2021 Goose Creek Watershed Interim Monitoring Project Final Report

Sheridan County Conservation District
SCCD Water Quality Improvements #6 NPS2019D

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EXECUTIVE SUMMARY

The Goose Creek watershed encompasses 267,520 acres (418 square miles) in Sheridan County located in north-central Wyoming. Big Goose Creek and Little Goose Creek originate in the Big Horn Mountains in the Bighorn National Forest (BNF) west of Sheridan. The creeks pass through the unincorporated town of Big Horn, several ranches, and rural subdivisions before joining to form Goose Creek within the City of Sheridan. Goose Creek continues north to its confluence with the Tongue River near the old Acme town site. Soldier Creek is the only major tributary to Goose Creek below the confluence of Big and Little Goose Creeks. Major tributaries to Big Goose Creek include Rapid Creek, Park Creek, and Beaver Creek. Sackett Creek, Jackson Creek, Kruse Creek, and McCormick Creek are the major tributaries to Little Goose Creek.

The project area includes a combination of private, state, and federal lands with private lands dominating the portion of the watershed downstream of the BNF boundary. Below the BNF, the Goose Creek watershed is predominately rangeland, with irrigated crops and hay lands along the streams and tributaries. Ranching operations within the Goose Creek watershed contain irrigated hay and crop lands, as well as pastureland for cattle grazing and corrals for feeding. In rural residential/small acreage areas, there may be more horses and domestic animals other than cattle. Subdivisions, converted from rural areas that are occasionally prime farmlands, are becoming more common along Big and Little Goose Creek. Big game, waterfowl, and other wildlife habitat can also be found on privately owned lands. The municipal water supply for the City of Sheridan and surrounding area is in the upper portion of the Goose Creek watershed.

Accessible to over 31,000 Sheridan County residents, these streams and their tributaries are used extensively throughout the year. Local citizens of all ages commonly recreate on these streams, especially in Sheridan's city parks and along recreational pathways. Due to their extensive use, easy access, and direct contact with the public it is essential that these waterways are of the highest quality.

Most streams in the Goose Creek watershed are classified as 2AB. Class 2AB waters are perennial waterbodies expected to support drinking water supplies (when treated), fish, and aquatic life, recreation, wildlife, industry, and agricultural uses (WDEQ/WQD, 2021b). Some tributaries and other draws, classified as Class 3B surface waters, are not expected to support fish populations or drinking water supplies. Big Goose Creek, Little Goose Creek, Goose Creek, and several of the associated tributaries have been identified as impaired for recreational use support because of high bacteria concentrations. All impaired segments (including tributaries) were addressed in the Goose Creek Watershed TMDL, which was completed in September 2010.

Past sampling efforts in the Goose Creek watershed started several decades ago by the United States Geological Survey (USGS) and the WDEQ. Since then, the SCCD, in partnership with USDA Natural Resources Conservation Service (NRCS), Sheridan County, and the City of Sheridan, has done extensive work to try to understand and address water quality concerns within the watershed. In 2001-2002, SCCD conducted the Goose Creek Watershed Assessment, in partnership with Sheridan County and the City of Sheridan. Interim monitoring was also conducted in 2005, 2009, 2012, 2015 and in 2018 to evaluate changes in water quality over the long-term. During interim monitoring, samples were collected at fewer stations and for fewer parameters than the initial assessment.

Watershed planning was initiated during the fall of 2003 and concluded in December 2004 with the development of the Goose Creek Watershed Management Plan. The plan included goals and objectives such as the continuation of local improvement programs offered by the SCCD-NRCS to address bacteria and

sediment contributions from livestock facilities, septic systems, unstable stream banks, and stormwater run-off. Despite efforts to increase awareness and installation of improvement projects, levels of bacteria within the watershed continued to exceed water quality standards. In the summer of 2008, WDEQ decided to move forward with the development of a TMDL on the Goose Creek watershed, which was completed in September of 2010. The Goose Creek Watershed TMDL and associated implementation strategies include continued water quality monitoring to evaluate whether planning and improvement efforts are impacting water quality over the long-term.

The purpose of this project was to complete the 2021 interim monitoring milestone in the Goose Creek Watershed Improvement Effort Implementation Strategy, which was developed by the local steering committee to address recommendations in the Goose Creek Watershed TMDL. The monitoring is part of a locally led collaborative process that includes information and education programs and project implementation through the organization and facilitation of local stakeholder groups.

In 2021, SCCD monitored water temperature, pH, conductivity, dissolved oxygen, discharge, turbidity, and *E. coli* at 17 sites. Continuous water temperature data loggers were used to monitor temperature at 15-minute intervals at seven sites. Macroinvertebrate sampling and habitat assessments were also performed at eight sites. Of the 17 sites, there were three sites on Goose Creek, four on Big Goose Creek, four on Little Goose Creek, and one each on Soldier Creek, Beaver Creek, Rapid Creek, McCormick Creek, Kruse Creek, and Jackson Creek.

Instantaneous temperature samples were recorded at or above the 20°C instream standard at one site on June 22, ten sites on July 7, 11 sites on July 20, and eight sites on August 2. Similarly, continuous water temperatures also exceeded the standard at all sites where temperature loggers were deployed (GC01, BG01, BG10, LG02, and LG08), apart from the two canyon sites (BG18 and LG22). Most exceedances occurred in July and August.

Conductivity and pH values were within the expected ranges during 2021. All samples met the minimum instantaneous dissolved oxygen concentration standard of 4.0 mg/L for other life stages and 5.0 mg/L for early life stages. Nine mainstem samples and six tributary samples were below the 8.0 mg/L recommended to achieve 5.0 mg/L intergravel concentrations for early life stages. Most samples that were below the recommendation were those collected in July and August. All other samples at mainstem and tributary sites were above the recommended 8.0 mg/L. Turbidity averages were considered normal for the watershed with occasional high values occurring during late-spring, early summer precipitation, and run-off events.

Early, mid, and late season bacteria geometric means exceeded the standard at all sites, except for early season geometric means at the three upper Big Goose sites (BG10, BG14, and BG18), LG08, and LG22, and mid-season and late season geometric means at BG18 and LG22. Late season concentrations were higher than mid and late-season concentrations at most sites. Overall, mean bacteria concentrations have been increasing since sampling first began in 2001 at all sites, despite 2021 concentrations at most mainstem sites being lower than those recorded when sampling was last completed in this watershed in 2018.

Benthic macroinvertebrate sampling was conducted at eight stations in September 2021. Biological condition was then determined based on the analysis of the benthic macroinvertebrate community.

Since 1998 biological condition at the lowermost Goose Creek station GC01 was indeterminate except for 2012 when it was partial/non-supporting. Biological condition has generally declined since 1998. However, biological condition at Goose Creek station GC01 was better than biological condition at the upper Goose

Creek station GC02. This observation contrasted with a general decline in biological condition from upstream to downstream stations noted at other Big Goose Creek and Little Goose Creek stations. Biological condition at station GC02 has exhibited an upward trend since 1998.

Biological condition was Indeterminate supporting at Big Goose Creek station BG02 during 2021. Biological condition varied at this station from full support in 1998 and 2018 to partial/non-supporting and indeterminate supporting from 2001 to 2015, and 2021. Biological condition at Big Goose Creek station BG10 has been variable since sampling began in 2001. Biological condition was fully supporting in 2001 with a subsequent decline to Indeterminate support from 2002 to 2009. Biological condition increased in 2009, decreased to partial/non-supporting in 2012, and increased to Indeterminate support in 2015 and 2018. Benthic macroinvertebrate sampling at the uppermost control station BG18 since 1998 found biological condition was fully supporting with the exception of 2018 when biological condition was reduced from full support to indeterminate support. The reduction in biological condition did not appear to be related to a reduction in water quality, but to an increase in sand in the stream substrate starting in 2012. Biological condition was fully supporting in 2021.

The biological condition at Little Goose Creek station LG2A has been variable since sampling by WDEQ began in 1994. The trend in biological condition at station LG2 has improved since 1994 at station LG2. This is an important observation since other than Goose Creek station GC02, no other station sampled in 2018 in the Goose Creek watershed exhibited an improving trend in biological condition. Biological condition at station LG10 was Indeterminate from 1998 to 2002, then decreased to partial/non-supporting from 2005 to 2021.

Biological condition at the uppermost Little Goose Creek control station LG22 was fully supporting from 1996 to 2021. However, the trend in biological condition at station LG22 was similar to the trend in biological condition observed at Big Goose Creek control station BG18 in that both stations have exhibited a decline in biological condition since 1998.

Continued benthic macroinvertebrate sampling is recommended at current Goose Creek, Big Goose Creek, and Little Goose Creek stations, and at all original Goose Creek watershed stations as funding allows, to track changes in biological condition. Planning and implementation of remedial measures should continue to restore full aquatic life use support in streams in the Goose Creek Watershed.

No threatened or endangered benthic macroinvertebrate taxa or fish species (incidentally captured during macroinvertebrate sampling) were identified. Whirling disease has not been identified in the Goose Creek watershed. However, whirling disease was identified in the adjacent Tongue River watershed in the North Tongue River as well as in the Clear Creek watershed located southeast of the Goose Creek watershed. No Wyoming Game and Fish Department (WGFD) designated aquatic invasive species were identified in the Goose Creek watershed. Brook stickleback (*Culaea inconstans*) is a smaller minnow-sized fish species of concern. This fish species has not been incidentally collected by SCCD in benthic macroinvertebrate sampling. However, they were collected by WGFD in 2017 in the lower Goose Creek watershed (near SCCD station GC01) and in the Tongue River below its confluence with Goose Creek.

Attempts to determine if improvements in overall water quality have been achieved are often difficult, particularly when comparing water quality data that has been collected during seasons with different hydrological and meteorological conditions. Although normal flow conditions cannot be anticipated nor expected during monitoring, these varying conditions make water quality comparisons more difficult.

Like other watersheds in Sheridan County, the Goose Creek watershed serves as an important resource for agriculture, wildlife, and scenic value. In addition, the Goose Creek watershed provides the municipal water supply for the City of Sheridan and surrounding area. The watershed, as it exists today, has been defined by residential development, irrigation practices, and agricultural production. Best Management Practices addressing bacteria and sediment sources, irrigation water conservation and management, and riparian livestock management can be implemented to improve water quality and the overall health of the watershed.

Efforts within the watershed have increased local awareness about several important resource issues and has led to more public interest in the watershed. Continued monitoring can provide information on water quality changes over the long-term. SCCD will continue to monitor water quality in the Goose Creek watershed on a three-year rotation, pending available funding sources. The SCCD anticipates that voluntary, incentive-based watershed planning, and implementation efforts will eventually be successful; however, it may require several years to measure these achievements. Nonetheless, each improvement project implemented in the watershed certainly induces positive water quality changes, whether they are immediately evident or not.

CHAPTER 1 PROJECT AREA DESCRIPTION

1.1 Watershed Description

The Goose Creek watershed encompasses 267,520 acres (418 square miles) in Sheridan County located in north-central Wyoming (Appendix A). The watershed is identified by hydrologic unit code (HUC) 1009010101. Big Goose Creek and Little Goose Creek originate in the Big Horn Mountains in the Bighorn National Forest (BNF) west of Sheridan. The creeks pass through the unincorporated Town of Big Horn, several ranches, and rural subdivisions before joining to form Goose Creek within the City of Sheridan. Goose Creek continues north to its confluence with the Tongue River near the old Acme town site.

Stream elevation is 4533 feet at the uppermost sample site on Little Goose Creek (LG22) and 4505 feet on Big Goose Creek (BG18), both of which are below the BNF. The elevation drops to 3660 feet at the lower most sample station on Goose Creek (GC01), above the confluence with the Tongue River. The lower portion of the watershed is in the 14-16" precipitation zones (Appendix A). Precipitation in the upper watershed, within the BNF, ranges from 20-36". All sampling stations are in precipitation zones that are less than 20". About half of the watershed is in the 20+" Mountains Ecological Site group (Appendix A); however, most of the sample sites are in the 15-19" Northern Plains Ecological Site group. The 10-14" Northern Plains Ecological Site group encompasses the northern tip of the watershed and contains the lowermost sample site on Goose Creek (GC01). After leaving the Big Horn Mountains, the predominant geology along the Goose Creek, Big Goose Creek, and Little Goose Creek channels is alluvium and colluvium comprised of clay, silt, sand, and gravel (Love, J.D. & Christiansen, A.C., 1985). Soils are primarily of the general Haverdad-Zigweid-Nuncho group, which are very deep, loamy, and clayey soils typically found in floodplains, alluvial fans, and terraces (USDA, 1986).

Soldier Creek is the only major tributary to Goose Creek below the confluence of Big and Little Goose Creeks. Major tributaries to Big Goose Creek include Rapid Creek, Park Creek, and Beaver Creek. Sackett Creek, Jackson Creek, Kruse Creek, and McCormick Creek are major tributaries to Little Goose Creek.

1.2 Land Ownership and Uses

The project area includes a combination of private, state, and federal lands with private lands dominating the portion of the watershed downstream of the BNF boundary (Appendix A). Approximately 136,700 acres (50%) are privately owned lands that include small and large ranch operations and residential development. The BNF consists of approximately 115,000 acres (43%) that are managed for recreation, seasonal cattle grazing, logging, and wildlife. The remaining 15,820 acres (7%) includes other state, county, or other federal lands.

Below the BNF, the Goose Creek watershed is predominately rangeland, with irrigated crop and hay lands along the streams and tributaries (Appendix A). Ranching operations within the Goose Creek Watershed contain irrigated hay and crop lands, as well as pastureland for cattle grazing and corrals for feeding. In rural residential/small acreage areas, there may be more horses and domestic animals other than cattle. Big game, waterfowl, and other wildlife habitat can also be found on privately owned lands. The density of rural housing generally increases from the mountain foothills downstream to Sheridan. North and downstream of Sheridan, agriculture again becomes the dominant land use. During recent years, this northern area of the watershed has also been used for the development of coal-bed methane production. Subdivisions, converted from rural areas that are occasionally prime farmlands, are becoming more common along Big and Little Goose Creek.

The municipal water supply for the City of Sheridan and surrounding area is in the upper portion of the Goose Creek watershed.

Since the area was settled in the late 1800's, a significant amount of change has been imposed on the stream channel systems within the project area. Miles of irrigation ditches and trans-basin diversions have been created. Several reservoirs have been built on the BNF for domestic and irrigation uses. Throughout Sheridan, much of Goose Creek, Big Goose Creek, and Little Goose Creek have been placed into straightened channels, often made of concrete, for flood control. Goose Creek, near the Tongue River confluence, has been extensively channelized as part of coal mine reclamation.

Accessible to over 31,000 Sheridan County residents, these streams and their tributaries are used extensively throughout the year. Local citizens of all ages commonly recreate on these streams, especially in Sheridan's city parks and along recreational pathways. Sheridan was settled around these streams and today they remain highly accessible; Big Goose Creek flows through Kendrick Park, Little Goose Creek flows through South, Emerson, and Washington Parks, and Goose Creek passes through Thorne-Rider and North Parks. Since early 2000, an extensive cement bike path follows these waterways within the city limits. Due to their extensive use, easy access, and direct contact with the public it is essential that these waterways are of the highest quality.

1.3 Stream Classification and Impaired Waters

The Wyoming Department of Environmental Quality (WDEQ) is charged with implementing the policies of the Clean Water Act and providing for the "highest possible water quality" for activities on a waterbody (WDEQ, 2018b). Depending upon its classification, a waterbody is expected to be suitable for certain uses (Table 1-1).

Table 1-1. Wyoming surface water classes and use designations (WDEQ/WQD, 2021b)

Class	Drinking Water	Game Fish	Non-Game Fish	Fish Consumption	Other Aquatic Life	Recreation	Wildlife	Agriculture	Industry	Scenic Value
1[1]	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	Yes	Yes	Yes	Yes	Yes
2AB	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2A	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
2B	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2C	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2D	No	When Present	When Present	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3 (A-D)	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
4 (A-C)	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

[1] Class 1 waters are not protected for all uses in all circumstances. For example, all waters in the National Parks and Wilderness are Class 1, however, all do not support fisheries or other aquatic life uses (e.g., hot springs, ephemeral waters, wet meadows etc.). For stormwater permitting, 401 Certification, and WQ assessment purposes, the actual uses on each particular water must be determined independently.

Stream classifications are assigned by WDEQ and identified on the Wyoming Surface Water Classification List (WDEQ/WQD, 2021b) or in subsequent reports. Chapter 1 of the Wyoming Water Quality Rules and Regulations (WDEQ, 2018b) describes the surface water classes and designated uses, as well as the water quality standards that must be achieved for a Wyoming waterbody to support its designated uses.

Most streams in the Goose Creek watershed are classified as 2AB. Class 2AB waters are perennial waterbodies expected to support drinking water supplies (when treated), fish, and aquatic life, recreation, wildlife, industry, and agricultural uses (WDEQ/WQD, 2021b). Beaver Creek, McCormick Creek, and Kruse Creek are classified as Class 3B surface waters, which are not expected to support fish populations or drinking water supplies.

States are required to summarize water quality conditions through section 305(b) of the Clean Water Act, commonly known as the 305(b) report. Section 303(d) of the Clean Water Act requires states to identify waters that are not supporting their designated uses and/or need to have a TMDL established to support the designated uses. Wyoming's 305(b) report and 303(d) list are published every two years. If a waterbody exceeds narrative or numeric water quality standards, it is listed as impaired or not meeting its designated uses. Big and Little Goose Creek were first placed on the list of impaired waters in 1996 for various parameters, including pathogens (Little Goose) and silt. In 2000, Beaver Creek, Big Goose Creek, Goose Creek, Jackson Creek, Kruse Creek, Little Goose Creek, Park Creek, Rapid Creek, Sackett Creek, and Soldier Creek were added for fecal coliform bacteria (Table 1-2).

Impaired waterbodies are first included on the Wyoming 303(d) list of Waters Requiring TMDLs under Category 5 (WDEQ/WQD, 2020a). Once a TMDL is completed, a waterbody is moved from Category 5 to Category 4, which includes the list of waterbodies with TMDLs. With the completion of the Goose Creek Watershed TMDL in 2010, most impaired segments continue to be included as Category 4A waters in the 2020 Integrated Report (WDEQ/WQD, 2020a). Two segments of Little Goose Creek are listed as Category 5 waters, indicating at least one designated use is not supported and a TMDL is needed for those sections. A 7.3-mile and 17-mile segment of Soldier Creek are listed as Category 3 and 2 waters, respectively. Category 2 waters include those that support one or more designated uses, while other designated uses are either indeterminate or have not been assessed. Category 3 waters include waters where data is insufficient to determine designated use support (WDEQ/WQD, 2020a).

Table 1-2. Impaired stream segments in the Goose Creek watershed (WDEQ/WQD, 2020a)

Name	Class	Miles	Location	Segment IR Category	Causes
Goose Creek	2AB	12.7	From the confluence with Little Goose Creek downstream to the confluence with the Tongue River	4A	Fecal Coliform, Habitat Alterations, Sediment
Soldier Creek	2AB	3.1	From the confluence with Goose Creek to a point 3.1 miles upstream	4A	Fecal Coliform
Big Goose Creek	2AB	19.2	From the confluence with Little Goose Creek upstream to the confluence with Rapid Creek	4A	Fecal Coliform
Beaver Creek	3B	6.5	From the confluence with Big Goose Creek upstream to the confluence with Apple Run	4A	Fecal Coliform
Park Creek	2AB	2.8	From the confluence with Big Goose Creek to a point 2.8 miles upstream	4A	Fecal Coliform
Rapid Creek	2AB	3.2	From the confluence with Big Goose Creek to a point 3.2 miles upstream	4A	Fecal Coliform
Little Goose Creek	2AB	3.5	From the confluence with Big Goose Creek upstream to Brundage Lane in Sheridan	4A	Fecal Coliform, Habitat Alterations, Sediment
Little Goose Creek	2AB	5.3	From Woodland Park Road to a point 5.3 miles upstream	5	*Escherichia coli*
Little Goose Creek	2AB	3.0	From the confluence with Kruse Creek to the confluence with Jackson Creek	5	*Escherichia coli*
McCormick Creek	3B	2.2	From the confluence with Little Goose Creek to a point 2.2 miles upstream	4A	Fecal Coliform
Kruse Creek	3B	2.5	From the confluence with Little Goose Creek upstream to the confluence with East Fork Kruse Creek	4A	Fecal Coliform
Jackson Creek	2AB	6.4	From the confluence with Little Goose Creek to a point 6.4 miles upstream	4A	Fecal Coliform
Sackett Creek	2AB	3.1	From the confluence with Little Goose Creek upstream to the confluence with East Fork Sackett Creek	4A	Fecal Coliform

CHAPTER 2 PROJECT BACKGROUND

2.1 Previous SCCD Monitoring Efforts

Past sampling efforts in the Goose Creek watershed started several decades ago by the United States Geological Survey (USGS) and the WDEQ. Since 2000, the SCCD, in partnership with USDA Natural Resources Conservation Service (NRCS), Sheridan County, and the City of Sheridan, has done extensive work to try to understand and address water quality concerns in the Goose Creek watershed.

The Goose Creek Watershed Assessment, which was initiated in April 2001, included collecting samples for pH, water temperature, specific conductivity, dissolved oxygen, total residual chlorine, fecal coliform, turbidity, alkalinity, biochemical oxygen demand, chloride, total hardness, sulfate, ammonia, nitrate nitrogen, total phosphorus, and total suspended solids samples. In total, 46 monitoring stations were sampled on Goose Creek, Big Goose Creek, Little Goose Creek, and the eight tributaries. Five stations were installed on Goose Creek, 15 on Big Goose Creek, and 18 on Little Goose Creek. In addition, each of the eight tributaries was monitored at a single, lower station located near its mouth. Fecal coliform and turbidity samples were collected five times during the months of April, May, August, and October to comply with WDEQ's fecal coliform monitoring protocol. Continuous temperature recorders were used to monitor water temperatures at 15-minute intervals at the lowermost Goose Creek station, three Big Goose Creek stations, and three Little Goose Creek stations. Benthic macroinvertebrate collection and habitat assessments were conducted at 19 sites on Goose Creek, Big Goose Creek, and Little Goose Creek during September. Monitoring in 2002 was like monitoring in 2001 with a few modifications. All tributaries, Goose Creek through the City of Sheridan, and the lower segments of Big Goose and Little Goose Creek exceeded state standards for bacteria. The lowermost station on Goose Creek (just before the confluence with Tongue River) and the upper reaches of Big and Little Goose Creek were within water quality standards for the most part. Evaluation of 2001, 2002, and historic macroinvertebrate data suggested that Goose Creek was not meeting its designated use for aquatic life from the Plachek Pit (located south of the confluence of Goose Creek and Tongue River) to the confluence of Big and Little Goose Creeks. Lower Big Goose Creek and lower Little Goose Creek also failed to meet their aquatic life designated uses.

Interim monitoring was not as comprehensive as the 2001-2002 assessment but focused on evaluating changes in bacteria and sediment, along with benthic macroinvertebrates and habitat assessments, at a limited number of stations. The first round of interim water quality monitoring included 18 of the original 46 sites and occurred from April through October of 2005. The parameters included: water temperature, pH, specific conductivity, dissolved oxygen, discharge, turbidity, fecal coliform, and *E. coli*. *E. coli* sampling was conducted (along with fecal coliform) in anticipation of a change in WDEQ water quality standards. Continuous water temperature data loggers were used to monitor temperature at seven stations on Goose Creek, Big Goose Creek, and Little Goose Creek. Macroinvertebrate sampling and habitat assessments were also performed at six stations. Results of the 2005 monitoring were generally like data collected during the 2001-2002 assessment (SCCD, 2006). The wet spring experienced on the watershed during 2005 produced higher bacteria concentrations, in general, than those observed during the 2001-2002 assessment.

Subsequently, interim monitoring on the Goose Creek occurred in 2009, 2012, 2015, and 2018 using many of the same monitoring sites, water quality parameters, and sampling periods, with some exceptions. In 2009, fecal coliform was replaced with *E. coli* bacteria sampling due to a WDEQ change in water quality standards. In 2012, some additional sites were added, but were discontinued in 2015 due to limited staff and funding resources.

The general trend in bacteria concentrations on Goose Creek appeared to increase upward from 2001 to 2018. Drought conditions in 2001-2002 may have contributed to the lower concentrations in those years, although 2012 also experienced drought conditions throughout the sampling season. Wetter conditions in 2005 and 2009 may have contributed to increased bacteria concentrations through additional run-off and overland flow and resuspension of instream sediments. The extremes in short and long-term weather conditions have produced bacteria data that are not directly comparable among years. Nonetheless, values that exceed bacteria standards were observed on essentially the same stream reaches year after year and indicate water quality impairments continue to exist, regardless of hydrologic conditions.

Sampling for benthic macroinvertebrates and habitat by SCCD began in 2001. Biological condition determined by the sampling and analysis of the stream macroinvertebrate samples to 2021 has varied among the Goose Creek, Big Goose Creek, and Little Goose Creek sampling stations. The uppermost control stations on Big Goose Creek (BG18) and Little Goose Creek (LG22) have generally been fully supporting for the narrative WDEQ standard for aquatic life use. The intermediate and lower stations on Big Goose Creek and Little Goose Creek as well as the two monitoring stations on Goose Creek were generally partially/non supporting or indeterminately supporting aquatic life use. The partial/non-support or indeterminate support determination for aquatic life use indicated that the aquatic communities were stressed and water quality or habitat improvements are required to restore the stream to full support.

2.2 Watershed Planning and Implementation

In 2003, SCCD received Clean Water Act (CWA) Section 319 funding to initiate watershed planning and improvement efforts on the Goose Creek watershed. This funding allowed SCCD to administer and guide a public Goose Creek watershed planning process, develop a watershed plan, implement remediation projects, develop a progress register, and conduct interim water quality monitoring. Watershed planning was initiated during the fall of 2003 and concluded in December 2004 with the development of the Goose Creek Watershed Management Plan (SCCD, 2004). The planning process included monthly planning meetings that averaged about 20 landowners, watershed residents, SCCD, Natural Resources Conservation Service (NRCS), WDEQ, Sheridan County officials, City of Sheridan officials, and members of the Sheridan County Planning Commission.

The Goose Creek Watershed Management Plan described goals and objectives to address watershed issues identified by meeting participants. The plan included the continuation of local improvement programs offered by the SCCD-NRCS to address bacteria and sediment contributions from livestock facilities, septic systems, unstable stream banks, and stormwater run-off. SCCD has assisted with approximately 65 projects within the watershed including livestock facility improvements, septic replacements, diversion replacements, and bank/channel stabilization through structural work or willow planting (Appendix A).

In 2003, SCCD assisted the Department of Health and WDEQ in posting signs along the creeks to warn residents of the potential for pathogens in highly used areas. The City of Sheridan, with assistance from SCCD, implemented a storm drain stenciling program to educate residents about dumping materials into City storm drains. Additional public information and education efforts for the Goose Creek watershed have included:

- Development of a watershed logo by a local student
- Distribution of a booklet summarizing watershed issues to ~2300 residents
- Distribution of annual watershed newsletters to ~9500 residents
- Distribution of a Goose Creek Watershed Social Indicators Survey to ~1525 households
- Creation of an informational stormwater display for use at public events

- Workshops on pathogens, animal feeding operations, and septic systems
- Various news stories in the local paper, radio stations, and television broadcasts

Despite efforts to increase awareness and installation of improvement projects, levels of bacteria within the Goose Creek watershed continue to exceed water quality standards. In the summer of 2008, WDEQ decided to move forward with the development of a TMDL on the Goose Creek watershed, which was completed in September of 2010 (SWCA, 2010).

2.3 Project Purpose and Objectives

The purpose of this project was to continue interim monitoring as identified in the Goose Creek Watershed Improvement Effort Implementation Strategy (SCCD, 2012), which was developed by the local steering committee to address recommendations in the Goose Creek Watershed TMDL (SWCA, 2010). The 2021 monitoring is within a three-year monitoring rotation currently conducted by SCCD on the Tongue River, Goose Creek, and Prairie Dog Creek watersheds and is funded through the Sheridan County Watershed Improvements #5 Project funded by WDEQ through Section 319 of the Clean Water Act.

The project was consistent with the goals and overarching principles outlined in the Wyoming Nonpoint Source Management Plan Update (WDEQ, 2013). The monitoring is part of a locally led collaborative process that includes information and education programs and project implementation through the organization and facilitation of local stakeholder groups. The specific objectives of this project were to use water quality monitoring information to:

- Identify and prioritize areas affected by nonpoint source pollution and
- Evaluate effectiveness of implementation of improvement projects and other activities

CHAPTER 3 HISTORICAL AND CURRENT DATA

Historical data, for the purposes of this project, are defined as data greater than five years old from the start of the 2001-2002 Assessment. These historical data were previously summarized in the *Goose Creek Watershed Assessment 2001-2002 Final Report* (SCCD, 2003). The Final Report included a comprehensive compilation of known water quality data for the watershed and contained historical and current data through 2002. Data collected by SCCD, government agencies, and various other sources were provided in tabular form in the appendices of the 2001-2002 Final Report. This data is not repeated in this document.

In the past, the United States Geological Survey (USGS) has collected water quality and hydrologic information from various locations in the Goose Creek watershed; however, most of these stations have been discontinued due to funding availability. Station 06305700 (Goose Creek near Acme) continues to collect flow data; Station 06305700 and Station 06302000 (Big Goose Creek near Sheridan) have historical discharge data available (Table 3-1).

The State Engineer's Office collects hydrologic information from Station 06301850 (Big Goose Creek above P.K. Ditch) and Station 06303500 (Little Goose Creek in Canyon near Big Horn), as well as from the two USGS stations listed above. SCCD uses hydrological measurements from these stations to compare to hydrographs developed for GC01 and BG18.

Table 3-1. USGS and SEO stations in the Goose Creek watershed (2018-2021)

Station ID	Location Relative to Site	Data Available	
		SEO	USGS
06301850 Big Goose Creek above P.K. Ditch	Approx. 0.5 miles upstream of BG18	Discharge Gauge height	None
06302000 Big Goose Creek near Sheridan	Approx. 100 ft. downstream of BG18	None	Historical discharge
06303500 Little Goose Creek in Canyon near Big Horn	Approx. 1 mile upstream of LG22	Discharge Gauge height	None
06305700 Goose Creek near Acme	Approx. 1200 ft. downstream of GC01	Discharge Gauge height	Discharge (Current and historical) Gauge height

CHAPTER 4 MONITORING DESIGN

4.1 Key Project Personnel and Responsibilities

This project involved various individuals from the SCCD, NRCS, WDEQ, and others (Table 4-1). The District Manager provided project oversight and assisted with field monitoring and data and reporting review. The Program Specialist supervised field monitoring and was responsible for the implementation of the Quality Assurance/Quality Control (QA/QC) procedures and report development. The seasonal intern and NRCS personnel assisted with the project as needed. WDEQ provided oversight as well as administration of the funds provided through Section 319 of the Clean Water Act. Stakeholders and landowners provided site access for sampling and other information.

Table 4-1. Key personnel and organizations involved

Personnel/Organization	Project Role
Carrie Rogaczewski, District Manager	Project oversight; assistance with field monitoring; QA/QC oversight; reporting review
Jackie Turner, Program Specialist	Field monitoring; data collection and validation; QA/QC protocols, and reporting
Maggie DeFosse, Watershed Intern	Assisted with site set-up, field monitoring and data entry
NRCS Sheridan Field Office Staff	Field monitoring assistance
SCCD Board of Supervisors	Project review; field monitoring assistance
WY Department of Environmental Quality	Project review; QA/QC review; field audits; funding administration
Pace Analytical	Laboratory analyses of water quality samples
Aquatic Assessments, Inc.	Macroinvertebrate sample sorting and midge identification; macroinvertebrate data interpretation
Aquatic Biology Associates	Macroinvertebrate sample identification and analyses
Landowners/ Steering Committee	Project and data review; sampling access

4.2 Monitoring Parameters

Water quality parameters monitored in 2021 included water temperature, pH, conductivity, dissolved oxygen, discharge, turbidity, and *E. coli*. Monitoring was performed at 17 sites including three sites on Goose Creek, four sites on Big Goose Creek, four sites on Little Goose Creek, and six tributary sites (Appendix A). Samples were collected five times in May-July and five times in July-September. Continuous data loggers recorded water temperature at seven mainstem sites at 15-minute intervals. Macroinvertebrate sampling and habitat assessments were performed at eight mainstem sites in September.

4.3 Sampling and Analysis Methods

Water quality samples, discharge measurements, macroinvertebrate sampling, and habitat assessments were performed according to the methods described in the Sampling Analysis Plan (SCCD, 2021) and the Quality Assurance Project Plan, 2018 Update (SCCD, 2018). These documents were developed according to the WDEQ Manual of Standard Operating Procedures for Sample Collection and Analysis (WDEQ/WQD, 2021a) and accepted analytical methods (Table 4-2). Samples were obtained from representative sample riffles.

Table 4-2. Standard field and laboratory methods applicable to 2021 monitoring

Parameter	Sample Method / SOP *	Reporting Units	Analytical Method	Preservative	Holding Time	Reporting Limit
Temperature, Water (Instantaneous)	See SOP for *Temperature, Water*	°C	SM 2550-B	Measured *in situ*	NA	0° to 100 °C 0.1 °C
Temperature, Water (Continuous)	See SOP for *Temperature Logger Calibration and Placement - Wadeable Streams and Rivers*	°C	SM 2550-B	Measured *in situ*	NA	-20° to 70°C 0.14°C (at 25°C)
pH	See SOP for *pH*	SU	SM 4500-H+B	Measured *in situ*	NA	0.0-14.0 ± 0.01
Conductivity	See SOP for *Conductance, Specific (Conductivity)*	µS/cm	SM 2510-B	Measured *in situ*	NA	0-1999 µS/cm ± 0.10
Dissolved Oxygen (Probe)	See SOP for *Dissolved Oxygen (DO)*	mg/L; % saturation	ASTM D 885-05 / SM 4500-O-G / EPA 360.1	Measured *in situ*	NA	0-50 mg/L ± 0.01
Escherichia coli (E. coli) Bacteria	See SOP for *Coliform Bacteria Sampling Procedure*	MPN/100 mL	SM 9223-B Pace Analytical	Iced to ≤ 10°C	8 hours	1 MPN/100 mL
Turbidity	See SOP for *Turbidity*	NTU	SM 2130-B Pace Analytical	Iced to ≤ 6°C	48 hours	± 0.10
Stage height	See SOP for Calibrated Staff Gauge	cfs	See SOP for *Stream Discharge - Wadeable Streams and Rivers*	None, FM	NA	NA
Discharge	See SOP for *Stream Discharge - Wadeable Streams and Rivers*	cfs	See SOP for *Stream Discharge - Wadeable Streams and Rivers*	None, FM	NA	0.01
Macroinvertebrates	See SOP for *Macroinvertebrate Sampling – Targeted Riffle/ Macroinvertebrate Sampling –Depths Up to 1.5 Feet*	Metrics	Targeted Riffle Method (King, K.W., 1993)	99% Ethyl Alcohol; see SOP for *Macro-invertebrate Sample Preservation*	Indefinite	NA

* Data collection methods typically follow referenced standard operating procedures; however, modifications may be made on a case-by-case basis. Modifications to the method will be documented either in the SAP or within the Methods section of publications presenting the data.
Abbreviations: SOP - Standard Operating Procedure (unless otherwise stated all SOPs can be found in WDEQ/WQD 2021a); SM – Standard Methods; NA – Not Applicable; FM – Field Measurement; MPN – Most Probable Number.

Sample sites were equipped with a staff gauge for flow estimation. During site reconnaissance, staff gauges were inspected, surveyed, and replaced if needed. Upon installation and inspection, gauges were surveyed and compared with a permanent benchmark. Staff gauge calibrations were performed by measuring instantaneous discharge with a Marsh-McBirney 2000 current meter using the mid-section method (WDEQ/WQD, 2021a). The resulting stage-discharge relationships were used to estimate flow during sampling events.

Grab samples for *E. coli* and turbidity were collected within two separate 60-day periods in May-July and July-September. Gauge height, pH, conductivity, dissolved oxygen, and instantaneous water temperature were also measured during these sampling events. Continuous temperature data were collected by securing data loggers to the staff gauges and downloading the recorded information.

Sample containers for bacteria and turbidity were provided by the contract laboratory and left unopened until sample collection. The bacteria containers were sealed, clear, cylindrical, IDEXX bottles that contained the sample preservative. The turbidity containers were 125 mL plastic, opaque bottles. Bacteria and turbidity containers had blank labels, which were completed in the field. Containers for macroinvertebrate samplers were 32 ounce, pre-cleaned, HDPE wide mouth bottles. Labels were completed and affixed in the field with packing tape.

Turbidity and *E. coli* samples were hand delivered to Pace Analytical in Sheridan, Wyoming for analysis. Macroinvertebrate samples were sorted by Aquatic Assessments, Inc. (AA) in Sheridan, Wyoming and analyzed by Aquatic Biology Associates, Inc. (ABA) in Corvallis, Oregon.

4.4 Site Descriptions

Sites were selected based on a review of the historical data, historical SCCD sampling sites, availability, and access (Table 4-3). All sites chosen for this project were previously used in the 2007-2008 assessment and/or in subsequent monitoring years. During the initial site reconnaissance and site set-up, SCCD identified land uses and other site characteristics. Considerations for site selection included the ability to reveal types and regions of non-point source pollution at a level that would optimize landowner participation in the watershed planning process and would allow SCCD to direct remediation assistance in the most cost-effective and environmentally sound ways.

Historically, SCCD requested and documented verbal permission to collect water quality samples and publish the data in a report. On July 1, 2012, changes to the Wyoming Public Records Act (W.S. 16-4-291 through 16-4-205) required written permission to release any information collected on agricultural operations. In addition, Wyoming Statute W.S. 6-3-414 through the 2015 Enrolled Act #61 requires written permission to access for the purpose of collecting data. Signed consent forms were maintained for all sample sites; all sites were accessed using public highways/roads or private driveways/parking areas where consent forms had been received.

Table 4-3. Goose Creek watershed sample site descriptions

Site	Sample Site Description	Latitude Longitude	HUC12	Elev. (feet)	Land Use(s)	Land Ownership
Water Quality Sites						
GC01	On Goose Creek approximately 75 yards downstream of HWY 339 bridge crossing near USGS Station 06305700	44° 52.974' N 106° 59.262'W	100901010109 Soldier Creek-Goose Creek	3,660	Wildlife habitat, cattle grazing, and irrigated haylands. A few residences, small subdivisions, and the City of Sheridan upstream. Railroad and HWY 338 run parallel to creek on east side.	Private
GC02	On Goose Creek approximately 20 yards downstream of walking bridge.	44° 49.315' N 106° 57.589'W	100901010109 Soldier Creek-Goose Creek	3,700	Located in a city park/natural area, downstream of a commercial/industrial area and Sheridan WWTP. A concrete plant with settling ponds is located to the east.	City of Sheridan
GC-SC01	On Soldier Creek approximately 10 yards downstream from Dana Avenue bridge.	44° 49.186' N 106° 57.749'W	100901010109 Soldier Creek-Goose Creek	3,705	In the Downer Addition in the City of Sheridan. Rural properties upstream.	City of Sheridan
GC05	On Goose Creek approximately 10 yards downstream of 11th St. bridge	44° 48.498' N 106° 57.374'W	100901010109 Soldier Creek-Goose Creek	3,710	Urban, residential, and recreational. Adjacent to Thorne Rider Park.	City of Sheridan
BG01	On Big Goose Creek off the bike path near Senior Center that is across from the YMCA upstream of the confluence	44° 48.176' N 106° 57.681'W	100901010108 Lower Big Goose Creek	3,735	Urban/residential. Adjacent to hill side below Sheridan Junior High School.	City of Sheridan
BG-BC01	Beaver Creek above the confluence with Big Goose Creek near County Road 87 (Beaver Creek Road)	44°45.583'N 107°04.451'W	100901010108 Lower Big Goose Creek	3,955	Rural residential, wildlife habitat, horse and cattle grazing, and irrigated haylands.	Private
BG10	On Big Goose Creek approximately 40 yards upstream from the County Road 87 bridge crossing	44° 45.611' N 107° 04.490'W	100901010108 Lower Big Goose Creek	3,955	Rural residential, wildlife habitat, horse, and cattle grazing, and irrigated haylands.	Private
BG14	On Big Goose Creek approximately 100 yards upstream of the Big Goose Road bridge crossing	44° 44.585' N 107° 07.845'W	100901010104 Upper Big Goose Creek	4,060	Rural residential, wildlife habitat, cattle grazing, and irrigated haylands. An animal feeding operation is to the northwest.	Private
BG-RC01	On Rapid Creek approximately 25 yards downstream of the County Road crossing	44° 43.492' N 107° 08.431'W	100901010104 Upper Big Goose Creek	4,160	Horse and cattle grazing, irrigated haylands, and wildlife habitat.	Private

Table 4-3. Goose Creek watershed sample site descriptions (cont.)

Site	Sample Site Description	Latitude Longitude	HUC12	Elev. (feet)	Land Use(s)	Land Ownership
Water Quality Sites						
BG18	On Big Goose Creek near the mouth of Big Goose Canyon at USGS Station No. 06302000	44° 42.131' N 107° 10.927'W	100901010104 Upper Big Goose Creek	4,505	Primarily wildlife habitat. Cattle and horse grazing. The BNF boundary is about 1 mile upstream.	Private
LG02	On Little Goose Creek approximately 30 yards upstream from the concrete flood channel in downtown Sheridan	44° 48.093' N 106° 57.147'W	100901010107 Lower Little Goose Creek	3,725	Urban – mostly business with some light industrial and residential areas. Railroad tracks are adjacent to the east bank.	City of Sheridan
LG08	On Little Goose Creek approximately ¼ mile downstream from McCormick Creek	44° 43.181' N 106° 57.062'W	100901010107 Lower Little Goose Creek	3,895	Small acreage properties with livestock grazing, wildlife habitat, and irrigated haylands.	Private
LG-MCC01	On McCormick Creek approximately 20 yards upstream from the confluence	44° 43.086' N 106° 57.258'W	100901010107 Lower Little Goose Creek	3,905	Small acreage properties with cattle grazing, wildlife habitat, and irrigated haylands.	Private
LG-KC01	On Kruse Creek approximately 100 yards upstream from the confluence	44° 42.613' N 106° 57.441'W	100901010107 Lower Little Goose Creek	3,915	Small acreage properties with cattle grazing and irrigated haylands.	Private
LG13	On Little Goose Creek approximately 10 yards upstream from the bridge crossing at Knode Ranch subdivision	44° 42.152' N 106° 58.104'W	100901010106 Middle Little Goose Creek	3,940	Large subdivisions with small acreage lots, wildlife habitat, and haylands.	Private
LG-JC01	On Jackson Creek approximately 20 yards upstream from the confluence	44° 41.348' N 106° 59.147'W	100901010106 Middle Little Goose Creek	4,020	Small acreage properties with cattle grazing and irrigated haylands.	Private
LG22	On Little Goose Creek downstream of County Road 77 bridge crossing at USGS Station No. 06303700.	44° 37.253' N 107° 02.267'W	100901010106 Middle Little Goose Creek	4,533	Ranch buildings, cattle grazing, and wildlife habitat. BNF boundary is approximately 3 miles upstream.	Private

Table 4-3. Goose Creek watershed sample site descriptions (cont.)

Site	Sample Site Description	Latitude Longitude	HUC12	Elev. (feet)	Land Use(s)	Land Ownership
Benthic Macroinvertebrate and Habitat Assessment Sites						
GC01	Base of riffle located approximately 300 yards upstream from the HWY 339 bridge	44° 52.974' N 106° 59.262'W	100901010109 Soldier Creek-Goose Creek	3,660	Wildlife habitat and cattle and horse grazing and irrigated haylands. A few residences.	City of Sheridan
GC02	Riffle is located about 150 yards upstream of walking bridge.	44° 49.315' N 106° 57.589'W	100901010109 Soldier Creek-Goose Creek	3,700	Located in a city park/natural area, downstream of a commercial/industrial area and Sheridan WWTP. A concrete plant with settling ponds is located to the east.	City of Sheridan
BG02	Located at first riffle upstream from the footbridge at Works and Elk Street	44° 47.783' N 106° 58.235'W	100901010108 Lower Big Goose Creek	3,745	Predominantly urban / residential.	City of Sheridan
BG10	Located at riffle near first bend upstream from County Road 87 bridge crossing	44° 45.611' N 107° 04.490'W	100901010108 Lower Big Goose Creek	3,955	Rural residential, wildlife habitat, cattle grazing, and irrigated haylands.	Private
BG18	Located at riffle upstream of old USGS gauge station	44° 42.131' N 107° 10.927'W	100901010104 Upper Big Goose Creek	4,505	Primarily wildlife habitat. Cattle and horse grazing.	Private
LG2A	Riffle is located near first bend downstream (100-150 yards) from Coffeen Avenue bridge crossing	44° 47.188' N 106° 56.490'W	100901010107 Lower Little Goose Creek	3,750	Predominantly urban/residential.	City of Sheridan
LG10	Located at first riffle below the Kruse Creek confluence	44° 42.737' N 106° 57.488'W	100901010107 Lower Little Goose Creek	3,915	Small acreage properties with cattle grazing, wildlife habitat, and irrigated haylands.	Private
LG22	Riffle is located just upstream of County Road 77 bridge crossing	44° 37.253' N 107° 02.267'W	100901010106 Middle Little Goose Creek	4,533	Ranch buildings, cattle grazing, and wildlife habitat.	Private

4.5 Monitoring Schedule

The 2021 monitoring schedule included sampling to determine the geometric means of *E. coli*, based on five samples collected within a 60-day period in May-July and five samples collected within a 60-day period in July-September (Table 4-4). A total of ten water quality samples were collected at each site.

Sample dates were chosen at random from Monday-Thursday due to lab availability and sampling holding times. Continuous temperature data loggers were deployed to measure instream temperatures from May 14 through October 7 and 8. Macroinvertebrate collections and habitat assessments were completed in October.

Table 4-4. Sample schedule for 2021 Goose Creek watershed interim monitoring

Date(s)	Sites	Parameters
May-October	GC01, BG01, BG10, BG18, LG02, LG08, LG22	Continuous Temperature
May 13th	GC01, GC02, GC-SC01, GC05, BG01, BG-BC01, BG10, BG14, BG-RC01, BG18, LG02, LG08, LG-McC01, LG-KC01, LG13, LG-JC01, LG22	Instantaneous temperature, pH, Conductivity, Dissolved Oxygen, Stage Height/Discharge, Turbidity, and *E. coli*
May 26th		
June 7th		
June 22nd		
July 7th		
July 20th	GC01, GC02, GC-SC01, GC05, BG01, BG-BC01, BG10, BG14, BG-RC01, BG18, LG02, LG08, LG-McC01, LG-KC01, LG13, LG-JC01, LG22	Instantaneous temperature, pH, Conductivity, Dissolved Oxygen, Stage Height/Discharge, Turbidity, and *E. coli*
August 2nd		
August 19th		
September 1st		
September 14th		
September-October	GC01, GC02, BG02, BG10, BG18, LG02A, LG10, LG22	Macroinvertebrates, Habitat, Photo

CHAPTER 5 QUALITY ASSURANCE/QUALITY CONTROL

5.1 Function of Quality Assurance and Quality Control

Quality Assurance (QA) may be defined as an integrated system of management procedures designed to evaluate the quality of data and to verify that the quality control system is operating within acceptable limits (Friendmann, L.C. & Erdmann, D.E., 1982; USEPA, 1995). Quality control (QC) may be defined as the system of technical procedures designed to ensure the integrity of data by adhering to proper field sample collection methods, operation and maintenance of equipment and instruments. Together, QA/QC functions to ensure that all data generated are consistent, valid and of known quality (USEPA, 1980). QA/QC should not be viewed as an obscure notion to be tolerated by monitoring and assessment personnel, but as a critical, deeply ingrained concept followed through each step of the monitoring process. Data quality must be assured before the results can be accepted with any scientific study. Project QA/QC is fully described in the SCCD QAPP (SCCD, 2018) and the project SAP (SCCD, 2021).

5.2 Sampling Personnel and Qualifications

Water quality monitoring, data management, and reporting were performed by SCCD personnel with the appropriate training and qualifications to implement the project (Table 5-1). SCCD NRCS Sheridan field office staff assisted with site set-up, surveys, discharge measurements, water quality monitoring, and macroinvertebrate collection when needed. During monitoring activities, SCCD personnel collected the samples/measurements, while other staff recorded the information on the appropriate data sheets. Assisting personnel were under the direct supervision of SCCD staff. The SAP defined all necessary field protocols and was available to the sampling team for every sampling event.

Table 5-1. SCCD sampling personnel and qualifications

Personnel	Qualifications
Carrie Rogaczewski District Manager	M.S. University of Wyoming in Rangeland Ecology and Watershed Management with an emphasis in Water Resources; BKS Environmental; 20+ years of experience with the SCCD; WACD Water Quality training
Jackie Turner Program Specialist	B.S. University of Wyoming in Geography and Environment and Natural Resources with a Journalism Minor; Natural Resource Management and GIS Concentrations; WACD Water Quality training; 4+ years of experience with SCCD

5.3 Sample Collection, Preservation, Analysis, and Custody

Accepted referenced methods for the collection, preservation and analysis of samples were adhered to as described in the SAP. In addition to field data sheets, samplers carried a field logbook to document conditions, weather, and other information for each sample day and/or site. Calibration logs were completed for each instrument every time a calibration was performed.

Project field measurements were recorded on field data sheets. Water samples requiring laboratory analysis were immediately preserved, placed on ice, and hand delivered to the laboratory. A Chain of Custody (COC) form was prepared and signed by the sampler before samples entered laboratory custody. A laboratory employee would then sign and date the COC form after receiving custody of the samples. After samples changed custody, internal COC procedures were implemented by the laboratory.

Benthic macroinvertebrate samples were preserved in the field, placed in a cooler, and transported to the SCCD office in Sheridan. A project specific macroinvertebrate COC form was completed. After all macroinvertebrate samples were collected, samples and COC forms were hand delivered to the contractor for initial sorting. COC forms were signed by SCCD and the contractor receiving the samples. Sorted samples, COC forms, and lab bench sheets were hand delivered to SCCD and then shipped to the contract laboratory for identification. Upon receipt, the contract laboratory performed a visual check for the number and general condition of samples and signed the COC form. The completed COC form was returned to SCCD.

5.4 Calibration and Operation of Field Equipment

The project SAP outlined requirements for calibration and maintenance of field equipment. On every sampling day, before leaving the office, the pH meter, conductivity meter, and dissolved oxygen were calibrated according to the manufacturer's instructions.

The Hanna 9025 pH meter was calibrated using a two-point calibration method with pH 7.01 and pH 10.01 buffer solutions. The Hanna 9033 specific conductivity meter was calibrated using a 1413 μmhos/cm calibration standard. All calibration solutions were discarded after each use. This process was repeated after sampling as a continuing calibration verification (CCV) check. Pre- and post-sampling calibration results were recorded in the corresponding instruments' calibration logbook.

The YSI Pro20 dissolved oxygen meter membrane cap was replaced the night before each sampling event. The meter was calibrated by inserting the probe into the moist calibration chamber. The barometric pressure on the dissolved oxygen meter was cross referenced to the barometric pressure at the Sheridan County airport to check calibration accuracy before leaving the office. The meter should be recalibrated after every 500-foot change in elevation; this was completed prior to sampling at BG-RC01, LG02, and LG22 each sampling day. Calibration results were recorded in the meter's logbook.

Equipment maintenance, including battery replacement, was performed according to the SAP and manufacturer's instructions. All maintenance activities were documented in the calibration logs.

The Marsh-McBirney flow meter was factory calibrated and did not require field calibration; however, SCCD conducted a zero check at the beginning and end of the field season using a five-gallon plastic bucket of water. Factory calibration of Onset HOBO data loggers, used for continuous temperature monitoring, was checked by performing a crushed-ice test at the beginning and end of the season to validate the loggers' accuracy.

Equipment used for benthic macroinvertebrate sample collection and reach level habitat assessments did not require calibration. Surber sampler nets and other equipment were checked for damage prior to entering the field.

5.5 Summary of QA/QC Results

Data quality objectives (DQOs) are qualitative and quantitative specifications used by water quality monitoring programs to limit data uncertainty to an acceptable level. DQOs were established for each monitoring parameter for precision, accuracy, and completeness at levels sufficient to allow SCCD to realize project goals and objectives (Table 5-2). SCCD evaluated collected data according to the DQOs in the SAP (SCCD, 2021)and WDEQ protocols (WDEQ/WQD, 2021a).

Table 5-2 Data quality objectives

Parameter	Precision (%)[1]	Accuracy (%)[2]	Completeness (%)	Reporting Limit
Temperature (Instantaneous)	10	10	95	0.1°C
Temperature (Continuous)	10	10	95	0.14°C (at 25°c)
pH	± 0.3 SU	5	95	0.01 SU
Conductivity	10	10	95	0.1 µs/cm
Dissolved Oxygen	10	20	95	0.01 mg/L
Turbidity	20	20	95	0.1 NTU
E. coli	50[3]		95	1 MPN/mL
Macroinvertebrates	Total Abundance = ± 50% Total Number of Taxa = ±15%		95	
Total Taxa	15		95	
Habitat Assessment			95	
Intra-Crew	15		10	
Discharge			95	
Stage-Discharge Relationships			95	$r^2 \geq 0.95$

Precision DQOs from WDEQ Quality Assurance Program Plan. Reporting limits from WDEQ Manual of Standard Operating Procedures, except for current laboratory analyzed parameters (turbidity and *E. coli*).

[1] For parameters with reporting limits, see WDEQ Quality Assurance Program Plan for values below 10 times the reporting limit (WDEQ, 2018a).

[2] Accuracy values shown are acceptable departures from 100 percent accuracy. A 10% accuracy value means accuracy values of 90 to 110% are acceptable.

[3]. The Relative Percent Difference (RPD) between Most Probable Number (MPN) duplicate samples should be <50% for MPNs >100. Due to the increased variability for MPNs <100, no RPD limit is required for duplicate pairs in which at least one of the MPNs is below 100.

5.5.1 Comparability

Comparability refers to the degree to which data collected during this project were comparable to data collected during other past or present studies. Current project data must be comparable to future data to detect water quality change with confidence. Recognizing that periodic adjustments to locations, parameters, and/or sampling methods are needed, several steps were taken to assure data comparability including:

- Collection of samples at previously used monitoring stations
- Collection of samples during the same time of year
- Collection of samples using the same field sampling methods and sampling gear
- Analysis of samples using the same laboratory analytical methods and equipment
- Use of the same reporting units and significant figures
- Use of the same data handling and reduction methods (rounding and censoring)
- Use of similar QA/QC processes

Chemical, physical, biological, and habitat data collected during this project were highly comparable because of close coordination prior to initiation of sampling. Where possible, each step identified above was implemented to assure comparability.

Prior to 2014, *E. coli* standards were based on a geometric mean of five samples collected within a 30-day period. SCCD collected water quality parameters on the same schedule as the *E. coli* samples; five sample geometric

means were calculated for all water quality parameters for the 30-day periods. During revisions to water quality standards and methods in 2014, WDEQ changed the basis for the *E. coli* standard to a geometric mean of five or more samples collected within a 60-day period (WDEQ, 2014). As a result, SCCD incorporated 60-day geometric means into future schedules. Comparisons among years are still valuable for evaluating water quality trends; both the 30-day geometric means and the 60-day geometric means capture samples collected during early season (May-July), mid-season (June-August), and late season (July-September) conditions. Arithmetic means are used for all other non-bacteria parameters.

5.5.2 Continuous Temperature Loggers

Onset's HOBO Pendent Temperature Loggers were deployed at GC01, BG01, BG10, BG18, LG02, LG08, and LG22 to record water temperature during the 2021 monitoring project. These loggers are factory calibrated, encapsulated devices that cannot be re-calibrated.

To verify the accuracy of the factory calibration, SCCD performed a crushed-ice test before and after the sampling season. A seven-pound bag of crushed ice was emptied into a 2.5-gallon bucket. Distilled water was added to just below the top level of the ice and the mixture was stirred. The data loggers were submerged in the bath and placed in a refrigerator to minimize temperature gradients. If the ice bath was prepared properly and if the loggers maintained their accuracy, the loggers should record temperatures between 0°C and 0.232°C while in the ice bath. Both pre- and post-season ice bath results were within the manufacturers recommended range (Appendix B).

Onset suggests the loggers should maintain their accuracy unless they have been utilized outside their range of intended use (-20°C to 50°C). None of the loggers were used outside of this range, thus, all temperature loggers used in the 2021 monitoring project were considered to have maintained their accuracy and provided valid water temperature data.

5.5.3 Stage Discharge Relationships

The relationship between stage height and discharge for a given location yields an equation that allows the calculation of discharge at various stage heights recorded on a staff gauge. Stage-discharge relationships were established for all staff gauges installed by SCCD. These relationships were developed by recording the stage height and measuring discharge using the mid-section method (WDEQ/WQD, 2021a) on at least three occasions with varying flow conditions. A correlation coefficient (R^2 value) of at least 0.95 (95%) is desirable for proper gauge calibration (Table 5-3).

Staff gauges installed by SCCD were surveyed against established benchmarks upon installation and at the end of the season. The difference between pre- and post-season survey results were compared to verify gauge stability (Table 5-3). A difference equal to or less than 0.05 is preferred between the pre- and post-season surveys. When the difference is greater, the post-season survey should be repeated, and the stability of the benchmark and gauge should be checked. All staff gauges were considered stable for the 2021 season as all survey differences were below 0.05.

Table 5-3. Summary of 2021 gauge surveys and r^2 values for stage-discharge relationships

Site	Pre-Season Survey	Post-Season Survey	Pre/Post Season Survey Difference	Stage-Discharge Relationship R^2 Value
GC01	1.79	1.76	0.03	0.9991
GC02	8.38	8.39	0.01	0.9999
GC-SC01	7.96	7.95	0.01	0.9987
GC05	1.42	1.37	0.05	0.9998
BG01	9.34	9.30	0.04	0.9999
BG-BC01	8.75	8.71	0.04	0.9573
BG10	7.58	7.54	0.04	0.9999
BG14	4.70	4.70	0.00	0.99997
BG-RC01	6.28	6.28	0.00	0.9972
BG18	2.07	2.05	0.02	0.9961
LG02	2.95	2.98	0.03	0.9850
LG08	0.32	0.32	0.00	0.9670
LG-MCC01	2.08	2.12	0.04	0.9999
LG-KC01	1.46	1.47	0.01	0.9967
LG13	2.80	2.80	0.00	0.9996
LG-JC01	1.16	1.14	0.02	0.9709
LG22	2.65	2.69	0.04	0.9995

5.5.4 Blanks

Trip blanks were prepared to determine whether samples might be contaminated by the sample container, preservative, or during transport and storage conditions. *E. coli* and turbidity trip blanks were prepared for every sampling event. Prior to sampling, the contract laboratory filled sample containers with laboratory de-ionized water and the appropriate preservative. The trip blanks were maintained in the cooler with the collected samples and returned to the laboratory for the analysis. Nine turbidity trip blanks had values at or above 0.1 NTU, however, this data was retained as the values were near the detection limit. No other samples used during the project contained detectable levels of *E. coli* or turbidity (Appendix B).

