DRAFT Total Maximum Daily Load for *Escherichia coli (E. coli)* in the Spring Creek (Heber) Assessment Unit

**Prepared by the Utah Department of Environmental Quality
Division of Water Quality**

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Utah Division of Water Quality

Spring Creek (Heber) Total Maximum Daily Load (TMDL)

Waterbody ID/Assessment Unit	Spring Creek (Heber) / UT16020203-027
Location	Spring Creek and tributaries from confluence with Provo River to headwaters
Pollutants of Concern	*Escherichia coli (E. coli)*
Impaired Beneficial Uses	Drinking water (1C), Infrequent primary contact recreation (2B)
Current Loading **Loading Capacity (TMDL)** **Load Reduction**	77.92 GigaMPN/day 14.66 GigaMPN/day 81 %
Wasteload Allocation **Load Allocation** **Margin of Safety (10% of Loading Capacity)**	0.57 GigaMPN/day 1.36 Giga MPN/day (background) 0.64 GigaMPN/day (reserve capacity) 10.46 GigaMPN/day (load allocation) 1.63 GigaMPN/day
Defined Targets/Endpoints	1. For recreation seasons (May 1st through October 31st) with ≥5 collection events, no more than 10% of samples shall exceed 668 MPN/100 mL 2. For recreation seasons with ≥5 collection events, no 30-day interval geometric means shall exceed 206 MPN/100 mL. 3. For recreation seasons with ≥10 collection events, the geometric mean of all samples shall not exceed 206 MPN/100 mL.
Implementation Strategy	Stakeholders will employ a voluntary adaptive management approach to address all anthropogenic sources of *E. coli* loading, with a focus on improvements in agricultural, onsite septic system, and stormwater management. Permitted facilities will adhere to their Utah Pollutant Discharge Elimination System permits. TMDL endpoints will be re-evaluated within 10 years, or sooner if new dischargers begin operating in the assessment unit.

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Executive Summary

Section 303(d) of the Clean Water Act (CWA) requires states to develop Total Maximum Daily Loads (TMDLs) for waters that do not meet water quality standards. The TMDL process establishes allowable loadings of pollutants or other quantifiable parameters for a waterbody. This TMDL addresses the *Escherichia coli (E. coli)* impairment in the Spring Creek (Heber) Assessment Unit. The study is designed to assess and restore the drinking water and recreational beneficial use of Spring Creek as defined by Utah Administrative Code R317-2-6 and the CWA.

The Spring Creek Assessment Unit was listed as impaired in the Utah 2012/2014 Integrated Report and was a high priority for *E. coli* TMDL development by the Utah Division of Water Quality (DWQ) because the impairment included drinking water uses and possible impacts to areas of high recreational use in the Provo River downstream. *E. coli* is an indicator of recent fecal contamination, and ingestion of water containing fecal pathogens poses a public health risk.

Water quality concerns in Spring Creek were first identified in 2009 through routine monitoring. Monthly monitoring by the Provo River Watershed Council (PRWC) documented elevated levels of *E. coli* that often exceeded numeric criteria. DWQ conducted intensive monitoring of the Spring Creek system in 2019 to identify potential *E. coli* sources, and these results provided DWQ with additional insight into the temporal and spatial extent of the *E. coli* impairment.

E. coli has been collected at the impaired monitoring site, Spring Creek above confluence of the Provo River, monthly from 2011 to the present. Exceedances of numeric criteria for the drinking water and infrequent contact recreation uses occur during the recreational season (May through October). Observed *E. coli* loading exceeded the TMDL threshold in every flow regime.

This study found that *E. coli* loading must be reduced by 81% to meet water quality standards during the recreation season. This required reduction will be shared among several nonpoint sources in the assessment unit, including livestock, unregulated stormwater, onsite septic systems, pet waste, and irrigated pastures. The single point source in the assessment unit, Jordanelle Special Service District Water Reclamation Facility, operates under a Utah Pollution Discharge Elimination System (UPDES) permit. Because this facility did not start operating until a decade after the E. *coli* impairments were first determined, its wasteload allocation is set at its permit limits with no reduction required. This TMDL allocates a reserve capacity for future growth due to high development pressures in the Heber Valley area and the possible future need for a Municipal Separate Storm Sewer System (MS4) permit.

DWQ believes *E. coli* loading will be reduced and beneficial uses restored and protected with implementation of the best management practices identified in this TMDL study and a nine-element watershed plan.

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List of Acronyms

≥	Greater than or equal to
BMPs	Best Management Practices
CWA	Clean Water Act
DWQ	Utah Division of Water Quality
DWR	Utah Division of Wildlife Resources
E. coli	*Escherichia coli*
IR	Integrated Report
JSSDWRF	Jordanelle Special Service District Water Reclamation Facility
LA	Load Allocation
LDC	Load Duration Curve
LID	Low Impact Development
MGD	Million Gallons Per Day
mi^2	Square Miles
MLID	Monitoring Location Identifier
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
MST	Microbial Source Tracking
NHD	National Hydrography Dataset
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
O & E	Outreach & Education
PIP	Project Implementation Plan
PPCP	Pharmaceutical and Personal Care Products
PRWC	Provo River Watershed Council
RA	Reasonable Assurance
RC	Reserve Capacity
SAP	Sampling and Analysis Plan
SWPPP	Storm Water Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
UAC	Utah Administrative Code
UDAF	Utah Department of Agriculture and Food
UPDES	Utah Pollution Discharge Elimination System
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	United States Geology Survey
WCD	Wasatch Conservation District
WCHD	Wasatch County Health Department
WCWEP	Wasatch County Water Efficiency Project
WLA	Wasteload Allocation

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WMU	Wildlife Management Unit
WRCC	Western Regional Climate Center

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Chapter 1. Project Overview

1.1 Purpose

This report represents the Total Maximum Daily Load (TMDL) analysis for the impaired Spring Creek Assessment Unit in fulfillment of Clean Water Act (CWA) requirements.

A TMDL analysis determines the amount of an identified pollutant (i.e., the load) that a waterbody can receive and still support its beneficial uses and meet state water quality standards. Once the pollutant loads and sources are identified, controls are implemented to reduce those loads until the waterbody is brought back into compliance with water quality standards. Upon completion of the TMDL analysis, the TMDL is submitted to the Utah Water Quality Board and the United States Environmental Protection Agency (USEPA) for final approval.

The purpose of the CWA is to improve and protect the physical, chemical, and biological integrity of the nation's waters. The CWA requires USEPA, or delegated authorities such as states, tribes, and territories, to evaluate the quality of waters, establish beneficial uses, and define water quality criteria to protect those uses. Section 303(d) of the CWA requires each state to publish a list of waterbodies that fail to meet state water quality standards as part of its biannual Integrated Report process. This list is made available for public review and subject to USEPA approval. Waterbodies placed on the 303(d) list are known as impaired waters. The CWA requires a TMDL analysis for 303(d) waters for each pollutant responsible for the impairment of their designated use(s).

DWQ collects biological and water quality data as part of the Integrated Report process and assesses whether the waterbody is meeting water quality standards for its designated beneficial uses. Based on this assessment, Spring Creek and its tributaries from the confluence with the Provo River to the headwaters was included on the State of Utah's 303(d) list in 2012/2014 for not meeting its drinking water (1C) and infrequent primary contact recreational (2B) uses due to exceedances of water quality standards for *E. coli* bacteria. The impairment addressed by this TMDL is part of the DWQ prioritization plan to meet USEPA's Long-Term Vision for Assessment, Restoration, and Protection under the CWA Section 303(d) Program. This report defines the TMDL and water quality targets that, when attained, will bring the river into full support of its recreational and drinking water beneficial uses.

1.2 Identification of Waterbodies

The Spring Creek Assessment Unit (Figure 1) is located within the Provo River Watershed, which is a tributary to the Jordan River via Utah Lake. Located in Wasatch County, the Provo River watershed is a significant source of drinking water for the areas in Utah with the largest populations. The Spring Creek Assessment Unit covers 20 square miles (mi^2) and is bordered by the Wasatch Mountains to the west and Uinta Mountains to the northeast. Spring Creek originates from several wet-meadow springs located in the Heber Valley. Its flow is augmented by numerous stormwater and irrigation conveyance ditches and canals, as well as irrigation return flow. The natural Spring Creek channel flows back into the Provo River just upstream of Deer Creek Reservoir. This lower reach has been hydrologically modified to convey water for downstream users, ultimately entering into Deer Creek Reservoir via Daniels Creek. The Spring Creek Assessment Unit is mostly privately owned (99%), and irrigation practices comprise 61% of all the water-related land uses in the watershed.

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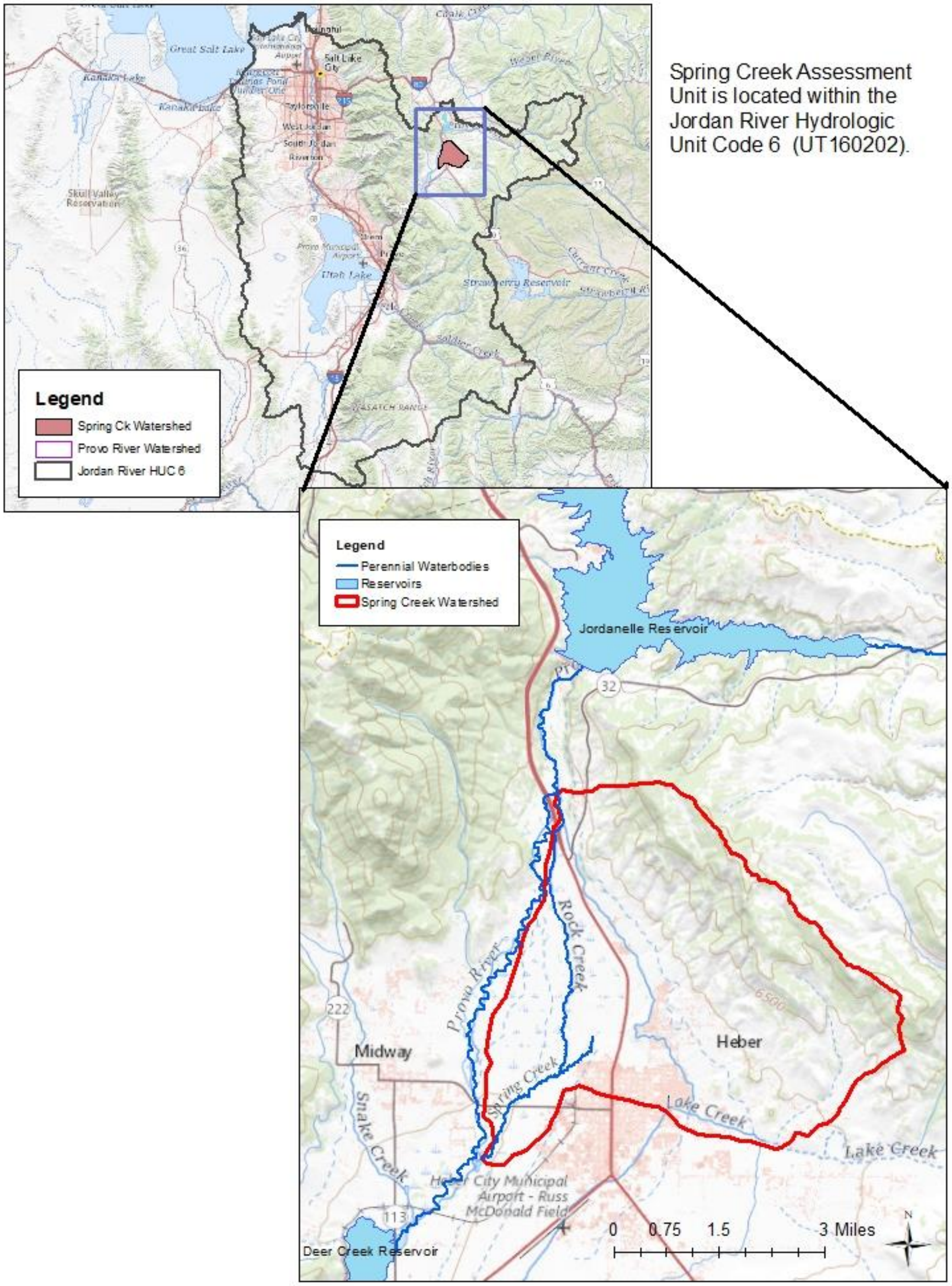

Figure 1. Location of Spring Creek Assessment Unit (UT16020203-027).

Chapter 2. TMDL Targets

The state is required to develop a TMDL to reduce pollutant levels in impaired waters after a 303(d) listing. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive on a daily basis and still meet water quality standards. It is the sum of individual wasteload allocations (WLAs) from point sources, load allocations (LAs) from nonpoint sources and natural background levels. It includes a margin of safety (MOS), either defined implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. This sum is calculated through the following equation:

$$\textbf{TMDL} = \sum \textbf{WLAs} + \sum \textbf{LAs} + \textbf{MOS}$$

The TMDL process consists of the following steps:

1. Review existing water quality data.
2. Identify sources and causes of pollutants.
3. Identify water quality goals.
4. Establish the amount of pollutant that can be allowed in total.
5. Allocate allowable pollutant loads to the various sources.
6. Identify and implement measures to achieve and maintain water quality standards.
7. Monitor to assure that the goals are met.

2.1 Overview of 303(d) List Status

Utah waters have designated uses that delineate existing uses of the water (UAC R317-2-6). All uses have numeric criteria associated with them that must be met to ensure beneficial use support. The designated beneficial uses for the Spring Creek Assessment Unit are provided in Table 1. Utah assesses surface waters of the state at the monitoring site level, then summarizes the site-level assessment up to a larger spatial scale known as an assessment unit (AU).

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Table 1. Designated uses for the impaired Spring Creek Assessment Unit Utah R317-2-13.

Assessment Unit	Description	Waterbody ID	Beneficial Uses
Spring Creek (Heber)	Spring Creek and tributaries from confluence with Provo River to headwaters	UT16020203-027	Drinking water (1C) Infrequent primary contact recreation (2B) Cold water aquatic life (3A) Agriculture (4)

The Spring Creek Assessment Unit does not support its drinking water (1C) and infrequent primary contact recreation (2B) beneficial uses due to exceedances in *E. coli* (Table 2). The assessment unit was included on Utah's 303(d) list of impaired waterbodies in the combined 2012/2014 Integrated Report.

This watershed also has elevated levels of Total Phosphorus (TP), with concentrations higher than the approved Deer Creek Reservoir TMDL target of 0.03 mg/L TP for streams (UDWQ, 2002). With continued implementation of nonpoint source project work within the watershed, it is likely that TP concentrations and loading into Deer Creek Reservoir will decrease. This project work is managed by the Provo River Watershed Council and other partners. This TMDL, however, will focus solely on the *E. coli* impairment.

Table 2. Impairment summary of the Spring Creek Assessment Unit.

Assessment Unit	Cause of Impairment	Impaired Beneficial Use	Year 303(d) Listed
Spring Creek UT16020203-027	*E. coli*	Drinking water (1C), Infrequent primary contact recreation (2B)	Combined 2012/2014 Integrated Report
	Total Phosphorus		Further investigations needed. Exceeds Deer Creek Reservoir TP instream TMDL target.

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2.2 Pollutant of Concern (*E. coli*)

Routine monitoring of surface waters and assessment programs are needed to ensure the protection of public health. Surface waters are monitored as part of Utah's bacteriological monitoring program for pathogens that originate from fecal pollution from human and animal waste. It is not feasible to monitor for all pathogens in water, but by analyzing for certain indicator organisms, it is possible to assess potential health risks. Utah samples for *E. coli* concentrations in surface waters using USEPA guidelines (EPA, 2012).

The use of indicator organisms as a means of assessing the presence of pathogens in surface waters has been adopted by the World Health Organization and USEPA (WHO, 2001). *E. coli* are the most abundant coliform bacteria present in human and animal intestines, numbering up to one billion organisms per gram of feces. Their presence in the environment can be attributed primarily to fecal origin, and their presence in water can be an indication of recent contamination. Common sources include failing septic systems, leaking sewer lines, grazed pastures, confined feedlots, wildlife, and dog parks (Benham, 2006). Bacteria from these sources, some of which may be pathogenic or disease causing, are washed into surface waters during rainfall or snowmelt or are deposited directly in the water. These pathogenic bacteria pose a threat to human health usually through ingestion.

2.3 Applicable Water Quality Standards

Utah's numeric criteria for *E. coli* can be found in Utah Administrative Code, Standards of Quality for Waters of the State (UAC R317-2). These criteria vary based on the beneficial use assignment of the waterbody. Table 3 below summarizes the *E. coli* water quality standards pertaining to the 303(d) listed Spring Creek Assessment Unit.

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Table 3. Applicable *E. coli* water quality standards for Spring Creek.

Beneficial Use	Description	*E. coli* Geometric Mean (MPN*/100 mL)	*E. coli* Not to Exceed (MPN*/100 mL)
1C	Drinking water	206	668
2B	Infrequent primary contact recreation	206	668
*MPN/100 mL = Most probable number [of colonies] per 100 milliliters of water			

The *E. coli* numeric standard for designated beneficial use Class 1C (drinking water) and 2B (infrequent primary contact recreation) waters states that sample concentrations may not exceed 206 MPN per 100 milliliter (mL) as a 30-day and recreation season geometric mean, or a maximum of 668 MPN per 100 mL in more than 10% of samples collected during the recreation season. The 30-day geometric mean is based on no less than five samples collected more than 48 hours apart within 30 days.

The likelihood of becoming ill when recreating in waters increases with elevated *E. coli* concentrations. USEPA published guidance (USEPA, 2012) that recommends both a geometric mean criterion and a statistical threshold value for assessing recreational waters. These values, which correspond with DWQ's numeric criteria, are based on an estimated illness rate of 36 illnesses per 1,000 primary contact recreationalists. Although *E. coli* is an indicator species and does not directly measure all waterborne pathogens, it is a strong indicator of recent fecal contamination of surface water that may introduce pathogens and pose a risk to human health.

2.4 Utah's Listing Methodology

Surface waters designated as having Class 1C drinking water and 2B recreational beneficial uses are assessed for *E. coli* using the water quality standards outlined in Table 3 and the assessment methodology presented in Section 4.1. The overarching goal of Utah's assessment approach is to define criteria that ensure protection of drinking water and recreational uses in rivers and lakes while also considering both false positive and false negative assessments. The rules discuss how these criteria are interpreted for varying numbers of samples collected during the years prior to making assessment decisions. Assessment units that fail to meet any of these *E. coli* criteria will be listed as failing to meet drinking water or recreation designated uses on Utah's 303(d) list of impaired waters.

The Spring Creek Assessment Unit (UT16020203-027) was listed on the 2012/2014 303(d) List of Impaired Waterbodies for failing to protect its drinking water (1C) and infrequent contact recreation (2B) uses due to elevated levels of *E. coli*. The Spring Creek above Provo River (4997250) monitoring location triggered the listing (Figure 16) for this monitoring site location. The 2012/2014 Assessment criteria stated that *E. coli* concentrations should not exceed the maximum numeric criteria more than 10% of the time during the recreational period of May through October (UDWQ, 2014). From May 2011 to September 2012 (sample size = 11), *E. coli* concentrations in Spring Creek above Provo River exceeded the maximum criterion 64% of the time (Table 9).

DWQ updated the *E. coli* assessment methodology in 2018 (UDWQ, 2018). Using this methodology and data set (2012 to 2019), the exceedance rate of the maximum criterion was 71% in the Spring Creek Assessment Unit. See Section 4.1.1 for more information on the assessment methodology.

2.5 TMDL Endpoints

TMDL endpoints represent water quality targets. The reductions specified in this report to meet the 30-day geometric mean water quality standard for *E. coli* will ensure that no sample will exceed the maximum *E. coli* water quality standard based on the current data set. The endpoints for the Spring Creek *E. coli* TMDL are as follows:

1. For years with ≥ 5 collection events in any recreation season (May 1 through October 30), no more than 10% of samples collected from May 1 through October 30 should exceed 668 MPN/100 mL.
2. For recreation seasons with ≥ 5 collection events, no 30-day interval geometric mean should exceed 206 MPN/100 mL.
3. For recreation seasons with ≥ 10 collection events, the geometric mean of all samples should not exceed 206 MPN/100 mL.

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Chapter 3. Study Area Characteristics

The Provo River originates in the Uinta Mountains and flows for over 70 miles through canyons, reservoirs, and urban and rural lands before emptying into Utah Lake. The river drains 673 mi^2 and spans three counties (Summit, Wasatch, and Utah) and several watersheds. The Provo River has high-quality potable water and is known for its blue-ribbon fisheries. Spring Creek is a small tributary to the Provo River located in the Heber Valley in Wasatch County.

Heber Valley was first occupied by Timpanogos Utes as summer hunting grounds. In 1859, Provo Canyon road was built, leading to the settlement of this valley. Pioneers converted the sagebrush and willow tree landscape to pastoral farms. The Heber Valley economy depended on agriculture, livestock, and dairy farms. After the Rio Grande Western railway was completed around 1900, the valley became a shipping center for agricultural products. Currently, there is a greater demand for development and tourism than farming. Heber City was the fastest growing micropolitan area in the United States according to the US Census Bureau Report in 2018.

3.1 Location

The Spring Creek Assessment Unit (UT16020203-027) is located in Wasatch County in northeastern Utah. It is in the northeast portion of the Provo River/Jordan River hydrologic unit. This small assessment unit lies between Jordanelle and Deer Creek Reservoirs just outside of Heber City (Figure 1). Flow from Spring Creek either drains into the Provo River and ultimately into Deer Creek Reservoir or is diverted into Daniels Creek for irrigation use. While the average elevation along the valley floor is 6,500 ft, the surrounding peaks are over 10,000 ft. Most of the land within this area is privately owned (99%).

Heber City has a population of approximately 11,000 residents (2010 census) and is located approximately one mile east of the Spring Creek Assessment Unit. Spring Creek is a heavily modified, 12-mile stream that delivers irrigation water to the surrounding valley (Figure 2). It originates from several valley springs, and most instream flow comes from the Rock Creek tributary (Section 4.2). Spring

Creek is a significant source of water for the surrounding community, with an average daily flow of 24.5 cubic feet per second (cfs) (USGS Gage 10155400).

Figure 2. North Fields in Spring Creek Assessment Unit. October 2018.

3.2 Climate

Precipitation and temperature are strongly influenced by topography. The Western Regional Climate Center (WRCC) has a weather station located just outside the Spring Creek Assessment Unit at the Deer Creek Reservoir Dam (Station ID: 422057). This station is located at an elevation of 5,270 feet and has been in operation since March 1938 (Western Regional Climate Center, 2020). The average monthly precipitation in the form of rainfall for this period of record is 1.8 inches and for snowfall is 6.5 inches.

Figure 3 shows a strong seasonal pattern with less rainfall in the summer (~ 1 inch) and higher snowfall amounts in the winter (~23 inches in January).

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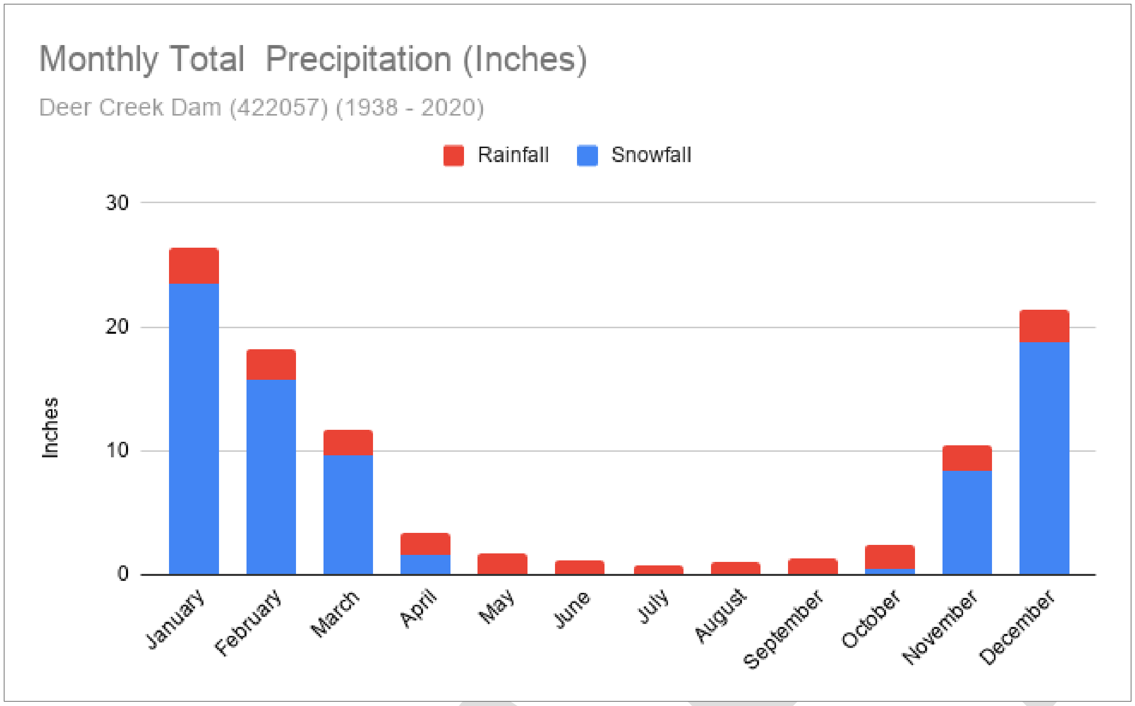

Figure 3. Monthly total precipitation data summary (1938 – 2020) at Deer Creek Reservoir Dam.

The total annual precipitation from years 2000 to 2020 (Figure 4) averaged 87 inches per year in the form of both snowfall (67 inches) and rainfall (20 inches).

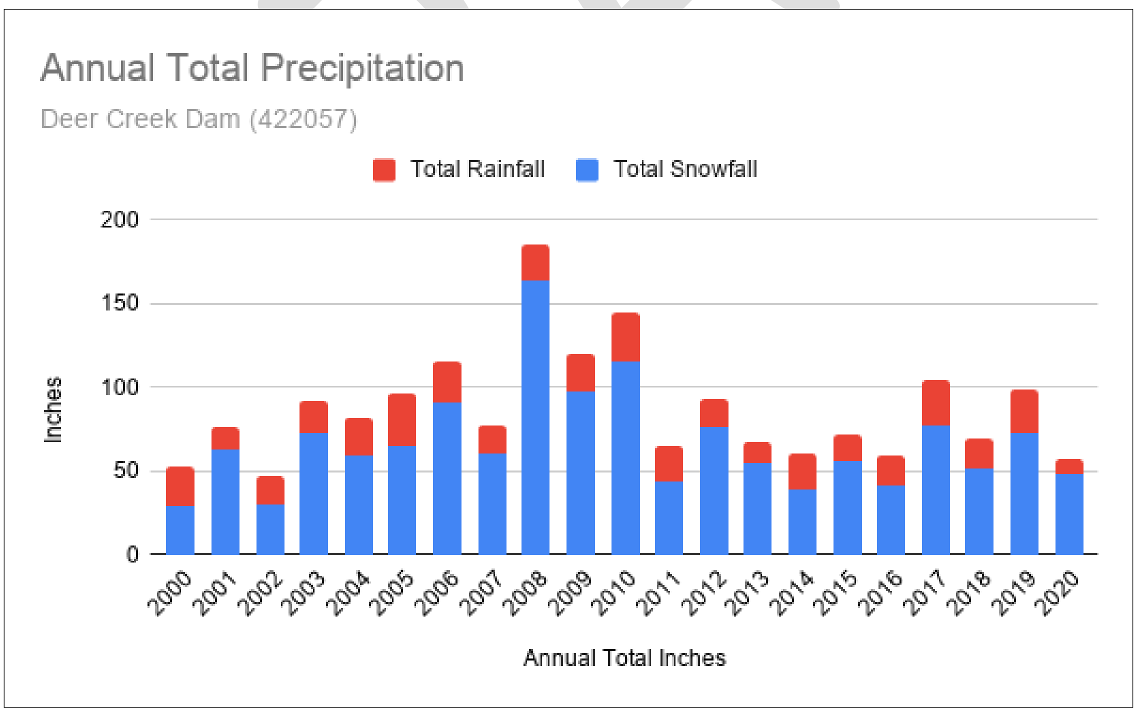

Figure 4. Total annual precipitation at Deer Creek Reservoir Dam (2000 – 2020).

