Spring Creek-Union Flat Watershed
National Water Quality Initiative (NWQI) Readiness Watershed Assessment

Prepared By: Palouse Conservation District
Pullman, WA

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Natural Resources Conservation Service

PALOUSE CONSERVATION DISTRICT

Table of Contents

Table of Figures

Table of Tables

Overview

The following document contains a readiness watershed assessment plan for the Spring Creek-Union Flat watershed (HUC12: 170601080403). The Spring Creek-Union Flat subwatershed is located within Whitman County, Washington and is part of the Union Flat watershed. This watershed assessment was written in support of the Natural Resource Conservation Service's (NRCS) National Water Quality Initiative (NWQI). The purpose of this report is to serve as a resource for conservation planning and to assist the implementation of conservation practices that improve water quality throughout the watershed. This report contains a description of the hydrology, climate, soils, and land use practices to develop an understanding of resource concerns throughout the watershed. Once resource concerns and critical source areas (CSA) are identified, the outreach plan will be developed in collaboration with Whitman County NRCS staff, landowners, and producers in the watershed. The outreach plan will target conservation practices that improve water quality and meet the needs and interests of landowners and producers. The primary objective of this report is to improve water quality by increasing the adoption of best management practices (BMP) and to connect landowners and producers with the resources and programs offered by NRCS and Palouse Conservation District (PCD).

The watershed assessment and outreach components follow the NRCS Nine Steps of Planning:

1. Identifying the pollutants of concern in the watershed
2. Determining the water quality objectives of the watershed
3. Inventory resources by collecting watershed data
4. Analyze the data via modeling to identify CSAs
5. Formulate alternatives by suggesting various conservation practices
6. Evaluate/model the impact of different conservation practices on water quality pollutants
7. Work with partners on decisions on plans of action for the watershed
8. Implement the Outreach and Implementation plan in the watershed
9. Evaluate the effectiveness of the plan and adapt as necessary to achieve water quality goals

For more detail on the general process for the development of a watershed assessment plan, see the NRCS National Planning Procedures Handbook (NPPH), Subpart F: Area-wise Conservation Planning (NPPH Part 600.50 B. (2)).

Additional information about the Spring Creek-Union Flat Watershed Assessment can be obtained by contacting:

Ryan Boylan - Research and Monitoring Coordinator: RyanB@PalouseCD.org
Nicholas Harris - Research and Monitoring Specialist: NickH@PalouseCD.org

Palouse Conservation District
1615 NE Eastgate Ste H
Pullman, WA 99163
(509) 332-4101

Written in collaboration with Washington State NRCS.