Field blanks were prepared to determine whether samples might be contaminated by conditions associated with sample collection procedures. *E. coli* and turbidity field blanks were prepared at one site during all sampling days. At the designated site, sample bottles were labeled, rinsed (if turbidity), and filled with de-ionized water provided by the contract laboratory. The bottles were then placed in the cooler and delivered to the contract laboratory with the other samples. No field blanks used during the project contained detectable levels of *E. coli*; all turbidity field blanks had detections ranging from 0.1-0.3 NTU (Appendix B). Because the reported values were at or near the detection limit of 0.1, the data was retained.

5.5.5 Sample Holding Times

All laboratory data sheets were reviewed to ensure all samples were analyzed before their holding times had expired. This review found that all *E. coli* samples were analyzed within their required 8-hour holding time and all turbidity samples were analyzed within the required 48 hour holding time. All water quality field samples were analyzed on-site immediately following sample collection. Benthic macroinvertebrate samples were preserved on-site upon sample collection; there is no holding time for benthic macroinvertebrate samples.

5.5.6 Duplicates

The project SAP specified that duplicate chemical, physical, biological, and habitat samples be obtained for at least 10% of all field samples. Duplicate water quality samples were obtained by collecting consecutive water quality samples from a representative stream riffle. Duplicate macroinvertebrate samples were collected by two field samplers, each equipped with a surber net, collecting samples simultaneously and adjacent to one another. Intra-crew habitat duplicates were conducted simultaneously by each observer performing independent assessments without communication, at the same site and same time. All DQOs for duplicates were met (Table 5-4).

Table 5-4. Summary of 2021 Goose Creek watershed monitoring duplicates

Parameter	No. of samples	No. of Duplicates	% Duplicated	DQO (%)
Water Quality Samples in 2021 (7 sites x 10 samples)	170	20	12%	10%
Macroinvertebrate Samples in 2021	8	1	12.5%	10%
Habitat Assessments in 2021	8	1	12.5%	10%

5.5.7 Precision

Precision was defined as the degree of agreement of a measured value as the result of repeated application under the same condition. The Relative Percent Difference (RPD) statistic was used because the determination of precision is affected by changes in relative concentration for certain chemical parameters. Precision was determined for water quality samples by conducting duplicate samples at 10 percent of the sample sites. RPD is calculated by the formula: RPD = [(A-B) / (A+B)] X 200 where A is the value for duplicate 1 and B is the value for duplicate 2.

All temperature and *E. coli* samples met the appropriate DQOs for precision (Table 5-5). Two pH samples exceeded the DQO, including Dup 02 on May 13 and Dup 01 on June 7. The DQO for Dup 02 conductivity was exceeded on May 26. Dissolved oxygen values, both in mg/L and percent, exceeded the DQO for Dup 02 on August 2. Finally, two turbidity samples, Dup02 on May 13 and September 14, exceeded the DQO. The pH, conductivity, and dissolved oxygen duplicates were near the data quality objective and were accepted. While the turbidity RPD values were quite high, the other duplicates collected on May 13 and September 14 did meet the DQO, therefore those data were retained.

Table 5-5. Precision of 2021 Goose Creek watershed water quality data

Date	Duplicate Sample ID	Site Duplicated	TEMP	pH	COND	DO mg/L	DO %	TURB	*E. coli*
			RPD (%)	RPD (%)	RPD (%)	RPD (%)	RPD (%)	RPD (%)	RPD (%)
WDEQ DQO Relative Percent Difference or Other:			*10*	*±0.3 SU*	*10*	*10*	*10*	*20*	*50 if >100 NA if <100*
05/13/21	Dup 01	GC01	2.0	0.20	1.3	1.1	0.7	0.0	0.0
	Dup 02	LG22	3.6	**0.33**	4.3	1.63	1.1	**161.8**	0.0
05/26/21	Dup 01	SC01	0.0	0.01	3.3	0.11	0.0	0.0	7.5
	Dup 02	LG13	0.0	0.30	**10.8**	1.03	0.9	14.7	49.0
06/07/21	Dup 01	BG01	0.9	**0.41**	1.3	3.1	1.9	5.7	10.6
	Dup 02	LG-MCC01	1.3	0.01	1.5	0.78	0.8	0.0	49.1

Table 5-5. Precision of 2021 Goose Creek watershed water quality data (cont.)

Date	Duplicate Sample ID	Site Duplicated	TEMP	pH	COND	DO mg/L	DO %	TURB	*E. coli*
			RPD (%)	RPD (%)	RPD (%)	RPD (%)	RPD (%)	RPD (%)	RPD (%)
WDEQ DQO Relative Percent Difference or Other:			*10*	*±0.3 SU*	*10*	*10*	*10*	*20*	*50 if >100 NA if <100*
Date	**Duplicate Sample ID**	**Site Duplicated**	**TEMP**	**pH**	**COND**	**DO mg/L**	**DO %**	**TURB**	***E. coli***
06/22/21	Dup 01	BG10	0.6	0.01	0.9	1.7	1.5	6.9	7.8
	Dup 02	LG02	0.5	0.04	0.5	1.10	1.2	11.0	6.0
07/07/21	Dup 01	BG-RC01	0.6	0.01	1.1	1.7	1.4	13.3	45.2
	Dup 02	BG18	0.6	0.07	1.5	1.68	1.7	0.0	6.7
07/20/21	Dup 01	BG10	0.9	0.00	1.5	1.4	1.5	2.1	35.5
	Dup 02	LG02	0.4	0.11	0.3	0.49	0.4	2.4	3.9
08/02/21	Dup 01	BG01	0.5	0.04	0.2	0.1	0.2	15.4	8.3
	Dup 02	LG-MCC01	9.6	0.06	1.2	**19.4**	**18.3**	8.7	34.1
08/19/21	Dup 01	GC-SC01	0.0	0.05	0.4	0.5	0.5	0.0	6.2
	Dup 02	LG13	0.0	0.13	0.0	0.88	0.5	18.2	12.4
09/01/21	Dup 01	GC01	0.0	0.03	0.6	0.1	0.0	2.8	30.9
	Dup 02	LG22	1.4	0.21	0.0	0.54	0.2	4.1	2.5
09/14/21	Dup 01	GC-SC01	0.0	0.00	2.8	3.1	3.3	4.1	11.6
	Dup02	LG13	0.0	0.01	1.0	1.35	1.5	**60.9**	5.7

Bold values do not meet the Data Quality Objective.

Duplicate samples were collected at 11% of the macroinvertebrate and habitat assessment sites. Intra-crew habitat duplicates were conducted simultaneously by each observer at 11% of sites conducting the assessment without communication. The RPD for total macroinvertebrate abundance was 6.4% and the RPD for total taxa was 5.7% during 2021 (Table 5-6). Precision for each parameter was within the established DQO. The RPD for the duplicate intra-crew habitat assessment at station BG02 was 4.1%, which was within the established DQO of 15%.

Table 5-6. Precision of 2021 benthic macroinvertebrate and habitat monitoring data

Parameter	BG02 Duplicate 1	BG02 Duplicate 2	(% - RPD)	DQO (%)
Total Abundance	11,056	11,782	6.4	50
Total Taxa	34	36	5.7	15
Intra-Crew Habitat Assessment Score	125	120	4.1	15

5.5.8 Accuracy

Accuracy is the degree of agreement of a measured value with the true or actual value. For water quality parameters measured in the field, accuracy was assured by calibration of equipment to known standards. Conductivity and pH meters were calibrated on the morning of every sampling event. The dissolved oxygen meter was calibrated prior to each sampling event and re-calibrated with every 500-foot change in elevation. A crushed ice test was used to verify the accuracy of the continuous temperature data loggers. Proficiency tests are run twice annually by Pace Analytical for *E. coli* and turbidity. Accuracy cannot be determined for

macroinvertebrate samples or habitat assessments because the true or actual values are unknown, therefore precision served as the primary QA check for these parameters.

5.5.9 Completeness

Completeness refers to the percentage of measurements determined to be valid and acceptable compared to the number of samples scheduled for collection. This DQO is achieved by avoiding loss of samples due to accidents, inadequate preservation, holding time exceedances, and proper access to sample sites for collection of samples as scheduled. DQOs were met for all parameters (Table 5-7). All scheduled benthic macroinvertebrate samples and habitat assessments were conducted as planned during 2021 resulting in 100% completeness.

Table 5-7. Completeness of 2021 Goose Creek watershed monitoring data

Parameter	# Planned	# Collected	% Completeness	DQO (%)
Water Temperature	170	170	100%	95%
pH	170	170	100%	95%
Conductivity	170	170	100%	95%
Dissolved Oxygen	170	170	100%	95%
Discharge	170	170	100%	95%
Turbidity	170	170	100%	95%
E. coli	170	170	100%	95%
Total Taxa	8	8	100%	95%
Intra-Crew Habitat Assessments	8	8	100%	100%

5.6 Data Validation

Data generated by the contract laboratories was subject to the internal QA/QC procedures before it was released. Data are assumed to be valid because the laboratory adhered to its internal QA/QC plan. Field data generated by SCCD were considered valid and usable only after defined QA/QC procedures and processes were applied, evaluated, and determined acceptable. Questionable data were rechecked by the contract laboratory and either confirmed or corrected. Data determined to be invalid was rejected and not used in preparation of this report.

Low flow values and lab results reported below the detection limit were to be reported as ½ the detection limit for summary statistics, as specified in the SAP for this project (Gilbert, R.O., 1987; SCCD, 2021). There were five instances where *E. coli* results were reported as >2419.6 MPN/100 mL and two instances where results were reported as <1 MPN/100 mL. SCCD used 2420 MPN/100 mL and 1 MPN/100 mL, respectively, for calculation of relative percent difference for precision and for calculation of geometric means and summary statistics.

5.7 Documentation and Records

All water quality field data were recorded on data sheets prepared for the appropriate waterbody and monitoring station. After each sampling day, water quality field data sheets were copied and maintained in a binder. Macroinvertebrate and habitat assessment data were recorded onto data sheets similar in format to those used by WDEQ in the past. WDEQ now uses a more comprehensive protocol for macroinvertebrate and habitat assessments, but SCCD has continued with their existing data sheets for consistency and simplicity. Field sheets are scanned and filed electronically after the monitoring season has ended. Equipment checklists, COC forms,

and calibration logs were documented on the appropriate forms and are maintained on file and/or electronically in the SCCD office. Photographs and photograph descriptions were organized by station and are stored electronically in the SCCD office.

Water quality and supporting QA/QC data were received electronically from the contract laboratory. Printed hard copies are maintained on file in the SCCD office. Macroinvertebrate sample results were received from the contract laboratory electronically and printed. All electronic data are maintained in a database on the SCCD server in Sheridan, Wyoming.

5.8 Database Construction and Data Reduction

The project database consists of a series of Excel© spreadsheets and computer files. Each project database was constructed with reportable data (accepted after QA/QC checks) by inputting into Microsoft Excel© spreadsheets. Electronic files for water quality, discharge, continuous water temperature, macroinvertebrate, and habitat data were constructed. All computer data entries were checked for possible mistakes made during data entry. If a mistake was suspected, the original field or laboratory data sheet was re-examined, and the data entry corrected. SCCD also maintains a Microsoft Access© database for all reportable water quality data collected by SCCD; validated data are copied into the Access© database and are considered provisional until approved by WDEQ.

After data validation and database construction, data were statistically summarized for several calculations (Appendix C) including the following: Number of samples, maximum, minimum, median, mean, geometric mean, and coefficient of variation.

These statistics and analyses provided insight for temporal and spatial water quality changes within the watershed. Microsoft Excel© was used to generate the statistical tables, geometric means, and graphics for this report. Arithmetic means were calculated for all water quality parameters except for *E. coli* using the ten sampling dates and then separately for the five samples collected during the early, mid, and late seasons. Geometric means were calculated for *E. coli* for the same time periods. Summary statistics did not include discarded data or instances where the staff gauge was submerged or unreadable.

5.9 Data Reconciliation

Data collected by SCCD were evaluated before being accepted and recorded into the project database. Obvious outliers were flagged after consideration of expected values based upon evaluation of historical and current data. Field data sheets were re-checked and if no calibration or field note anomalies were identified, the data were accepted as presented. Otherwise, data were discarded and noted as such in the data validation log.

5.10 Data Reporting

Data collected by SCCD for this project are presented in tabular, narrative, and graphical formats throughout this report. This report will be submitted to WDEQ, and other interested parties as requested. Copies of this report will be available through the SCCD office. Compact disks containing the Microsoft Excel®, Microsoft Word®, Adobe Reader X®, and Arc Map 10® files used to construct this document can be produced upon request.

In addition to this report, the SCCD will submit a separate data package to WDEQ. The complete data package will include copies of all field and laboratory data sheets, field and equipment calibration logs, survey notes, and QA/QC documentation. Other information may be submitted as requested by WDEQ.

CHAPTER 6 DISCUSSION OF RESULTS

6.1 Water Quality Standards

Wyoming's surface waters are protected through application of numeric and narrative (descriptive) water quality standards (WDEQ, 2018b). The applicable water quality standards and other recommendations were used in interpretation of results and included in this report (Table 6-1).

Table 6-1. Numeric and narrative water quality standards for Wyoming surface waters applicable to waters in the Goose Creek watershed (WDEQ, 2018b)

NUMERIC STANDARDS FOR NON-PRIORITY POLLUTANTS		
Parameter	**Reference**	**Standard / Description**
Dissolved Oxygen	Chapter 1 Sections 24 and 30 & Appendix D	For Class 1, 2AB, 2B, and 2C waters 1 day minima Early life stages: 5.0 mg/L intergravel concentration 8.0 mg/L water column Other life stages: 4.0 mg/L
E. coli	Chapter 1 Section 27	Geometric mean within a 60 day period shall not exceed 126 organisms per 100 ml for primary contact recreation waters/seasons (May 1-Sept 30) and shall not exceed 630 organisms per 100 ml for secondary contact recreation waters/seasons.
pH	Chapter 1 Sections 21 and 26 & Appendix B	6.5-9.0 standard units
Temperature	Chapter 1 Section 25	Discharge shall not increase temperature by more than 2 degrees F; maximum allowable temperature is 68 degrees F/20 degrees C (cold water fisheries) except on Class 2D, 3 and 4 waters.
Turbidity	Chapter 1 Section 23	For cold water fisheries and drinking water supplies, discharge shall not create increase of 10 NTU's.
NARRATIVE STANDARDS FOR NON-PRIORITY POLLUTANTS		
Settleable Solids	Chapter 1 Section 15	Shall not be present in quantities that could degrade aquatic life habitat, affect public water supplies, agricultural or industrial use, or affect plant and wildlife.
Floating and Suspended Solids	Chapter 1 Section 16	Shall not be present in quantities that could degrade aquatic life habitat, affect public water supplies, agricultural or industrial use, or affect plant and wildlife.
Taste, Odor, Color	Chapter 1 Section 17	Substances shall not be present in quantities that would produce taste, odor, or color in fish flesh, skin, clothing, vessels, structures, or public water supplies.
Macroinvertebrates	Chapter 1 Section 32 Hargett (2011)	Score for Full, Indeterminate, or Partial/Non-Support *Sedimentary Mountains Bioregion: >52.3, 34.8-52.3; <34.8;* *High Valleys Bioregion: >48.8, 32.5-48.8, <32.5;* *Northeast Plains Bioregion: >58.4, 38.9-58.4, <38.9*
ADDITIONAL PARAMETERS AND RECOMMENDED STANDARDS		
Habitat	King (1993); Stribling et al. (2000)	Habitat condition no less than 50 percent of reference; total habitat score >100 to qualify as reference
Specific Conductivity	King (1990)	Concentrations greater than 6900 µmhos/cm may affect aquatic organisms in ponds in NE Wyoming.

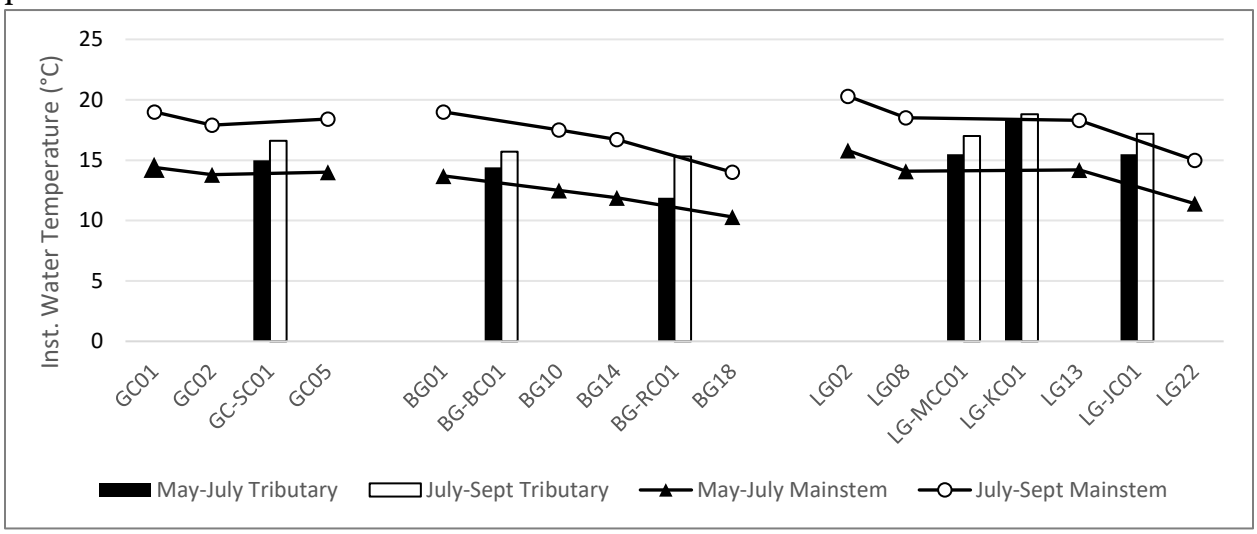
6.2 Field Water Chemistry and Physical Parameters

Water quality data were collected from May 13 through September 14 at 17 sites (Appendix C). Summary statistics were calculated for all instantaneous monitoring parameters on accepted data. Geometric means for three 60-day periods were calculated for bacteria samples; arithmetic means for all other parameters were established for the same 60-day periods as well as for the season. In addition, historical and current hydrological information was used from the USGS and SEO for comparisons with SCCD data.

6.2.1 Instantaneous Water Temperature

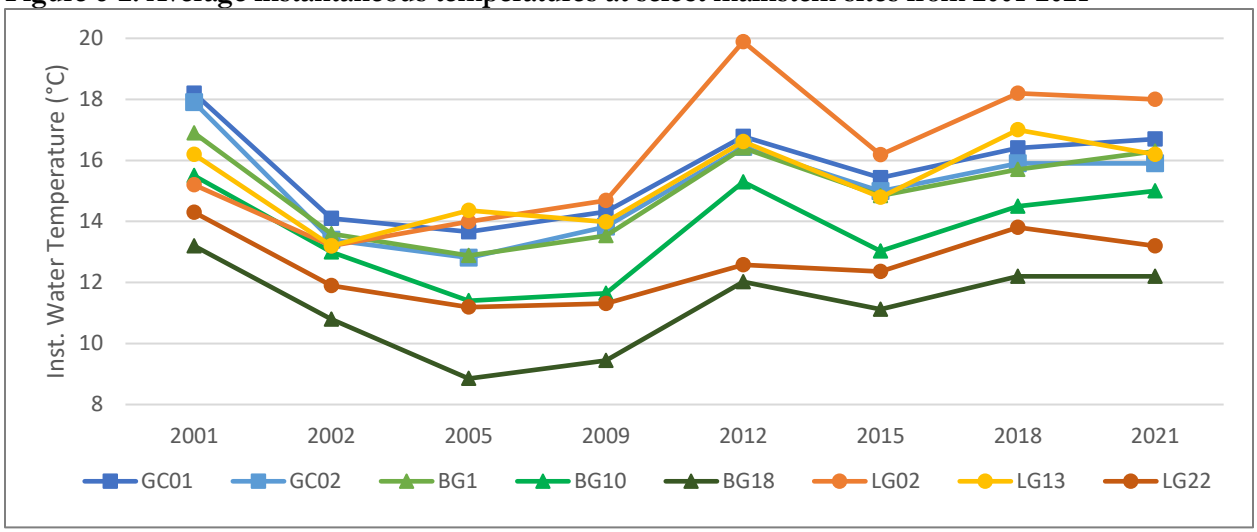
Instantaneous temperature measurements are taken solely at the time of sample collection and were recorded at or above the maximum 20°C instream temperature standard at one site on June 22, ten sites on July 7, 11 sites on July 20, and eight sites on August 2. Early (May-July) and late (July-September) season instantaneous averages were below the 20°C standard at all sites apart from LG02 during the late season (Figure 6-1). Late season average instantaneous water temperatures were higher than early season temperatures at all sites.

Figure 6-1. Average instantaneous water temperature in the Goose Creek watershed by site and sample period



Instantaneous temperature averages were slightly higher at most sites in 2021 than in 2018 apart from the four Little Goose sites (Figure 6-2). The lowest average temperatures were observed in 2002 and 2005, with the highest average temperatures observed in 2001, apart from a few exceptions in 2012, 2018, and 2021. Changes in annual instantaneous temperature averages from years sampled in 2001-2021 ranged from 0.6-6.69°C, with much of the larger fluctuations (±5°C) occurring at sites located in the lower portions of the watershed.

Figure 6-2. Average instantaneous temperatures at select mainstem sites from 2001-2021



6.2.2 Continuous Water Temperature

Continuous temperature data loggers were deployed at one Goose Creek site, three Big Goose Creek sites, and three Little Goose sites. Each site reported temperatures exceeding the standard (20°C) apart from the uppermost canyon sites, BG18 and LG22. Temperatures at GC01, BG01, BG10, and LG02 surpassed the standard in mid-June and continued to do so through August with some exceedances also occurring in early September (Appendix C). The same was observed at LG08 except there were none above 20°C in September.

Temperatures at BG10 were unusually high for six days in July and one day in August, exceeding 30°C. Maximum temperatures at lower sites, like GC01, BG01, and LG02, were all below 25°C during the same time periods. In 2018, temperatures at BG10 in July were between 20-25°C with a few measurements above 25°C. The temperature logger may have been out of water, buried in sand, or located in shallower water during these times. Because there is no way of knowing what caused the higher-than-normal measurements, all data was retained in the temperature chart (Appendix C), but statistical calculations were not completed for BG10. The highest continuous water temperature was recorded on July 21 at LG02; the lowest was at LG22 on May 22 (Table 6-2).

Table 6-2. Daily maximum, minimum, and average continuous temperatures at mainstem sites

Site	Max. Temp. (°C)		Min. Temp. (°C)		Seasonal Average Temp (°C)	# Of Days Daily Max Temp >20°C
	Temp.	Date	Temp.	Date		
GC01	29.3	7/27	5.5	5/22	18.6	78
BG01	28.5	7/27	4.3	5/22	17.6	51
BG10						
BG18	19.6	7/21	3.4	5/22	12.4	0
LG02	29.4	7/21	5.0	5/22	17.7	75
LG08	24.8	7/21	4.4	5/22	16.6	58
LG22	18.0	7/31	2.6	5/22	12.1	0

Daily average temperatures at GC01 were like those in 2012, 2015, and 2018 with some exceptions (Appendix C). Averages were lower at the start of the season and for a few periods in August and September than in past years. Temperatures at GC01 exceeded the standard briefly in mid-June where they typically have not in past years.

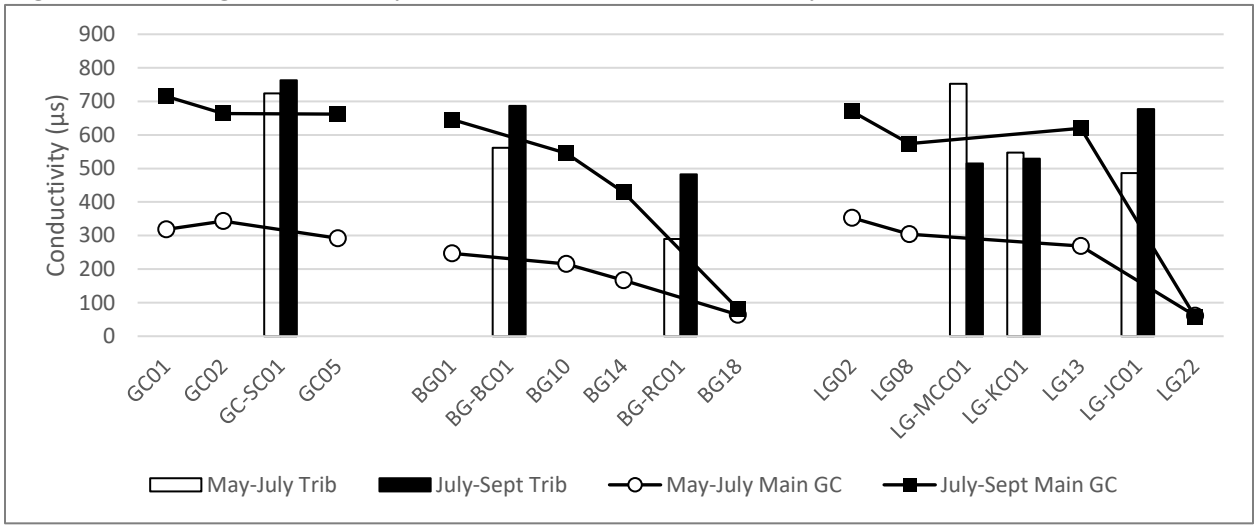
6.2.3 pH

Ranging from 7.08 SU at BG18 to 8.97 SU at Jenks Creek, all pH measurements were within the Wyoming water quality standard of 6.5-9.0 SU. Average seasonal pH at all sites ranged from 7.9-8.5 SU. Most sites had a higher average pH during the early season (May-July) than the late season (July-September). Overall, average pH values have remained relatively consistent since sampling began in the Goose Creek watershed, ranging from 7.7-8.9 SU.

6.2.4 Conductivity

Overall, average conductivity decreased from upstream to downstream in the Goose Creek watershed in 2021 (Figure 6-3). Conductivity was lower in the early season than in the late season at all mainstem and tributary sites apart from tributaries McCormick Creek and Kruse Creek. The highest conductivity measurements were taken at Soldier Creek (1031 µs/cm on 8/19) and at McCormick Creek (1331 µs/cm on 5/13 and 1127 µs/cm on 5/26). There were no other measurements over 1000 µs/cm.

Figure 6-3. Average conductivity in the Goose Creek watershed by site and sample period



There is no standard for specific conductivity in the state of Wyoming; however, because conductivity is highly dependent on the number of dissolved solids, high values could be a concern for agricultural operations related to crop and/or hay production. Quality standards are established for Wyoming groundwater such that concentrations of total dissolved solids (TDS) for domestic, agricultural, or livestock use shall not exceed 500 mg/L, 2000 mg/L, or 5000 mg/L, respectively (WDEQ, 2018c). Conductivity is not directly proportional to the TDS concentration, but it can be used to estimate the relative concentration of TDS.

Conductivity values were relatively consistent among years at most sites. Early season averages were generally lower than late season averages with some exceptions (Table 6-3). The lowermost sites, and some tributaries, tend to have the highest conductivity averages, whereas the canyon sites have the lowest averages.

Table 6-3. Average conductivity in the Goose Creek watershed from 2005-2021

Site	May-July						Site	July-September					
	2005 *	2009 *	2012 *	2015	2018	2021		2005 *	2009 *	2012 *	2015	2018	2021
GC01	338	260	423	294	372	318	**GC01**	682	580	778	745	657	715
GC02	334	249	395	277	347	343	**GC02**	649	540	713	705	618	664
Soldier	821	694	547	608	596	724	**Soldier**	640	602	657	817	575	763
GC05						292	**GC05**						662
BG01/02	282	198	273	203	261	247	**BG01/02**	680	492	727	773	608	646
Beaver	709	568	673		424	562	**Beaver**	617	571	803		732	687
BG10	203	134	192	134	189	215	**BG10**	681	407	737	675	444	545
BG14			143	105	158	167	**BG14**			752	603	358	429
Rapid	237	244	273	207	185	290	**Rapid**	493	438	473	521	384	482
BG18	71	63	60	55	53	64	**BG18**	102	81	81	86	77	82
LG02	313	244	536	282	444	353	**LG02**	594	535	696	634	599	670
LG08	234	190	421	217	344	304	**LG08**	515	512	630	555	509	574
McCormick	1105	938	568	1205	1266	752	**McCormick**	583	668	783	857	701	515
Kruse	607	643	631	572	474	547	**Kruse**	436	440	545	555	469	529
LG13	192	166	347	188	303	269	**LG13**	449	410	584	484	456	620
Jackson	537	539	575	584	566	486	**Jackson**	603	571	712	678	587	677
LG22	72	60	58	60	65	61	**LG22**	63	60	58	72	65	58

*2005, 2009, and 2012 are 30-day averages, whereas all other years are 60-day averages.

6.2.5 Dissolved Oxygen

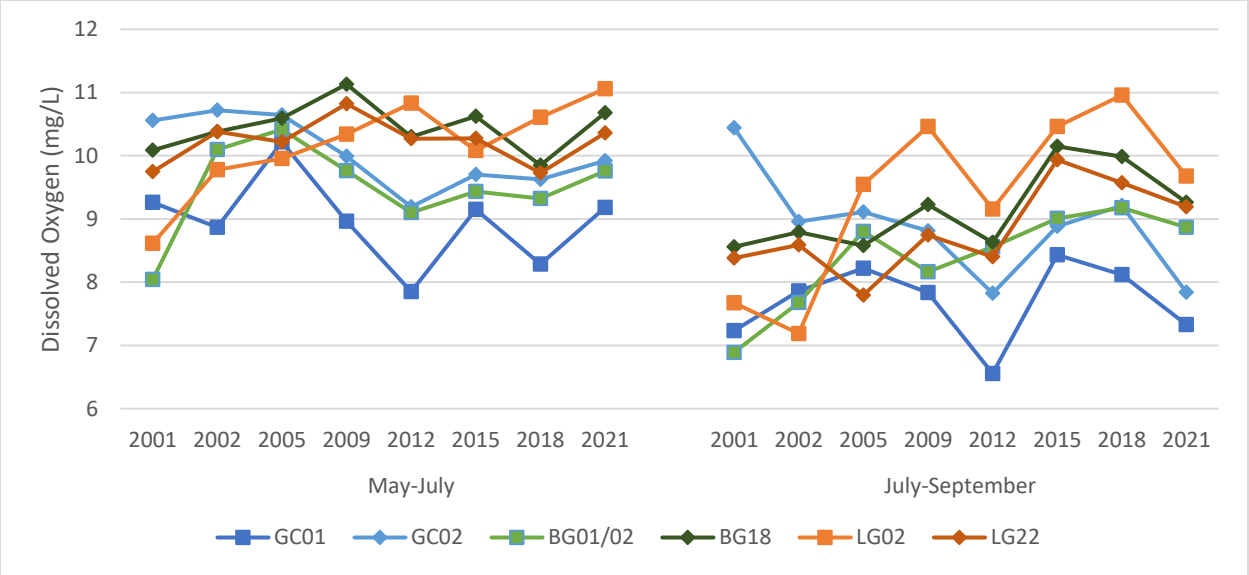
All sites met the minimum instantaneous dissolved oxygen concentration standard of 4.0 mg/L for other life stages and 5.0 mg/L for early life stages. Nine mainstem samples were below the 8.0 mg/L recommended to achieve 5.0 mg/L intergravel concentrations for early life stages, including six at GC01 and three at GC02 (Table 6-4). Six tributary samples were below 8.0 mg/L, including four at Soldier Creek and two at McCormick Creek. Most of the samples that were below the recommendation were taken in July and August. All other samples at mainstem and tributary sites were above the recommended 8.0 mg/L. Overall, dissolved oxygen concentrations ranged from 6.24 at GC01 to 12.99 at LG02.

Table 6-4. Dissolved oxygen ranges and number of samples below 8.0 mg/L in 2021

Site	Samples below 8.0 mg/L	Range (mg/L)	Site	Samples below 8.0 mg/L	Range (mg/L)
GC01	6	6.24-11.31	**BG18**	0	8.95-11.88
GC02	3	7.03-11.72	**LG02**	0	8.12-12.99
Soldier	4	6.25-10.50	**LG08**	0	8.14-11.92
GC05	0	8.13-11.88	**McCormick**	2	7.40-10.72
BG01	0	8.26-10.91	**Kruse**	2	7.94-9.91
Beaver	0	8.47-11.53	**LG13**	0	9.13-12.13
BG10	0	9.06-12.25	**Jackson**	0	8.28-11.71
BG14	0	9.16-12.09	**LG22**	0	8.27-11.76
Rapid	0	8.62-11.22			

Early season and late season averages were above 4.0 mg/L and 5.0 mg/L at all mainstem sites pictured below (Figure 6-4). Generally, early season averages at select mainstem sites were higher than those in 2018. The opposite was true for the late season with averages being lower at select mainstem sites than those in 2018. Early season averages have generally been higher than late season averages. Dissolved oxygen averages at tributaries are more variable among years and sites.

Figure 6-4. Comparisons of early and late season dissolved oxygen averages at select mainstem sites from 2001-2021



6.3 Discharge

SCCD used calibrated staff gauges to estimate discharge during water sampling events (Appendix C). Real-time flow information and historical hydrological information from the USGS was available for Station 06305700 Goose Creek Near Acme (near GC01); historical information from the USGS was available for Station 06302000 Big Goose Creek near Sheridan (near BG18).

The highest instantaneous discharge measurements were recorded on June 7, with a few exceptions. The highest discharge was recorded on May 26 at LG08 and Jackson Creek and on August 2 at McCormick Creek (Figure 6-7). Discharge patterns were similar at all Goose Creek mainstem and tributary sites with the most fluctuations occurring in the earlier part of the season (Figure 6-5). The same was true for both Big Goose Creek (Figure 6-6) and Little Goose Creek mainstem and tributary sites. The highest measurements with the most variation occurred at sites located in the lower portions of the watershed, such as GC05, BG01, and LG02.

SCCD discharge values at GC01 correspond relatively closely with the 2021 daily flow data from the USGS (Appendix C); however, flows in 2021 were generally lower than the normal mean daily flow from USGS, apart from a few spikes in May, mid-June, and mid-August. Discharge values collected by SCCD at BG18 were also lower overall than the USGS normal mean daily flow, apart from one measurement in mid-August.

Figure 6-5. Discharge at Goose Creek mainstem and tributary sites

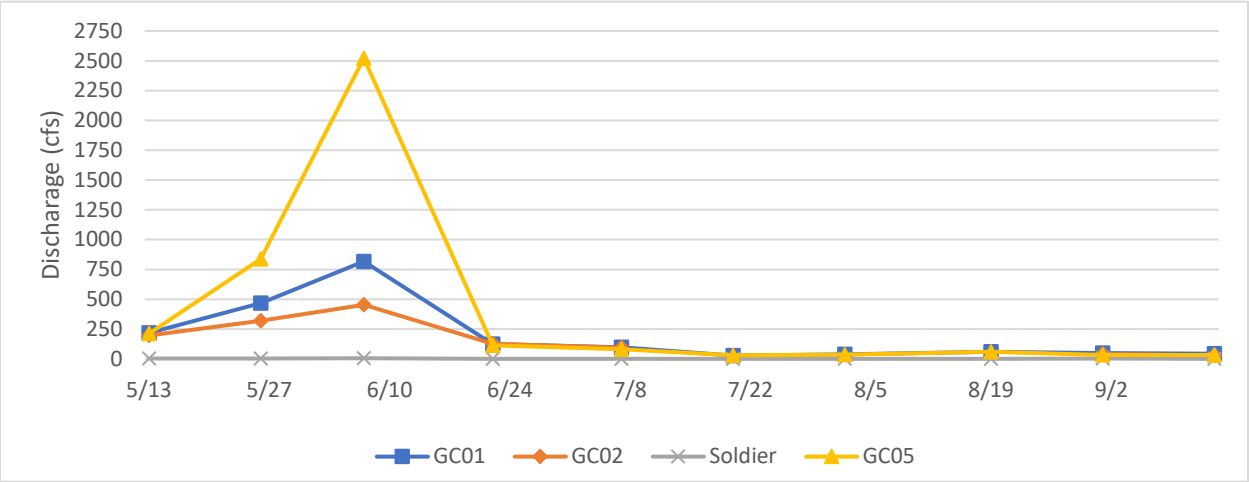


Figure 6-6. Discharge at Big Goose Creek mainstem and tributary sites

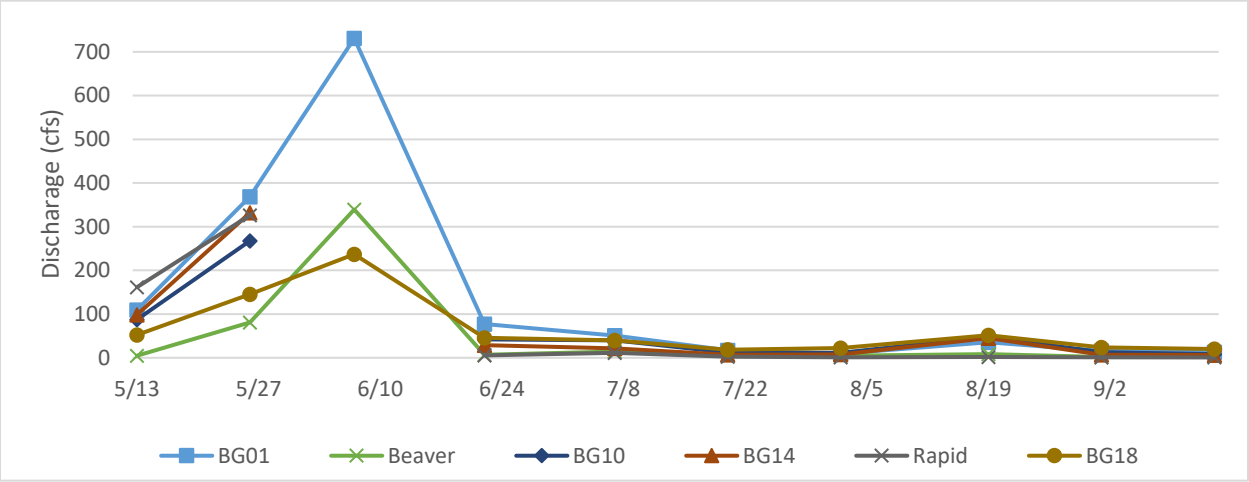
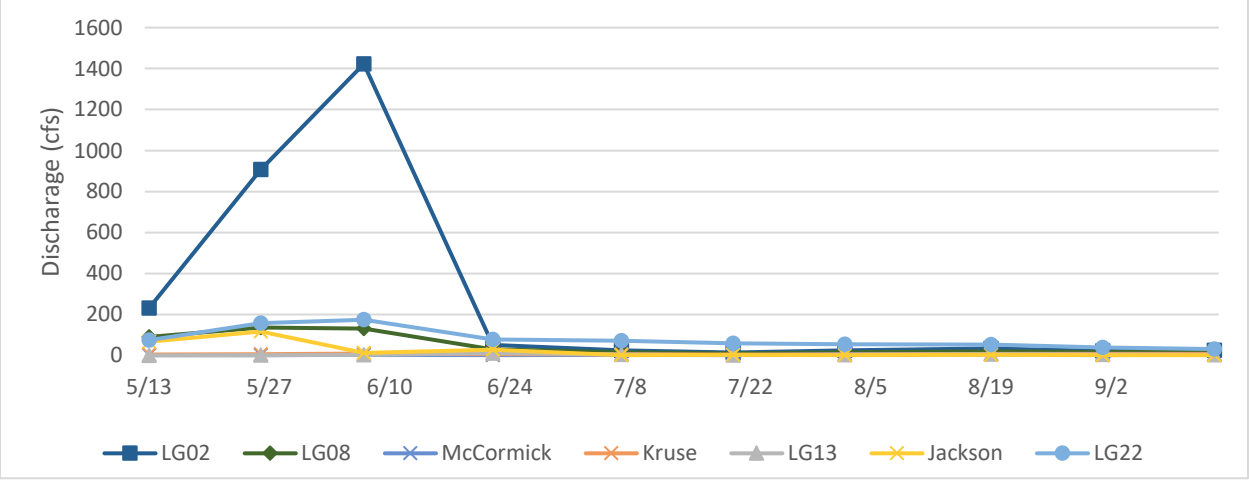


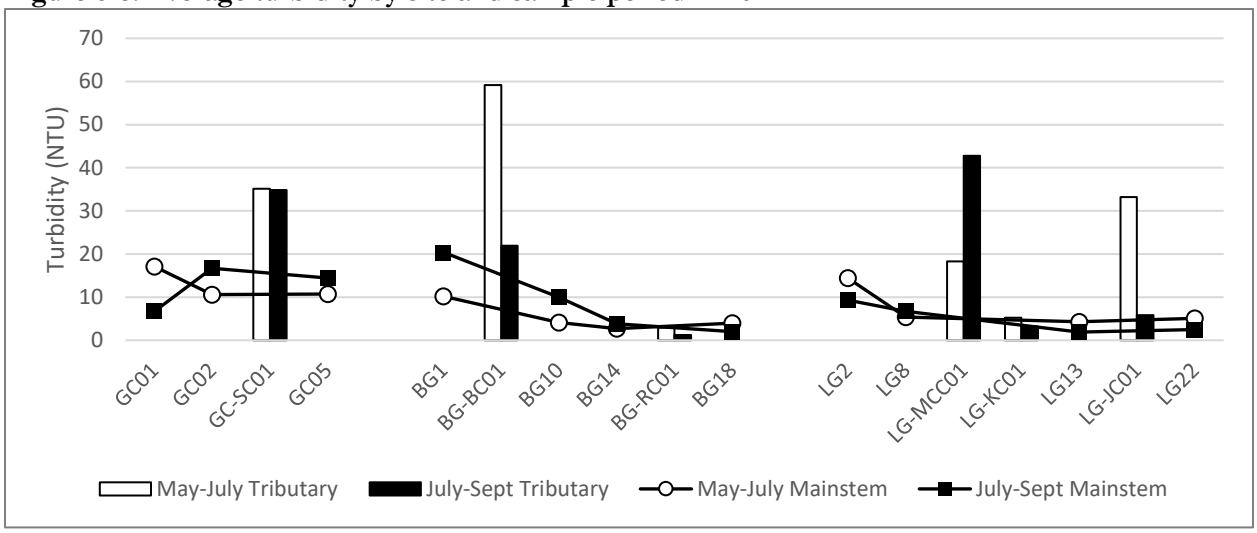
Figure 6-7. Discharge at Little Goose Creek mainstem and tributary sites



6.4 Turbidity

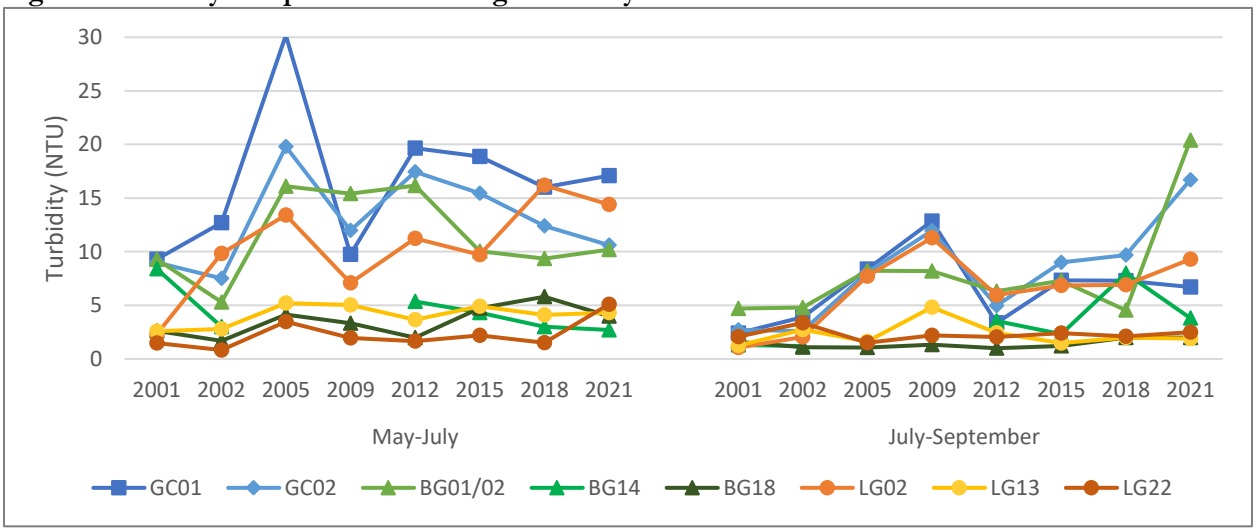
Turbidity averages generally increased from upstream to downstream, apart from GC01, which had a lower average turbidity during the late season than the upper site, GC05 (Figure 6-8). Early season turbidity averages were higher than late season averages at most tributary sites, apart from McCormick Creek. Turbidity averages at Goose Creek and Big Goose Creek mainstem sites were generally higher during the late season; averages at Little Goose Creek mainstem sites were similar throughout both seasons.

Figure 6-8. Average turbidity by site and sample period in 2021



Early season average turbidity values tend to be more variable than averages in the late season, as can be seen across all sampled years at select mainstem sites within the watershed (Figure 6-9). Early season turbidity averages were higher at GC01, BG01, LG13, and LG22 in 2021 in 2018; the opposite was true for GC02, BG14, BG18, and LG02. Late season turbidity averages were higher at all select mainstem sites in 2021 than in 2018 apart from GC01 and BG14. Early season averages have remained below 35 NTU at select mainstem sites, while late season averages have remained below 25 NTU.

Figure 6-9. Yearly comparisons of average turbidity at select mainstem sites from 2001-2021

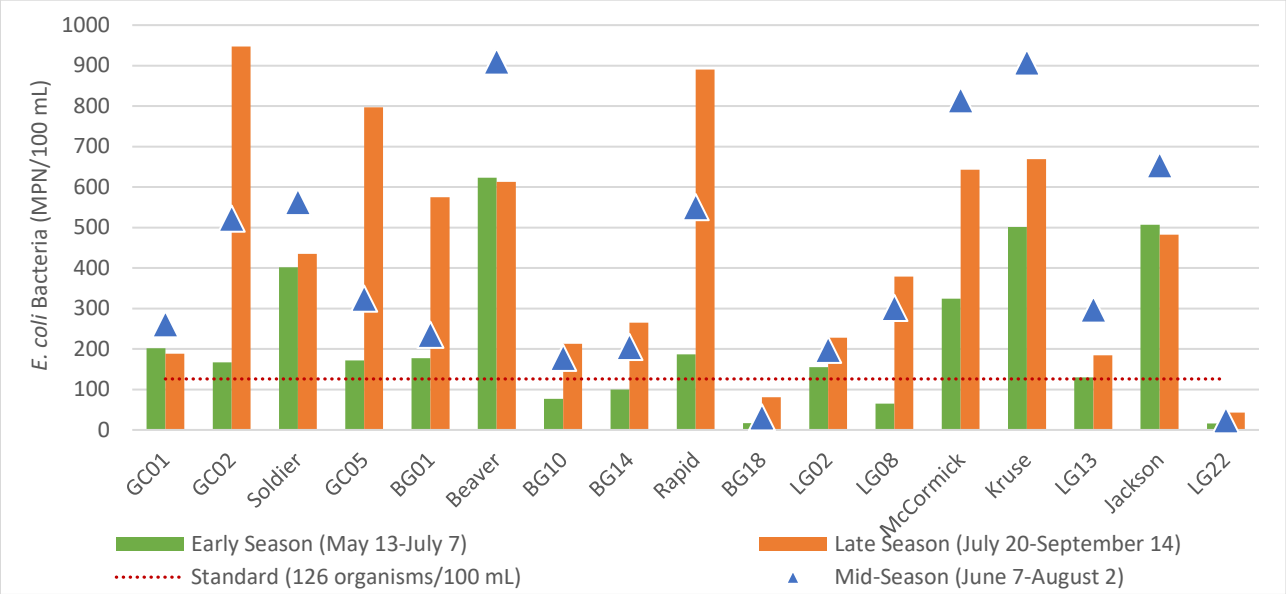


6.5 Bacteria

In 2021, ten *E. coli* bacteria samples were obtained from 17 sites in the Goose Creek watershed from May to September (Appendix C). Rolling geometric means were calculated for each site from five early season samples (May 13-July 7), five mid-season samples (June 7-August 2), and five late season samples (July 20-September 14).

Early, mid, and late season geometric means exceeded the standard at all sites, except for early season geometric means at the three upper Big Goose sites (BG10, BG14, and BG18), LG08, and LG22, and mid-season and late season geometric means at BG18 and LG22 (Figure 6-10). Late season concentrations were higher than mid and late-season concentrations at most sites.

Figure 6-10. Goose Creek watershed *E. coli* bacteria geometric means by site and sample period



Mean (geometric) bacteria concentrations were calculated from all samples collected for each sampling season and charted with a linear trendline (Figure 6-11 through Figure 6-14). Concentrations at all sites appear to be increasing across the seven sampling years. Annual mean concentrations at mainstem sites decreased from concentrations in 2018, apart from GC01 and LG22, which increased just slightly. The opposite was true for tributary sites, with mean concentrations increasing from those in 2018, except at McCormick Creek and Rapid Creek. Most sites appear to have mean concentrations higher than concentrations observed when sampling began in 2001, with highs and lows observed in similar patterns at similar sites across the seven years.

Bacteria concentrations vary in response to several water quality and water quantity factors, including changes in water temperature, water quantity, and suspended sediment loads. These factors can make trend comparisons difficult, particularly when looking at geometric means at various sites over various years with varying climatic and hydrological conditions. In addition, deeper, faster moving water within the stream channels can scour and suspend sediment that has been previously deposited on the channel bottom. These bed sediments have been found to contain elevated levels of bacteria. Rangeland studies in Idaho have shown that *E. coli* concentrations can be 2 to 760 times greater in bottom sediment than in the water column (Stephenson, G. & Rhychert, R., 1982). A similar study on Goose Creek watershed showed up to 3-fold increases of fecal coliform bacteria when disturbing the bed sediment (SCCD, 2003). The approximate duration for which sediment dwelling bacteria populations can remain viable is unknown.

Figure 6-11. Annual mean bacteria concentrations and trendlines at mainstem Goose Creek sites (2001-2021)

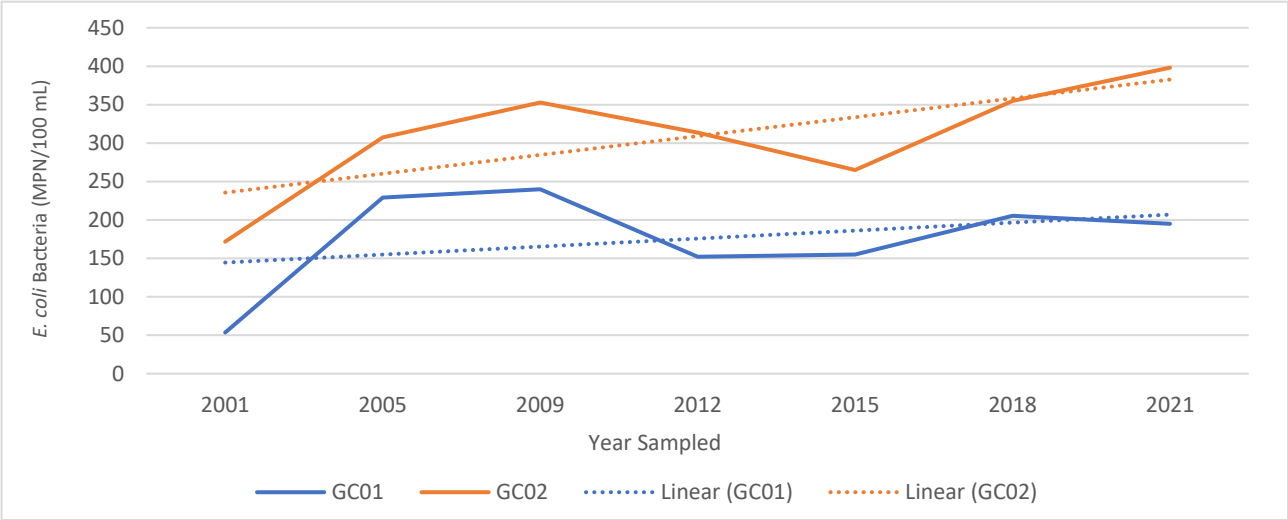


Figure 6-12. Annual mean bacteria concentrations and trendlines at mainstem Big Goose Creek sites (2001-2021)

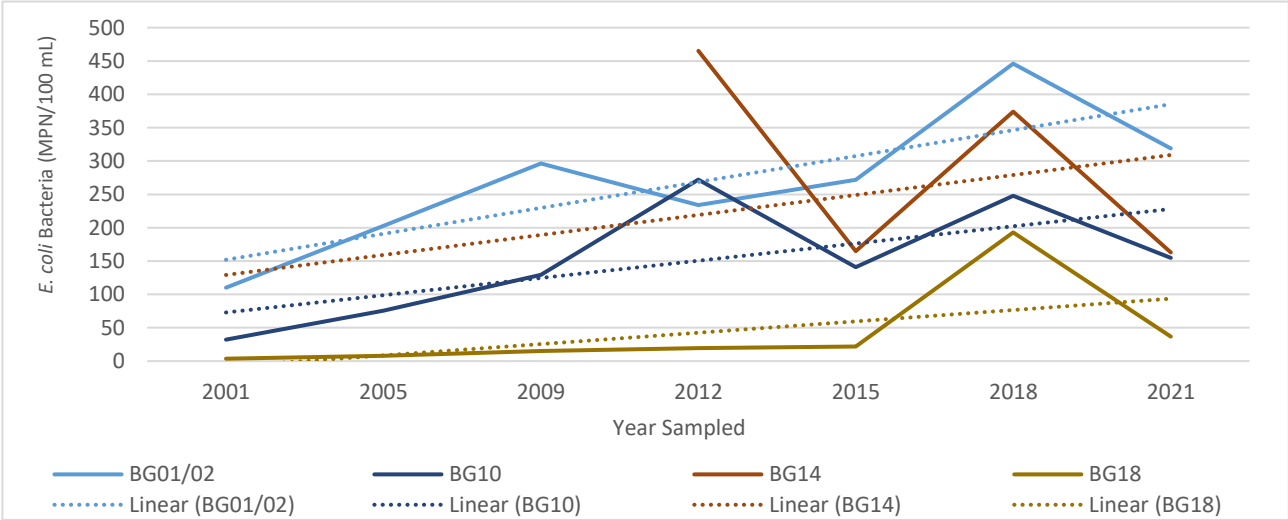


Figure 6-13. Annual mean bacteria concentrations and trendlines at mainstem Little Goose Creek sites (2001-2021)

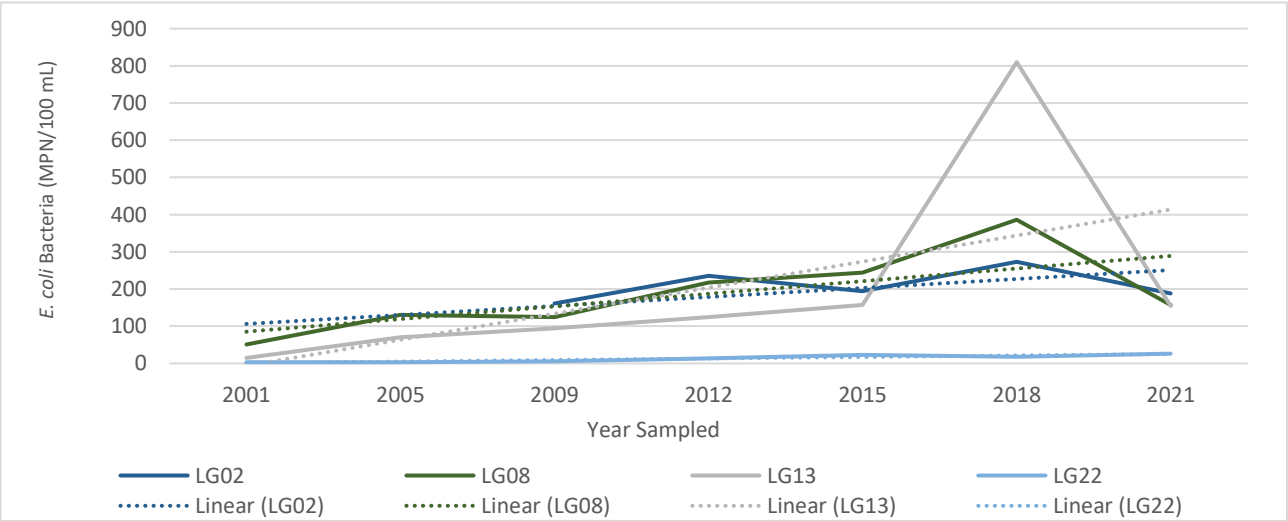
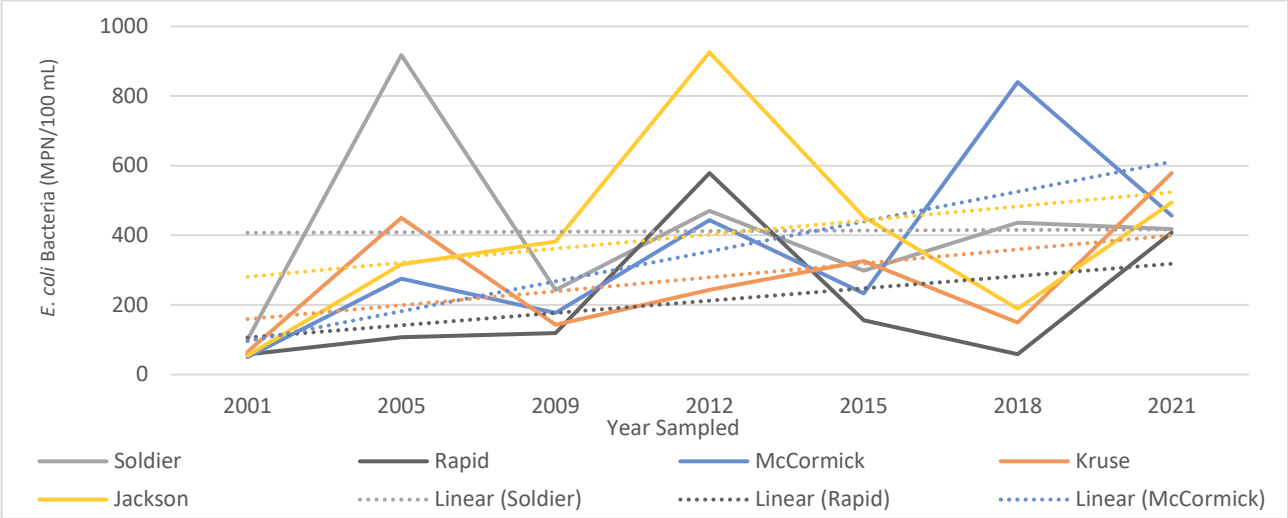


Figure 6-14. Annual mean bacteria concentrations and trendlines at tributary sites (2001-2021)



To supplement bacteria trend analysis, the SCCD uses single day samples to calculate the overall average reduction needed at each site to meet the standard. Average site reductions are combined to calculate reductions needed within each subwatershed. Reduction categories are used to visualize changes in concentrations within subwatersheds over time as well as to prioritize projects or areas of concern (Map A-7, Appendix A). Reduction categories are set as follows: 0-39% for low, 40-64% for medium, 65-74% for high, and 75-100% for very high.