The average annual air temperature at Deer Creek Reservoir Dam is 41°F, with a minimum of 39°F and maximum of 100°F. Figure 5 shows a typical seasonal pattern, with the warmest temperatures in the summer months. Figure 6 shows the average annual temperature from 1960 to 2020.

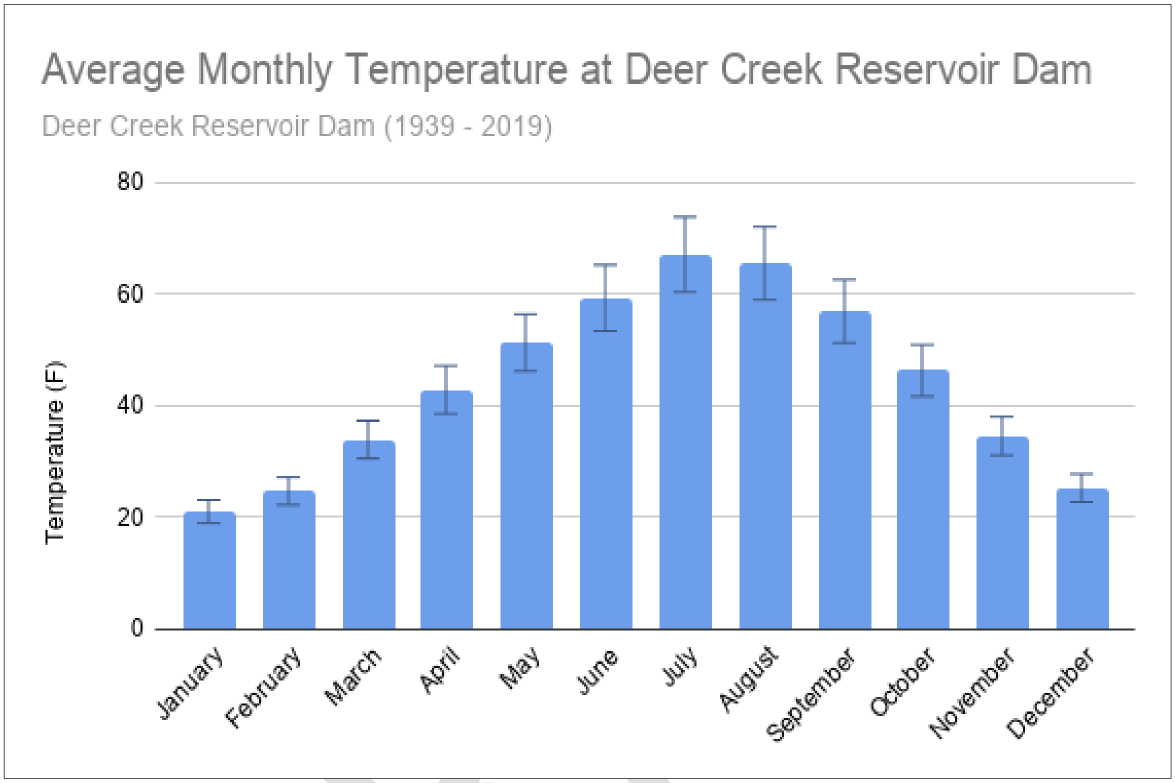

Figure 5. Average monthly temperature at Deer Creek Reservoir Dam (1939 – 2019).

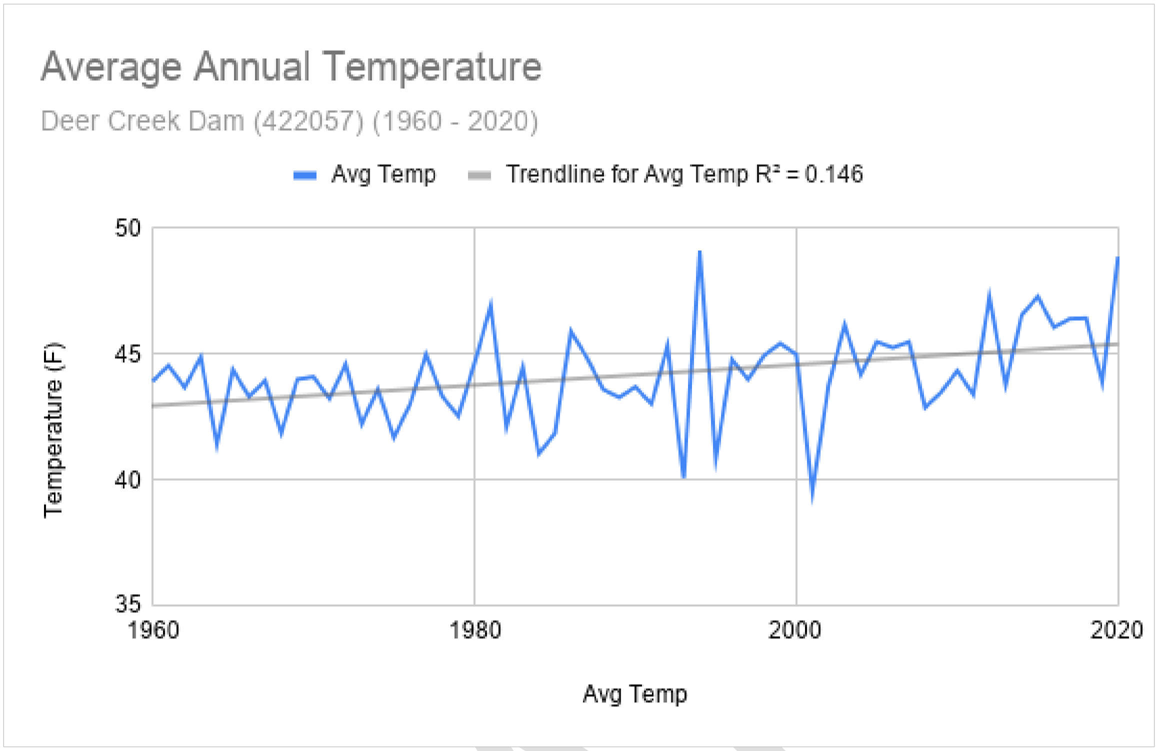

Figure 6. Average annual temperature in Deer Creek Dam (1960 – 2020).

3.3 Hydrology

There are approximately 85 miles of surface waterways within the Spring Creek Assessment Unit. The National Hydrography Dataset (NHD) created by USEPA and USGS shows four different stream types in this watershed—ephemeral streams, canals/ditches, perennial streams, and natural springs. (Table 4).

Table 4. Summary of Stream Types in Spring Creek Assessment Unit.

Stream Type *	River Miles	% Total
Ephemeral Streams	38	45
Canal/Ditch	30.3	36
Perennial Streams	12.5	15
Connectors	1.6	2
Pipeline	1.6	2
Streams – Intermittent	0.4	< 1
Artificial Paths	0.2	< 1
Total	84.6	100%
*Note: In the CWA, Congress explicitly directed agencies to protect “navigable waters.” The 2020 Navigable Waters Protection Rule defines those and includes perennial and intermittent tributaries to traditional navigable waters.		

Most of the surface waterways in the Spring Creek Assessment Unit are ephemeral streams (45% of total). Ephemeral streams only flow for short periods of time during and after a precipitation event. Canals and ditches account for 36% of the total surface waterways. Human-made ditches carved out across the valley convey water for irrigation purposes to neighboring fields and canals divert water to downstream communities for both culinary and irrigation purposes. Diversions from the Spring Creek main channel have altered the natural flow paths, leading to a reduction in high spring and base summer flows. Perennial streams flow continuously and originate from both springs and groundwater intrusion along the streambed.

Figure 7 shows perennial Spring Creek as it flows through grazed pastureland. Natural springs and irrigation return flows augment instream flows.

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Figure 7. Collecting flow measurements in Spring Creek. Fall 2019.

Most of the flow within the Assessment Unit originates from a diversion from the Provo River via Rock Creek. This flow is managed for two important users: Wasatch County Water Efficiency Project (WCWEP) and Daniels Irrigation Company. A maximum of 225 cubic feet per second (cfs) is diverted approximately 0.6 miles (mi) downstream on Rock Creek into the Wasatch Canal from May through mid-October as mandated by the WCWEP. This project delivers pressurized water to irrigation companies using the Timpanogos, Wasatch, and Humbug Canals in the Heber Valley. Note that there is no surface connection from these canals and the Spring Creek Assessment Unit. The canals end at terminal basins. Rock Creek is diverted into several smaller ditches throughout the North Fields, conveying water to neighboring agricultural fields. Base flow in Rock Creek, below the diversion from Wasatch Canal, ranges from 1 to 11 cfs.

Spring Creek is fed by the outflows from Rock Creek, McDonald Ditch, London Ditch and Creamery Ditch (Figure 8).

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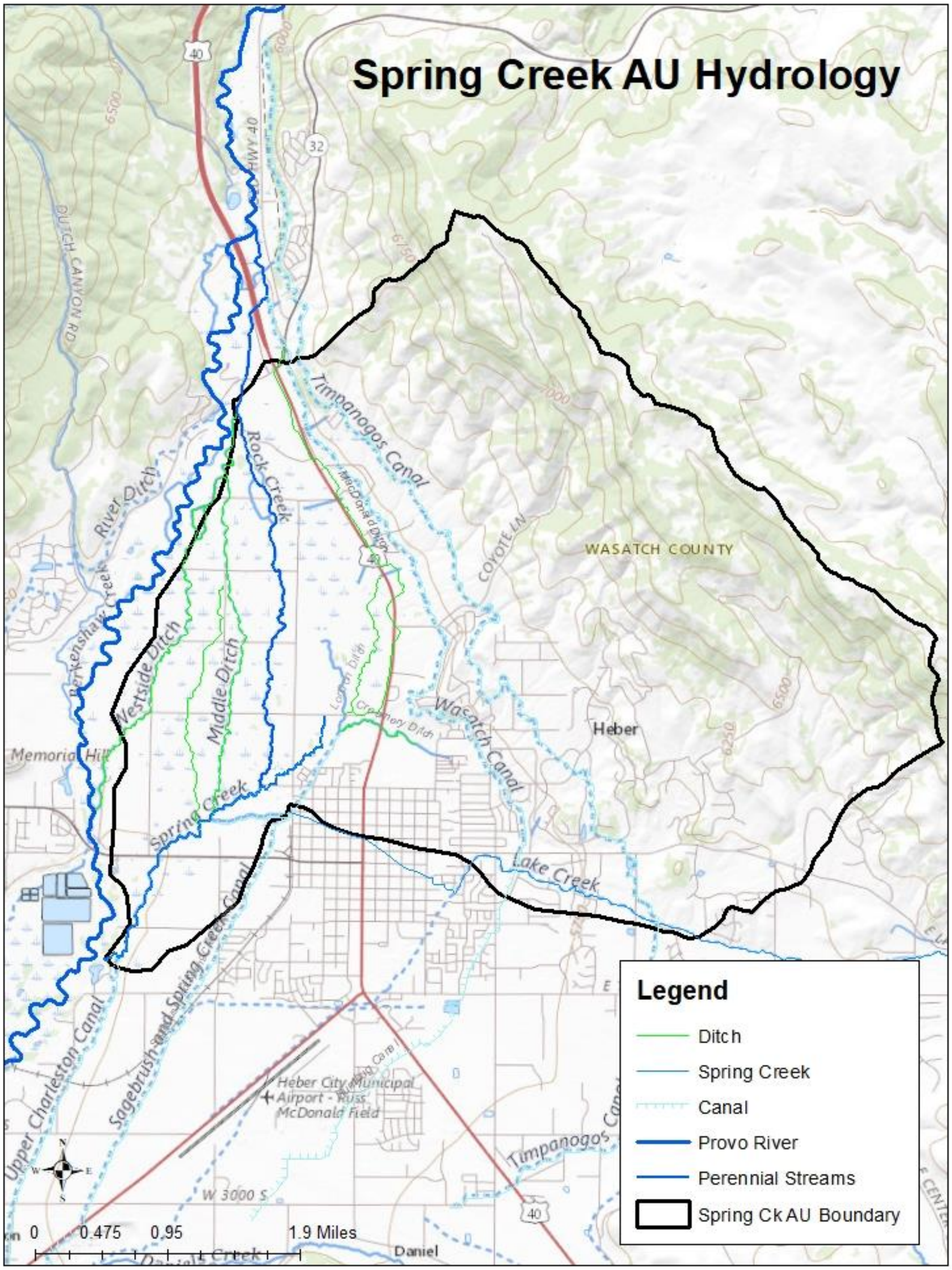

Figure 8. Hydrology in Spring Creek Assessment Unit.

The creek gains surface flow through subsurface irrigation return flows and seeps. Both the McDonald and London Ditches divert water from braided, unnamed ditches along Highway 40 and ultimately flow into Spring Creek in the North Fields area. Creamery Ditch originates at Hatch Spring, crosses under Highway 40, and terminates at Spring Creek. Most ditches are privately owned and used for irrigation purposes. Estimated flows at all individual ditches ranges from 1 to 7 cfs.

Lake Creek has the potential to flow into Spring Creek during moderate precipitation events. The lower reach of Lake Creek is often dry due to upstream reservoirs and irrigation diversions. When the channel's capacity is exceeded during runoff, flow is diverted to a flood-control channel, bypassing this reach entirely.

The two major diversions along Spring Creek are Sagebrush and Spring Creek Canal (50 cfs capacity) and Upper Charleston Canal (25 cfs capacity). The Sagebrush and Spring Creek Canal begins directly below the confluence of Spring Creek and Creamery Ditch. Most of the flow is directed southwest through Heber City. The second diversion, located directly upstream of the confluence of the Provo River and Spring Creek, diverts most of the water into the Upper Charleston Canal. The natural channel is dewatered during the summer (Central Utah Water Conservancy District, 1996). Upper Charleston Canal and Sagebrush and Spring Creek Canal eventually flow into Deer Creek Reservoir via Daniels Creek.

The water table is at its shallowest along the riparian zones of both the Provo River and Spring Creek, with an annual minimum depth of 18 inches. Subsurface flows from springs and irrigation return flows augment in-channel stream flow moving downstream. This shallow subsurface water and porous soils could convey contaminants to Spring Creek from a variety of sources such as faulty onsite septic systems or runoff from irrigated lands (Chapter 5).

3.4 Land Use

Land use and land cover can impact water quality due to where and when precipitation falls on the landscape. When rain falls on well-vegetated (forested) cover with minimal disturbance, it soaks into the ground, and soils filter out

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pollutants as the flow returns to the river system. River flows are steady and erosion is minimal. On the other hand, when precipitation falls onto non-vegetated surfaces (urban areas), it cannot soak into the impermeable surfaces, which increases the potential for high runoff. This decrease in surface permeability negatively impacts water quality because decreases in vegetation buffering capacity leads to increased erosion and pollutant loading and inconsistent instream flows.

Forested lands, shrublands, and agricultural areas are similar in size in this watershed (Figures 9 and 10).

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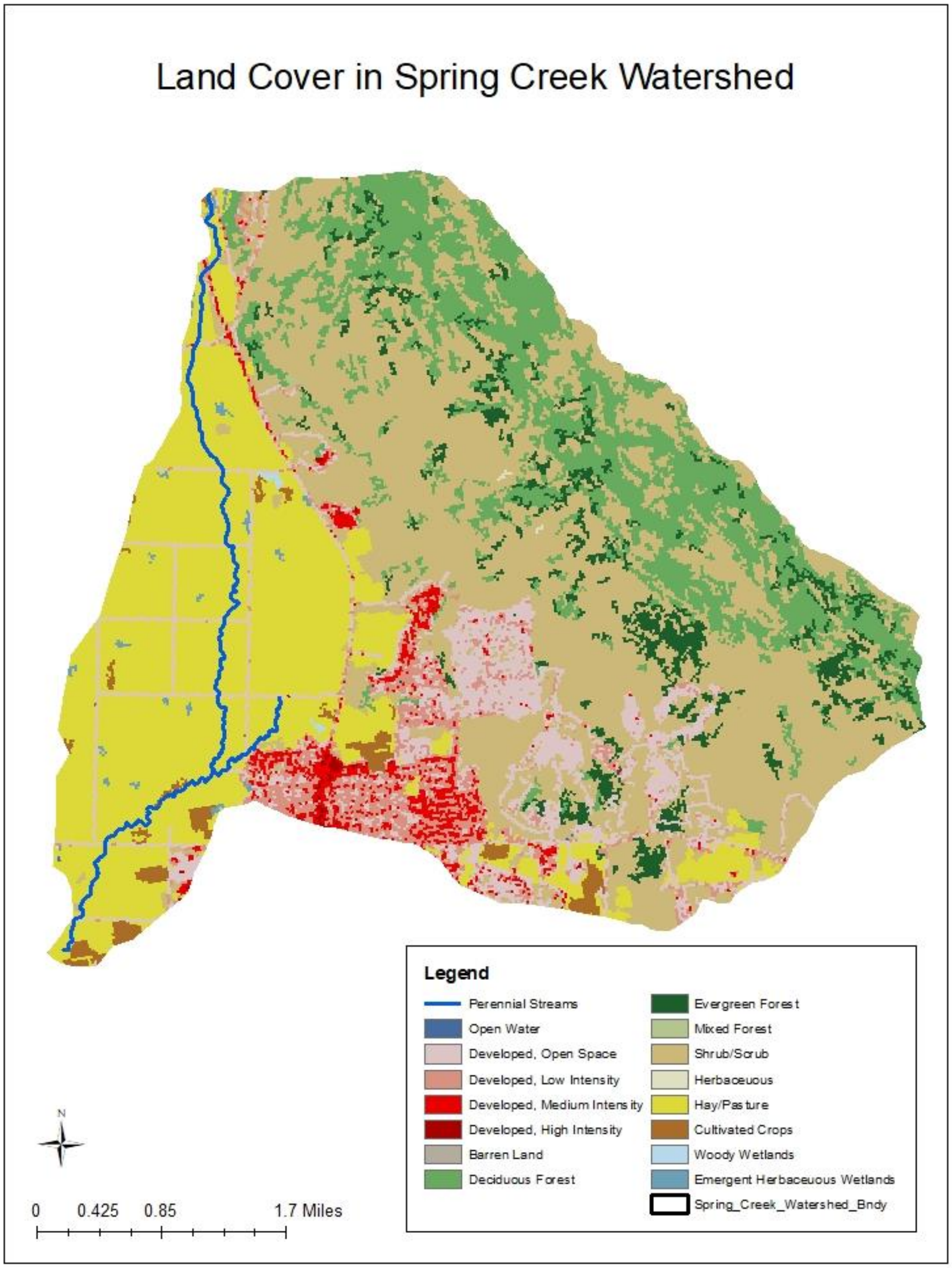

Figure 9. Land cover and use in the Spring Creek Assessment Unit.

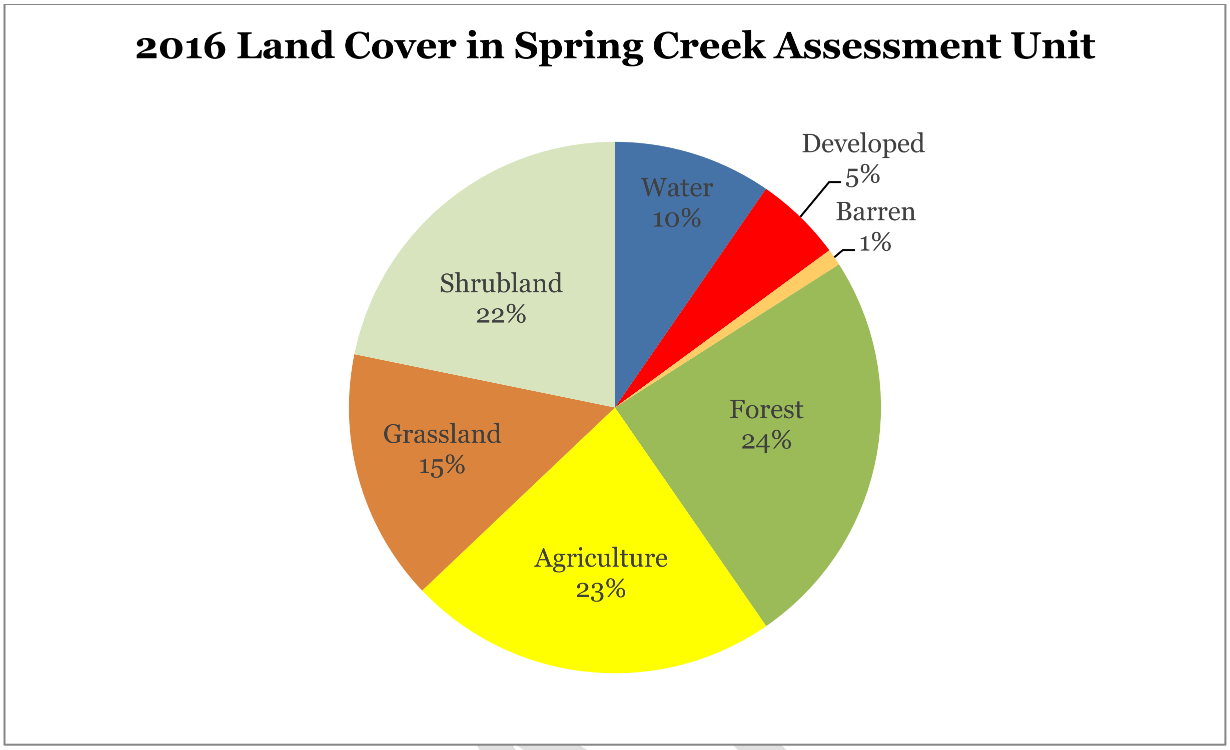

Figure 10. Land cover (2016) in the Spring Creek Assessment Unit.

The forested areas (24% of total) are located on the tops of the hillslopes in the western part of the assessment unit. Shrublands (22%) lie along the hillslopes. The agricultural areas (23%) are located solely in the valley bottom. Urban areas (5%) are associated with Heber City.

Modifications to the natural landscape can alter the flow path of the water and impact downstream water quality. Wasatch County, and specifically the Heber Valley area, has seen changes to land uses in recent years. The typical progression of a change in areas with high development pressure is croplands to pasture to urbanized areas. Chapters 5 and 6 provide more details about how changes in land use could impact not only *E. coli* loading into the riverine system but also be potential sources.

Soil conditions also play a role in how pollutants can enter a stream. The soils in this assessment unit are loamy in surface texture with moderate erodibility. Data obtained from United States Department of Agriculture (USDA) Soil Surveys show that soils along the riparian areas and lowland agricultural fields have slow infiltration rates and higher runoff potential The area also has a shallow water table. These soil attributes can explain how *E. coli* may enter the riverine network from sources such as failing onsite septic systems and flood-irrigated grazing pastures (Chapter 5).

3.5 Water Use

3.5.1 Water-related Land Use

The Utah Division of Water Resources compiles a detailed, spatial database of water-related land use in the state (Utah Automated Geographic Resource Center Water Related Land Use, 2019) that provides information for the state's annual water budget. The 2019 data show that a total of 10.2 mi^2 (6,508 acres) in the Spring Creek Assessment Unit, or approximately 50% of the watershed, are devoted to water-related land uses. Table 5 shows the distinct water-related land-use types for the watershed and their associated area.

Table 5. Water-related land use in Spring Creek Assessment Unit.

Water-related Land Use	Description	Area (acres)
Agricultural 3,285 acres (51%)	Pasture	2,290
	Hay / Alfalfa	828
	Fallow	160
	Garden	7
Urban 2,434 acres (37%)	Urban	2,393
	Turf Grass	41
Dry Land 740 acres (11%)	Shrubland / Dry Land	740
Water 45 acres (< 1%)	Water	45
Riparian 4 acres (< 1%)	Riparian / Wetlands	4
Total		**6,508 acres**

Water-related land use in the Spring Creek Assessment Unit is predominantly agricultural (51%) and urban (37%). Most agricultural lands are in the North Fields area between the Provo River and Heber City (Figure 11).

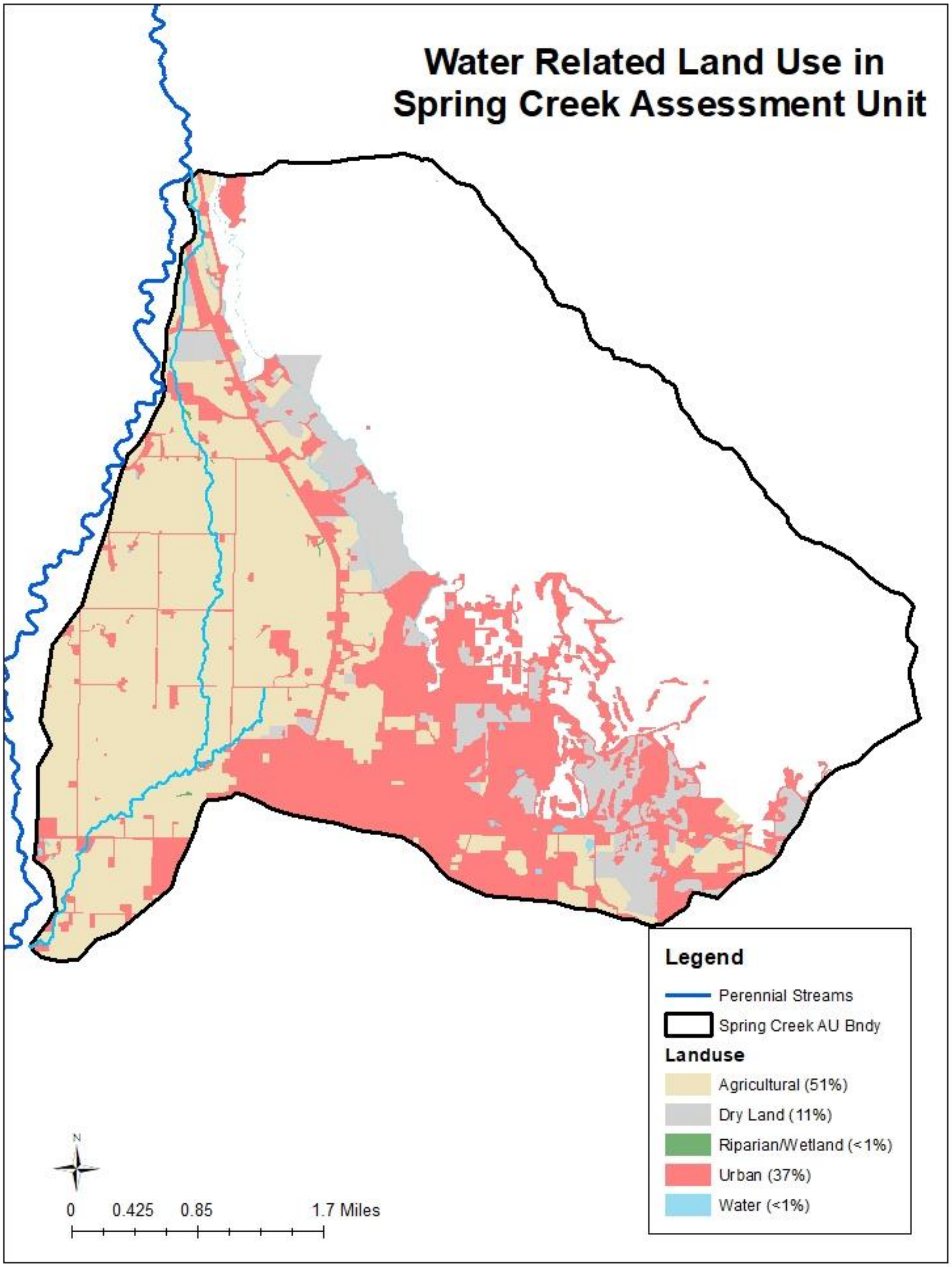

Figure 11. Water-related land use in Spring Creek Assessment Unit.