805 S Vista Point Dr
Colfax, WA 99111
(509) 397-4301

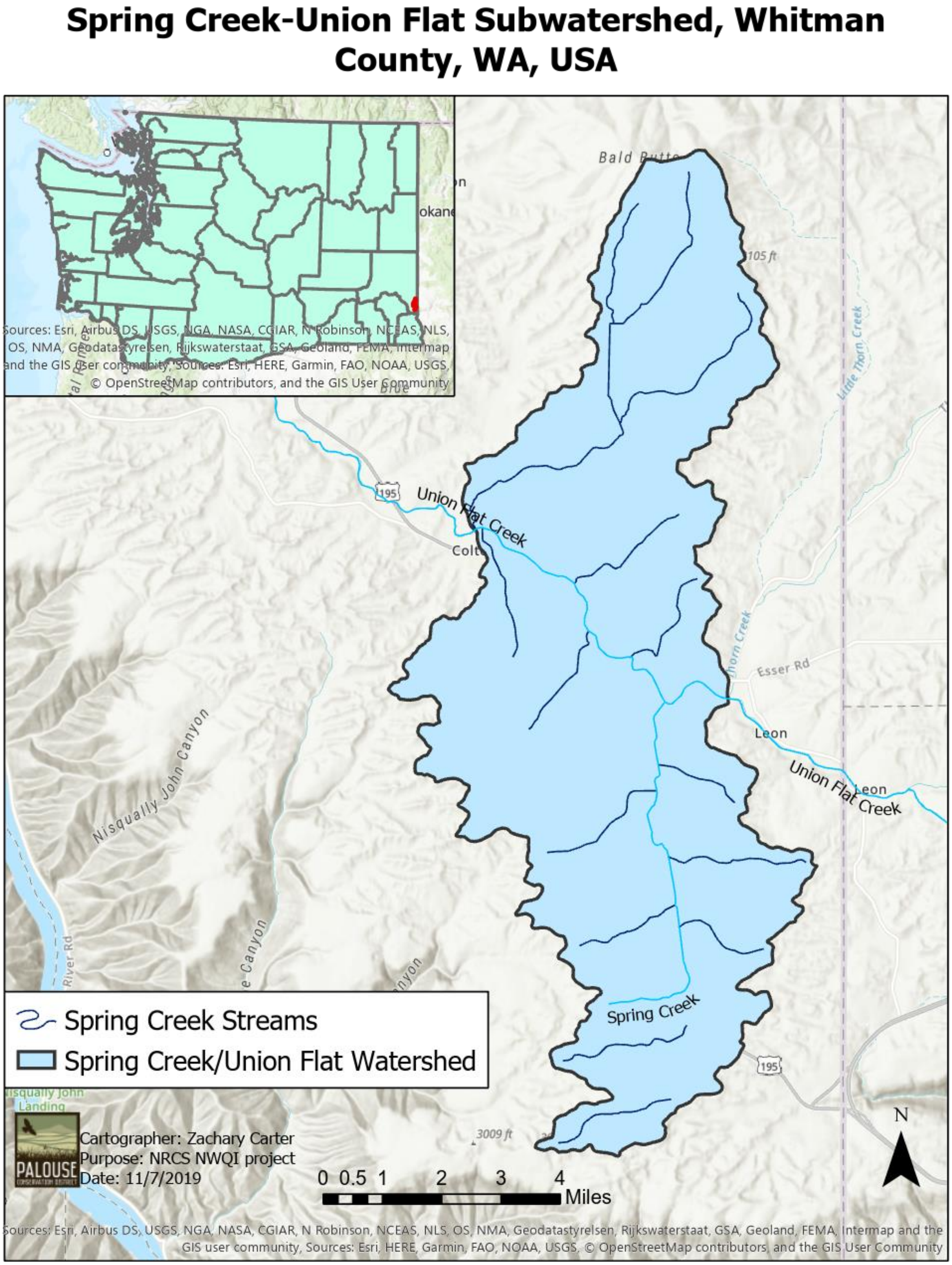
1. Background and Purpose

1.A. Background

The Spring Creek-Union Flat watershed is part of the Palouse Region, an area that has a rich history of agricultural productivity and innovation. This region is characterized by large-scale dryland agriculture, including the cultivation of cereal grains and pulse crops on a three-year rotation. Approximately 94% of land use in this watershed is dryland agriculture; with this large percentage of agricultural land, the adoption of BMPs may have a significant influence on water quality. Conservation efforts in this watershed are primarily dependent on landowner and producer access to technical and financial assistance, which relies on conservation agency assistance or regulation. This report provides a detailed HUC-12 watershed-level analysis that will inform the conservation planning process by identifying resource concerns and CSAs, and help to identify areas that could be treated to improve water quality.

Water quality information is limited for the Spring Creek-Union Flat watershed; however, Total Maximum Daily Loads (TMDLs) of temperature and phosphorus have been developed for the headwaters of this watershed by Idaho Department of Environmental Quality (IDEQ). These TMDLs provide insight into water quality issues that the Spring Creek-Union Flat watershed faces, though impairments have not been directly assessed for this drainage. Contributing water from the adjacent Cow Creek subbasin in Idaho is 303(d) listed through the Clean Water Act (CWA) as impaired for nutrients, temperature, and habitat alterations. Given the high percentage of agricultural land in the watershed, the lack of available water quality information combined with the incoming water quality impairments are a strong impetus for targeted conservation outreach and assistance.

The purpose of the NRCS NWQI is to connect landowners and producers with resources to improve water quality through the adoption of management practices and programs offered by conservation agencies. This watershed readiness assessment identifies resource concerns and CSAs throughout the Spring Creek-Union Flat watershed. These areas will be used in targeted outreach and implementation of management practices identified to have the greatest positive impact on water quality.



Cartographer: Zachary Carter
Purpose: NRCS NWQI project
Date: 11/7/2019

Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Figure 1. Spring Creek-Union Flat watershed.

1.B. Location of Watershed Assessment Area

The Spring Creek-Union Flat subwatershed (HUC12: 170601080403) is located in the southeastern portion of Washington State. It contains within its boundaries the towns of Colton and Uniontown. This subwatershed is part of the Palouse subbasin (HUC8: 17060108) and is located within the Water Resource Inventory Area (WRIA) 34. The Spring Creek-Union Flat subwatershed exists entirely within Whitman County, Washington and contributes to the Union Flat Creek watershed. The spatial extent of the assessment area is 28.2 mi^2 and contains 37.9 mi of streams. The Union Flat Creek watershed receives water from Latah and Nez Perce counties in Idaho and Whitman County in Washington before its confluence with the Palouse River, which is a tributary to the Snake River.

The Spring Creek-Union Flat subwatershed was selected for the NWQI Watershed Assessment because of the potential for landowner participation, TMDLs and 303(d) listed waters entering from Idaho, and a lack of water quality information within the subwatershed.

1.C. Water Quality Resource Concerns

Palouse Conservation District (PCD) monitors water quality on Cow and Thorn Creeks, which are both tributaries to Union Flat Creek. Water flowing into the Spring Creek-Union Flat subwatershed from the Cow Creek subbasin in Idaho is 303(d) listed as impaired for nutrients, temperature, and habitat alterations. TMDLs have been put in place for both phosphorus and temperature (IDEQ, 2005, 2013). Additionally, Union Flat Creek is listed as impaired for pH near its confluence with the Palouse River, and TMDLs have been created for both temperature and bacteria (Tarbutton *et al*., 2010, Snowaert and Stuart, 2013). While water upstream and downstream of the watershed assessment area has been assessed for water quality impairments, this particular area has not been assessed by the Washington State Department of Ecology.