In 2021, most load reductions needed to meet the standard either stayed the same or decreased from load reductions in 2018, apart from Beaver Creek, which increased from Medium to High (Table 6-5). There were no subwatersheds in need of a Very High load reduction in 2021, in comparison to 2018 when there were two (Kruse and Jackson Creek), and in 2012 when there were five (Soldier, Beaver, Rapid, and Kruse Creek, and the Upper Big Goose Creek subwatersheds). Load reductions have stayed relatively consistent in the mid to upper Big Goose and Little Goose Creek subwatersheds in the last three sampling years (2015, 2018, and 2021).

Table 6-5. Average load reductions needed within subwatersheds in 2012, 2015, 2018, and 2021

Subwatershed	2012	2015	2018	2021
Lower Goose Creek (GC01)	Low	Low	Medium	Low
Soldier Creek (GC-SC01)	Very High	Medium	High	Medium
City Goose Creek (GC02, GC05)	Medium	Medium	Medium	Medium
Lower Big Goose (BG01)	Medium		Medium	Medium
Beaver Creek (BG-BC01)	Very High		Medium	High
Middle Big Goose (BG10)	Medium	Low	Low	Low
Upper Big Goose (BG14)	Very High	Low	Low	Low
Rapid Creek (BG-RC01)	Very High	Low	Medium	Medium
Above Big Goose (BG18)	None Needed	Low	Low	Low
Lower Little Goose (LG02)	Medium	Medium	Low	Medium
Middle Little Goose (LG08)	Medium	Medium	Medium	Medium
McCormick Creek (LG-McC01)	High	Medium	Medium	Medium
Kruse Creek (LG-KC01)	Very High	Medium	Very High	High
Upper Little Goose (LG13)	Low	Low	Low	Low
Jackson Creek (LG-JC01)	High	High	Very High	High
Above Little Goose (LG22)	None Needed	Low	Low	Low

6.6 Meteorological Data and Supporting Information

Average daily air temperatures in 2021 were above normal for much of the sampling season, with a few large dips below normal mean temperatures occurring in May and later in mid-August (Appendix C). In June, average daily temperatures were 20°C above normal at times. In contrast, in mid-August, temperatures were nearly 20°C below normal. Most fluctuations in daily air temperatures occurred towards the beginning and the end of the season, with mid-season temperatures consistently being warmer than the normal mean temperature.

Cumulative precipitation from January-April was over two inches higher in 2021 than the normal cumulative precipitation (Appendix C). Precipitation in 2021 remained higher than normal through mid-May, then dropped below normal for the rest of the season. From mid-May, cumulative precipitation was generally one to two inches less than normal cumulative precipitation.

6.7 Benthic Macroinvertebrates

Benthic macroinvertebrates reside on and in the bottom substrate of streams and provide a valuable tool for the assessment of water quality. They are small but visible to the naked eye and large enough to be retained in a U.S. Standard Number 30 sieve.

Water chemistry sampling provides information for the quality of water at the time of sample collection. In contrast, benthic macroinvertebrates serve as continuous monitors of stream water quality since they live in the water during most of their life cycle and are exposed to often variable concentrations of pollutants over extended periods of time. This is an important concept because water quality sampling may miss important changes in water quality due to normal seasonal and spatial variability, changes in land use, water management, or accidental pollutant spills. An optimal water quality monitoring program involves both water chemistry sampling and biological monitoring (Rosenberg, D.M. & Resh, V.H., 1993).

Wyoming water quality standards for chemical and physical water quality parameters (WDEQ, 2018b) were established to protect aquatic life and human health. Instead of using sampling results from individual chemical and physical water quality parameters, evaluation of benthic macroinvertebrate populations may serve as a direct measure for the attainment of the Aquatic Life beneficial use in addition to validating the effectiveness of individual numeric water quality chemical and physical standards. Benthic macroinvertebrates also serve to integrate water quality and habitat quality interaction and evaluate potential synergistic effects from multiple chemical and physical water pollutants not measured during routine water quality monitoring.

Wyoming has developed biological criteria for streams statewide, but they have not been adopted as numeric, enforceable standards (Stribling, Jessup, & Gerritsen, 2000; Jessup, B.K. & Stribling, J.B., 2002; Hargett, E.G. & ZumBerge, J.R., 2006; Hargett, 2011). As such, they may be used as narrative standards to determine beneficial use for aquatic life and the protection and propagation of fish and wildlife. The Biological Criteria in Chapter 1, Section 32 of the Wyoming Water Quality Standards provide a narrative standard for protection of indigenous or intentionally introduced aquatic communities (i.e., brown, brook, and rainbow trout species). In addition, Section 4 in the Wyoming Water Quality Standards relates the presence of food sources (e.g., benthic macroinvertebrates) for game and non-game fish as a criterion for Surface Water Classes and (beneficial) uses (WDEQ, 2018b).

6.7.1 Previous Benthic Macroinvertebrate Sampling

The historic benthic macroinvertebrate data collected in the Goose Creek watershed through 2002 were presented and discussed in the Goose Creek Watershed Assessment 2001-2002, Final Report (SCCD, 2003). Subsequent benthic macroinvertebrate data collected by WDEQ in 2004 and SCCD in 2005 in the Goose Creek

watershed were presented and discussed in the 2005 Goose Creek Watershed Interim Monitoring Report (SCCD, 2006). Benthic macroinvertebrate data collected by SCCD in 2009 in the Goose Creek watershed were presented and discussed in the 2009 Goose Creek Watershed Interim Monitoring Project (SCCD, 2011). Further, the benthic macroinvertebrate data collected by SCCD in 2012 were presented and discussed in the 2012 Goose Creek Watershed Interim Monitoring Project (SCCD, 2014). Benthic macroinvertebrate samples collected in 2015 were presented in the 2015 Goose Creek Watershed Interim Monitoring Project (SCCD, 2017). WDEQ collected duplicate macroinvertebrate samples at Little Goose Creek station MRC 38 (SCCD station LG22) during 2014.

During 2001 and 2002, a total of twenty-one samples were collected each year by SCCD from nineteen stations (SCCD, 2003). A total of seven benthic macroinvertebrate samples were collected by SCCD in 2005 from six stations (SCCD, 2006). WDEQ collected ten benthic macroinvertebrate samples at nine stations in the Goose Creek watershed during 2004. The WDEQ benthic macroinvertebrate sampling occurred in and near Sheridan as part of the Goose Creeks storm water project. The purpose of the storm water project was to identify and assess significant potential water quality problems related to storm water discharges within the Goose Creek watershed, identify sources of pollutants in storm water runoff, and assess the impacts of storm water runoff on receiving waters (WDEQ, 2005). Apart from four of the WDEQ benthic macroinvertebrate sampling stations assessed in 2004, all samples were collected at stations previously established in the Goose Creek watershed. SCCD collected a total of seven benthic macroinvertebrate samples from six stations in the Goose Creek watershed in 2009 and a total of nine samples from eight stations in 2012. Macroinvertebrate sampling and habitat assessments were performed at six stations in October of 2015, and at eight stations in October of 2018.

6.7.2 Benthic Macroinvertebrate Sampling in 2021

Macroinvertebrate sampling and habitat assessments were performed at eight stations in September 2021. The location of the eight stations is shown on Map A-1, Appendix A. A total of nine macroinvertebrate samples were collected from the eight stations including a duplicate sample at Big Goose Creek station BG02. Benthic macroinvertebrate samples were collected from two Goose Creek stations (station GC01 and station GC02), four samples were collected from three Big Goose Creek stations (station BG02, station BG10 and station BG18), and three samples were collected from three Little Goose Creek stations (station LG2A, station LG10 and station LG22). Included in the total number of samples was a duplicate sample collected at Big Goose Creek station BG02. The duplicate sample was used only for QA/QC purposes, construction of taxa lists and for general discussion of macroinvertebrate results.

The number of sampling stations and the number of samples collected by SCCD in 2021 differed slightly to the number of stations sampled and number of samples collected in 2005, 2009, 2012 and 2015 and 2018. Big Goose Creek upstream control station BG18 and Little Goose Creek upstream control station LG22 added to the 2012 and 2018 benthic macroinvertebrate sampling schedule were not sampled during 2015. The overall reduced number of sample stations and samples collected during 2005, 2009, 2012, 2015, 2018 and 2021 when compared to the sampling regime in 2001 and 2002 precluded a complete evaluation of the benthic macroinvertebrate communities between years, and the comparison of biological condition at each station in the Goose Creek watershed.

Field benthic macroinvertebrate sample collection methods and laboratory analytical methods employed by SCCD in 2001, 2002, 2005, 2009, 2012, 2015, and 2018 were the same as those used for sampling in 2021. In addition, WDEQ benthic macroinvertebrate sampling methods for samples collected in 1994, 1998, 2004 and

2014 were identical to those used by SCCD resulting in comparable benthic macroinvertebrate data. Macroinvertebrate samples collected in 2021 were sorted by Aquatic Assessments, Inc. in Sheridan, Wyoming and analyzed by Aquatic Biology Associates, Inc. (ABA) in Corvallis, Oregon. Previous benthic macroinvertebrate samples collected by WDEQ in 1994 and 1998 were analyzed by ABA. Samples collected by WDEQ in 2004 and 2014 were analyzed by Rhithron Associates, Inc. in Missoula, MT.

6.7.3 Benthic Macroinvertebrate Taxa

Taxa lists for benthic macroinvertebrate samples collected in the Goose Creek watershed in 2021 are presented in Tables D-1 through D-9. The cumulative list of macroinvertebrate taxa identified from samples collected in the Goose Creek watershed from 2001 through 2021 is presented in Appendix D, Table D-10. The list of benthic macroinvertebrate metrics for samples collected in 1994, 1998, 2001, 2002, 2004, 2005, 2009, 2012, 2015, 2018 and 2021 is presented in Appendix D, Table D-11.

A total of 267 benthic macroinvertebrate taxa have been identified since 2001 from a total of 100 samples collected during the project (Appendix D). Eight new taxa were identified during 2021 including the Chironomidae genera *Labrundinia, Larsia and Metriocnemus*, the moth genus *Eloephila*, the caddisfly genera *Anagepetus*, *Apatania*, the caddisfly species *Amiocentrus aspilus*, and the flatworm genus *Polycelis*.

No threatened or endangered benthic macroinvertebrate taxa or fish species (incidentally captured during macroinvertebrate sampling) were identified. The generally widespread occurrence of the freshwater shrimp genera *Gammarus, Hyalella*, *Crangonyx,* and the freshwater shrimp species group *Hyalella azteca* (commonly used in laboratory toxicity tests) in the Goose Creek watershed indicated that water in Goose Creek, Big Goose Creek and Little Goose Creek contained no toxic substances in sufficient concentration to prevent the establishment and survival of these organisms.

The worm genus *Tubifex* or the species *Tubifex tubifex* has not been identified in the Goose Creek watershed. This is encouraging because the presence of *Tubifex* in streams is of concern since T*ubifex tubifex* is implicated in the occurrence of whirling disease. Whirling disease is caused by a destructive parasite that may reduce or decimate trout populations. *T. tubifex* is significantly involved in the whirling disease life cycle caused by a parasite (*Myxobolus cerebralis*) that penetrates the head and spinal cartilage of fingerling trout. Whirling disease may eventually cause death in trout. The lack of the genus *Tubifex* in the watershed indicates reduced potential occurrence of *T. tubifex*. It should be noted that SCCD samples were collected in riffle and riffle/run habitats, and not the preferred *T. tubifex* slow water and pool habitats containing deposits of silt. Continued monitoring for this organism is suggested not only as an environmental indicator, but as an indicator of future health of trout populations in the Goose Creek watershed. Whirling disease has not been identified in the Goose Creek watershed and nearby Prairie Dog Creek watersheds. However, whirling disease was identified in the Tongue River watershed in the North Tongue River as well as in the Clear Creek watershed east, and adjacent to the Prairie Dog Creek watershed.

Wyoming Game and Fish Department (WGFD) implemented an aquatic invasive species monitoring program throughout Wyoming including mandatory aquatic invasive species check stations. The program is designed to prevent the establishment of the zebra mussel (*Dreissena polymorpha)* and the quagga mussel (*Dreissena rostriformis bugensis)* in Wyoming waterbodies**.** The two clam species may produce serious negative impact to aquatic resources, ecological functions of waterbodies, drinking water intakes and water distribution systems. Although the mussels have been identified in Utah, Colorado, eastern South Dakota, and eastern Nebraska, they are not present in Wyoming to date. No zebra or quagga mussels have been identified by SCCD sampling in the Goose Creek watershed or the nearby Tongue River and Prairie Dog Creek watersheds.

Other aquatic invasive species of significant concern currently in Wyoming include the New Zealand Mudsnail species (*Potamopyrgus antipodarum)* and the Asian Clam species (*Corbicula fluminea*). The New Zealand Mudsnail is present in Wyoming in Yellowstone National Park, Lake Cameahwait, Boysen Reservoir and in the Bighorn, Shoshone, North Platte, Salt and Snake rivers. The distribution of the Asian Clam in Wyoming is restricted to a few locations in south-east Wyoming and Keyhole Reservoir in Crook County. Historic benthic macroinvertebrate sampling and current monitoring by SCCD have not identified the New Zealand Mudsnail or the Asian clam in the Goose Creek watershed or the nearby Tongue River and Prairie Dog Creek watersheds.

Brook stickleback (*Culaea inconstans*) is a smaller minnow-sized fish species of concern. It is not native to Wyoming and is of concern since it may compete with and negatively affect other fish species and the food sources for waterfowl. Brook stickleback have not been incidentally collected by SCCD in benthic macroinvertebrate sampling. However, they were collected by WGFD in 2017 in the lower Goose Creek watershed (near SCCD station GC01) and in the Tongue River below its confluence with Goose Creek (A. Nikirk, Wyoming Game and Fish Department, Sheridan, WY; personal communication, March 3, 2021).

Turbellaria flatworms (subclass Trepaxonemata) were most common in the Goose Creek watershed and occurred in 90% of the total samples collected (Appendix D, Table D.10). Acari (water mites) (88%), the riffle beetle genus *Microcylloepus* (87%), the Chironomidae midge fly genera *Cricotopus* (87%) and *Rheotanytarsus* (78%), and the blackfly genus *Simulium* (77%) were common in benthic macroinvertebrate samples collected since 2001.

Chironomidae, Coleoptera and Ephemeroptera were present in 100 percent of samples collected in the Goose Creek watershed since 2001. The Dipteran family Chironomidae (midges) had the greatest number of taxa in the project area (N = 62 taxa), followed by the order Ephemeroptera (N = 42 mayfly taxa), the order Trichoptera (N = 41 caddisfly taxa), the class Oligochaeta (N = 23 worm taxa), the order Plecoptera (N = 14 stonefly taxa), the Diptera family Tipulidae (N = 11 cranefly taxa) and the Coleopteran family Elmidae (N = 10 riffle beetle taxa) (Appendix D, Table D-10).

6.8 Biological Condition

Biological condition scores were determined using the Wyoming Stream Integrity Index (WSII) initially developed by Jessup and Stribling (2002), updated by Hargett and ZumBerge (2006) and revised by Hargett (2011). The WSII is based on the analysis of 1,488 benthic macroinvertebrate monitoring data collected by WDEQ from 1993 through 2009 from multiple reference and non-reference quality streams statewide. The WSII identified eleven bioregions for Wyoming. Each bioregion used different scoring criteria because the biological communities naturally differ between bioregions.

Biological condition scoring criteria developed for the High Valleys bioregion were used to evaluate biological condition for streams in the Goose Creek watershed within the project area. Table 6-6 lists the WSII metrics and metric formulae used to determine biological condition for benthic macroinvertebrate communities in the High Valleys bioregion.

Table 6-6. Wyoming Stream Integrity Index (WSII) metrics and scoring criteria for benthic macroinvertebrate communities in the High Valleys bioregion (Hargett, 2011)

Macroinvertebrate Metric	Metric Scoring Formulae	5^{th} or 95^{th} %ile (as per formula)
% Chironomidae Taxa of Total Taxa	100*(33.3-X) / (33.3-5th%ile)	0
% Ephemeroptera Taxa of Total Taxa	100*X / 95th%ile	24
No. EPT Taxa	100*X / 95th%ile	23
% EPT (less Arctopsychidae and Hydropsychidae)	100*X / 95th%ile	81.3
% Scraper	100*X / 95th%ile	52
BCICTQa	100*(79.9-X) / (79.9-5th%ile)	54.2

The calculated biological condition value was then used to rate the biological community as Full-support, Indeterminate, or Partial/Non-support (Table 6-7). A biological condition rating of Full support indicates full support for narrative aquatic life use. The Indeterminate biological classification is not an attainment category, but rather a designation requiring the use of ancillary information and/or additional data in a weight of evidence evaluation to determine a narrative assignment such as full support or partial/non-support (Hargett, 2011). The Partial/Non-support classification indicates the aquatic community is stressed by anthropogenic stressors. Water quality and/or habitat improvements are required to restore the stream to full support for narrative aquatic life use.

Table 6-7. Assessment rating criteria for benthic macroinvertebrate communities based on the Wyoming Stream Integrity Index (WSII) in the High Valleys bioregion of Wyoming (Hargett, 2011)

Rating of Biological Condition (Aquatic Life Use Support)	High Valleys bioregion
Full Support	>48.77
Indeterminate Support	32.51 – 48.76
Partial/ (Non - Support)	0 – 32.50

Table 6-8 lists other select macroinvertebrate metrics that may be evaluated when assessing biological condition since their expected response to water quality and habitat change is relatively well known. Biological condition for each station sampled through 2021 is presented in Table 6-9.

Table 6-8. Definition of select macroinvertebrate metrics and expected response to perturbation including water quality and habitat change (King, K.W., 1993; Barbour, 1999)

Metric	Definition	Expected Response
Total Number Taxa	Measures the overall variety of the macroinvertebrate assemblage	Decrease
Total Number EPT Taxa	Number of taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)	Decrease
Total Number Ephemeroptera Taxa	Total Number of mayfly taxa	Decrease
% Ephemeroptera	Percent of mayfly nymphs	Decrease
Total Number Plecoptera Taxa	Total Number of stonefly taxa	Decrease
% Plecoptera	Percent of stonefly nymphs	Decrease
Total Number Insect Taxa	Total Number taxa in the Class Insecta	Decrease
Total Number Non - Insect Taxa	Total Number taxa not in the Class Insecta	Increase
% Non - Insects	Percent of Non - Insects	Increase
% Chironomidae	Percent of midge larvae	Increase
% Oligochaeta	Percent of worms	Increase
% 5 Dominant	Total Percent of the 5 most dominant taxa	Increase
% 10 Dominant	Total Percent of the 10 most dominant taxa	Increase
Number Predator Taxa	Number of taxa that feed upon other organisms or themselves in some instances	Variable, but appears to decrease in most regions of Wyoming
Total Number Scraper Taxa	Total Number of taxa that scrape periphyton for food	Decrease
% Scrapers	Percent organisms that scrape periphyton for food	Decrease
% Collector - Filterers	Percent organisms that filter Fine Particulate Organic Material from either the water column or sediment	Increase in most Wyoming ecoregions
% Collector - Gatherers	Percent organisms that either collect or gather food particles	Increase
Modified HBI	Uses tolerance values to weight abundance in an estimate of overall pollution. Originally designed to evaluate organic pollution.	Increase
BCI CTQa	Tolerance classification based on nonpoint source impact of sedimentation and velocity alteration	Increase
Shannon H (Log base 2)	Incorporates both richness and evenness in a measure of general diversity and composition	Decrease
% Multivoltine	Percent of organisms having short (several per year) life cycle	Increase
% Univoltine	Percent of organisms relatively long-lived (life cycles of 1 or more years)	Decrease

Table 6-9. Biological condition score and rating for comparable historic and current Goose Creek Watershed benthic macroinvertebrate sample stations sampled in 2021; based on the Wyoming Stream Integrity Index (WSII) for the High Valleys bioregion (Hargett, 2011)

Sampling Station	Sampling Year	Sampling Group	Score	Support Rating
Goose Creek GC01	2021	SCCD	25.9	Partial/ (Non - Support)
	2018	SCCD	38.9	Indeterminate
	2015	SCCD	33.3	Indeterminate
	2012	SCCD	27.7	Partial/ (Non - Support)
	2009	SCCD	36.9	Indeterminate
	2005	SCCD	36.4	Indeterminate
	2005 - Duplicate	SCCD	38.7	Indeterminate
	2002	SCCD	38.9	Indeterminate
	2001	SCCD	36.1	Indeterminate
	1998	WDEQ	45.2	Indeterminate
Goose Creek GC02	2021	SCCD	41.9	Indeterminate
	2018	SCCD	39.1	Indeterminate
	2015	SCCD	23	Partial/ (Non - Support)
	2012	SCCD	21.7	Partial/ (Non - Support)
	2009	SCCD	30.9	Partial/ (Non - Support)
	2005	SCCD	36.1	Indeterminate
	2002	SCCD	21.3	Partial/ (Non - Support)
	2002 - Duplicate	SCCD	21.1	Partial/ (Non - Support)
	2001	SCCD	15.6	Partial/ (Non - Support)
	1998	WDEQ	32.7	Indeterminate
Big Goose Creek BG02	2021	SCCD	28.4	Partial/ (Non - Support)
	2021 - Duplicate	SCCD	37.5	Indeterminate
	2018	SCCD	50.2	Full
	2018 - Duplicate	SCCD	46.9	Indeterminate
	2015	SCCD	32.2	Partial/ (Non - Support)
	2012	SCCD	36.5	Indeterminate
	2012 - Duplicate	SCCD	37.6	Indeterminate
	2009	SCCD	36.3	Indeterminate
	2009 - Duplicate	SCCD	44.8	Indeterminate
	2005	SCCD	32.5	Partial/ (Non - Support)
	2004	WDEQ	40.9	Indeterminate
	2002	SCCD	43.7	Indeterminate
	2001	SCCD	44.5	Indeterminate
	1998	WDEQ	56	Full
	1994	WDEQ	33.6	Indeterminate
Big Goose Creek BG10	2021	SCCD	57.4	Full
	2018	SCCD	35.3	Indeterminate
	2015	SCCD	45.7	Indeterminate
	2015 - Duplicate	SCCD	52.5	Full
	2012	SCCD	32.2	Partial/ (Non - Support)
	2009	SCCD	48.1	Indeterminate

Table 11. Biological condition score and rating for comparable historic and current Goose Creek Watershed benthic macroinvertebrate sample stations sampled in 2021 (cont.)

Sampling Station	Sampling Year	Sampling Group	Score	Support Rating
Big Goose Creek BG10	2005	SCCD	40	Indeterminate
	2002	SCCD	41.1	Indeterminate
	2001	SCCD	61.7	Full
Big Goose Creek BG18	2021	SCCD	57.7	Full
	2018	SCCD	36.1	Indeterminate
	2012	SCCD	64.1	Full
	2002	SCCD	63.6	Full
	2001	SCCD	65.6	Full
	1998	WDEQ	74	Full
Little Goose Creek LG2A	2021	SCCD	48.3	Indeterminate
	2018	SCCD	38.7	Indeterminate
	2015	SCCD	39.3	Indeterminate
	2012	SCCD	30.4	Partial/ (Non - Support)
	2009	SCCD	35.7	Indeterminate
	2005	SCCD	44.6	Indeterminate
	2004	WDEQ	36.7	Indeterminate
	2002	SCCD	25.7	Partial/ (Non - Support)
	2001	SCCD	26.3	Partial/ (Non - Support)
	1998	WDEQ	28.7	Partial/ (Non - Support)
	1997	WEST *	32.7	Indeterminate
	1994	WDEQ	21.9	Partial/ (Non - Support)
Little Goose Creek LG10	2021	SCCD	26.4	Partial/ (Non - Support)
	2018	SCCD	25.9	Partial/ (Non - Support)
	2015	SCCD	31.5	Partial/ (Non - Support)
	2012	SCCD	25.7	Partial/ (Non - Support)
	2009	SCCD	25.3	Partial/ (Non - Support)
	2005	SCCD	23.9	Partial/ (Non - Support)
	2002	SCCD	35.3	Indeterminate
	2001	SCCD	43.6	Indeterminate
	2001 - Duplicate	SCCD	37.5	Indeterminate
	1998	WDEQ	39.6	Indeterminate
	1998 - Duplicate	WDEQ	37.6	Indeterminate
Little Goose Creek LG22	2021	SCCD	58.8	Full
	2018	SCCD	62.3	Full
	2014	WDEQ	79.9	Full
	2014 - Duplicate	WDEQ	80.2	Full
	2012	SCCD	62.1	Full
	2002	SCCD	76.4	Full
	2001	SCCD	80.3	Full
	1998	WDEQ	81.5	Full
	1996	WDEQ	70.4	Full

** Sample collected by Western EcoSystems Technology, Inc., Cheyenne, Wyoming*

6.8.1 Goose Creek Biological Condition

Biological condition at Goose Creek station GC01 was indeterminate for all years except for 2012 when it was partial/non-supporting (Table 6-9). Biological condition has declined since 1998 at station GC01 as evidenced by the slightly negative trend line shown in Figure 6-15. The slight negative trend in biological condition at station GC01 may be related to negative effects on the biological community related to the upstream predominant land uses including irrigated pasture/hayland, livestock and wildlife grazing, and rural residential development.

Of note, biological condition at Goose Creek station GC01 was better than biological condition at the upper Goose Creek station GC02 from 1998 to 2015. This observation was in contrast to a general decline in biological condition from upstream to downstream stations noted at Big Goose Creek and Little Goose Creek stations. However, biological condition at station GC01 was lower than biological condition at GC02 in 2018 and 2021. Station GC01 is located several stream miles downstream of station GC02 and is not directly affected by the Sheridan WWTF Wastewater Treatment Facility (WWTF) effluent, storm water discharges and urban land use effects potentially affecting GC02.

Biological condition at Goose Creek station GC02 was variable since sampling began in 1994. Biological condition was partial/non-supporting in 2005, 2015 and 2021 (Table 6-9). Biological condition was indeterminate in 1994, 2001, 2002, 2004, 2009 and 2012, and fully supporting in 1998 and 2018. Overall, the biological condition at station GC02 improved since 1998 as evidenced by the positive trend line shown in Figure 6.12. Station GC02 is located just downstream of the Sheridan WWTF. Biological communities at GC02 are exposed to treated effluent discharged from the Sheridan WWTF as well as numerous upstream urban storm water discharges and urban land use effects. The positive trend in biological condition at station GC02 Station suggests enhanced wastewater treatment and reduced effects from storm water discharges and urban land use effects.

Continued sampling should be conducted at station GC01 and station GC02, and at all original Goose Creek stations, if possible, to determine if the changes observed in biological condition through 2021 continue. The generally low biological condition scores continue to indicate indeterminate or partial/non-support of the narrative WDEQ water quality standard for aquatic life use. Planning and implementation of remedial measures to restore full aquatic life use support in Goose Creek should continue.

6.8.2 Big Goose Creek Biological Condition

Biological condition was partial/non-supporting at Big Goose Creek station BG02 during the most recent sampling event in 2021 (Table 6-9). Biological condition has varied at this station from full support in 1998 and 2018 to partial/non-supporting in 2005, 2015 and 2021. Biological condition increased from 1994 to 1998, then gradually declined from 1998 to 2005. A slight increase in biological condition was observed from 2005 to 2012 with a subsequent slight decrease from 2012 to 2015. Biological condition increased from 2015 to 2018 when full support was observed. However, the overall trend in biological condition declined slightly since 1998 at station BG02 as evidenced by the negative trend line shown in Figure 6-15.

Biological condition at BG10 has been variable since sampling began in 2001. Biological condition was fully supporting in 2001 with a subsequent decline to Indeterminate support from 2002 to 2009. The biological condition increase noted in 2009 then decreased to partial/non-supporting in 2012 with an increase to Indeterminate support in 2015 and 2018, and full support in 2021 (Figure 6-15).

Big Goose Creek station BG18 was first sampled for benthic macroinvertebrates and biological condition in 1998. Station BG18 is the most upstream sampling location on Big Goose Creek for water quality,

macroinvertebrates, and stream habitat. The station represents the control, or least impacted station with which to determine change in water quality, biological condition, or habitat at downstream Big Goose Creek stations.

Initial benthic macroinvertebrate sampling at station BG18 by WDEQ in 2001 found biological condition was fully supporting (Table 6-9). Subsequent sampling by SCCD in 2001, 2002, and 2012 found that biological condition was also fully supporting. Sampling in 2018 showed a reduction in biological condition from full support to indeterminate support. The reduction in biological condition did not appear to be related to a reduction in water quality, but to an increase in sand in the stream substrate starting in 2012. Sand comprised 33 percent of the stream substrate in 2012 and 27 percent of stream substrate in 2018 (Appendix E). Chutter (1969) reported that the amount of silt and sand in the stream substrate were detrimental to trout egg survival and maintenance of healthy benthic macroinvertebrate populations that provide food for trout. Tiziano et. al. (2007) found the abundance of macroinvertebrates and the number of taxa were inversely related to the total amount of sand. Nuttall (1972) found that the poor occurrence of macroinvertebrates and plants in the Camel River were associated with the unstable shifting nature of the sand deposits. He found that sand deposition accounted for the low diversity of macroinvertebrate species below a tributary that was a source of sand which resulted in the elimination of several species which were frequent upstream of the tributary. The literature is consistent in that the greater amount of sand in stream substrate, the lower number of macroinvertebrate abundance and the number of macroinvertebrate taxa. Sand is unstable and shifts with changes in stream water velocity resulting in an abrasive and grinding action on organisms. The increase in sand at station BG18 suggested that upstream disruption occurred in the watershed resulting in the increased contribution of sand to the stream channel. The amount of sand in the stream substrate at station BG18 should continue to be tracked to determine if the sand deposition increases.

The overall negative trend in biological condition since 1998 at station BG18 is evidenced by the negative trend line shown in Figure 6-15. As previously indicated, the reduction in biological condition appeared to be related to deposition of sand in the stream substrate and not to declining water quality.

It was not possible to determine change in benthic macroinvertebrate communities through the entire length of Big Goose Creek within the project area because only three stations (BG02, BG10 and BG18) out of the total seven benthic macroinvertebrate stations established at Big Goose Creek in 2001 have been consistently sampled. Whether biological condition has improved or declined at the other Big Goose Creek stations is unknown since they were not sampled.

Continued macroinvertebrate sampling should be conducted at Big Goose Creek stations BG02, BG10 and BG18, and at all original Big Goose Creek stations, if possible, to track changes in biological condition.

6.8.3 Little Goose Creek Biological Condition

Biological condition at station LG2A has been variable since sampling by WDEQ began in 1994 (Table 6-9). Since 1994, biological condition was Indeterminate during 58 percent of samples collected and partial/non-supporting during 42 percent of samples collected. The trend in biological condition has improved since 1994 at station LG2A as evidenced by the positive trend line shown in Figure 6-15. This is an important observation since other than Goose Creek station GC02, no other station sampled in 2015, 2018 or 2021 in the Goose Creek watershed exhibited an improving trend in biological condition. Station LG2A is located downstream of a large storm drain outfall that likely discharged highly variable quantity and quality of storm drain effluent. The improvement in biological condition suggested that pollutants from the storm drain and upstream land use effects were reduced over the years. Further, there appears to be no negative remnant effects on the benthic macroinvertebrate community caused by an oil spill at station LG2A in the early 2000's.

Biological condition at station LG10 was Indeterminate from 1998 to 2002 and decreased to partial/non-supporting from 2005 to 2021 (Table 6-9). Pollution tolerant taxa have increased over the years and the percent composition of silt and sand in the stream substrate have generally increased over the years (Appendix E). As indicated previously in this report, the abundance of macroinvertebrates and the number of taxa will be reduced with an increase in the total amount of sand in the stream substrate.

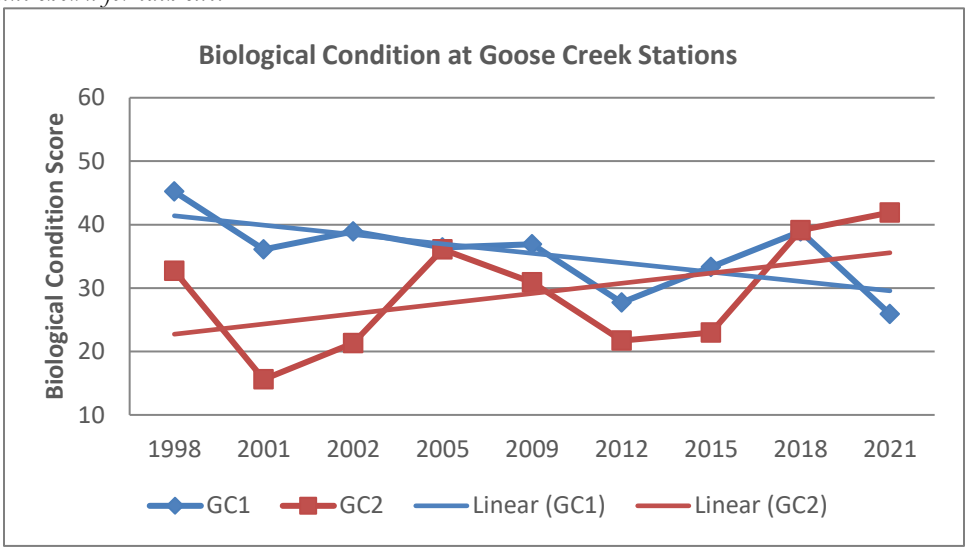
Little Goose Creek station LG22 was first sampled for benthic macroinvertebrates and biological condition in 1996 by WDEQ. Station LG22 is the most upstream sampling location on Little Goose Creek for water quality, macroinvertebrates, and stream habitat. The station represents the control, or least impacted station with which to determine change in water quality, biological condition, or habitat at downstream Little Goose Creek stations.

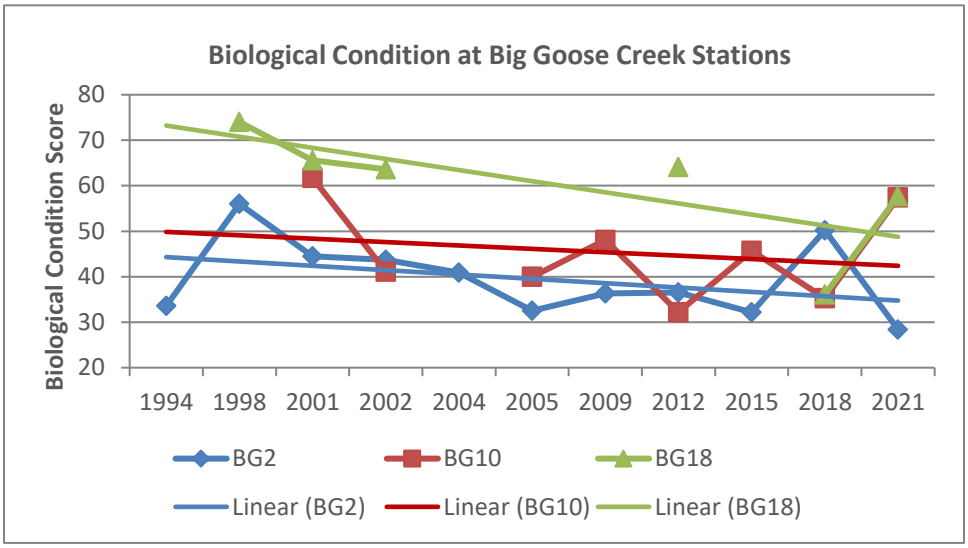
Biological condition at Little Goose Creek reference station LG22 was fully supporting from 1996 to 2021 (Table 6-9). However, the trend in biological condition at station LG22 was similar to the trend in biological condition at the Big Goose Creek reference station BG18 in that both stations have exhibited a slight decline in biological condition since the latter 1990's.

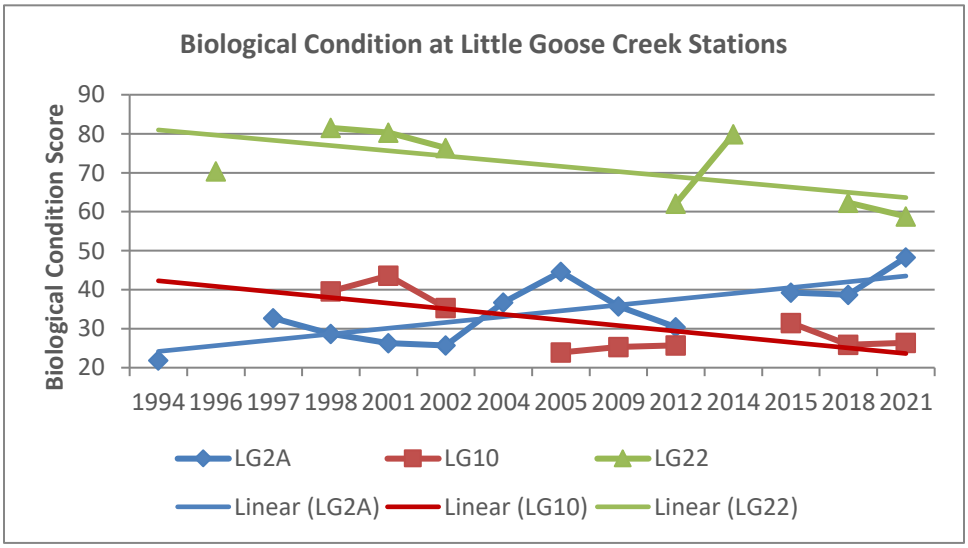
Change in the benthic macroinvertebrate communities through the entire length of Little Goose Creek within the project area could not be determined because only three stations (LG2A, LG10, and LG22) were consistently sampled out of the total seven benthic macroinvertebrate stations established in 2001. Whether biological condition has improved or declined at the other Little Goose Creek stations since 2001 is unknown since they were not sampled.

Continued sampling should be conducted at all Little Goose Creek stations to track potential changes in biological condition with special consideration toward monitoring the apparent upward trend in biological condition noted at station LG2A. Planning and implementation of remedial measures to restore full aquatic life use support in Little Goose Creek should continue.

Figure 6-15. Biological condition trends at select sites in the Goose Creek watershed
Note solid trendline shown for each site.







6.9 Habitat Assessments

6.9.1 Previous Habitat Assessments

The historic habitat assessment data collected in the Goose Creek watershed through 2002 were presented and discussed in the Goose Creek Watershed Assessment 2001-2002, Final Report (SCCD, 2003). Subsequent limited habitat assessment data collected by WDEQ in 2004 in the Goose Creek watershed were presented and discussed in the 2005 Goose Creek Watershed Monitoring Project (SCCD, 2006). Habitat assessment data collected by SCCD in 2009 in the Goose Creek watershed were presented and discussed in the 2009 Goose Creek Watershed Interim Monitoring Project (SCCD, 2011). No habitat assessments were conducted in the Goose Creek watershed during 2003, 2006, 2007 and 2008. Further habitat assessment data collected by SCCD in 2012 were presented and discussed in the 2012 Goose Creek Watershed Interim Monitoring Project (SCCD, 2014). The number of stations assessed by SCCD in 2012 was slightly higher than the number of stations assessed in both 2005 and 2009. Big Goose Creek upstream control station BG18 and Little Goose Creek upstream control station LG22 were added to the 2012 sampling schedule. Habitat assessment data collected in 2015 were presented in the 2015 Goose Creek Watershed Interim Monitoring Project (SCCD, 2017). Big Goose Creek BG18 and Little Goose Creek station LG22 were not included in the 2015 sampling schedule. WDEQ collected duplicate macroinvertebrate samples at Little Goose Creek station MRC 38 (SCCD station LG22) during 2014 but did not collect comparable habitat assessment data to that collected by SCCD and thus, was not included in this report.

6.9.2 Habitat Assessments in 2021

A total of nine habitat assessments were conducted by SCCD in 2021 from eight stations. One habitat assessment was conducted from two Goose Creek stations (station GC01 and station GC02), four habitat assessments were conducted from three Big Goose Creek stations (station BG02, station BG10 and station BG18) and three habitat assessments were conducted from three Little Goose Creek stations (station LG2A, station LG10 and station LG22). Included in the total number of habitat assessments was a duplicate habitat assessment collected at Big Goose Creek station BG2. The duplicate assessment was used only for QA/QC purposes and for general discussion of habitat assessment results.

The reduced number of stations assessed during 2005, 2009, 2012, 2015, 2018 and 2021 when compared to the initial project sampling regime in 2001 and 2002 precluded a complete evaluation of the habitat assessments between years and the comparison of habitat assessments at each station in the Goose Creek watershed.

Field habitat assessment methods employed by SCCD in 2001, 2002, 2005, 2009, 2015, 2018 and 2021 were the same since the initial habitat assessments in 2001. The habitat assessments over the years were conducted in September or October. Habitat assessments at a station were generally conducted on sampling dates within $\pm$ two (2) weeks of one another each year. Results from the habitat assessments conducted during 2021 are presented in Appendix E. Because the habitat assessments were qualitative, SCCD used caution by providing a conservative interpretation of data. Although several elements of the habitat assessments were subjective, the habitat data when combined with photo points, may identify general habitat quality change among sample stations, between sample stations over time, and identify differences in habitat components such as stream channel and riparian zone characteristics, substrate composition and silt deposition.

6.9.3 Goose Creek Habitat Assessments

There was no large change in habitat at Goose Creek stations GC01 or GC02 from 1998 to 2012. The total habitat score at station GC01 varied little between those years ranging from a total score of 121.5 in 2001 to a

total score of 131 in 2012 (Appendix E). Habitat assessment values increased at station GC01 during 2015 (158) and 2018 (155.5). The enhanced habitat assessment score at station GC01 was due to lower embeddedness (amount of sand and silt surrounding or covering cobble, coarse and fine gravel substrate) and increased instream cover (Appendix E). The total habitat score decreased to 123 in 2021. The decrease in the habitat score was due primarily to increased embeddedness and reduced instream cover. The total habitat score at station GC02 also varied little between 1998 to 2012 ranging from a total score of 99.5 in 2012 to a total score of 132 in 2015 (Appendix E). Habitat assessment values slightly increased at station GC02 during 2015 (132) and 2018 (140.5), then declined to 116 in 2021. The reduction in habitat from 2015 and 2018 to 2021 was due to increased embeddedness and moderate to slight decreases in several other habitat parameters.

Stream substrate composition at station GC01 and station GC02 generally improved since 2001 with an increase in percent cobble and percent coarse gravel, and a decrease in sand (Appendix E). A mixture of substrate of different sizes was present and provided good microhabitat for the establishment and maintenance of a diverse benthic macroinvertebrate community which serves as a food source for fish. The amount of fine silt covering cobble and gravel (the weighted embeddedness value) was variable at station GC01 and station GC02 since 2001.

6.9.4 Big Goose Creek Habitat Assessments

Habitat quality scores at Big Goose Creek station BG02 were variable from 1994 to 2021 (Appendix E). The habitat quality at station BG10 declined from 2001 to 2005, then improved in 2009 and decreased in 2012 and 2015. The habitat quality increased in 2018 and 2021. The habitat at upstream control station BG18 was relatively consistent during the period from 1998 through 2021 (Appendix E). The habitat assessment scores ranged from 146 in 2002 to 167 in 2001. The habitat assessments conducted over the years at Big Goose Creek stations consistently found with few exceptions, that the upstream control station BG18 exhibited the highest habitat quality when compared to the other downstream stations.

The composition of stream substrate was dominated by cobble at stations BG02, BG10 and BG18 since monitoring began in 1994 except for the percent of cobble at station BG02 in 1998 when cobble comprised 39 percent and coarse gravel comprised 52 percent. Of concern was the occasional high occurrence of sand at certain Big Goose Creek stations over the years. As previously indicated in Section 6.8.2, sand and silt in stream substrate are concerning since they are detrimental to trout egg survival and the maintenance of healthy benthic macroinvertebrate populations that provide food for trout.

From 1994 to 2021, the composition of sand at station BG02 varied from 0 percent in 1998 and 2021 to 31 percent in 1994. Most readings for the composition for sand in the stream substrate ranged from 14 percent to 26 percent composition (Appendix E). Stream substrate composition for sand was generally low and stable at station BG10 from 2001 to 2018 ranging from 4 percent in 2002 to 19 percent in 2021. The average percent composition of sand at station BG10 from 2001 to 2021 was 9 percent. The composition of sand at BG18 previously mentioned in Section 6.8, found that sand was relatively low from 1998 to 2002 (averaging 10 percent), but increased to 33 percent of the stream substrate in 2012, 27 percent in 2018 and 21 percent in 2021 (Appendix E).

6.9.5 Little Goose Creek Habitat Assessments

Habitat quality has remained low at Little Goose Creek station LG2A since sampling began by WDEQ in 1994 (Appendix E). The lowest habitat score (77) at station LG2A during 2012 was due primarily to channelization of Little Goose Creek for flood control in Sheridan that reduced undercut banks, the number of pools, instream cover for fish, and the riparian zone width. The channelization for flood control isolated the stream from the

normal floodplain affecting the dynamics of stream flow and disrupting stream habitat at and downstream from the immediate channelized reaches. The habitat quality at station LG2A ranked 2nd lowest among all stations assessed in the Goose Creeks watershed during 2001-2002 (SCCD, 2003). Cobble dominated the stream substrate followed by coarse gravel and then sand. Sand averaged about 20 percent of the stream substrate from 1994 to 2021 which was considered moderate.

There were no large changes in habitat at Little Goose Creek station LG10 from 2001 to 2021 (Appendix E). The range in habitat assessment scores ranged from 126.5 during 2001 to 154.0 during 2021. The average total habitat assessment score since 2001 at LG10 was 143 compared to an average total habitat assessment score of 108 at station LG2A. Cobble dominated the stream substrate followed by coarse gravel and then sand. Sand has averaged about 21 percent of the stream substrate since 2001, which was considered moderate.

Upstream control station LG22 exhibited the best habitat. Total habitat scores ranged from 150 in 2012 to 172 in 1998 (Appendix E). The average habitat quality score from 1996 to 2021 was 162. The stream substrate at station LG22 was dominated by cobble ranging from 25 percent in 2021 to 72 percent in 1998 and averaged 59 percent. Mean coarse gravel from 1996 to 2021 was 11 percent, fine gravel was 13 percent and sand comprised 17 percent of the total stream substrate. The mean weighted embeddedness value (amount of silt covering and surrounding cobble and gravels) during this time frame was 92 indicating that about 88 percent of cobble and gravels were free of silt.

6.9.6 Relation of Habitat Assessments to Biological Condition

Good stream habitat is critical for the establishment and maintenance of good fishery, benthic macroinvertebrate populations and other aquatic life. Habitat quality is directly related to biological condition at streams in the Goose Creek watershed (see Figure 8-99 in Goose Creek Watershed Assessment 2001-2002, Final Report (SCCD, 2003)). The relationship between habitat quality and biological condition was strong and significant (Correlation Coefficient = 0.7235; $p<0.99$). This relationship is important because improvement in habitat quality, in the absence of effects due to water quality, will result in improved biological condition. Those Goose Creek, Big Goose Creek and Little Goose Creek stations exhibiting Indeterminate Support or Partial/ Non - Support of aquatic life use may be improved by enhancing habitat quality.

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

In 2021, SCCD monitored water temperature, pH, conductivity, dissolved oxygen, discharge, turbidity, and *E. coli* at 17 sites including 11 mainstem sites and six tributary sites. There were three mainstem sites on Goose Creek, four mainstem sites on Big Goose Creek, and four mainstem sites on Little Goose Creek. Tributary sites included Soldier Creek (tributary to Goose Creek); Beaver Creek and Rapid Creek (tributaries to Big Goose Creek); and McCormick Creek, Kruse Creek, and Jackson Creek (tributaries to Little Goose Creek).

Instantaneous temperature samples were recorded at or above the 20°C instream standard at one site on June 22, ten sites on July 7, 11 sites on July 20, and eight sites on August 2. Similarly, continuous water temperatures also exceeded the standard at all sites where temperature loggers were deployed (GC01, BG01, BG10, LG02, and LG08), apart from the two canyon sites (BG18 and LG22). Most exceedances occurred in July and August.

Conductivity and pH values were within the expected ranges during 2021. All samples met the minimum instantaneous dissolved oxygen concentration standard of 4.0 mg/L for other life stages and 5.0 mg/L for early life stages. Nine mainstem samples and six tributary samples were below the 8.0 mg/L recommended to achieve 5.0 mg/L intergravel concentrations for early life stages. Most samples that were below the recommendation were those collected in July and August. All other samples at mainstem and tributary sites were above the recommended 8.0 mg/L. Turbidity averages were considered normal for the watershed with occasional high values occurring during late-spring, early summer precipitation, and run-off events.

Early, mid, and late season bacteria geometric means exceeded the standard at all sites, except for early season geometric means at the three upper Big Goose sites (BG10, BG14, and BG18), LG08, and LG22, and mid-season and late season geometric means at BG18 and LG22. Late season concentrations were higher than mid and late-season concentrations at most sites. Overall, mean bacteria concentrations have been increasing since sampling first began in 2001 at all sites, despite 2021 concentrations at most mainstem sites being lower than those recorded when sampling was last completed in this watershed in 2018.

Benthic macroinvertebrate sampling was conducted at eight stations in September 2021. Biological condition at the lowermost Goose Creek station GC1, was indeterminate for all years except for 2012 and 2021 when it was partial/non-supporting. Biological condition has generally declined since 1998. However, biological condition at the lower Goose Creek station GC1 was generally better than biological condition at the upper Goose Creek station GC2. This observation contrasted with a general decline in biological condition from upstream to downstream stations noted at Big Goose Creek and Little Goose Creek stations.

Biological condition was fully supporting at Big Goose Creek station BG2 during 2018. Biological condition varied at this station from full support in 1998 and 2018 to partial/non-supporting and indeterminate supporting from 2001 to 2015 and 2021. Biological condition at Big Goose Creek station BG10 has been variable since sampling began in 2001. Biological condition was fully supporting in 2001 with a subsequent decline to Indeterminate support from 2002 to 2009. Biological condition increased in 2009, decreased to partial/non-supporting in 2012, and increased to Indeterminate support in 2015 and 2018. Biological condition was fully supporting in 2021. Benthic macroinvertebrate sampling at the uppermost control station BG18 in 1998 by WDEQ, and subsequent sampling by SCCD in 2001, 2002, and 2012 found that biological condition was fully supporting. Sampling in 2018 showed a reduction in biological condition from full support to indeterminate support. The reduction in biological condition did not appear to be related to a

reduction in water quality, but to an increase in sand in the stream substrate starting in 2012. Biological condition was fully supporting in 2021.

The biological condition at Little Goose Creek station LG2A has been variable since sampling by WDEQ began in 1994. The trend in biological condition at station LG2 has improved since 1994 at station LG2. This is an important observation since other than Goose Creek station GC2, no other station sampled in 2021 in the Goose Creek watershed exhibited an improving trend in biological condition. Biological condition at station LG10 was Indeterminate from 1998 to 2002, then decreased to partial/non-supporting from 2005 to 2021. Although biological condition decreased from the 1998-2002 period to the 2005-2015 period, biological condition was generally similar during each sampling event from 2005 to 2021.

Biological condition at the uppermost Little Goose Creek control station LG22 was fully supporting from 1996 to 2021. However, the trend in biological condition at station LG22 was similar to the trend in biological condition at the Big Goose Creek reference station BG18 in that both stations have exhibited a decline in biological condition since 1998.

Continued benthic macroinvertebrate sampling is recommended at current Goose Creek, Big Goose Creek, and Little Goose Creek stations, and at all original Goose Creek watershed stations as funding allows, to track changes in biological condition. Planning and implementation of remedial measures should continue to restore full aquatic life use support in streams in the Goose Creek watershed.

Attempts to determine if improvements in overall water quality have been achieved are often difficult, especially when comparing water quality data that has been collected during seasons with different hydrological and meteorological conditions. Although normal flow conditions cannot be anticipated nor expected during monitoring, these varying conditions do make water quality comparisons more difficult. Bacteria concentrations are known to vary in response to several different water quality and water quantity factors, including changes in water temperature, water quantity, and suspended sediment loads.

Attempts to determine if improvements in overall water quality have been achieved are often difficult, particularly when comparing water quality data that has been collected during seasons with different hydrological and meteorological conditions. Although normal flow conditions cannot be anticipated nor expected during monitoring, these varying conditions make water quality comparisons more difficult.

Like other watersheds in Sheridan County, the Goose Creek watershed serves as an important resource for agriculture, wildlife, and scenic value. In addition, the Goose Creek watershed provides the municipal water supply for the City of Sheridan and surrounding area. The watershed, as it exists today, has been defined by residential development, irrigation practices, and agricultural production. Best Management Practices addressing bacteria and sediment sources, irrigation water conservation and management, and riparian livestock management can be implemented to improve water quality and the overall health of the watershed.

Efforts within the watershed have increased local awareness about several important resource issues and has led to more public interest in the watershed. Continued monitoring can provide information on water quality changes over the long-term. SCCD will continue to monitor water quality in the Goose Creek watershed on a three-year rotation, pending available funding sources. The SCCD anticipates that voluntary, incentive-based watershed planning, and implementation efforts will eventually be successful; however, it may require several years to measure these achievements. Nonetheless, each improvement project implemented in the watershed certainly induces positive water quality changes, whether they are immediately evident or not.

CHAPTER 8 REFERENCES CITED

Barbour, M. G. (1999). *Rapid bioassessment of use in streams and wadeable rivers; periphyton benthic macroinvertebrates, and fish.* Washington, D.C. : U.S. Environmental Protection Agency, Office of Water.

Chutter, F.M. (1969). The effects of sand and silt on the invetebrate fauna of streams and rivers. *Hydrobiologia 34*, 57-76.

Friendmann, L.C. & Erdmann, D.E. (1982). Quality assurance practices for chemical and biological analyses of water and fluvial sediments. In *Techniques of water-resources investigations of the United States Geological Survey* (Vols. 5, Laboratory analysis). Washington, D.C.

Gilbert, R.O. (1987). *Statistical methods for environmental pollution monitoring.* New York, NY: Van Nostrand Reinhold Press.

Hargett, E. (2011). *Wyoming Stream Integrity Index (WSII) - multimeric indices for assessment of wadeable streams and large rivers in Wyoming.* Water Quality Division. Cheyenne, WY: Wyoming Department of Environmental Quality.

Hargett, E.G. & ZumBerge, J.R. (2006). *Redevelopment of the Wyoming Stream Integrity Index for assessing the biological condition of wadeable streams in Wyoming.* Water Quality Division. Cheyenne, WY: Wyoming Department of Environmental Quality.

Jessup, B.K. & Stribling, J.B. (2002). *Further evaluation of the Wyoming Stream Integrity Index, considering quantitative and qualitative reference site criteria.* U.S. EPA Region 8. Denver, CO: Tetra Tech, Inc.

King, K.W. (1990). *Effects of oil field produced water discharges on pond zooplankton populations.* Cheyenne, WY: Wyoming Department of Environmental Quality, Water Quality Division.

King, K.W. (1993). *A bioassessment method for use in Wyoming stream and river water quality monitoring.* Cheyenne, WY: Wyoming Department of Environmental Quality, Water Quality Division.

Love, J.D. & Christiansen, A.C. (1985). *Geologic map of Wyoming.* U.S. Geological Survey.

Nutall, P. (1972). *The effects of sand deposition upon the macroinvertebrate fauna of the River Camel, Cornwall.* Freshwater Biology 2(3): 181-186.

Rosenberg, D.M. & Resh, V.H. (1993). Introduction to freshwater biomonitoring and benthic macroinvertebrates. In D. Rosenberg, & V. Resh, *Freshwater biomonitoring and benthic macroinvertebrates* (pp. 1-9). New York: Chapman and Hall.

SCCD. (2003). *Goose Creek Watershed Assessment 2001-2002 Final Report.* Sheridan, WY: Sheridan County Conservation District.

SCCD. (2004). *The Goose Creek Watershed Management Plan.* Sheridan, WY: Sheridan County Conservation District.

SCCD. (2006). *2005 Goose Creek Watershed Interim Monitoring Report.* Sheridan, WY: Sheridan County Conservation District.

SCCD. (2011). *2009 Goose Creek Watershed Interim Monitoring Report.* Sheridan, WY: Sheridan County Conservation District.

SCCD. (2012). *Goose Creek Watershed Improvement Effort Implementation Strategy* . Sheridan, WY: Sheridan County Conservation District.

SCCD. (2014). *2012 Goose Creek Watershed Interim Monitoring Project Final Report.* Sheridan, WY: Sheridan County Conservation District.

SCCD. (2017). *2015 Goose Creek Watershed Interim Monitoring Project Final Report.* Sheridan, WY: Sheridan County Conservation District.

SCCD. (2018). *Quality Assurance Project Plan.* Sheridan, WY: Sheridan County Conservation District.

SCCD. (2020). *2018 Goose Creek Watershed Interim Monitoring Project Final Report.* Sheridan, WY: Sheridan County Conservation District.

SCCD. (2021). *2021 Goose Creek Watershed Sampling and Analysis Plan.* Sheridan, WY: Sheridan County Conservation District.

Stephenson, G. & Rhychert, R. (1982). Bottom Sediment: A Reservoir of Escherichia coli in Rangeland Streams. *Journal of Range Management*(35), 119-123.

Stribling, J., Jessup, B., & Gerritsen, J. (2000). *Development of biological and physical habitat criteria for Wyoming streams and their use in the TMDL process.* US. EPA Region 8. Denver, CO: Tetra Tech, Inc.

SWCA. (2010). *Goose Creek Watershed TMDLs. Prepared for Wyoming Department of Environmental Quality.* Sheridan, WY: SWCA Environmental Consultants.

Tiziano, B. S. (2007). *Effects of clogging on stream macroinvertebrates: An experimental approach.* Limnologica (37)2: 186-192.

USDA. (1986). *1986 Major Land Resource Areas Map and Descriptions for Wyoming from Sheridan Field Office Technical Guide.* Sheridan, WY: United States Department of Agriculture Natural Resources Conservation Service.

USEPA. (1980). *Interim guidelines and specifications for preparing quality assurance project plans.* Office of Research and Development. Washington, D.C.: United States Environmental Protection Agency.

USEPA. (1995). *Generic quality assurance project plan guidance for programs using community-level biological assessment in streams and wadeable rivers.* Office of Water. Washington, D.C.: United States Environmental Protection Agency.

WDEQ. (2005). *Goose Creeks storm water report.* Cheyenne, WY: Water Quality Division, Wyoming Department of Environmental Quality.

WDEQ. (2013). *Wyoming Nonpoint Source Management Plan Update.* Wyoming Department of Environmental Quality, Water Quality Division, Nonpoint Source Program, Cheyenne, WY.

WDEQ. (2014). *Wyoming's Methods for Determining Surface Water Quality Condition and TMDL Prioritization.* Cheyenne, WY: Wyoming Department of Environmental Quality.

WDEQ. (2018a). *Quality Assurance Program Plan.* Water Quality Division, Watershed Program. Cheyenne, WY: Wyoming Department of Environmental Quality.

WDEQ. (2018b). *Water Quality Rules and Regulations, Chapter 1, Quality standards for Wyoming surface waters.* Cheyenne, WY: Wyoming Department of Environmental Quality.

WDEQ. (2018c). *Water Quality Rules and Regulations Chapter VIII, Quality standards for Wyoming groundwaters.* Cheyenne, WY: Wyoming Department of Environmental Quality.