Most agricultural water is used for pastures that support livestock such as cows and horses. These fields are watered via flood irrigation (Figure 12). Agricultural fields along the creek temporarily store the irrigated water, which is slowly returned to the stream, often through subsurface flow.

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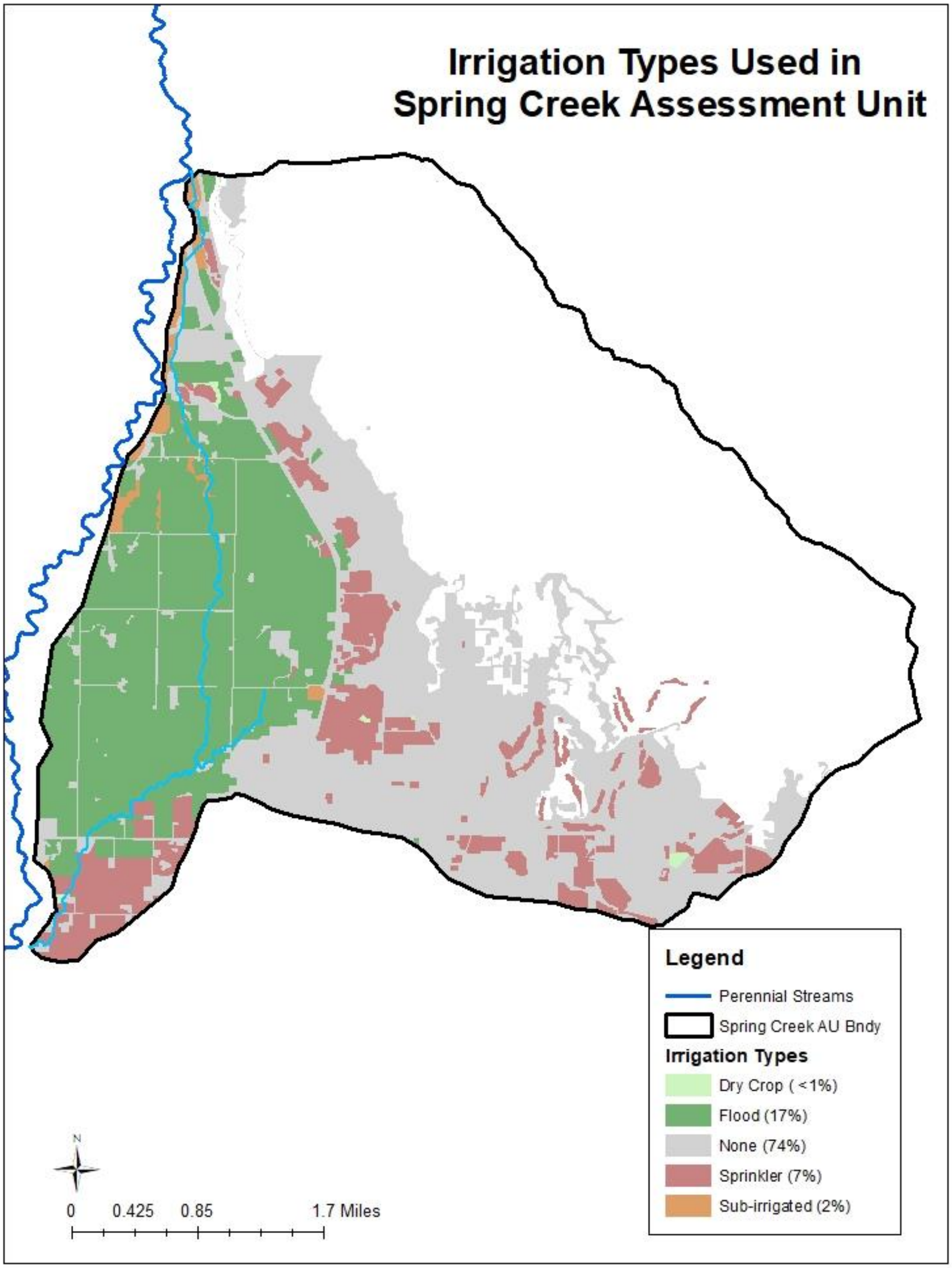

Figure 12. Irrigation types in Spring Creek Assessment Unit.

3.5.2 Water Supply

Water in the Spring Creek Assessment Unit is used for pasture irrigation, livestock watering, wildlife, recreation, and municipal uses. Figure 13 shows the major diversion from the Provo River to Rock Creek below Jordanelle Reservoir dam. There are approximately 302 points of diversion with associated water rights located in this watershed (Figure 14).

Figure 13. Rock Creek diversion from the Provo River (headwater of Spring Creek).

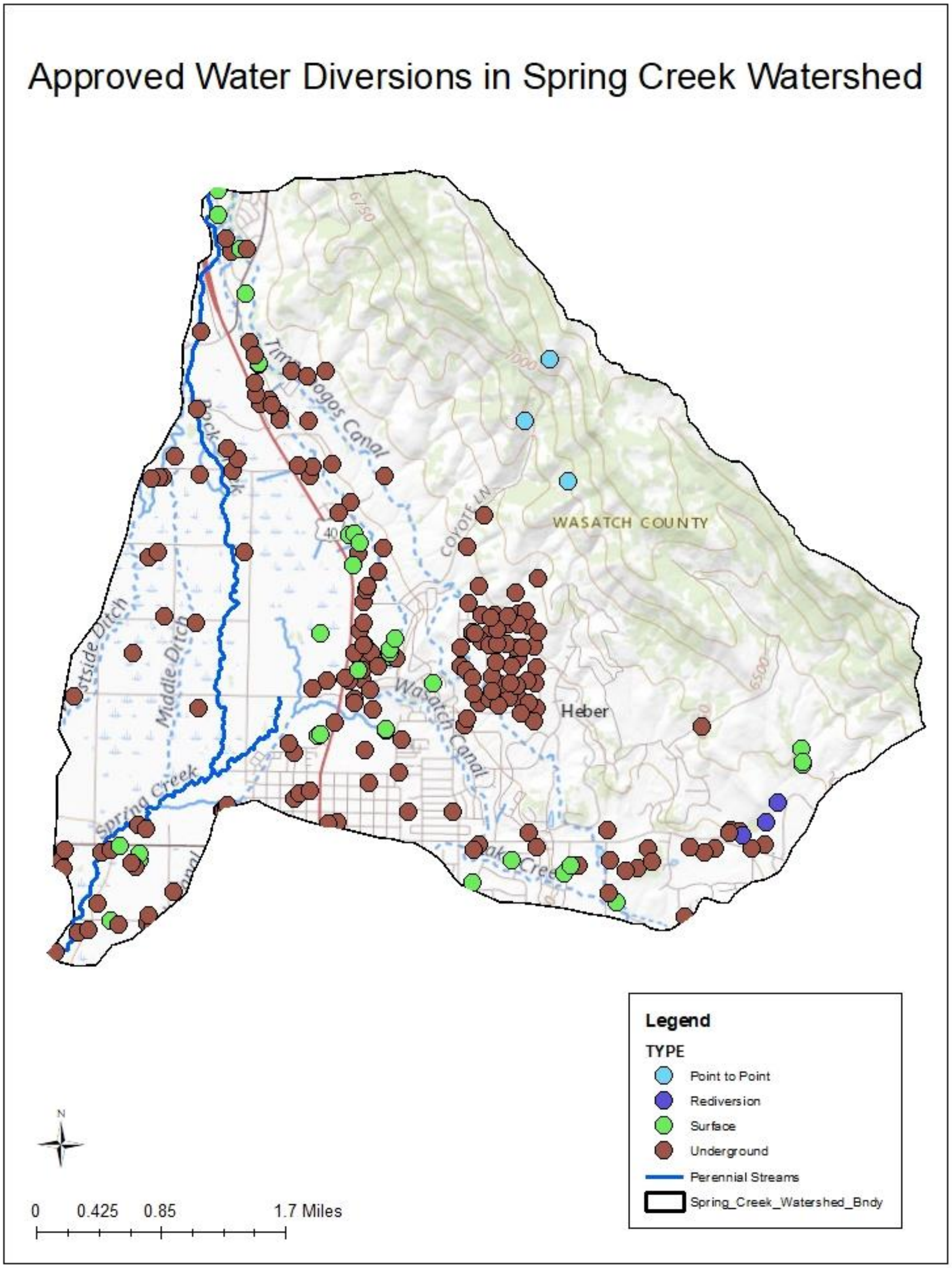

Figure 14. Approved water diversions in Spring Creek Assessment Unit (May 2020).

The main water right holders include Heber City, Central Utah Water Conservancy District, U.S. Bureau of Reclamation, and the Wasatch and North Fields Irrigation Companies.

There are four different types of diversions (Table 6). Most of the diversions used in this assessment unit comes from groundwater wells (67% or 2,736 ac-ft). There are 60 surface water diversions totaling 15,829 acre-ft/day, and 24 re-diversions (diverted water which was previously diverted and released upstream) totaling 104,240 acre-ft/day.

Table 6. Water diversions in the Spring Creek Assessment Unit.

Type of Diversion	Number	Volume (ac-ft/day)	CFS
Surface	60	15,829	243
Underground	215	2,736	17
Point to Point	3	N/A	N/A
Re-diversion	24	104,240	808
Total	**302**	**122,805**	**1,068**

Utah's Division of Water Resource Water Consumptive Use Reports show an average use of 30,858 ac-ft/year in Wasatch County since 2009. The ratio of water removed from the system in Wasatch County compared to instream flows in the Provo River (USGS 10163000) averaged 38% from 2009 to 2016 (Table 7). Note that the area of Wasatch County is considerably larger than the Spring Creek Assessment Unit.

Table 7. Consumptive use in Wasatch County compared to instream flow in the Provo River.

Year	Consumptive Use (ac-ft/year)	Consumptive Use (cfs/year)	Mean Daily Flow (cfs)	Total Annual Flow (cfs/year)	Consumptive Use % Related to Total Flow
2009	29,572	14,909	214	78,001	19%
2010	26,166	13,192	138	50,224	26%
2011	36,338	18,320	494	180,237	10%
2012	33,146	16,711	191	69,533	24%
2014	28,313	14,274	72	26,134	55%
2015	29,802	15,025	66	23,908	63%
2016	32,669	16,470	65	23,616	70%

Consumptive use does not change considerably from year to year even though instream flows do. Note that this comparison does not include reservoir storage capacity, reservoir evaporation or the small portion of Utah County's consumptive use in this reach.

According to The Utah State Water Plan for the Utah Lake area, the consumptive use for Wasatch County in 2010 was well below the steady supply of water. However, given future growth and climate change, the demand could overwhelm the supply by 2060 (Table 8). Certain water quality pollutants such as *E. coli* could increase in concentration if instream flows in the Provo River and its tributaries decrease.

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Table 8. Current public community system water supplies vs. future demands.

Water System	2010 Demand (ac-ft/yr)	2010 Reliable Supply (ac-ft/yr)	Water Use Projections w/Water Conservation (ac-ft/yr)		Water Supply Deficits/Surpluses (ac-ft/yr)	
			2030	2060	2030	2060
Canyon Meadows	15	186	16	17	170	169
Center Creek Culinary Water Co.	88	154	136	479	18	(325)
Charleston WCD	216	207	436	2,712	(229)	(2,505)
Country Estates Mobile Homes	16	3	16	16	(13)	(13)
Daniel Domestic Water Company	341	321	585	2,068	(264)	(1,747)
Heber City Water System	2,640	3,282	4,322	6,049	(1,040)	(2,767)
Interlaken Mutual Water Company	71	182	166	592	16	(410)
Jordanelle Special Service District	244	4,150	569	2,032	3,581	2,118
Midway City Water System	1,368	2,492	2,494	5,488	(2)	(2,996)
Storm Haven	35	64	26	28	38	36
Swiss Alpine Water Co.	30	31	72	160	(41)	(129)
Timber Lakes Water SSD	132	192	309	1,103	(117)	(911)
Twin Creeks SSD	305	725	461	1,007	264	(282)
Wallsburg Town Water System	128	198	117	383	81	(185)
Woodland Hills Irrigation Co.	31	40	21	22	19	18
Wasatch County Total	**5,662**	**12,227**	**9,746**	**22,156**	**2,481**	**(9,929)**

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Chapter 4. Data Inventory and Review

The Provo River Watershed Council (PRWC), in partnership with several other entities, collects water quality data throughout the entire watershed for long-term trend analysis. The locations where ambient water quality is monitored are widely distributed in the watershed to gain a more complete understanding of overall watershed aquatic health. These data were used by DWQ to assess water quality conditions against water quality standards (Section 4.1).

The TMDL required further investigations of the temporal and spatial extent of the *E. coli* impairment in the Spring Creek Assessment Unit. As a result, DWQ added 16 additional, targeted monitoring locations (Figure 15) to aid in the source assessment for the TMDL.

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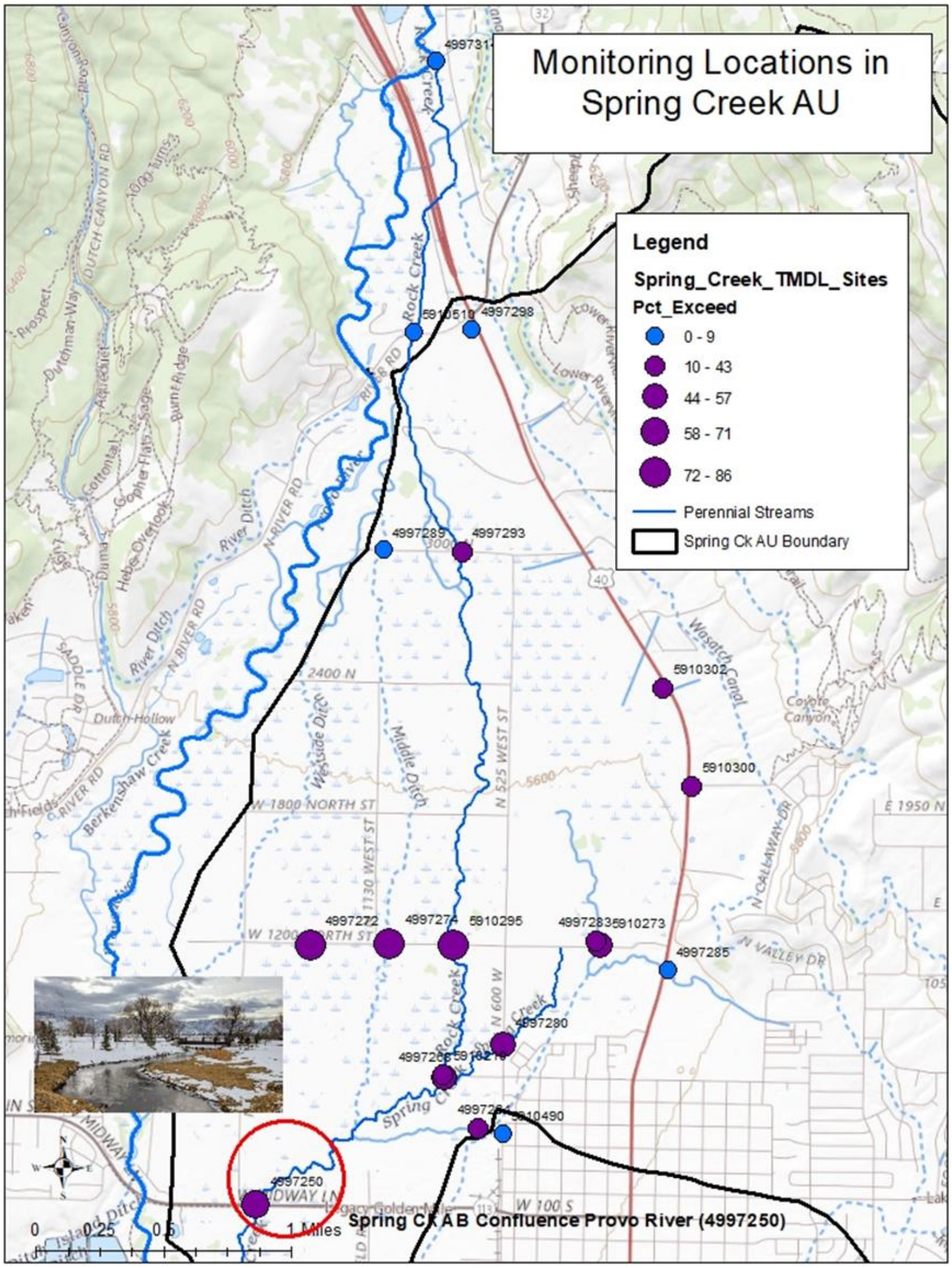

Figure 15. Monitoring locations and their relative percent exceedance of the maximum *E. coli* criterion.

4.1 *E. coli* Data Summary

4.1.1 Assessment Data Summary

The Spring Creek Assessment Unit (UT16020203-027) was listed on the 2012/2014 303(d) List of Impaired Waterbodies for elevated levels of *E. coli*. The Spring Creek above the confluence with the Provo River monitoring location (Monitoring Location ID (MLID) 4997250) triggered the listing (Figure 16).

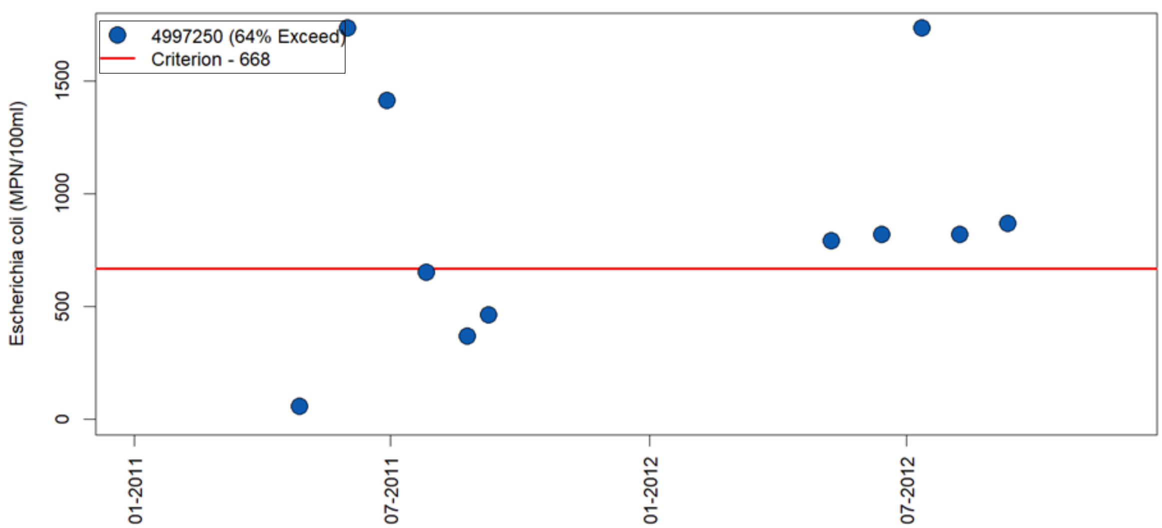

Figure 16. Assessment results for the 2012/2014 303(d) list for Spring Creek above Provo River (4997250).

The Assessment Methodology for the 2014 Integrated Report (IR) focused on samples collected during the recreation season (May through September) when increased contact with the water poses the greatest risk to human health. This period also coincides with higher *E. coli* concentrations that result from low instream flows and warmer water temperatures, which can increase the growth and reproduction rates of these pathogens (Islam 2017).

The 2014 IR Assessment Methodology Rule 2 states that no more than 10% of the samples should exceed the 668 most probable number (MPN)/100mL for each location with five or more samples in any recreation season. During the assessment period from 2011 to 2012, 7 of 11 (or 64% of) samples collected at MLID 4997250 in the Spring Creek Assessment Unit during two consecutive recreational seasons exceeded the 668 MPN/100mL criterion (Figure 16). These exceedances led to the 2014 impairment listing for the Spring Creek Assessment Unit.

The 303(d) list assessments only apply to perennial and intermittent streams. However, *E. coli* samples from ditches and canals may be used to identify potential sources of pathogen loading and guide implementation efforts.

In 2018, DWQ updated the *E. coli* Assessment Methodology for the Integrated Report. DWQ now assesses using three different scenarios based on sampling frequency and the number of sampling events at a monitoring location:

- Scenario A: A seasonal assessment against the maximum criterion
- Scenario B: A 30-day geometric mean assessment
- Scenario C: A seasonal geometric mean assessment

Scenario A was applied to the more recent *E. coli* data since there were ≥ 5 collection events during the recreation season. Overall, 38 samples were collected from the 2011 to 2019 recreation seasons. Seventy-one percent of samples (27) exceeded the maximum criterion of 668 MPN/100 mL (Figure 17). Table 9 shows that at monitoring location MLID 4997250 water quality was impaired annually since 2009 with exceedances ranging from 33 to 100%. Note that several records were above the maximum detection limit of 2,419 MPN / 100 mL. Any records that exceeded this value were reported this maximum detection limit.

Two other monitoring locations (London Ditch at US Highway 40, and London Ditch at 1200 North) were sampled as part of the long-term PRWC data collection effort (see Table 10). These sites are canals and thus not part of the biennial IR assessment.

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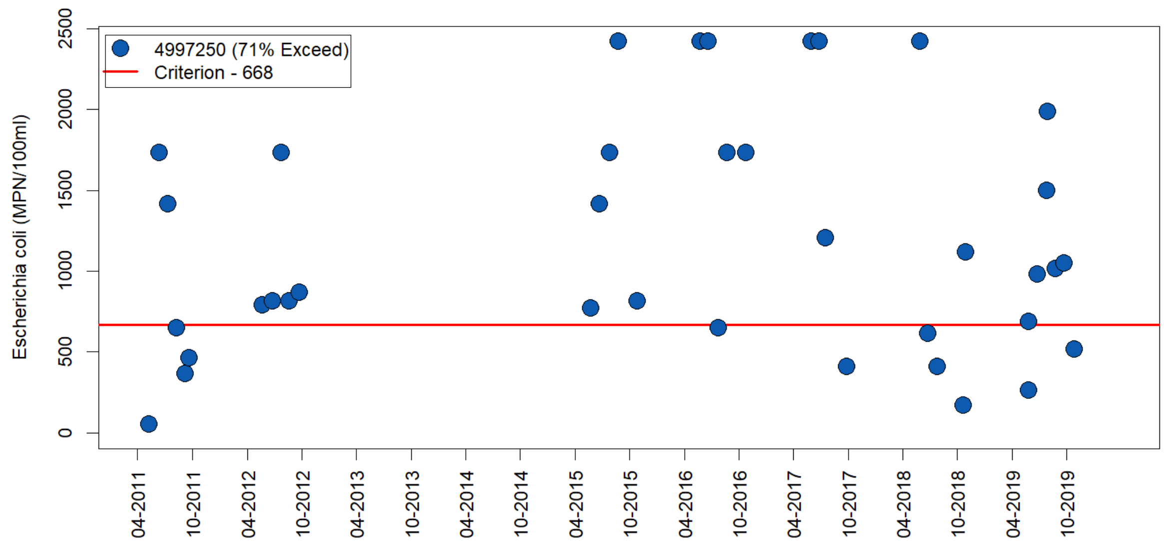

Figure 17. Assessment results for Spring Creek above Provo River (MLID 4997250) with current data (2011 to 2019).

Table 9. Percent exceedance of *E. coli* criteria (maximum) at Spring Creek above Provo River (MLID 4997250) from 2011 to 2019.

Year	Sample Size	# Exceed	% Exceedance*	Impaired
2011	6	2	33%	Yes
2012	5	5	100%	Yes
2013	No samples collected in 2013			
2014	No samples collected in 2014			
2015	5	5	100%	Yes
2016	5	4	80%	Yes
2017	4	3	75%	Yes
2018	5	2	40%	Yes
2019	8	6	75%	Yes

*Assessment Criteria is 10%.

In 2019, DWQ conducted intensive sampling in the Spring Creek Assessment Unit to identify pollution sources and further understand the spatial and temporal variation of *E. coli* throughout the system. *E. coli*, nutrients, and field measurements (i.e., dissolved oxygen, temperature, and pH) were collected at 19 sites. Canals, ditches, and perennial waterways were monitored. Of those 19 sites, 13 failed to protect their infrequent primary contact recreation (2B) or culinary use (1C) designated beneficial uses (Table 10) when compared to the maximum criterion for *E. coli* (668 MPN/100 mL). Figure 15 displays the impaired locations and Table 10 shows the percent exceedance of these monitoring sites.

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Table 10. Spring Creek Assessment Unit *E. coli* assessment analysis using recreation season data.

MLID	Name	Impaired	% Exceedance	# Rec Seasons	Sample Size	Minimum	Maximum	Geometric Mean
4997314	Rock Ck at Diversion from Provo River	No	0%	2	7	1	4	1
5910510	Rock Ck @ River Road Xing	No	0%	2	7	2	86	11
4997298	McDonald Ditch BL River Road	No	0%	1	6	8	183	31
4997289	Middle Ditch @ 3000 North	No	0%	2	7	10	138	49
4997293	Rock Ck @ 3000 N	Yes	14%	2	7	2	2420	57
4997272	North Fields Ditch #1 @ 1200 N	Yes	83%	1	6	488	2420	1490
4997274	Middle Ditch @ 1200 N	Yes	86%	2	7	613	2420	1307
5910295	Rock Ck @ 1200 N AB Spring Ck	Yes	83%	1	6	186	2420	886
4997283	Spring Ck AB 1200 N	Yes	43%	2	7	140	2420	570
5910273*	London Ditch AB 1200 N	Yes	54%	8	37	172	2420	655
5910302*	London Ditch @ HWY 40	Yes	31%	8	39	30	2420	434
5910300	McDonald Ditch W HWY40 Coyote Ln	Yes	33%	1	6	241	2420	499
4997285	Creamery Ditch @ HWY 40	No	0%	2	7	14	567	53
4997280	Spring Ck AB Old Heber WWTP	Yes	57%	2	7	1	1207	252
4997268	Spring Ck AB Confl Rock Ck	Yes	57%	2	7	236	2420	887
5910210	Rock Ck AB Confl Spring Ck	Yes	43%	2	7	261	2420	640
4997264	Sagebrush Canal Diversion Inflow	Yes	14%	2	7	190	1367	393
5910490	Lake Ck W Heber City	No	0%	1	1	5	5	5
4997250*	Spring Ck AB Confl Provo R	Yes	71%	7	38	55	2420	923

Note: Light blue highlighted rows are impaired.