Water that flows into the Union Flat Creek watershed has designated beneficial uses for aquatic life, recreation, and agriculture. Water quality standards for this area, which are found in Table 1, reflect water quality criteria for salmonid spawning, rearing, and migration. Water is a vital resource for landowners and producers in the watershed, who use it for domestic, industrial, agricultural, livestock, wildlife habitat, harvesting, commercial, aesthetic, and primary contact recreational purposes.

Additionally, the Washington State Department of Ecology has identified low dissolved oxygen and elevated temperatures, pH, fecal coliform, PCBs, and historic pesticides as detriments to water quality throughout the Palouse River (Washington State Department of Ecology).

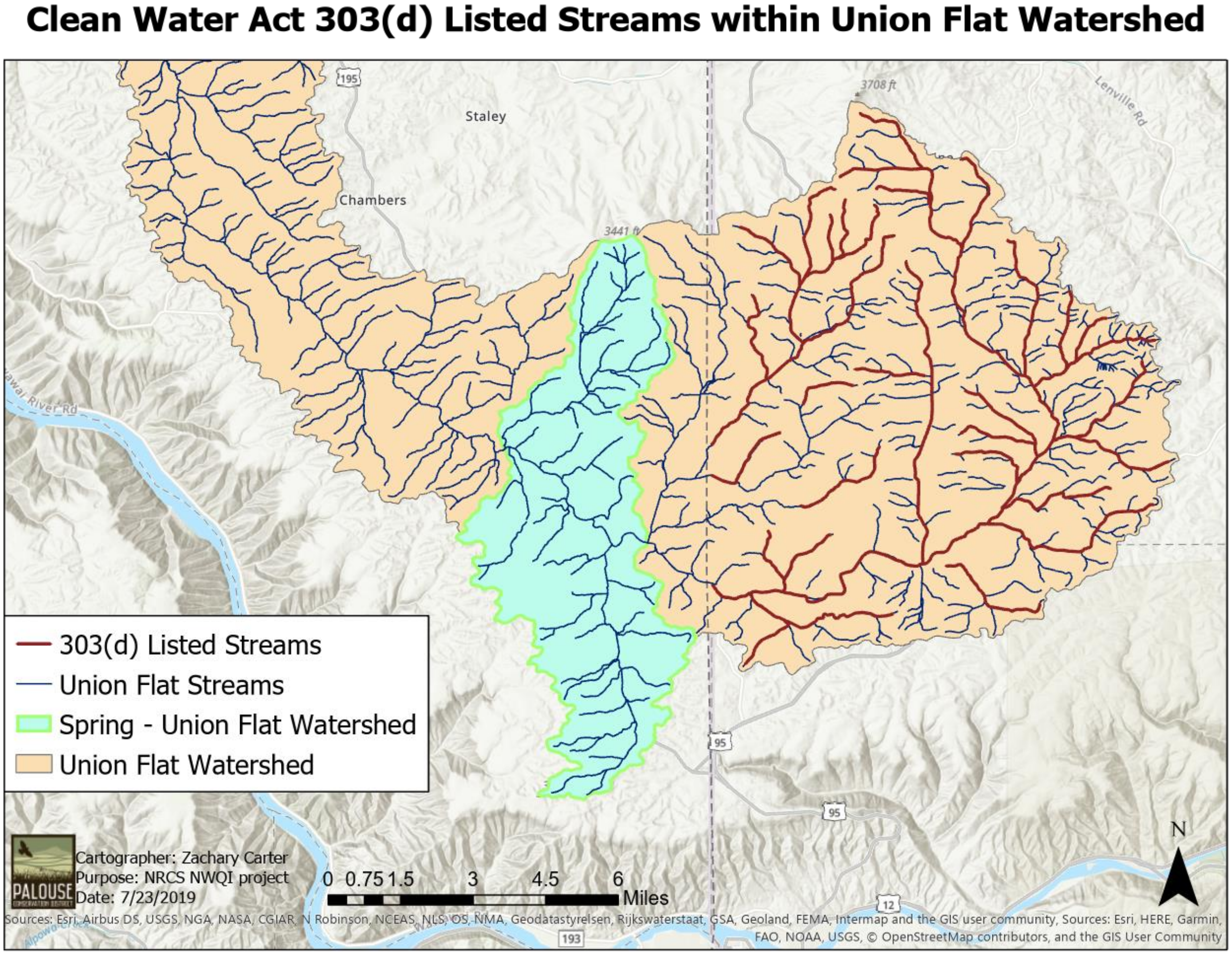


Figure 2. 303(d) listed streams within the Union Flat watershed.