WDEQ/WQD. (2020a). *Wyoming's 2020 Integrated 305(b) and 303(d) Report.* Cheyenne, WY: Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program. Retrieved from http://deq.wyoming.gov/water-quality/watershed-protection/water-quality-assessment

WDEQ/WQD. (2021a). *Manual of Standard Operating Procedures for Sample Collection and Analysis.* Cheyenne, wyoming: Wyoming Department of Environmental Quality. Water Quality Division, Watershed Protection Program.

WDEQ/WQD. (2021b). *Wyoming Surface Water Classification List.* Water Quality Division, Surface Water Quality Standards. Cheyenne, WY: Wyoming Department of Enviornmental Quality. Retrieved from https://deq.wyoming.gov/water-quality/watershed-protection/surface-water-quality-standards/

APPENDIX A

2021 GOOSE CREEK WATERSHED MAPS

APPENDIX A. 2021 GOOSE CREEK WATERSHED MAPS
FIGURE A-1. PROJECT AREA WITH SAMPLE SITES

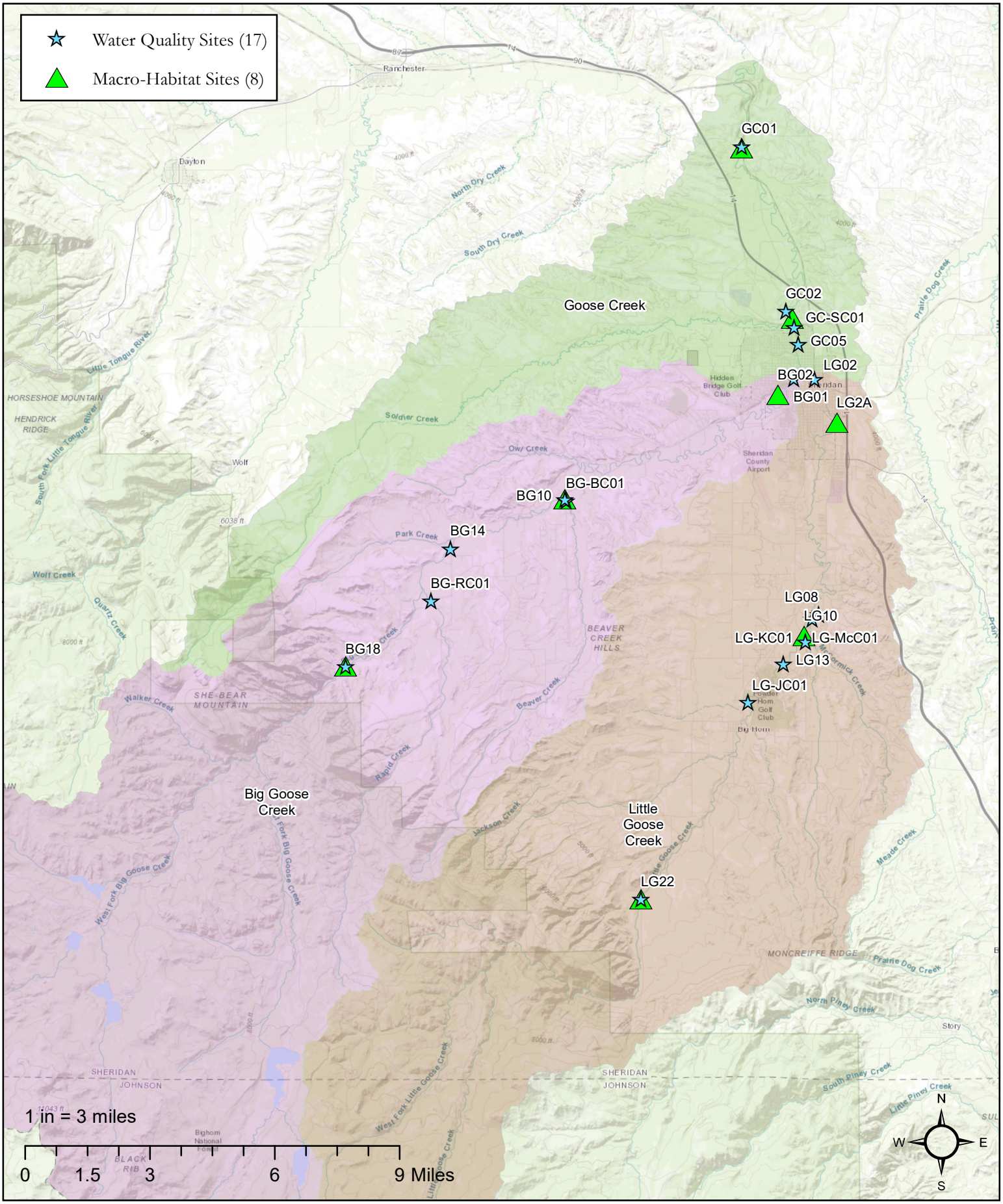


FIGURE A-2. PRECPITATION ZONES (INCHES)

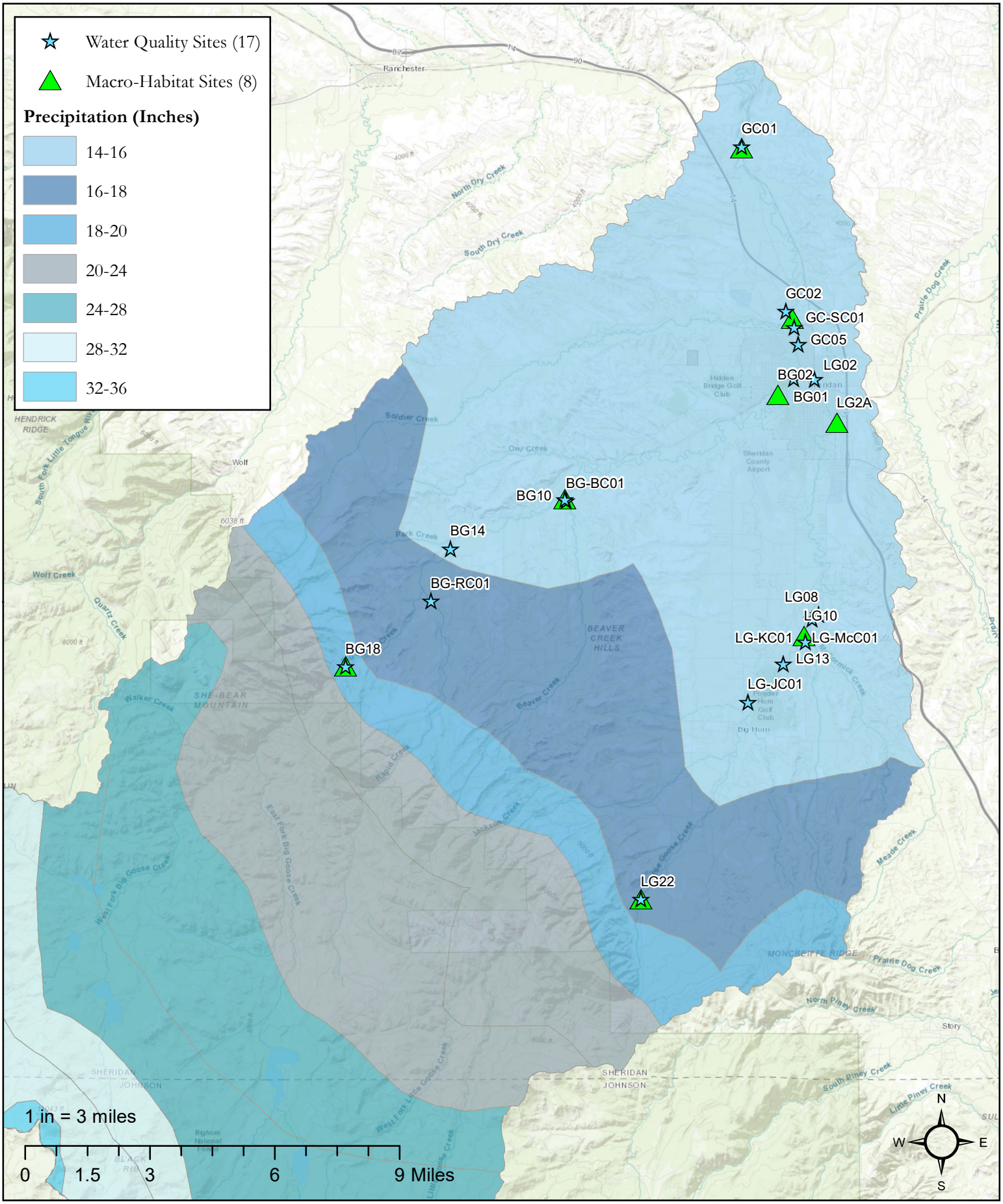


FIGURE A-3. ECOSITES

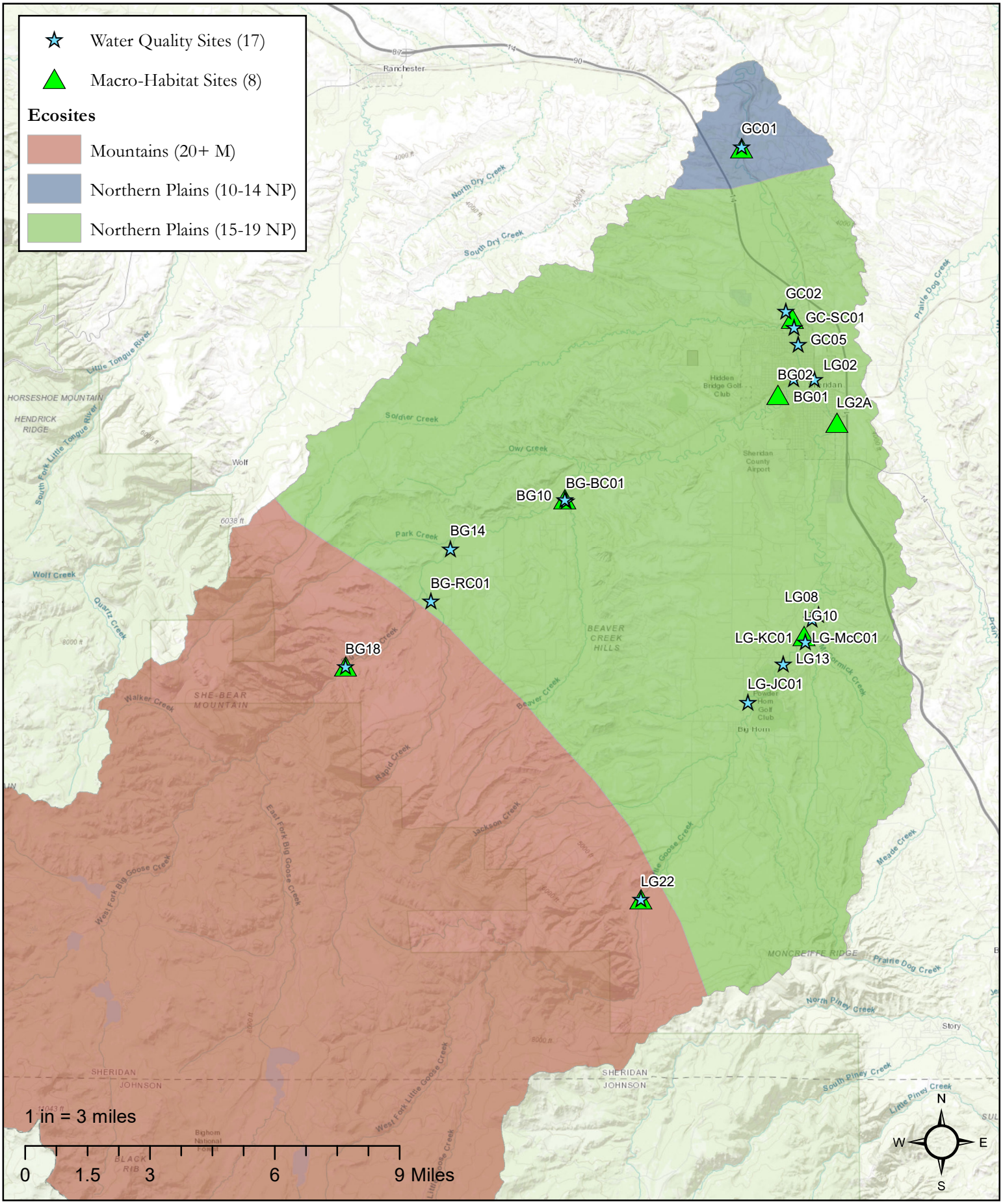


FIGURE A-4. LAND OWNERSHIP

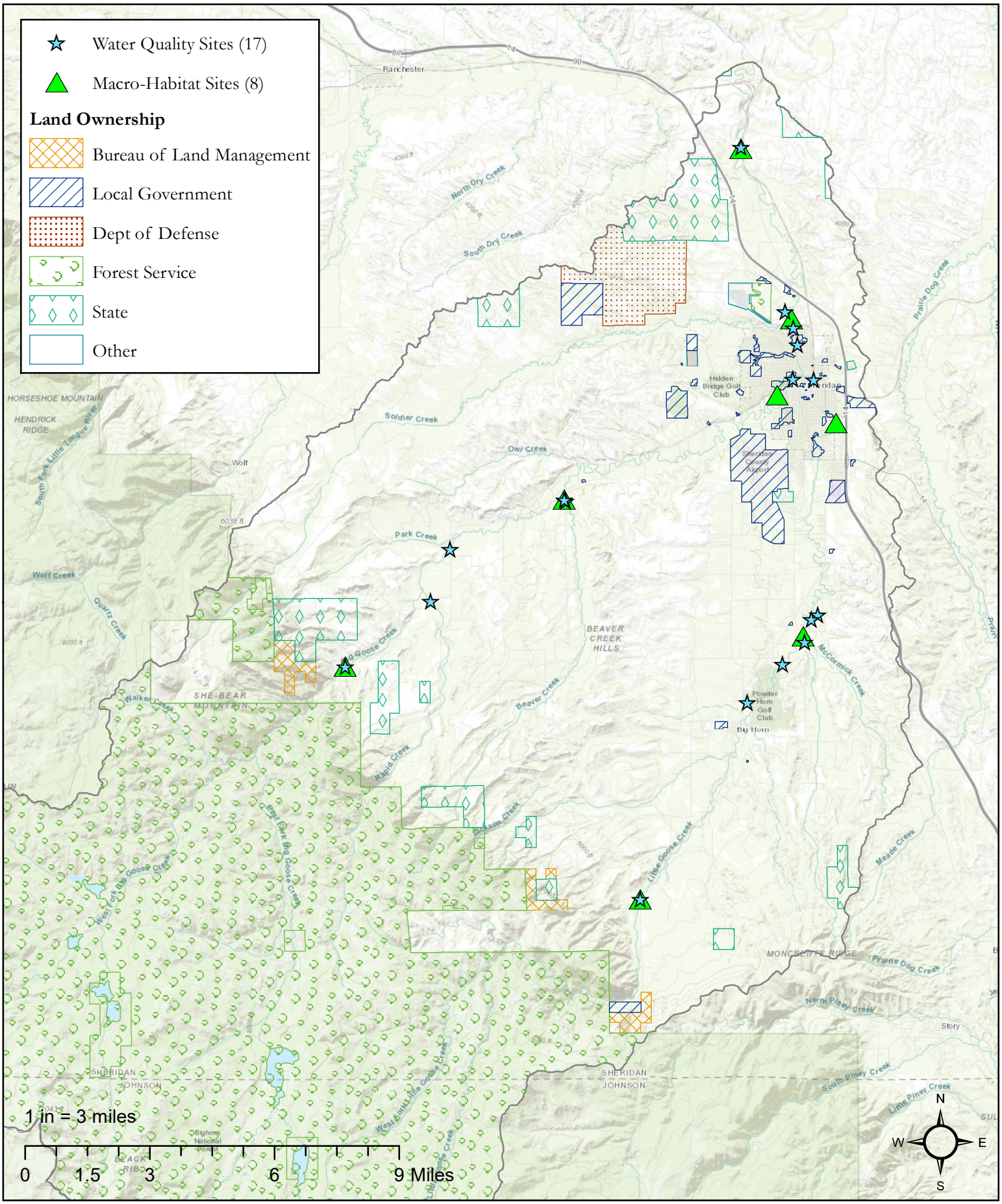


FIGURE A-5. LAND USE

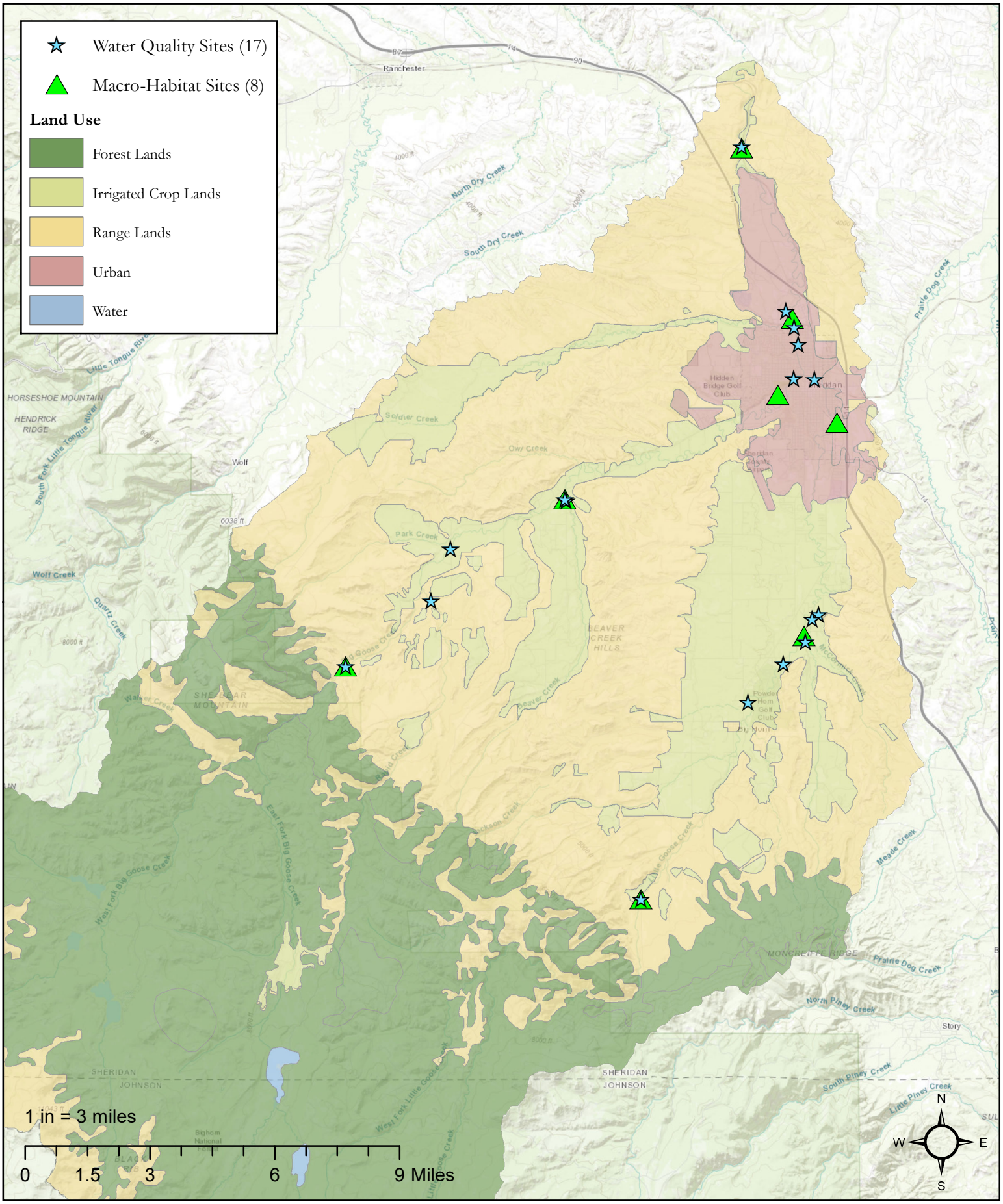


FIGURE A-6. PROGRESS REGISTER

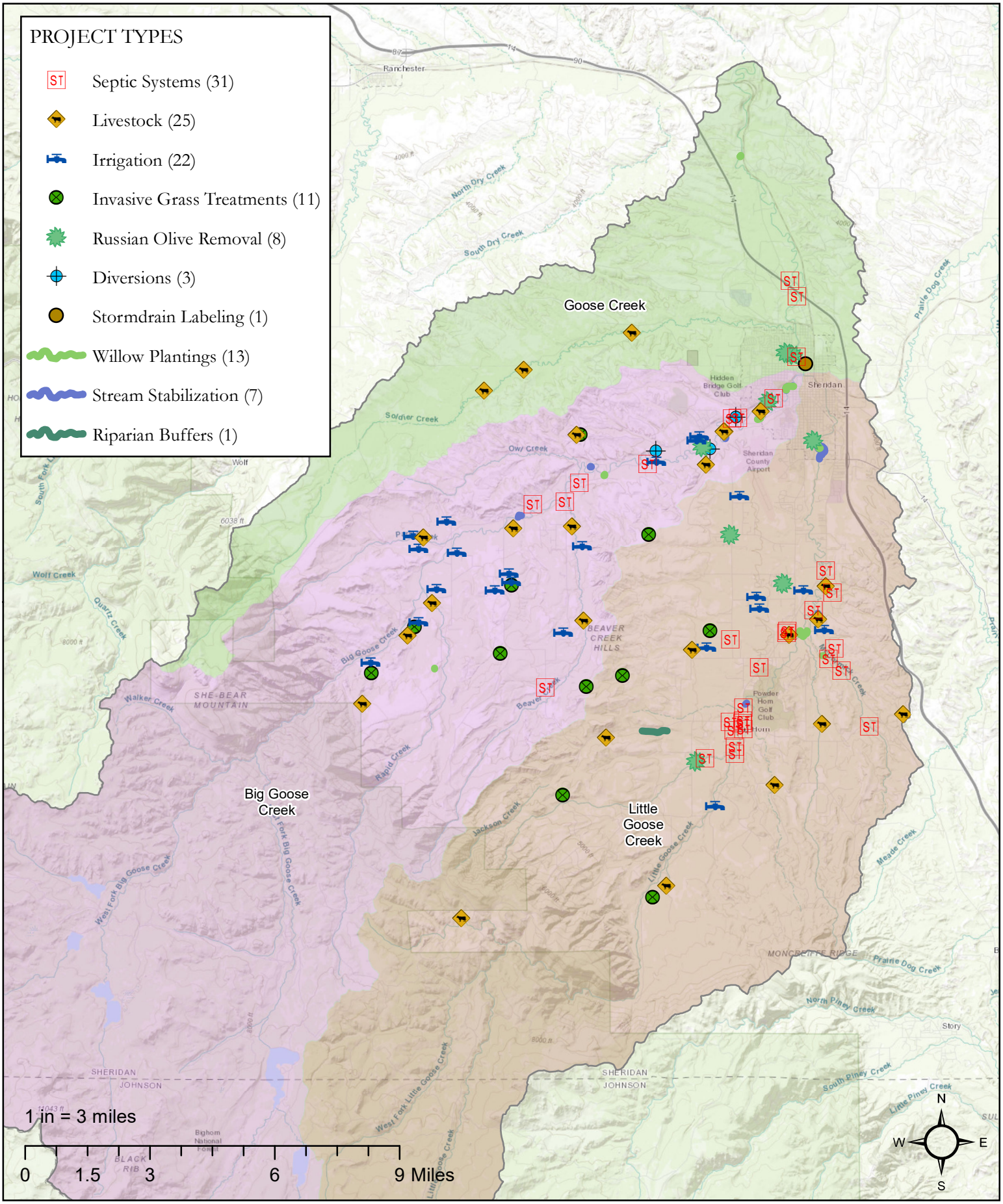
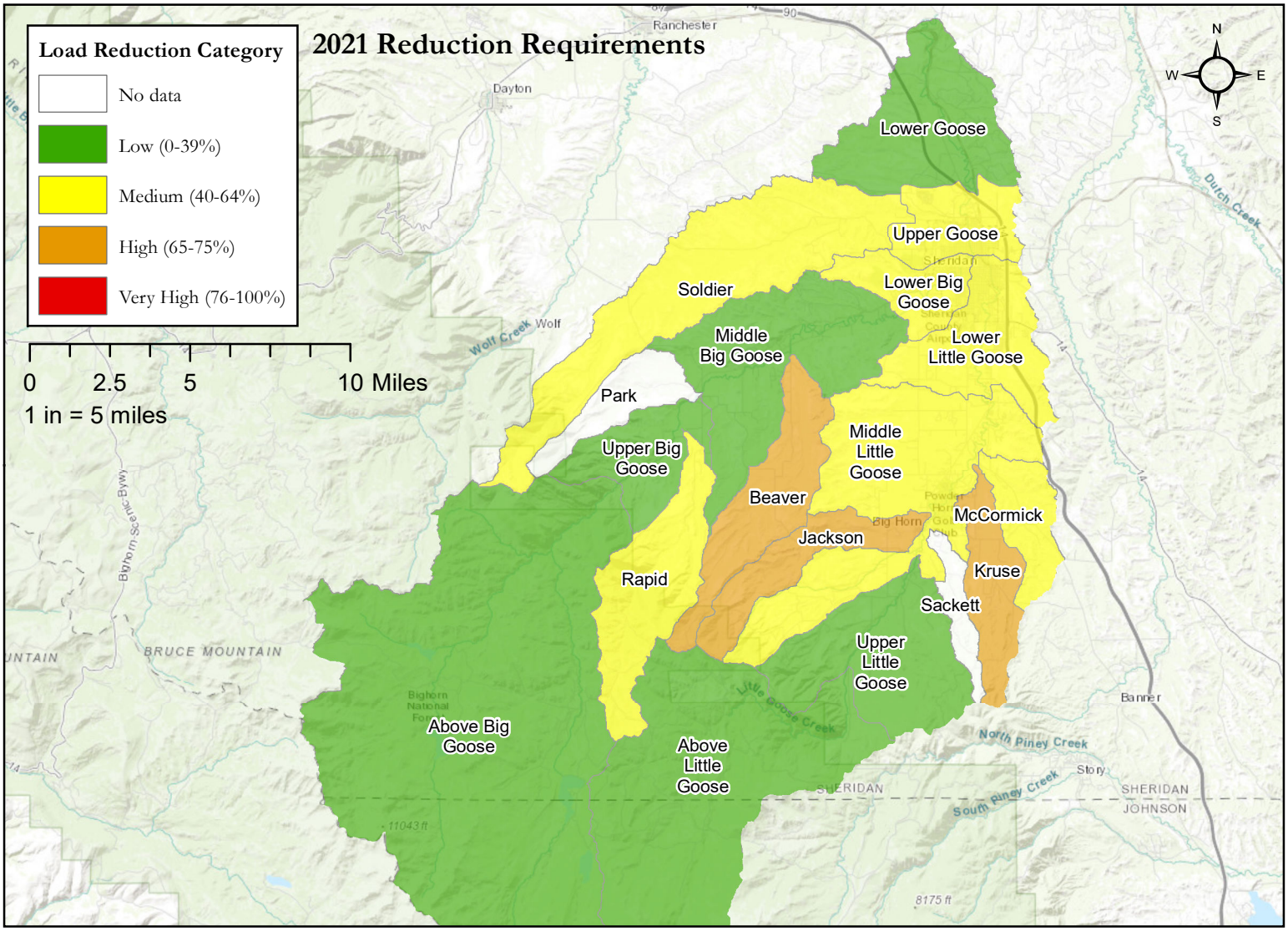
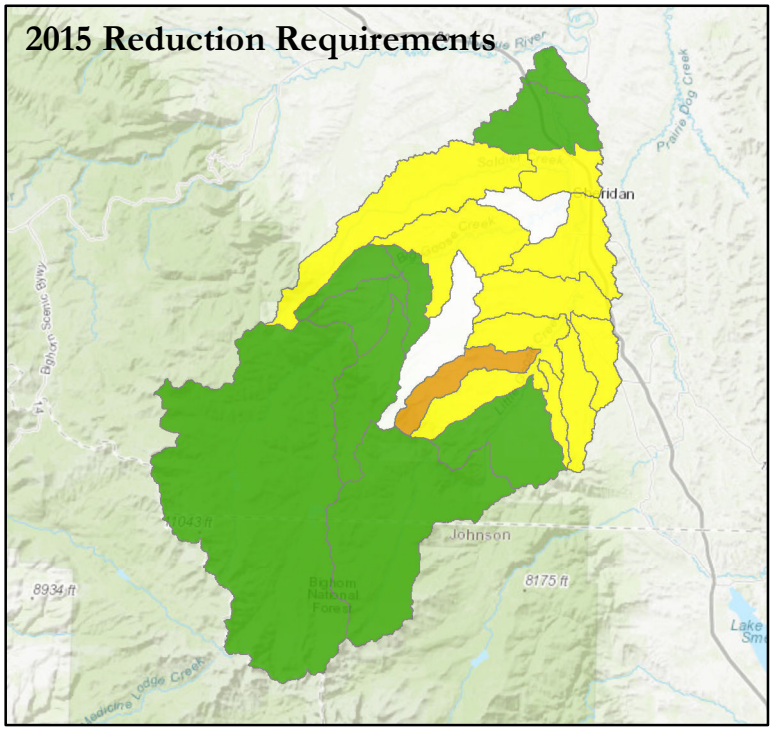
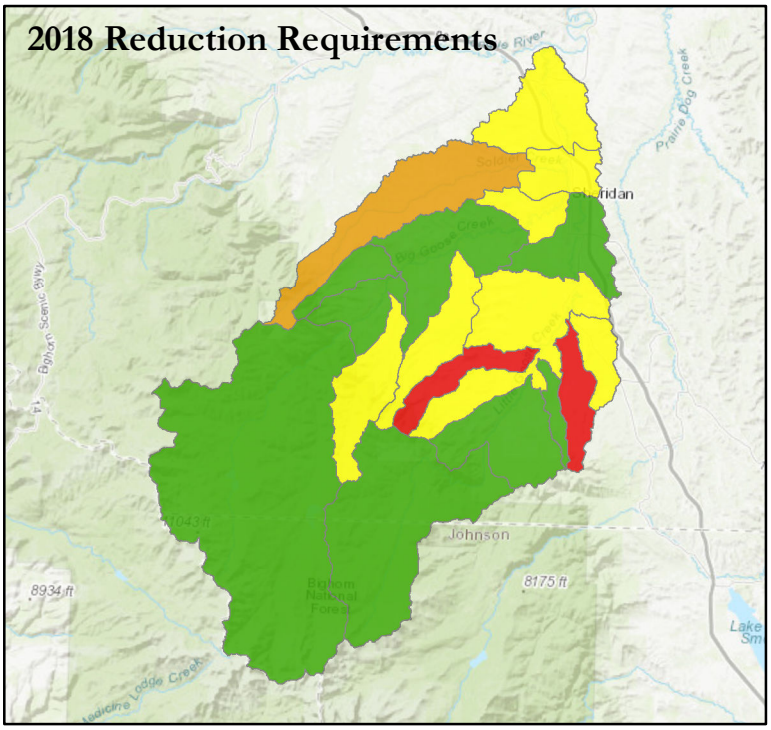


FIGURE A-7. LOAD REDUCTION COMPARISONS







APPENDIX B

2021 GOOSE CREEK WATERSHED QUALITY CONTROL/QUALITY ASSURANCE

APPENDIX TABLE B-1. GOOSE CREEK WATERSHED 2021 CODES

Water Quality Data Codes	Parameter	Unit
DATE	Collection Date	Year, Month, Day
TIME	Collection Time	Military Time
TEMP	Water Temperature	Degrees Centigrade
PH	pH	Standard Units
COND	Specific Conductivity	µmho/cm
DO	Dissolved Oxygen	mg/L
DO %	Dissolved Oxygen % Saturation	%
STAFF	Staff Gauge Height	Feet
DISCH	Stream Flow	CFS
TURB	Turbidity	NTU
E.COLI	*Escherichia coli*	MPN/100ml
QAQC	QA/QC Validation Complete	Initials

APPENDIX TABLE B-2. GOOSE CREEK WATERSHED 2021 DATA QUALIFIERS

Data Qualifier Codes	Definition
B	Analyte deteced in the associated method blank
CG	Sample result reported as greater than 1 µmho/cm
DIS	Sample results rejected due to inability to meet quality control critiera
DO	100 percent air saturation exceeded
DQ	Data quality objective not met
EG	Sample result reported as greater than 2419 MPN/100 mL
EL	Sample result reported as less than 1 MPN/100 mL
H	Holding time exceeded
LE	Lab reporting error, correct value listed. See lab sheets for initial value reported.
ND	Not detectable at reporting limits
NS	Not sampled
SA	Staff height adjusted
SO-SUB	Gauge fully submerged; unable to take reading.
SO-OUT	Gauge out of water; unable to take reading.

Agency Abbreviations	Agency
SCCD	Sheridan County Conservation District
USFS	United States Forest Service
USGS	United States Geological Survey
WDEQ	Wyoming Department Environmental Quality
WGFD	Wyoming Game and Fish Department
WWRC	Wyoming Water Resources Center

APPENDIX TABLE B-3. RESULTS OF PRE- AND POST-SEASON ICE TESTS

GC01				BG01				BG10				BG18			
S/N: 9927129				S/N: 20029727				S/N: 9927127				S/N: 9775391			
Pre 5/8/2021		Post 2/19/2022		Pre 5/8/2021		Post 2/19/2022		Pre 5/8/2021		Post 2/19/2022		Pre 5/8/2021		Post 2/19/2022	
Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C
8:30	0.563	9:30	0.893	8:30	0.453	9:30	1.112	8:30	0.784	9:30	1.003	8:30	0.784	9:30	1.439
8:31	0.453	9:31	0.563	8:31	0.343	9:31	0.784	8:31	0.563	9:31	0.674	8:31	0.563	9:31	1.003
8:32	0.343	9:32	0.343	8:32	0.343	9:32	0.563	8:32	0.453	9:32	0.453	8:32	0.453	9:32	0.784
8:33	0.343	9:33	0.343	8:33	0.232	9:33	0.343	8:33	0.343	9:33	0.343	8:33	0.343	9:33	0.563
8:34	0.232	9:34	0.232	8:34	0.232	9:34	0.343	8:34	0.343	9:34	0.343	8:34	0.343	9:34	0.453
8:35	0.232	9:35	0.232	8:35	0.232	9:35	0.232	8:35	0.343	9:35	0.232	8:35	0.232	9:35	0.343
8:36	0.232	9:36	0.121	8:36	0.121	9:36	0.232	8:36	0.232	9:36	0.232	8:36	0.232	9:36	0.232
8:37	0.232	9:37	0.121	8:37	0.121	9:37	0.121	8:37	0.232	9:37	0.232	8:37	0.232	9:37	0.232
8:38	0.121	9:38	0.121	8:38	0.121	9:38	0.121	8:38	0.232	9:38	0.232	8:38	0.232	9:38	0.232
8:39	0.121	9:39	0.121	8:39	0.121	9:39	0.121	8:39	0.232	9:39	0.232	8:39	0.121	9:39	0.232
8:40	0.121	9:40	0.121	8:40	0.121	9:40	0.121	8:40	0.232	9:40	0.232	8:40	0.121	9:40	0.121
8:41	0.121	9:41	0.121	8:41	0.121	9:41	0.121	8:41	0.232	9:41	0.232	8:41	0.121	9:41	0.121
8:42	0.121	9:42	0.121	8:42	0.121	9:42	0.121	8:42	0.232	9:42	0.232	8:42	0.121	9:42	0.121
8:43	0.121	9:43	0.121	8:43	0.121	9:43	0.121	8:43	0.232	9:43	0.232	8:43	0.121	9:43	0.121
8:44	0.121	9:44	0.121	8:44	0.121	9:44	0.121	8:44	0.232	9:44	0.232	8:44	0.121	9:44	0.121
8:45	0.121	9:45	0.121	8:45	0.121	9:45	0.121	8:45	0.232	9:45	0.121	8:45	0.121	9:45	0.121
8:46	0.121	9:46	0.121	8:46	0.121	9:46	0.121	8:46	0.232	9:46	0.232	8:46	0.121	9:46	0.121
8:47	0.121	9:47	0.121	8:47	0.121	9:47	0.121	8:47	0.232	9:47	0.232	8:47	0.121	9:47	0.121
8:48	0.121	9:48	0.121	8:48	0.121	9:48	0.121	8:48	0.232	9:48	0.232	8:48	0.121	9:48	0.121
8:49	0.121	9:49	0.121	8:49	0.121	9:49	0.121	8:49	0.232	9:49	0.232	8:49	0.121	9:49	0.121
8:50	0.121	9:50	0.121	8:50	0.121	9:50	0.121	8:50	0.232	9:50	0.232	8:50	0.121	9:50	0.121
8:51	0.121	9:51	0.121	8:51	0.121	9:51	0.121	8:51	0.232	9:51	0.232	8:51	0.121	9:51	0.121
8:52	0.121	9:52	0.121	8:52	0.121	9:52	0.121	8:52	0.232	9:52	0.232	8:52	0.121	9:52	0.121
8:53	0.121	9:53	0.121	8:53	0.121	9:53	0.121	8:53	0.232	9:53	0.232	8:53	0.121	9:53	0.121
8:54	0.121	9:54	0.121	8:54	0.121	9:54	0.121	8:54	0.121	9:54	0.121	8:54	0.121	9:54	0.121
8:55	0.121	9:55	0.121	8:55	0.121	9:55	0.121	8:55	0.232	9:55	0.232	8:55	0.121	9:55	0.121
8:56	0.121	9:56	0.121	8:56	0.121	9:56	0.121	8:56	0.232	9:56	0.121	8:56	0.121	9:56	0.121
8:57	0.121	9:57	0.121	8:57	0.121	9:57	0.121	8:57	0.232	9:57	0.121	8:57	0.121	9:57	0.121
8:58	0.121	9:58	0.121	8:58	0.121	9:58	0.121	8:58	0.232	9:58	0.232	8:58	0.121	9:58	0.121
8:59	0.121	9:59	0.121	8:59	0.121	9:59	0.121	8:59	0.232	9:59	0.232	8:59	0.121	9:59	0.121
9:00	0.121	10:00	0.121	9:00	0.121	10:00	0.121	9:00	0.121	10:00	0.232	9:00	0.121	10:00	0.121
9:01	0.121	10:01	0.121	9:01	0.121	10:01	0.121	9:01	0.121	10:01	0.232	9:01	0.121	10:01	0.121
9:02	0.121	10:02	0.121	9:02	0.121	10:02	0.121	9:02	0.232	10:02	0.121	9:02	0.121	10:02	0.121
9:03	0.121	10:03	0.121	9:03	0.121	10:03	0.121	9:03	0.232	10:03	0.232	9:03	0.121	10:03	0.121
9:04	0.121	10:04	0.121	9:04	0.121	10:04	0.121	9:04	0.232	10:04	0.232	9:04	0.121	10:04	0.121
9:05	0.121	10:05	0.121	9:05	0.121	10:05	0.121	9:05	0.232	10:05	0.121	9:05	0.121	10:05	0.121
9:06	0.121	10:06	0.121	9:06	0.121	10:06	0.121	9:06	0.232	10:06	0.121	9:06	0.121	10:06	0.121
9:07	0.121	10:07	0.121	9:07	0.121	10:07	0.121	9:07	0.121	10:07	0.232	9:07	0.121	10:07	0.121
9:08	0.121	10:08	0.121	9:08	0.121	10:08	0.121	9:08	0.232	10:08	0.232	9:08	0.121	10:08	0.121
9:09	0.121	10:09	0.121	9:09	0.121	10:09	0.121	9:09	0.232	10:09	0.121	9:09	0.121	10:09	0.121
9:10	0.121	10:10	0.121	9:10	0.121	10:10	0.121	9:10	0.232	10:10	0.121	9:10	0.121	10:10	0.121
9:11	0.121	10:11	0.121	9:11	0.121	10:11	0.121	9:11	0.232	10:11	0.232	9:11	0.121	10:11	0.121
9:12	0.121	10:12	0.121	9:12	0.121	10:12	0.121	9:12	0.232	10:12	0.232	9:12	0.121	10:12	0.121
9:13	0.121	10:13	0.121	9:13	0.121	10:13	0.121	9:13	0.232	10:13	0.232	9:13	0.121	10:13	0.121
9:14	0.121	10:14	0.121	9:14	0.121	10:14	0.121	9:14	0.232	10:14	0.232	9:14	0.121	10:14	0.121
9:15	0.121	10:15	0.121	9:15	0.121	10:15	0.121	9:15	0.121	10:15	0.232	9:15	0.121	10:15	0.121
9:16	0.121	10:16	0.121	9:16	0.121	10:16	0.121	9:16	0.121	10:16	0.232	9:16	0.121	10:16	0.121
9:17	0.121	10:17	0.121	9:17	0.121	10:17	0.121	9:17	0.121	10:17	0.121	9:17	0.121	10:17	0.121
9:18	0.121	10:18	0.121	9:18	0.121	10:18	0.121	9:18	0.121	10:18	0.121	9:18	0.121	10:18	0.121
9:19	0.121	10:19	0.121	9:19	0.121	10:19	0.121	9:19	0.232	10:19	0.232	9:19	0.121	10:19	0.121
9:20	0.121	10:20	0.121	9:20	0.121	10:20	0.121	9:20	0.121	10:20	0.121	9:20	0.121	10:20	0.121
9:21	0.121	10:21	0.121	9:21	0.121	10:21	0.121	9:21	0.232	10:21	0.232	9:21	0.121	10:21	0.121
9:22	0.121	10:22	0.121	9:22	0.121	10:22	0.121	9:22	0.121	10:22	0.232	9:22	0.121	10:22	0.121
9:23	0.121	10:23	0.121	9:23	0.121	10:23	0.121	9:23	0.232	10:23	0.232	9:23	0.121	10:23	0.121
9:24	0.121	10:24	0.121	9:24	0.121	10:24	0.121	9:24	0.232	10:24	0.232	9:24	0.121	10:24	0.121
9:25	0.121	10:25	0.121	9:25	0.121	10:25	0.121	9:25	0.121	10:25	0.121	9:25	0.121	10:25	0.121
9:26	0.121	10:26	0.121	9:26	0.121	10:26	0.121	9:26	0.232	10:26	0.121	9:26	0.121	10:26	0.121
9:27	0.121	10:27	0.121	9:27	0.121	10:27	0.121	9:27	0.232	10:27	0.121	9:27	0.121	10:27	0.121
9:28	0.121	10:28	0.121	9:28	0.121	10:28	0.121	9:28	0.232	10:28	0.121	9:28	0.121	10:28	0.121
9:29	0.121	10:29	0.121	9:29	0.121	10:29	0.121	9:29	0.232	10:29	0.121	9:29	0.121	10:29	0.121
9:30	0.121	10:30	0.121	9:30	0.121	10:30	0.121	9:30	0.232	10:30	0.232	9:30	0.121	10:30	0.121
9:31	0.121	10:31	0.121	9:31	0.121	10:31	0.121	9:31	0.232	10:31	0.232	9:31	0.121	10:31	0.121
9:32	0.121	10:32	0.121	9:32	0.121	10:32	0.121	9:32	0.232	10:32	0.121	9:32	0.121	10:32	0.121
9:33	0.121	10:33	0.121	9:33	0.121	10:33	0.121	9:33	0.232	10:33	0.232	9:33	0.121	10:33	0.121
9:34	0.121	10:34	0.121	9:34	0.121	10:34	0.121	9:34	0.232	10:34	0.232	9:34	0.121	10:34	0.121
9:35	0.121	10:35	0.121	9:35	0.121	10:35	0.121	9:35	0.232	10:35	0.121	9:35	0.121	10:35	0.121
9:36	0.121	10:36	0.121	9:36	0.121	10:36	0.121	9:36	0.232	10:36	0.232	9:36	0.121	10:36	0.121
9:37	0.121	10:37	0.121	9:37	0.121	10:37	0.121	9:37	0.232	10:37	0.232	9:37	0.121	10:37	0.121
9:38	0.121	10:38	0.121	9:38	0.121	10:38	0.121	9:38	0.121	10:38	0.232	9:38	0.121	10:38	0.121
9:39	0.121	10:39	0.121	9:39	0.121	10:39	0.121	9:39	0.121	10:39	0.232	9:39	0.121	10:39	0.121
9:40	0.121	10:40	0.121	9:40	0.121	10:40	0.121	9:40	0.232	10:40	0.232	9:40	0.121	10:40	0.121
9:41	0.121	10:41	0.121	9:41	0.121	10:41	0.121	9:41	0.232	10:41	0.121	9:41	0.121	10:41	0.121
9:42	0.121	10:42	0.121	9:42	0.121	10:42	0.121	9:42	0.232	10:42	0.121	9:42	0.121	10:42	0.121
9:43	0.121	10:43	0.121	9:43	0.121	10:43	0.121	9:43	0.232	10:43	0.232	9:43	0.121	10:43	0.121
9:44	0.121	10:44	0.121	9:44	0.121	10:44	0.121	9:44	0.121	10:44	0.232	9:44	0.121	10:44	0.121

APPENDIX TABLE B-3 (CONTINUED). RESULTS OF PRE- AND POST-SEASON ICE TESTS

GC01 S/N: 9927129				BG01 S/N: 20029727				BG10 S/N: 9927127				BG18 S/N: 9775391			
Pre 5/8/2021		Post 2/19/2022		Pre 5/8/2021		Post 2/19/2022		Pre 5/8/2021		Post 2/19/2022		Pre 5/8/2021		Post 2/19/2022	
Time	**Temp, °C**	**Time**	**Temp, °C**	**Time**	**Temp, °C**	**Time**	**Temp, °C**	**Time**	**Temp, °C**	**Time**	**Temp, °C**	**Time**	**Temp, °C**	**Time**	**Temp, °C**
9:45	0.121	10:45	0.121	9:45	0.121	10:45	0.121	9:45	0.232	10:45	0.121	9:45	0.121	10:45	0.121
9:46	0.121	10:46	0.121	9:46	0.121	10:46	0.121	9:46	0.232	10:46	0.121	9:46	0.121	10:46	0.121
9:47	0.121	10:47	0.121	9:47	0.121	10:47	0.121	9:47	0.121	10:47	0.121	9:47	0.121	10:47	0.121
9:48	0.121	10:48	0.121	9:48	0.121	10:48	0.121	9:48	0.232	10:48	0.232	9:48	0.121	10:48	0.121
9:49	0.121	10:49	0.121	9:49	0.121	10:49	0.121	9:49	0.121	10:49	0.121	9:49	0.121	10:49	0.121
9:50	0.121	10:50	0.121	9:50	0.121	10:50	0.121	9:50	0.232	10:50	0.232	9:50	0.121	10:50	0.121
9:51	0.121	10:51	0.121	9:51	0.121	10:51	0.121	9:51	0.121	10:51	0.121	9:51	0.121	10:51	0.121
9:52	0.121	10:52	0.121	9:52	0.121	10:52	0.121	9:52	0.232	10:52	0.232	9:52	0.121	10:52	0.121
9:53	0.121	10:53	0.121	9:53	0.121	10:53	0.121	9:53	0.232	10:53	0.232	9:53	0.121	10:53	0.121
9:54	0.121	10:54	0.121	9:54	0.121	10:54	0.121	9:54	0.232	10:54	0.232	9:54	0.121	10:54	0.121
9:55	0.121	10:55	0.121	9:55	0.121	10:55	0.121	9:55	0.232	10:55	0.232	9:55	0.121	10:55	0.121
9:56	0.121	10:56	0.121	9:56	0.121	10:56	0.121	9:56	0.232	10:56	0.232	9:56	0.121	10:56	0.121
9:57	0.121	10:57	0.121	9:57	0.121	10:57	0.121	9:57	0.232	10:57	0.232	9:57	0.121	10:57	0.121
9:58	0.121	10:58	0.121	9:58	0.121	10:58	0.121	9:58	0.232	10:58	0.232	9:58	0.121	10:58	0.121
9:59	0.121	10:59	0.121	9:59	0.121	10:59	0.121	9:59	0.232	10:59	0.232	9:59	0.121	10:59	0.121
10:00	0.121	11:00	0.121	10:00	0.121	11:00	0.121	10:00	0.232	11:00	0.121	10:00	0.121	11:00	0.121

APPENDIX TABLE B-3 (CONTINUED). RESULTS OF PRE- AND POST-SEASON ICE TESTS

LG02				LG08				LG22			
S/N: 10484455				S/N: 9775538				S/N: 10612497			
Pre 5/8/2021		Post 2/19/2022		Pre 5/8/2021		Post 2/19/2022		Pre 5/8/2021		Post 2/19/2022	
Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C
8:30	0.893	9:30	1.33	8:30	1.003	9:30	1.003	8:30	0.563	9:30	1.112
8:31	0.674	9:31	0.893	8:31	0.784	9:31	0.674	8:31	0.343	9:31	0.784
8:32	0.563	9:32	0.674	8:32	0.674	9:32	0.563	8:32	0.232	9:32	0.563
8:33	0.453	9:33	0.453	8:33	0.563	9:33	0.453	8:33	0.232	9:33	0.343
8:34	0.343	9:34	0.343	8:34	0.453	9:34	0.343	8:34	0.121	9:34	0.232
8:35	0.232	9:35	0.232	8:35	0.453	9:35	0.343	8:35	0.121	9:35	0.232
8:36	0.232	9:36	0.232	8:36	0.343	9:36	0.232	8:36	0.121	9:36	0.121
8:37	0.232	9:37	0.121	8:37	0.343	9:37	0.232	8:37	0.121	9:37	0.121
8:38	0.121	9:38	0.121	8:38	0.343	9:38	0.232	8:38	0.121	9:38	0.121
8:39	0.121	9:39	0.121	8:39	0.343	9:39	0.232	8:39	0.121	9:39	0.121
8:40	0.121	9:40	0.121	8:40	0.343	9:40	0.232	8:40	0.121	9:40	0.121
8:41	0.121	9:41	0.01	8:41	0.232	9:41	0.232	8:41	0.121	9:41	0.121
8:42	0.121	9:42	0.01	8:42	0.232	9:42	0.232	8:42	0.121	9:42	0.01
8:43	0.01	9:43	0.01	8:43	0.232	9:43	0.232	8:43	0.121	9:43	0.01
8:44	0.01	9:44	0.01	8:44	0.232	9:44	0.232	8:44	0.121	9:44	0.01
8:45	0.01	9:45	0.01	8:45	0.232	9:45	0.232	8:45	0.121	9:45	0.121
8:46	0.01	9:46	0.01	8:46	0.232	9:46	0.232	8:46	0.01	9:46	0.121
8:47	0.01	9:47	0.01	8:47	0.232	9:47	0.232	8:47	0.01	9:47	0.121
8:48	0.01	9:48	0.01	8:48	0.232	9:48	0.232	8:48	0.121	9:48	0.121
8:49	0.01	9:49	0.01	8:49	0.232	9:49	0.232	8:49	0.121	9:49	0.121
8:50	0.01	9:50	0.01	8:50	0.232	9:50	0.232	8:50	0.121	9:50	0.121
8:51	0.01	9:51	0.01	8:51	0.232	9:51	0.232	8:51	0.01	9:51	0.01
8:52	0.01	9:52	0.01	8:52	0.232	9:52	0.232	8:52	0.01	9:52	0.01
8:53	0.01	9:53	0.01	8:53	0.232	9:53	0.232	8:53	0.121	9:53	0.01
8:54	0.01	9:54	0.01	8:54	0.232	9:54	0.232	8:54	0.01	9:54	0.01
8:55	0.01	9:55	0.01	8:55	0.232	9:55	0.232	8:55	0.121	9:55	0.01
8:56	0.01	9:56	0.01	8:56	0.232	9:56	0.232	8:56	0.01	9:56	0.01
8:57	0.01	9:57	0.01	8:57	0.232	9:57	0.232	8:57	0.01	9:57	0.01
8:58	0.01	9:58	0.01	8:58	0.232	9:58	0.232	8:58	0.01	9:58	0.01
8:59	0.01	9:59	0.01	8:59	0.232	9:59	0.232	8:59	0.121	9:59	0.01
9:00	0.01	10:00	0.01	9:00	0.232	10:00	0.232	9:00	0.121	10:00	0.01
9:01	0.01	10:01	0.01	9:01	0.232	10:01	0.232	9:01	0.121	10:01	0.01
9:02	0.01	10:02	0.01	9:02	0.232	10:02	0.232	9:02	0.121	10:02	0.01
9:03	0.01	10:03	0.01	9:03	0.232	10:03	0.232	9:03	0.01	10:03	0.01
9:04	0.01	10:04	0.01	9:04	0.232	10:04	0.232	9:04	0.01	10:04	0.01
9:05	0.01	10:05	0.01	9:05	0.232	10:05	0.232	9:05	0.01	10:05	0.01
9:06	0.01	10:06	0.01	9:06	0.232	10:06	0.232	9:06	0.01	10:06	0.01
9:07	0.01	10:07	0.01	9:07	0.232	10:07	0.232	9:07	0.01	10:07	0.01
9:08	0.01	10:08	0.01	9:08	0.232	10:08	0.232	9:08	0.01	10:08	0.01
9:09	0.01	10:09	0.01	9:09	0.232	10:09	0.232	9:09	0.01	10:09	0.01
9:10	0.01	10:10	0.01	9:10	0.232	10:10	0.232	9:10	0.01	10:10	0.01
9:11	0.01	10:11	0.01	9:11	0.232	10:11	0.232	9:11	0.01	10:11	0.01
9:12	0.01	10:12	0.01	9:12	0.232	10:12	0.232	9:12	0.121	10:12	0.01
9:13	0.01	10:13	0.01	9:13	0.232	10:13	0.232	9:13	0.01	10:13	0.01
9:14	0.01	10:14	0.01	9:14	0.232	10:14	0.232	9:14	0.01	10:14	0.01
9:15	0.01	10:15	0.01	9:15	0.232	10:15	0.232	9:15	0.01	10:15	0.01
9:16	0.01	10:16	0.01	9:16	0.232	10:16	0.232	9:16	0.01	10:16	0.01
9:17	0.01	10:17	0.01	9:17	0.232	10:17	0.232	9:17	0.01	10:17	0.01
9:18	0.01	10:18	0.01	9:18	0.232	10:18	0.232	9:18	0.121	10:18	0.01
9:19	0.01	10:19	0.01	9:19	0.232	10:19	0.232	9:19	0.01	10:19	0.01
9:20	0.01	10:20	0.01	9:20	0.232	10:20	0.232	9:20	0.121	10:20	0.01
9:21	0.01	10:21	0.01	9:21	0.232	10:21	0.232	9:21	0.121	10:21	0.01
9:22	0.01	10:22	0.01	9:22	0.232	10:22	0.232	9:22	0.01	10:22	0.01
9:23	0.01	10:23	0.01	9:23	0.232	10:23	0.232	9:23	0.121	10:23	0.01
9:24	0.01	10:24	0.01	9:24	0.232	10:24	0.232	9:24	0.01	10:24	0.121
9:25	0.01	10:25	0.01	9:25	0.232	10:25	0.232	9:25	0.01	10:25	0.01
9:26	0.01	10:26	0.01	9:26	0.232	10:26	0.232	9:26	0.01	10:26	0.121
9:27	0.01	10:27	0.01	9:27	0.232	10:27	0.232	9:27	0.01	10:27	0.121
9:28	0.01	10:28	0.01	9:28	0.232	10:28	0.232	9:28	0.121	10:28	0.01
9:29	0.01	10:29	0.01	9:29	0.232	10:29	0.232	9:29	0.01	10:29	0.121
9:30	0.01	10:30	0.01	9:30	0.232	10:30	0.232	9:30	0.01	10:30	0.01
9:31	0.01	10:31	0.01	9:31	0.232	10:31	0.232	9:31	0.01	10:31	0.01
9:32	0.01	10:32	0.01	9:32	0.232	10:32	0.232	9:32	0.01	10:32	0.01
9:33	0.01	10:33	0.01	9:33	0.232	10:33	0.232	9:33	0.121	10:33	0.01
9:34	0.01	10:34	0.01	9:34	0.232	10:34	0.232	9:34	0.121	10:34	0.01
9:35	0.01	10:35	0.01	9:35	0.232	10:35	0.232	9:35	0.01	10:35	0.01
9:36	0.01	10:36	0.01	9:36	0.232	10:36	0.232	9:36	0.01	10:36	0.01
9:37	0.01	10:37	0.01	9:37	0.232	10:37	0.232	9:37	0.121	10:37	0.121
9:38	0.01	10:38	0.01	9:38	0.232	10:38	0.232	9:38	0.01	10:38	0.121
9:39	0.01	10:39	0.01	9:39	0.232	10:39	0.232	9:39	0.01	10:39	0.01
9:40	0.01	10:40	0.01	9:40	0.232	10:40	0.232	9:40	0.01	10:40	0.121
9:41	0.01	10:41	0.01	9:41	0.232	10:41	0.232	9:41	0.01	10:41	0.121
9:42	0.01	10:42	0.01	9:42	0.232	10:42	0.232	9:42	0.01	10:42	0.01
9:43	0.01	10:43	0.01	9:43	0.232	10:43	0.232	9:43	0.01	10:43	0.01
9:44	0.01	10:44	0.01	9:44	0.232	10:44	0.232	9:44	0.01	10:44	0.01

APPENDIX TABLE B-3 (CONTINUED). RESULTS OF PRE- AND POST-SEASON ICE TESTS

LG02 S/N: 10484455				LG08 S/N: 9775538				LG22 S/N: 10612497			
Pre 5/8/2021		Post 2/19/2022		Pre 5/8/2021		Post 2/19/2022		Pre 5/8/2021		Post 2/19/2022	
Time	**Temp, °C**	**Time**	**Temp, °C**	**Time**	**Temp, °C**	**Time**	**Temp, °C**	**Time**	**Temp, °C**	**Time**	**Temp, °C**
9:45	0.01	10:45	0.01	9:45	0.232	10:45	0.232	9:45	0.01	10:45	0.01
9:46	0.01	10:46	0.01	9:46	0.232	10:46	0.232	9:46	0.01	10:46	0.01
9:47	0.01	10:47	0.01	9:47	0.232	10:47	0.232	9:47	0.01	10:47	0.01
9:48	0.01	10:48	0.01	9:48	0.232	10:48	0.232	9:48	0.01	10:48	0.01
9:49	0.01	10:49	0.01	9:49	0.232	10:49	0.232	9:49	0.121	10:49	0.121
9:50	0.01	10:50	0.01	9:50	0.232	10:50	0.232	9:50	0.01	10:50	0.01
9:51	0.01	10:51	0.01	9:51	0.232	10:51	0.232	9:51	0.01	10:51	0.01
9:52	0.01	10:52	0.01	9:52	0.232	10:52	0.232	9:52	0.01	10:52	0.01
9:53	0.01	10:53	0.01	9:53	0.232	10:53	0.232	9:53	0.01	10:53	0.01
9:54	0.01	10:54	0.01	9:54	0.232	10:54	0.232	9:54	0.01	10:54	0.121
9:55	0.01	10:55	0.01	9:55	0.232	10:55	0.232	9:55	0.01	10:55	0.01
9:56	0.01	10:56	0.01	9:56	0.232	10:56	0.232	9:56	0.121	10:56	0.01
9:57	0.01	10:57	0.01	9:57	0.232	10:57	0.232	9:57	0.01	10:57	0.01
9:58	0.01	10:58	0.01	9:58	0.232	10:58	0.232	9:58	0.121	10:58	0.121
9:59	0.01	10:59	0.01	9:59	0.232	10:59	0.232	9:59	0.121	10:59	0.121
10:00	0.01	11:00	0.01	10:00	0.232	11:00	0.232	10:00	0.01	11:00	0.121

APPENDIX TABLE B-4. SUMMARY OF 2021 WATER QUALITY SAMPLE BLANK DATA FOR THE GOOSE CREEK WATERSHED

Sample Date	Sample ID	Trip Blank Data		Field Blank Data			
		TURB (NTU)	*E. COLI* (MPN/100mL)	Location of Field Blank	Collection Time	TURB (NTU)	*E. COLI* (MPN/100mL)
05/13/21	01	0.1[B]	ND	GC02	8:55	0.2B	ND
05/26/21	01	ND	ND	GC05	9:20	0.1B	ND
06/07/21	01	0.1[B]	ND	BG-BC01	10:20	0.2B	ND
06/22/21	01	0.1[B]	ND	BG14	10:15	0.1B	ND
07/07/21	01	0.3[B]	ND	BG14	11:20	0.2B	ND
07/20/21	01	ND	ND	BG-BC01	9:55	0.1B	ND
08/02/21	01	ND	ND	GC05	9:40	0.1B	ND
08/19/21	01	ND	ND	GC02	9:05	0.1B	ND
09/01/21	01	ND	ND	GC02	8:55	0.1B	ND
09/14/21	01	0.2[B]	ND	GC05	9:25	0.1B	ND

[B] Analyte detected in the associated method blank

[H] Holding time exceeded

[ND] Not detectable at reporting limits

APPENDIX TABLE B-5. SUMMARY OF 2021 DUPLICATE WATER SAMPLES FOR THE GOOSE CREEK WATERSHED

					Field Data						Laboratory Data	
Site	Duplicate of Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	TURB (NTU)	*E.coli* (MPN/100mL)
Precision DQO's					10%	10%	0.3 SU	10%	10%	10%	20%	50% if >100; NA if <100
GC01		SCCD	5/13/2021	9:55	9.8	9.8	8.15	392	10.40	90.7	8.7	63
GCDup01	GC01	SCCD	5/13/2021	9:55	10	9.5	7.95	397	10.29	90.1	8.7	63
Relative Percent Difference					***2.0***	***3.1***	***0.20***	***1.3***	***1.1***	***0.7***	***0.0***	***0.0***
SC01		SCCD	5/26/2021	11:00	12.7	12.1	8.13	568	8.92	83.00	40.0	166
GCDup01	SC01	SCCD	5/26/2021	11:00	12.7	12.1	8.12	587	8.91	83.00	40.0	154
Relative Percent Difference					***0.0***	***0.0***	***0.01***	***3.3***	***0.11***	***0.0***	***0.0***	***7.5***
BG01		SCCD	6/7/2021	10:45	11.2	10.7	7.67	77	9.89	89.0	18.0	179
GCDup01	BG01	SCCD	6/7/2021	10:45	11.3	10.8	7.26	76	9.59	87.30	17.0	161
Relative Percent Difference					***0.9***	***0.9***	***0.41*** [DQ]	***1.3***	***3.1***	***1.9***	***5.7***	***10.6***
BG10		SCCD	6/22/2021	10:15	15.7	15.2	8.21	319	9.84	98.0	4.2	199
GCDup01	BG10	SCCD	6/22/2021	10:15	15.8	15.3	8.20	316	9.67	96.50	4.5	184
Relative Percent Difference					***0.6***	***0.7***	***0.01***	***0.9***	***1.7***	***1.5***	***6.9***	***7.8***
BG-RC01		SCCD	7/7/2021	8:45	16.9	16.5	8.15	374	9.15	93.60	1.4	461
GCDup01	BG-RC01	SCCD	7/7/2021	8:45	17.0	16.5	8.16	378	9.00	92.30	1.6	291
Relative Percent Difference					***0.6***	***0.0***	***0.01***	***1.1***	***1.7***	***1.4***	***13.3***	***45.2***
BG10		SCCD	7/20/2021	10:00	22.4	22.0	8.40	528	9.06	103.8	4.90	219
GCDup01	BG10	SCCD	7/20/2021	10:00	22.6	22.0	8.40	536	8.93	102.30	4.8	153
Relative Percent Difference					***0.9***	***0.0***	***0.00***	***1.5***	***1.4***	***1.5***	***2.1***	***35.5***
BG01		SCCD	8/2/2021	10:55	21.8	21.3	8.44	652	9.88	111.4	2.4	356
GCDup01	BG01	SCCD	8/2/2021	10:55	21.9	21.3	8.40	651	9.87	111.60	2.8	387
Relative Percent Difference					***0.5***	***0.0***	***0.04***	***0.2***	***0.1***	***0.2***	***15.4***	***8.3***
GC-SC01		SCCD	8/19/2021	11:20	14.2	13.6	8.14	1031	8.01	87.4	24.0	921
GCDup01	GC-SC01	SCCD	8/19/2021	11:20	14.2	13.6	8.09	1027	8.05	87.80	24.0	980
Relative Percent Difference					***0.0***	***0.0***	***0.05***	***0.4***	***0.5***	***0.5***	***0.0***	***6.2***
GC01		SCCD	9/1/2021	9:20	17.5	17.0	8.38	683	7.28	75.20	7.0	56
GCDup01	GC01	SCCD	9/1/2021	9:20	17.5	17.0	8.41	679	7.29	75.20	7.2	41
Relative Percent Difference					***0.0***	***0.0***	***0.03***	***0.6***	***0.1***	***0.0***	***2.8***	***30.9***
GC-SC01		SCCD	9/14/2021	11:15	14.2	13.7	8.09	539	8.28	79.70	24.0	201
GCDup01	GC-SC01	SCCD	9/14/2021	11:15	14.2	13.7	8.09	524	8.03	77.10	25.0	179
Relative Percent Difference					***0.0***	***0.0***	***0.00***	***2.8***	***3.1***	***3.3***	***4.1***	***11.6***

DQ Data quality objective not met.