*Monitoring locations collected by PRWC.

This assessment analysis shows (Table 10) that the upstream monitoring locations (MLIDs 4997314, 5910510, 4997298, 4997289) and Creamery Ditch inflow (MLID 4997285) were not impaired for *E. coli*. Potential sources could be located downstream of 3000 North Road. Note that this assessment analysis only focuses on data collected during the 2019 recreational season. Data collected year-round were analyzed to fully understand the scope and trend of *E. coli* in the Spring Creek Assessment Unit.

4.1.2 Watershed Data Summary

DWQ and PRWC collected monthly water quality data at 19 sites in the Spring Creek Assessment Unit in late 2018 through December 2019. These monitoring locations (Figure 15) targeted all major riverine inputs and outputs including springs, canals, and stormwater outfalls. *E. coli* data summarized in Section 4.1.1 was specific to the IR Assessment Methodology and time frame of May through October (recreation season). The data summarized in this section include year-round data to help determine seasonal trends and critical seasons. Table 11 displays all the monitoring locations and their associated summary statistics from upstream to downstream.

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Table 11. *E. coli* (MPN/100mL) summary statistics in the Spring Creek Assessment Unit.

MLID	Name	Date Range	Sample Size	Minimum	Annual Geometric Mean	Maximum
4997314	Rock Ck at Diversion from Provo River	2018 - 2019	12	1	2	13
5910510	Rock Ck @ River Road Xing	2018 - 2019	12	2	12	86
4997298	McDonald Ditch BL River Road	2019	11	5	20	183
4997289	Middle Ditch @ 3000 North	2018 - 2019	12	10	44	138
4997293	Rock Ck @ 3000 N	2018 - 2019	12	2	32	2,420
4997272	North Fields Ditch #1 @ 1200 N	2019	10	43	689	2,420
4997274	Middle Ditch @ 1200 N	2018 - 2019	12	76	574	2,420
5910295	Rock Ck @ 1200 N AB Spring Ck	2019	11	33	440	2,420
4997283	Spring Ck AB 1200 N	2018 - 2019	12	21	199	2,420
5910273	London Ditch AB 1200 N	2010 - 2019	61	18	522	2,420
5910302	London Ditch @ HWY 40	2010 - 2019	62	4	287	2,420
5910300	McDonald Ditch W HWY40 Coyote Ln	2018 - 2019	11	70	324	2,420
4997285	Creamery Ditch @ HWY 40	2018 - 2019	12	1	26	567
4997280	Spring Ck AB Old Heber WWTP	2018 - 2019	12	1	198	1,207
4997268	Spring Ck AB Confl Rock Ck	2018 - 2019	11	102	594	2,420
5910210	Rock Ck AB Confl Spring Ck	2018 - 2019	12	35	350	2,420
4997264	Sagebrush Canal Diversion Inflow	2018 - 2019	11	28	209	1,367
5910490	Lake Ck W Heber City	2019	1	5	5	5
4997250	Spring Ck AB Confl Provo R	2011 - 2019	62	16	464	2,420

Sources of *E. coli* that contribute to the impairment at the farthest-downstream site in the Spring Creek Assessment Unit come from a variety of locations upstream:

- Spring Creek above the confluence of the Provo River (MLID 4997250) has an annual geometric mean of 464 MPN/100 mL, calculated from 62 samples from 2011 to 2019.
- There are two long-term monitoring sites on London Ditch (MLID 5910273 and 5910302) with similar sample sizes having geometric means of 522 and 287 MPN/100 mL, respectively.

- *E. coli* concentrations at the top of the assessment unit (Rock Creek at diversion from Provo River) are low and generally increase downstream (Figures 18 and 19).
- McDonald Ditch at River Road crossing (MLID 5910510) has a similar pattern, with low *E. coli* concentrations at the top of the assessment unit and higher concentrations downstream (MLID 5910300).
- North Fields and Middle Ditches lie within agricultural fields and are close to onsite septic systems. *E. coli* concentrations in these areas exceed water quality standards.
- Creamery Ditch at Highway 40 has lower *E. coli* concentrations, while the diversion from Sagebrush Canal (MLID 4997264) has elevated *E. coli* concentrations.
- The Lake Creek monitoring site (MLID 5910490) is one of the major stormwater outfalls for Heber City. It was sampled once in May 2019. *E. coli* concentrations were low.

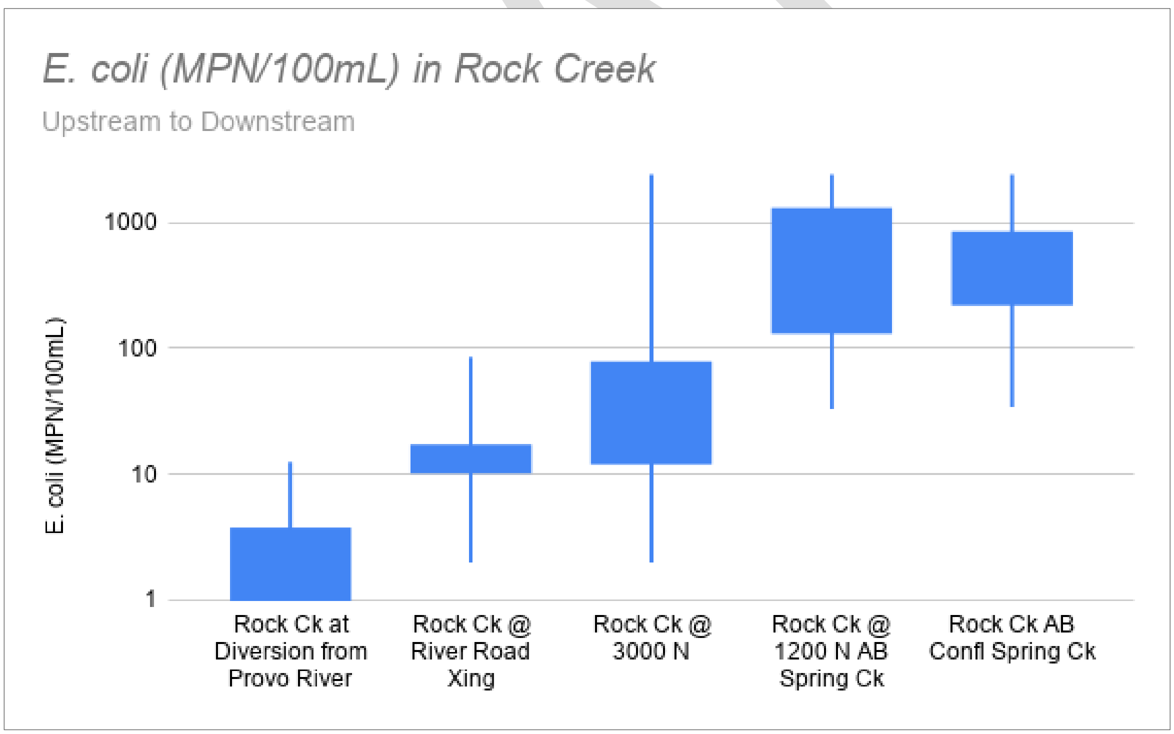

Figure 18. *E. coli* (MPN/100 mL) in Rock Creek from upstream to downstream (year-round records).

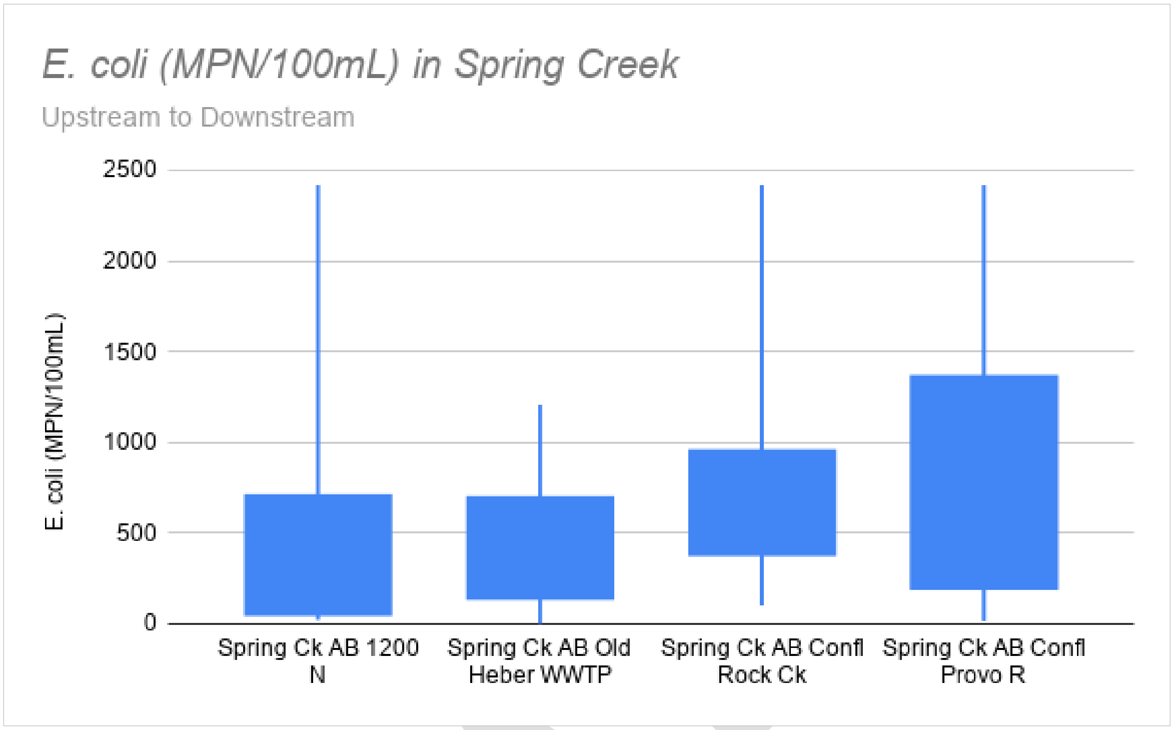

Figure 19. *E. coli* (MPN / 100 mL) in Spring Creek upstream to downstream (year-round records).

The rest of the summary analysis focuses on Spring Creek above the Provo River, MLID 4997250 (Figure 20).

Figure 20. Spring Creek above the Provo River (4997250) in January 2021.

Figure 21 shows that throughout the entire *E. coli* dataset (n=62), the not to exceed 10% of the time water quality standard of 668 MPN/100mL had an annual exceedance rate of 48%.

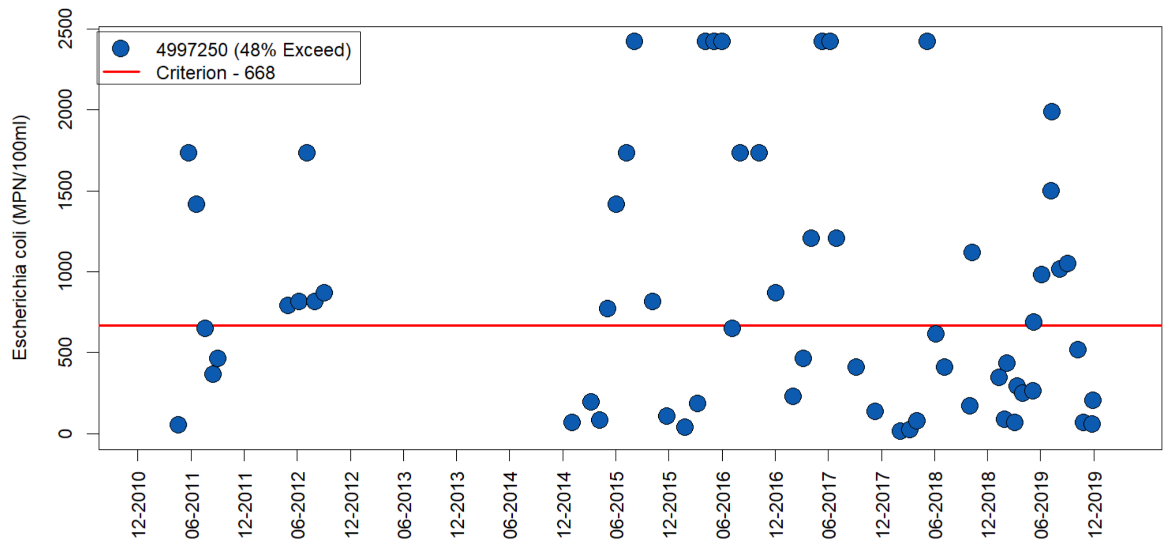

Figure 21. ***E. coli*** **(MPN/100mL) in Spring Creek above Provo River (4997250) time series.**

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There is a strong monthly seasonality to *E. coli* concentrations, with an increase from April through October (Figure 22) that corresponds with the recreational and irrigation seasons.

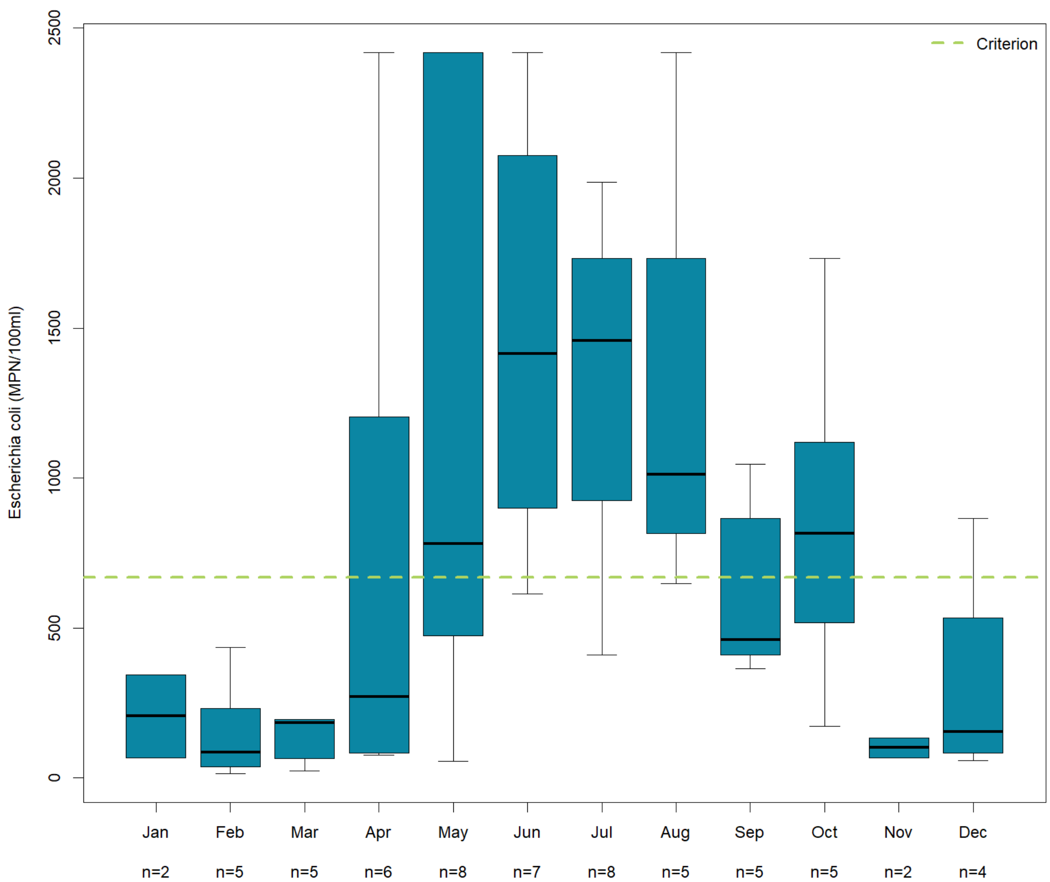

Figure 22. Monthly *E. coli* (MPN/100mL) in Spring Creek above Provo River (4997250).

E. coli concentrations are higher during the warmer months than cooler ones regardless of the year. Figure 23 shows the recreation seasons from 2011 to 2019, which spans May through October. Figure 24 shows the irrigation season (2011 to 2019) which typically spans from mid-May to mid-October. Chapter 5 discusses sources of *E. coli* in further detail.

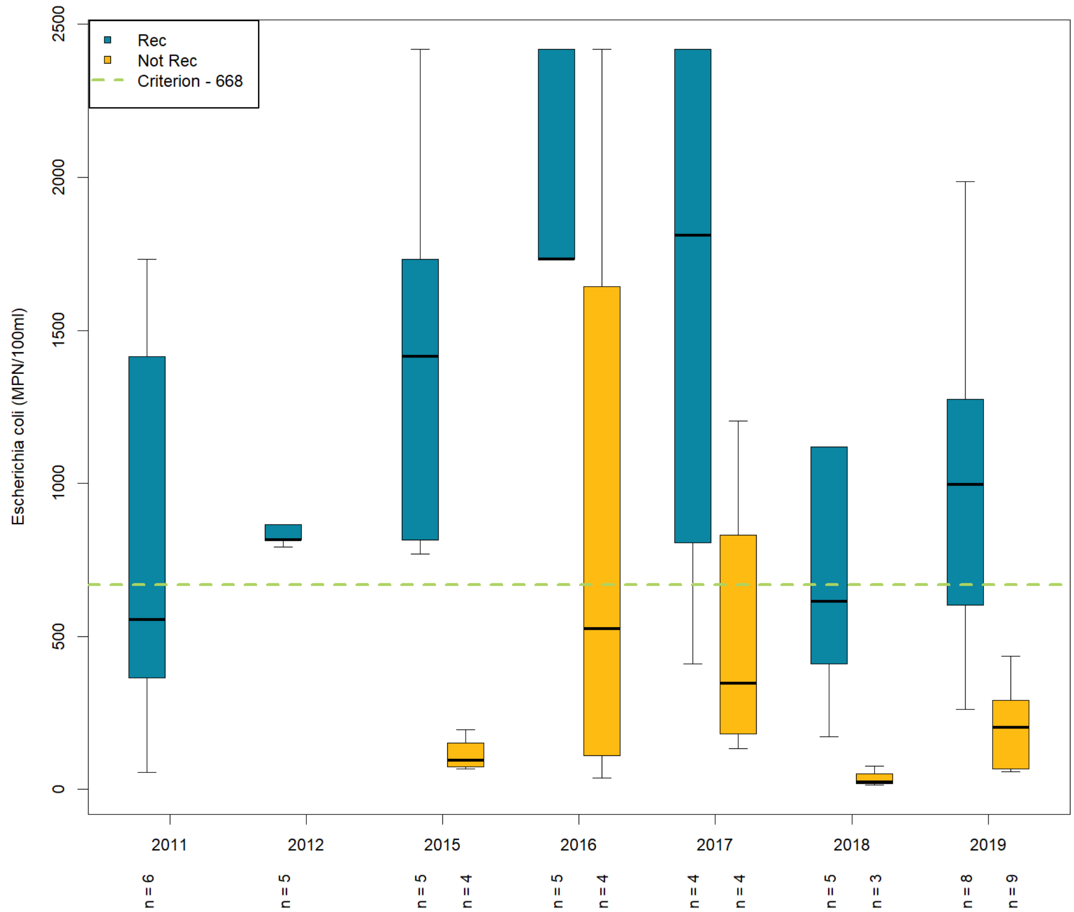

Figure 23. *E. coli* (MPN/100mL) in both recreation and non-recreation seasons in Spring Creek above Provo River (4997250).

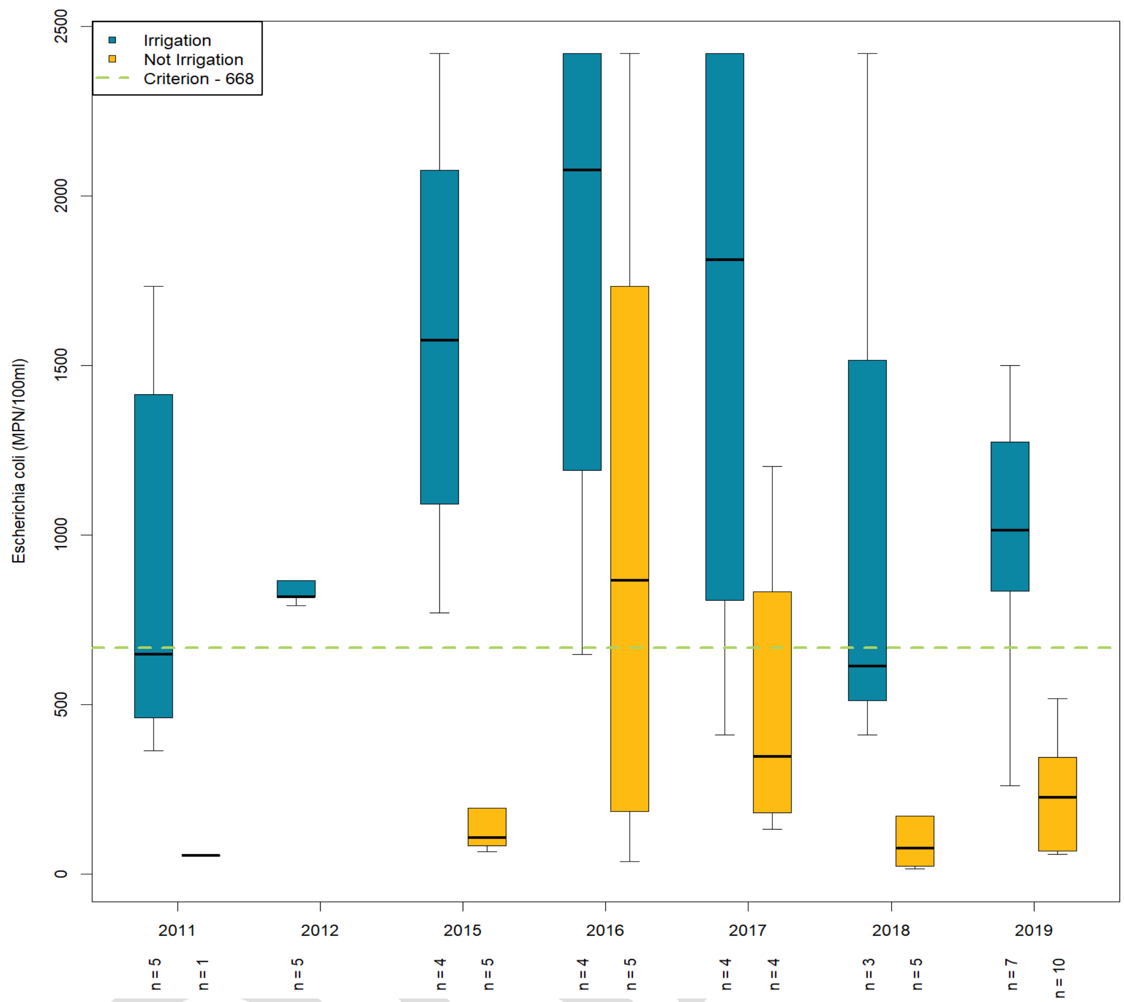

Figure 24. ***E. coli*** **(MPN/100mL) in both irrigation and non-irrigation seasons in Spring Creek above Provo River (4997250).**

4.1.3 Stormwater Data Summary

It is difficult to collect water quality samples during wet-weather (storm) events. DWQ collected one *E. coli* sample at the Lake Creek (MLID 5910490) stormwater monitoring site during the targeted monitoring year (2019), and it was during dry conditions (Figure 25). The *E. coli* sample was collected in May 2019 and had a value of 5 MPN/100mL, which is below the water quality standards (Table 11 above).

Figure 25. Lake Creek west of Heber City (5910490) in January 2021.

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Heber City collected seven additional *E. coli* samples during storm events in March 2020 along the Lake Creek conveyance network, a tributary that can eventually flow to Spring Creek at MLID 5910490. All samples were below numeric criteria and ranged between 4 and 35 MPN/100mL. Further investigation is needed during wet-weather events to fully understand if stormwater is a possible source of *E. coli* in the creek. Regardless, stormwater management will be critical in the future given development pressures in the Heber Valley area.

4.2 Flow Data Summary

There is only one active flow gage (USGS 101554400 Spring Creek near Heber) in the Spring Creek Assessment Unit. It was operated and maintained by the United States Geology Survey (USGS) from 1993 to 2005 and by Central Utah Water Conservancy District from 2005 to present. It is located a few feet upstream of the Spring Creek above Provo River monitoring location (MLID 4997250) where water quality is impaired.

Daily peak flows average between 80 and 100 cfs, with summer monthly averages closer to 30 cfs (Figure 26).

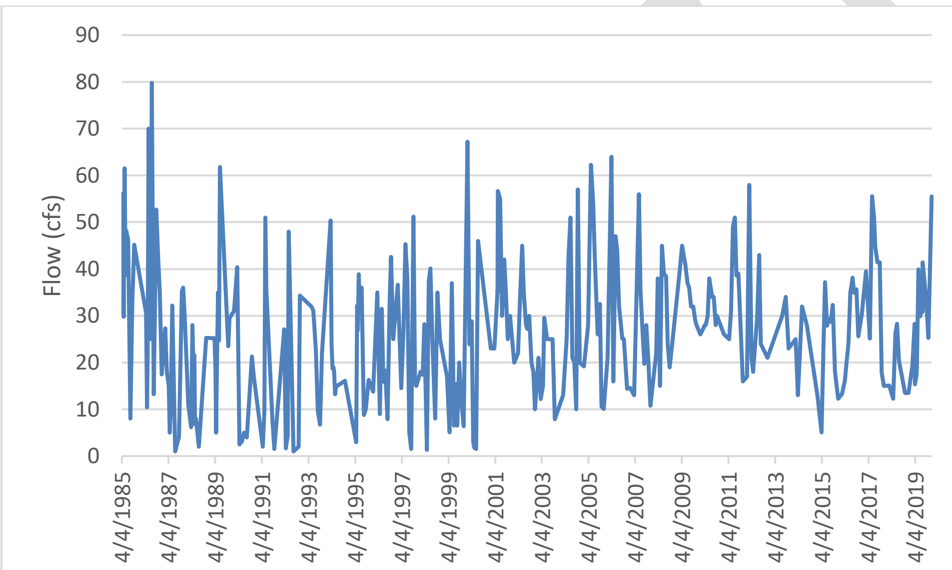

Figure 26. Flow (cfs) at Spring Creek near Heber (USGS 10155400) from 1985 to 2019.

Flow in Spring Creek remains relatively constant throughout the year per an agreement with a downstream water user, Daniels Irrigation Company (Section 3.3). This riverine system is highly managed and does not follow the normal hydrograph for this area of highest peak flows during spring runoff and lower base flows in late summer (Figure 27).

