalition**
        i. Hosted a web page as the hub for information regarding the Fish Creek Watershed Plan, including a recording of the June 7th, 2023 public stakeholder meeting.
2. **Newspaper Outlets**
    a. Press Release – Jackson Hole News & Guide *(May 17, 2023)*
    b. Advertisement
        i. Jackson Hole News & Guide - 1 week ad duration (Wednesday, May 31, 2023)
        ii. Jackson Hole Daily - 6-day ad duration (Wednesday May 31st, Thursday June 1st, Friday June 2nd, Saturday June 3rd, Monday June 5th, Tuesday, June 6th, 2023)
3. **Buckrail**
    a. Sponsored post, includes 2-3 days of front-page website article, Facebook post, weekly roundup email to Buckrail subscribers.
        i. Run ad package on Buckrail starting on Tuesday May 23rd, 2023.
4. **Social Media Outlets**
    a. Two rounds of Facebook and Instagram posts to advertise stakeholder meetings. First post on the week of May 29th, 2023, second post on June 5th, 2023.
        i. Teton Conservation District
        ii. Jackson Hole Clean Water Coalition
5. **Agency Invites and Correspondence**
    a. A list of relevant agencies in the Fish Creek watershed was compiled, and invitations to the June 7th, 2023, stakeholder meeting were emailed to invitees. Email invitations were sent to the following list for the agency-specific meeting:
        i. Town of Jackson, Teton County, Teton County Weed & Pest District, Teton Conservation District, Wilson Sewer District, Aspens Pines Sewer & Water District, Teton Village Water & Sewer District, Grand Teton National Park, United States Geological Survey, Jackson Hole Mountain Resort, Teton Village Association, Wyoming Department of Environmental Quality, Wyoming Game and Fish Department, Wyoming Department of Transportation, Bridger Teton National Forest,
    b. The following organizations were sent email invitations to the public stakeholder meeting:

i. Protect Our Water Jackson Hole, Snake River Fund, Ducks Unlimited, Trout Unlimited, Teton Pines HOA, Snake River Ranch, Shooting Star HOA, Jackson Hole Land Trust, Shooting Star Golf Course, Teton Pines Golf Course.

C-3 Stakeholder Meetings and Input Gathered

A stakeholder meeting was held on June 7, 2023 at the Old Wilson Schoolhouse Community Center in Wilson, WY. The meeting was divided into two parts, an agency-specific meeting followed by a public meeting. The format for both sessions included a three-part presentation from Alder Environmental, Teton Conservation District, and Wyoming Department of Environmental Quality. The presentation covered the watershed planning process, a summary of water quality studies on Fish Creek, and background information on nutrient pollution and assessment in the watershed. The second half of stakeholder meetings was reserved for discussion facilitation led by Alder Environmental. Discussion questions were prompted by the facilitator, and feedback from participants was recorded by meeting organizers.

Input Gathered

Gathering feedback from stakeholders and participants was prioritized throughout the watershed planning process. The following methods were used to track and gather comments from members of the public and agency representatives. Written and verbal comments from the sources listed below were synthesized into Table C-1.

1. **Online Survey**
   a. An online survey hosted by Google Forms was available from June 7, 2023, until January 29, 2024. The survey link was posted on the Jackson Hole Clean Water Coalition website and advertised in social media posts by the Teton Conservation District.
2. **Stakeholder Meeting Public Comment**
   a. Meeting minutes were recorded during the discussion facilitation portion of the June 7th, 2023 stakeholder meetings. Notes from public comment were distilled into key points, and these summaries are included in Table C-1.
3. **Stakeholder Meeting Written Comment**
   a. Attendees of the June 7, 2023, stakeholder meetings were presented with the option to fill out written comments on printed handouts that included the discussion facilitation questions. The meeting organizers collected the completed handouts and compiled this information for inclusion in the watershed plan document. One participant from the agency-specific meeting submitted written comments to the discussion questions in a digital format.
4. **Email Communications for Long- Form Written Comments**
   a. An email address for Alder Environmental staff was made available during the stakeholder meetings and on the Jackson Hole Clean Water Coalition website during the watershed planning process. Several emails were received in the days following the stakeholder meeting in longer-form written comments. Key points from these statements were summarized to include in the watershed plan in the Public Comment Summary table below.

Table C-1. Online participation survey responses from Fish Creek stakeholder process, 2023.

Survey Questions	**1 = low priority; 5 = high priority**				
	1	**2**	**3**	**4**	**5**
How would you prioritize water quality improvement (*E. coli* bacteria and nutrient loading) as compared to other issues on Fish Creek?	0%	0%	7%	21%	71%
How would you prioritize riparian habitat improvement (streambank and corridor vegetation) as compared to other issues on Fish Creek?	7%	7%	7%	50%	29%
How would you prioritize aquatic habitat improvement (instream habitat for fish and wildlife) as compared to other issues on Fish Creek?	0%	7%	21%	36%	36%
How would you rank the importance of collecting *E. coli* bacteria data to inform the Wyoming Department of Environmental Quality and the general public on health hazards related to recreation?	0%	8%	0%	0%	92%
How would you rank the importance of collecting nutrient data to inform the Wyoming Department of Environmental Quality on the degree of aquatic life impairment in Fish Creek?	0%	0%	8%	15%	77%
How would you rank the importance of conducting riparian vegetation surveys to identify feasible locations for restoration and enhancement projects on Fish Creek?	7%	0%	14%	29%	50%
How would you rank the importance of conducting stream habitat assessments to identify feasible aquatic habitat enhancement opportunities on Fish Creek?	7%	0%	14%	43%	36%

*Percentages represent the number of respondents that answered for each ranking assessment. A red shaded square represents a high priority, receiving 50% or greater of the responses for that question. A yellow square represents a medium priority, while a green square represents a low priority. No shading represents an answer with no responses.