APPENDIX TABLE B-6. SUMMARY OF 2021 WATER QUALITY SAMPLE BLANK DATA FOR THE GOOSE CREEK WATERSHED

Sample Date	Sample ID	Trip Blank Data		Field Blank Data			
		TURB (NTU)	*E. COLI* (MPN/100mL)	Location of Field Blank	Collection Time	TURB (NTU)	*E. COLI* (MPN/100mL)
05/13/21	02	ND	ND	LG-JC01	12:55	0.3[B]	ND
05/26/21	02	ND	ND	LG-KC01	13:05	0.2[B]	ND
06/07/21	02	0.1[B]	ND	LG08	12:15	0.3[B]	ND
06/22/21	02	ND	ND	BG18	11:05	0.2[B]	ND
07/07/21	02	0.3[B]	ND	BG18	11:55	0.2[B]	ND
07/20/21	02	ND	ND	LG08	12:50	0.2[B]	ND
08/02/21	02	0.1[B]	ND	LG-KC01	13:20	0.1[B]	ND
08/19/21	02	ND	ND	LG-JC01	14:05	0.2[B]	ND
09/01/21	02	ND	ND	LG-JC01	13:40	0.2[B]	ND
09/14/21	02	0.1[B]	ND	LG-KC01	13:10	0.1[B]	ND

[B] Analyte detected in the associated method blank

[H] Holding time exceeded

[ND] Not detectable at reporting limits

APPENDIX TABLE B-7. SUMMARY OF 2021 DUPLICATE WATER SAMPLES FOR THE GOOSE CREEK WATERSHED

					Field Data						Laboratory Data	
Site	Duplicate of Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	TURB (NTU)	*E.coli* (MPN/100mL)
Precision DQO's					10%	10%	0.3 SU	10%	10%	10%	20%	50% if >100; NA if <100
LG22		SCCD	5/13/2021	9:55	8.3	7.8	7.74	96	11.76	98.9	18.0	0.5
GCDup02	LG22	SCCD	5/13/2021	9:55	8.6	8.0	7.41	92	11.57	97.8	1.9	0.5
Relative Percent Difference					***3.6***	***2.5***	***0.33 [DQ]***	***4.3***	***1.63***	***1.1***	***161.8 [DQ]***	***0.0***
LG13		SCCD	5/26/2021	11:00	8.2	7.8	7.96	155	10.70	89.4	7.3	37
GCDup02	LG13	SCCD	5/26/2021	11:00	8.2	7.6	7.66	139	10.59	88.6	6.3	61
Relative Percent Difference					***0.0***	***2.6***	***0.30***	***10.8 [DQ]***	***1.03***	***0.9***	***14.7***	***49.0***
LG-MCC01		SCCD	6/7/2021	10:45	15.1	14.6	7.80	324	9.02	88.7	26.0	1200
GCDup02	LG-MCC01	SCCD	6/7/2021	10:45	15.3	14.7	7.81	329	8.95	88.0	26.0	727
Relative Percent Difference					***1.3***	***0.7***	***0.01***	***1.5***	***0.78***	***0.8***	***0.0***	***49.1***
LG02		SCCD	6/22/2021	10:15	20.0	19.5	8.54	431	11.79	128.5	6.9	114
GCDup02	LG02	SCCD	6/22/2021	10:15	20.1	19.6	8.58	433	11.92	130.0	7.7	121
Relative Percent Difference					***0.5***	***0.5***	***0.04***	***0.5***	***1.10***	***1.2***	***11.0***	***6.0***
BG18		SCCD	7/7/2021	8:45	16.3	15.8	7.82	68	9.02	91.1	1.2	31
GCDup02	BG18	SCCD	7/7/2021	8:45	16.4	15.9	7.75	69	8.87	89.6	1.2	29
Relative Percent Difference					***0.6***	***0.6***	***0.07***	***1.5***	***1.68***	***1.7***	***0.0***	***6.7***
LG02		SCCD	7/20/2021	10:00	25.6	25.1	8.52	794	10.25	124.6	4.2	105
GCDup02	LG02	SCCD	7/20/2021	10:00	25.7	25.2	8.41	792	10.20	124.1	4.1	101
Relative Percent Difference					***0.4***	***0.4***	***0.11***	***0.3***	***0.49***	***0.4***	***2.4***	***3.9***
LG-MCC01		SCCD	8/2/2021	10:55	19.7	19.2	8.09	413	7.40	91.2	120.0	1990
GCDup02	LG-MCC01	SCCD	8/2/2021	108/3/202055	17.9	17.6	8.03	418	8.99	109.6	110.0	1410
Relative Percent Difference					***9.6***	***8.7***	***0.06***	***1.2***	***19.4 [DQ]***	***18.3 [DQ]***	***8.7***	***34.1***
LG13		SCCD	8/19/2021	11:20	15.0	14.5	8.64	567	9.13	102.5	3.0	866
GCDup02	LG13	SCCD	8/19/2021	11:20	15.0	14.5	8.51	567	9.05	102.0	2.5	980
Relative Percent Difference					***0.0***	***0.0***	***0.13***	***0.0***	***0.88***	***0.5***	***18.2***	***12.4***
LG22		SCCD	9/1/2021	9:20	14.0	13.5	8.25	58	9.25	88.8	2.5	120
GCDup02	LG22	SCCD	9/1/2021	9:20	14.2	13.6	8.04	58	9.20	88.6	2.4	117
Relative Percent Difference					***1.4***	***0.7***	***0.21***	***0.0***	***0.54***	***0.2***	***4.1***	***2.5***
LG13		SCCD	9/14/2021	11:15	17.5	17.0	8.14	583	10.44	107.9	1.6	51
GCDup02	LG13	SCCD	9/14/2021	11:15	17.5	17.0	8.13	589	10.30	106.3	3.0	54
Relative Percent Difference					***0.0***	***0.0***	***0.01***	***1.0***	***1.35***	***1.5***	***60.9 [DQ]***	***5.7***

DQ Data quality objective not met.

APPENDIX C

2021 GOOSE CREEK WATERSHED WATER QUALITY DATA

APPENDIX TABLE C-1. GOOSE CREEK WATERSHED 2021 CODES

Water Quality Data Codes	Parameter	Unit
DATE	Collection Date	Year, Month, Day
TIME	Collection Time	Military Time
TEMP	Water Temperature	Degrees Centigrade
PH	pH	Standard Units
COND	Specific Conductivity	µmho/cm
DO	Dissolved Oxygen	mg/L
DO %	Dissolved Oxygen % Saturation	%
STAFF	Staff Gauge Height	Feet
DISCH	Stream Flow	CFS
TURB	Turbidity	NTU
E.COLI	*Escherichia coli*	MPN/100ml
QAQC	QA/QC Validation Complete	Initials

APPENDIX TABLE C-2. GOOSE CREEK WATERSHED 2021 DATA QUALIFIERS

Data Qualifier Codes	Definition
B	Analyte deteced in the associated method blank
CG	Sample result reported as greater than 1 µmho/cm
DIS	Sample results rejected due to inability to meet quality control critiera
DO	100 percent air saturation exceeded
DQ	Data quality objective not met
EG	Sample result reported as greater than 2419 MPN/100 mL
EL	Sample result reported as less than 1 MPN/100 mL
H	Holding time exceeded
LE	Lab reporting error, correct value listed. See lab sheets for initial value reported.
ND	Not detectable at reporting limits
NS	Not sampled
SA	Staff height adjusted
SO-SUB	Gauge fully submerged; unable to take reading.
SO-OUT	Gauge out of water; unable to take reading.

APPENDIX TABLE C-3. GOOSE CREEK WATERSHED 2021 AGENCY ABBREVIATIONS

Agency Abbreviations	Agency
SCCD	Sheridan County Conservation District
USFS	United States Forest Service
USGS	United States Geological Survey
WDEQ	Wyoming Department Environmental Quality
WGFD	Wyoming Game and Fish Department
WWRC	Wyoming Water Resources Center

APPENDIX TABLE C-4. SCCD 2021 WATER QUALITY DATA AT SITE GC01

			Field Data										Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	*TURB* (NTU)	E_COLI (cfu/100mL)
Goose Creek	GC01	SCCD	5/13/2021	8:30	9.8	9.8	8.15	392	10.40	90.7	1.30	217.64	8.7	63
Goose Creek	GC01	SCCD	5/26/2021	8:40	10.4	10.3	7.66	206	11.31	100.1[DO]	2.08	466.13	15.0	133
Goose Creek	GC01	SCCD	6/7/2021	8:55	13.0	12.4	7.84	125	9.24	86.6	2.94	816.63	21.0	210
Goose Creek	GC01	SCCD	6/22/2021	8:40	17.4	16.9	8.04	354	8.40	86.7	0.92	124.29	12.6	147
Goose Creek	GC01	SCCD	7/7/2021	8:35	21.4	20.8	8.06	512	6.56	73.3	0.78	95.12	28.0	1300
Goose Creek	GC01	SCCD	7/20/2021	8:30	23.7	23.2	8.31	745	6.24	73.0	0.36	27.17	5.0	326
Goose Creek	GC01	SCCD	8/2/2021	9:00	21.6	21.0	8.38	673	7.52	84.4	0.44	37.62	8.6	93
Goose Creek	GC01	SCCD	8/19/2021	8:45	16.0	15.5	8.34	788	7.95	90.0	0.58	58.85	6.7	921
Goose Creek	GC01	SCCD	9/1/2021	8:35	17.5	17.0	8.38	683	7.28	75.2	0.52	49.31	7.0	56
Goose Creek	GC01	SCCD	9/14/2021	8:45	16.4	15.9	8.34	684	7.65	77.1	0.48	43.31	6.1	150

DO: 100 percent air saturation exceeded

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	14.4	14.0	7.95	318	9.18	87.5	1.60	343.96	17.1	202
June 7-August 2	19.4	18.9	8.13	482	7.59	80.8	1.09	220.16	15.0	261
July 20-September 14	19.0	18.5	8.35	715	7.33	79.9	0.48	43.25	6.7	188
Annual	16.7	16.3	8.15	516	8.26	83.7	1.04	193.61	11.9	

APPENDIX TABLE C-5. SCCD 2021 WATER QUALITY DATA AT SITE GC02

			Field Data										Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	*TURB* (NTU)	E_COLI (cfu/100mL)
Goose Creek	GC02	SCCD	5/13/2021	8:55	9.7	9.7	8.31	398	11.72	101.1[DO]	0.91[SA]	195.17	5.5[B]	10
Goose Creek	GC02	SCCD	5/26/2021	8:50	9.4	9.5	7.78	194	10.84	93.2	1.92[SA]	319.85	7.7	135
Goose Creek	GC02	SCCD	6/7/2021	9:15	11.9	11.3	7.74	234	9.84	90.0	3.04[SA]	452.90	15.0	411
Goose Creek	GC02	SCCD	6/22/2021	8:55	17.3	16.8	8.17	396	9.33	96.2	0.38[SA]	126.82	8.9	308
Goose Creek	GC02	SCCD	7/7/2021	8:50	20.9	20.4	8.20	491	7.88	87.4	0.14[SA]	94.78	16.0	770
Goose Creek	GC02	SCCD	7/20/2021	8:45	22.0	21.5	8.16	719	7.03	79.7	SO-OUT	SO-OUT	5.3	727
Goose Creek	GC02	SCCD	8/2/2021	9:10	20.2	19.6	8.31	655	7.92	86.4	SO-OUT	SO-OUT	8.2	548
Goose Creek	GC02	SCCD	8/19/2021	9:05	15.8	15.3	8.21	648	8.09	91.5	SO-OUT	SO-OUT	35[B]	2420
Goose Creek	GC02	SCCD	9/1/2021	8:55	16.5	16.0	8.30	658	8.08	81.8	0.24	38.65	19[B]	326
Goose Creek	GC02	SCCD	9/14/2021	9:00	15.1	14.6	8.20	641	8.06	79.1	0.17	28.20	16.0	>2419.6[EG]

SO-OUT: Gauge out of water; unable to take reading
DO: 100 percent air saturation exceeded
SA: Staff height adjusted
B: Analyte detected in the associated method blank
EG: Sample result reported as greater than 2419 MPN/100 mL

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	13.8	13.5	8.04	343	9.92	93.6	1.78	237.91	10.6	167
June 7-August 2	18.5	17.9	8.12	499	8.40	87.9	1.69	224.84	10.7	522
July 20-September 14	17.9	17.4	8.24	664	7.84	83.7	0.21	33.43	16.7	947
Annual	15.9	15.5	8.14	503	8.88	88.6	1.33	179.48	13.7	

APPENDIX TABLE C-6. SCCD 2021 WATER QUALITY DATA AT SITE GC-SC01

			Field Data										Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	*TURB* (NTU)	E_COLI (cfu/100mL)
Soldier Creek	GC-SC01	SCCD	5/13/2021	9:15	10.2	9.7	8.30	880	10.50	92.2	1.51	1.15	7.4	109
Soldier Creek	GC-SC01	SCCD	5/26/2021	9:05	12.7	12.1	8.13	568	8.92	83.0	2.21	2.66	40.0	166
Soldier Creek	GC-SC01	SCCD	6/7/2021	9:30	16.6	16.1	8.10	829	7.06	71.8	2.92	4.92	34.0	1550
Soldier Creek	GC-SC01	SCCD	6/22/2021	9:10	16.3	15.8	8.08	635	8.07	81.5	0.26	0.02	53.9	461
Soldier Creek	GC-SC01	SCCD	7/7/2021	9:05	19.3	18.8	8.02	708	6.64	71.3	0.12	0.00	40.0	816
Soldier Creek	GC-SC01	SCCD	7/20/2021	9:00	20.7	20.2	8.02	851	6.25	69.1	0.96	0.42	25.0	387
Soldier Creek	GC-SC01	SCCD	8/2/2021	9:25	18.7	18.2	8.04	941	7.06	75.2	0.96	0.42	16.0	250
Soldier Creek	GC-SC01	SCCD	8/19/2021	9:25	14.2	13.6	8.14	1031	8.01	87.4	1.06	0.53	24.0	921
Soldier Creek	GC-SC01	SCCD	9/1/2021	9:30	15.4	14.8	8.34	452	8.29	81.6	1.47	1.08	85.0	866
Soldier Creek	GC-SC01	SCCD	9/14/2021	9:15	14.2	13.7	8.09	539	8.28	79.7	1.12	0.60	24.0	201

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	15.0	14.5	8.13	724	8.24	80.0	1.40	1.75	35.1	402
June 7-August 2	18.3	17.8	8.05	793	7.02	73.8	1.04	1.16	33.8	563
July 20-September 14	16.6	16.1	8.13	763	7.58	78.6	1.11	0.61	34.8	435
Annual	15.8	15.3	8.13	743	7.91	79.3	1.26	1.18	34.9	

APPENDIX TABLE C-7. SCCD 2021 WATER QUALITY DATA AT SITE CG05

			Field Data										Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	*TURB* (NTU)	E_COLI (cfu/100mL)
Goose Creek	GC05	SCCD	5/13/2021	9:30	9.9	9.4	8.19	351	11.88	103.9[DO]	1.04	212.45	5.5	41
Goose Creek	GC05	SCCD	5/26/2021	9:20	8.9	8.6	8.07	172	10.73	91.5	1.75	836.82	9.6[B]	155
Goose Creek	GC05	SCCD	6/7/2021	9:40	11.7	11.1	7.80	110	10.05	91.3	2.66	2521.51	18.0	179
Goose Creek	GC05	SCCD	6/22/2021	9:20	17.6	17.0	8.27	343	9.70	100.5[DO]	0.82	113.59	8.5	192
Goose Creek	GC05	SCCD	7/7/2021	9:50	21.7	21.2	8.36	482	8.86	99.8	0.72	80.64	12.0	687
Goose Creek	GC05	SCCD	7/20/2021	9:15	22.9	22.3	8.34	705	8.13	93.6	0.49	29.26	4.6	326
Goose Creek	GC05	SCCD	8/2/2021	9:40	20.9	20.4	8.33	630	8.89	98.7	0.52	34.22	9.8[B]	461
Goose Creek	GC05	SCCD	8/19/2021	9:40	15.7	15.2	8.38	660	8.57	96.0	0.64	59.13	28.0	2420
Goose Creek	GC05	SCCD	9/1/2021	9:45	17.1	16.5	8.48	694	8.77	89.6	0.50	30.86	4.6	365
Goose Creek	GC05	SCCD	9/14/2021	9:25	15.4	14.9	8.33	619	8.67	85.7	0.51	32.51	25[B]	>2419.6[EG]

EG: Sample result reported as greater than 2419 MPN/100 mL
DO: 100 percent air saturation exceeded
B: Analyte detected in the associated method blank

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	14.0	13.5	8.14	292	10.24	97.4	1.40	753.00	10.7	172
June 7-August 2	19.0	18.4	8.22	454	9.13	96.8	1.04	555.85	10.6	324
July 20-September 14	18.4	17.9	8.37	662	8.61	92.7	0.53	37.20	14.4	797
Annual	16.2	15.7	8.26	477	9.43	95.1	0.97	395.10	12.6	

APPENDIX TABLE C-8. SCCD 2021 WATER QUALITY DATA AT SITE BG01

Field Data													Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	*TURB* (NTU)	E_COLI (cfu/100mL)
Big Goose Creek	BG01	SCCD	5/13/2021	9:45	10.4	10.1	8.04	351	10.88	96.40	1.20	109.43	6.7	41
Big Goose Creek	BG01	SCCD	5/26/2021	9:35	8.4	8.0	7.70	138	10.91	91.7	2.12	368.88	12.0	326
Big Goose Creek	BG01	SCCD	6/7/2021	9:55	11.2	10.7	7.67[DQ]	77	9.89	89.0	2.92	730.80	18.0	179
Big Goose Creek	BG01	SCCD	6/22/2021	9:30	17.1	16.6	8.04	262	8.84	90.7	1.02	77.34	5.8	166
Big Goose Creek	BG01	SCCD	7/7/2021	10:05	21.3	20.8	8.24	406	8.29	92.7	0.84	51.09	8.4	435
Big Goose Creek	BG01	SCCD	7/20/2021	9:30	23.8	23.2	8.31	632	8.26	96.7	0.50	16.88	2.5	156
Big Goose Creek	BG01	SCCD	8/2/2021	9:55	21.8	21.3	8.44	652	9.88	111.4[DO]	0.38	9.39	2.4	356
Big Goose Creek	BG01	SCCD	8/19/2021	9:50	15.6	15.0	8.31	740	8.58	96.6	0.71	35.68	18.0	1990
Big Goose Creek	BG01	SCCD	9/1/2021	9:55	18.0	17.5	8.44	703	8.75	91.6	0.48	15.47	3.9	236
Big Goose Creek	BG01	SCCD	9/14/2021	9:40	15.6	15.1	8.28	504	8.88	88.3	0.44	12.84	75.0	>2419.6[EG]

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	13.7	13.2	7.94	247	9.76	92.1	1.62	267.51	10.2	177
June 7-August 2	19.0	18.5	8.14	406	9.03	96.1	1.13	177.10	7.4	235
July 20-September 14	19.0	18.4	8.36	646	8.87	96.9	0.50	18.05	20.4	575
Annual	16.3	15.8	8.15	447	9.32	94.5	1.06	142.78	15.3	

DQ: Data quality objective not met
DO: 100 percent of air saturation exceeded
EG: Sample result reported as greater than 2419 MPN/100 mL

APPENDIX TABLE C-9. SCCD 2021 WATER QUALITY DATA AT SITE BG-BC01

Field Data													Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	*TURB* (NTU)	E_COLI (cfu/100mL)
Beaver Creek	BG-BC01	SCCD	5/13/2021	10:05	10.6	10.1	8.46	722	11.53	102.4[DO]	0.33	4.91	11.0	41
Beaver Creek	BG-BC01	SCCD	5/26/2021	9:55	11.7	11.3	8.22	546	10.05	91.5	1.08	80.95	37.0	921
Beaver Creek	BG-BC01	SCCD	6/7/2021	10:20	15.2	14.7	8.28	608	9.11	89.5	1.98	339.24	70[B]	1410
Beaver Creek	BG-BC01	SCCD	6/22/2021	10:00	15.8	15.3	8.43	502	9.24	92.3	0.38	6.85	113.0	>2419.6[EG]
Beaver Creek	BG-BC01	SCCD	7/7/2021	10:30	18.5	18.1	8.31	432	8.53	90.1	0.52	14.38	65.0	727
Beaver Creek	BG-BC01	SCCD	7/20/2021	9:55	19.5	19.0	8.33	507	8.47	91.6	0.36	6.03	25[B]	411
Beaver Creek	BG-BC01	SCCD	8/2/2021	10:20	17.8	17.2	8.31	699	8.79	91.4	0.33	4.91	13.0	613
Beaver Creek	BG-BC01	SCCD	8/19/2021	10:15	13.6	13.0	8.36	644	9.26	100.5[DO]	0.42	8.68	60.0	>2419.6[EG]
Beaver Creek	BG-BC01	SCCD	9/1/2021	10:15	14.6	14.1	8.43	855	9.33	90.7	0.22	1.88	6.3	345
Beaver Creek	BG-BC01	SCCD	9/14/2021	10:00	13.2	12.7	8.42	732	9.48	89.5	0.28	3.33	5.2	411

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	14.4	13.9	8.34	562	9.69	93.2	0.86	89.27	59.2	623
June 7-August 2	17.4	16.9	8.33	550	8.83	91.0	0.71	74.28	57.2	910
July 20-September 14	15.7	15.2	8.37	687	9.07	92.7	0.32	4.97	21.9	613
Annual	15.1	14.6	8.36	625	9.38	93.0	0.59	47.12	40.6	

DO: 100 percent of air saturation exceeded
B: Analyte detected in the associated method blank
EG: Sample result reported as greater than 2419 MPN/100 mL

APPENDIX TABLE C-10. SCCD 2021 WATER QUALITY DATA AT SITE BG10

Field Data													Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	*TURB* (NTU)	E_COLI (cfu/100mL)
Big Goose Creek	BG10	SCCD	5/13/2021	10:15	7.9	7.4	7.94	239	12.25	101.8[DO]	1.77	87.14	3.7	10
Big Goose Creek	BG10	SCCD	5/26/2021	10:25	7.5	7.4	7.96	107	11.81	97.1	2.94	267.57	3.9	41
Big Goose Creek	BG10	SCCD	6/7/2021	10:30	11.0	10.4	7.83	54	10.50	93.8	SO-SUB	SO-SUB	4.6	91
Big Goose Creek	BG10	SCCD	6/22/2021	10:10	15.7	15.2	8.21	319	9.84	98.0	1.27	41.83	4.2	199
Big Goose Creek	BG10	SCCD	7/7/2021	11:05	20.6	20.1	8.38	357	9.39	103.5[DO]	1.24	39.68	4.3	361
Big Goose Creek	BG10	SCCD	7/20/2021	10:30	22.4	22.0	8.40	528	9.06	103.8[DO]	0.72	11.93	4.9	219
Big Goose Creek	BG10	SCCD	8/2/2021	10:30	20.2	19.7	8.30	537	9.40	102.9[DO]	0.70	11.21	2.1	125
Big Goose Creek	BG10	SCCD	8/19/2021	10:20	13.8	13.2	8.05	354	9.14	99.6	1.35	47.88	38.0	1410
Big Goose Creek	BG10	SCCD	9/1/2021	10:25	16.0	15.5	8.31	631	9.13	91.4	0.75	13.05	3.2	123
Big Goose Creek	BG10	SCCD	9/14/2021	10:15	14.9	14.4	8.27	677	9.40	92.1	0.61	8.27	2.0	93

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	12.5	12.1	8.06	215	10.76	98.8	1.81	109.05	4.1	77
June 7-August 2	18.0	17.5	8.22	359	9.64	100.4	0.98	26.16	4.0	178
July 20-September 14	17.5	17.0	8.27	545	9.23	98.0	0.83	18.47	10.0	213
Annual	15.0	14.5	8.17	380	9.99	98.4	1.26	58.73	7.1	

SUB: Gauge submerged; unable to take reading
DO: 100 percent air saturation exceed

APPENDIX TABLE C-11. SCCD 2021 WATER QUALITY DATA AT SITE BG14

Field Data													Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	*TURB* (NTU)	E_COLI (cfu/100mL)
Big Goose Creek	BG14	SCCD	5/13/2021	10:30	7.5	7.0	7.81	182	12.09	99.6	1.71	98.73	2.9	52
Big Goose Creek	BG14	SCCD	5/26/2021	10:40	7.0	6.6	7.63	77	11.61	94.4	2.84	331.71	3.3	62
Big Goose Creek	BG14	SCCD	6/7/2021	10:45	10.6	10.1	7.50	42	10.70	94.8	SO-SUB	SO-SUB	1.8	61
Big Goose Creek	BG14	SCCD	6/22/2021	10:15	15.2	14.7	8.25	231	9.93	97.8	1.02	28.73	2.6[B]	225
Big Goose Creek	BG14	SCCD	7/7/2021	11:20	19.3	18.8	8.38	304	9.16	98.3	0.90	21.31	2.8[B]	228
Big Goose Creek	BG14	SCCD	7/20/2021	10:50	21.5	21.0	8.55	496	9.53	106.9[DO]	0.57	7.16	2.1	579
Big Goose Creek	BG14	SCCD	8/2/2021	10:40	19.3	18.8	8.60	417	10.24	110.0[DO]	0.58	7.46	1.7	199
Big Goose Creek	BG14	SCCD	8/19/2021	10:30	13.2	12.7	8.15	207	9.55	103.2[DO]	1.23	44.94	12.0	688
Big Goose Creek	BG14	SCCD	9/1/2021	10:35	15.3	14.7	8.32	485	9.54	94.4	0.57	7.16	2.2	105
Big Goose Creek	BG14	SCCD	9/14/2021	10:25	14.2	13.6	8.44	542	9.86	94.8	0.54	6.29	1.2	158

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	11.9	11.4	7.91	167	10.70	97.0	1.62	120.12	2.7	100
June 7-August 2	17.2	16.7	8.26	298	9.91	101.6	0.77	16.16	2.2	205
July 20-September 14	16.7	16.2	8.41	429	9.74	101.9	0.70	14.60	3.8	265
Annual	14.3	13.8	8.16	298	10.22	99.4	1.11	61.50	3.3	

SO-SUB: Gauge fully submerged; unable to take reading
DO: 100 percent air saturation exceeded
B: Analyte detected in the associated method blank

APPENDIX TABLE C-12. SCCD 2021 WATER QUALITY DATA AT SITE BG-RC01

					Field Data								Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Rapid Creek	BG-RC01	SCCD	5/13/2021	10:45	7.6	7.1	7.78	235	11.22	92.8	1.69	161.75	6.1	74
Rapid Creek	BG-RC01	SCCD	5/26/2021	10:55	7.3	6.9	7.60	126	10.87	88.9	1.85	326.18	3.3	56
Rapid Creek	BG-RC01	SCCD	6/7/2021	10:55	13.6	13.1	8.17	381	9.64	91.7	SO-SUB	SO-SUB	1.8	387
Rapid Creek	BG-RC01	SCCD	6/22/2021	10:30	14.1	14.3	8.16	336	10.32	99.3	1.10	5.79	1.7	308
Rapid Creek	BG-RC01	SCCD	7/7/2021	11:35	16.9	16.5	8.15	374	9.15	93.6	1.20	11.37	1.4	461
Rapid Creek	BG-RC01	SCCD	7/20/2021	11:00	17.3	16.8	7.99	438	8.62	89.0	0.98	2.37	1.2	816
Rapid Creek	BG-RC01	SCCD	8/2/2021	10:55	17.0	16.5	8.10	485	9.23	108.3[DO]	0.91	1.33	1.1	1120
Rapid Creek	BG-RC01	SCCD	8/19/2021	10:50	13.4	12.9	8.49	524	9.16	99.8	0.93	1.58	1.8	866
Rapid Creek	BG-RC01	SCCD	9/1/2021	10:50	14.7	14.1	8.65	476	9.40	91.6	0.88	1.03	1.0	816
Rapid Creek	BG-RC01	SCCD	9/14/2021	10:40	14.1	13.7	8.27	489	10.24	98.4	0.85	0.78	0.9	866

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	11.9	11.6	7.97	290	10.24	93.3	1.46	126.27	2.9	187
June 7-August 2	15.8	15.4	8.11	403	9.39	96.4	1.05	5.22	1.4	550
July 20-September 14	15.3	14.8	8.30	482	9.33	97.4	0.91	1.42	1.2	890
Annual	13.6	13.2	8.14	386	9.79	95.3	1.15	56.91	2.0	

DO: 100 percent air saturation exceed

SO-SUB: Gauge fully submerged; unable to take reading

APPENDIX TABLE C-13. SCCD 2021 WATER QUALITY DATA AT SITE BG18

					Field Data								Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Big Goose Creek	BG18	SCCD	5/13/2021	11:05	5.5	4.9	7.08	100	11.88	92.9	1.30	52.30	2.4	31
Big Goose Creek	BG18	SCCD	5/26/2021	11:30	5.8	5.6	7.44	50	11.50	90.7	2.46	145.67	3.1	10
Big Goose Creek	BG18	SCCD	6/7/2021	11:15	10.2	9.7	7.80	34	10.56	92.9	3.33	236.92	12.0	3
Big Goose Creek	BG18	SCCD	6/22/2021	11:05	13.6	13.1	7.95	69	10.44	99.3	1.20	45.99	1.1[B]	46
Big Goose Creek	BG18	SCCD	7/7/2021	11:55	16.3	15.8	7.82	68	9.02	91.1	1.10	39.99	1.2[B]	31
Big Goose Creek	BG18	SCCD	7/20/2021	11:20	17.0	16.4	8.11	92	8.95	91.5	0.68	18.47	0.9	147
Big Goose Creek	BG18	SCCD	8/2/2021	11:10	15.7	15.2	8.14	88	9.25	107.3[DO]	0.76	22.08	1.0	44
Big Goose Creek	BG18	SCCD	8/19/2021	11:05	12.4	11.8	8.12	68	8.95	96.2	1.29	51.66	1.9	96
Big Goose Creek	BG18	SCCD	9/1/2021	11:10	13.0	12.5	8.40	81	9.13	85.5	0.79	23.50	2.4	58
Big Goose Creek	BG18	SCCD	9/14/2021	11:20	12.1	11.5	8.11	79	10.02	91.6	0.72	20.25	4.0	99

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	10.3	9.8	7.62	64	10.68	93.4	1.88	104.17	4.0	17
June 7-August 2	14.6	14.0	7.96	70	9.64	96.4	1.41	72.69	3.2	31
July 20-September 14	14.0	13.5	8.18	82	9.26	94.4	0.85	27.19	2.0	81
Annual	12.2	11.7	7.90	73	9.97	93.9	1.36	65.68	3.0	

DO: 100 percent air saturation exceeded

B: Analyte detected in the associated method blank

APPENDIX TABLE C-14. SCCD 2021 WATER QUALITY DATA AT SITE LG02

					Field Data								Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Little Goose Creek	LG02	SCCD	5/13/2021	11:45	10.2	9.7	8.27	336	12.99	114.1[DO]	2.15	231.32	11.0	20
Little Goose Creek	LG02	SCCD	5/26/2021	12:10	10.0	9.5	7.29	231	9.91	86.7	2.58	906.50	32.0	461
Little Goose Creek	LG02	SCCD	6/7/2021	11:50	13.1	12.6	8.15	160	10.82	101.5[DO]	2.74	1422.72	12.0	326
Little Goose Creek	LG02	SCCD	6/22/2021	11:45	20.0	19.5	8.54	431	11.79	128.5[DO]	1.76	51.64	6.9	114
Little Goose Creek	LG02	SCCD	7/7/2021	13:05	25.5	25.0	8.39	605	9.77	118.3[DO]	1.60	25.29	10.0	260
Little Goose Creek	LG02	SCCD	7/20/2021	12:15	25.6	25.1	8.52	794	10.25	124.6[DO]	1.48	14.10	4.2	105
Little Goose Creek	LG02	SCCD	8/2/2021	12:05	23.6	23.1	8.47	610	10.23	135.1[DO]	1.60	25.29	7.2	299
Little Goose Creek	LG02	SCCD	8/19/2021	12:05	15.8	15.3	8.67	620	8.12	91.8	1.66	33.32	21.0	613
Little Goose Creek	LG02	SCCD	9/1/2021	11:50	17.9	17.4	8.85	685	9.73	101.6[DO]	1.56	20.92	4.8	124
Little Goose Creek	LG02	SCCD	9/14/2021	11:55	18.4	17.9	8.38	640	10.05	106[DO]	1.60	25.29	9.5	260

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	15.8	15.3	8.13	353	11.06	109.8	2.17	527.50	14.4	155
June 7-August2	21.6	21.1	8.41	520	10.57	121.6	1.84	307.81	8.1	198
July 20-September 14	20.3	19.8	8.58	670	9.68	111.8	1.58	23.78	9.3	228
Annual	18.0	17.5	8.35	511	10.37	110.8	1.87	275.64	11.9	

DO: 100 percent air saturation exceeded

APPENDIX TABLE C-15. SCCD 2021 WATER QUALITY DATA AT SITE LG08

					Field Data								Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Little Goose Creek	LG08	SCCD	5/13/2021	12:15	9.0	8.5	7.86	262	11.92	101.8[DO]	1.39	90.17	3.1	<1[EL]
Little Goose Creek	LG08	SCCD	5/26/2021	12:40	8.4	8.4	7.42	169	10.65	89.6	1.82	136.03	6.3	71
Little Goose Creek	LG08	SCCD	6/7/2021	12:15	11.5	11.0	7.66	133	10.62	95.5	1.78	131.49	4.3[B]	110
Little Goose Creek	LG08	SCCD	6/22/2021	12:15	18.7	18.2	8.47	418	10.29	109.2[DO]	0.66	28.94	4.8	411
Little Goose Creek	LG08	SCCD	7/7/2021	13:30	23.0	22.6	8.34	538	9.53	110.2[DO]	0.44	15.59	8.5	365
Little Goose Creek	LG08	SCCD	7/20/2021	12:50	22.4	21.9	8.33	621	9.44	107.7[DO]	0.32	9.59	6.3[B]	435
Little Goose Creek	LG08	SCCD	8/2/2021	12:35	21.3	20.8	8.37	551	10.00	127.4[DO]	0.44	15.59	11.0	344
Little Goose Creek	LG08	SCCD	8/19/2021	12:35	15.1	14.6	8.44	610	8.14	91.4	0.52	20.12	6.9	816
Little Goose Creek	LG08	SCCD	9/1/2021	12:30	16.9	16.4	8.77	584	9.98	101.8[DO]	0.46	16.69	3.2	148
Little Goose Creek	LG08	SCCD	9/14/2021	12:20	16.9	16.3	8.34	503	9.89	100.9[DO]	0.47	17.24	6.0	435

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	14.1	13.7	7.95	304	10.60	101.3	1.22	80.44	5.4	65
June 7-August2	19.4	18.9	8.23	452	9.98	110.0	0.73	40.24	7.0	301
July 20-September 14	18.5	18.0	8.45	574	9.49	105.8	0.44	15.85	6.7	379
Annual	16.3	15.9	8.20	439	10.05	103.6	0.83	48.15	6.0	

DO: 100 percent air saturation exceeded

B: Analyte detected in the associated method blank

EL: Sample result reported as less than 1 MPN/100 mL

APPENDIX TABLE C-16. SCCD 2021 WATER QUALITY DATA AT SITE LG-MCC01

					Field Data								Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
McCormick Creek	LG-McC01	SCCD	5/13/2021	12:25	12.4	11.9	8.18	1331	10.72	99.3	0.74	1.21	2.5	41
McCormick Creek	LG-McC01	SCCD	5/26/2021	12:50	12.8	12.1	8.13	1127	9.02	84.2	0.66	0.88	3.0	121
McCormick Creek	LG-McC01	SCCD	6/7/2021	12:30	15.1	14.6	7.80	324	9.02	88.7	1.08	3.43	26.0	1200
McCormick Creek	LG-McC01	SCCD	6/22/2021	12:25	17.1	17.3	8.15	472	9.44	96.6	0.86	1.83	19.8	461
McCormick Creek	LG-McC01	SCCD	7/7/2021	14:10	20.3	19.8	8.13	506	8.24	90.3	0.96	2.48	40.0	1300
McCormick Creek	LG-McC01	SCCD	7/20/2021	13:20	20.2	19.7	8.02	577	7.48	82.0	0.88	1.95	26.0	249
McCormick Creek	LG-McC01	SCCD	8/2/2021	12:45	19.7	19.2	8.09	413	7.40[DQ]	91.2[DQ]	1.38	6.74	120.0	1990
McCormick Creek	LG-McC01	SCCD	8/19/2021	13:05	14.4	13.9	8.30	445	8.62	95.2	1.17	4.28	30.0	1300
McCormick Creek	LG-McC01	SCCD	9/1/2021	12:45	15.4	14.9	8.36	771	8.79	87.0	0.86	1.83	14.0	248
McCormick Creek	LG-McC01	SCCD	9/14/2021	12:40	15.4	14.9	8.14	371	8.90	88.0	1.20	4.59	24.0	687

DQ: Data quality objective not met

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	15.5	15.1	8.08	752	9.29	91.8	0.86	1.97	18.3	324
June 7-August 2	18.5	18.1	8.04	458	8.32	89.8	1.03	3.29	46.4	814
July 20-September 14	17.0	16.5	8.18	515	8.24	88.7	1.10	3.88	42.8	643
Annual	16.3	15.8	8.13	634	8.76	90.3	0.98	2.92	30.5	

APPENDIX TABLE C-17. SCCD 2021 WATER QUALITY DATA AT SITE LG-KC01

					Field Data								Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Kruse Creek	LG-KC01	SCCD	5/13/2021	12:35	13.9	13.4	8.09	651	9.91	95.1	2.09	4.88	6.2	148
Kruse Creek	LG-KC01	SCCD	5/26/2021	13:05	14.6	14.1	8.07	583	8.93	86.8	2.20	6.58	3.2[B]	345
Kruse Creek	LG-KC01	SCCD	6/7/2021	12:40	20.4	19.9	8.28	517	8.15	89.3	2.32	8.96	6.2	1730
Kruse Creek	LG-KC01	SCCD	6/22/2021	12:50	20.1	20.3	8.39	474	9.22	102.8[DO]	2.14	5.60	7.4	649
Kruse Creek	LG-KC01	SCCD	7/7/2021	14:15	22.7	22.2	8.32	509	8.59	98.7	2.12	5.30	2.9	548
Kruse Creek	LG-KC01	SCCD	7/20/2021	13:30	21.8	21.5	8.29	565	7.94	89.7	2.01	3.89	4.7	1730
Kruse Creek	LG-KC01	SCCD	8/2/2021	13:20	21.7	21.3	8.21	558	8.46	107.9[DO]	2.06	4.49	3.2[B]	579
Kruse Creek	LG-KC01	SCCD	8/19/2021	13:35	15.9	15.4	8.45	559	8.48	97.0	2.28	8.10	2.8	866
Kruse Creek	LG-KC01	SCCD	9/1/2021	12:50	17.1	16.5	8.18	477	8.73	89.4	2.21	6.76	2.4	299
Kruse Creek	LG-KC01	SCCD	9/14/2021	13:10	17.4	16.9	8.31	485	9.34	96.9	2.28	8.10	2.8[B]	517

DO: 100 percent air saturation exceeded

B: Analyte detected in the associated method blank

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	18.3	18.0	8.23	547	8.96	94.5	2.17	6.27	5.2	501
June 7-August 2	21.3	21.0	8.30	525	8.47	97.7	2.13	5.65	4.9	908
July 20-September 14	18.8	18.3	8.29	529	8.59	96.2	2.17	6.27	3.2	669
Annual	18.6	18.2	8.26	538	8.78	95.4	2.17	6.27	4.2	

APPENDIX TABLE C-18. SCCD 2021 WATER QUALITY DATA AT SITE LG13

					Field Data								Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Little Goose Creek	LG13	SCCD	5/13/2021	12:45	9.3	8.8	8.26	222	12.13	104.5[DO]	1.21[SA]	0.28	3.2	20
Little Goose Creek	LG13	SCCD	5/26/2021	13:20	8.2	7.8	7.96	155[DQ]	10.70	89.4	1.46[SA]	1.53	7.3	37
Little Goose Creek	LG13	SCCD	6/7/2021	13:00	11.5	11.0	8.02	107	10.50	95.0	1.52[SA]	2.21	3.8	727
Little Goose Creek	LG13	SCCD	6/22/2021	13:25	19.6	19.5	8.41	374	9.62	103.9[DO]	1.81	10.76	4.7	261
Little Goose Creek	LG13	SCCD	7/7/2021	14:25	22.2	21.7	8.67	486	11.06	125.7[DO]	1.64	4.40	2.6	261
Little Goose Creek	LG13	SCCD	7/20/2021	14:00	20.3	19.7	8.22	691	10.48	114.6[DO]	1.47	1.63	1.0	178
Little Goose Creek	LG13	SCCD	8/2/2021	13:55	21.9	21.5	8.38	642	11.18	144.8[DO]	1.58	3.14	2.1	260
Little Goose Creek	LG13	SCCD	8/19/2021	13:50	15.0	14.5	8.64	567	9.13	102.5[DO]	1.70	6.10	3.0	866
Little Goose Creek	LG13	SCCD	9/1/2021	13:30	16.7	16.1	8.64	619	9.62	98.1	1.65	4.65	1.6	102
Little Goose Creek	LG13	SCCD	9/14/2021	13:30	17.5	17.0	8.14	583	10.44	107.9[DO]	1.54	2.49	1.6[DQ]	51

DQ: Data quality objective not met

DO: 100 percent air saturation exceeded

SA: Staff height adjusted

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	14.2	13.8	8.26	269	10.80	103.7	2.51	734.50	4.3	130
June 7-August 2	19.1	18.7	8.34	460	10.57	116.8	1.93	331.90	2.8	297
July 20-September 14	18.3	17.8	8.40	620	10.17	113.6	1.59	3.60	1.9	184
Annual	16.2	15.8	8.33	445	10.49	108.6	2.05	369.05	3.1	

APPENDIX TABLE C-19. SCCD 2021 WATER QUALITY DATA AT SITE LG-JC01

					Field Data								Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Jackson Creek	LG-JC01	SCCD	5/13/2021	12:55	11.5	11.0	8.38	615	11.71	106.2[DO]	1.55	67.17	5.8[B]	97
Jackson Creek	LG-JC01	SCCD	5/26/2021	13:30	8.8	8.2	7.76	236	10.12	85.8	1.68	116.42	50.0	387
Jackson Creek	LG-JC01	SCCD	6/7/2021	13:10	17.4	16.8	8.30	465	9.28	95.7	1.20	11.70	21.0	816
Jackson Creek	LG-JC01	SCCD	6/22/2021	14:45	19.1	18.6	8.36	396	8.79	94.0	1.36	27.50	77.3	1990
Jackson Creek	LG-JC01	SCCD	7/7/2021	14:55	20.8	20.3	8.48	716	8.28	91.6	0.82	0.87	12.0	548
Jackson Creek	LG-JC01	SCCD	7/20/2021	14:15	20.4	20.2	8.62	702	8.70	95.6	0.93	2.05	5.2	308
Jackson Creek	LG-JC01	SCCD	8/2/2021	14:10	20.9	20.5	8.62	630	9.44	120.2[DO]	0.88	1.41	6.5	435
Jackson Creek	LG-JC01	SCCD	8/19/2021	14:05	13.9	13.3	8.97	708	9.52	104.5[DO]	0.95	2.37	8.4[B]	727
Jackson Creek	LG-JC01	SCCD	9/1/2021	13:40	15.2	14.6	8.58	692	9.61	94.5	0.91	1.77	5.4[B]	816
Jackson Creek	LG-JC01	SCCD	9/14/2021	13:45	15.7	15.2	8.54	653	10.63	105.5[DO]	0.86	1.20	3.3	326

DO: 100 percent air saturation

B: Analyte detected in the associated method blank

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	15.5	15.0	8.26	486	9.64	94.7	1.32	44.73	33.2	507
June 7-August 2	19.7	19.3	8.48	582	8.90	99.4	1.04	8.71	24.4	654
July 20-September 14	17.2	16.8	8.67	677	9.58	104.1	0.91	1.76	5.8	482
Annual	16.4	15.9	8.46	581	9.61	99.4	1.11	23.25	19.5	

APPENDIX TABLE C-20. SCCD 2021 WATER QUALITY DATA AT SITE LG22

					Field Data									Laboratory Data	
Waterbody	Site	Agency	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	PH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Little Goose Creek	LG22	SCCD	5/13/2021	13:15	8.3	7.8	7.74[DQ]	96	11.76	98.9	1.19	74.60	18[DQ]	<1[EL]
Little Goose Creek	LG22	SCCD	5/26/2021	13:50	6.8	6.3	7.98	70	11.23	93.2	1.86	156.88	2.0	140
Little Goose Creek	LG22	SCCD	6/7/2021	13:30	10.0	9.4	7.82	36	10.91	95.3	1.98	174.09	2.1	15
Little Goose Creek	LG22	SCCD	6/22/2021	15:00	15.3	14.9	8.01	50	9.61	95.0	1.22	77.76	1.6	13
Little Goose Creek	LG22	SCCD	7/7/2021	15:15	16.7	16.2	8.45	54	8.27	84.1	1.16	71.50	1.7	42
Little Goose Creek	LG22	SCCD	7/20/2021	14:50	15.7	15.1	8.16	50	9.28	92.4	1.04	59.62	2.4	39
Little Goose Creek	LG22	SCCD	8/2/2021	14:45	17.9	17.4	8.02	56	8.79	107[DO]	0.98	54.00	2.4	26
Little Goose Creek	LG22	SCCD	8/19/2021	14:45	12.7	12.2	8.50	61	9.35	102.1[DO]	0.96	52.18	2.7	50
Little Goose Creek	LG22	SCCD	9/1/2021	14:15	14.0	13.5	8.25	58	9.25	88.8	0.81	39.33	2.5	120
Little Goose Creek	LG22	SCCD	9/14/2021	14:25	14.8	14.3	8.06	64	9.27	90.5	0.70	30.85	2.4	23

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 13-July 7	11.4	10.9	8.00	61	10.36	93.3	1.48	110.97	5.1	16
June 7-August 2	15.1	14.6	8.09	49	9.37	94.8	1.28	87.39	2.0	24
July 20-September 14	15.0	14.5	8.20	58	9.19	96.2	0.90	47.20	2.5	43
Annual	13.2	12.7	8.10	60	9.77	94.7	1.19	79.08	3.8	

DQ: Data quality objective not met
DO: 100 percent air saturation exceeded
EL: Sample result reported as less than 1 MPN/100 mL

Data Qualifiers

B	Analyte detected in the associated method blank.
CG	Sample result reported as greater than 1 µmho/cm; use 1999 µmhos for statistics.
DIS	Sample results rejected due to inability to meet quality control critiera.
DO	100 percent air saturation exceeded.
DQ	Data quality objective not met.
EG	Sample result reported as greater than 2419 MPN/100 mL; use 2420 MPN/100 mL for statistics.
EL	Sample result reported as less than 1 MPN/100 mL; use 1 MPN/100 mL for statistics.
H	Holding time exceeded.
NS	Not sampled.
SA	Staff height adjusted.
SO-OUT	Gauge out of water; unable to take reading.
SO-SUB	Gauge fully submerged; unable to take reading.