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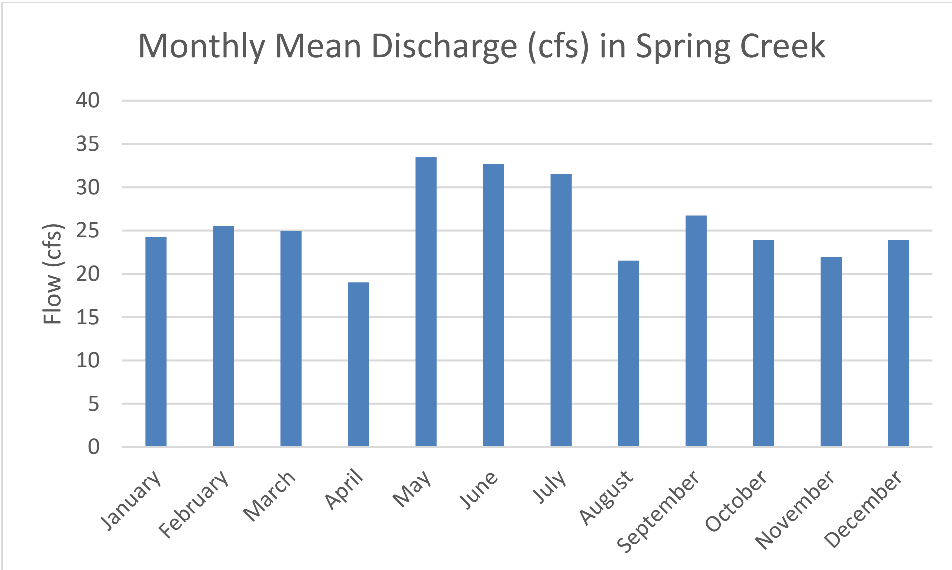

Figure 27. Monthly mean discharge in Spring Creek (1985 - 2019).

4.3 Other Parameters

Nitrates, pharmaceuticals and personal care products (PPCPs), and optical brighteners can serve as indicators of *E. coli* contamination from failing onsite septic systems. DWQ examination of these parameters in its source analysis did not show onsite septic systems to be a major source of contamination. More monitoring (e.g., microbial source tracking) is needed and will be included in future monitoring for this TMDL (Chapter 9). See Appendix A for more information on these parameters.

Chapter 5. Source Assessments

Pollutant sources are characterized as either point or nonpoint sources. Point sources are spatially discrete and regulated under the Utah Pollution Discharge Elimination System (UPDES) permits, while nonpoint sources are spatially distributed and not regulated. A summary of each source is provided below along with an estimate of the relative contribution of each.

5.1 Transport Pathways

There are three main transport pathways for *E. coli* to enter surface waters in the Spring Creek Assessment Unit: surface water runoff, shallow groundwater leaching, and direct deposition. Figure 28 shows a schematic of possible contamination routes.

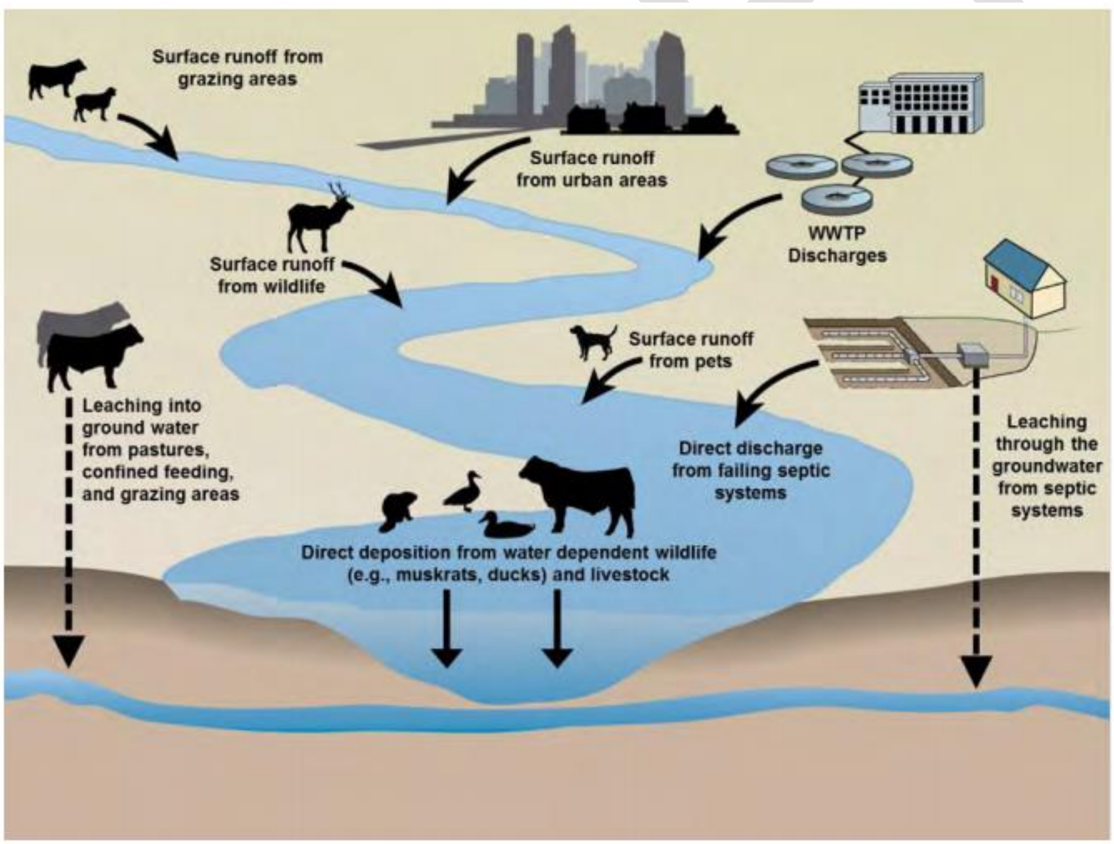

Figure 28. Possible bacteria transport pathways schematic (WY DEQ, 2018).

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Surface water runoff can transport *E. coli* to a waterbody when the water flowing over the ground does not filter into the soil. This potential pathway includes sources such as stormwater runoff and irrigation return flows.

Leaching (infiltration) is a process where precipitation or irrigation water carry pathogens downgradient through the soil. While soil generally has a filtering effect on contaminants, areas with shallow groundwater tables may increase subsurface *E. coli* loading to adjacent streams from sources such as failing onsite septic systems. This subsurface flow eliminates the exposure to direct sunlight and other limiting factors that reduce pathogen counts (USGS, 2005). The potential for subsurface flow varies throughout the year, but is typically more common in spring, co-occurring with melting snow, increased river flows, and saturated soils.

Direct deposition occurs when wildlife or livestock defecate directly into surface water or from illicit discharges. Often there is no reduction in *E. coli* loading between the source and receiving water body.

The hydrology of this assessment unit is complex (Chapter 3). Water is diverted from canals and ditches at several points and ends in pastures via flood irrigation. Water not absorbed by the soil becomes return flow to the river and accumulates *E. coli* when it encounters fresh fecal material. Precipitation events carrying water over impervious surfaces with little infiltration opportunities are also a likely source of *E. coli* loading to nearby surface waters.

The following sections provide more detail on the potential sources of *E. coli* contamination in the Spring Creek Assessment Unit. The source assessment presented below was conducted under the assumption that bacteria are deposited directly into the river. While it is likely that most defecation occurs on the landscape and most *E. coli* die before reaching the waterway, DWQ decided to omit a die-off rate to make the analysis more.

5.2 Point Sources

A point source is defined by CWA section 502(14) as “any discernible, confined and discrete conveyance, including any ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

This term does not include agriculture stormwater discharges and return flow from irrigated agriculture."

A point source may discharge effluent to a waterbody if the discharge is covered by a National Pollutant Discharge Elimination System (NPDES) permit. Effluent discharges are illegal when they violate the terms and conditions of an NPDES permit, or if they are not covered by a NPDES permit. In Utah, USEPA issues NPDES permits for point sources on federal property and tribal lands, and DWQ issues UPDES permits for discharges from all other point sources.

DWQ issues two types of UPDES permits: individual and general. Individual permits are for discharges from a single entity and involve a comprehensive permit application process. General permits cover a similar type of discharge across multiple entities. The general permits contain requirements for all permittees and are not specific to a single entity. NPDES and UPDES permits are reissued every five years or when a permit must be modified to account for alterations to the point source. NPDES/UPDES permits must be consistent with wasteload allocations developed in the TMDL process when they are reissued. Both NPDES/UPDES permits and TMDLs protect waterbodies from receiving more pollutant loading than the waterbody can assimilate.

5.2.1 Utah Pollutant Discharge Elimination System (UPDES)

The Jordanelle Special Service District Water Reclamation Facility (JSSDWRF, UT0025747) is the only permitted facility within this assessment unit (Table 12).

Table 12. Permitted point sources in the Spring Creek Assessment Unit.

Permittee	UPDES Permit #	Activity
Jordanelle Special Service District Water Reclamation Facility (JSSDWRF)	UT0025747	Domestic Wastewater Treatment

JSSDWRF is a domestic wastewater treatment facility with a maximum design flow rate of 1.2 million gallons per day (mgd). The facility was built in 2008 to serve future developments in the northern part of the Spring Creek Assessment Unit (Figure 29) around Jordanelle Reservoir north of Heber City. The facility began operating in the summer of 2020 and started receiving domestic wastewater and discharging effluent in September, 2020. JSSDWRF primarily discharges to the Timpanogos Canal. Timpanogos Canal has a terminal detention pond, so there is no surface connection between the canal and downstream

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waters. JSSDWRF has an alternative discharge point in the Wasatch Canal depending on agreements with the canal companies. Wasatch Canal is hydrologically linked to the Spring Creek system. The facility has an option to discharge to the Provo River, but that is limited to emergency situations.

The facility has an ultraviolet light system in place for disinfection purposes, so *E. coli* exceedances are very unlikely. *E. coli* limits are included in the permit and are set at 126 MPN/100 mL as a monthly average and 157 MPN/100 mL as a weekly maximum average, which is below the *E. coli* water quality standards for Spring Creek.

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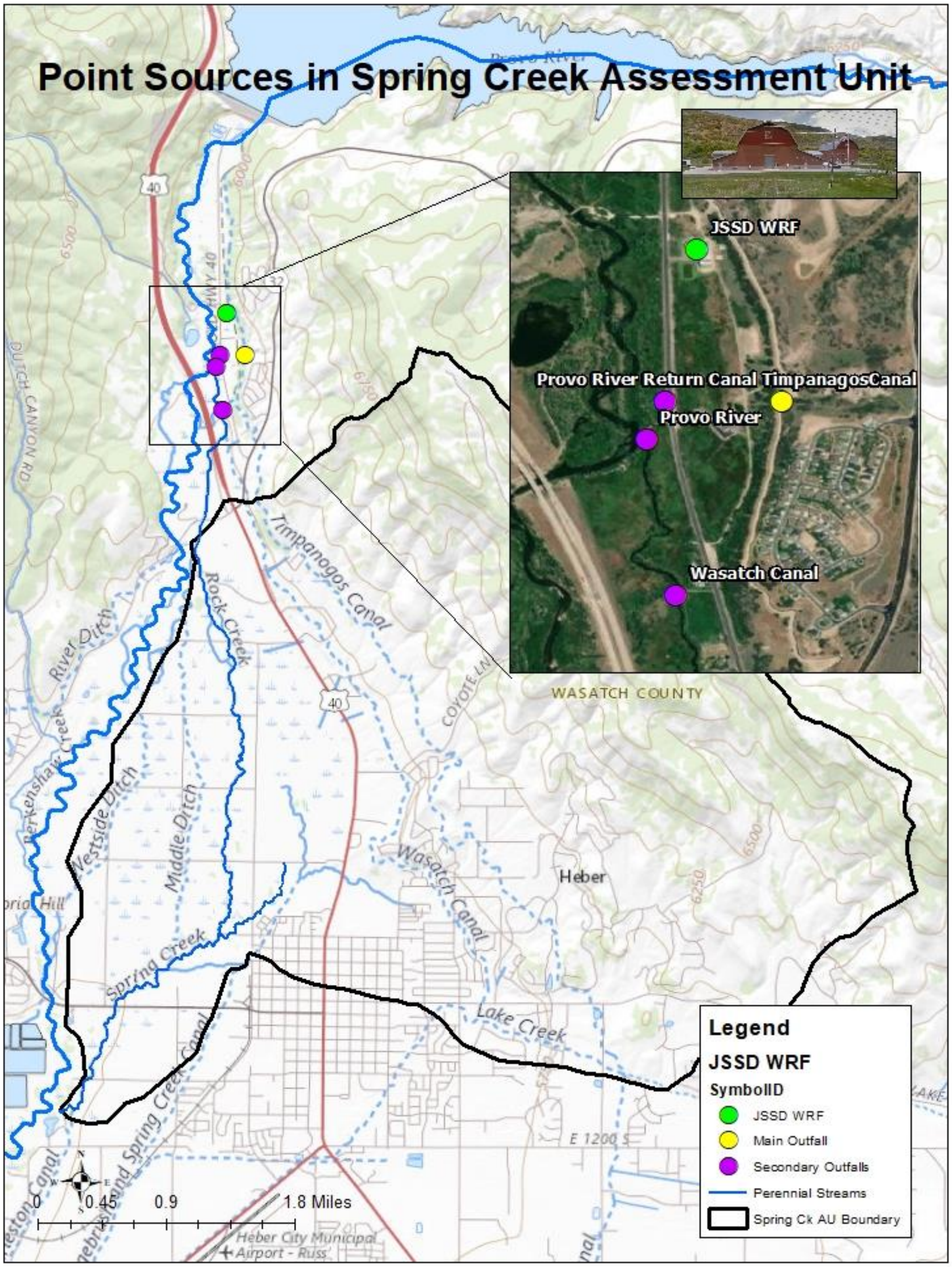

Figure 29. Point sources in the Spring Creek Assessment Unit.

5.2.2 Municipal Separate Storm Sewer Systems (MS4s)

A municipal separate storm sewer system (MS4) is a conveyance system designed to collect and carry stormwater. Most MS4s discharge untreated water into local waterbodies and can be a potential source of significant pollutant loading, including *E. coli,* to waterways. MS4 operators are required to obtain a permit for the system and to develop stormwater management programs (USEPA, 2020). Phase 1 MS4 permits are for medium and large municipalities serving over 100,000 people. Phase 2 MS4 permits are for smaller facilities that serve less than 100,000 people in an urbanized area defined by the Bureau of Census. Phase 2 permits take a slightly different approach than Phase 1 since they focus primarily on six main stormwater control measures: public outreach, public participation, illicit discharge, construction site runoff control, post-construction runoff control, and pollution prevention/good housekeeping (USEPA, 2005).

DWQ does not yet require Wasatch County, Heber City, and the surrounding areas to have an MS4 permit, but one may become necessary with the likely increase in development and population growth in the watershed. In the interim, Heber City is considering entering the MS4 program voluntarily. Details of their programs can be found in Section 5.3.6.

5.2.3 Animal Feeding Operations (AFOs)

USEPA defines animal feeding operations (AFOs) as agricultural enterprises where animals are kept and raised in confined situations. AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland (NRCS, 2020).

A confined animal feeding operation (CAFO) is a high-density AFO that contains more than 1,000 animal units. An animal unit is defined as an animal equivalent of 1,000 pounds live weight and equates to 1,000 head of beef cattle, 700 dairy cows, 2,500 swine weighing more than 55 pounds, 125 thousand broiler chickens, or 82,000 laying hens or pullets, confined on site for more than 45 days during the year. Any size AFO that discharges manure or wastewater into a natural or manmade ditch, stream or other waterway is defined as a CAFO, regardless of size (NRCS, 2020). Both operations have the potential to be a source of *E. coli* loading to any nearby waterbodies if runoff is not properly controlled.

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There are no permitted CAFOs located within the Spring Creek Assessment Unit. However, based on visual inspection, cattle and horse AFOs are present in the watershed. One goal of the TMDL implementation plan will be to identify AFOs and follow up with producers who are interested in making improvements to their operations.

5.3 Nonpoint Sources

Nonpoint source pollution comes from diffuse sources in the watershed rather than a single source. Nonpoint source pollution enters waterbodies through surface water runoff such as rainfall or snowmelt, or is deposited directly into streams. Potential contributors of nonpoint source *E. coli* pollution within the Spring Creek Assessment Unit include humans, wildlife, dogs, and livestock.

DWQ gathered and assessed nonpoint source information from the Wasatch County Health Department (WCHD), Wasatch Conservation District (WCD), Utah Division of Wildlife Resources, Wasatch County Planning Department, Heber City, and local landowners for this source analysis. This assessment sought to evaluate potential sources qualitatively so financial and technical resources can be directed efficiently and effectively to reduce their contribution.

5.3.1 Onsite Septic Systems

Onsite septic systems pose no significant threat to surface water quality when properly designed and maintained. However, failing or improperly designed or maintained systems can be a potential source of bacteria to waterways. WCHD records (2020) show 163 onsite septic systems within the Spring Creek Assessment Unit. Figure 30 below shows the distribution of those systems throughout the assessment unit.

WCHD has the authority to establish measures to promote and protect the health and wellness of county residents. The health department requires soil exploration tests, percolation tests, plot plans, and other items be submitted before a building permit is issued, and approval is only given when WCHD determines the system will not have a negative impact on public health or the environment. Utah Administrative Rule R317-4 also lists considerations and requirements to ensure proper system function, including a table of the required setback distances between onsite septic systems and critical water resources.

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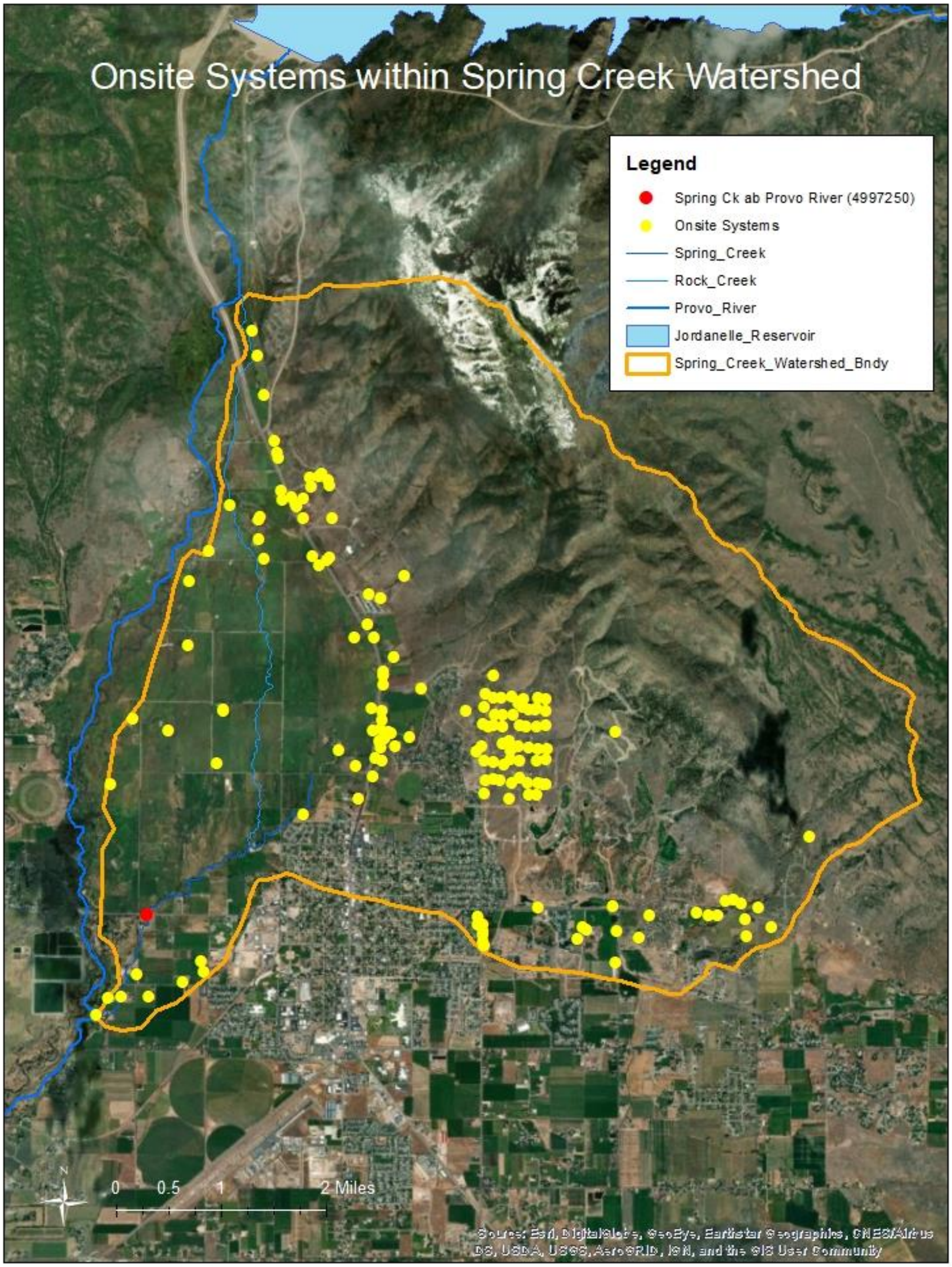

Figure 30. Onsite septic systems in the Spring Creek Assessment Unit.

Onsite septic systems near riparian areas can impact water quality. Riparian areas have higher water tables which increases the chance that onsite septic system discharge could intercept groundwater and make its way into surface waters.

It is difficult to estimate the failure rates of onsite septic systems due to the number of environmental variables that can affect them. Local health departments in Utah have been required since 2014 to track and submit data on onsite septic system complaints and failures in the annual reports they submit to DWQ. The actual numbers could be much higher from unreported failures or in cases where the untreated water does not ever reach the ground surface and remains undetected. USEPA estimates onsite septic systems have a failure rate between 10% to 20% nationally (USEPA, 2002). WCHD found similar failure rates for the county. There are no large underground wastewater disposal systems in the area (email from Robert Beers, DWQ, December 3, 2020).

The *E. coli* contribution from onsite septic systems for the TMDL was estimated using 163 households, coupled with the US Census Bureau estimate of three people per household in Wasatch County, an estimated system failure rate of 20%, the average daily fecal coliform production rate for humans, and 184 days in the recreation season (Table 14). Future monitoring in the area will continue to target nitrates, PPCPs, and optical brighteners, as they can be indicative of improperly functioning systems.

5.3.2 Livestock

Livestock grazing occurs year-round on private land in the Spring Creek Assessment Unit, particularly in the North Fields (Figure 31). In many cases, livestock graze near the creeks and have direct access to surface waters for stock watering. There are also instances of livestock grazing on irrigated pastures with return flows into the creek.

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Figure 31. Livestock grazing in the winter (2021).

Landowners are not required to report the number of animals on their property, and the numbers vary from year to year. Estimates of the number of animals grazing on private lands in the watershed were provided by the Wasatch Conservation District (January 2020 Wasatch Conservation District Board meeting). Those estimates are provided in Table 13.

Table 13. Estimated livestock numbers in the Spring Creek Assessment Unit.

Livestock Type	Estimated Number in Assessment Unit/Year (2020)
Beef cows	1,200
Dairy cows	100
Horses	350
Sheep	100

The livestock *E. coli* contribution for the TMDL was estimated using 100% of the estimates in Table 14 multiplied by 184 days in the recreation season and the average daily fecal coliform production rate specific to each livestock type.

Table 14. Bacteria production by source.

Animal[1]	Bacteria Production Rate (cfu[2]/animal/day)
Humans	2.00×10^{9}
Elk	3.30×10^{10}
Deer	3.50×10^{8}
Moose	$4.2 \text{ X } 10^{10}$
Beef Cattle	3.30×10^{10}
Dairy Cow	$2.5 \text{ X } 10^{10}$
Sheep	1.20×10^{10}
Horses	4.20×10^{10}
Dogs	5×10^{9}

[1]Human value taken from (Metcalf and Eddy, 1991). Dog value taken from (Horsley and Witten, 1996). All others taken from (Zeckoski, 2005). No moose value in literature so horse value used.

[2]cfu = colony forming unit. Note that CFU and MPN are similar measurements of bacterial concentration but they may vary slightly in values (Cho, 2010)

5.3.3 Wildlife

Wildlife could also be a source of *E. coli* loading in this assessment unit. Transport of animal waste to surface waters is dependent on animal habitat and proximity to surface waters. Waterfowl and riparian mammals often deposit waste directly into streams, while other riparian species deposit waste in the floodplain where it can be transported to surface waters by runoff during precipitation events. Animal waste deposited in upland areas can also be transported to canals, streams, and rivers; however, due to the distance from uplands to surface streams, only larger precipitation events can sustain enough runoff to transport upland animal waste to surface waters (Colorado Department of Public Health and Environment, 2019).

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The Spring Creek watershed overlaps the Wasatch Mountains West (17a) Wildlife Management Unit (WMU). The Utah Division of Wildlife Resources (DWR) Springville Office provided population estimates for big game for the WMU (personal communication between Dale Liechty, DWR, and Amy Dickey, DWQ, January 5, 2021). The Spring Creek watershed accounts for less than 2% of the WMU acreage. UDWR estimates that there are 3,000 deer, 800 elk, and 200 moose in the WMU based on the 2019 Utah Big Game Annual Report.

The wildlife *E. coli* contribution for the TMDL was estimated using 5% of the big game population estimates provided by DWR coupled with 184 days in the recreation season and the average daily fecal coliform production rate specific to each wildlife type (Table 14). Wildlife is considered a natural source and part of the background loading allocation for the purposes of this TMDL (Chapter 6).

5.3.4 Domestic Pets

Improper management of domestic pet waste is another potential source of *E. coli* loading into waterbodies. Dog waste in the immediate vicinity of a waterway can contribute to local water quality impacts.

The Heber City Dog Park, constructed in 2018, is the only dog park in the watershed. Located adjacent to Muirfield Park, it has a dog run, play features, water stations, restrooms, clean-up bags, and trash receptacles. DWQ staff investigated the potential for *E. coli* loading from the site and determined that the properly constructed berm and fence around the perimeter are likely sufficient to capture any potential runoff from the park.

According to an American Veterinary Medical Association survey of pet-owning households, 36% of Utah households own dogs, with a mean number of 1.6 dogs per household (AVMA, 2018). The dog *E. coli* contribution for this TMDL was estimated using 163 households, an average of two dogs per household, a 50% rate of improper disposal of waste, 184 days in the recreation season, and the average daily fecal coliform production rate for dogs (Table 14 above). Domestic pet waste appears to be a minor contributor of fecal contamination in the Spring Creek Assessment Unit because the estimated magnitude of this source is small compared to other sources.

5.3.5 Recreation

Individuals recreate throughout the watershed, and it is likely that a small percentage of those who use the North Fields for recreation are not properly disposing human waste. While it is a challenge to quantify this behavior, improper disposal of human waste does not appear to be a problem throughout the Spring Creek Assessment Unit based on field observations. People hiking and fishing in the assessment unit are considered an unlikely source of significant *E. coli* loading to Spring Creek for the purposes of this TMDL.

5.3.6 Unregulated Urban Stormwater

Impervious surfaces such as buildings and roads can increase the salts, sediment, nutrients, and bacteria flowing into surface waters from stormwater runoff. Bacteria sources in urban stormwater may include pet waste, leaking septic systems, and sewer lines.

There are several communities surrounding the Spring Creek Assessment Unit that generate urban stormwater runoff. The biggest and closest community is Heber City. The city formally recognized stormwater management as a priority in the Heber City Envision 2050 plan (Heber City, 2020). Heber City and the surrounding valley could soon be classified as a small MS4 due to the rapid growth of the area. DWQ has regulations and guidelines to help facilitate stormwater control for a such systems.