Table C-2. Additional summarized survey results for the Fish Creek Watershed Plan online participation survey.

Rank the following three methods of Fish Creek Watershed Management Plan implementation in order of most effective to least effective in achieving the watershed improvement goals.	Points received in weighted ranking assessment*
Non- Structural Management Practices - Involves changes to activities or behavior and focus on controlling pollutants at their source and preventing degradation of habitat.	**31**
Administration and Monitoring - Involves administration of watershed Plan implementation, annual evaluations and reporting, monitoring of management practice success and revisions to the Watershed Plan.	**24**
Structural Management Practices - Involves construction, installation, and maintenance to capture pollutants, improve or enhance habitat, and eliminate erosion.	**17**
What do you think are the primary causes and sources of pollution affecting water quality that need to be controlled in the Fish Creek watershed?	Number of Responses
Septic tank pollution	9
Cattle/livestock grazing	5
Stormwater management/surface runoff	3
Treated sewage effluent reduction	2
Fertilizer application	2
Atmospheric nutrient deposition	1
Pet waste pollution	1
What water quality, riparian habitat, and aquatic habitat issues would you like to see addressed in the Fish Creek Watershed Management Plan?	Number of Responses
Septic systems	3
Nutrients	3
Riparian buffer areas	3
Stormwater runoff	3
Fertilizer reduction	2
Recreational float use controlled	2
Trash	1
Development	1
Point & nonpoint pollutants	1

E. coli	1
Agricultural inputs	1
What watershed improvement activities would you like to see included in the Fish Creek Watershed Management Plan to address the issues identified in the previous question?	Number of Responses
Septic system monitoring, assessment, regulations	6
Agricultural best management practices	3
Riparian buffer establishment/updated stream setback recommendations	3
Fertilizer reduction	2
Stormwater management	2
Impervious surface limitations	1
Manmade pond impact study	1
Native plant landscaping	1
Aquifer mapping	1
Access restrictions	1
Enforcement of regulations	1
What watershed data collection and surveys would you like to see included in the Fish Creek Watershed Management Plan?	Number of Responses
E. coli bacteria studies	4
Nutrient assessments	4
Riparian vegetation surveys	3
Septic functionality assessments	2
Macroinvertebrate studies	2
Dissolved oxygen levels	1
Land use characterization	1
Stormwater sampling	1
Trash volume	1
What potential partnerships and sources of funding to implement identified watershed improvement and data collection activities would you like to see included in the Fish Creek Watershed Management Plan?	Number of Responses
Teton County	4
Non-profit	3

State of WY	2
Teton Conservation District	2
Trout Unlimited	1
Old Bills Fun Run	1
Federal funding	1
Teton Village Resort District	1
Public funds	1
Natural Resources Conservation Service	1
United States Department of Agriculture	1
Fish Creek watershed residents' tax	1
WY grants for infrastructure	1
Trust for Public Lands	1

*The weighted assessment ranking awarded 3 points for a most effective ranking, 2 points for a middle ranking, and one point for a least effective ranking. The scores for each of the three options were summed to provide a total ranking based on survey results. A higher weighted ranking sum means that survey respondents prioritized that method in their judgment of effectiveness of achieving watershed improvement goals.

Public Comment Summary

In addition to the online survey information, additional feedback was gathered through in-person meeting participation, in-person meeting written comment, and email correspondence. The following points summarize public comments from the above sources.

1. What issues do you see as the biggest concerns regarding water quality in the Fish Creek watershed?
    - Septic leachfields and wastewater, effect on nutrients and E. coli
    - Groundwater surface water exchange and the effect on nutrient and E. coli loads in Fish Creek and drinking water wells
    - Sources of nutrients and E. coli contributing to impairments
    - Nuisance algal biomass
    - Effect on water quality from irrigation diversions
2. What previous/current Fish Creek watershed improvement practices are you aware of that have been implemented?
    - Teton Village Water & Sewer District completed multiple projects to cut nitrogen load in half
    - Riparian fencing projects organized by Trout Unlimited
    - Trout Friendly Lawns program - Jackson Hole Clean Water Coalition and others
3. What Fish Creek watershed-related research or studies are you aware of that have been conducted?
    - Algal growth studies
    - Monitoring of residential drinking water wells
    - Surface water monitoring for pesticides by Teton County Weed & Pest and USGS
    - Septic system inventory and efficacy studies
    - Ongoing water quality monitoring program at Shooting Star Golf Course
4. What ideas do you have for watershed improvement projects or best management practices (BMPs) that would improve Fish Creek water quality?
    - Full wastewater collection system along the West bank
    - Utilize existing wastewater facilities to take on more sewage
    - Implementation of regulations for residential wastewater treatment systems
    - Establishment of riparian buffer areas on grazing pasture lands
5. What Fish Creek watershed health assessments/research projects do you propose?
    - Effect of biosolid dispersion on groundwater
    - Trends of rooted macrophytes in Fish Creek
    - Riparian restoration projects increasing buffer zones along Fish Creek

- Effluent discharge tracer studies
- Study focusing on cumulative impact of manmade ponds
- Surface water monitoring for pesticides
- Research land development regulations from similar environments/ communities to provide ideas of beneficial management practices.
- Identifying ‘ghost’ leach fields from abandoned septic tanks
- Fish Creek substrate embeddedness studies
- Quantifying stormwater inputs to Fish Creek
- Fish Creek bank assessment-inventory eroding areas without vegetation and engage landowners about restoration projects.

6. What funding source suggestions or partnership ideas do you have?
    - Federal funding
    - State loans through wastewater districts
    - Teton County SPET funding
    - Section 319 Funding through EPA- Clean Water Act
    - Natural Resources Conservation Service