APPENDIX TABLE C-21. 2021 WATER QUALITY DATA SUMMARY STATISTICS

		Hanna	YSI	PH	COND	DO	DO	STAFF	DISCH	TURB	*E. Coli*
Site	Statistic	Temp (°C)	Temp (°C)	(SU)	(uS/cm)	(mg/L)	(%)		(cfs)	(NTU)	(cfu/100mL)
GC01	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	23.7	23.2	8.38	788	11.31	100.1	2.94	816.63	28.0	1300.0
	MINIMUM	9.8	9.8	7.66	125	6.24	73.0	0.36	27.17	5.0	56.0
	MEDIAN	16.9	16.4	8.23	593	7.80	85.5	0.68	76.99	8.7	148.5
	MEAN	16.7	16.3	8.15	516	8.26	83.7	1.04	193.61	11.9	339.9
	GEOMETRIC MEAN	16.1	15.7	8.15	450	8.12	83.3	0.82	102.32	10.2	194.8
	COEFFICIENT OF VARIATION	28.04	27.85	3.06	45.56	19.70	10.64	81.46	132.37	63.1	124.47
GC02	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	7.0	7.0	10.0	10.0
	MAXIMUM	22.0	21.5	8.31	719	11.72	101.1	3.54	452.90	35.0	2420.0
	MINIMUM	9.4	9.5	7.74	194	7.03	79.1	0.17	28.20	5.3	10.0
	MEDIAN	16.2	15.7	8.20	566	8.09	88.7	0.88	126.82	12.0	479.5
	MEAN	15.9	15.5	8.14	503	8.88	88.6	1.33	179.48	13.7	807.5
	GEOMETRIC MEAN	15.3	14.9	8.14	463	8.77	88.4	0.83	120.57	11.5	398.1
	COEFFICIENT OF VARIATION	28.19	27.84	2.55	37.71	16.92	8.13	93.66	87.32	65.5	109.23
GC-SC01	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	20.7	20.2	8.34	1031	10.50	92.2	2.92	4.92	85.0	1550.0
	MINIMUM	10.2	9.7	8.02	452	6.25	69.1	0.12	0.00	7.4	109.0
	MEDIAN	15.9	15.3	8.10	769	8.04	80.6	1.09	0.56	29.5	424.0
	MEAN	15.8	15.3	8.13	743	7.91	79.3	1.26	1.18	34.9	572.7
	GEOMETRIC MEAN	15.5	15.0	8.13	720	7.82	79.0	0.93	0.40	29.0	418.2
	COEFFICIENT OF VARIATION	20.18	20.99	1.36	25.75	15.69	9.37	66.47	128.66	63.1	80.05
GC05	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	22.9	22.3	8.48	705	11.88	103.9	2.66	2521.51	28.0	2420.0
	MINIMUM	8.9	8.6	7.80	110	8.13	85.7	0.49	29.26	4.6	41.0
	MEDIAN	16.4	15.9	8.33	551	8.88	94.8	0.68	69.89	9.7	345.5
	MEAN	16.2	15.7	8.26	477	9.43	95.1	0.97	395.10	12.6	724.6
	GEOMETRIC MEAN	15.5	14.9	8.25	411	9.36	94.9	0.81	109.33	10.3	370.1
	COEFFICIENT OF VARIATION	30.15	30.87	2.36	46.27	12.36	5.98	73.51	199.10	66.7	125.82
BG01	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	23.8	23.2	8.44	740	10.91	111.4	2.92	730.80	75.0	2420.0
	MINIMUM	8.4	8.0	7.67	77	8.26	88.3	0.38	9.39	2.4	41.0
	MEDIAN	16.4	15.9	8.26	455	8.86	92.2	0.78	43.39	7.6	281.0
	MEAN	16.3	15.8	8.15	447	9.32	94.5	1.06	142.78	15.3	630.5
	GEOMETRIC MEAN	15.5	15.0	8.14	366	9.27	94.3	0.84	51.49	8.6	319.0
	COEFFICIENT OF VARIATION	31.59	32.21	3.43	53.23	10.78	7.06	78.68	163.24	142.5	133.80
BG-BC01	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	19.5	19.0	8.46	855	11.53	102.4	1.98	339.24	113.0	2420.0
	MINIMUM	10.6	10.1	8.22	432	8.47	89.5	0.22	1.88	5.2	41.0
	MEDIAN	14.9	14.4	8.35	626	9.25	91.5	0.37	6.44	31.0	670.0
	MEAN	15.1	14.6	8.36	625	9.38	93.0	0.59	47.12	40.6	971.9
	GEOMETRIC MEAN	14.8	14.3	8.35	612	9.34	92.9	0.46	10.79	25.9	617.8
	COEFFICIENT OF VARIATION	19.39	20.03	0.94	20.83	9.46	4.94	92.34	223.57	87.8	87.21
BG10	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0
	MAXIMUM	22.4	22.0	8.40	677	12.25	103.8	2.94	267.57	38.0	1410.0
	MINIMUM	7.5	7.4	7.83	54	9.06	91.4	0.61	8.27	2.0	10.0
	MEDIAN	15.3	14.8	8.24	356	9.40	98.8	1.24	39.68	4.1	124.0
	MEAN	15.0	14.5	8.17	380	9.99	98.4	1.26	58.73	7.1	267.2
	GEOMETRIC MEAN	14.1	13.6	8.16	304	9.94	98.3	1.11	31.04	4.4	128.0
	COEFFICIENT OF VARIATION	34.34	35.20	2.49	55.67	11.60	4.79	58.67	140.25	153.8	154.89
BG14	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0
	MAXIMUM	21.5	21.0	8.60	542	12.09	110.0	2.84	331.71	12.0	688.0
	MINIMUM	7.0	6.6	7.50	42	9.16	94.4	0.54	6.29	1.2	52.0
	MEDIAN	14.7	14.2	8.29	268	9.90	98.1	0.90	21.31	2.4	178.5
	MEAN	14.3	13.8	8.16	298	10.22	99.4	1.11	61.50	3.3	235.7
	GEOMETRIC MEAN	13.5	12.9	8.15	233	10.18	99.3	0.94	23.48	2.6	163.0
	COEFFICIENT OF VARIATION	34.40	35.54	4.74	60.02	9.44	5.60	68.58	171.74	96.2	93.97
BG-RC01	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0
	MAXIMUM	17.3	16.8	8.65	524	11.22	108.3	1.85	326.18	6.1	1120.0
	MINIMUM	7.3	6.9	7.60	126	8.62	88.9	0.85	0.78	0.9	56.0
	MEDIAN	14.1	13.9	8.16	410	9.52	93.2	0.98	2.37	1.6	638.5
	MEAN	13.6	13.2	8.14	386	9.79	95.3	1.15	56.91	2.0	577.0
	GEOMETRIC MEAN	13.1	12.6	8.13	360	9.75	95.2	1.11	6.22	1.7	407.9
	COEFFICIENT OF VARIATION	26.12	26.98	3.77	32.66	8.59	6.36	31.89	199.95	78.2	63.87
BG18	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	17.0	16.4	8.40	100	11.88	107.3	3.33	236.92	12.0	147.0
	MINIMUM	5.5	4.9	7.08	34	8.95	85.5	0.68	18.47	0.9	3.0
	MEDIAN	12.7	12.2	8.03	74	9.64	92.3	1.15	42.99	2.2	45.0
	MEAN	12.2	11.7	7.90	73	9.97	93.9	1.36	65.68	3.0	56.5
	GEOMETRIC MEAN	11.4	10.9	7.89	70	9.92	93.7	1.18	44.90	2.1	36.9
	COEFFICIENT OF VARIATION	32.96	34.00	4.90	27.17	10.97	6.31	63.54	107.79	110.7	79.48

APPENDIX TABLE C-21 (continued). 2021 WATER QUALITY DATA SUMMARY STATISTICS

		Hanna	YSI	PH	COND	DO	DO	STAFF	DISCH	TURB	E. Coli
Site	Statistic	Temp (°C)	Temp (°C)	(SU)	(uS/cm)	(mg/L)	(%)		(cfs)	(NTU)	(cfu/100mL)
LG02	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	25.6	25.1	8.85	794	12.99	135.1	2.74	1422.72	32.0	613.0
	MINIMUM	10.0	9.5	7.29	160	8.12	86.7	1.48	14.10	4.2	20.0
	MEDIAN	18.2	17.7	8.43	608	10.14	110.1	1.63	29.31	9.8	260.0
	MEAN	18.0	17.5	8.35	511	10.37	110.8	1.87	275.64	11.9	258.2
	GEOMETRIC MEAN	17.1	16.6	8.34	460	10.29	109.8	1.83	69.01	9.8	188.0
	COEFFICIENT OF VARIATION	32.23	33.15	5.05	41.04	12.56	14.42	24.29	177.15	71.9	69.80
LG08	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	23.0	22.6	8.77	621	11.92	127.4	1.82	136.03	11.0	816.0
	MINIMUM	8.4	8.4	7.42	133	8.14	89.6	0.32	9.59	3.1	1.0
	MEDIAN	16.9	16.4	8.34	521	9.99	101.8	0.50	18.68	6.2	354.5
	MEAN	16.3	15.9	8.20	439	10.05	103.6	0.83	48.15	6.0	313.6
	GEOMETRIC MEAN	15.4	15.0	8.19	390	10.00	103.0	0.68	30.20	5.6	157.2
	COEFFICIENT OF VARIATION	32.54	33.03	5.07	42.16	9.71	10.59	71.30	105.32	40.1	76.68
LG-McC01	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	20.3	19.8	8.36	1331	10.72	99.3	1.38	6.74	120.0	1990.0
	MINIMUM	12.4	11.9	7.80	324	7.40	82.0	0.66	0.88	2.5	41.0
	MEDIAN	15.4	14.9	8.14	489	8.85	89.5	0.92	2.22	25.0	574.0
	MEAN	16.3	15.8	8.13	634	8.76	90.3	0.98	2.92	30.5	759.7
	GEOMETRIC MEAN	16.0	15.6	8.13	568	8.72	90.1	0.96	2.45	18.6	456.3
	COEFFICIENT OF VARIATION	18.03	18.90	1.87	53.73	10.92	6.07	22.93	62.50	109.8	85.90
LG-KC01	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	22.7	22.2	8.45	651	9.91	107.9	2.32	8.96	7.4	1730.0
	MINIMUM	13.9	13.4	8.07	474	7.94	86.8	2.01	3.89	2.4	148.0
	MEDIAN	18.8	18.4	8.29	538	8.66	96.0	2.17	6.09	3.2	563.5
	MEAN	18.6	18.2	8.26	538	8.78	95.4	2.17	6.27	4.2	741.1
	GEOMETRIC MEAN	18.3	17.9	8.26	535	8.76	95.2	2.17	6.05	3.9	578.7
	COEFFICIENT OF VARIATION	17.15	18.00	1.48	10.42	6.73	7.05	4.77	27.33	43.2	75.23
LG13	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	22.2	21.7	8.67	691	12.13	144.8	3.15	1639.57	7.3	866.0
	MINIMUM	8.2	7.8	7.96	107	9.13	89.4	1.47	1.63	1.0	20.0
	MEDIAN	17.1	16.6	8.32	527	10.49	104.2	1.68	5.37	2.8	219.0
	MEAN	16.2	15.8	8.33	445	10.49	108.6	2.05	369.05	3.1	276.3
	GEOMETRIC MEAN	15.4	14.9	8.33	379	10.45	107.6	1.96	21.84	2.7	154.3
	COEFFICIENT OF VARIATION	31.43	32.45	3.10	48.49	8.35	14.97	33.54	172.17	59.9	105.54
LG-JC01	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	20.9	20.5	8.97	716	11.71	120.2	1.68	116.42	77.3	1990.0
	MINIMUM	8.8	8.2	7.76	236	8.28	85.8	0.82	0.87	3.3	97.0
	MEDIAN	16.6	16.0	8.51	642	9.48	95.7	0.94	2.21	7.5	491.5
	MEAN	16.4	15.9	8.46	581	9.61	99.4	1.11	23.25	19.5	645.0
	GEOMETRIC MEAN	15.8	15.3	8.46	554	9.56	98.9	1.08	5.63	11.1	494.0
	COEFFICIENT OF VARIATION	25.26	26.51	3.66	27.90	10.48	9.89	28.17	167.04	126.6	81.87
LG22	COUNT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	MAXIMUM	17.9	17.4	8.50	96	11.76	107.0	1.98	174.09	18.0	140.0
	MINIMUM	6.8	6.3	7.74	36	8.27	84.1	0.70	30.85	1.6	1.0
	MEDIAN	14.4	13.9	8.04	57	9.32	94.1	1.10	65.56	2.4	32.5
	MEAN	13.2	12.7	8.10	60	9.77	94.7	1.19	79.08	3.8	46.9
	GEOMETRIC MEAN	12.7	12.1	8.10	58	9.71	94.5	1.13	68.60	2.7	26.3
	COEFFICIENT OF VARIATION	28.04	29.23	3.04	26.53	11.60	7.01	35.20	60.79	132.5	98.97

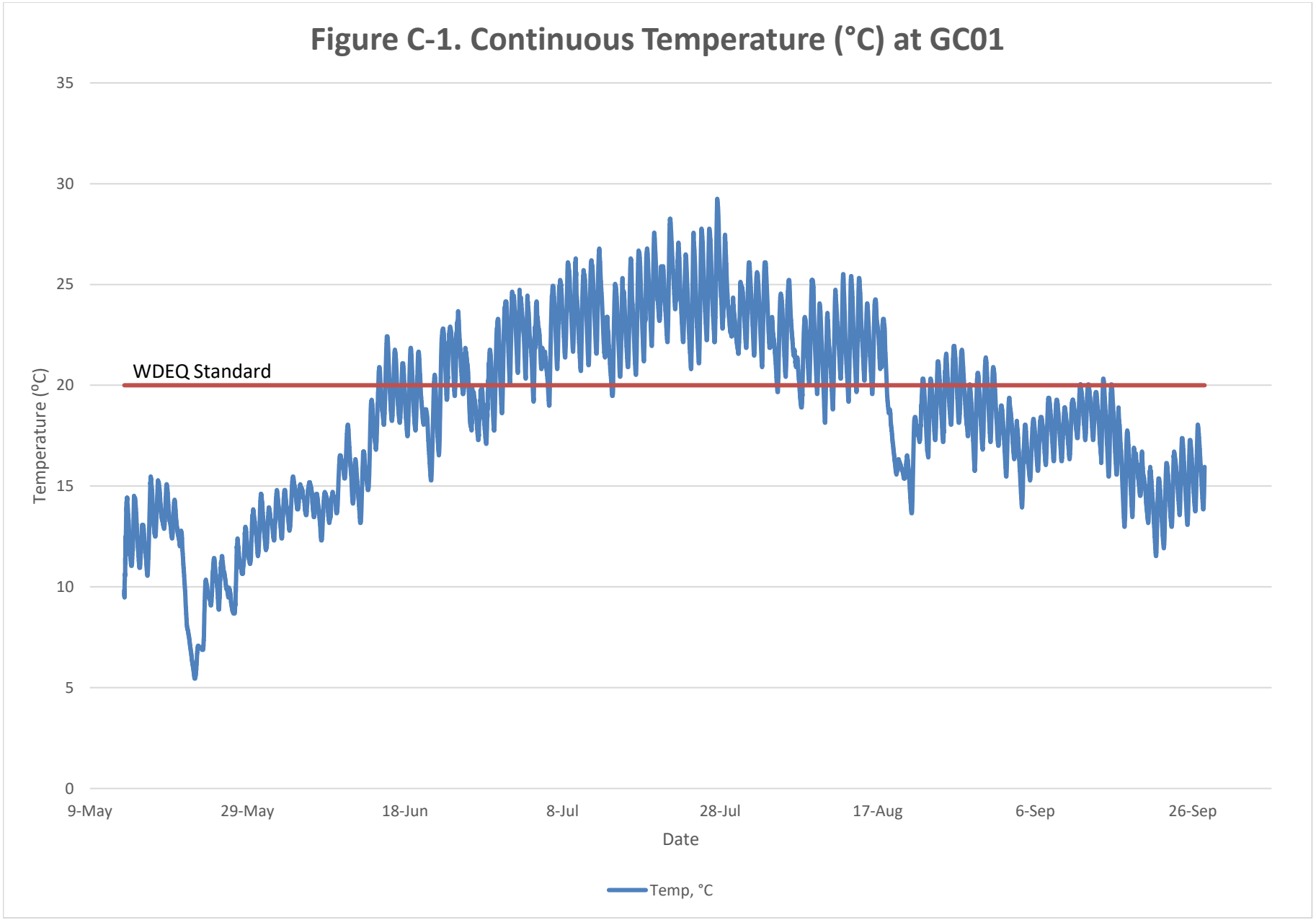


Figure C-1. Continuous Temperature (°C) at GC01
35
30
25
20
15
10
5
0
Temperature (°C)
WDEQ Standard
9-May
29-May
18-Jun
8-Jul
28-Jul
17-Aug
6-Sep
26-Sep
Date
Temp, °C

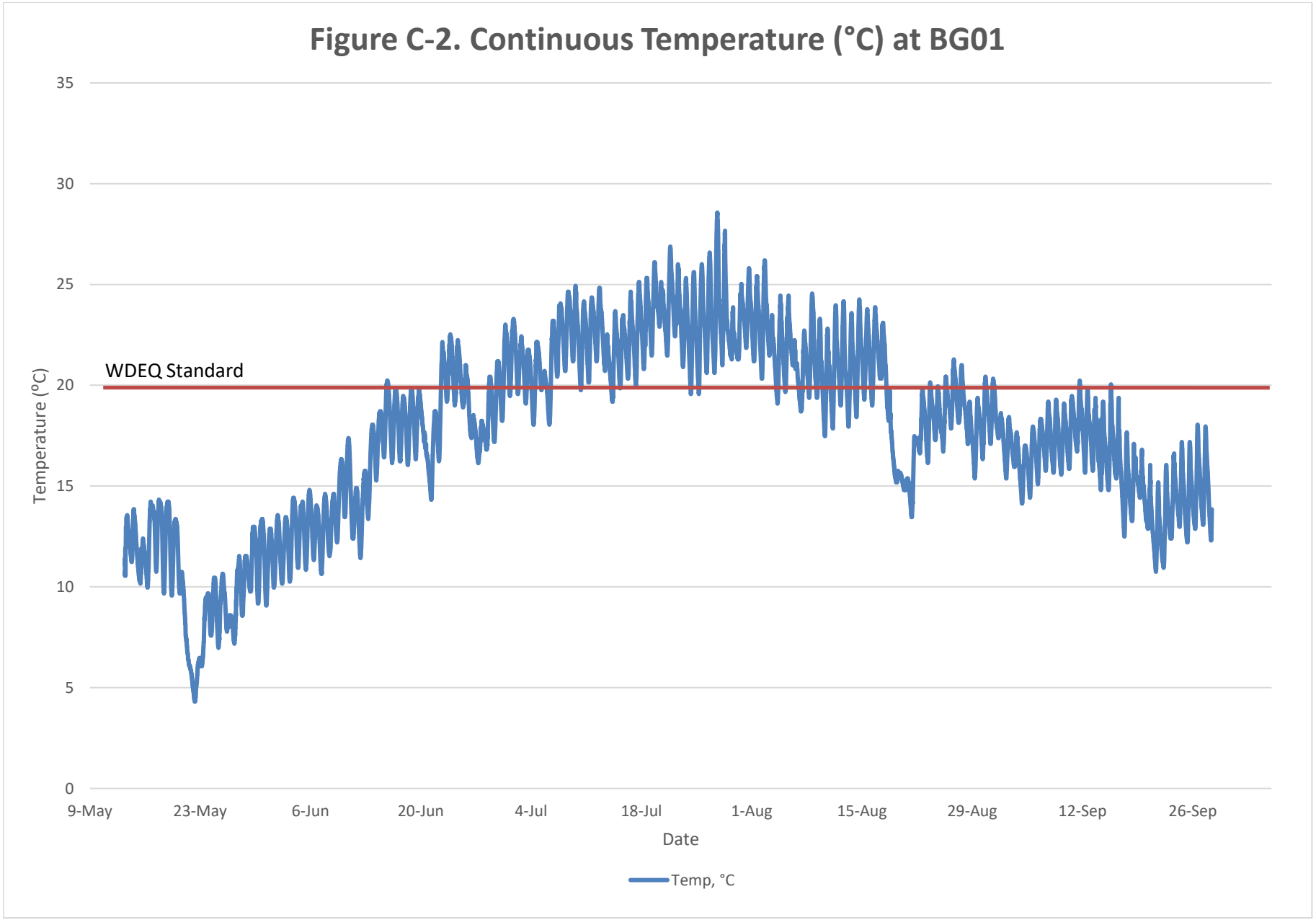


Figure C-2. Continuous Temperature (°C) at BG01
35
30
25
20
15
10
5
0
Temperature (°C)
WDEQ Standard
9-May
23-May
6-Jun
20-Jun
4-Jul
18-Jul
1-Aug
15-Aug
29-Aug
12-Sep
26-Sep
Date
Temp, °C

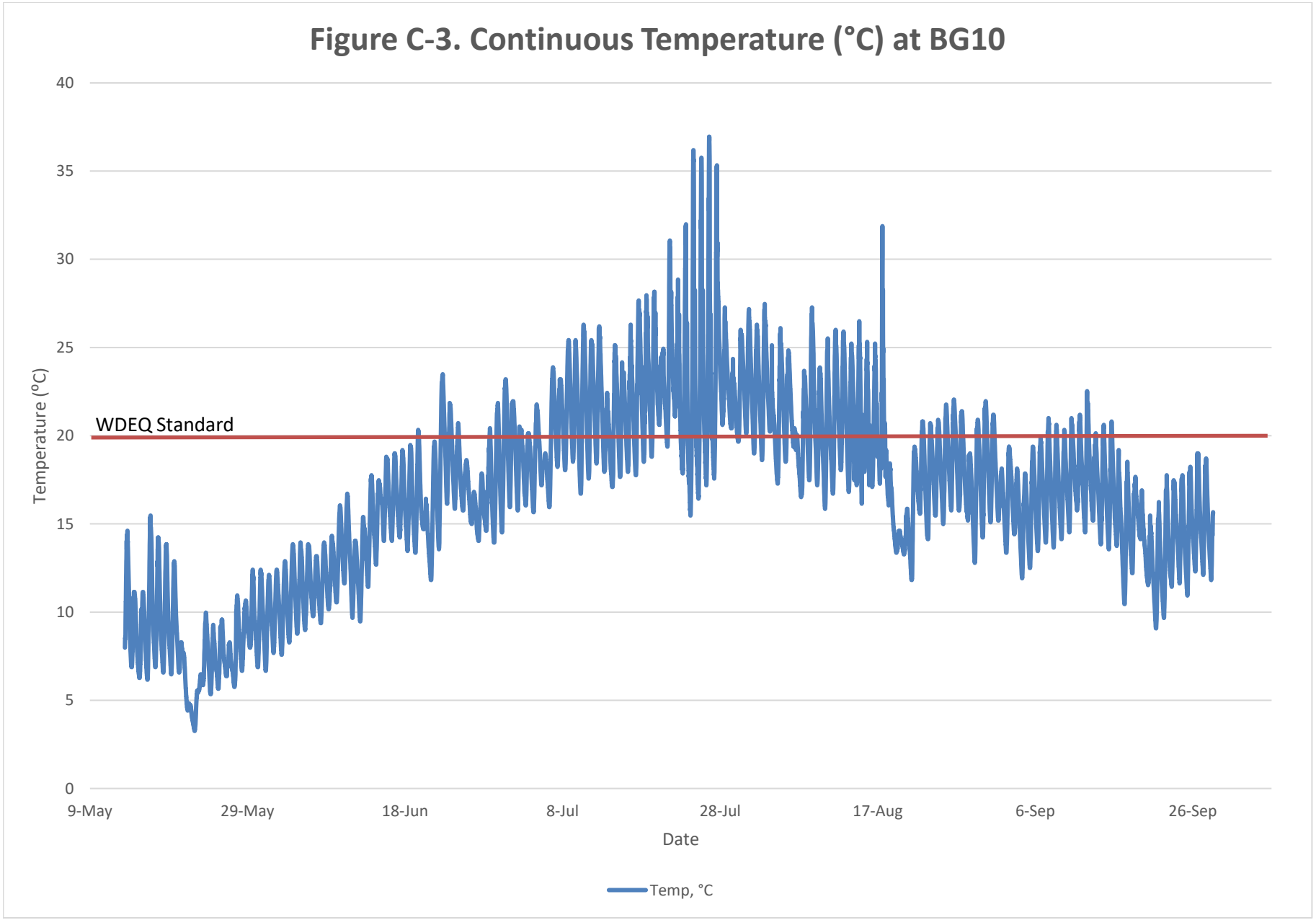


Figure C-3. Continuous Temperature (°C) at BG10
40
35
30
25
20
15
10
5
0
Temperature (°C)
WDEQ Standard
9-May
29-May
18-Jun
8-Jul
28-Jul
17-Aug
6-Sep
26-Sep
Date
Temp, °C

Figure C-4. Continuous Temperature (°C) at BG18

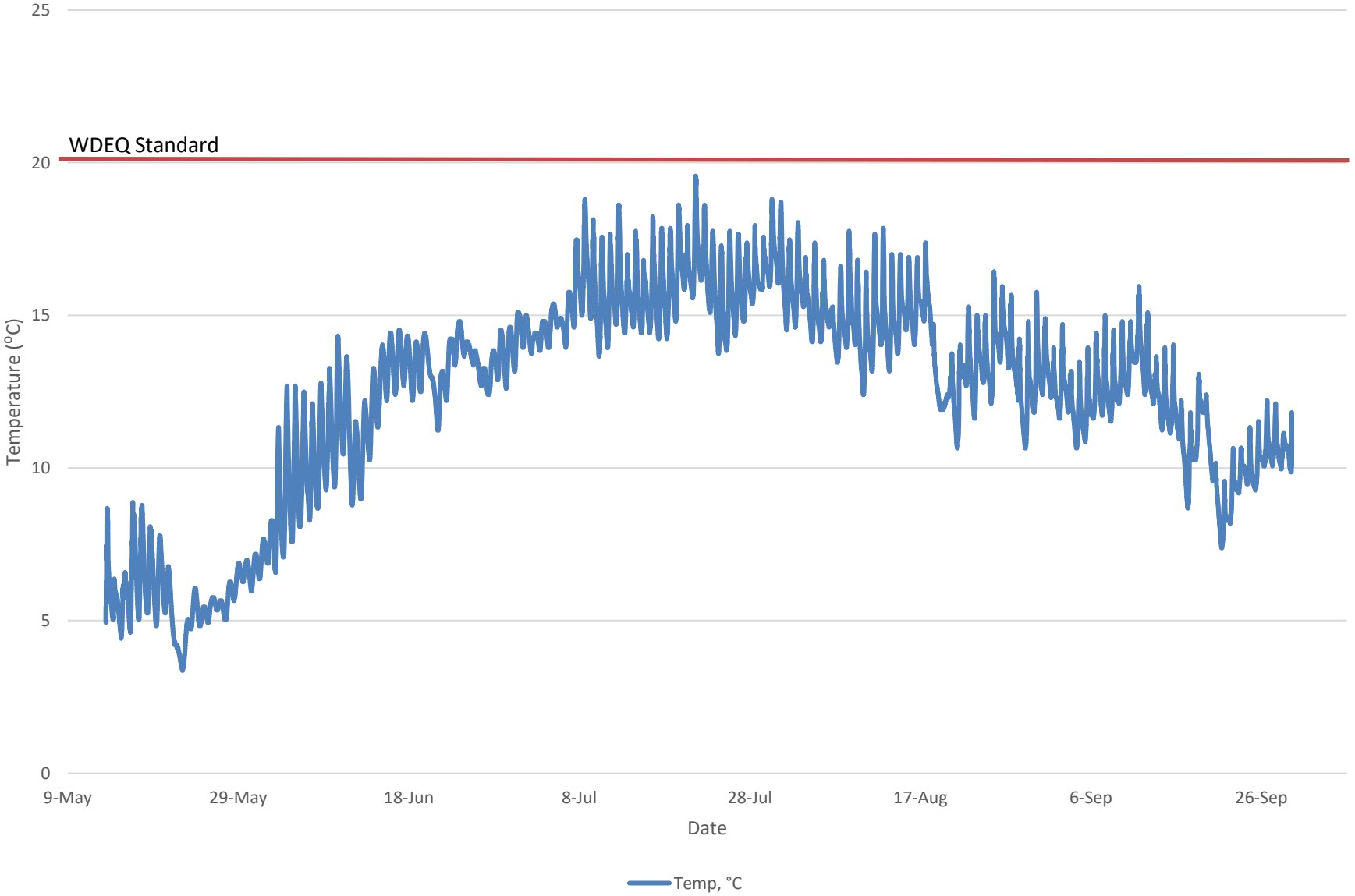


Figure C-5. Continuous Temperature (°C) at LG02

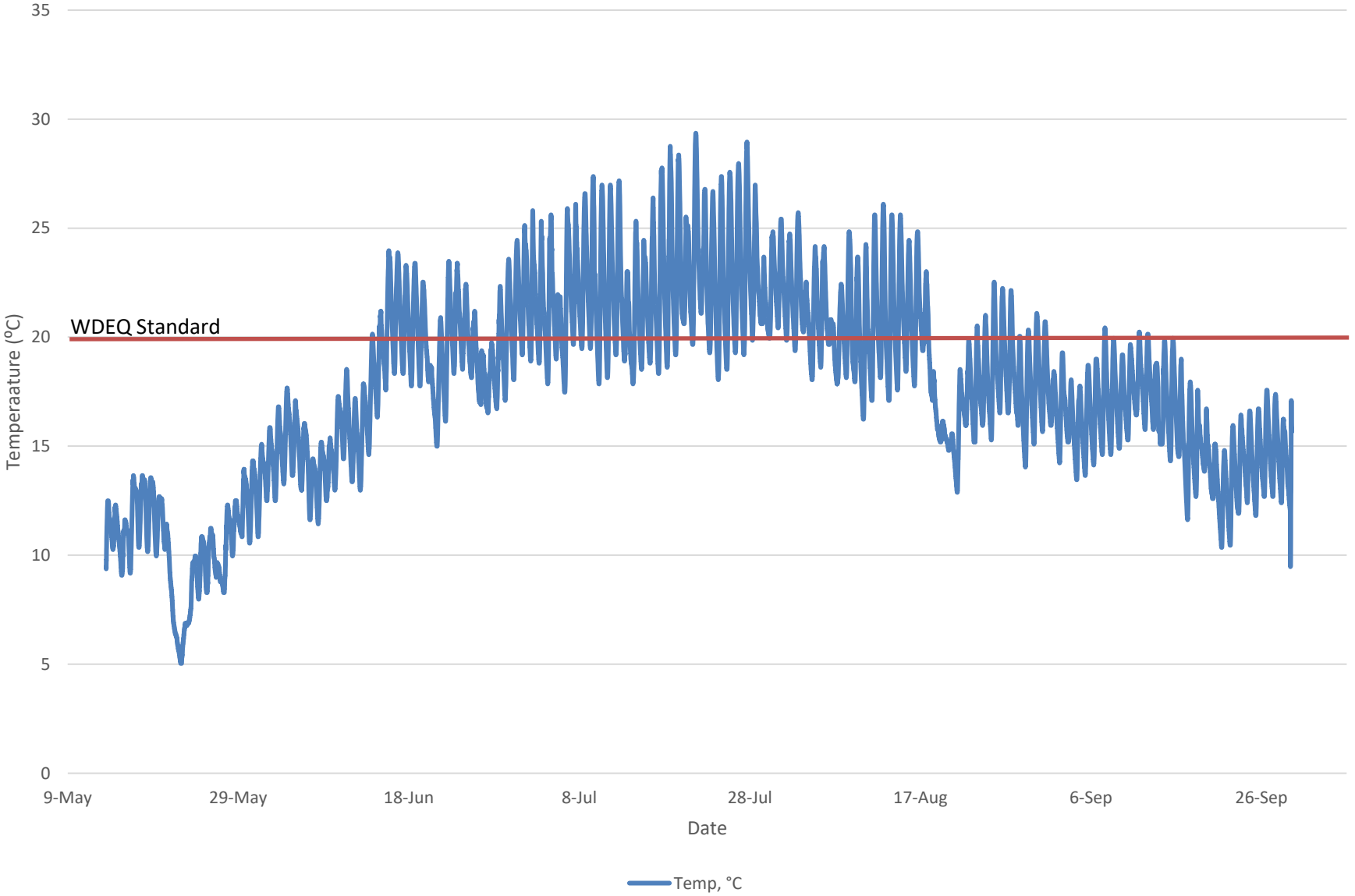


Figure C-6. Continuous Temperature (°C) at LG08

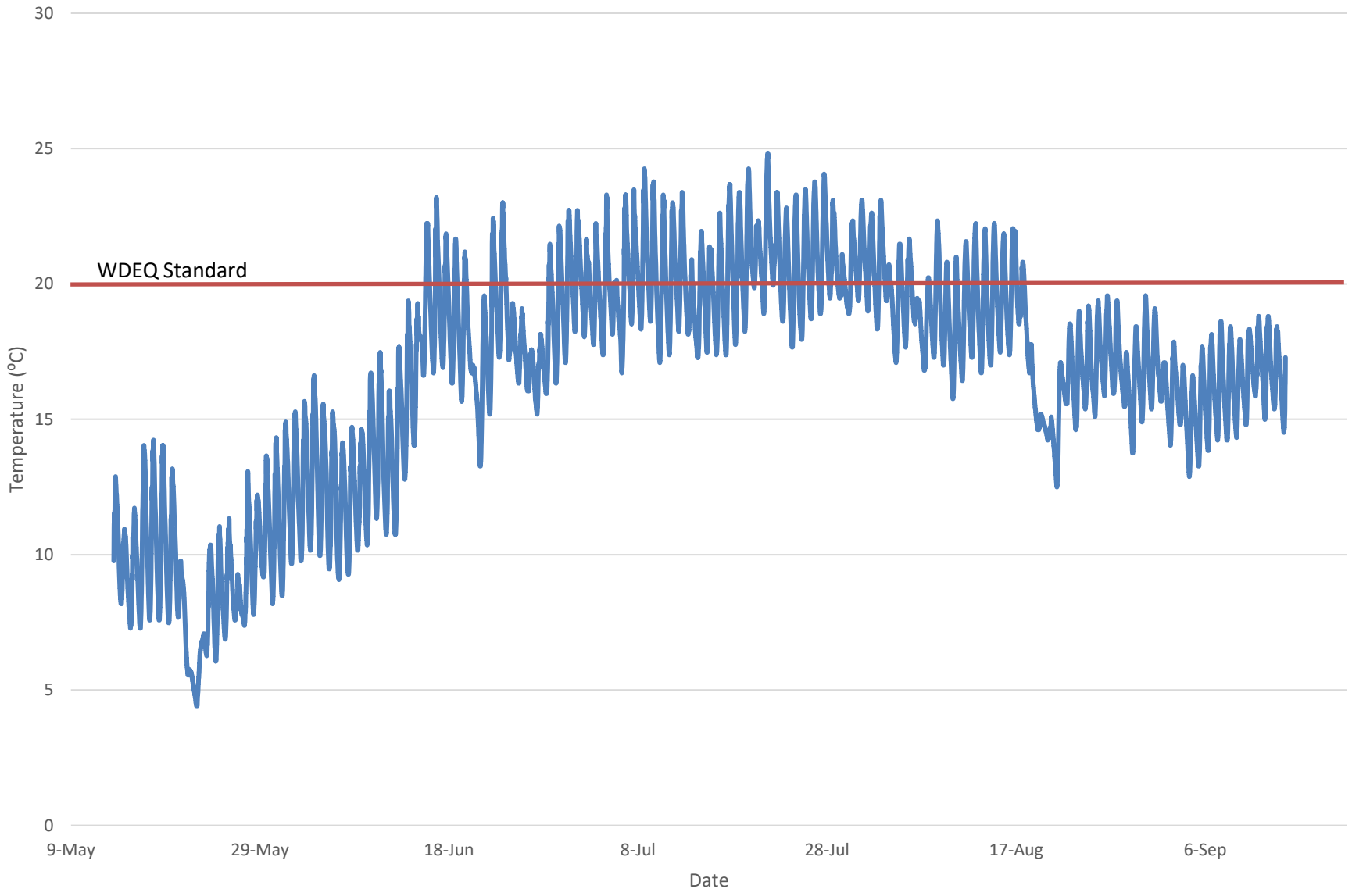


Figure C-7. Continuous Temperature (°C) at LG22

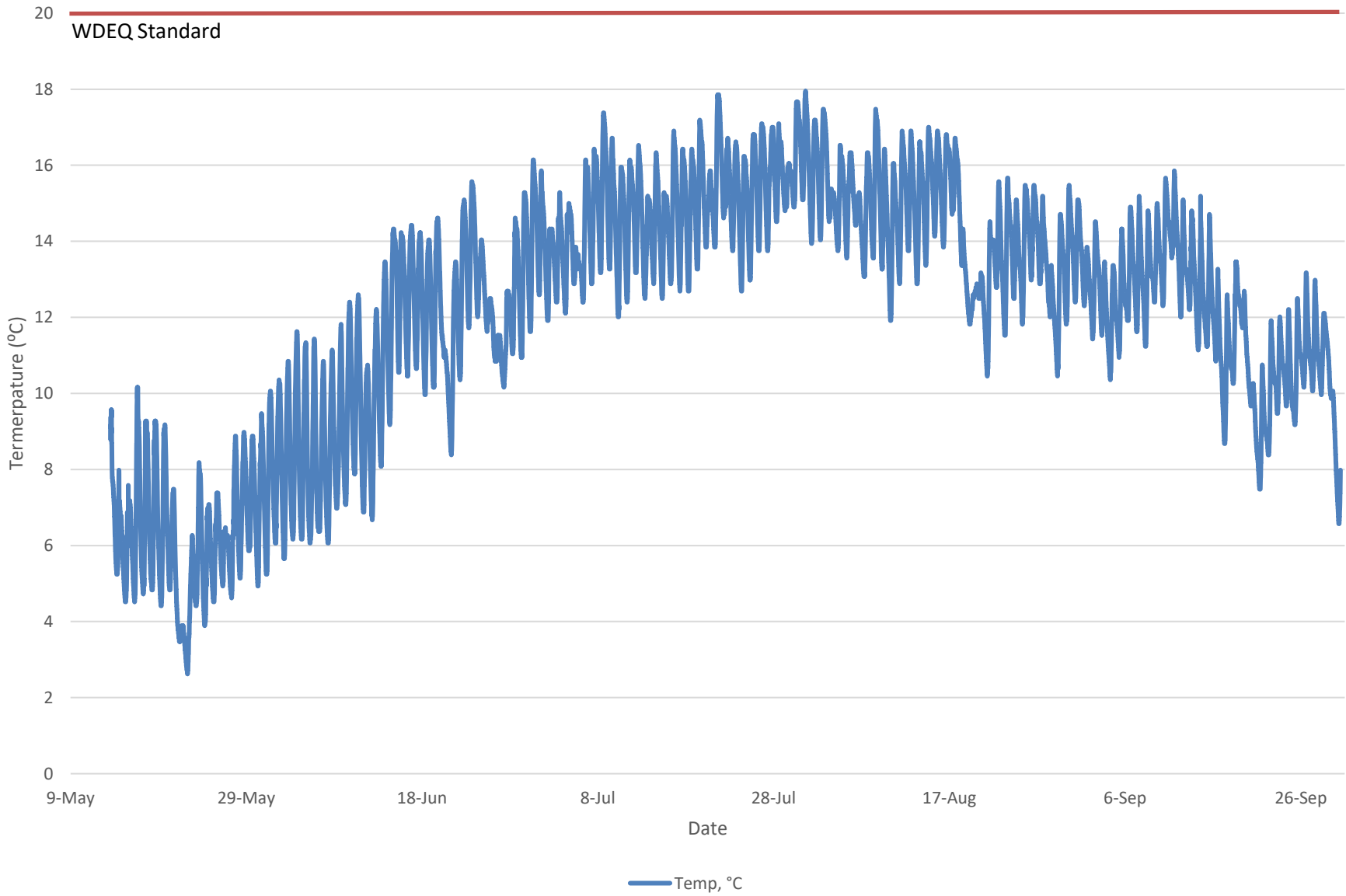


Figure C-8. Yearly Mean Daily Water Temperature Comparisons for GC01

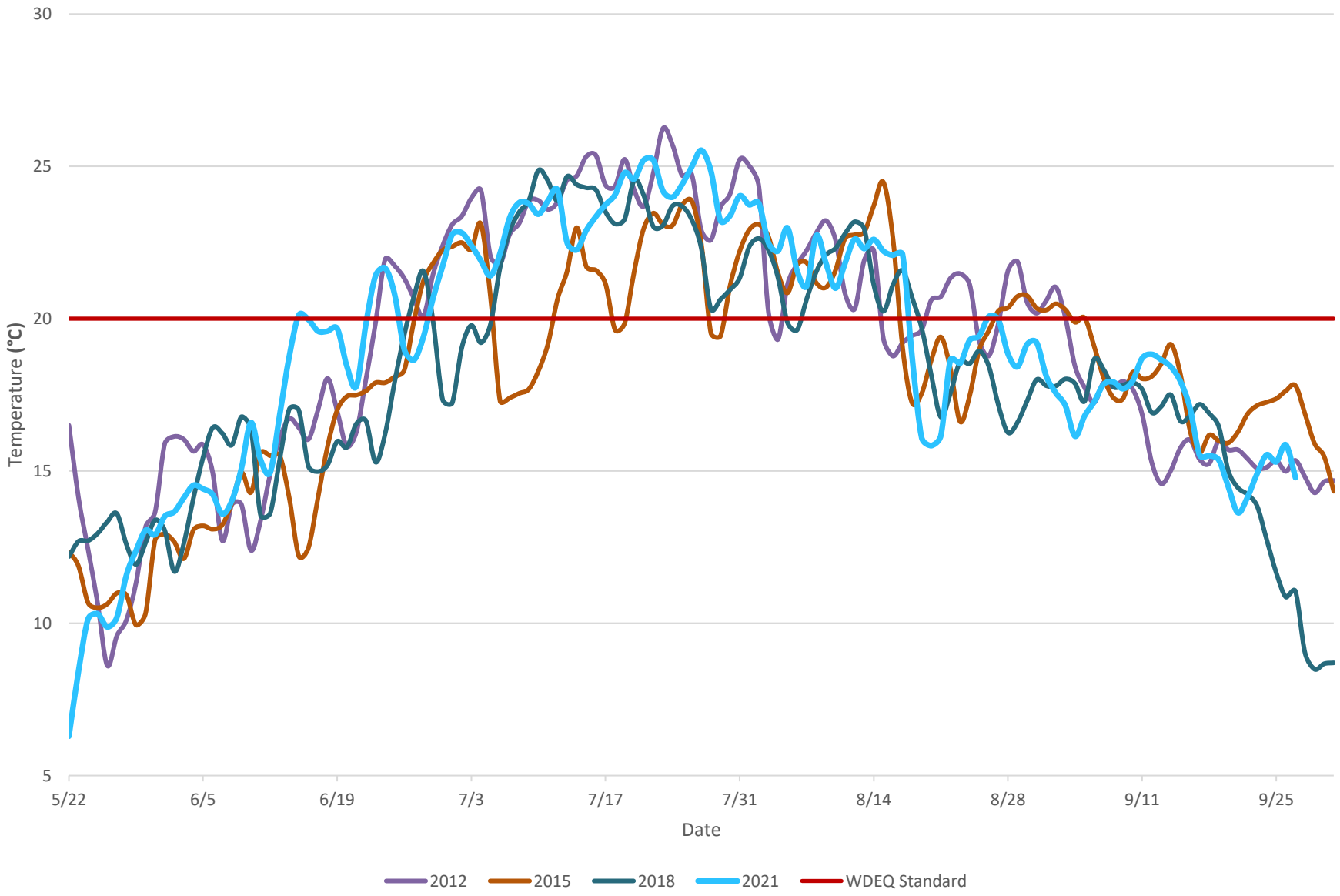


Figure C-9. 2021 Mean Daily Flow and Historical Mean Daily Flow at USGS Station 06307500 (Goose Creek near Acme) with 2021 Instantaneous Discharge at GC01

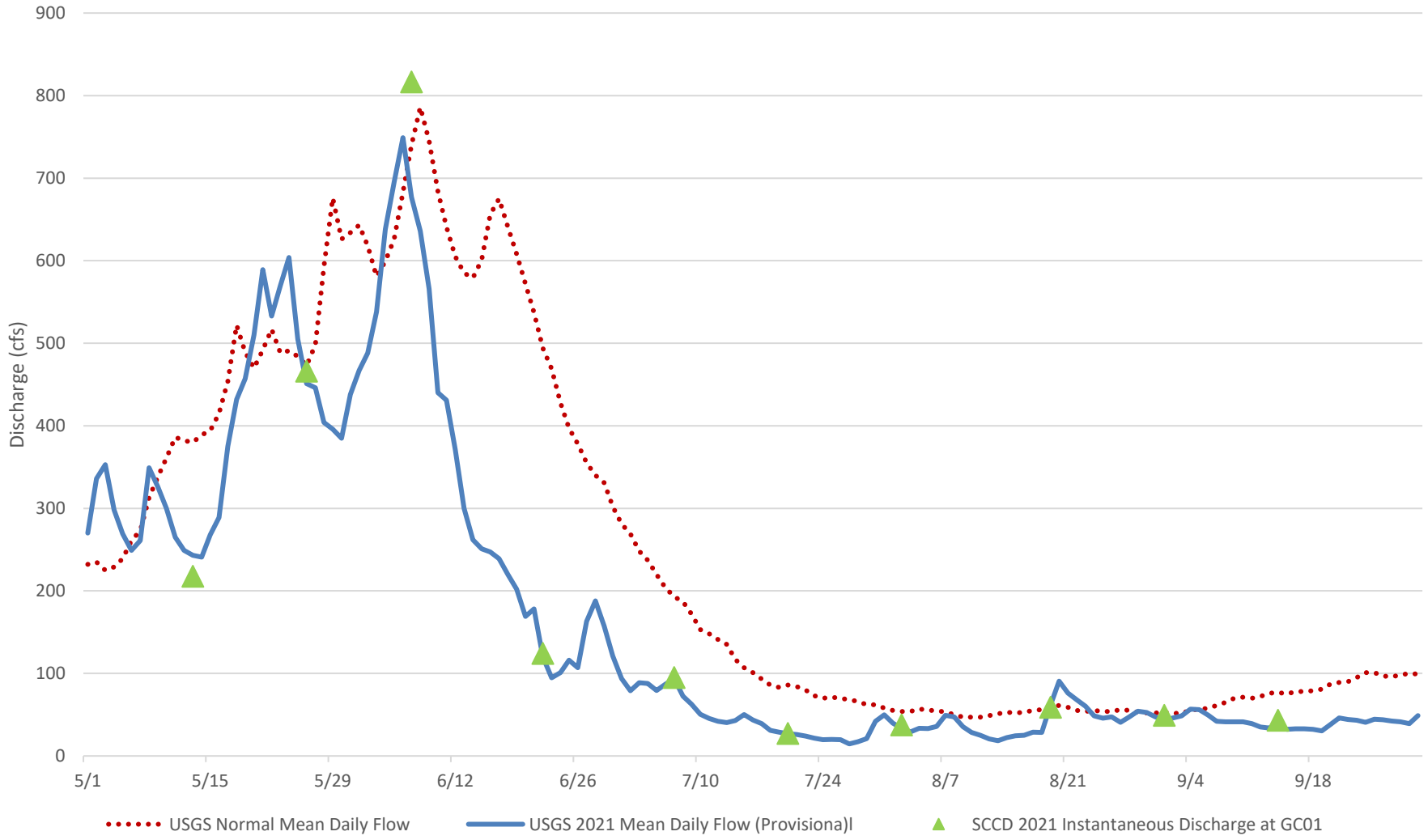


Figure C-10. Historical Mean Daily Flow at USGS Station 06302000 (Big Goose Creek near Sheridan) with 2021 Instantaneous Discharge at BG18

Figure C-11. 2021 Mean Daily Air Temperature and Normal Mean Daily Air Temperature from the National Weather Service at the Sheridan County Airport

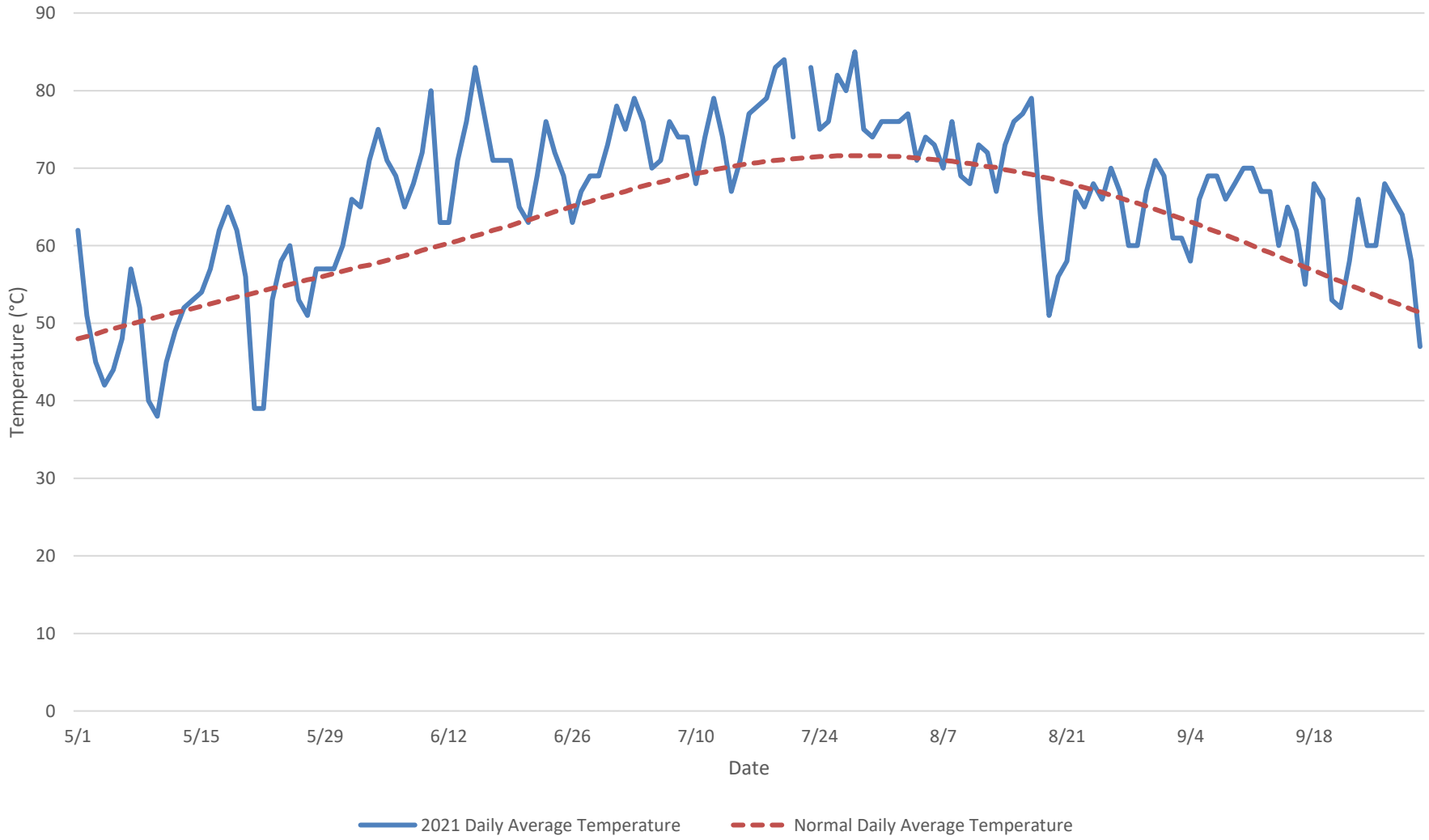
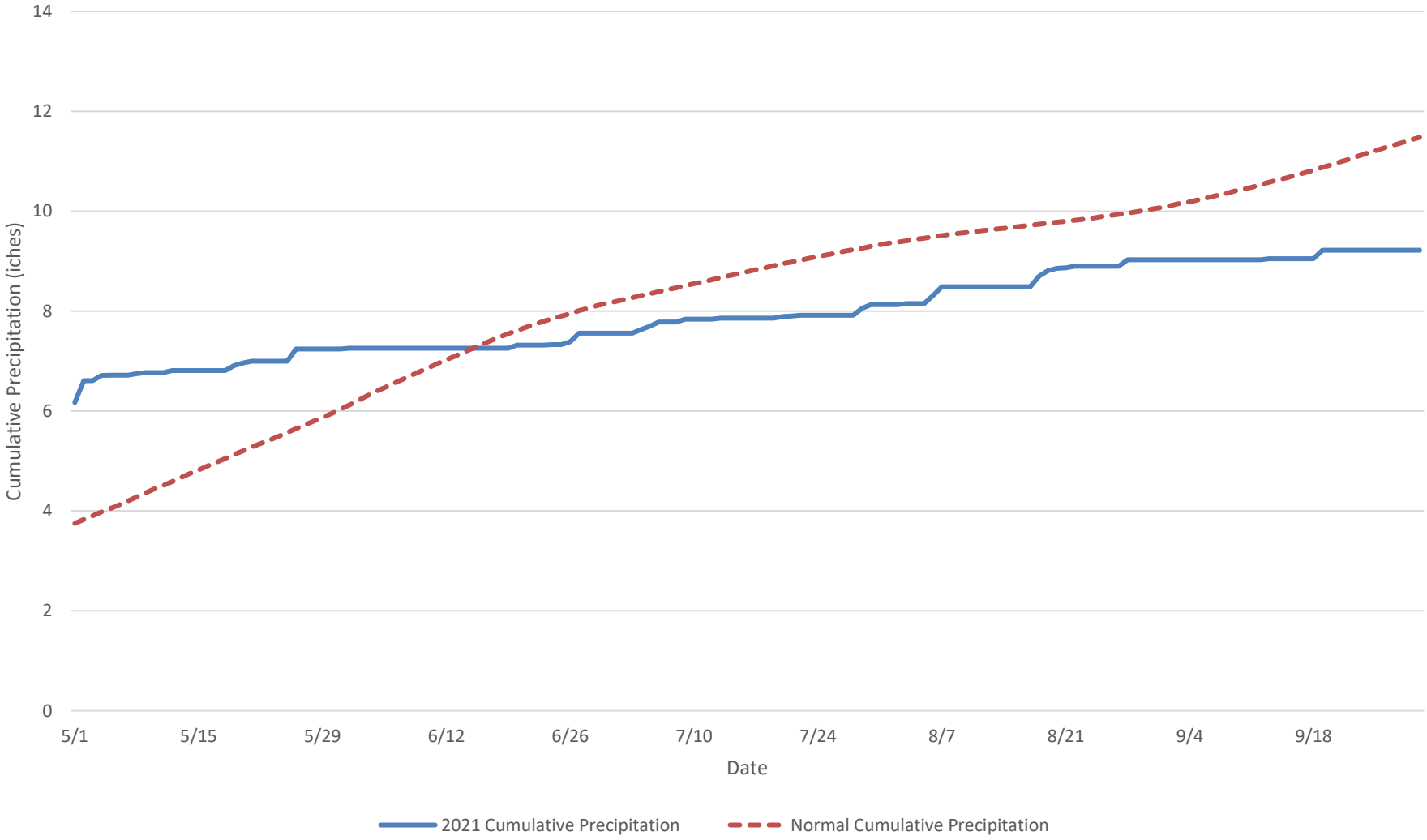


Figure C-12. 2021 Mean Daily Precipitation and Normal Mean Daily Precipitation from the National Weather Service at Sheridan County Airport



APPENDIX D

2021 GOOSE CREEK WATERSHED BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-1. 2021 MACROINVERTEBRATE DATA COLLECTED AT GC1

Goose Cr., above Highway 339 Bridge
GC01, September 27 2021
WY: Sheridan County Conservation District. WY DEQ protocols.
Benthic invertebrate biomonitoring. Riffle, composite 8 Surber, 500 micron.
Abundances per square meter. Analysis by ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	

Taxon	Abundance	%
Erpobdella	27	0.33
Physella	13	0.17
Sphaerium	13	0.17
Sperchon	13	0.17
TOTAL: NON INSECTS	67	0.83
Acentrella insignificans	67	0.83
Baetis tricaudatus complex	54	0.67
Fallceon	13	0.17
Iswaeon	27	0.33
Tricorythodes explicatus	1601	19.84
TOTAL: EPHEMEROPTERA	1762	21.84
Petrophila	121	1.50
TOTAL: LEPIDOPTERA	121	1.50
Brachycentrus occidentalis	54	0.67
Cheumatopsyche	1762	21.84
Hydropsyche	2165	26.84
Hydroptila	202	2.50
Marilia	13	0.17
TOTAL: TRICHOPTERA	4196	52.01
Dubiraphia	53	0.66
Microcylloepus	309	3.83
Stenelmis	309	3.83
TOTAL: COLEOPTERA	671	8.32
Simulium	538	6.67
TOTAL: DIPTERA	538	6.67
Chironomidae pupae	121	1.50
Cricotopus	94	1.17
Cricotopus bicinctus group	81	1.00
Cricotopus trifascia group	161	2.00
Eukiefferiella	13	0.17
Microtendipes	13	0.17
Nanocladius	40	0.50
Polypedilum	121	1.50
Rheocricotopus	54	0.67
Thienemannimyia group	13	0.17
TOTAL: CHIRONOMIDAE	713	8.83
GRAND TOTAL	8069	100.00

APPENDIX TABLE D-2. 2021 MACROINVERTEBRATE DATA COLLECTED AT GC2

Goose Cr., below Sheridan WWTP
GC02, September 27 2021
WY: Sheridan County Conservation District. WY DEQ protocols.
Benthic invertebrate biomonitoring. Riffle, composite 8 Surber, 500 micron.
Abundances per square meter. Analysis by ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	

Taxon	Abundance	%
Trepaxonemata	40	0.49
Naididae (Tubificinae) without capillary setae	54	0.66
Sperchon	13	0.16
TOTAL: NON INSECTS	108	1.31
Acentrella insignificans	417	5.08
Baetis tricaudatus complex	67	0.82
Fallceon	13	0.16
Ephemera simulans	27	0.33
Maccaffertium	148	1.80
Tricorythodes explicatus	3806	46.39
Leptophlebiidae	13	0.16
TOTAL: EPHEMEROPTERA	4492	54.75
Petrophila	430	5.25
TOTAL: LEPIDOPTERA	430	5.25
Cheumatopsyche	511	6.23
Hydropsyche	1399	17.05
Hydroptila	202	2.46
Oecetis	54	0.66
Marilia	13	0.16
TOTAL: TRICHOPTERA	2179	26.56
Microcylloepus	40	0.49
Zaitzevia	13	0.16
TOTAL: COLEOPTERA	54	0.66
Ceratopogoninae	13	0.16
Simulium	121	1.48
TOTAL: DIPTERA	135	1.64
Chironomidae pupae	148	1.80
Cricotopus	215	2.62
Cricotopus bicinctus group	229	2.79
Cricotopus trifascia group	94	1.15
Eukiefferiella	13	0.16
Polypedilum	27	0.33
Rheocricotopus	13	0.16
Rheotanytarsus	13	0.16
Thienemanniella	54	0.66
TOTAL: CHIRONOMIDAE	807	9.84
GRAND TOTAL	8205	100.00

APPENDIX TABLE D-3. 2021 MACROINVERTEBRATE DATA COLLECTED AT BG2

Big Goose Cr., upstream Works Street Footbridge
BG2 - Dup.1, September 28, 2021
WY: Sheridan County Conservation District. WY DEQ protocols.
Benthic invertebrate biomonitoring. Riffle, composite 8 Surber, 500 micron.
Abundances per square meter. Analysis by ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	15

Taxon	Abundance	%
Trepaxonemata	262	2.37
Erpobdella	20	0.18
Physella	81	0.73
Pisidium	20	0.18
Sphaerium	81	0.73
Sperchon	81	0.73
TOTAL: NON INSECTS	545	4.93
Acentrella insignificans	202	1.82
Baetis tricaudatus complex	101	0.91
Heptagenia	20	0.18
Tricorythodes explicatus	4560	41.24
TOTAL: EPHEMEROPTERA	4882	44.16
Argia	20	0.18
TOTAL: ODONATA	20	0.18
Helicopsyche	242	2.19
Cheumatopsyche	847	7.66
Hydropsyche	121	1.09
Hydroptila	605	5.47
Oecetis	504	4.56
Marilia	121	1.09
TOTAL: TRICHOPTERA	2441	22.08
Dubiraphia	101	0.91
Microcylloepus	1574	14.24
Stenelmis	161	1.46
Zaitzevia	40	0.36
TOTAL: COLEOPTERA	1876	16.97
Hemerodromia	40	0.36
Simulium	61	0.55
TOTAL: DIPTERA	101	0.91
Cricotopus	282	2.55
Cricotopus bicinctus group	141	1.28
Cricotopus trifascia group	343	3.10
Labrundinia	20	0.18
Pentaneura	20	0.18
Polypedilum	61	0.55
Rheocricotopus	40	0.36
Rheotanytarsus	81	0.73
Tanytarsus	20	0.18
Thienemanniella	20	0.18
Thienemannimyia group	161	1.46
TOTAL: CHIRONOMIDAE	1190	10.77
GRAND TOTAL	11056	100.00

APPENDIX TABLE D-4. 2021 MACROINVERTEBRATE DATA COLLECTED AT BG2

Big Goose Cr., upstream Works Street Footbridge
BG2 - Dup.2, September 28, 2021
WY: Sheridan County Conservation District. WY DEQ protocols.
Benthic invertebrate biomonitoring. Riffle, composite 8 Surber, 500 micron.
Abundances per square meter. Analysis by ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	15

Taxon	Abundance	%
Trepaxonemata	81	0.69
Erpobdella	20	0.17
Physella	81	0.69
Sphaerium	20	0.17
Sperchon	61	0.51
TOTAL: NON INSECTS	262	2.23
Acentrella insignificans	121	1.03
Baetis tricaudatus complex	40	0.34
Iswaeon	20	0.17
Maccaffertium	20	0.17
Tricorythodes explicatus	6476	54.97
Leptophlebiidae	40	0.34
TOTAL: EPHEMEROPTERA	6718	57.03
Argia	20	0.17
TOTAL: ODONATA	20	0.17
Helicopsyche	61	0.51
Cheumatopsyche	484	4.11
Hydropsyche	242	2.06
Hydroptila	1009	8.56
Oecetis	625	5.31
Marilia	121	1.03
Neureclipsis	20	0.17
TOTAL: TRICHOPTERA	2562	21.75
Dubiraphia	81	0.69
Microcylloepus	988	8.39
Stenelmis	121	1.03
Zaitzevia	60	0.51
TOTAL: COLEOPTERA	1250	10.61
Hemerodromia	20	0.17
Simulium	20	0.17
TOTAL: DIPTERA	40	0.34
Chironomidae pupae	20	0.17
Cricotopus	121	1.03
Cricotopus bicinctus group	141	1.20
Cricotopus trifascia group	282	2.40
Eukiefferiella	40	0.34
Labrundinia	20	0.17
Microtendipes	40	0.34
Polypedilum	61	0.51
Rheocricotopus	40	0.34
Rheotanytarsus	20	0.17
Thienemannimyia group	121	1.03
Tvetenia bavarica group	20	0.17
TOTAL: CHIRONOMIDAE	928	7.88
GRAND TOTAL	11781	100.00

APPENDIX TABLE D-5. 2021 MACROINVERTEBRATE DATA COLLECTED AT BG10

Big Goose Cr., above County Road 87 Bridge
BG10, September 28, 2021
WY: Sheridan County Conservation District. WY DEQ protocols.
Benthic invertebrate biomonitoring. Riffle, composite 8 Surber, 500 micron.
Abundances per square meter. Analysis by ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	6

Taxon	Abundance	%
Trepaxonemata	5	0.18
Nais	5	0.18
Eiseniella tetraedra	5	0.18
Sperchon	15	0.55
TOTAL: NON INSECTS	30	1.11
Acentrella insignificans	45	1.66
Baetis tricaudatus complex	20	0.74
Iswaeon	5	0.18
Drunella grandis	5	0.18
Ephemera simulans	10	0.37
Heptagenia	45	1.66
Maccaffertium	71	2.58
Tricorythodes explicatus	303	11.07
Neoleptophlebia	50	1.85
TOTAL: EPHEMEROPTERA	555	20.30
Chloroperlidae	5	0.18
Skwala	10	0.37
TOTAL: PLECOPTERA	15	0.55
Petrophila	177	6.46
TOTAL: LEPIDOPTERA	177	6.46
Brachycentrus occidentalis	126	4.61
Helicopsyche	222	8.12
Cheumatopsyche	66	2.40
Hydropsyche	827	30.27
Oecetis	30	1.11
Marilia	106	3.88
Chimarra	187	6.83
Neureclipsis	10	0.37
Psychomyia	10	0.37
TOTAL: TRICHOPTERA	1584	57.95
Microcylloepus	131	4.79
Optioservus	5	0.18
Stenelmis	10	0.37
Zaitzevia	156	5.71
TOTAL: COLEOPTERA	302	11.05
Chironomidae pupae	5	0.18
Cricotopus	15	0.55
Cricotopus trifascia group	10	0.37
Eukiefferiella	10	0.37
Rheotanytarsus	30	1.11
TOTAL: CHIRONOMIDAE	71	2.58
GRAND TOTAL	2733	100.00