Heber City currently has guidelines in place to support proper stormwater management. These include:

1. Public outreach and education targeting residents, businesses, developers/contractors, and industrial facilities. The outreach focuses on specific pollutants that impact receiving waters, including sediments (dirt, clay, and sand), fertilizers and pesticides (nutrients such as nitrogen and phosphorus), and chemicals/hazardous waste (oil/grease, fuels, paint, cleaning products, etc.).
2. Storm water facilities inventory including a map of all storm drain components such as inlets, manholes, culverts, pipes, ponds, storage facilities, sumps, oil separator boxes, canals, discharge points, etc. The most up-to-date map can be seen in Figure 32.
3. Construction site stormwater runoff management. Construction operators are required to prepare a Storm Water Pollution Prevention Plan (SWPPP) and apply necessary controls to protect water quality and reduce pollutant discharge.

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4. Heber City Ordinance 15.08.080 which provides construction and building site stormwater control requirements.

Figure 32 shows the stormwater infrastructure of Heber City. One of its main stormwater outfalls flows into Spring Creek. This outfall was sampled once during source assessment monitoring (Section 4.1.3). This wet-weather sample was below the water quality standard for *E. coli*. In addition, Heber City conducted a synoptic survey in March 2020 at five storm drains that might contribute to the *E. coli* impairment in Spring Creek, including two replicates (n=7). All results were below the standard (Section 4.1.3). Though it does not appear that urban stormwater runoff is a significant source of *E. coli* contamination, any future monitoring plans for this area will include a wet-weather sampling component.

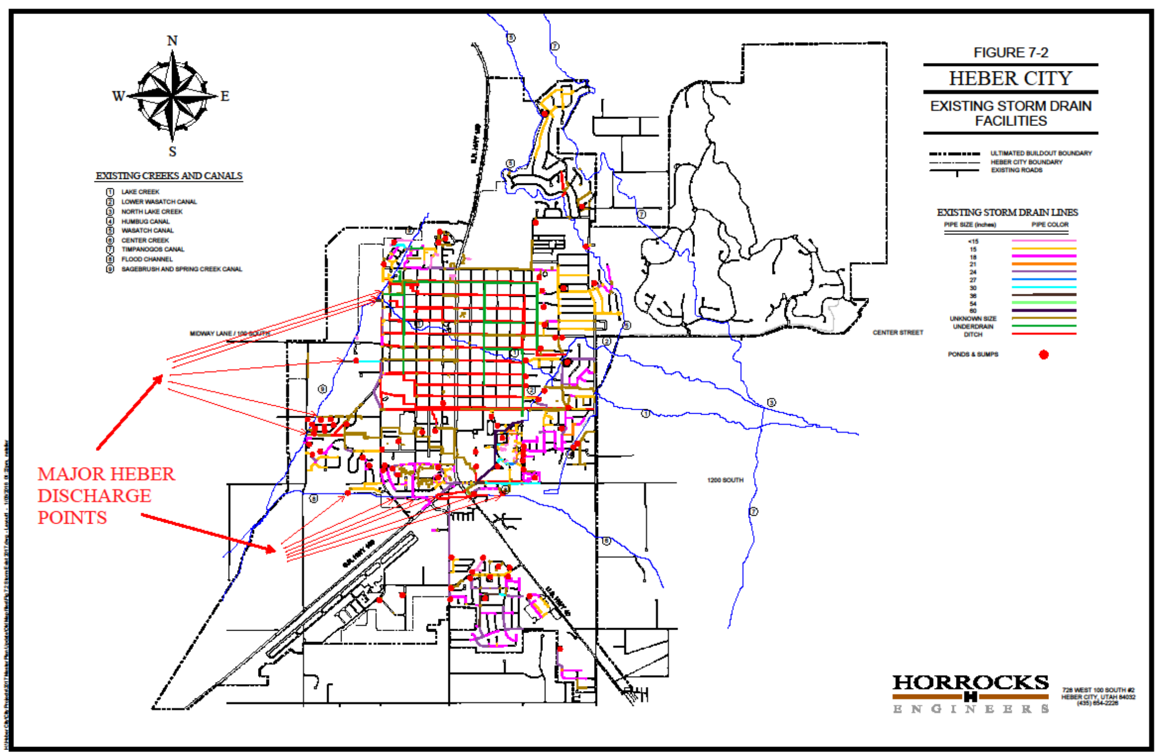

Figure 32. Storm drain facilities in Heber City.

5.4 Source Assessment Summary

An evaluation of *E. coli* loads by source was conducted using the bacteria production rate per animal and the number of animals in the watershed. The bacteria production rates presented below are based on research of fecal coliform bacteria, of which *E. coli* constitutes a large proportion. Fecal coliform levels have been shown to be well correlated with *E. coli* concentrations (Francy D. D., 1993). The intent of this evaluation was to compare the different sources relative to each other, provide evidence of likely contributors to the impairment, and help ensure that appropriate implementation measures can be taken. DWQ has assessed the possible contributions from plausible sources and have concluded the principal source is from animals. The assumptions used in this assessment are described below.

5.4.1 Bacteria Production

Bacteria production rates vary by animal, with cows and horses producing the largest loads, and deer producing the lowest (Table 14). In cases where literature estimates were not available, estimates were used based on animals with similar weights (i.e., livestock estimate for elk, and horse estimate for moose).

5.4.2 Source Assessment

Bacteria production rates from Table 14 were coupled with the estimated number of animals in the watershed during the recreation season to identify the relative contribution of bacteria by source. The number of animals in the watershed per source was estimated based on available data. Bacteria production was then summed by source to determine the relative contribution by source (Table 15 and Figure 33). According to this analysis, livestock contribute 96% of the *E. coli* loading, wildlife at 3%, and dogs and humans at less than1% each.

Table 15. Bacteria contribution by source during the recreation season.

Source	Bacterial Source	Fecal Coliform Production Rate (CFU/Animal/Day)	Number in Spring Creek (Heber) AU/Rec Season	Total Bacteria Production/Rec Season	Percent of Total Bacteria Production (%)
Elk	Wildlife	3.30×10^{10}	40 (5% of WMU total)	2.43E+14	2%
Deer	Wildlife	3.50×10^{8}	150 (5% of WMU total)	9.66E+12	<1%
Moose	Wildlife	4.2×10^{10}	10 (5% of WMU total)	7.73E+13	<1%
Septic Systems	Human	2.0×10^{9}	163	3.60E+13	<1%
Dogs	Dogs	5×10^{9}	326	9.78E+13	<1%
Horse	Livestock	4.20×10^{10}	350	2.70E+15	24%
Dairy Cow	Livestock	2.5×10^{10}	100	4.60E+14	4%
Beef Cow	Livestock	3.30×10^{10}	1,200	7.29E+15	66%
Sheep	Livestock	1.20×10^{10}	100	2.21E+14	2%

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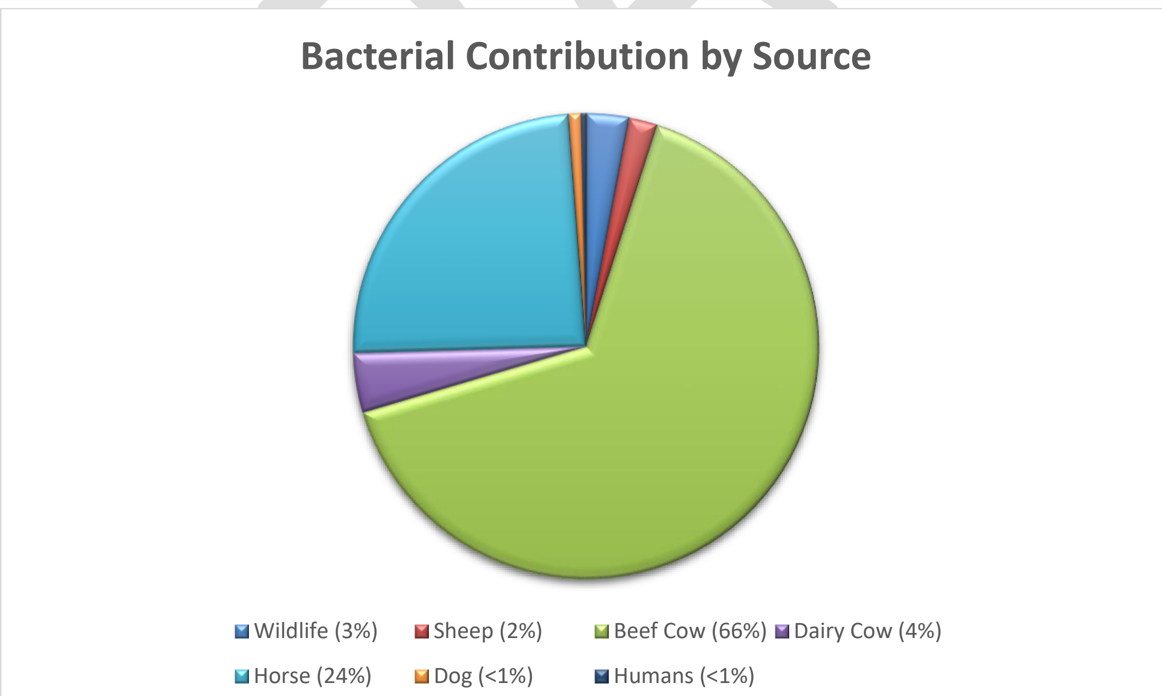

Figure 33. Estimated bacteria contribution by source during the recreation season.

5.4.3 Assumptions and Uncertainty

DWQ used several assumptions to conduct this source assessment and there are areas of uncertainty that are impossible to avoid in a study of this nature:

- DWR wildlife estimates do not consider the movement of animals in and out of the study area. This analysis does not account for any wildlife species other than deer, elk, and moose. It is likely that other species utilize the watershed. Five percent of the total WMU big game population estimates were used for source assessment purposes.
- Source contribution calculations for humans used the number of onsite septic systems with an assumed household population of three (US Census Bureau, 2020) and a system failure estimate of 20%. That number is based on the Bacteria Source Load Calculator Model (Zeckoski, 2005), which estimates that 20% of systems installed between 1966 and 1985 are failing. This percentage matched information provided by WCHD.
- Grazing numbers for livestock were estimates and can vary from year to year.
- DWQ assumed that recreators are not likely to be defecating in or near the river, so an estimate of the human recreation contribution was not included in this assessment.
- DWQ assumed that stormwater runoff is not likely to be a chronic source of *E. coli* loading to the Spring Creek Assessment Unit, so an estimate of the stormwater contribution was not included.

Chapter 6. Technical Approach

6.1 Calculation of Loading Capacity and Existing Loading

Loading capacity is the amount of pollutant that can be assimilated by a waterbody while still meeting water quality standards and protecting the waterbody's designated beneficial uses. This loading capacity is calculated by multiplying the water quality standard, the corresponding flow, and a conversion factor to determine the allowable pollutant load. The existing load is the amount of pollution that is observed in the river at the time of sample collection. If the existing load exceeds the loading capacity, the waterbody may be assessed as impaired and loading must be reduced.

The TMDL is equal to the loading capacity and is allocated among identified sources as wasteload allocations (WLA) from point sources, load allocations (LA) from nonpoint sources, a reserve capacity (RC) for future growth, natural background conditions (BC), plus a margin of safety (MOS). It is defined by the following equation:

$$TMDL = WLA + LA + RC + BC + MOS$$

Load Duration Curves (LDC) are generally calculated for the target site to compare existing water quality conditions with those required to meet water quality standards (US EPA, 2007). An LDC identifies the allowable and existing loads, uses data for all flow and loading conditions, and provides insight into critical conditions. LDCs are well-suited for analysis of periodic monitoring data collected by grab samples because they can help identify the major issues contributing to the impairment and differentiate between various types of sources.

The LDC calculation consists of the following steps:

1. Measured flow data are used to generate a flow frequency table ranking all the observed flows from the highest observed flow to the lowest. The ranked flows are plotted to create a flow duration curve.
2. The flow duration curve is translated into a load duration curve by multiplying each flow by the water quality standard (206 MPN/100 mL) and a conversion factor. This curve represents the loading capacity (or TMDL) for each observation.
3. Each instream sample value is converted to a daily load by multiplying the observed concentration by the corresponding observed flow and a correction factor.
4. The difference between the observed load and loading capacity for each flow regime quantifies the necessary load reductions during critical conditions. Both observed loads and loading capacities for conditions ranging from high flow to low flow are then plotted.

Loads plotted above the load duration curve represent exceedances of the loading capacity. Loads plotted below the curve represent allowable daily loads and are in

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attainment of water quality standards. Loads that plot above the allowable load curve in the 1-10% flow ranges (rare high-flow conditions) represent hydrologic conditions of flooding. Loads plotting above the curve between the 10% to 40% (moist) and 40% to 60% (mid-range) flow ranges likely reflect precipitation-driven contributions. Those plotting above the curve in the 60% to 90% flow ranges are indicative of constant discharge sources. Loads that plot above the curve in greater than 90% of all recorded flows reflect hydrologic conditions of drought.

An underlying premise of the LDC approach is the correlation of water quality impairments to flow conditions. The LDC alone does not consider specific fate and transport mechanisms, which can vary depending on watershed or pollutant characteristics. The LDC approach helps identify the issues surrounding the impairment and roughly differentiates among sources. Table 16 summarizes the relationship between the five hydrologic regimes and potential contributing source areas (US EPA, 2007). For example, when a stream is dominated by point source loading under drier conditions, the loads calculated from observed instream data will form a linear cluster in the drier conditions of the LDC. If the linear cluster plots are above the LDC, then the point source loading is causing the impairment.

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Table 16. Relationship between LDC hydrologic regimes and the probability of contribution from applicable sources.

Contributing Source Area	Hydrologic Regime				
	High (0-10%)	Moist (10-40%)	Mid-Range (40-60%)	Dry (60-90%)	Low (90-100%)
Point Sources	Low	Low	Low	Medium	High
Onsite Septic Systems Treatment	Low	Low	Low	Medium	Low
Riparian Areas	Low	High	High	High	Low
Stormwater: Impervious	Low	High	High	High	Low
Stormwater: Upland	High	High	Medium	Low	Low
Bank Erosion	High	High	Low	Low	Low

The LDC for Spring Creek above the confluence of the Provo River (MLID 4992750) shows exceedances occurring at all flow regimes. (Figure 34). Exceedances of the TMDL (red line) in high to low conditions indicate the potential for multiple sources of *E. coli* in the Spring Creek Assessment Unit. *E. coli* loading reductions of 100% are needed during the high flow and low flow regimes. Reductions ranging from 40 to 95% are needed during the dry to moist conditions. The necessary load reduction by flow regime is provided in parentheses under each flow regime label in Figure 34.

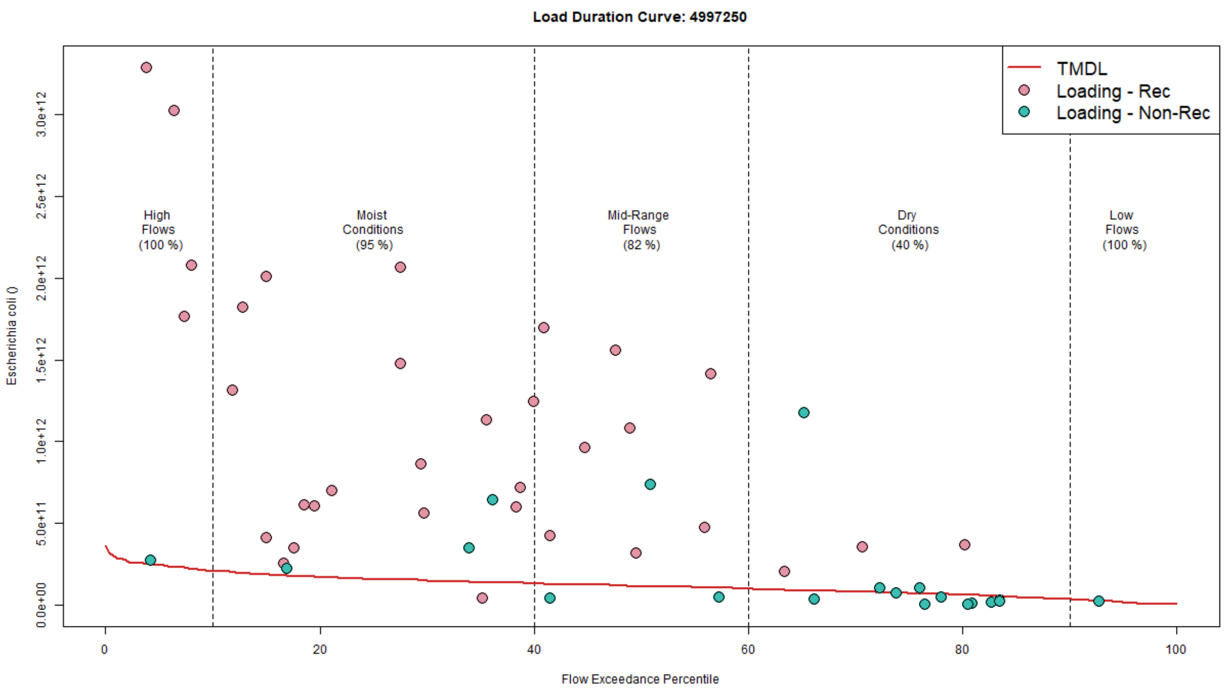

Figure 34. Recreation and non-recreation season load duration curve for Spring Creek above Provo River (4997250).

Figure 35 shows the distribution of *E. coli* loading by flow regime. *E. coli* loading during high flow conditions (n=5) is greater than the other flow regimes, suggesting that pollutant sources are likely nonpoint sources and driven by precipitation events

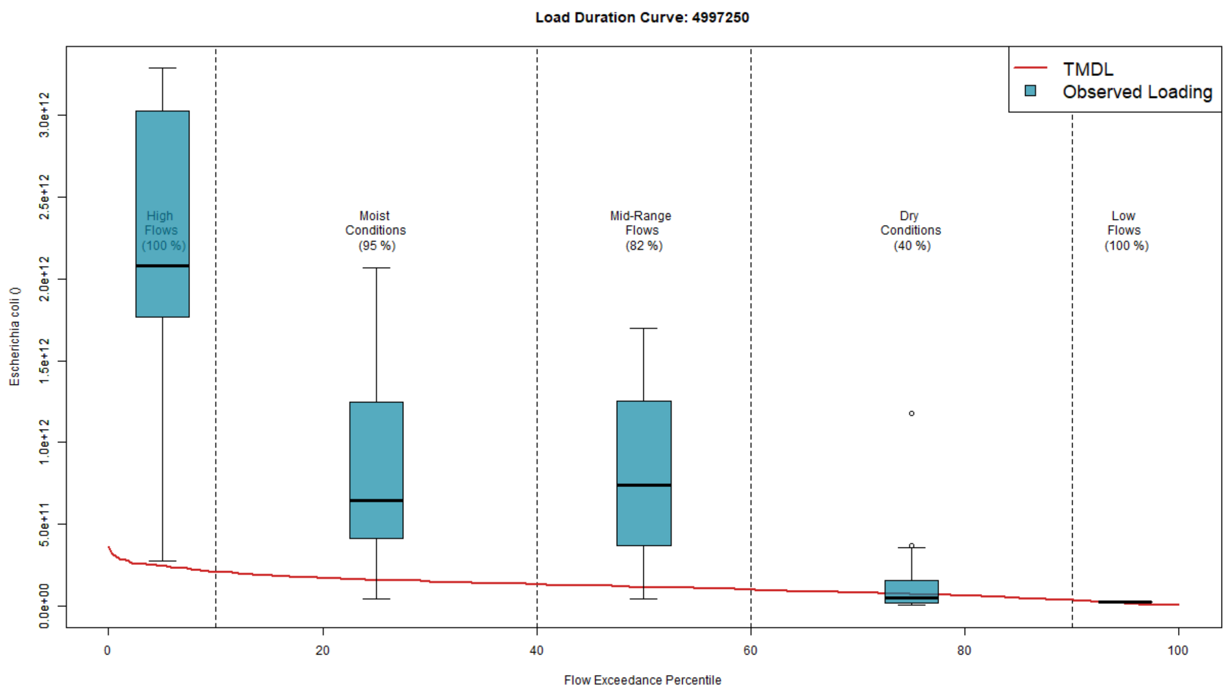

Figure 35. Recreation season LDC for Spring Creek above Provo River (4997250) as a boxplot.

6.2 TMDL Results

TMDL results were calculated using daily flow measurements and daily geometric means of *E. coli* concentrations. Loading capacities and observed loadings were calculated at the Spring Creek above the confluence of Provo River (4997250) site for each month and each flow regime. Figure 36 and Table 17 show that a larger reduction in loading is needed during the warmer months, coinciding with the recreation season of May through October. The percentages next to the month labels in Figure 36 are the percent reductions needed to ensure water quality standards are met for protection of the recreational beneficial use.

The geometric mean standard of 206 MPN/100mL was used to determine the loading capacity. An overall reduction of 81% of *E. coli* loading is needed to meet water quality standards. The overall percent reduction needed was calculated by averaging and comparing the observed loading and TMDL (loading capacity minus margin of safety) within these five months. The average critical season observed loading is 77.92 GigaMPN/day and loading capacity is 16.29 GigaMPN/day (Table 17).

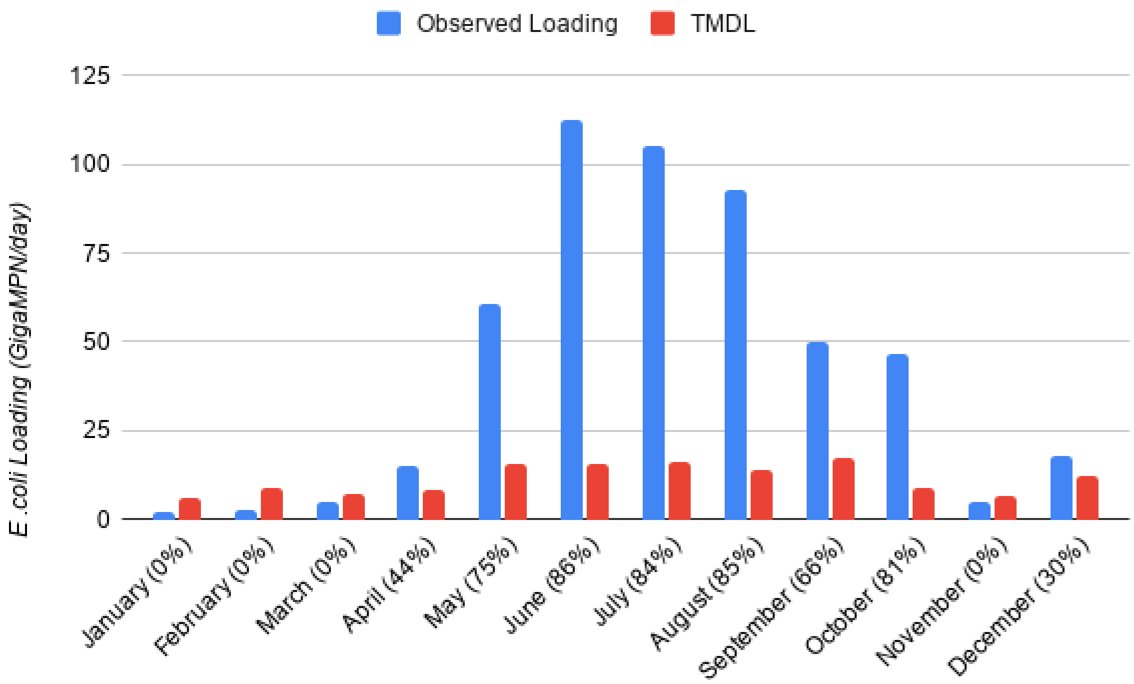

Figure 36. Geometric mean *E. coli* observed loading vs. geometric mean loading capacity (TMDL) per month for Spring Creek above Provo River (4997250).

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Table 17. Monthly *E. coli* load (GigaMPN/day) reductions needed for Spring Creek above Provo River (4997250).

Month	Observed Loading	Loading Capacity	MOS	TMDL	Necessary Reduction
January	2.13	6.55	0.66	5.90	0 %
February	2.84	9.97	1.00	8.97	0 %
March	4.70	7.96	0.80	7.16	0 %
April	14.94	9.26	0.93	8.33	44 %
May	60.77	17.21	1.72	15.49	75 %
June	112.55	17.54	1.75	15.79	86 %
July	105.06	18.17	1.82	16.35	84 %
August	92.70	15.64	1.56	14.08	85 %
September	50.06	19.12	1.91	17.21	66 %
October	46.36	10.04	1.00	9.03	81 %
November	4.90	7.56	0.76	6.80	0 %
December	17.88	13.85	1.38	12.46	30 %
Critical Season	**77.92**	**16.29**	**1.63**	**14.66**	**81%**

6.2.1 Seasonality

Data for this TMDL were collected during the recreational season and throughout the winter months to better understand the seasonality of exceedances. The critical season for this *E. coli* TMDL is determined by the months when a reduction is warranted. Figure 36 shows the critical season to be May through October. Though exceedances were observed in April and December, these months are outside of the recreational period and are not defined in this TMDL's critical season. The recreational period (May through October) is designed to protect human health (Section 2.4).

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6.2.2 Margin of Safety

The margin of safety (MOS) refers to a required component of the TMDL that accounts for uncertainty in the relationship between the pollutant loads and the quality of the receiving waterbody (CWA section 303(d)(1)(C)). The MOS can be implicit through use of conservative assumptions and values for calculations, or explicit as a certain percentage of the loading capacity. Implicit components in this TMDL include the use of the more conservative geometric mean standard of 206 MPN/100 mL for calculations and averaging the critical season months for required reductions in the TMDL calculations. For the Spring Creek TMDL, the MOS is explicitly defined as 10% of the loading capacity. The MOS for the Spring Creek Assessment Unit is 1.63 GigaMPN/day.

The TMDL equation is the loading capacity minus the MOS.

$$16.29 \text{ GigaMPN/day} - 1.63 \text{ GigaMPN/day} = 14.66 \text{ GigaMPN/day}$$

An overall seasonal reduction of 81% is necessary for the Spring Creek Assessment Unit to meet the TMDL and protect its drinking water and recreational beneficial uses.

6.3. Loading Allocation

A loading analysis provides an estimate of a waterbody's pollutant load capacity, MOS, and allocations of pollutant loads to sources defined as the TMDL in USEPA regulations (40 CFR 130.2). Pollutants loads are allocated among the sources in a manner that will describe the maximum amount of each pollutant (the total maximum load) that can be discharged into a waterbody over a specified amount of time while maintaining water quality standards for a particular beneficial use. These source allocations are required for each permitted point source (as WLAs) and for all categories of nonpoint sources (as LAs), and the sum of these allocations must not exceed the load capacity. Load allocations are an integral part of the TMDL, as they represent the basic road map to attainment of water quality standards (US EPA, 2007). The TMDL for the critical season (May through October) for the Spring Creek Assessment Unit is 14.66 GigaMPN/day.