Table 1. Summary of relevant water quality criteria for the Spring Creek-Union Flat watershed according to Washington Administrative Code (WAC) 173-201A-200.

Parameter	Criteria
Fecal coliform (criteria expires 12/31/2020)	Fecal coliform organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained within an averaging period exceeding 200 CFU or MPN per 100 mL.
E. coli	E. coli organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained within the averaging period exceeding 320 CFU or MPN per 100 mL.
Dissolved Oxygen	Dissolved oxygen concentration will not fall below 8.0 mg L^{-1} more than once every ten years on average. When a water body's DO is lower than 8.0 mg L^{-1} (or within 0.2 mg L^{-1}) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg L^{-1}.
pH	pH shall be within the range of 6.5 to 8.5 with a human-caused variation within the above range of less than 0.5 units.
Temperature	7-day average of the daily maximum temperature (7-DADMax) will not exceed 17.5°C more than once every ten years on average. When a water body's temperature is warmer than 17.5°C (or within 0.3°C) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C.
Turbidity	5 NTU over background when the background is 50 NTU or less; or A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

1.D. Opportunities and Objectives for Meeting Water Quality Goals

The Spring Creek-Union Flat subwatershed is part of the highly productive agricultural Palouse Region where 94% of the land is dominated by dryland cereal grains and pulse crops. Crop rotations in this area typically follow a three-year cycle, which includes winter wheat, then spring wheat, spring barley, or canola, and finally a pulse crop (garbanzos, lentils, or dry peas). The remaining 6% of land cover includes developed open space and developed low-intensity areas covered mostly by the towns of Colton and Uniontown. The high intensity of agricultural practices (roughly 25.9 mi^2 or 16552 acres) and the erosive nature of the soils found in the watershed provide an opportunity to work with producers and operators to reduce sediment, nutrient loading, and instream temperatures. The implementation of BMPs has the potential to reduce pollutant loading and improve water quality in the watershed.

Since water quality data is limited and there are no streams with listed TMDLs within the Spring Creek-Union Flat subwatershed, goals and objectives should reflect the water quality data collected upstream by PCD and follow recommendations listed in the TMDLs created by IDEQ to reduce pollution loads within the Cow Creek watershed. Data collected by PCD in Cow and Thorn Creeks, two major water bodies flowing into the Spring Creek-Union Flat subwatershed, indicate that fecal coliform bacteria, dissolved oxygen, and pH exceeded water quality criteria for these pollutants at least once throughout the 2018 water year. Furthermore, Cow Creek has TMDLs for both phosphorus and temperature. The recommended practices to reduce nutrient loads in Cow Creek include the adoption of conservation tillage practices and the development of nutrient management plans for agricultural lands (IDEQ, 2009). Water temperature reductions can be attained through the establishment of riparian buffers, which increase shade on the stream and reduce edge-of-stream farming practices (IDEQ, 2013). See section 3 for a complete description of water quality within the study area.

Outreach and education are also mentioned in the TMDLs as ways to address nutrient and temperature loading issues. PCD hosts several outreach events annually to engage landowners and producers, promoting discussion and education on conservation practices and programs. One such event is the annual Alternative Cropping Symposium, which provides a platform for producers to discuss the use of cropping systems that promote resource conservation. Building off the momentum generated through these events will help spread the word about conservation planning and practice implementation in the Spring Creek-Union Flat watershed.

1.E. NRCS's Partnership in Reaching Goals

PCD and the local NRCS are active members of the community and provide technical and financial assistance to residents of Whitman County. However, there are landowners and producers that are unable to receive assistance because of funding and personnel limitations. These limitations present an immense opportunity to provide voluntary assistance to improve water quality and soil health by assisting residents throughout the Spring Creek-Union Flat subwatershed. NRCS and PCD have a strong partnership under the Regional Conservation Partnership Program (RCPP). Whitman County NRCS will work with PCD to reach local audiences through public meetings, news releases, and other strategies as outlined in the outreach plan, as well as provide technical information to the public regarding available NRCS programs and interface with the public submitting applications under this program.