APPENDIX TABLE D-6. 2021 MACROINVERTEBRATE DATA COLLECTED AT BG18

Big Goose Cr., above USGS Station
BG18, September 29 2021
WY: Sheridan County Conservation District. WY DEQ protocols.
Benthic invertebrate biomonitoring. Riffle, composite 8 Surber, 500 micron.
Abundances per square meter. Analysis by ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	

Taxon	Abundance	%
Polycelis	9	0.37
Nais	31	1.29
Sperchon	4	0.18
TOTAL: NON INSECTS	45	1.84
Baetis tricaudatus complex	9	0.37
Drunella doddsii	22	0.92
Drunella grandis	125	5.17
Ephemerella excrucians group	63	2.58
Rhithrogena	27	1.11
Tricorythodes explicatus	4	0.18
Neoleptophlebia	4	0.18
TOTAL: EPHEMEROPTERA	255	10.51
Sweltsa	112	4.61
Claassenia sabulosa	4	0.18
Skwala	4	0.18
Pteronarcys	9	0.37
TOTAL: PLECOPTERA	130	5.35
Amiocentrus aspilus	72	2.95
Brachycentrus americanus	4	0.18
Micrasema	4	0.18
Glossosoma	197	8.12
Helicopsyche	9	0.37
Arctopsyche	4	0.18
Hydropsyche	40	1.66
Lepidostoma (Neodinarthrum)	587	24.17
Oligophlebodes	143	5.90
TOTAL: TRICHOPTERA	1061	43.72
Optioservus	605	24.92
Zaitzevia	67	2.77
TOTAL: COLEOPTERA	672	27.68
Atherix	31	1.29
Chelifera/Metachela	4	0.18
Wiedemannia	13	0.55
Antocha	13	0.55
Hexatoma	4	0.18
TOTAL: DIPTERA	67	2.77
Cladotanytarsus	45	1.84
Cricotopus	4	0.18
Diamesa	9	0.37
Eukiefferiella	18	0.74
Lopescladius	4	0.18
Micropsectra	13	0.55
Microtendipes	94	3.87
Nanocladius	9	0.37
TOTAL: CHIRONOMIDAE	197	8.12
GRAND TOTAL	2428	100.00

APPENDIX TABLE D-7. 2021 MACROINVERTEBRATE DATA COLLECTED AT LG02A

Little Goose Cr., below Coffeen Avenue Bridge
LG02A, September 29 2021
WY: Sheridan County Conservation District. WY DEQ protocols.
Benthic invertebrate biomonitoring. Riffle, composite 8 Surber, 500 micron.
Abundances per square meter. Analysis by ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	

Taxon	Abundance	%
Trepaxonemata	40	0.75
Naididae (Tubificinae) with capillary setae	61	1.13
Naididae (Tubificinae) without capillary setae	30	0.57
Erpobdella	10	0.19
Sphaerium	10	0.19
Sperchon	20	0.38
TOTAL: NON INSECTS	172	3.21
Acentrella insignificans	50	0.94
Baetis tricaudatus complex	30	0.57
Iswaeon	10	0.19
Tricorythodes explicatus	1634	30.57
TOTAL: EPHEMEROPTERA	1725	32.27
Ophiogomphus	10	0.19
TOTAL: ODONATA	10	0.19
Petrophila	182	3.40
TOTAL: LEPIDOPTERA	182	3.40
Helicopsyche	1342	25.10
Cheumatopsyche	252	4.72
Hydropsyche	272	5.09
Hydroptila	91	1.70
Nectopsyche	81	1.51
Oecetis	242	4.53
Marilia	40	0.75
TOTAL: TRICHOPTERA	2320	43.40
Microcylloepus	383	7.16
Optioservus	30	0.57
Stenelmis	10	0.19
Zaitzevia	91	1.70
TOTAL: COLEOPTERA	514	9.62
Hemerodromia	10	0.19
Simulium	81	1.51
Hexatoma	10	0.19
TOTAL: DIPTERA	101	1.89
Chironomidae pupae	20	0.38
Cricotopus bicinctus group	10	0.19
Cricotopus trifascia group	242	4.53
Orthocladius complex	10	0.19
Polypedilum	30	0.57
Rheotanytarsus	10	0.19
TOTAL: CHIRONOMIDAE	323	6.04
GRAND TOTAL	5346	100.00

APPENDIX TABLE D-8. 2021 MACROINVERTEBRATE DATA COLLECTED AT LG10

Little Goose Cr., above Highway 87 Bridge
LG10, September 30, 2021
WY: Sheridan County Conservation District. WY DEQ protocols.
Benthic invertebrate biomonitoring. Riffle, composite 8 Surber, 500 micron.
Abundances per square meter. Analysis by ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	

Taxon	Abundance	%
Trepaxonemata	104	3.11
Nemata	6	0.17
Naididae (Tubificinae) with capillary setae	12	0.35
Naididae (Tubificinae) without capillary setae	6	0.17
Eiseniella tetraedra	23	0.69
Crangonyx	81	2.42
Sperchon	12	0.35
TOTAL: NON INSECTS	242	7.26
Baetis tricaudatus complex	58	1.73
Tricorythodes explicatus	837	25.08
Neoleptophlebia	17	0.52
TOTAL: EPHEMEROPTERA	912	27.33
Isoperla	6	0.17
TOTAL: PLECOPTERA	6	0.17
Petrophila	58	1.73
TOTAL: LEPIDOPTERA	58	1.73
Helicopsyche	52	1.56
Cheumatopsyche	260	7.78
Hydropsyche	773	23.18
Oecetis	17	0.52
Marilia	6	0.17
Chimarra	490	14.70
TOTAL: TRICHOPTERA	1598	47.91
Dubiraphia	23	0.69
Microcylloepus	17	0.52
Optioservus	58	1.74
Stenelmis	29	0.86
Zaitzevia	231	6.92
TOTAL: COLEOPTERA	358	10.74
Ceratopogoninae	6	0.17
Simulium	6	0.17
Cryptolabis	35	1.04
Dicranota	6	0.17
TOTAL: DIPTERA	52	1.56
Cricotopus	6	0.17
Cryptochironomus	6	0.17
Eukiefferiella	23	0.69
Lopescladius	6	0.17
Metriocnemus	6	0.17
Micropsectra	6	0.17
Parametriocnemus	6	0.17
Pentaneura	6	0.17
Rheotanytarsus	35	1.04
Thienemannimyia group	12	0.35
TOTAL: CHIRONOMIDAE	110	3.29
GRAND TOTAL	3336	100.00

APPENDIX TABLE D-9. 2021 MACROINVERTEBRATE DATA COLLECTED AT LG22

Little Goose Cr., above County Road 77 Bridge
LG22, September 30, 2021
WY: Sheridan County Conservation District. WY DEQ protocols.
Benthic invertebrate biomonitoring. Riffle, composite 8 Surber, 500 micron.
Abundances per square meter. Analysis by ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	

Taxon	Abundance	%
Polycelis	4	0.19
Nemata	11	0.56
Hygrobates	7	0.37
TOTAL: NON INSECTS	22	1.12
Baetis tricaudatus complex	81	4.09
Drunella grandis	15	0.74
Ephemerella excrucians group	246	12.46
Cinygmula	7	0.37
Epeorus	4	0.19
Epeorus grandis group	4	0.19
Rhithrogena	15	0.74
Siphlonurus	4	0.19
TOTAL: EPHEMEROPTERA	375	18.96
Sweltsa	40	2.05
TOTAL: PLECOPTERA	40	2.05
Apatania	4	0.19
Amiocentrus aspilus	7	0.37
Brachycentrus americanus	73	3.72
Micrasema	4	0.19
Anagapetus	15	0.74
Hydropsyche	37	1.86
Lepidostoma (Neodinarthrum)	793	40.16
Chimarra	4	0.19
Dolophilodes	4	0.19
Oligophlebodes	95	4.83
TOTAL: TRICHOPTERA	1035	52.43
Heterlimnius corpulentus	4	0.19
Optioservus	55	2.79
Zaitzevia	15	0.74
TOTAL: COLEOPTERA	73	3.72
Atherix	4	0.19
Neoplasta	4	0.19
Pericomaini	95	4.83
Simulium	4	0.19
Antocha	18	0.93
Dicranota	7	0.37
Eloeophila	4	0.19
Hesperoconopa	22	1.12
Hexatoma	26	1.30
TOTAL: DIPTERA	184	9.30
Chironomidae pupae	4	0.19
Cladotanytarsus	70	3.53
Cricotopus	18	0.93
Cricotopus (Nostococladius)	7	0.37
Diamesa	7	0.37
Larsia	4	0.19
Lopescladius	22	1.12
Micropsectra	26	1.30
Parametriocnemus	4	0.19
Polypedilum	81	4.09
Tanytarsus	4	0.19
TOTAL: CHIRONOMIDAE	246	12.46
GRAND TOTAL	1975	100.00

APPENDIX TABLE D-10. BENTHIC MACROINVERTEBRATE TAXA IN THE GOOSE CREEK WATERSHED 2001 - 2021

Total Number of Samples in which a taxon was present (Number), Frequency of Occurrence (Occ (%)), Mean Density in Number per Meter^2 (Den), Percent Composition (%), Pollution Tolerance Value (HBI) and Functional Feeding Group (FFG) designation for macroinvertebrate taxa in samples (N = 100 total samples) collected from stations in the Goose Creek Watershed - 2001, 2002, 2004, 2005, 2009, 2012, 2015, 2018 and 2021.

Taxon	Number	Occ	Den	%	HBI	FFG
Acari (water mites)						
Acari	88	88	159	0.70	5	CG
Lebertia	1	1	27	0.12	5	PA
Protzia	1	1	9	0.04	3	PA
Sperchon	22	22	116	0.51	5	PA
Hygrobates	2	2	6	0.03	4	PA
Amphipoda (freshwater shrimp)						
Gammarus	1	**1**	27	0.12	6	CG
Hyalella	29	29	46	0.20	8	CG
Hyalella azteca	15	15	50	0.22	8	CG
Crangonyx	3	3	79	0.35	5	CG
Bivalvia (clams)						
Pisidium	33	33	80	0.35	8	CG
Sphaerium	25	25	44	0.19	8	CG
Sphaerium striatinum	8	**8**	39	0.17	8	CG
Coleoptera: Elmidae (riffle beetles)						
Cleptelmis addenda	3	3	16	0.07	4	CG
Dubiraphia	69	69	582	2.57	8	CG
Heterlimnius corpulentus	2	2	5	0.02	3	CG
Lara avara	1	1	5	0.02	3	SH
Microcylloepus	87	87	934	4.13	7	SC
Narpus	1	1	24	0.11	4	SC
Narpus concolor	1	1	6	0.03	4	CG
Optioservus	52	52	221	0.98	5	SC
Stenelmis	70	70	143	0.63	7	SC
Zaitzevia	72	72	197	0.87	6	SC
Coleoptera: Other Taxa						
Haliplus	5	**5**	17	0.08	8	MH
Helichus	3	**3**	6	0.03	5	SH
Postelichus	2	**2**	8	0.04	5	SH
Decapoda (crayfish)						
Orconectes	3	**3**	17	0.08	6	OM
Diptera: Chironomidae (midge flies)						
Apedilum	2	2	10	0.04	NA	CG
Brillia	3	3	9	0.04	5	SH
Cardiocladius	4	4	14	0.06	5	PR
Chaetocladius	2	2	6	0.03	6	CG
Chironomidae pupae	72	72	63	0.28	6	UN
Chironomus	8	8	97	0.43	10	CG
Cladotanytarsus	13	13	66	0.29	7	CG
Corynoneura	4	4	24	0.11	7	CG
Cricotopus	87	87	533	2.35	7	CG
Cricotopus Isocladius group	2	2	40	0.18	7	CG
Cricotopus (Nostococladius)	8	8	32	0.14	3	MH
Cricotopus bicinctus group	43	43	93	0.41	7	CG
Cricotopus trifascia group	73	73	93	0.41	6	CG
Cryptochironomus	13	13	30	0.13	8	PR
Demicryptochironomus	1	1	4	0.02	8	PR
Diamesa	11	11	73	0.32	5	CG
Dicrotendipes	21	21	253	1.12	8	CG
Endochironomus	3	3	45	0.20	10	MH
Epoicocladius	3	3	10	0.04	4	CG
Eukiefferiella	56	56	39	0.17	8	OM
Eukiefferiella brehmi group	1	1	27	0.12	4	OM

APPENDIX TABLE D-10. (continued) BENTHIC MACROINVERTEBRATE TAXA IN THE GOOSE CREEK WATERSHED 2001 - 2021

Taxon	Number	Occ	Den	%	HBI	FFG
Diptera: Chironomidae (midge flies)						
Eukiefferiella devonica group	1	1	3	0.01	4	OM
Heterotrissocladius	3	3	61	0.27	0	CG
Hydrobaenus	1	1	9	0.04	4	SC
Labrundinia	2	2	20	0.09	4	PR
Larsia	1	1	4	0.02	4	PR
Limnophyes	2	2	17	0.08	8	CG
Lopescladius	16	16	23	0.10	6	CG
Macropelopia	1	1	7	0.03	6	PR
Metriocnemus	1	1	6	0.03	4	CG
Micropsectra	31	31	128	0.57	7	CG
Microtendipes	36	36	113	0.50	6	CG
Nanocladius	5	5	13	0.06	3	CG
Odontomesa	2	2	22	0.10	4	CG
Orthocladius	5	5	71	0.31	6	CG
Orthocladius (Euorthocladius)	1	1	40	0.18	3	CG
Orthocladius complex	32	32	34	0.15	6	CG
Pagastia	13	13	26	0.11	1	CG
Paracladopelma	1	1	9	0.04	7	CG
Parakiefferiella	24	24	36	0.16	4	CG
Parametriocnemus	12	12	15	0.07	5	CG
Paraphaenocladius	1	1	16	0.07	4	CG
Paratanytarsus	2	2	15	0.06	6	UN
Paratendipes	2	2	14	0.06	8	CG
Pentaneura	33	33	45	0.20	6	PR
Phaenopsectra	3	3	117	0.52	7	SC
Polypedilum	47	47	74	0.33	6	OM
Potthastia?	2	2	27	0.12	2	CG
Procladius	2	2	27	0.12	9	PR
Pseudochironomus	21	21	66	0.29	5	CG
Pseudosmittia	3	3	24	0.11	6	UN
Radotanypus	3	3	10	0.04	11	PR
Rheocricotopus	45	45	42	0.19	6	OM
Rheotanytarsus	78	78	568	2.51	6	CF
Stempellinella	8	8	18	0.08	4	UN
Stenochironomus	1	1	10	0.04	9	CG
Stictochironomus	4	4	25	0.11	9	CG
Tanytarsus	11	11	14	0.06	6	CF
Thienemanniella	37	37	28	0.12	6	CG
Thienemannimyia group	38	38	25	0.11	6	PR
Tvetenia bavarica group	17	17	29	0.13	5	CG
Tvetenia discoloripes group	4	4	36	0.16	5	CG
Zavrelimyia	4	4	94	0.42	8	PR
Diptera: Dixidae (dixid midges)						
Dixa	1	1	16	0.07	3	CG
Diptera: Empididae (dance flies)						
Chelifera/Metachela	9	9	29	0.13	6	PR
Hemerodromia	35	35	50	0.22	6	PR
Neoplasta	6	6	10	0.04	6	PR
Wiedemannia	4	4	14	0.06	6	PR
Diptera: Muscidae (muscid & stable flies)						
Limnophora	3	3	9	0.04	8	PR
Diptera: Psychodidae (moth & sand flies)						
Pericoma	7	7	24	0.11	5	CG
Pericoma/Telmatoscopus	2	2	56	0.25	4	CG
Diptera: Simuliidae (black flies)						
Simulium	77	77	213	0.94	6	CF
Diptera: Stratiomyidae (soldier flies)						
Caloparyphus	3	**3**	30	0.13	8	CG
Odontomyia	2	**2**	7	0.03	8	CG

APPENDIX TABLE D-10. (continued) BENTHIC MACROINVERTEBRATE TAXA IN THE GOOSE CREEK WATERSHED 2001 - 2021

Taxon	Number	Occ	Den	%	HBI	FFG
Diptera: Tipulidae (craneflies)						
Antocha	6	6	28	0.12	6	CG
Cryptolabis	14	14	41	0.18	4	UN
Dicranota	12	12	24	0.11	6	PR
Eloeophila	1	1	4	0.02	4	CG
Erioptera	1	1	7	0.03	4	CG
Hesperoconopa	3	3	11	0.05	1	UN
Hexatoma	27	27	9	0.04	5	PR
Limnophila	2	2	12	0.05	7	PR
Limonia	2	2	4	0.02	7	MH
Pseudolimnophila	1	1	4	0.02	4	UN
Tipula	14	14	23	0.10	6	OM
Diptera: Other Taxa						
Atherix	3	3	21	0.09	7	PR
Ceratopogoninae	42	42	35	0.15	7	PR
Dasyhelea	6	6	14	0.06	7	CG
Dolichopodidae	2	2	6	0.03	6	PR
Ephydridae	5	5	9	0.04	9	CG
Sciomyzidae	1	1	3	0.01	8	PR
Tabanidae	1	1	13	0.06	7	PR
Enopla (proboscis and ribbon worms)						
Prostoma	9	**9**	64	0.28	8	CG
Ephemeroptera (mayflies)						
Acentrella	35	35	80	0.35	6	CG
Acentrella insignificans	50	50	101	0.45	6	CG
Acentrella parvula	2	2	27	0.12	6	CG
Ameletus	5	5	9	0.04	3	CG
Asioplax	3	3	21	0.09	7	CG
Baetis tricaudatus complex	70	70	299	1.32	6	CG
Caenis	4	4	68	0.30	7	CG
Camelobaetidius	1	1	4	0.02	4	CG
Centroptilum	1	1	7	0.03	6	CG
Choroterpes	6	6	144	0.63	7	CG
Cinygmula	6	6	29	0.13	4	SC
Drunella doddsii	5	5	26	0.11	1	CG
Drunella grandis	6	6	35	0.15	1	PR
Drunella grandis/spinifera	6	6	33	0.15	2	CG
Epeorus	10	10	49	0.22	1	SC
Epeorus grandis group	3	3	5	0.02	0	SC
Ephemera	17	17	24	0.11	4	CG
Ephemerella	10	10	87	0.38	3	CG
Ephemerella dorothea infrequens	1	1	457	2.02	1	CG
Ephemerella excrucians group	12	12	55	0.24	3	CG
Ephemerella inermis/infrequens	8	8	102	0.45	3	CG
Ephemera simulans	8	8	26	0.11	0	CG
Fallceon	15	15	72	0.32	4	CG
Fallceon quilleri	58	58	340	1.50	4	CG
Heptagenia	8	8	33	0.15	4	SC
Heptagenia/Nixe	3	3	4	0.02	4	SC
Iswaeon	7	7	20	0.09	4	CG
Maccaffertium	17	17	112	0.49	6	SC
Maccaffertium terminatum	2	2	141	0.62	6	SC
Neochoroterpes	25	25	179	0.79	7	CG
Neoleptophlebia	7	7	38	0.17	4	CG
Paraleptophlebia	22	22	109	0.48	4	CG
Paraleptophlebia bicornuta	3	3	9	0.04	4	CG
Paraleptophlebia bicornuta group	1	1	13	0.06	4	CG
Plauditus punctoventris	2	2	54	0.24	6	CG
Rhithrogena	11	11	60	0.27	2	SC
Siphlonurus	1	1	4	0.02	4	CG

APPENDIX TABLE D-10. (continued) BENTHIC MACROINVERTEBRATE TAXA IN THE GOOSE CREEK WATERSHED 2001 - 2021

Taxon	Number	Occ	Den	%	HBI	FFG
Ephemeroptera (mayflies)						
Stenonema	9	9	19	0.08	6	SC
Stenonema femoratum	6	6	20	0.09	6	SC
Timpanoga hecuba	1	1	7	0.03	5	CG
Tricorythodes	69	69	1650	7.29	7	CG
Tricorythodes explicatus	76	76	1373	6.07	7	CG
Gastropoda (snails)						
Ferrissia	8	8	29	0.13	6	SC
Fossaria	8	8	840	3.71	8	CG
Gyraulus	3	3	36	0.16	8	SC
Lymnaeidae	9	9	35	0.15	8	CG
Physidae	37	37	423	1.87	8	CG
Planorbidae	1	1	27	0.12	8	SC
Physa	35	35	220	0.97	8	CG
Physella	6	6	41	0.18	5	CG
Pisidium	7	7	18	0.08	8	CF
Stagnicola	2	2	27	0.12	8	CG
Heteroptera (true bugs)						
Ambrysus	17	17	32	0.14	7	PR
Corixidae	1	1	32	0.14	8	PR
Hirudinea (leeches)						
Hirudinea	39	39	26	0.11	10	PR
Erpobdellidae	13	13	20	0.09	10	PR
Erpobdella	9	9	73	0.32	8	PR
Glossiphonia complanata	1	1	27	0.12	8	PR
Helobdella	2	2	18	0.08	8	PR
Helobdella stagnalis	3	3	21	0.09	9	PR
Hydroida (hydranths)						
Hydra	3	3	19	0.08	5	PR
Lepidoptera (butterflies and moths)						
Petrophila	75	75	208	0.92	6	SC
Megaloptera (alderflies)						
Sialis	10	10	26	0.11	7	PR
Nemata (nematode worms)						
Nemata	56	56	44	0.19	5	UN
Odonata (dragonflies and damselflies)						
Argia	27	27	21	0.09	7	PR
Coenagrionidae	9	9	89	0.39	9	PR
Enallagma	1	1	511	2.26	9	PR
Hetaerina	3	3	11	0.05	6	PR
Ophiogomphus	11	11	11	0.05	4	PR
Oligochaeta (worms)						
Oligochaeta	64	64	287	1.27	5	CG
Bothrioneurum vejdovskyanum	5	5	76	0.34	8	CG
Eiseniella tetraedra	4	4	17	0.08	4	CG
Enchytraeidae	2	2	7	0.03	10	CG
Enchytraeus	1	1	2	0.01	10	CG
Naididae (Tubificinae) without capillary setae	28	28	297	1.31	9	CG
Naididae (Tubificinae) with capillary setae	6	6	25	0.11	9	CG
Tubificinae	7	7	89	0.39	9	CG
Limnodrilus hoffmeisteri	2	2	19	0.08	10	CG
Limnodrilus udekemianus	1	1	16	0.07	5	CG
Lumbricidae	4	4	25	0.11	8	CG
Lumbriculidae	10	10	17	0.08	8	CG
Lumbriculus	1	1	4	0.02	8	CG
Naididae	4	4	52	0.23	8	CG
Nais	16	16	16	0.07	8	CG
Nais bicuspidalis	1	1	16	0.07	8	CG
Nais communis	3	3	27	0.12	8	CG
Nais communis/variabilis	2	2	16	0.07	8	CG
Nais variabilis	10	10	13	0.06	8	CG

APPENDIX TABLE D-10. (continued) BENTHIC MACROINVERTEBRATE TAXA IN THE GOOSE CREEK WATERSHED 2001 - 2021

Taxon	Number	Occ	Den	%	HBI	FFG
Ophidonais serpentina	10	10	65	0.29	6	CG
Pristinella	1	1	10	0.04	8	CG
Rhyacodrilus	1	1	13	0.06	8	CG
Slavina appendiculata	1	1	12	0.05	6	CG
Plecoptera (stoneflies)						
Acroneuria	1	1	4	0.02	4	PR
Capniidae	4	4	5	0.02	3	SH
Chloroperlidae	12	12	23	0.10	3	PR
Claassenia sabulosa	3	3	5	0.02	4	PR
Doroneuria	3	3	16	0.07	2	PR
Haploperla	3	3	127	0.56	3	PR
Hesperoperla pacifica	1	1	8	0.04	4	PR
Isoperla	12	12	78	0.34	4	PR
Malenka	4	4	8	0.04	4	SH
Pteronarcella	1	1	5	0.02	4	OM
Pteronarcys	2	2	6	0.03	2	SH
Skwala	9	9	21	0.09	4	PR
Sweltsa	16	16	65	0.29	3	PR
Zapada cinctipes	5	5	12	0.05	4	SH
Trichoptera (caddis flies)						
Amiocentrus aspilus	2	2	40	0.18	3	CG
Anagapetus	1	1	15	0.07	2	SC
Apatania	1	1	4	0.02	2	SC
Arctopsyche grandis	1	1	6	0.03	3	PR
Arctopsyche	2	2	14	0.06	3	PR
Brachycentrus americanus	6	6	42	0.19	4	SC
Brachycentrus occidentalis	16	16	27	0.12	4	SC
Cheumatopsyche	71	71	290	1.28	8	CF
Chimarra	45	45	428	1.89	5	CF
Culoptila	5	5	63	0.28	6	SC
Dolophilodes	4	4	11	0.05	2	CF
Glossosoma	5	5	78	0.34	4	SC
Helicopsyche	21	21	239	1.06	7	SC
Helicopsyche borealis	57	57	529	2.34	7	SC
Hydropsyche	86	86	855	3.78	7	CF
Hydroptila	47	47	204	0.90	7	PH
Lepidostoma (Neodinarthrum)	6	6	461	2.04	5	SH
Lepidostoma pluviale group	9	9	509	2.25	5	SH
Leucotrichia	4	4	12	0.05	7	SC
Limnephilidae	1	1	8	0.04	0	SH
Marilia	12	12	43	0.19	3	SH
Micrasema	11	11	11	0.05	4	MH
Nectopsyche	52	52	148	0.65	7	OM
Neotrichia	3	3	22	0.10	7	SC
Neureclipsis	8	8	22	0.10	7	PR
Ochrotrichia	2	2	4	0.02	6	PH
Oecetis	62	62	138	0.61	8	OM
Oecetis avara group	13	13	176	0.78	8	PR
Oligophlebodes	11	11	77	0.34	1	SC
Oxyethira	1	1	3	0.01	8	PH
Polycentropus	5	5	23	0.10	6	PR
Protoptila	5	5	237	1.05	6	SC
Psychomyia	5	5	8	0.04	4	SC
Rhyacophila	10	10	13	0.06	2	PR
Rhyacophila angelita group	1	1	5	0.02	4	PR
Rhyacophila atrata group	2	2	41	0.18	4	PR
Rhyacophila brunnea group	2	2	35	0.15	4	PR
Rhyacophila brunnea/vemna group	2	2	28	0.12	4	PR
Rhyacophila coloradensis group	1	1	12	0.05	5	PR
Rhyacophila hyalinata group	3	3	14	0.06	4	PR
Trichoptera (caddis flies)						
Rhyacophila pellisa	2	2	8	0.04	3	PR
Trepaxonemata (flatworms)	90	90	200	0.88	**4**	PR
Polycelis	2	2	6	0.03	3	PR

APPENDIX TABLE D-11. BENTHIC MACROINVERTEBRATE METRICS FOR GOOSE CREEK STATIONS GC1 and GC2

METRIC	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.
	GC1	GC1	GC1	GC1	GC1-Dup	GC1	GC1	GC1	GC1	GC1	GC2	GC2
	WDEQ	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	GC2	SCCD
	10/29/98	09/12/01	09/19/02	09/19/05	09/19/05	09/15/09	09/19/12	10/05/15	10/01/18	09/27/21	10/30/98	09/12/01
% Oligochaete Density	3.01	2.29	1.67	1.32	0.54	1.61	0.00	3.41	4.55	0.00	7.74	3.88
% Turbellaria Density	1.13	6.85	4.28	0.56	2.17	3.75	1.42	0.00	0.91	0.00	0.72	4.19
% *C.Nostococladius* Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Density (No./ m^2)	10716	7507	10857	7438	7142	2509	5673	7895	5841	8070	11221	5205
EPT Density (No./ m^2)	6478	2048	7326	5017	5043	1604	3268	5730	3410	5958.35	7548	960
Total Taxa	34	32	34	41	41	38	35	31	40	28	44	35
No. EPT Taxa	14	7	12	14	15	12	12	10	14	10	14	4
HBI	5.08	6.21	5.26	6.55	6.43	6.90	6.21	6.73	6.01	6.05	4.89	6.08
Brillouin Diversity	2.61	2.36	2.43	2.75	2.64	2.62	NC	NC	NC	ND	2.41	2.41
No. Non-Insect Taxa	7	11	8	7	7	10	6	6	9	4	10	10
% Non-Insect Density	5.08	20.97	8.18	3.97	4.33	9.29	2.71	7.50	6.39	0.8333	12.06	51.66
No. Odonata Taxa	0	0	0	0	1	0	1	0	2	0	1	1
% Odonata Density	0.00	0.00	0.00	0.00	0.19	0.00	0.18	0.00	0.35	0	0.18	0.16
No. Ephemeroptera Taxa	7	2	7	8	8	6	6	6	7	5	6	3
% Ephemeroptera Density	35.02	12.77	48.33	22.76	29.37	36.96	43.05	57.41	43.35	21.83	45.51	17.83
% Ephem. Dens. w/o Baetidae	28.82	7.12	29.56	10.92	8.69	8.21	31.60	55.21	31.51	19.84	41.18	17.67
No. Plecoptera Taxa	0	0	0	0	0	0	0	0	0	0	0	0
% Plecoptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00
No. Hemiptera Taxa	0	1	0	1	0	0	0	0	0	0	0	0
% Hemiptera Density	0.00	0.13	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. Megaloptera Taxa	0	0	0	0	0	0	0	0	0	0	0	0
% Megaloptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. Trichoptera Taxa	7	5	5	6	7	6	6	4	7	5	8	1
% Trichoptera Density	25.42	14.51	19.14	44.67	41.24	26.97	27.20	15.16	15.03	52	21.77	0.62
% Trichop. w/o Hydropsychidae	6.40	14.39	19.14	7.53	13.92	9.46	3.25	1.70	13.82	3.34	4.86	0.62
No. Lepidoptera Taxa	1	0	0	1	1	0	0	1	1	1	1	0
% Lepidoptera Density	0.38	0.00	0.00	0.18	0.19	0.00	0.00	0.17	4.84	1.5	0.36	0.00
No.Coleoptera Taxa	4	4	3	4	3	3	3	2	3	3	2	4
% Coleoptera Density	14.12	47.98	15.24	7.42	4.70	16.60	2.31	1.53	10.36	8.333	1.80	15.36
No. Misc. Diptera Taxa	1	2	2	1	3	2	1	1	11	1	3	3
% Misc. Diptera Density	12.99	0.80	1.49	0.90	1.32	5.36	1.88	0.17	19.69	6.67	1.62	0.63
No. Chironomidae Taxa	7	7	9	13	11	11	12	11	10	9	13	13
% Chironomidae Density	6.98	2.82	7.63	19.88	18.65	4.83	23.12	18.06	9.33	8.833	16.74	13.85
No. Predator Taxa	3	3	2	2	4	3	6	4	6	2	5	4
% Predator Density	0.57	0.80	0.56	0.36	0.95	0.72	3.07	1.87	1.9	0.5	1.26	1.10
No. Parasite Taxa	2	2	0	2	2	1	2	0	1	1	2	1
% Parasite Density	0.38	0.53	0.00	1.08	2.07	0.71	0.53	0.00	0.1727	0.1667	1.98	0.62
No. Collector Gatherer Taxa	16	17	21	18	18	19	18	19	21	15	21	23
% Collector Gatherer Density	41.99	46.78	68.97	40.66	43.87	48.40	63.15	81.09	61.83	37.33	69.63	85.34
No. Collector Filterer Taxa	4	2	3	4	5	4	6	4	5	5	4	1
% Collector Filterer Density	32.20	0.94	4.64	33.28	35.78	21.79	30.05	14.82	26.42	55.67	18.53	1.09

Note: NC = Metric not calculated.

APPENDIX TABLE D-11. (continued) BENTHIC MACROINVERTEBRATE METRICS FOR GOOSE CREEK STATIONS GC1 and GC2

METRIC	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.	Goose Cr.
	GC1	GC1	GC1	GC1	GC1-Dup	GC1	GC1	GC1	GC1	GC1	GC2	GC2
	WDEQ	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	WDEQ	SCCD
	10/29/98	09/12/01	09/19/02	09/19/05	09/19/05	09/15/09	09/19/12	10/05/15	10/01/18	09/27/21	10/30/98	09/12/01
No. Macrophyte Herbivore Taxa	0	0	0	0	0	0	1	1	1	1	0	0
% Macrophyte Herbivore Density	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.51	0.35	1.5	0.00	0.00
No. Piercer Herbivore Taxa	0	1	1	1	1	0	1	0	1	1	0	0
% Piercer Herbivore Density	0.00	0.67	0.37	1.08	0.56	0.00	0.71	0.00	0.35	2.5	0.00	0.00
No. Scraper Taxa	5	3	2	6	5	4	0	2	3	1	5	2
% Scraper Density	18.45	48.12	21.56	13.56	11.11	17.14	0.00	1.36	8.12	1.5	2.88	9.15
No. Shredder Taxa	0	0	0	0	0	0	1	0	2	1	0	0
% Shredder Density	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.86	0.1667	0.00	0.00
No. Xylophage Taxa	0	0	0	0	0	0	NC	NC	NC	NC	0	0
% Xylophage Density	0.00	0.00	0.00	0.00	0.00	0.00	NC	NC	NC	NC	0.00	0.00
No. Omnivore Taxa	3	3	4	5	4	6	0	1	0	1	6	3
% Omnivore Density	4.14	1.74	3.17	7.95	2.82	11.07	0.00	0.34	0.00	0.6667	5.04	1.25
No. Unknown Taxa	1	2	1	3	2	1	0	0	0.00	0	1	2
% Unknown Density	2.26	0.40	0.74	1.99	2.83	0.18	0.00	0.00	0.00	0	0.72	1.56
Percent 1 Dominant	22.22	35.75	28.81	27.31	30.70	25.71	24.00	54	25.91	26.83	38.85	28.53
Percent 5 Dominant	67.03	68.27	71.19	58.41	65.36	63.92	68.28	79.56	58.2	79	69.44	71.63
Percent 10 Dominant	81.72	88.85	86.80	77.94	81.37	81.42	83.39	89.10	77.55	90.33	83.48	88.39
Ratio EPT/Chironomidae	8.68	9.67	8.85	3.39	3.79	13.26	3.04	4.02	6.26	8.36	4.02	1.34
Ratio Hydropsych./Tot. Trichop.	0.75	0.01	0.00	0.69	0.82	0.65	0.91	0.89	0.86	0.94	0.78	0.00
Ratio Baetidae/Tot. Ephem.	0.18	0.44	0.39	0.62	0.65	0.78	0.00	0.04	10.36	0.09	0.09	0.01
Ratio Scraper/Collector Filterers	0.57	51.14	4.64	0.41	0.31	0.79	0.00	0.09	45.6	0.03	0.16	8.43
Ratio Scraper/Scrap.+Coll. Filter.	0.36	0.98	0.82	0.29	0.24	0.44	0.00	0.08	0.23	0.03	0.13	0.89
Ratio Shredders/Tot. Density	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.002	0.00	0.00
BCI	74	93	66	64	65	65	62	63	64	61	54	53
BCI Predicted	65	90	60	60	60	60	60	60	60	60	50	55
BCI CTQA	87.65	97.15	90.88	93.41	92.02	92.05	96.00	95.55	94.26	97.78	92.30	103.06
BCI CTQD	88.21	95.63	89.55	91.39	91.20	90.35	97.98	96.97	93.79	99.22	93.21	104.30
Diversity LOGe	2.62	2.38	2.44	2.76	2.65	2.65	2.58	1.95	2.78	2.22	2.42	2.44
Diversity LOG2	3.78	3.43	3.52	3.99	3.83	3.83	3.73	2.81	4.01	3.2	3.49	3.51
Evenness	0.74	0.68	0.69	0.74	0.71	0.73	NC	0.57	0.75	0.67	0.64	0.68
Simpson D	0.11	0.17	0.14	0.11	0.13	0.12	NC	NC	NC	NC	0.19	0.14
% Multivoltine	16.24	14.28	24.49	37.25	39.74	34.02	87.84	83.13	68.05	62	22.71	15.27
% Univoltine	67.46	35.72	59.06	55.33	55.55	49.11	10.14	16.35	26.25	29.83	74.24	69.15
% Semivoltine	16.29	50.00	16.45	7.41	4.71	16.88	2.03	0.51	5.70	8.167	3.06	15.58

Note: NC = Metric not calculated.

APPENDIX TABLE D-11. (continued) BENTHIC MACROINVERTEBRATE METRICS FOR GOOSE CREEK STATION GC2 and BIG GOOSE CREEK STATION BG2

METRIC	Goose Cr. GC2 SCCD 09/17/02	Goose Cr. GC2 SCCD 09/19/05	Goose Cr. GC2 SCCD 09/15/09	Goose Cr. GC2 SCCD 09/19/12	Goose Cr. GC2 SCCD 10/05/15	Goose Cr. GC2 SCCD 10/02/18	Goose Cr. GC2 SCCD 09/27/21	B. Goose Cr. BG2 WDEQ 10/25/94	B. Goose Cr. BG2 WDEQ 10/29/98	B. Goose Cr. BG2 SCCD 09/10/01	B. Goose Cr. BG2 SCCD 09/23/02	B. Goose Cr. BG2 WDEQ 10/27/04	B. Goose Cr. BG2 SCCD 09/19/05	B. Goose Cr. BG2 SCCD 09/14/09
% Oligochaete Density	2.24	4.34	1.10	3.42	3.19	2.86	0.66	5.97	0.36	11.05	0.76	0.17	1.53	1.48
% Turbellaria Density	2.99	0.39	1.28	0.20	1.24	0.19	0.49	0.94	0.35	1.36	4.56	0.00	7.49	1.11
% *C.Nostococladius* Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Density (No./ m^2)	21628	13692	3156	9443	11381	8457	8204.5	3658	3266	1782	14149	15683	1402	1455
EPT Density (No./ m^2)	10491	7613	2118	3986	4499	6101	6671.2	1089	2356	648	7290	7209	433	659
Total Taxa	32	36	37	37	40	35	28	54	39	39	32	31	29	32
No. EPT Taxa	7	12	12	8	10	13	12	12	18	12	10	10	8	12
HBI	5.28	6.62	6.90	6.75	6.99	6.61	6.26	6.07	4.97	6.59	5.40	6.46	6.42	6.82
Brillouin Diversity	2.22	2.56	2.62	NC	NC	NC	ND	3.03	2.60	2.38	2.24	NC*	2.49	2.37
No. Non-Insect Taxa	6	11	8	9	11	9	3	17	5	7	8	6	8	5
% Non-Insect Density	6.92	9.45	5.48	5.47	9.04	4.01	1.311	16.52	1.94	16.12	7.22	4.29	12.28	7.38
No. Odonata Taxa	1	0	0	1	1	0	0	0	0	1	1	0	1	0
% Odonata Density	0.19	0.00	0.00	0.01	0.18	0.00	0	0.00	0.00	1.19	0.19	0.00	0.19	0.00
No. Ephemeroptera Taxa	2	6	7	4	4	6	7	6	9	5	4	3	3	5
% Ephemeroptera Density	45.71	40.87	32.36	36.41	35.63	58.97	54.75	17.32	44.79	20.06	44.86	35.33	23.03	33.83
% Ephem. Dens. w/o Baetidae	42.72	24.75	17.19	34.94	35.28	56.49	48.69	16.22	18.52	19.56	39.55	19.03	9.02	7.97
No. Plecoptera Taxa	0	0	0	0	0	0	0	0	1	0	0	0	0	0
% Plecoptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.88	0.00	0.00	0.00	0.00	0.00
No. Hemiptera Taxa	0	0	0	0	0	0	0	0	0	0	1	0	0	0
% Hemiptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00
No. Megaloptera Taxa	0	0	0	0	0	0	0	1	0	1	0	0	0	0
% Megaloptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.17	0.00	0.00	0.00	0.00
No. Trichoptera Taxa	5	6	5	4	6	7	5	6	8	7	6	7	5	7
% Trichoptera Density	2.80	14.74	34.73	19.14	3.90	13.17	26.56	12.44	26.46	16.32	6.65	10.63	7.87	11.44
% Trichop. w/o Hydropsychidae	2.24	4.32	2.56	1.03	1.77	49.28	3.28	7.56	9.18	15.65	3.99	7.71	2.88	1.11
No. Lepidoptera Taxa	1	1	1	1	1	1	1	1	1	1	1	2	1	1
% Lepidoptera Density	0.37	1.18	3.29	1.03	1.60	1.34	5.246	2.52	6.88	0.68	1.71	2.23	8.45	22.18
No.Coleoptera Taxa	4	2	2	4	2	3	2	5	5	5	4	4	3	4
% Coleoptera Density	10.46	5.31	1.82	3.76	3.37	2.48	0.6557	25.99	14.64	45.74	30.03	34.31	24.75	16.27
No. Misc. Diptera Taxa	2	1	1	2	2	9	2	5	3	3	2	4	1	3
% Misc. Diptera Density	0.75	0.59	0.55	0.68	1.09	20.04	1.64	1.58	1.24	0.51	2.47	3.60	0.19	3.69
No. Chironomidae Taxa	11	9	13	12	13	9	8	13	7	9	5	6	7	7
% Chironomidae Density	32.84	27.92	21.75	33.50	45.20	20.04	9.836	23.43	3.19	2.04	6.65	9.61	23.22	5.16
No. Predator Taxa	3	1	2	5	6	3	3	6	4	5	4	3	4	1
% Predator Density	0.57	0.20	0.36	1.38	2.51	3.053	1.311	1.57	1.77	4.90	0.95	1.89	1.53	0.18
No. Parasite Taxa	2	2	1	2	2	2	1	1	1	0	2	0	2	2
% Parasite Density	1.31	3.34	0.91	1.54	1.06	0.5725	0.1639	1.57	0.88	0.00	0.57	0.00	1.92	4.8
No. Collector Gatherer Taxa	14	18	21	19	19	20	15	29	16	20	15	13	12	14
% Collector Gatherer Density	81.55	58.78	52.11	72.81	81.19	76.15	63.61	64.22	48.32	43.69	60.25	45.45	55.84	39.54
No. Collector Filterer Taxa	4	5	3	7	5	3	4	3	4	5	5	1	3	3
% Collector Filterer Density	6.72	24.76	32.72	21.36	5.67	14.5	24.92	5.67	17.99	3.06	8.36	10.63	6.72	13.68

Note: NC = Metric not calculated.

APPENDIX TABLE D.11 (continued) BENTHIC MACROINVERTEBRATE METRICS FOR GOOSE CREEK STATION GC2 and BIG GOOSE CREEK STATION BG2

METRIC	Goose Cr. GC2 SCCD 09/17/02	Goose Cr. GC2 SCCD 09/19/05	Goose Cr. GC2 SCCD 09/15/09	Goose Cr. GC2 SCCD 09/19/12	Goose Cr. GC2 SCCD 10/05/15	Goose Cr. GC2 SCCD 10/02/18	Goose Cr. GC2 SCCD 09/27/21	B. Goose Cr. BG2 WDEQ 10/25/94	B. Goose Cr. BG2 WDEQ 10/29/98	B. Goose Cr. BG2 SCCD 09/10/01	B. Goose Cr. BG2 SCCD 09/23/02	B. Goose Cr. BG2 WDEQ 10/27/04	B. Goose Cr. BG2 SCCD 09/19/05	B. Goose Cr. BG2 SCCD 09/14/09
No. Macrophyte Herbivore Taxa	1	0	0	2	2	1	1	0	0	0	0	1	0	0
% Macrophyte Herbivore Density	0.19	0.00	0.00	1.54	5.85	0.38	0.3279	0.00	0.00	0.00	0.00	0.69	0.00	0.00
No. Piercer Herbivore Taxa	0	1	0	0	1	1	1	1	1	1	0	0	0	2
% Piercer Herbivore Density	0.00	0.20	0.00	0.00	0.71	0.19	2.459	0.16	0.18	0.17	0.00	0.00	0.00	0.36
No. Scraper Taxa	3	5	5	1	4	3	2	7	8	3	3	5	3	4
% Scraper Density	5.97	7.47	6.02	1.03	2.30	1.72	7.049	23.31	24.87	45.06	27.75	34.65	29.94	38.63
No. Shredder Taxa	0	0	0	1	1	1	1	1	0	1	0	1	1	0
% Shredder Density	0.00	0.00	0.00	0.34	0.71	3.05	0.1639	0.31	0.00	0.17	0.00	1.89	0.19	0.00
No. Xylophage Taxa	0	0	0	NC	NC	NC	NC	0	0	0	0	0	0	0
% Xylophage Density	0.00	0.00	0.00	NC	NC	NC	NC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. Omnivore Taxa	4	4	4	0	0	1	0	5	4	4	2	3	3	5
% Omnivore Density	3.36	5.31	6.76	0.00	0.00	0.38	0	2.99	5.83	5.27	1.71	4.80	2.88	2.39
No. Unknown Taxa	1	0	1	0	0	0.00	0	1	1	2	1	0	1	1
% Unknown Density	0.37	0.00	1.10	0.00	0.00	0.00	0	0.16	0.18	0.51	0.38	0.00	0.96	0.37
Percent 1 Dominant	42.72	23.58	18.46	34.87	34.39	55.92	46.39	14.49	24.87	35.88	36.31	27.62	21.11	22.55
Percent 5 Dominant	72.94	67.39	68.01	77.77	65.94	81.68	80	54.97	68.96	69.03	72.23	71.01	64.68	73.2
Percent 10 Dominant	88.07	86.25	83.18	88.53	80.48	91.98	91.48	72.61	82.89	87.90	85.53	83.88	88.49	89.1
Ratio EPT/Chironomidae	1.48	1.99	3.08	1.66	0.87	3.6	8.27	1.27	22.72	17.83	7.74	4.79	1.33	8.75
Ratio Hydropsych./Tot. Trichop.	0.20	0.71	0.93	0.95	0.54	0.51	0.88	0.39	0.65	0.04	0.40	0.27	0.63	0.90
Ratio Baetidae/Tot. Ephem.	0.07	0.39	0.47	0.04	0.01	10.69	0.11	0.06	0.59	0.03	0.12	0.46	0.61	0.84
Ratio Scraper/Collector Filterers	0.89	0.30	0.18	0.05	0.41	74.43	0.13	4.11	1.38	14.72	3.32	3.26	4.46	2.82
Ratio Scraper/Scrap.+Coll. Filter.	0.47	0.23	0.16	0.05	0.29	0.11	0.22	0.80	0.58	0.94	0.77	0.77	0.82	0.74
Ratio Shredders/Tot. Density	0.00	0.00	0.00	0.01	0.01	0.03	0.002	0.00	0.00	0.00	0.00	NC*	0.00	0.00
BCI	57	59	59	55.00	56	60	59.00	53	62	94	94	NC	91	91
BCI Predicted	55	55	55	55	55	55	55	50	50	86	86	NC	86	86
BCI CTQA	97.09	93.61	93.03	100.41	97.45	91.71	92.81	94.25	80.05	91.63	91.94	90.00	94.89	94.94
BCI CTQD	98.40	94.06	94.68	101.03	99.32	92.2	94.32	95.00	75.79	85.81	91.44	NC	97.33	94.42
Diversity LOGe	2.23	2.57	2.65	2.25	2.56	1.84	2	3.06	2.63	2.52	2.25	2.39	2.54	2.41
Diversity LOG2	3.21	3.71	3.82	3.24	3.7	2.66	2.89	4.42	3.79	3.63	3.25	3.44	3.66	3.48
Evenness	0.64	0.72	0.73	NC	0.69	0.52	0.6	0.77	0.72	0.68	0.65	NC	0.75	0.70
Simpson D	0.21	0.12	0.11	NC	NC	NC	NC	0.07	0.12	0.17	0.20	0.15	0.11	0.14
% Multivoltine	31.30	39.49	37.93	83.07	85.97	82.25	74.43	22.44	27.78	3.57	14.78	27.96	38.68	33.87
% Univoltine	57.04	55.11	59.78	13.50	10.13	16.03	24.59	49.76	53.00	49.41	54.52	37.74	36.56	49.86
% Semivoltine	11.66	5.40	2.29	3.43	3.9	1.72	0.9836	27.79	19.22	47.02	30.70	34.31	24.76	16.26

Note: NC = Metric not calculated.

APPENDIX TABLE D-11. (continued) BENTHIC MACROINVERTEBRATE METRICS FOR BIG GOOSE CREEK STATIONS BG2 AND BG10

METRIC	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.
	BG2	BG2-Dup	BG2	BG2	BG2-Dup	BG2	BG2-Dup	BG10	BG10	BG10	BG10	BG10
	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD
	09/25/12	09/25/12	10/06/15	10/03/18	10/03/18	09/28/21	09/28/21	09/14/01	09/24/02	09/20/05	09/23/09	09/26/12
% Oligochaete Density	0.17	0.02	0.49	0.00	0.38	0	0	1.00	0.16	1.70	0.18	0.25
% Turbellaria Density	1.05	0.55	2.13	0.90	1.35	2.37	0.69	0.14	6.69	2.21	1.27	0.34
% *C.Nostococladius* Density	0.00	0.00	0.00	0.00	0.00	0	0	0.00	0.00	0.00	0.00	0.00
Density (No./ m^2)	5802	5480	12327	11258	10492	11055.9	11782.2	2548	12370	6768	1858	5947
EPT Density (No./ m^2)	3270	3268	9563	9402	8756	7323.52	9280.5	1856	6337	4566	1068	3178
Total Taxa	35	34	38	34	35	34	36	44	38	43	41	41
No. EPT Taxa	14	13	11	17	15	10	13	22	15	13	18	15
HBI	6.41	6.61	6.46	6.27	6.26	6.76	6.77	5.25	5.33	6.24	6.53	5.54
Brillouin Diversity	NC	NC	NC	NC	NC	ND	ND	2.53	2.80	2.74	2.74	NC*
No. Non-Insect Taxa	5	6	7	3	5	6	5	2	4	12	4	6
% Non-Insect Density	2	2	7.69	3.76	5.96	4.927	2.226	1.14	8.64	6.80	3.43	1.62
No. Odonata Taxa	0	0	0	0	1	1	1	0	0	0	0	0
% Odonata Density	0	0	0.00	0.00	0.01	20.18	20.18	0.00	0.00	0.00	0.00	0.00
No. Ephemeroptera Taxa	7	6	4	8	7	4	6	10	5	6	10	7
% Ephemeroptera Density	38	42	52.21	61.83	56.53	44.16	57.02	31.98	16.15	29.31	20.43	13.06
% Ephem. Dens. w/o Baetidae	36.55	41.06	47.14	44.27	39.58	41.43	55.49	24.87	9.79	10.56	8.50	11.02
No. Plecoptera Taxa	0	0	1	0	0	0	0	2	1	0	1	3
% Plecoptera Density	0.00	0.00	0.16	0.00	0.00	0	0	0.28	0.16	0.00	1.63	3.39
No. Hemiptera Taxa	0	0	0	0	0	0	0	1	1	1	0	0
% Hemiptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.65	1.02	0.00	0.00
No. Megaloptera Taxa	0	0	0	0	0	0	0	0	0	0	0	0
% Megaloptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. Trichoptera Taxa	7	7	6	9	8	6	7	10	9	7	7	5
% Trichoptera Density	18.08	17.67	25.20	21.68	26.92	22.08	21.75	40.56	34.90	38.16	35.43	36.98
% Trichop. w/o Hydropsychidae	4.33	3.51	59.76	38.61	26.3	13.33	15.58	29.57	20.39	14.65	6.86	2.20
No. Lepidoptera Taxa	1	1	1	1	1	0	0	1	1	1	1	1
% Lepidoptera Density	4.35	2.39	1.15	3.23	4.62	0	0	4.86	1.79	6.13	13.02	5.09
No.Coleoptera Taxa	4	5	4	4	4	4	4	6	5	5	4	5
% Coleoptera Density	12.87	16.01	5.40	5.74	2.31	16.97	10.62	14.86	23.98	11.92	12.11	19.51
No. Misc. Diptera Taxa	0	0	15	9	9	2	2	3	3	1	2	3
% Misc. Diptera Density	0.00	0.00	8.18	3.76	3.65	0.91	0.34	1.28	3.26	0.17	2.71	2.20
No. Chironomidae Taxa	11	9	13	8	8	11	11	9	9	10	12	11
% Chironomidae Density	24.17	20.25	7.20	3.05	2.31	10.77	7.877	4.70	10.45	6.46	11.19	18.15
No. Predator Taxa	3	4	6	3	4	8	7	7	4	2	3	7
% Predator Density	2.09	2.23	4.58	2.509	4.051	9.489	7.705	1.13	1.46	1.19	2.17	5.26
No. Parasite Taxa	1	2	2	1	1	1	1	0	1	2	1	1
% Parasite Density	0.70	0.92	1.15	2.688	4.038	0.7299	0.5137	0.00	1.63	1.53	1.08	0.68
No. Collector Gatherer Taxa	19	16	20	17	17	13	16	17	16	22	18	21
% Collector Gatherer Density	70.79	73.10	67.43	65.59	55.76	69.16	73.8	38.97	32.31	39.51	27.48	37.75
No. Collector Filterer Taxa	4	5	4	6	7	7	7	5	5	5	6	7
% Collector Filterer Density	16.00	16.01	11.13	17.03	23.07	11.13	7.192	20.99	33.78	33.05	36.70	48.17

Note: NC = Metric not calculated.

APPENDIX TABLE D-11. (continued) BENTHIC MACROINVERTEBRATE METRICS FOR BIG GOOSE CREEK STATIONS BG2 AND BG10

METRIC	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.
	BG2	BG2-Dup	BG2	BG2	BG2-Dup	BG2	BG2-Dup	BG10	BG10	BG10	BG10	BG10
	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD
	09/25/12	09/25/12	10/06/15	10/03/18	10/03/18	09/28/21	09/28/21	09/14/01	09/24/02	09/20/05	09/23/09	09/26/12
No. Macrophyte Herbivore Taxa	1	0	1	1	1	1	1	0	0	0	0	0
% Macrophyte Herbivore Density	0.17	0.00	0.98	0.54	0.19	0.5474	0.5137	0.00	0.00	0.00	0.00	0.00
No. Piercer Herbivore Taxa	1	1	1	1	1	1	1	1	0	1	0	0
% Piercer Herbivore Density	0.52	0.18	2.95	1.97	2.31	5.474	8.562	0.14	0.00	0.17	0.00	0.00
No. Scraper Taxa	4	4	3	4	3	2	2	8	6	5	7	4
% Scraper Density	7.13	6.81	9.82	7.71	10.19	2.372	0.6849	34.01	27.39	21.46	24.22	7.46
No. Shredder Taxa	1	1	1	1	0	1	1	1	0	1	1	1
% Shredder Density	2.43	0.55	1.96	1.97	0.00	1.095	1.027	0.14	0.00	0.17	2.71	0.68
No. Xylophage Taxa	NC	NC	NC	NC	NC	NC	NC	0	0	0	0	NC
% Xylophage Density	NC	NC	NC	NC	NC	NC	NC	0.00	0.00	0.00	0.00	NC
No. Omnivore Taxa	1	1	0	0	1	0	0	4	4	4	4	0
% Omnivore Density	0.17	0.18	0.00	0.00	0.38	0	0	3.14	3.09	2.72	5.05	0.00
No. Unknown Taxa	0	0	0	0.00	0.00	0	0	2	2	1	1	0
% Unknown Density	0.00	0.00	0.00	0.00	0.00	0	0	1.43	0.32	0.17	0.54	0.00
Percent 1 Dominant	34.25	37.18	47.14	39.78	34.23	41.24	54.97	23.71	16.64	22.49	27.12	26.97
Percent 5 Dominant	75.98	76.94	72.18	70.43	72.3	73.18	81.34	69.99	55.31	59.97	60.39	62.08
Percent 10 Dominant	88.15	89.27	85.43	84.23	87.49	85.22	89.04	86.55	81.09	81.78	76.11	82.27
Ratio EPT/Chironomidae	2.33	2.96	10.77	27.41	36.17	6.15	10.00	15.45	4.91	10.42	5.13	2.95
Ratio Hydropsych./Tot. Trichop.	0.76	0.80	0.40	0.66	0.74	0.40	0.28	0.27	0.42	0.62	0.81	0.94
Ratio Baetidae/Tot. Ephem.	0.04	0.02	0.10	12.72	13.65	0.06	0.03	0.22	0.39	0.64	0.58	0.16
Ratio Scraper/Collector Filterers	0.45	0.42	0.88	60.22	58.65	0.06	0.02	1.62	0.81	0.65	0.66	0.15
Ratio Scraper/Scrap.+Coll. Filter.	0.31	0.30	0.47	0.31	0.31	0.18	0.09	0.62	0.45	0.39	0.40	0.13
Ratio Shredders/Tot. Density	0.02	0.01	0.20	0.02	0.00	0.011	0.010	0.00	0.00	0.00	0.03	0.01
BCI	96	96	89	97	97	87	89	69	74	66	74	73
BCI Predicted	86	86	86	86	86	86	86	55	62	62	62	62
BCI CTQA	89.54	89.94	96.66	88.29	89.03	98.76	96.2	79.93	83.64	93.19	83.24	85.39
BCI CTQD	92.17	90.57	95.07	87.76	87.68	98.21	97.02	81.29	83.59	89.08	83.06	86.77
Diversity LOGe	2.33	2.26	2.23	2.37	2.39	2.3	1.93	2.57	2.81	2.76	2.79	2.71
Diversity LOG2	3.36	3.26	3.21	3.41	3.44	3.32	2.79	3.71	4.05	3.98	4.03	3.91
Evenness	NC	NC	0.61	0.67	0.67	0.65	0.54	0.68	0.77	0.73	0.75	NC
Simpson D	NC	NC	NC	NC	NC	NC	NC	0.12	0.08	0.10	0.11	NC
% Multivoltine	69.55	71.79	77.74	79.75	78.84	72.63	79.45	12.04	24.67	28.66	27.04	41.39
% Univoltine	18.60	15.49	17.35	15.41	18.66	10.22	10.27	72.89	51.10	59.16	60.67	38.93
% Semivoltine	11.85	12.73	4.91	4.84	2.50	17.15	10.27	15.07	24.22	12.18	12.29	19.68

Note: NC = Metric not calculated.