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6.3.1 Wasteload Allocation (WLA)

JSSDWRF is the only point source in the Spring Creek Assessment Unit that could contribute to *E. coli* loading (depending on the discharge point). JSSDWRF's discharge location is determined by a Memorandum of Understanding with the canal companies. Currently, the facility discharges into Timpanogos Canal, which terminates at a detention pond with no direct connection to Spring Creek. If the facility uses its alternate discharge point into the Wasatch Canal, there is the potential for some treated effluent to enter the Spring Creek riverine system.

The WLA portion of the TMDL is reserved for the JSSDWRF (Section 5.2.1) discharge and is based on the *E. coli* geometric mean standard of 126 MPN/100mL as a monthly average in the facility's existing UPDES permit. The wastewater treatment facility began discharging in 2020 and did not contribute to the original *E. coli* impairment. The maximum daily discharge volume under the facility's permit is 1.2 million gallons per day (MGD) or 1.86 cfs. Table 18 shows the WLA for JSSDWRF is calculated as 0.57 GigaMPN/day.

6.3.2 Natural Background

A portion of the load allocation is earmarked for natural background conditions (BC). It is represented by the wildlife category. This loading is based on the wildlife fecal contribution described in Section 5.3.3. BC for the Spring Creek Assessment Unit is 1.36 GigaMPN/day.

6.3.3 Reserve Capacity (RC)

Reserve capacity (RC) is an optional allocation for future growth. RC is included in a TMDL to account for new or increased pollutant loading in the watershed due to anticipated land use changes and growth demands. Both Heber City and Wasatch County are expected to double their population by 2050 (Heber City, 2020). Heber Valley has already seen a significant shift in land use from agriculture and open space to developed lands (Appendix B). This trend will likely continue given the future demand for growth. Changes due to growth include increased impervious surfaces, centralized stormwater runoff, and loss of vegetation and soils to dampen the speed of runoff. This reserve can be either a separate element in the mathematical equation or included implicitly in the WLAs or LAs (USEPA, 2015).

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RC for the WLA was addressed implicitly using JJSDWRF's maximum design flow of 1.2 million gallons per day (mgd), an increase to its current average daily discharge of 1 mgd. Given the anticipated growth demands and land use changes in the Heber Valley area, the RC for the LA is expressed explicitly. It is calculated by subtracting the WLA and natural background allocation from the TMDL and calculating five percent of the remaining load allocation (WI Department of Natural Resources, 2020). The RC for this TMDL is calculated as 0.64 GigaMPN/day.

6.3.4 Load Allocation (LA)

The LAs represent the maximum amount of a pollutant that can be contributed from diffuse sources. Because these sources are not regulated by a discharge permit, their *E. coli* contributions are addressed through voluntary programs. LAs also include background or natural conditions in the calculation. This portion of the TMDL focuses on estimating the cumulative contribution of all nonpoint sources in the Spring Creek Assessment Unit.

The LA was calculated as the TMDL minus the WLA, RC, and BC. The LA of 10.46 GigaMPN/day is shared among the nonpoint sources outlined in Chapter 5.

This TMDL does not mandate how to attain load reductions for nonpoint sources, but it does provide recommendations in the Implementation Plan (Chapter 9) for voluntary incentive grants to facilitate nonpoint source reductions.

6.3.5 TMDL Allocation

The final TMDL allocation for the Spring Creek Assessment Unit is provided in Table 18 and calculated as the:

Wasteload Allocation (WLA) + Background Concentration (BC) + Reserve Capacity (RC) + Load Allocation (LA) + Margin of Safety (MOS) = TMDL

0.57 GigaMPN/day (WLA) + 1.36 GigaMPN/day (BC) + 0.64 GigaMPN/day (RC) + 10.46 GigaMPN/day (LA) + 1.63 GigaMPN/day (MOS) = 14.66 GigaMPN/day

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Table 18. TMDL allocation for Spring Creek above Provo River (4997250).

TMDL Allocation		*E. coli* Loading (GigaMPN/day)
Observed Loading	Total	77.92
TMDL	WLA	0.57*
	Background	1.36
	Reserve Capacity**	0.64
	LA	10.46
	MOS	1.63
	TMDL	14.66

*Calculated at maximum design flow to account for future growth.
**RC is explicit calculation for LA.

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Chapter 7. Reasonable Assurance

USEPA requires TMDLs with pollutant load reductions from point and nonpoint sources to provide reasonable assurance (RA) that load allocations will be achieved. This requirement prevents excessive assumptions about reductions to nonpoint source pollution and enhances the TMDL's defensibility. RA is typically implemented through ordinances, state rules and discharge permits, and watershed or guidance documents.

The RA for permitted sources in the Spring Creek Assessment Unit provides compliance through their UPDES permit or local ordinances. RA for nonpoint sources, such as livestock or onsite septic systems, is provided by the 2022 Heber Valley Watershed Plan, the state nonpoint source reduction program, other planning documents, and partnerships with stakeholders.

Point Source RA

Permitted Wastewater NPDES Program

Wastewater dischargers that operate under a UPDES permit are required to disinfect wastewater to reduce *E. coli* concentrations to 157 organisms/100 mL or less as a weekly geometric mean under their discharge permit. Utah

Administrative Code (UAC) R317-8 authorizes this permit limit. The primary function of a bacterial effluent limit is to assure that the effluent is being adequately treated with a disinfectant to assure complete or near-complete kill of fecal bacteria prior to discharge. JSSDWRF has an ultraviolet light system in place for disinfection, so *E. coli* exceedances are very unlikely.

MS4 Program

This TMDL will be updated to accurately reflect the allocation for stormwater if Heber City and surrounding municipalities obtain a MS4 Stormwater Permit. These permits require the implementation of best management practices (BMPs) to reduce pollutants in stormwater. Permittees are required to develop a Stormwater Pollution Prevention Plan (SWPPP) that outlines their activities for managing stormwater within their jurisdictional boundary. UAC 317-8.9 authorizes this permit.

CAFOs

Currently, the Spring Creek Assessment Unit does not contain any permitted CAFOs. If new feeding operations arise, they will be required to obtain a UPDES discharge permit. UAC R317-8-2.5 and R317-8-10 authorize the issuance of this general permit to protect water quality from potential pollution sources resulting from CAFO operations.

Nonpoint Source RA

There are several non-permitted sources identified in this report that can support reductions of *E. coli* loading into the Spring Creek Assessment Unit. These sources and associated programs identify and prioritize BMPs via ordinances, initiatives, and dedicated funding programs. Chapter 9 outlines a strategic implementation plan to address nonpoint sources in the Spring Creek Assessment Unit.

Monitoring and reporting will be conducted to determine the effectiveness of BMPs in reducing *E. coli* loading into Spring Creek. If monitoring shows that load reductions are not occurring to the extent necessary, BMPs will be modified accordingly. This monitoring and the BMP modification "feedback loop" provides further assurance that estimated load reductions will be achieved through a suite of BMPs. The monitoring plan is included in Chapter 8.

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Livestock/Agriculture

Utah Code 17D-3 authorizes the Wasatch Conservation District to work with local landowners to promote and conserve soils, wildlife, forests, and water resources by addressing natural resource concerns at a local scale. WCD secured nonpoint source funds to develop a watershed plan for the Heber Valley to address natural resource concerns, including elevated levels of *E. coli* in Spring Creek. The watershed plan will be developed by 2022 (Chapter 9), with projects under the plan eligible for state and federal funds. Stakeholders are already implementing strategies to improve water quality before the plan is finalized. The Conservation District is committed to implementing agricultural BMPs on its own irrigated pastures to serve as demonstration projects for the community.

DWQ, in cooperation with the Utah Department of Agriculture and Food (UDAF), manages the Agricultural Voluntary Incentive Program (AG-VIP). This program incentivizes producers to develop Comprehensive Nutrient Management Plans (CNMPs) that help maximize crop yields while staying in compliance with state water quality regulations. These plans could help reduce nonpoint source pollution in the Spring Creek Assessment Unit.

Onsite Septic Systems

Onsite septic systems are permitted and managed by the Wasatch County Health Department per Wasatch County Code Title 10.02. The health department oversees the design, approval, construction, installation, inspection, and maintenance of these disposal systems and requires a separation from groundwater and soil percolation test. UAC R317-4 also lists considerations and requirements to ensure proper system function, including a table of the required setback distances between onsite septic systems and critical water resources.

Pets

Wasatch County strictly enforces dog leash laws in this assessment unit (County Code 8 for Animal Control) and stipulates conditions and penalties for noncompliance. Dog waste stations can help pet owners clean up after their pets, and an outreach and education campaign can educate dog owners on the potential impacts of pet waste on water quality.

Unregulated Stormwater

Heber City has developed a SWPPP that includes recommendations for appropriate BMPs at a site-specific level. The city is currently discussing a standardized approach to stormwater management across the valley, regardless

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of jurisdictional boundaries, that could incorporate more stringent requirements aimed at protecting water quality. Wasatch County (via County Code Title 14 and Title 16:40) manages stormwater by minimizing runoff from construction sites and implementing their SWPPP. Wasatch County's recent watershed inventory recommends taking a "performance-based" approach to stormwater regulation. Performance based approach refers to manufactured BMPs able to meet specific performance goals retaining offsite runoff. "The County has water quality goals for developers to satisfy, however, the developers choose and can reasonably demonstrate compliance" (T-O Engineers, 2019). A combination of thorough evaluation and performance-based standards could be ideal to ensure water quality goals are met.

The PRWC is committed to protecting and restoring water resources within the Provo River drainage. They provide stormwater development reviews and follow-up inspections for Wasatch County through an interlocal agreement. These reviews and post construction inspections aid county planners to ensure development follows local ordinances controlling stormwater runoff.

DWQ manages stormwater by issuing UPDES permits for MS4s, construction, and industrial sources. Permittees are required to obtain a discharge permit which prevents stormwater runoff from washing pollutants into surface waters. The permit provides information on pertinent BMPs by source, guidance on how to retain 90th percentile storm events onsite, example ordinances, and a newly developed low-impact development (LID) manual.

Chapter 8. Monitoring Plan

Follow-up monitoring ensures implementation efforts result in the attainment of water quality standards. DWQ, in collaboration with other stakeholders, will continue to collect *E. coli* samples when and where appropriate to evaluate the effectiveness of pollution-control efforts. Current water quality trends will be analyzed on a routine basis to determine TMDL attainment.

DWQ will monitor the impaired site (MLID 4997250: Spring Creek above the confluence with the Provo River) until full-support status is reached for the assessment unit and it can be delisted for *E. coli*. Ideally, samples will be collected twice per month throughout the recreation season so results can be compared to the recreation season geo-mean standard that requires five or more samples collected between May through October. This effort will depend on the

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availability of monitoring resources to collect samples during the recreation season. The PRWC will continue *E. coli* monitoring and flow measurement at three long-term monitoring sites.

Data collection for development of this TMDL included 19 monitoring locations sampled year-round. Future monitoring will only take place at the target site that triggered the impairment and only during the recreation season from May through October. Additional sites will be added above and below nonpoint source reduction projects to determine project effectiveness on a smaller scale.

Many *E. coli* studies include a microbial source tracking (MST) component to determine the sources of bacteria in the river through genetic analysis. MST techniques can often help determine if the source is human, wildlife, or domestic animal. This source tracking monitoring will be a priority in this watershed. Ideally, samples are collected during multiple flow regimes including spring runoff, precipitation events, and base-flow conditions. MST analysis is expensive, so stakeholders will have to develop the most efficient strategy to collect this type of data.

Various entities have monitored nitrogen in the Spring Creek watershed in the past, and this monitoring will continue to be a priority. PRWC will continue to collect PPCP samples at the impaired site, including parameters indicative of anthropogenic sources of *E. coli*. Future monitoring of nitrogen and PPCPs will be important as increased development leads to additional onsite septic systems throughout the valley.

Stormwater outfalls in the watershed have the potential to result in *E. coli* loading to Spring Creek. It is likely that the amount of stormwater runoff will increase as development continues to increase in the area. Stormwater has been sampled intermittently in the Spring Creek Assessment Unit over the past few years. If Heber City becomes a permitted MS4, sampling may be required on a more regular basis as part of the permit requirements, with a focus on sample collection during precipitation events to obtain the maximum *E. coli* loading potential from stormwater.

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Chapter 9. Implementation Strategy

BMPs will be implemented for nonpoint source reductions to achieve TMDL endpoints. BMPs are practices used to protect and improve the physical, chemical, and biological integrity of surface and groundwater from nonpoint sources of pollution. These management practices are most effective when combined to create a comprehensive BMP system that reduces or eliminates pollution from a single source. It should be noted that no single BMP system is the most effective way of controlling a particular pollutant in all situations; rather, the design of a BMP system should consider local conditions known to influence the production and delivery of nonpoint source pollutants. The design of a BMP system should not only account for the type and source of pollutants but also consider background factors such as the physical, climatic, biological, social, and economic setting.

Implementation of BMPs to improve water quality in the Heber Valley area has already proven to be effective. The Wasatch Conservation District, in cooperation with its partners, has implemented numerous projects in the Heber Valley area to improve water quality. Since 2013, over eight miles of stream bank in the Wallsburg watershed have been reshaped, stabilized, and re-vegetated. In addition to the work in the Wallsburg watershed, the Utah Reclamation Mitigation and Conservation Commission oversaw a large-scale restoration project on the Provo River that began in 1999 and was completed in 2008. This project improved water quality in the Middle Provo River between Jordanelle Reservoir and Deer Creek Reservoir. Implementation of these types of projects, outlined in the approved Deer Creek Reservoir TMDL, has dramatically improved water quality in this downstream reservoir by reducing total phosphorus loading and minimizing algal blooms.

In 2020, the Wasatch Conservation District secured a Nonpoint Source grant to develop an USEPA nine-element watershed plan to address nonpoint source pollution. Specific BMPs and an implementation schedule to reduce nonpoint source pollution including *E. coli* will be identified in the watershed plan, Since the TMDL will be finalized before the watershed planning effort concludes, the BMPs identified in this TMDL are general recommendations rather than specific project information and milestones.

BMPs applied in the Spring Creek Assessment Unit to reduce *E. coli* loading should include both structural and nonstructural techniques. Structural BMPs could include vegetative buffer strips to filter out contaminants before they reach the stream, fencing to restrict livestock access to stream channels, off-site watering systems, livestock access to clean drinking water outside riparian areas, and upgrades to pasture irrigation systems. Repairing or replacing failing onsite septic systems and upgrading the stormwater system could reduce *E. coli* contamination from urban areas. Installing pet waste collection bags and disposal bins in known recreation areas could further reduce *E. coli* contamination in high-use areas.

Grazing management plans or irrigation management plans are examples of nonstructural techniques that could improve water quality. While these management plans are not considered structural, they often require the installation of structures such as fencing, watering facilities, and improved irrigation systems. Additional nonstructural BMPs could include preservation of open space, reduction in impervious surfaces, increased street sweeping, and outreach and education campaigns.

Other practices outside of the scope of this TMDL that help address natural resource concerns may be implemented in conjunction with the projects recommended in this plan to support the larger goal of improving the overall health of the watershed.

Irrigation Improvements

Over half of the water consumption in the Spring Creek Assessment Unit is agriculture related. One potential source of *E. coli* loading is the flood irrigation practices used to water pastures adjacent to the river. As irrigation water runs across the field, it can transport manure from the field into local surface waters. Li *et al.* (2016) found that an increase in irrigation frequency can temporarily increase *E. coli* contamination to the surrounding soils. Solomon *et. al* (2002) identified livestock from neighboring fields as the culprit for an *Escherichia coli* O157:H7 outbreak from contaminated lettuce due to polluted water from flood-irrigated pastures.

Currently, 3,120 acres in the Spring Creek Assessment Unit are irrigated. Of those acres, roughly 2,040 acres, or 65%, are flood irrigated. Irrigation improvements should focus on upgrading these types of systems to ensure they are functioning as efficiently as possible, or are replaced, when feasible, with systems that decrease the potential for the excessive overland flow that delivers pollutants to waterbodies.

A variety of structural improvements can reduce pollutant loading from irrigation. While an upgrade to sprinkler irrigation is ideal since it minimizes the transportation of manure into surface waters, local hydrologic conditions and cost may make it prohibitive for all pastures. Alternative improvements can include gated pipe, field leveling, or other NRCS approved irrigation practices that have the potential to improve water quality by reducing return flows that are high in *E. coli* and other pollutants while improving crop yields and productivity. It may also be beneficial to install buffer strips between irrigated cropland and surface water. These buffer strips can serve as a filtration system that removes pollutants from irrigation return flows before they enter adjacent rivers or streams.

Irrigation improvements can also include non-structural practices such as grazing and irrigation management, either in combination with structural practices or in areas where structural improvements are not feasible. Removing cattle from the pasture prior to irrigation can potentially dry out the *E. coli* in the manure and reduce *E. coli* loading. Reducing the over-application of water also reduces the amount of *E. coli*-contaminated water entering surface waters and conserves water while improving crop and pasture productivity. Irrigation management plans should be developed cooperatively between landowners and conservation planners. Each irrigation management plan should be developed specifically for each field. Crop type, water needs, and irrigation returns should be considered while developing these plans.

Grazing Management

Grazing management requires both structural and non-structural practices. Appropriate grazing management is a viable option in areas of the watershed where landowners can distribute their livestock across a large landscape. This may not be as effective in areas where livestock are concentrated in smaller pastures. In some situations, it may be necessary to install fences along the creek and its tributaries to restrict livestock access to the riparian area. The protected area may still be grazed but the animals will need to be removed when the riparian vegetation becomes stressed or overgrazed. This would require the installation of offsite watering troughs or access points to provide clean drinking water for livestock.

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Cross-fencing could distribute livestock across the landscape. Additional cross-fencing allows landowners to better manage the feed within their pastures and provide increased rest periods. These rest periods can help improve plant health, thereby increasing the amount of feed available for livestock and reducing the amount of time the livestock spend in the riparian corridor. This will help manure dry out, which reduces the amount of *E. coli* available for transport during irrigation.

Approximately 46 miles of pasture adjacent to the Spring Creek Assessment Unit could benefit from improved grazing management. The WCD estimates that there are 20 large livestock operations and 20 small livestock operations in the watershed that may be eligible for assistance through this TMDL implementation plan. Follow-up ground truthing on a site-by-site basis is recommended. While there is some urban development and livestock upstream of the watershed, the riparian areas appear to be in good condition, with no *E. coli* exceedances upstream of Rock Creek at River Road (MLID 5910510) in the upstream portion of the assessment unit.

While beef cattle are likely the predominant source of *E. coli* loading (based on local livestock inventories), horse, dairy cow, and sheep operations should also be targeted for improved grazing management. Many of the management strategies listed above, such as hardened crossings, fencing, and grazing management, can apply to a variety of livestock operations.

The most effective practices for limiting livestock access to surface waters vary by site characteristics and landowner preferences. Conservation planners should work with landowners to determine which practices the landowner would implement voluntarily. Ideally, these practices will help improve the effectiveness and functionality of livestock operations while improving water quality.

Animal Feeding Operations (AFOs)

DWQ has made it a high priority to address all AFOs identified as potential *E. coli* sources. Per state law (Utah Water Quality Act, Section 105.5), AFOs that discharge to waters of the state are in violation of water quality regulations and may be subject to fines if action is not taken to eliminate runoff from the facility.

Feedlots that are adjacent to rivers, streams, or open canals should be relocated to another location when feasible so runoff from the feedlot will not reach surface waters. If this is not possible, appropriate BMPs should be installed to contain the runoff leaving the facility. These BMPs can consist of fences and offsite watering systems to restrict animal access to open ditches and streams. Berms should also be installed to catch any runoff leaving the facility.

There are currently no permitted feedlots located in the Spring Creek Assessment Unit. However, it is possible that there are operations in the watershed that could benefit from manure management plans or need repairs and maintenance. It would be beneficial to conduct an inventory of livestock operations in the area that have the potential to discharge into Spring Creek and its tributaries. This inventory would help identify operations that may need additional assistance to come into compliance with state water quality standards. If operations need improvements, the Wasatch Conservation District, along with DWQ and partner agencies, can provide technical assistance and funding to complete the work.

The cost to manage water quality concerns originating from AFOs and install appropriate BMPs can range from $1,000 to $150,000. Some water quality concerns can be fixed with the installation of a simple berm to prevent water from leaving the operation, while others may require that the feedlot be decommissioned and rebuilt in another location. Conservation planners can work with the landowners on a case-by-case basis to determine the most cost-effective approach while maintaining the functionality of the feedlot.

Open Space Preservation

The Heber City General Plan (Heber City, 2020) identified the preservation of open space and protection of agricultural fields (North Fields) as a priority for local landowners and residents. One goal of this plan is to maintain the rural atmosphere despite growing development demands, and guiding principles outlined in the plan lay the foundation to permanently protect the North Fields area. Strategies include, but are not limited to, developing conservation easements, selling development rights, and zoning for larger agricultural parcels. A $10 million bond was passed in November 2018 to protect open space in the valley but it will not be enough to protect the land in perpetuity.

Partnerships are key to protecting and preserving the North Fields area. Conservation easements are legally binding agreements that are entered into voluntarily and mutually between a landowner and the conservation organization protecting the land from some or all future development. DWQ will support these easements in partnership with Utah Open Lands and the National Resource

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Conservation Service (NRCS) as long as appropriate agricultural BMPs are installed and properly maintained to reduce *E. coli* loading into surface waters.

Onsite Septic Systems

Improperly installed or maintained onsite septic systems are one of the potential sources of *E. coli* loading to Spring Creek (Section 5.3.1). A recent study characterizing groundwater quality in Spring Creek and the surrounding area recommended several approaches to managing onsite septic development to minimize impacts to groundwater. This included monitoring groundwater quality (nitrates), limiting septic system density, limiting nitrate load, or a hybrid approach that limits onsite septic system density with site-specific load exceptions (Wasatch County Health Department, 2020). WCHD's local wastewater rules (Rule 00-1, 00-2, 00-3, 14-1, 06-1) incorporate several of these recommendations and impose stricter requirements than UAC Onsite Wastewater Systems Rule R317-4. Adherence and enforcement of these local rules will minimize *E. coli* loading from onsite septic systems.

The annual cost of maintaining an onsite septic system can range from $250 to $500, which is a fraction of the cost to replace an entire system. The average household onsite septic system should be inspected at least every three years by a septic-service professional. Household septic tanks are typically pumped every three to five years.

Since it can be challenging to know which households are properly maintaining their onsite septic systems and which are not, one of the best ways to address this issue is to inform and educate the public about the impacts onsite septic systems can have on public health and what can be done to maintain them. Wasatch County has a digitized inventory of onsite septic systems within county boundaries that could facilitate the distribution of recommended maintenance schedules to homeowners with onsite septic systems.

DWQ has a cost-assistance program to help homeowners who cannot afford to repair their failing onsite septic system., Eligibility for assistance is based on adjusted gross income. DWQ recommends creation of local incentive programs to help homeowners inspect and maintain their septic systems. In some instances, this incentive program could help pay for system replacement if it is determined that the system is failing or contributing to the *E. coli* loading in the watershed. This program could be developed by a local working group.

Stormwater Management

Although stormwater does not appear to significantly contribute to *E. coli* loading in the Spring Creek Assessment Unit, further investigation is needed during wet-weather events to fully characterize the loading potential from local stormwater systems. The nearest city, Heber City, has a stormwater management plan and should continue to implement the plan's management actions. Heber City and the surrounding areas should continue to review the opportunity to voluntarily enter a MS4-like program to better manage the stormwater runoff from future development and protect natural resources. These entities should investigate the need for a more cohesive approach to development, construction reviews/inspections, and ordinances to plan for residents' needs. The creation of a regional stormwater coalition will help standardize outreach on the importance of protecting downstream water from urban runoff.

Domestic Pets

Improperly managed pet waste is another potential source of *E. coli* loading in the Spring Creek Assessment Unit (Section 5.3.4). Pet owners use several roadways in the area to walk their dogs, and while there are signs encouraging owners to keep their pets on a leash, there are no waste clean-up bags, waste disposal receptacles, or signs encouraging proper pet waste disposal. The addition of educational signs and waste disposal materials along roadways and walking trails used for recreation will encourage proper pet waste disposal and reduce the risk of pet waste entering the Spring Creek riverine network.

Information and Education Strategy

The Information and Education Strategy for Spring Creek consists of seven main action items:

1. Continue to work with the PRWC and the WCD to help inform local landowners, state, federal, and local agencies, and environmental groups on pertinent issues within the watershed.
2. Work with the WCD to hold an education event with local landowners to inform them of the problems that exist, potential solutions, and entities that can provide technical and financial assistance.
3. Implement demonstration projects that show local landowners the benefits of improved grazing and irrigation management.
4. Develop an education campaign addressing the need for onsite septic system inspection and maintenance. Develop an incentive program to help

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landowners pay for the inspection and maintenance of their septic systems if needed.

5. Develop an education campaign on the proper disposal of pet waste in recreation areas in the watershed.
6. Develop an education campaign addressing the benefits of proper stormwater management, Low Impact Development practices, SWPPPs in managing the impacts of construction on water quality, voluntarily entering the MS4-like program, and forming a county-level stormwater coalition.
7. Continue to host the annual Provo River Water Festival in cooperation with partners in the watershed.

One of the best ways to educate all interested stakeholders is to establish a local working group to discuss issues that affect the watershed. Topics addressed by this group can include potential BMPs for the watershed, local landowner concerns, reports on the status of water quality in the watershed, and identification of the short-term and long-term goals of each member of the working group.

The PRWC is currently meeting these objectives and will continue to acknowledge and address water quality concerns from various partners, not only within the Spring Creek Assessment Unit but also in the Provo River watershed.

The Wasatch Conservation District also supports local landowners in addressing their natural resource concerns. Their Board is an active advocate for realistic approaches to environmental protection within its jurisdiction and recently secured a grant to develop an USEPA nine-element watershed plan to address nonpoint source pollution.

Demonstration projects are highly effective at helping landowners decide whether to implement BMPs on their property. These projects help landowners gain trust in the process and agency staff. It also gives other landowners the opportunity to see an example of successful BMPs and how they can improve both their agricultural operations and water quality.

An intensive information and education campaign on the ways failing onsite septic systems impact water quality and how homeowners can properly maintain those systems will help address degraded water quality from onsite septic systems. The PRWC and WCHD is sending flyers with information about onsite

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septic system maintenance BMPs to Wasatch County homeowners who received a septic permit within the last seven years (approximately 350 permittees). DWQ also recommends the development of an educational video that shows septic owners how to conduct yearly visual inspections of their systems, describes incentives for homeowners to have their systems inspected and pumped and provides targeted messaging that encourages proper septic system maintenance.

DWQ recommends hosting a stormwater BMP workshop, in partnership with Utah State University and PRWC, to address water quality impacts from construction activities. This workshop will educate local construction companies on the importance of creating and implementing a robust SWPPPs. It will also review how construction activities could impact local water quality and how BMPs could help minimize that impact.

While some residents of the assessment unit may be aware of the local water quality issues, it is more likely that they are unaware that their practices could be contributing to water quality problems. This implementation plan recommends increased outreach to residents within the assessment unit. Educational opportunities such as the annual Provo River Water Festival can provide a forum for sharing water quality concerns and solutions with the public.

Implementation Cost and Technical Assistance

The implementation of nonpoint source projects is voluntary. The ability to correct the issues encountered will depend on the willingness of homeowners and producers to implement the recommended practices. A Project Implementation Plan (PIP) will be developed that highlights the funding needs once individual projects and willing partners are identified. It will be necessary to obtain funding from other partner agencies to fully finance all the projects needed to achieve the required *E. coli* load reduction. Table 19 shows potential agencies that could contribute funding or resources to the implementation effort.