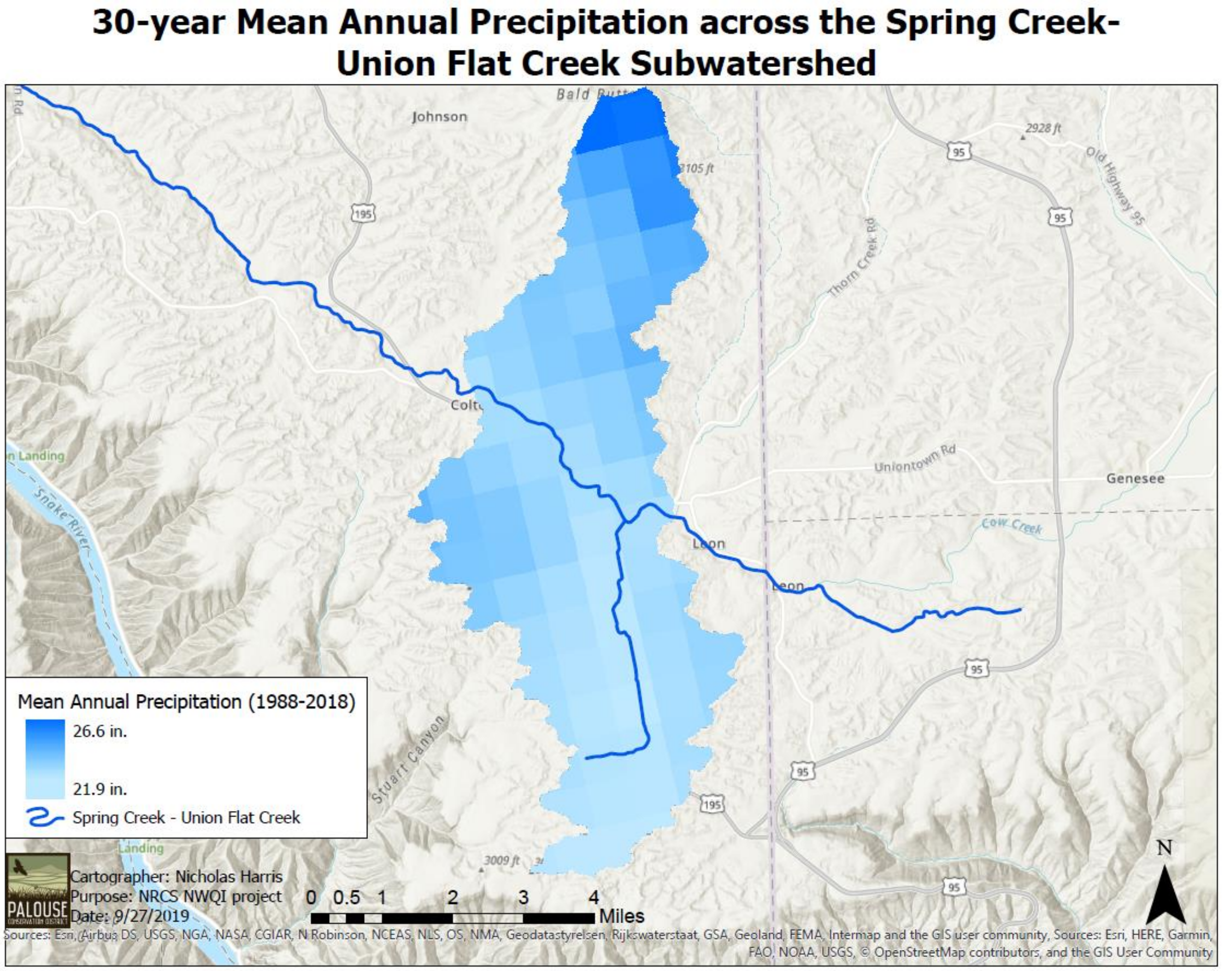
2. Watershed Characterization

2.A. Watershed Location

See section 1.B for a description of the study area located within the Palouse River watershed.

2.B. Climate

The Spring Creek-Union Flat watershed is located in southeast Washington State and is characterized by a warm-summer Mediterranean climate (Csb) under the Köppen-Climate Classification (Arnfield, 2020). The mean annual precipitation for this watershed is 23 inches, with precipitation falling as both rain and snow. The annual precipitation is enough to sustain dryland agricultural practices throughout the region. This watershed receives the majority of its precipitation during late fall through spring (November-April). Given the size of the watershed, precipitation does differ spatially, with the greatest difference being 4.7 inches in precipitation across its entirety (Figure 3). Mean regional temperatures range from 26.5-39.4 °F in the winter, and 51.4-80.2 °F in the summer (Table 2; Thornton *et al.,* 2016).



30-year Mean Annual Precipitation across the Spring Creek-Union Flat Creek Subwatershed

Cartographer: Nicholas Harris
Purpose: NRCS NWQI project
Date: 9/27/2019

Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Figure 3. Thirty-year daily mean precipitation across the Spring Creek-Union Flat subwatershed (Daymet, 2019).

Table 2. Monthly mean climate summary (1988-2018) for the Spring Creek-Union Flat watershed, Washington compiled from Daymet: Daily Surface Weather Data (2019).

Month	Precipitation (in)	Max Temp (°F)	Mean Temp (°F)	Min Temp (°F)
January	2.70	38.5	30.2	26.5
February	2.05	42.8	34.2	27.8
March	2.54	50.2	39.9	31.8
April	2.29	57.0	46.8	36.1
May	2.22	65.9	54.0	42.7
June	1.60	72.5	60.4	47.9
July	0.61	84.1	68.0	53.5
August	0.64	84.1	67.6	52.9
September	0.78	74.9	59.2	46.4
October	1.89	59.5	49.5	37.9
November	2.85	45.2	38.5	31.3
December	2.83	36.9	31.8	25.3

2.C. Physical Characteristics

Landscape Characteristics

The Palouse Region is characterized by rolling loess hills with highly productive soils dominated by annual dryland agricultural systems. The loess hills are composed of wind deposited sediments originating from the erosion of alluvial material left behind by the Missoula Floods. Before European settlement, this area was home to the now critically endangered Palouse Prairie, which consisted of perennial bunchgrasses (*Festuca idahoensis, Pseudorogneria spicata,* and *Koleria macrantha*), shrubs (*Symphoricarpos albus* and *Rosa woodsii*), and a litany of forbs, including the rare *Silene spaldingii*.