APPENDIX TABLE D-11. (continued) BENTHIC MACROINVERTEBRATE METRICS FOR BIG GOOSE CREEK STATIONS BG10 AND BG18, AND LITTLE GOOSE CREEK STATION LG2A

METRIC	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	L. Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.
	BG10	BG10-Dup.	BG10	BG10	BG18	BG18	BG18	BG18	BG18	BG18	LG2A	LG2A	LG2A	LG2A	LG2A	LG2A
	SCCD	SCCD	SCCD	SCCD	WDEQ	SCCD	SCCD	SCCD	SCCD	SCCD	WDEQ	WEST	WDEQ	SCCD	SCCD	WDEQ
	10/07/15	10/07/15	10/05/18	09/28/21	10/22/98	09/17/01	09/20/02	09/26/12	10/05/18	9/29/21	10/25/94	10/08/97	10/27/98	09/18/01	09/24/02	10/26/04
% Oligochaete Density	0.00	0.16	1.18	0.36	0.00	0.49	13.38	1.15	1.54	1.29	36.44	1.07	0.94	5.19	0.00	0.57
% Turbellaria Density	0.50	0.00	0.50	0.18	0.00	0.33	0.54	0.18	0.19	0.37	0.47	0.00	1.50	6.82	6.48	1.52
% C.Nostococladius Density	0.00	0.00	0.00	0.00	0.35	0.16	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Density (No./ m^2)	4042	6254	4803	2733.71	7279	2733	3716	1655	2333	2427.54	3196	18088	6157	8285	10272	8506
EPT Density (No./ m^2)	3134	4832	3268	2153.68	6807	1918	1095	717	847	1446.67	1053	16312	3355	2502	3128	4390
Total Taxa	42	41	43	33	35	37	40	41	50	38	46	30	35	33	30	29
No. EPT Taxa	22	19	16	20	23	20	18	16	16	20	10	9	9	6	6	7
HBI	5.10	4.96	5.22	5.03	1.64	4.50	4.57	3.75	4.6	2.62	5.66	4.16	5.24	6.15	5.68	6.36
Brillouin Diversity	NC	NC	NC	ND	2.07	1.68	2.39	NC	NC	ND	2.54	1.72	2.70	2.70	2.48	NC*
No. Non-Insect Taxa	2	3	6	4	1	3	6	5	7	3	10	2	6	8	7	7
% Non-Insect Density	2.50	1.45	4.20	1.107	0.17	1.31	18.80	3	2.50	1.845	39.44	1.25	3.38	41.40	11.21	7.21
No. Odonata Taxa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
% Odonata Density	0	0	0.00	0	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.20	0.00
No. Ephemeroptera Taxa	9	8	8	9	8	10	10	6	7	7	5	6	4	2	2	3
% Ephemeroptera Density	24.29	24.52	19.99	20.3	28.16	8.01	13.00	7.32	16.70	10.52	25.72	52.69	31.84	15.26	20.82	41.56
% Ephem. Dens. w/o Baetidae	19.30	22.42	14.78	17.72	19.97	7.54	10.65	7.38	12.47	10.14	25.24	45.37	23.60	15.10	19.85	38.90
No. Plecoptera Taxa	4	4	2	2	6	3	2	3	3	4	1	0	0	0	0	0
% Plecoptera Density	2.16	4.52	3.70	0.5535	4.95	1.14	1.81	1.31	3.65	5.351	0.16	0.00	0.00	0.00	0.00	0.00
No. Hemiptera Taxa	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
% Hemiptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.38
No. Megaloptera Taxa	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
% Megaloptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00
No. Trichoptera Taxa	9	7	6	9	9	7	6	7	6	9	4	3	5	4	4	4
% Trichoptera Density	51.08	48.23	44.36	57.93	60.40	60.97	14.64	34.71	15.93	43.73	7.10	37.50	22.67	14.93	9.64	10.06
% Trichop. w/o Hydropsychidae	41.05	37.47	23.11	25.28	57.34	60.65	14.46	32.47	73.51	42.06	0.79	1.61	8.80	14.13	9.43	9.49
No. Lepidoptera Taxa	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	1
% Lepidoptera Density	10.32	8.55	6.22	6.458	0.17	0.00	0.00	0.00	0.00	0	0.16	1.61	3.37	0.49	0.00	0.38
No.Coleoptera Taxa	4	4	4	4	3	2	2	2	4	2	4	5	5	5	4	4
% Coleoptera Density	3.99	7.10	7.73	11.07	3.58	22.30	43.04	15.57	7.10	27.68	6.95	1.08	8.80	21.74	25.74	25.24
No. Misc. Diptera Taxa	13	14	16	0	3	6	4	4	23	5	5	3	4	3	3	5
% Misc. Diptera Density	5.66	5.65	13.81	0.00	1.53	1.46	2.16	5.08	54.13	2.75	3.01	1.07	4.50	0.97	2.17	4.74
No. Chironomidae Taxa	11	12	13	4	4	6	10	14	16	8	16	10	10	8	9	5
% Chironomidae Density	5.16	5.32	13.11	2.583	1.02	4.74	6.50	32.83	51.63	8.118	17.53	4.84	25.47	4.52	30.26	10.44
No. Predator Taxa	8	7	5	5	8	6	7	8	11	10	4	3	3	5	4	3
% Predator Density	6.66	7.26	4.397	2.03	4.09	2.12	4.15	4.50	6.526	12.92	0.80	1.07	2.81	2.76	2.37	3.80
No. Parasite Taxa	1	1	1	1	1	1	2	2	2	1	1	0	1	0	2	0
% Parasite Density	2.00	1.13	2.352	0.5535	0.17	0.49	2.53	1.50	0.5758	0.1845	1.42	0.00	0.75	0.00	3.54	0.00
No. Collector Gatherer Taxa	18	21	25	14	9	15	18	16	24	17	23	13	19	19	14	15
% Collector Gatherer Density	29.12	32.10	39.65	28.6	18.25	15.55	38.14	40.71	63.72	40.22	77.94	57.16	54.70	66.50	49.90	59.39
No. Collector Filterer Taxa	6	6	6	5	1	1	2	3	5	3	4	3	3	2	3	3
% Collector Filterer Density	36.27	38.06	46.21	40.96	3.07	0.33	0.36	4.32	5.758	7.38	12.15	36.61	16.49	1.62	11.01	9.68

Note: NC = Metric not calculated.

APPENDIX TABLE D-11. (continued) BENTHIC MACROINVERTEBRATE METRICS FOR BIG GOOSE CREEK STATIONS BG10 AND BG18, AND LITTLE GOOSE CREEK STATION LG2A

METRIC	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	B. Goose Cr.	L. Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.
	BG10	BG10-Dup.	BG10	BG10	BG18	BG18	BG18	BG18	BG18	BG18	LG2A	LG2A	LG2A	LG2A	LG2A	LG2A
	SCCD	SCCD	SCCD	SCCD	WDEQ	SCCD	SCCD	SCCD	SCCD	SCCD	WDEQ	WEST	WDEQ	SCCD	SCCD	WDEQ
	10/07/15	10/07/15	10/05/18	09/28/21	10/22/98	09/17/01	09/20/02	09/26/12	10/05/18	09/29/21	10/25/94	10/08/97	10/27/98	09/18/01	09/24/02	10/26/04
No. Macrophyte Herbivore Taxa	0	1	0	0	1	1	1	1	2	0	0	0	0	0	0	1
% Macrophyte Herbivore Density	0.00	0.16	0.00	0	0.17	0.16	0.36	0.19	5.76	0	0.00	0.00	0.00	0.00	0.00	0.38
No. Piercer Herbivore Taxa	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
% Piercer Herbivore Density	0.00	0.00	0.00	0	0.34	0.16	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00
No. Scraper Taxa	6	5	4	6	8	7	7	8	6	6	7	7	5	4	2	4
% Scraper Density	24.63	21.13	7.06	19.37	23.04	24.57	41.94	27.95	17.47	38.75	4.90	3.59	12.92	22.20	27.51	18.41
No. Shredder Taxa	2	1	1	1	2	2	1	2	1	0	2	0	0	0	0	1
% Shredder Density	1.00	0.16	0.17	3.875	48.98	55.73	11.39	19.89	0.19	0	0.48	0.00	0.00	0.00	0.00	1.52
No. Xylophage Taxa	NC	NC	NC	NC	0	0	0	NC	NC	NC	0	0	0	0	0	0
% Xylophage Density	NC	NC	NC	NC	0.00	0.00	0.00	NC	NC	NC	0.00	0.00	0.00	0.00	0.00	0.00
No. Omnivore Taxa	1	0	1	1	3	1	1	1	0	2	4	3	3	3	4	2
% Omnivore Density	0.33	0.00	0.17	4.613	1.53	0.33	0.90	0.19	0.00	0.5535	0.96	1.43	8.43	5.84	4.14	6.45
No. Unknown Taxa	0	0	0.00	0	1	2	1	1	0.00	0	1	1	1	1	1	1
% Unknown Density	0.00	0.00	0.00	0	0.34	0.49	0.18	0.75	0.00	0	1.42	0.18	3.93	0.97	1.57	0.38
Percent 1 Dominant	29.95	29.52	30.08	30.26	47.44	55.57	37.43	19.70	31.67	24.91	24.61	37.86	22.66	15.10	21.81	38.90
Percent 5 Dominant	66.56	64.35	63.01	62.73	78.67	85.40	72.15	62.10	52.98	68.27	69.88	89.11	58.43	57.31	67.19	77.42
Percent 10 Dominant	82.2	82.42	82.5	84.32	90.28	93.10	83.72	76.74	73.13	85.06	85.19	95.00	82.21	86.04	88.02	89.75
Ratio EPT/Chironomidae	15.03	14.52	5.19	30.50	91.34	14.77	4.53	1.32	0.7	7.34	1.88	18.70	2.14	6.64	1.01	4.95
Ratio Hydropsych./Tot. Trichop.	0.59	0.62	0.77	0.56	0.05	0.01	0.01	0.06	0.33	0.04	0.89	0.96	0.61	0.05	0.02	0.06
Ratio Baetidae/Tot. Ephem.	0.20	0.09	11.59	0.13	0.29	0.06	0.18	0.00	5.95	0.04	0.02	0.14	0.26	0.01	0.05	0.06
Ratio Scraper/Collector Filterers	0.68	0.56	51.41	0.12	7.50	75.00	116.00	6.52	42.99	0.21	0.40	0.10	0.78	13.70	2.50	1.90
Ratio Scraper/Scrap.+Coll. Filter.	0.40	0.36	0.13	0.32	0.88	0.99	0.99	0.87	0.75	0.84	0.29	0.09	0.44	0.93	0.71	0.66
Ratio Shredders/Tot. Density	0.01	0.00	0.00	0.039	0.49	0.56	0.11	0.20	0.00	0.000	0.00	0.00	0.00	0.00	0.00	NC*
BCI	78	76	70	81	105	92	82	83	77	98	54	56	71	94	60	NC
BCI Predicted	62	62	62	62	50	60	60	60	60	60	50	50	65	90	60	NC
BCI CTQA	79.12	81.5	88.93	76.56	47.51	65.54	72.90	72.32	78.14	61.03	93.11	89.20	91.66	95.56	99.23	95.75
BCI CTQD	75.6	77.33	89.07	75.21	45.64	65.80	73.34	73.21	77.35	59.59	98.00	88.26	92.30	94.64	98.34	NC
Diversity LOGe	2.64	2.64	2.64	2.57	2.08	1.71	2.42	2.80	2.85	2.51	2.57	1.73	2.72	2.24	2.49	2.13
Diversity LOG2	3.81	3.8	3.81	3.71	3.00	2.46	3.48	4.04	4.11	3.62	3.71	2.49	3.93	3.23	3.59	3.07
Evenness	0.71	0.71	0.7	0.74	0.58	0.47	0.65	NC	0.73	0.69	0.67	0.51	0.77	0.64	0.73	NC
Simpson D	NC	NC	NC	NC	0.25	0.35	0.18	NC	NC	NC	0.13	0.28	0.10	0.09	0.12	0.20
% Multivoltine	40.1	36.29	46.88	38.75	7.85	4.83	9.76	46.90	63.92	17.9	16.96	18.08	30.99	12.17	33.50	17.65
% Univoltine	55.91	56.29	45.2	49.82	86.18	72.87	39.33	35.27	22.26	46.49	66.88	80.31	60.11	61.85	40.37	57.12
% Semivoltine	3.993	7.419	7.93	11.44	5.97	22.29	50.90	17.82	13.82	35.61	16.17	1.61	8.90	25.97	26.13	25.24

Note: NC = Metric not calculated.

APPENDIX TABLE D-11. (continued) BENTHIC MACROINVERTEBRATE METRICS FOR LITTLE GOOSE CREEK STATIONS LG2A and LG10

METRIC	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.
	LG2A	LG2A	LG2A	LG2A	LG2A	LG2A	LG10	LG10-Dup	LG10	LG10-Dup	LG10	LG10	LG10	LG10
	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	WDEQ	WDEQ	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD
	09/20/05	09/14/09	09/20/12	10/06/15	10/03/18	9/29/21	10/27/98	10/27/98	09/10/01	09/10/01	09/26/02	09/20/05	09/23/09	09/20/12
% Oligochaete Density	1.14	0.00	1.29	0.00	0.36	1.70	3.31	3.80	0.48	1.33	2.04	2.14	0.18	1.65
% Turbellaria Density	1.72	0.17	0.18	0.16	0.53	0.75	2.79	2.54	0.64	1.82	7.81	0.89	0.36	2.58
% C.Nostococladius Density	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Density (No./ m^2)	7035	3364	8734	12792	9185	5346.38	9249	5559	6969	27032	19014	5660	4471	5469
EPT Density (No./ m^2)	4883	2458	4568	10955	7410	4045.09	6182	3622	4058	13898	8329	3128	3478	2471
Total Taxa	39	27	31	31	33	31	40	39	28	32	34	38	37	44
No. EPT Taxa	12	10	9	12	13	11	15	15	12	10	12	9	12	12
HBI	6.49	6.61	6.74	6.11	6.42	6.6	4.42	4.65	4.99	5.04	5.03	6.34	6.22	5
Brillouin Diversity	2.42	2.27	NC	NC	NC	ND	2.58	2.54	2.26	2.44	2.46	2.54	1.84	NC
No. Non-Insect Taxa	11	2	8	3	4	6	6	8	5	6	5	9	4	6
% Non-Insect Density	6.30	1.20	4.1	2.06	2.28	3.208	6.27	7.06	2.56	4.49	11.72	5.71	2.89	7
No. Odonata Taxa	2	0	1	1	0	1	0	0	0	0	0	0	0	1
% Odonata Density	0.38	0.00	0.18	0.32	0.00	10.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
No. Ephemeroptera Taxa	6	6	4	5	6	4	8	6	4	4	6	3	5	5
% Ephemeroptera Density	56.03	32.75	41.58	51.41	59.58	32.26	30.88	22.87	7.36	8.30	12.74	16.76	11.01	11
% Ephem. Dens. w/o Baetidae	40.34	4.63	39.18	49.53	55.02	30.57	16.58	10.17	0.96	2.16	1.52	0.00	4.33	7.76
No. Plecoptera Taxa	0	0	0	0	0	0	3	4	2	0	0	1	1	2
% Plecoptera Density	0.00	0.00	0.00	0.00	0.00	0	2.79	2.90	0.32	0.00	0.00	0.18	0.18	0.55
No. Hemiptera Taxa	1	0	0	0	0	0	0	0	0	0	0	0	0	0
% Hemiptera Density	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. Megaloptera Taxa	0	0	0	0	0	0	0	0	0	1	0	0	0	0
% Megaloptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00
No. Trichoptera Taxa	6	4	5	7	7	7	4	5	6	6	6	5	6	6
% Trichoptera Density	13.37	40.32	10.72	34.22	21.09	43.4	33.16	39.37	50.56	43.11	31.07	38.32	66.60	33.94
% Trichop. w/o Hydropsychidae	6.50	11.67	3.33	21.65	15.84	33.59	2.44	6.16	15.04	13.44	25.98	2.85	6.31	7.94
No. Lepidoptera Taxa	1	1	1	1	1	1	1	1	1	1	1	1	1	1
% Lepidoptera Density	3.06	2.23	0.37	4.10	1.23	3.396	3.84	2.36	1.92	2.32	2.89	4.46	1.81	5.90
No.Coleoptera Taxa	2	2	4	4	4	4	4	4	4	5	3	4	5	5
% Coleoptera Density	7.45	1.20	6.1	1.74	3.69	9.623	10.12	12.34	32.32	37.66	11.54	12.12	7.04	22.32
No. Misc. Diptera Taxa	4	2	1	10	11	3	4	2	3	3	4	4	4	5
% Misc. Diptera Density	1.14	1.71	0.74	6.15	12.12	1.89	7.15	5.81	3.20	2.66	25.64	11.59	1.08	1.12
No. Chironomidae Taxa	6	10	7	7	9	5	10	9	3	6	9	11	11	14
% Chironomidae Density	11.85	20.57	36.22	4.73	11.42	6.038	5.74	7.25	1.76	1.35	4.42	10.86	9.37	18.26
No. Predator Taxa	7	1	5	5	3	6	6	5	2	1	2	3	3	9
% Predator Density	1.90	0.51	3.34	6.15	2.284	6.038	8.54	6.53	0.32	0.17	0.34	0.54	1.08	5.37
No. Parasite Taxa	2	1	2	1	1	1	0	1	2	2	2	2	2	2
% Parasite Density	1.72	1.03	2.4	1.89	1.406	0.3774	0.00	0.36	1.28	1.00	1.02	2.32	2.35	2.77
No. Collector Gatherer Taxa	15	13	13	14	17	12	20	18	11	17	16	17	15	21
% Collector Gatherer Density	66.16	45.78	80.2	56.31	71.71	48.3	47.26	41.00	16.48	24.25	31.25	27.09	17.68	42.06
No. Collector Filterer Taxa	4	3	6	3	5	5	3	4	5	5	5	5	5	7
% Collector Filterer Density	14.14	29.85	11.84	27.13	19.86	11.7	32.29	35.57	51.04	41.95	55.18	49.55	66.42	35.42

Note: NC = Metric not calculated.

APPENDIX TABLE D-11. (continued) BENTHIC MACROINVERTEBRATE METRICS FOR LITTLE GOOSE CREEK STATIONS LG2A and LG10

METRIC	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.
	LG2A	LG2A	LG2A	LG2A	LG2A	LG2A	LG10	LG10-Dup	LG10	LG10-Dup	LG10	LG10	LG10	LG10
	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	WDEQ	WDEQ	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD
	09/20/05	09/14/09	09/20/12	10/06/15	10/03/18	9/30/21	10/27/98	10/27/98	09/10/01	09/10/01	09/26/02	09/20/05	09/23/09	09/20/12
No. Macrophyte Herbivore Taxa	0	0	1	1	1	1	0	0	0	0	0	0	1	1
% Macrophyte Herbivore Density	0.00	0.00	0.37	1.10	1.23	0.566	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.37
No. Piercer Herbivore Taxa	1	0	0	1	1	1	0	0	1	1	1	0	0	0
% Piercer Herbivore Density	0.19	0.00	0	0.16	0.18	1.698	0.00	0.00	0.16	0.17	0.34	0.00	0.00	0.00
No. Scraper Taxa	4	4	3	4	3	3	7	5	4	4	4	6	4	3
% Scraper Density	10.70	12.35	1.11	6.31	2.28	29.06	10.12	13.79	28.16	30.85	9.51	17.47	5.78	13.65
No. Shredder Taxa	0	0	1	1	1	1	0	0	1	0	0	1	1	2
% Shredder Density	0.00	0.00	0.74	0.79	0.53	0.7547	0.00	0.00	0.16	0.00	0.00	0.18	0.18	0.37
No. Xylophage Taxa	0	0	NC	NC	NC	NC	0	0	0	0	0	0	0	NC
% Xylophage Density	0.00	0.00	NC	NC	NC	NC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NC
No. Omnivore Taxa	6	4	0	1	1	1	3	5	1	3	3	3	6	0
% Omnivore Density	5.15	9.95	0.00	0.16	0.53	1.509	1.39	2.53	0.96	1.00	1.70	2.67	6.31	0.00
No. Unknown Taxa	0	1	0	0	0.00	0	1	1	2	2	1	1	0	0
% Unknown Density	0.00	0.51	0.00	0.00	0.00	0	0.35	0.18	1.44	0.67	0.68	0.18	0.00	0.00
Percent 1 Dominant	39.01	27.27	39.17	48.58	54.83	30.57	30.72	33.03	32.48	25.70	24.28	32.44	59.93	22.50
Percent 5 Dominant	67.11	74.11	78.53	84.06	79.78	72.64	66.49	64.61	76.32	72.80	70.97	66.84	77.43	59.39
Percent 10 Dominant	83.74	88.86	90.55	91.63	88.21	88.49	82.20	82.21	90.40	87.73	86.25	83.42	89.18	79.87
Ratio EPT/Chironomidae	5.85	3.55	1.44	18.1	7.06	12.53	11.61	8.97	33.09	38.75	9.92	5.08	8.29	2.47
Ratio Hydropsych./Tot. Trichop.	0.51	0.71	0.69	0.96	0.84	0.23	0.93	0.84	0.70	0.69	0.16	0.93	0.91	0.77
Ratio Baetidae/Tot. Ephem.	0.28	0.86	0.06	0.04	12.48	0.05	0.46	0.56	0.87	0.74	0.88	1.00	0.61	0.28
Ratio Scraper/Collector Filterers	0.76	0.41	0.09	0.23	72.57	0.35	0.31	0.39	0.55	0.74	0.17	0.35	0.09	0.39
Ratio Scraper/Scrap.+Coll. Filter.	0.43	0.29	0.09	0.19	0.10	0.71	0.24	0.28	0.36	0.42	0.15	0.26	0.09	0.28
Ratio Shredders/Tot. Density	0.00	0.00	0.01	0.01	0.01	0.008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
BCI	66	65	62	66	66	64	61	59	70	64	66	63	71	68
BCI Predicted	60	60	60	60	60	60	50	50	60	60	60	60	60	60
BCI CTQA	90.73	92.15	96.03	90.23	90.94	93.23	81.35	84.36	85.31	93.29	90.35	94.95	84.27	88.02
BCI CTQD	90.17	91.45	96.48	89.56	93.06	91.54	81.43	83.70	86.40	91.67	89.56	94.73	85.69	91.51
Diversity LOGe	2.43	2.29	2.08	1.84	1.92	2.3	2.59	2.56	2.27	2.45	2.46	2.56	1.86	2.82
Diversity LOG2	3.51	3.31	3.01	2.65	2.77	3.32	3.73	3.69	3.27	3.53	3.56	3.70	2.69	4.07
Evenness	0.66	0.70	NC	0.53	0.55	0.67	0.70	0.70	0.67	0.69	0.70	0.70	0.52	NC
Simpson D	0.18	0.17	NC	NC	NC	NC	0.14	0.15	0.17	0.13	0.14	0.14	0.37	NC
% Multivoltine	25.96	44.90	86.48	63.73	79.25	71.89	25.52	26.18	17.04	15.96	22.07	32.80	29.83	41.69
% Univoltine	66.40	53.90	8.13	33.75	17.04	17.74	64.27	61.21	50.56	46.39	65.36	55.08	62.95	36.71
% Semivoltine	7.65	1.20	5.39	2.523	3.71	10.38	10.21	12.61	32.41	37.64	12.56	12.12	7.22	21.61

Note: NC = Metric not calculated.

APPENDIX TABLE D-11. BENTHIC MACROINVERTEBRATE METRICS FOR LITTLE GOOSE CREEK STATIONS LG10 AND LG22

METRIC	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.
	LG10	LG10	LG10	LG22	LG22	LG22	LG22	LG22	LG22	LG22	LG22	LG22
	SCCD	SCCD	SCCD	WDEQ	WDEQ	SCCD	SCCD	SCCD	WDEQ	WDEQ	SCCD	SCCD
	10/07/15	10/03/18	9/30/21	10/01/96	10/27/98	09/20/01	09/26/02	09/24/12	10/08/14	10/08/14	10/04/18	9/30/21
% Oligochaete Density	0.19	0.01	1.21	0.00	0.00	0.00	0.17	3.14	0.00	0.00	0.00	0.00
% Turbellaria Density	0.00	0.99	3.11	0.39	0.69	0.00	0.00	0.00	0.18	0.00	0.00	0.19
% C.Nostococladius Density	0.00	0.00	0.00	0.19	0.00	0.00	0.17	2.91	0.00	0.17	3.23	0.37
Density (No./ m^2)	14472	12248	3335.09	5196	13444	2964	3312	3473	4495	6187	3214	1979.13
EPT Density (No./ m^2)	11379	9825	2515.74	4631	12314	2357	2585	1648	3478	4882	2412	1450.38
Total Taxa	27	35	37	28	40	43	47	41	42	35	45	45
No. EPT Taxa	11	13	10	16	24	26	27	15	27	25	23	19
HBI	4.59	4.86	5.51	1.58	1.77	3.79	3.75	3.49	3.11	1.71	3.28	2.29
Brillouin Diversity	NC	NC	ND	2.31	1.96	2.66	2.67	NC	NC	NC	NC	ND
No. Non-Insect Taxa	3	4	7	3	2	1	4	5	5	1	3	4
% Non-Insect Density	3.72	4.13	7.266	1.36	0.86	1.16	2.26	5.85	3.052	0.3261	0.90	1.299
No. Odonata Taxa	0	0	0	0	0	0	0	0	0	0	0	0
% Odonata Density	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
No. Ephemeroptera Taxa	4	3	3	6	7	8	9	7	8	7	8	8
% Ephemeroptera Density	5.39	12.85	27.34	28.16	18.35	24.11	21.42	17.62	28.19	32.39	31.42	18.92
% Ephem. Dens. w/o Baetidae	2.60	9.39	25.6	17.09	12.00	14.19	12.20	15.68	9.7	31.17	10.41	14.87
No. Plecoptera Taxa	1	2	1	2	7	6	3	2	4	5	4	1
% Plecoptera Density	0.19	2.80	0.173	2.14	8.05	6.62	3.48	9.30	5.745	5.109	3.23	2.041
No. Hemiptera Taxa	0	0	0	0	0	0	0	0	0	0	0	0
% Hemiptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. Megaloptera Taxa	0	0	0	0	0	0	0	0	0	0	0	0
% Megaloptera Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. Trichoptera Taxa	6	8	6	8	10	12	15	5	15	13	11	10
% Trichoptera Density	73.05	64.57	47.92	58.85	65.18	48.87	53.12	20.72	43.45	41.41	40.39	52.32
% Trichop. w/o Hydropsychidae	4.07	25.77	16.95	55.35	61.06	43.39	48.09	19.00	35.55	35.64	65.33	50.57
No. Lepidoptera Taxa	1	1	1	0	0	0	0	0	0	0	0	0
% Lepidoptera Density	1.86	1.65	1.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
No.Coleoptera Taxa	4	4	5	2	4	3	2	2	3	3	4	3
% Coleoptera Density	12.45	8.73	10.73	5.05	2.74	11.73	8.89	6.97	7.72	13.15	6.82	3.711
No. Misc. Diptera Taxa	8	13	4	3	4	7	4	7	3	2	15	9
% Misc. Diptera Density	3.35	5.27	1.55	2.34	1.37	3.81	2.62	5.62	2.51	3.67	17.24	9.31
No. Chironomidae Taxa	6	10	10	4	6	6	10	12	4	4	10	10
% Chironomidae Density	2.23	2.64	3.287	2.13	3.42	3.80	8.17	34.08	9.34	5.33	13.11	12.43
No. Predator Taxa	2	6	8	3	9	12	9	11	11	10	11	9
% Predator Density	0.93	5.765	4.844	2.13	5.47	9.60	5.73	14.18	7.72	13.37	6.463	5.38
No. Parasite Taxa	2	1	2	2	1	1	2	2	2	1	3	2
% Parasite Density	3.53	1.977	0.519	0.97	0.17	1.16	1.92	1.16	1.98	0.33	0.8977	0.9276
No. Collector Gatherer Taxa	13	15	18	9	13	13	15	18	12	10	17	16
% Collector Gatherer Density	16.36	22.91	42.56	22.35	19.89	24.29	21.07	46.71	40.22	22.93	52.06	68.27
No. Collector Filterer Taxa	5	8	5	2	3	3	3	3	4	2	4	6
% Collector Filterer Density	71.75	61.77	46.89	3.89	4.46	6.11	6.45	4.26	8.98	3.80	15.80	6.122

Note: NC = Metric not calculated.

APPENDIX TABLE D-11. BENTHIC MACROINVERTEBRATE METRICS FOR LITTLE GOOSE CREEK STATIONS LG2A, LG10 AND LG22

METRIC	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.	L.Goose Cr.
	LG10	LG10	LG10	LG22	MRC38	LG22	LG22	LG22	LG22	LG22	LG22	LG22
	SCCD	SCCD	SCCD	WDEQ	WDEQ	SCCD	SCCD	SCCD	WDEQ	WDEQ	SCCD	SCCD
	10/07/15	10/03/18	9/30/21	10/01/96	10/27/98	09/20/01	09/26/02	09/24/12	10/08/14	10/08/14	10/04/18	9/30/21
No. Macrophyte Herbivore Taxa	1	0	0	1	1	1	1	1	0	0	**1**	1
% Macrophyte Herbivore Density	0.19	0	0	0.58	0.86	1.98	0.87	9.68	0.00	0.00	**2.87**	4.082
No. Piercer Herbivore Taxa	0	0.00	0	1	0	1	1	0	0	0	**0**	0
% Piercer Herbivore Density	0.00	3	0	0.19	0.00	0.33	0.17	0.00	0.00	0.00	**0.00**	0
No. Scraper Taxa	3	4.94	3	6	6	7	9	3	9	8	**6**	8
% Scraper Density	6.88	3	3.979	56.13	7.89	24.11	26.48	6.78	22.62	53.91	12.75	10.02
No. Shredder Taxa	2	2.64	2	2	4	2	2	2	2	2	1	0
% Shredder Density	0.37		1.211	11.46	59.86	31.85	32.93	14.33	12.21	0.22	0.72	0
No. Xylophage Taxa	NC	NC	NC	0	0	0	0	NC	NC	NC	NC	NC
% Xylophage Density	NC	NC	NC	0.00	0.00	0.00	0.00	NC	NC	NC	NC	NC
No. Omnivore Taxa	0	0	0	1	2	1	4	0	2	1	1	1
% Omnivore Density	0.00	0.00	0	1.75	1.20	0.17	4.17	0.00	6.28	5.33	5.03	3.711
No. Unknown Taxa	0	0.00	0	1	1	2	1	1	0	1	2.00	2
% Unknown Density	0.00	0.00	0	0.58	0.17	0.50	0.17	2.90	0.00	0.11	3.41	1.484
Percent 1 Dominant	68.96	43.16	25.09	35.15	55.06	31.68	32.58	13.94	18.49	26.63	21.01	40.07
Percent 5 Dominant	84.57	73.8	77.68	72.83	78.22	61.23	60.98	58.87	52.60	65.22	60.32	66.23
Percent 10 Dominant	93.87	85.16	88.41	89.35	89.71	80.05	79.62	74.94	76.84	82.61	78.1	82.37
Ratio EPT/Chironomidae	35.25	30.44	22.95	41.72	26.70	20.96	9.53	1.39	8.28	14.79	5.73	5.90
Ratio Hydropsych./Tot. Trichop.	0.78	0.74	0.65	0.06	0.06	0.11	0.10	0.08	0.18	0.09	0.35	0.04
Ratio Baetidae/Tot. Ephem.	0.52	11.86	0.06	0.39	0.35	0.41	0.43	0.11	0.66	0.33	0.67	0.22
Ratio Scraper/Collector Filterers	0.10	63.91	0.03	14.45	1.77	3.95	4.11	1.59	2.52	14.14	0.81	0.04
Ratio Scraper/Scrap.+Coll. Filter.	0.09	0.07	0.08	0.94	0.64	0.80	0.80	0.61	0.76	0.93	0.45	0.62
Ratio Shredders/Tot. Density	0.00	0.03	0.012	0.11	0.60	0.32	0.33	0.14	0.12	0.01	0.01	0.000
BCI	68	68	65	86	89	96	85	68	96	1	80	76
BCI Predicted	60	60	60	50	50	50	50	50	50	50	50	50
BCI CTQA	88.46	88.79	91.78	58.36	56.40	52.09	58.64	73.10	51.86	46.66	62.73	65.58
BCI CTQD	89.56	86.15	90.35	54.74	54.42	53.38	58.61	73.42	51.44	49.18	61.72	63.73
Diversity LOGe	1.45	2.26	2.36	2.32	1.97	2.70	2.70	2.94	2.92	2.55	2.82	2.48
Diversity LOG2	2.09	3.26	3.4	3.35	2.84	3.90	3.89	4.24	4.21	3.68	4.07	3.58
Evenness	0.44	0.64	0.65	0.70	0.53	0.72	0.70	NC	0.78	0.72	0.74	0.65
Simpson D	NC	NC	NC	0.17	0.32	0.13	0.14	NC	NC	NC	NC	NC
% Multivoltine	15.24	39.37	58.13	12.14	9.22	12.79	16.25	37.18	33.57	12.28	38.06	18.37
% Univoltine	72.3	51.9	31.83	80.78	85.98	73.68	72.78	44.97	46.68	66.20	48.65	74.21
% Semivoltine	12.45	8.73	10.03	7.09	4.80	13.53	10.97	17.85	19.75	21.52	13.29	7.421

Note: NC = Metric not calculated.

APPENDIX E

2021 GOOSE CREEK WATERSHED HABITAT ASSESSMENT DATA

TABLE E- 1. STREAM HABITAT, SUBSTRATE, EMBEDDEDNESS, AND VELOCITY DATA COLLECTED DURING BURP ASSESSMENTS AT STATIONS GOOSE CREEK STATIONS GC1 AND GC2

Stream Name	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Goose Creek
Station	GC1	GC1	GC1	GC1	GC1	GC1	GC1	GC1	GC1	GC2	GC2	GC2
Date Collected	10/21/1998	9/12/2001	9/19/2002	9/19/2005	9/15/2009	9/19/2012	10/15/2015	10/1/2018	9/27/2021	10/30/1998	9/12/2001	9/17/2002
Assessed By	WDEQ	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	WDEQ	SCCD	SCCD
HABITAT PARAMETER												
Percent Fines	18	9	10	16	17	16	19	10	9	10	9	16
Embeddedness	6	8	7	4	4	2	15	20	4	10	9	2
Instream Cover	18	5	7	6	13	11	17	14	8	12	6	12
Velocity / Depth	6	11	16	16	16	16	16	16	16	17	8	16
Channel Flow Status	19	18	19	18	17	18	17	19	17	14	19	17
Channel Shape	10	10	9	9	10	11	12	13	13	8	11	9
Pool / Riffle Ratio	10	11	12	7	11	12	9	13	12	10	4	14
Channel Alteration	11	10	10	9	4	9	10	11	11	14	6	7
Width / Depth Ratio	3	4	2	3	5	4	6	3	2	6	5	3
Bank Vegetation	8	10	8	9.5	8.5	8.5	9.5	9.5	8	7	9	9
Bank Stability	8	9	9	9	8.5	8.5	9.5	9.5	8	7	7.5	9
Disruptive Pressures	9	9	8	8	8	9.5	9.5	10	10	8	9	9
Riparian Zone Width	2	7.5	7	7.5	4	5.5	9	7.5	5	4	7	7.5
Total Score	128	121.5	124	122	126	131	158	155.5	123	127	109.5	130.5
SUBSTRATE												
% Cobble	4	43	38	59	46	77	37	34	61	33	19	59
% Coarse Gravel	75	15	27	23	26	12	49	28	8	28	20	28
% Fine Gravel	18	13	10	9	16	3	12	15	2	19	30	4
% Silt	0	2	10	1	0	0	0	10	0	0	7	4
% Sand	4	27	16	9	12	9	2	13	28	20	24	6
% Clay	0	0	0	0	0	0	0	0	0	0	0	0
% Organic	0	0	0	0	0	0	0	0	0	0	0	0
% Precipitate	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Embeddedness	56.0	50.5	41.0	35.5	57.0	25.5	79.1	99.8	36.0	58.0	55.0	26.0
STREAM VELOCITY												
Mean (ft/sec)	2.16	1.26	1.81	1.79	1.59	1.48	1.27	2.02	1.63	2.47	1.57	0.87

TABLE E- 2. STREAM HABITAT, SUBSTRATE, EMBEDDEDNESS, AND VELOCITY DATA COLLECTED DURING BURP ASSESSMENTS AT GOOSE CREEK STATION GC2 AND BIG GOOSE CREEK STATION BG2

Stream Name	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek
Station	GC2	GC2	GC2	GC2	GC2	GC2	BG2	BG2	BG2	BG2	BG2	BG2
Date Collected	9/19/2005	9/15/2009	9/19/2012	10/15/2015	10/2/2018	9/27/2021	10/25/1994	10/21/1998	9/10/2001	9/23/2002	10/27/2004	9/19/2005
Assessed By	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	WDEQ	WDEQ	SCCD	SCCD	WDEQ	SCCD
HABITAT PARAMETER												
Percent Fines	16	18	16	19	12	19	7	20	11	14	NC*	10
Embeddedness	12	2	8	6	8	1	5	6	9	3	NC*	3
Instream Cover	10	11	10	15	15	16	7	17	3	10	NC*	10
Velocity / Depth	16	16	5	16	16	16	12	14	9	16	NC*	15
Channel Flow Status	16	18	16	16	18	13	19	19	14	13	NC*	18
Channel Shape	8	11	8	12	14	9	8	6	5	8	NC*	7
Pool / Riffle Ratio	7	11	2	11	9	5	3	13	4	12	NC*	5
Channel Alteration	8	5	2	6	11	7	2	4	10	8	NC*	10
Width / Depth Ratio	4	4	1	6	4	6	2	5	2	4	NC*	3
Bank Vegetation	8.5	8.5	9	9	8.5	6	9	9	7	7.5	NC*	8
Bank Stability	9	8.5	8.5	9	8.5	6	7	9	9.5	8	NC*	9
Disruptive Pressures	9	9	9	8.5	9	8	9	9	7.5	8.5	NC*	7.5
Riparian Zone Width	8.5	5.5	5	2.5	7.5	4	7	1	5.5	7.5	NC*	4.5
Total Score	132	127.5	99.5	136	140.5	116	97	132	96.5	119.5	NC*	110
SUBSTRATE												
% Cobble	47	88	62	78	61	86	34	39	66	63	45	68
% Coarse Gravel	32	6	18	14	14	6	14	52	9	13	21	6
% Fine Gravel	11	3	11	7	8	6	14	9	7	12	21	5
% Silt	6	0	0	2	0	0	9	0	4	3	0	1
% Sand	4	4	9	0	16	2	31	0	14	9	26	22
% Clay	0	0	0	0	0	0	0	0	0	0	0	0
% Organic	0	0	0	0	0	0	0	0	0	0	0	0
% Precipitate	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Embeddedness	67.9	24.0	49.9	41.8	50.0	22.6	39.6	41.0	55.3	30.4	46.4	29.5
STREAM VELOCITY												
Mean (ft/sec)	1.48	1.20	2.07	0.88	1.05	1.64	2.1	2.1	1.21	1.09	NC*	1.69

NC* = Data not collected.

TABLE E- 3. STREAM HABITAT, SUBSTRATE, EMBEDDEDNESS, AND VELOCITY DATA COLLECTED DURING BURP ASSESSMENTS AT BIG GOOSE CREEK STATIONS BG2 AND BG10

Stream Name	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek
Station	BG2	BG2	BG2	BG2-Dup. 1	BG2-Dup. 2	BG2-Dup. 1	BG2-Dup. 2	BG10	BG10	BG10	BG10
Date Collected	9/14/2009	9/25/2012	10/6/2015	10/3/2018	10/3/2018	9/28/2021	9/28/2021	9/14/2001	9/24/2002	9/20/2005	9/23/2009
Assessed By	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD
HABITAT PARAMETER											
Percent Fines	19	16	10	11	12	20	20	13	18	18	17
Embeddedness	5	1	2	2	5	7	4	17	9	12	18
Instream Cover	11	11	5	14	10	7	7	10	14	16	17
Velocity / Depth	7	14	11	16	15	14	14	18	17	18	15
Channel Flow Status	17	18	15	19	18	8	10	18	15	16	13
Channel Shape	9	8	8	11	11	11	12	9	8	11	11
Pool / Riffle Ratio	4	11	3	11	13	10	7	12	12	13	13
Channel Alteration	10	11	11	11	11	11	10	12	11	8	9
Width / Depth Ratio	4	7	1	3	2	4	4	5	9	2	9
Bank Vegetation	8.5	8.5	8.5	9	8	9	9	9.5	7	6	7.5
Bank Stability	8.5	9	8	8.5	9	9	9	8	7.5	4	7.5
Disruptive Pressures	9	10	9	9	9	9	9	9.5	9	8	8
Riparian Zone Width	3	3.5	2.5	8.5	4	6	5	9.5	7	8.5	8.5
Total Score	115	128	94	133	127	125	120	150.5	143.5	140.5	153.5
SUBSTRATE											
% Cobble	91	52	66	54	57	89	85	75	91	80	81
% Coarse Gravel	2	10	13	24	16	0	0	8	2	10	10
% Fine Gravel	5	4	0	5	10	11	15	3	3	5	0
% Silt	0	13	0	0	0	0	0	4	1	0	0
% Sand	3	21	21	17	18	0	0	10	4	5	9
% Clay	0	0	0	0	0	0	0	0	0	0	0
% Organic	0	0	0	0	0	0	0	0	0	0	0
% Precipitate	0	0	0	0	0	0	0	0	0	0	0
Weighted Embeddedness	37.2	23.0	27.12	25.2	37.5	45.1	34.6	86.9	55.9	67.1	85.3
STREAM VELOCITY											
Mean (ft/sec)	1.35	1.32	1.25	1.93	2.1	0.92	0.89	1.67	1.28	1.16	1.32

TABLE E-4. STREAM HABITAT, SUBSTRATE, EMBEDDEDNESS, AND VELOCITY DATA COLLECTED DURING BURP ASSESSMENTS AT BIG GOOSE CREEK STATIONS BG10, BG18 AND LITTLE GOOSE CREEK STATION LG2A

Stream Name	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Big Goose Creek	Little Goose	Little Goose	Little Goose	Little Goose	Little Goose
Station	BG10	BG10	BG10	BG10	BG18	BG18	BG18	BG18	BG18	BG18	LG2A	LG2A	LG2A	LG2A	LG2A
Date Collected	9/26/2012	10/7/2015	10/5/2018	9/28/2021	10/22/98	9/17/2001	9/20/2002	9/26/2012	10/5/2018	9/29/2021	9/18/1994	9/18/1997	9/18/1998	9/18/2001	9/24/2002
Assessed By	SCCD	SCCD	SCCD	SCCD	WDEQ	SCCD	SCCD	SCCD	SCCD	SCCD	WDEQ	WEST	WDEQ	SCCD	SCCD
HABITAT PARAMETER															
Percent Fines	12	12	16	11	15	10	10	16	9	10	12	12	6	9	13
Embeddedness	6	2	1	13	20	20	15	17	19	16	15	11	13	5	2
Instream Cover	17	6	13	12	19	20	17	19	17	19	6	10	16	4	12
Velocity / Depth	15	12	16	15	18	18	18	18	17	18	5	6	6	16	6
Channel Flow Status	17	11	17	15	18	20	11	20	18	18	19	18	19	19	18
Channel Shape	7	8	11	12	6	6	6	7	11	10	7	8	5	10	8
Pool / Riffle Ratio	14	9	13	13	14	15	14	10	14	14	3	4	7	12	12
Channel Alteration	13	12	12	10	15	14	14	14	15	14	2	3	3	2	4
Width / Depth Ratio	8	7	3	3	6	4	3	7	6	6	2	2	5	2	3
Bank Vegetation	5	7	7	8	9	10	10	10	8	10	8	8	9	8.5	8.5
Bank Stability	5	6.5	6.5	8	10	10	10	10	9	10	9	9	9	9	9
Disruptive Pressures	8.5	5	8.5	9	10	10	9	9	10	10	9	8	9	9	8
Riparian Zone Width	5	5	4.5	4	1	10	9	8.5	3	5	3	2	1	2.5	5.5
Total Score	132.5	102.5	128.5	133	161	167	146	165.5	156	160	100	101	108	108	109
SUBSTRATE															
% Cobble	79	73	59	78	72	49	61	60	59	62	32	69	22	31	50
% Coarse Gravel	7	8	24	3	8	16	7	5	10	2	40	7	16	32	27
% Fine Gravel	9	2	9	0	9	11	8	3	4	15	10	6	18	10	9
% Silt	0	0	0	0	1	12	16	0	0	0	0	13	25	2	2
% Sand	5	16	8	19	9	12	9	33	27	21	16	3	19	24	13
% Clay	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Organic	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
% Precipitate	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Weighted Embeddedness	42.7	25.6	23.5	70.2	99.0	96.5	78.3	88.3	94.8	82.4	78.2	61.2	71.0	37.2	28.0
STREAM VELOCITY															
Mean (ft/sec)	0.97	0.60	1.02	0.72	0.94	0.81	0.70	0.75	0.69	0.96	2.80	1.90	1.62	1.14	1.83

TABLE E-5. STREAM HABITAT, SUBSTRATE, EMBEDDEDNESS, AND VELOCITY DATA COLLECTED DURING BURP ASSESSMENTS AT LITTLE GOOSE CREEK STATIONS LG2A and LG10

Stream Name	Little Goose	Little Goose	Little Goose	Little Goose	Little Goose	Little Goose	Little Goose	Little Goose Creek	Little Goose	Little Goose	Little Goose	Little Goose
Station	LG2A	LG2A	LG2A	LG2A	LG2A	LG2A	LG2A	LG10	LG10	LG10	LG10	LG10
Date Collected	9/20/2004	9/20/2005	9/14/2009	9/20/2012	10/6/2015	10/3/2018	9/29/2021	10/27/1998	9/10/2001	9/26/2002	9/20/2005	9/23/2009
Assessed By	WDEQ	SCCD	SCCD	SCCD	SCCD	SCCD	SCCD	WDEQ	SCCD	SCCD	SCCD	SCCD
HABITAT PARAMETER												
Percent Fines	NC*	10	16	8	11	9	9	15	12	16	9	17
Embeddedness	NC*	5	5	1	14	3	4	13	16	15	16	7
Instream Cover	NC*	5	7	4	11	14	16	13	8	16	17	13
Velocity / Depth	NC*	12	5	9	18	17	17	18	11	14	14	16
Channel Flow Status	NC*	17	16	16	16	18	17	16	15	16	11	14
Channel Shape	NC*	7	10	8	12	12	7	11	9	10	10	9
Pool / Riffle Ratio	NC*	12	3	2	13	13	13	12	7	12	13	5
Channel Alteration	NC*	4	3	2	4	7	8	10	7	12	12	9
Width / Depth Ratio	NC*	3	3	3	5	3	6	6	5	6	3	8
Bank Vegetation	NC*	8	8.5	7.5	9	9	8	8	9	10	8.5	7.5
Bank Stability	NC*	9	8	9.5	10	8	9	8	9.5	6.5	8	7.5
Disruptive Pressures	NC*	8.5	8	4.5	9	9	9	10	8.5	10	10	9
Riparian Zone Width	NC*	2	1.5	2.5	2.5	3	2	8	9.5	9	9.5	8
Total Score	NC*	102.5	94	77	134.5	125	125	147.5	126.5	152.5	141	130
SUBSTRATE												
% Cobble	31	59	46	41	66	34	55	43	66	65	48	75
% Coarse Gravel	24	13	24	14	15	25	11	32	11	20	17	1
% Fine Gravel	12	8	4	12	0	12	9	14	7	7	8	1
% Silt	10	0	6	0	0	0	0	0	1	1	0	2
% Sand	23	20	14	33	19	29	26	10	15	7	28	21
% Clay	0	0	13	0	0	0	0	0	0	0	0	0
% Organic	0	0	0	0	0	0	0	0	0	0	0	0
% Precipitate	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Embeddedness	48.2	39.9	28.7	24.7	75.3	30.5	35.2	69.0	82.9	81.3	81.3	55.5
STREAM VELOCITY												
Mean (ft/sec)	NC*	1.33	2.13	1.00	1.98	2.16	1.10	2.85	1.77	0.86	1.24	1.09

NC* = Data not collected.

TABLE E-6. STREAM HABITAT, SUBSTRATE, EMBEDDEDNESS, AND VELOCITY DATA COLLECTED DURING BURP ASSESSMENTS AT LITTLE GOOSE CREEK STATIONS LG10 and LG22

Stream Name	Little Goose Creek	Little Goose Creek	Little Goose Creek	Little Goose Creek	Little Goose Creek	Little Goose Creek	Little Goose Creek	Little Goose Creek	Little Goose Creek	Little Goose Creek	Little Goose Creek	Little Goose Creek
Station	LG10	LG10	LG10	LG10	LG22	LG22	LG22	LG22	LG22	LG22	LG22	LG22
Date Collected	9/20/2012	10/7/2015	10/3/2018	9/30/2021	10/1/1996	10/27/1998	9/20/2001	9/26/2002	9/24/2012	10/8/2014	10/4/2018	9/30/2021
Assessed By	SCCD	SCCD	SCCD	SCCD	WDEQ	WDEQ	SCCD	SCCD	SCCD	WDEQ	SCCD	SCCD
HABITAT PARAMETER												
Percent Fines	16	6	8	15	13	14	18	17	10	NC*	10	8
Embeddedness	5	14	4	11	19	19	20	20	13	NC*	16	19
Instream Cover	18	18	18	19	20	20	12	18	19	NC*	18	20
Velocity / Depth	17	19	17	16	19	19	14	18	15	NC*	17	19
Channel Flow Status	15	18	18	18	18	19	15	14	20	NC*	16	18
Channel Shape	12	8	7	13	10	10	8	6	7	NC*	11	14
Pool / Riffle Ratio	11	13	13	13	13	14	12	14	9	NC*	13	14
Channel Alteration	11	8	13	12	13	13	13	14	14	NC*	15	14
Width / Depth Ratio	2	7	6	6	8	8	4	5	9	NC*	8	10
Bank Vegetation	9.5	9	8.5	8	9	9	9	9.5	10	NC*	9	9
Bank Stability	9	8.5	7.5	8	6	7	10	10	10	NC*	9	9
Disruptive Pressures	8.5	9	9	9	10	10	7	9.5	9.5	NC*	10	9
Riparian Zone Width	2.5	6.5	3	6	10	10	9	9.5	4.5	NC*	5	7
Total Score	136.5	144	132	154	168	172	151	164.5	150	NC*	157	170
SUBSTRATE												
% Cobble	86	35	51	75	69	72	68	50	69	NC*	62	25
% Coarse Gravel	2	8	11	4	11	9	9	16	9	NC*	8	15
% Fine Gravel	3	11	6	11	7	6	17	27	1	NC*	4	28
% Silt	0	0	0	0	0	0	1	0	0	NC*	0	0
% Sand	9	46	33	11	14	13	5	7	21	NC*	25	32
% Clay	0	0	0	0	0	0	0	0	0	NC*	0	0
% Organic	0	0	0	0	0	0	0	0	0	NC*	0	0
% Precipitate	0	0	0	0	0	0	0	0	0	NC*	0	0
Weighted Embeddedness	38.9	76.4	36.2	64.4	99.8	100.0	98.7	98.8	69.3	NC*	81.9	95.8
STREAM VELOCITY												
Mean (ft/sec)	0.76	2.09	1.93	1.23	0.90	1.11	0.82	1.29	0.96	NC*	1.01	1.09

NC* = Data not collected.

APPENDIX F

2021 GOOSE CREEK WATERSHED PHOTOS

Goose Creek Site GC01 Photopoints

Early Season
Upstream

Site GC01 Facing Upstream
5/26/2021

Late Season
Upstream

Site GC01 Facing Upstream
9/1/2021

Early Season
Downstream

Site GC01 Facing Downstream
5/26/2021

Late Season
Downstream

Site GC01 Facing Downstream
9/1/2021

Goose Creek Site GC02 Photopoints

Early Season
Upstream

Site GC02 Facing Upstream
5/26/2021

Late Season
Upstream

Site GC02 Facing Upstream
9/1/2021

Early Season
Downstream

Site GC02 Facing Downstream
5/26/2021

Late Season
Downstream

Site GC02 Facing Downstream
9/1/2021

Goose Creek Site GC-SC01 Photopoints

Early Season
Upstream

Site GC-SC01 Facing Upstream
5/26/2021

Late Season
Upstream

Site GC-SC01 Facing Upstream
9/1/2021

Early Season
Downstream

Site GC-SC01 Facing Downstream
5/26/2021

Late Season
Downstream

Site GC-SC01 Facing Downstream
9/1/2021

Goose Creek Site GC05 Photopoints

Early Season
Upstream

Site GC05 Facing Upstream
5/26/2021

Late Season
Upstream

Site GC05 Facing Upstream
9/1/2021

Early Season
Downstream

Site GC05 Facing Downstream
5/26/2021

Late Season
Downstream

Site GC05 Facing Downstream
9/1/2021

Big Goose Creek Site BG01 Photopoints

Early Season
Upstream

Site BG01 Facing Upstream
5/26/2021

Late Season
Upstream

Site BG01 Facing Upstream
9/1/2021

Early Season
Downstream

Site BG01 Facing Downstream
5/26/2021

Late Season
Downstream

Site BG01 Facing Downstream
9/1/2021

Beaver Creek Site BG-BC01 Photopoints

Early Season
Upstream

Site BG-BC01 Facing Upstream
5/26/2021

Late Season
Upstream

Site BG-BC01 Facing Upstream
9/1/2021

Early Season
Downstream

Site BG-BC01 Facing Downstream
5/26/2021

Late Season
Downstream

Site BG-BC01 Facing Downstream
9/1/2021

Big Goose Creek Site BG10 Photopoints

Early Season
Upstream

Site BG10 Facing Upstream
5/26/2021

Late Season
Upstream

Site BG10 Facing Upstream
9/1/2021

Early Season
Downstream

Site BG10 Facing Downstream
5/26/2021

Late Season
Downstream

Site BG10 Facing Downstream
9/1/2021

Big Goose Creek Site BG14 Photopoints

Early Season
Upstream

Site BG14 Facing Upstream
5/26/2021

Late Season
Upstream

Site BG14 Facing Upstream
9/1/2021

Early Season
Downstream

Site BG14 Facing Downstream
5/26/2021

Late Season
Downstream

Site BG14 Facing Downstream
9/1/2021

Rapid Creek Site BG-RC01 Photopoints

Early Season
Upstream

Site BG-RC01 Facing Upstream
5/26/2021

Late Season
Upstream

Site BG-RC01 Facing Upstream
9/1/2021

Early Season
Downstream

Site BG-RC01 Facing Downstream
5/26/2021

Late Season
Downstream

Site BG-RC01 Facing Downstream
9/1/2021

Big Goose Creek Site BG18 Photopoints

Early Season
Upstream

Site BG18 Facing Upstream
5/26/2021

Late Season
Upstream

Site BG18 Facing Upstream
9/1/2021

Early Season
Downstream

Site BG18 Facing Downstream
5/26/2021

Late Season
Downstream

Site BG18 Facing Downstream
9/1/2021

Little Goose Creek Site LG02 Photopoints

Early Season
Upstream

Site LG02 Facing Upstream
5/26/2021

Late Season
Upstream

Site LG02 Facing Upstream
9/15/2020

Early Season
Downstream

Site LG02 Facing Downstream
5/26/2021

Late Season
Downstream

Site LG02 Facing Downstream
9/1/2021

Little Goose Creek Site LG08 Photopoints

Early Season
Upstream

Site LG08 Facing Upstream
5/26/2021

Late Season
Upstream

Site LG08 Facing Upstream
9/1/2021

Early Season
Downstream

Site LG08 Facing Downstream
5/26/2021

Late Season
Downstream

Site LG08 Facing Downstream
9/1/2021

McCormick Creek Site LG-MCC01 Photopoints

Early Season
Upstream

Site LG-MCC01 Facing Upstream
5/26/2021

Late Season
Upstream

Site LG-MCC01 Facing Upstream
9/1/2021

Early Season
Downstream

Site LG-MCC01 Facing Downstream
5/26/2021

Late Season
Downstream

Site LG-MCC01 Facing Downstream
9/1/2021

Kruse Creek Site LG-KC01 Photopoints

Early Season
Upstream

Site LG-KC01 Facing Upstream
5/26/2021

Late Season
Upstream

Site LG-KC01 Facing Upstream
9/14/2021

Early Season
Downstream

Site LG-KC01 Facing Downstream
5/26/2021

Late Season
Downstream

Site LG-KC01 Facing Downstream
9/14/2021

Little Goose Creek Site LG-13 Photopoints

Early Season
Upstream

Site LG13 Facing Upstream
5/26/2021

Late Season
Upstream

Site LG13 Facing Upstream
9/1/2021

Early Season
Downstream

Site LG13 Facing Downstream
5/26/2021

Late Season
Downstream

Site LG13 Facing Downstream
9/1/2021

Jackson Creek Site LG-JC01 Photopoints

Early Season
Upstream

Site LG-JC01 Facing Upstream
5/26/2021

Late Season
Upstream

Site LG-JC01 Facing Upstream
9/1/2021

Early Season
Downstream

Site LG-JC01 Facing Downstream
5/26/2021

Late Season
Downstream

Site LG-JC01 Facing Downstream
9/1/2021

Little Goose Creek Site LG22 Photopoints

Early Season
Upstream

Site LG22 Facing Upstream
5/26/2021

Late Season
Upstream

Site LG22 Facing Upstream
9/1/2021

Early Season
Downstream

Site LG22 Facing Downstream
5/26/2021

Late Season
Downstream

Site LG22 Facing Downstream
9/1/2021

Goose Creek Site GC01 Reach Assessment Photos

Upstream

Site GC01 Bottom of Riffle Facing Upstream
9/27/2021 10:50

Downstream

Site GC01 Top of Riffle Facing Downstream
9/27/2021 10:50

Panorama of Riffle

Site GC01 Panorama from River Left
9/27/2021 10:50

Goose Creek Site GC02 Reach Assessment Photos

Upstream

Site GC02 Bottom of Riffle Facing Upstream
9/27/2021 14:15

Downstream

Site GC02 Top of Riffle Facing Downstream
9/27/2021 14:15

Panorama of Riffle

Site GC02 Panorama from River Left
9/27/2021 14:15

Big Goose Creek Site BG02 Reach Assessment Photos

Upstream

Site BG02 Bottom of Riffle Facing Upstream
9/28/2021 11:45

Downstream

Site BG02 Top of Riffle Facing Downstream
9/28/2021 11:45

Panorama of Riffle

Site BG02 Panorama from River Left
9/28/2021 11:45

Big Goose Creek Site BG10 Reach Assessment Photos

Upstream

Site BG10 Bottom of Riffle Looking Upstream
9/28/2021 14:10

Downstream

Site BG10 Bottom of Riffle Facing Downstream
9/28/2021 14:10

Panorama of Riffle

Site BG10 Panorama from River Left
9/28/2021 14:10

Big Goose Creek Site BG18 Reach Assessment Photos

Upstream

Site BG18 Base of Riffle Facing Upstream
9/29/2021 12:35

Downstream

Site BG18 Base of Riffle Facing Downstream
9/29/2021 12:35

Panorama of Riffle

Site BG18 Panorama from River Right
9/29/2021 12:35

Little Goose Creek Site LG02A Reach Assessment Photos

Upstream

Site LG02A Bottom of Riffle Facing Upstream
9/29/2021 10:40

Downstream

Site LG02A Top of Riffle Facing Downstream
9/29/2021 10:40

Panorama of Riffle

Site LG02A Panorama from River Left
9/29/2021 10:40

Little Goose Creek Site LG10 Reach Assessment Photos

Upstream

Site LG10 Bottom of Riffle Facing Upstream
9/30/2021 10:20

Downstream

Site LG10 Top of Riffle Facing Downstream
9/30/2021 10:20

Panorama of Riffle

Site LG10 Panorama from River Right
9/30/2021 10:20

Little Goose Creek Site LG22 Reach Assessment Photos

Upstream

Site LG22 Bottom of Riffle Facing Upstream
9/30/2021 12:00

Downstream

Site LG22 Top of Riffle Facing Downstream
9/30/2021 12:00

Panorama of Riffle

Site LG22 Panorama from River Right
9/30/2021 12:00