Table 19. Potential funding opportunities for NPS Projects.

Entity	Grant Program
Utah Division of Water Quality	Section 319 Grant Funding, Utah Nonpoint Source Pollution Grants, Hardship Onsite Septic Systems Grants, Agricultural Voluntary Incentive Program, Water Quality Board
Natural Resources Conservation Service	Environmental Quality Incentives Program, National Water Quality Initiative Program
Utah Department of Agriculture and Food	Agriculture Resource Development Loan, Grazing Improvement Program Grants
Utah Department of Natural Resources	Watershed Restoration Initiative
State of Utah	LeRay McAllister Critical Lands Conservation Fund
Provo River Watershed Council	Watershed Health Improvements
Others	Wells Fargo, Walton Family Foundation, Utah Outdoor Recreation Grant, USEPA Five Star, Urban Waters Restoration Grant Program

Technical assistance will be needed in addition to funding for actual project implementation to ensure projects are meticulously planned and installed. This assistance can include soliciting grant funding, working with landowners to identify proper practices, obtaining proper permits, and writing reports highlighting the restoration activities. In general, much of this technical assistance will be provided by DWQ, NRCS, or UDAF, but in some instances, contractors may be required to develop designs or other critical planning components. The cost of this assistance should be calculated when determining the cost to implement this TMDL.

Implementation Schedule and Milestones

A schedule with milestones is a key element to any plan. These milestones should clearly identify activities and timelines to ensure transparency and help agencies plan with funding proposals and reporting (Table 20). This implementation plan will follow the WCD's Heber Valley Watershed Plan, which will have more detailed project information and implementation timelines.

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Table 20. Implementation schedule and milestones.

Activity	Year	Responsible Agency	Year	Responsible Agency	Year	Year	Year
	2020		2021		2022	2023	2024
Watershed Plan	Apply for funding. Scope of Work	UDAF, WCD, DWQ	Develop a watershed plan for the Heber Valley Watershed	UDAF, WCD, DWQ	Finalize watershed plan	Implement plan	Implement plan
Project Monitoring	Implement Sampling Analysis Plan (SAP)	UDAF, DWQ, PRWC	Implement SAP	UDAF, DWQ, PRWC	Implement SAP	Implement SAP	Implement SAP
Demonstration Projects			Identify ≥ 1 agricultural BMP projects. Apply for funding	UDAF, WCD	Implement projects	Identify ≥ 1 stormwater BMP projects. Apply for funding	Implement projects
Stormwater Management	Apply funding for outreach & education (O & E) workshop	UDAF, USU Extension, DWQ	Host virtual stormwater workshop and field tour specific to small builders. Discuss voluntary stormwater coalition	UDAF, USU Ext, DWQ, PRWC, Heber City, Wasatch County	Valley-wide stormwater coalition. O&E materials	Valley-wide stormwater coalition. O&E materials	Valley-wide stormwater coalition. O&E materials
Onsite Septic Systems	Develop homeowner O&E campaign	UDAF, PRWC, DWQ, WCHD	Print and distribute materials to homeowners. Host Onsite Septic Week (September)	UDAF, PRWC, DWQ, WCHD	Host Onsite Septic Week (September)	Host Onsite Septic Week (September)	Host Onsite Septic Week (September)

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Grazing Management			Conduct O & E campaign targeting landowners in conjugation with watershed plan	UDAF, WCD	Identify grazing improvement projects	Plan & apply for project funding	Implement plan
Irrigation Management			Conduct O & E campaign targeting landowners in conjugation with watershed plan	UDAF, WCD	Identify irrigation efficiency projects	Plan & apply for project funding	Implement plan
Pet Waste Management					Construct pet waste management plan (O&E)	Apply for funding	Implement plan
Plan Evaluation					Evaluate plan with partners annually		

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Chapter 10. Public Participation

Stakeholder participation for this TMDL process was achieved through meetings and site visits with governmental agency representatives and local landowners. Spring Creek stakeholders include:

Utah Division of Water Quality
Utah Department of Agriculture and Food
Wasatch Conservation District
Wasatch County Planning Department
Wasatch County Health Department
Heber City
Natural Resources Conservation Service
Provo River Watershed Council
Central Utah Water Conservancy District
Jordanelle Special Service District
North Fields Irrigation Company
Utah Open Lands
Private landowners
USEPA

Public Participation Timeline

2017

The TMDL process began in July 2017 with a field tour to the North Fields area with engaged stakeholders to obtain local information about the drainages.

2018

The first official TMDL kickoff meeting was held in April 2018 at a Provo River Watershed Council meeting. DWQ presented general information on water quality assessments and TMDL basics. This same information was later shared with the Wasatch County Commission in May 2018.

2019

Conversations began with Heber City in March 2019 about stormwater outfalls and possible *E. coli* contributions. Several informal conservations and collaborations among PRWC, Heber City, Wasatch County Health Department, and WCD occurred in 2019 to further understand possible sources. In the fall of 2019, WCD began drafting a scope of work for the Heber Valley watershed plan that will serve as the implementation strategy for this TMDL.

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2020

Stakeholder discussions included source analysis and possible solutions to reduce *E. coli* loading per source.

2021

In early 2021, the TMDL source analysis results were presented to both WCD and PRWC. During March and April, the final results of the TMDL were presented to stakeholders. Agriculture specific BMPs were discussed and planned with WCD. Stormwater specific BMPs were also considered with Heber City and other surrounding municipalities. The TMDL report was reviewed by DWQ internal team and comments were addressed in early summer. WCD received the draft TMDL for their review in late July followed a week later by the PRWC.

July 22, 2021 – WCD review begins

July 29, 2021 – PRWC review begins

August 11, 2021 – WCD meeting

August 16, 2021 – stakeholder comments due (~ 3 weeks)

Mid August – address stakeholder comments

August 25 - WQB initiation rule making (30 day public comment period)

August/September - public comment

September 22 - WQB final rule making

Sept - USEPA submission

Stakeholders were given the opportunity to provide feedback on the TMDL as part of the initial review process, as well as during rulemaking when the study is posted for a 30-day public review.

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Appendix A

Other Water Quality Parameters

Nitrates

Functioning onsite septic systems remove some nitrogen during the system's denitrification cycle before waste enters the drain fields. Unfortunately, nitrogen can end up in groundwater as subsurface flow to surface waters if an onsite septic system is failing and unable to remove it. Nitrogen contamination, measured as nitrates in drinking water, is a serious health concern to infants because it reduces oxygen in their blood. (Knobeloch L, 2000). Nitrates are also one of the primary water quality indicators for failing onsite septic systems.

Nitrogen from human waste is generally converted to nitrates in onsite septic systems. If oxygen is present, ammonia in the drain fields is converted to nitrates during the nitrification process. Nitrates can be converted to nitrogen gas or leach into the groundwater (subsurface water) since it does not bind to soil particles. If nitrates are elevated in surface waters, they can contribute to eutrophication of the receiving waterbodies. If ammonia is present in surface waters, it could be evidence of a direct discharge of an onsite septic system and raise human health concerns.

The Wasatch County Health Department (WCHD) uses nitrates as a major factor in their septic system density recommendations. WCHD conducted a groundwater study that looked specifically at septic tank influence on its groundwater (Wasatch County Health Department, 2020). The health department found that the average nitrate concentration in the Heber Valley aquifer is 2.36 mg/L, which is below the drinking water standard of 10 mg/L (Figure A-1). Groundwater wells in the Spring Creek Assessment Unit had nitrate levels below 2 mg/L.

Data collected by DWQ and the Central Utah Water Conservancy District (CUWCD) showed ammonia concentrations from 1985 to 2019 at Spring Creek above confluence of the Provo River (4997250) falling predominantly below the laboratory detection limit. Average inorganic nitrite-nitrate (dissolved) from the same time averaged 0.45 mg/L. Average total nitrogen was less than 1 mg/L.

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Monitoring results did not reveal significant nitrate contributions from failing septic systems. Therefore, it can be assumed that failing septic systems are not a major contributor of *E. coli* concentrations in the Spring Creek system.

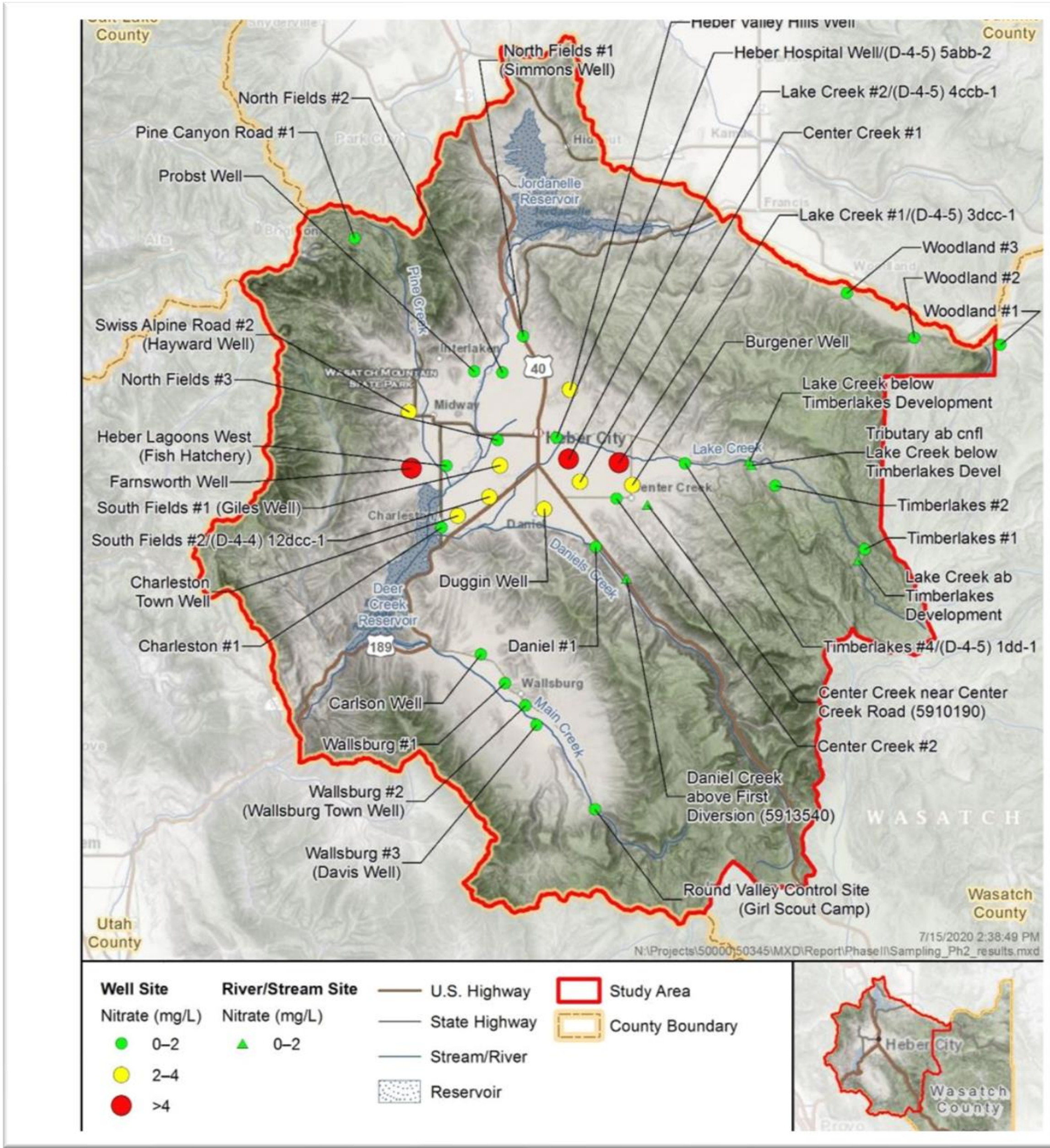

Figure A-1. Nitrate (mg/L) concentrations in Wasatch County (WCHD 2020).

Pharmaceuticals and Personal Care Products

EPA defines pharmaceuticals and personal care products (PPCPs) as products used by individuals for personal health or cosmetic reasons or used by agribusiness to enhance growth or health of livestock. PPCPs have been detected in surface and groundwater worldwide and often persist in the environment. Sources include human elimination, flushing of unused products, leachate from landfills, rinse water from showering or bathing, and agricultural runoff. Potential health effects for humans and aquatic species are still being studied. A 2002 USGS study (Kolpin et al., 2002) found that of 130 waterways surveyed in 30 states, eighty percent contained trace amounts of PPCPs.

PPCPs analysis can help indicate failure of onsite wastewater treatment systems. Properly sized and maintained septic tanks and leach fields allow for adequate degradation and sorption of organic wastewater compounds. However, aging and failing systems may contribute PPCPs directly or indirectly to surface and groundwater.

PPCP samples were collected in September 2019 in the Spring Creek Assessment Unit at the following five locations:

- 4997250 Spring Creek above Confluence with Provo River
- Replicate of 4997250
- 5910210 Rock Creek above Confluence with Spring Creek
- 4997268 Spring Creek above Confluence with Rock Creek
- 5910273 London Ditch at 1200 North
- 5910510 Rock Creek at River Road

Twenty-two analytes, including hormones, prescription and over-the-counter medications, soaps, cosmetics, and cleaning products were analyzed. No PPCPs were found in the upstream section of the assessment unit at Rock Creek at River Road. Samples there also showed low *E. coli* concentrations. Two PPCPs, caffeine and diclofenac (anti-inflammatory) were detected in the lower monitoring locations (Table A-1.). These lower monitoring locations also had elevated levels of *E. coli*. These sampling results could indicate failing onsite septic systems as a source of both PPCPs and *E. coli*.

Groundwater does not appear to be affected. WCHD conducted research into groundwater quality in 2020 and reported that no PPCPs in the Spring Creek Assessment Unit were discovered. Further supplemental research from USGS National Water Information System (NWIS) did not detect caffeine in its samples from groundwater wells between 2009 and 2013 in the same area(Wasatch County Health Department, 2020).

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Optical Brighteners

Optical brighteners (OBs) are added to soaps and detergents to brighten fabrics and surfaces. They are also added to toilet paper. Household plumbing systems combine both toilets and washing machines, so OBs can make their way to the wastewater treatment systems. As the soap or toilet paper breaks down, OBs are released into the surrounding waters. Since they have a slow decay rate and longer persistence in the environment, they can serve as surrogates for discharges from failing septic tanks and storm drains and can aid in source identification of fecal contamination (Hartel, 2007). DWQ conducted two OB surveys in the Spring Creek AU at the same monitoring locations as the PPCP sampling (Table A-1). Results were inclusive.

Table A-1. PPCPs in Spring Creek Assessment Unit (September 2019).

MLID	Site ID	PPCPs
5910510	Rock Creek at River Road	All below detection
5910273	London Ditch at 1200 North	Caffeine
5910210	Rock Creek above Confluence with Spring Creek	Diclofenac
4997268	Spring Creek above Confluence with Rock Creek	Diclofenac
4997250	Spring Creek above Confluence with Provo River	Diclofenac Caffeine

Conclusion

Sampling results suggest that failing onsite septic systems could be a potential source of *E. coli* in these areas. Evidence of failing onsite septic systems do not solely rely on the detection of elevated *E. coli* concentration in the adjacent waters. Nitrates are one of the main chemical water quality indicators of failing systems. Improperly functioning systems result in an excess of nitrates into the surrounding environment. Nitrate concentrations in the Spring Creek AU's groundwater are below 2 mg/L, which corresponds to pristine aquifer quality. Water quality analysis results show failing onsite system systems are not a major source of groundwater contamination in this area; however, PPCPs are in the surface waters. It is possible that contamination from onsite septic systems may not be infiltrating to the groundwater level but remaining higher in the surface and shallow subsurface waters. More monitoring (Microbial Source Tracking) is needed and will be included in the future monitoring for this TMDL (Chapter 9).

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Appendix B

Land Use Changes in Wasatch County

Wasatch County and specifically the Heber Valley area has seen land uses change in recent years. Figure B-1 shows that alfalfa fields (highlighted in pink) dominated the riparian valleys in 2008 (USDA's Cropland Data Coverage). Eleven years later in 2019, Figure B-2 reveals how land use has changed to pasture (yellow). Figure B-3 shows changes in land use, including the conversion of crops to pastures and a slight increase in urban land use.

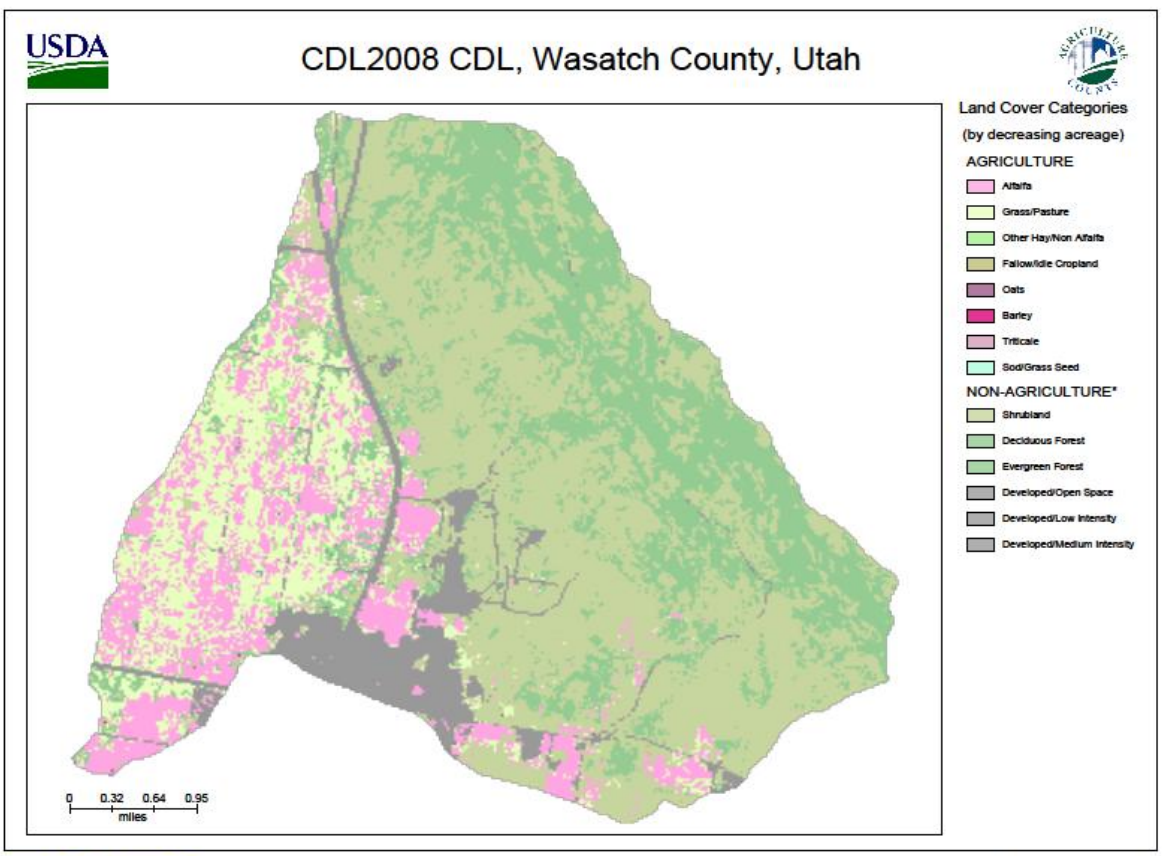

Figure B-1. USDA cropland data layer (CDL) cover for Spring Creek Assessment Unit 2008.

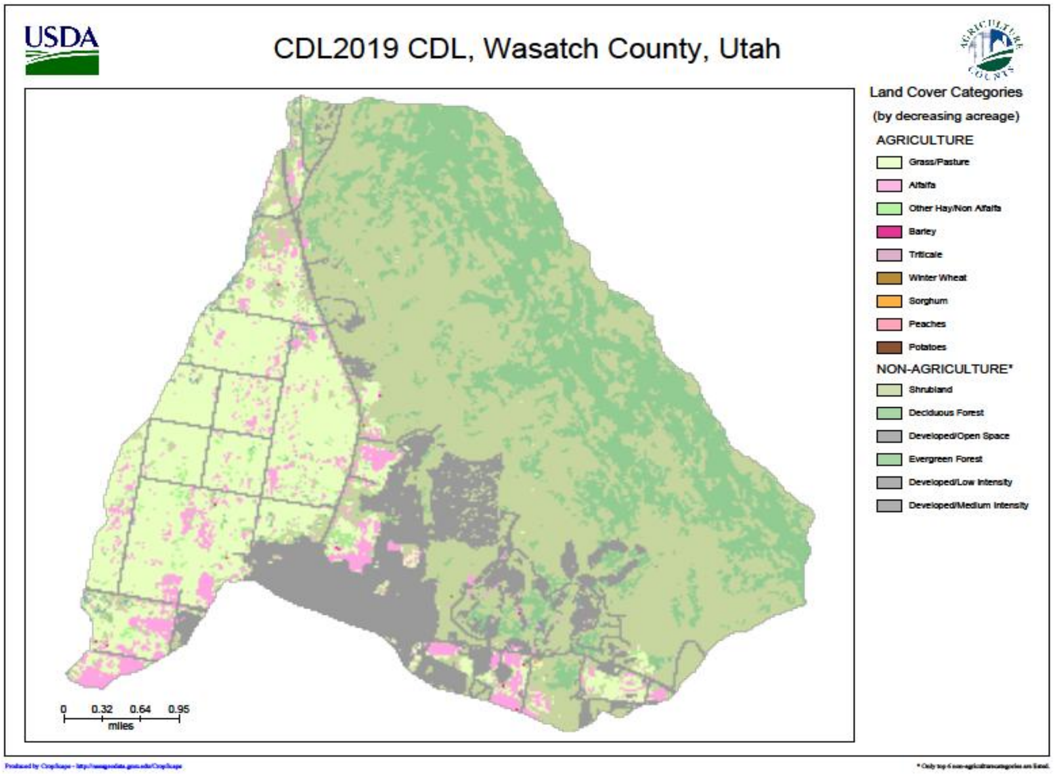

Figure B-2. USDA cropland data layer (CDL) cover for Spring Creek Assessment Unit 2019.

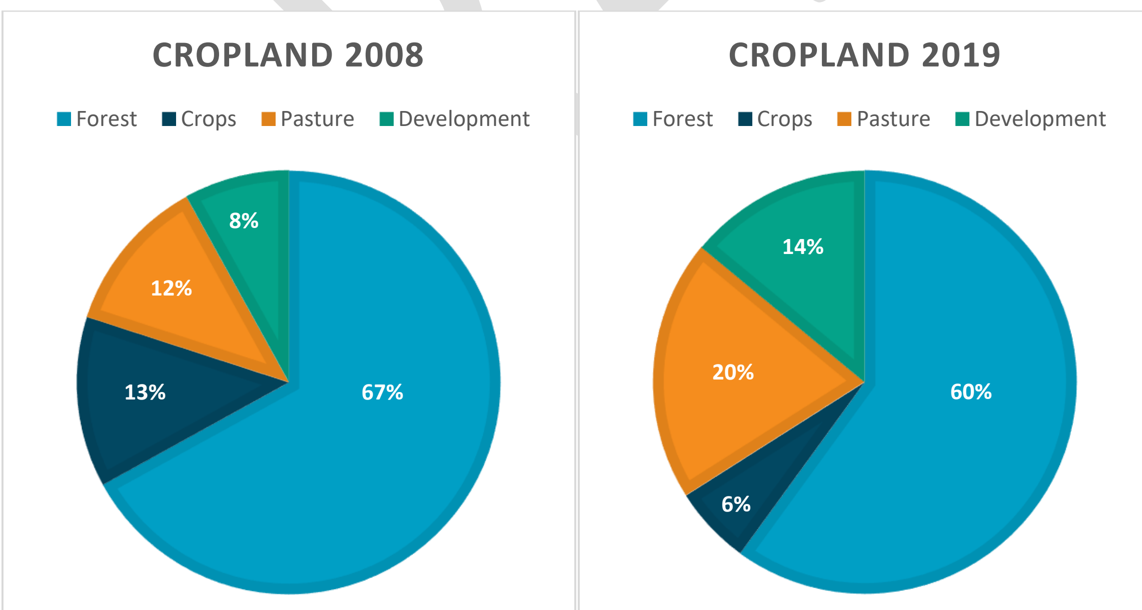

Figure B-3. Cropland data layer (CDL) comparison between 2008 and 2019.

Cropland Data Layer (CDL) data indicate that between 2008 and 2019 there has been an increase in pastureland (+59%) and development (+78%) that coincides with a decrease in forest (-10%) and crop (-57%) land (Figure B-4). The potential implication of the shift to more pasture is that more land is available for livestock grazing, a known source of *E. coli* loading in the watershed. The increase in developed land means more households will have onsite septic systems, which also have the potential to impact water quality if not effectively managed and maintained. Increased development could also increase surface water runoff from impervious surfaces. Since Wasatch County is one of the fastest growing counties in the country, it is likely this trend will continue.

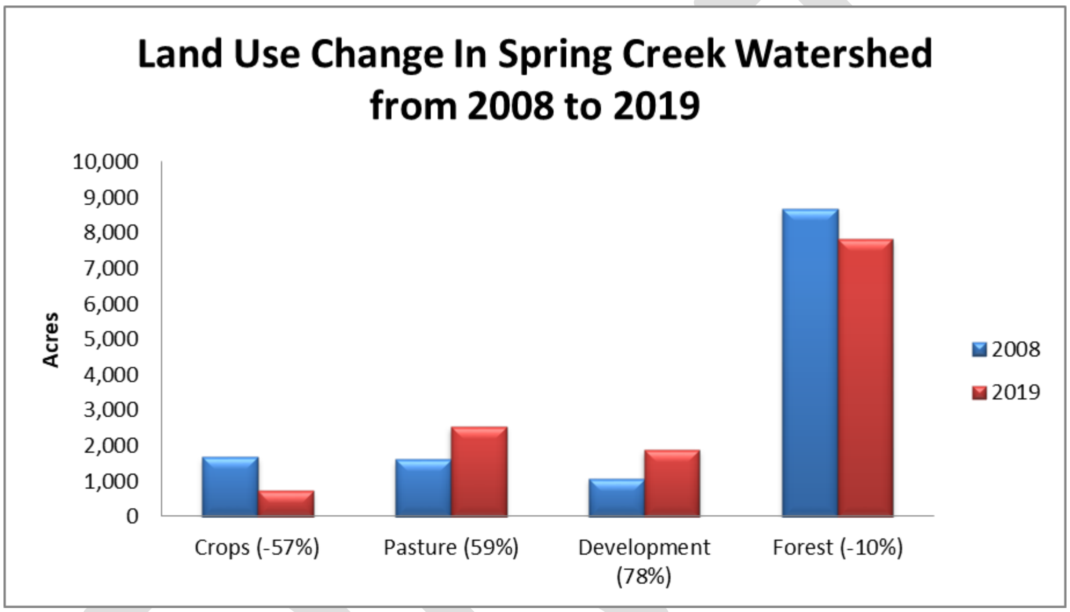

Figure B-4. Land use change in Spring Creek from 2008 to 2019.