Topography

A Digital Elevation Model (DEM) for the Spring Creek-Union Flat subwatershed indicates a minimum elevation of 2539 ft occurring at the center of the drainage and a maximum elevation of 3438 ft at the northern- and southernmost portions of the drainage (Figure 4).

Digital Elevation Model (DEM) of Spring Creek-Union Flat Creek Subwatershed

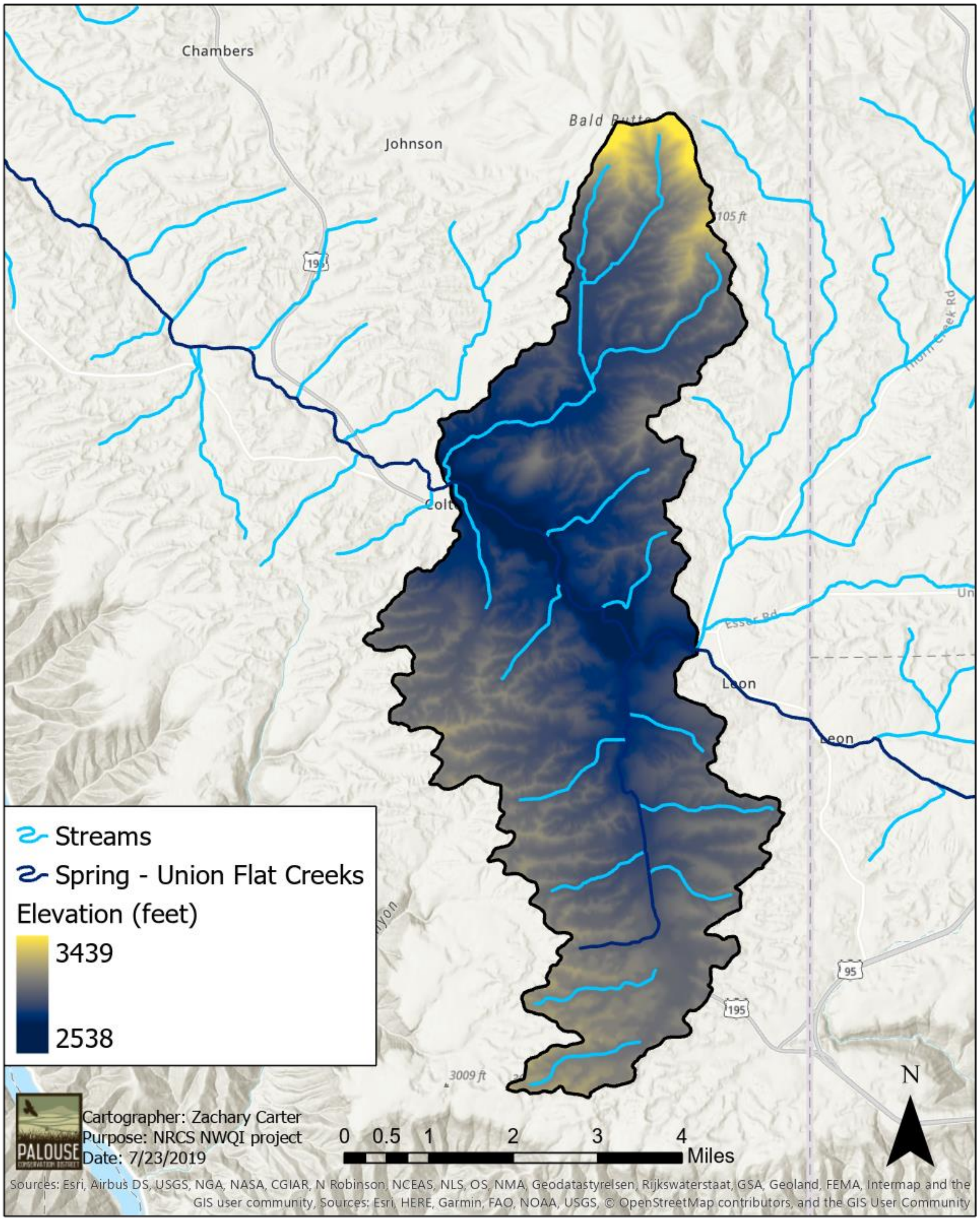


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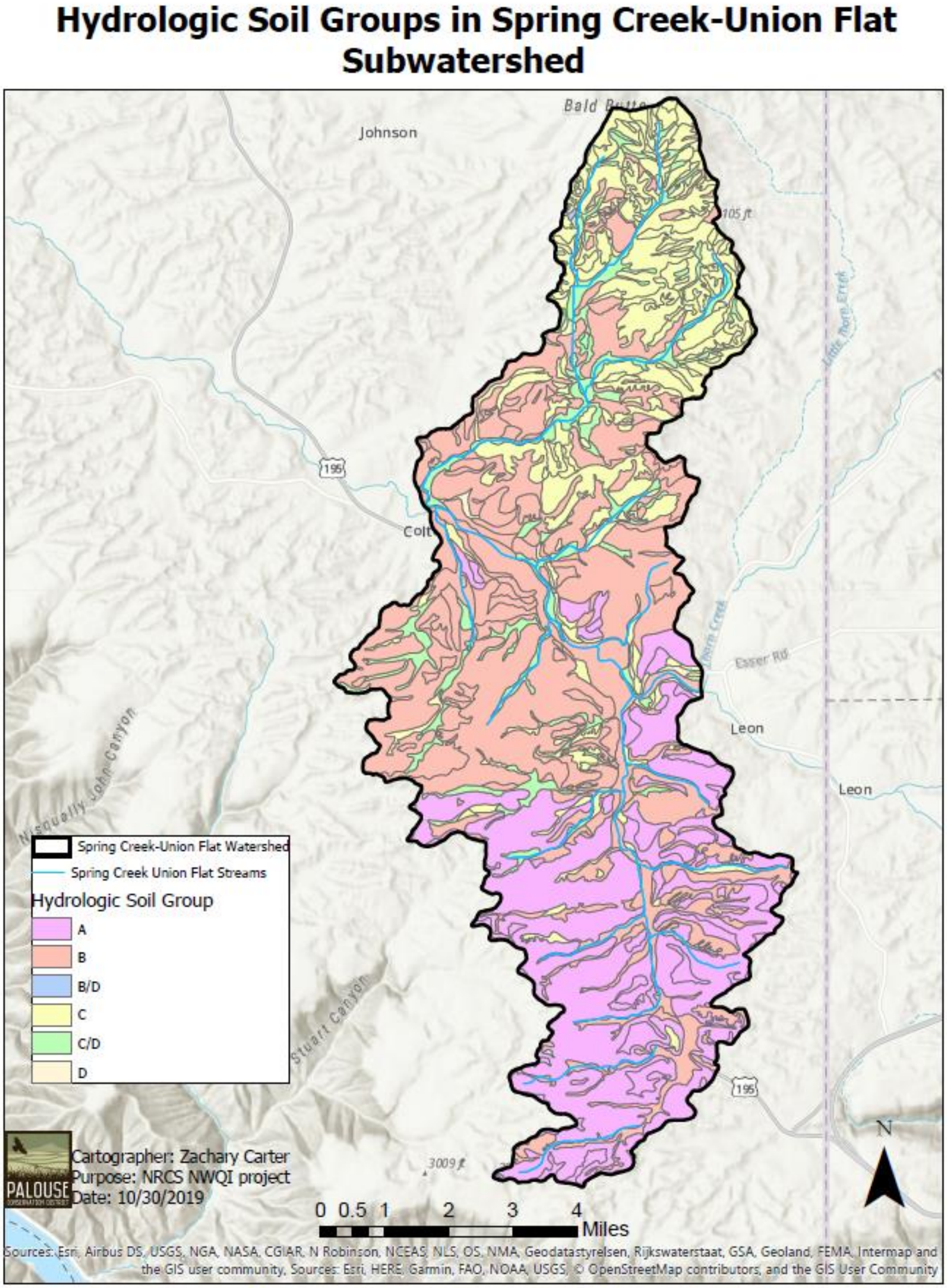
Figure 4. A digital elevation model (DEM) of the Spring Creek-Union Flat watershed.

Soils

Soil information was gathered from the Soil Survey Geographic Database (SSURGO). The Spring Creek-Union Flat watershed is dominated by mollisols, typical of productive agricultural land in this region. The major soil subgroups in this drainage are Pachic Ultic Haploxerolls, Pachic Haploxerolls, Cumulic Haploxerolls, and Oxyaquic Argixerolls. The most common soil series is Palouse silt loam and Athena silt loam, though there are 23 different soil series present within the watershed. Nearly 75% of the soils throughout the area of interest are silt loams with slopes between 7-25% (Figure 5 and Table 3).

As a generalized trend throughout this watershed, runoff potential tends to increase and infiltration rates tend to decrease from south to north (Figure 6). Approximately 29% of the watershed is considered to be hydrologic soil group A, which are well-drained soils with high rates of water infiltration and conductivity, relating to a low runoff potential. The majority of the watershed (44%) consists of hydrologic soil group B, which is moderately well-drained to well-drained due to reduced infiltration rates as compared to group A, and contains moderate- to coarse-sized soil texture. Nearly 20% of the watershed contains soil group C, which has low infiltration rates, usually caused by a restrictive soil layer which negatively impacts downward water movement through the soil. The remainder of the watershed (7.8%) is either group C/D or D, which is characterized by very low infiltration rates and, as a result, greatly increased runoff potential (USDA, 1986).

Soil erodibility for Spring Creek-Union Flat watershed was estimated using K-factor from the Universal Soil Loss Equation (USLE) as developed by the United States Department of Agriculture (USDA) Agricultural Research Service (ARS). Soil erodibility (K-factor) across the entire watershed ranges between 0.31-0.64. Spatial distribution of soil erodibility throughout the watershed is as follows: 9% of soils are classified between 0.31-0.40, 86% of soils are classified between 0.41-0.50, and 4% of soils are classified as 0.51-0.64. Mean soil erodibility across the entire watershed is 0.45 (Figure 7), typical of soils with high silt content (USDA, 2001). These results indicate that soils in this watershed are moderately to highly susceptible to erosional losses.

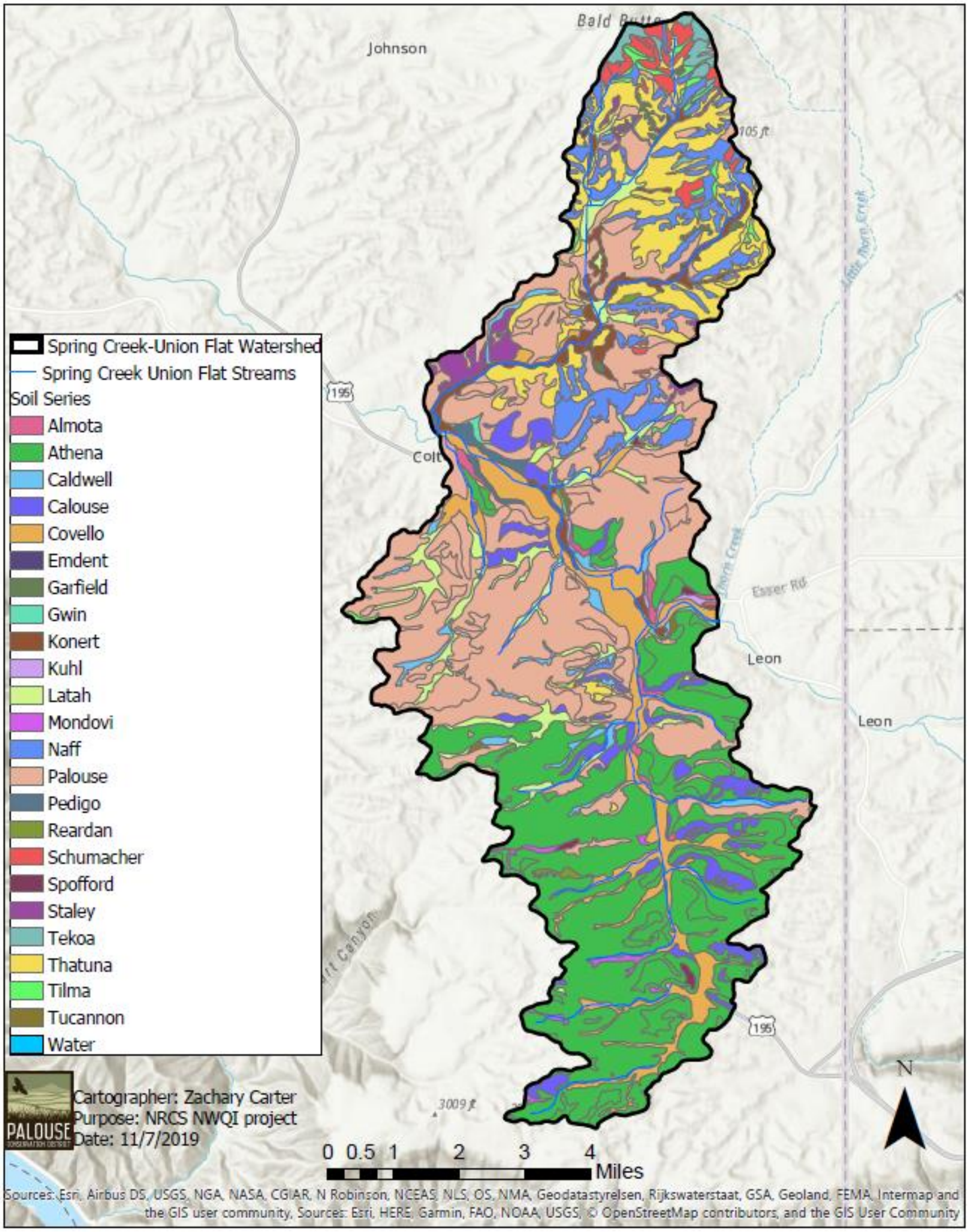


Hydrologic Soil Groups in Spring Creek-Union Flat Subwatershed

Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Figure 5. Hydrologic soil groups throughout the Spring Creek-Union Flat watershed (SSURGO).

Soil Series of Spring Creek-Union Flat Subwatershed

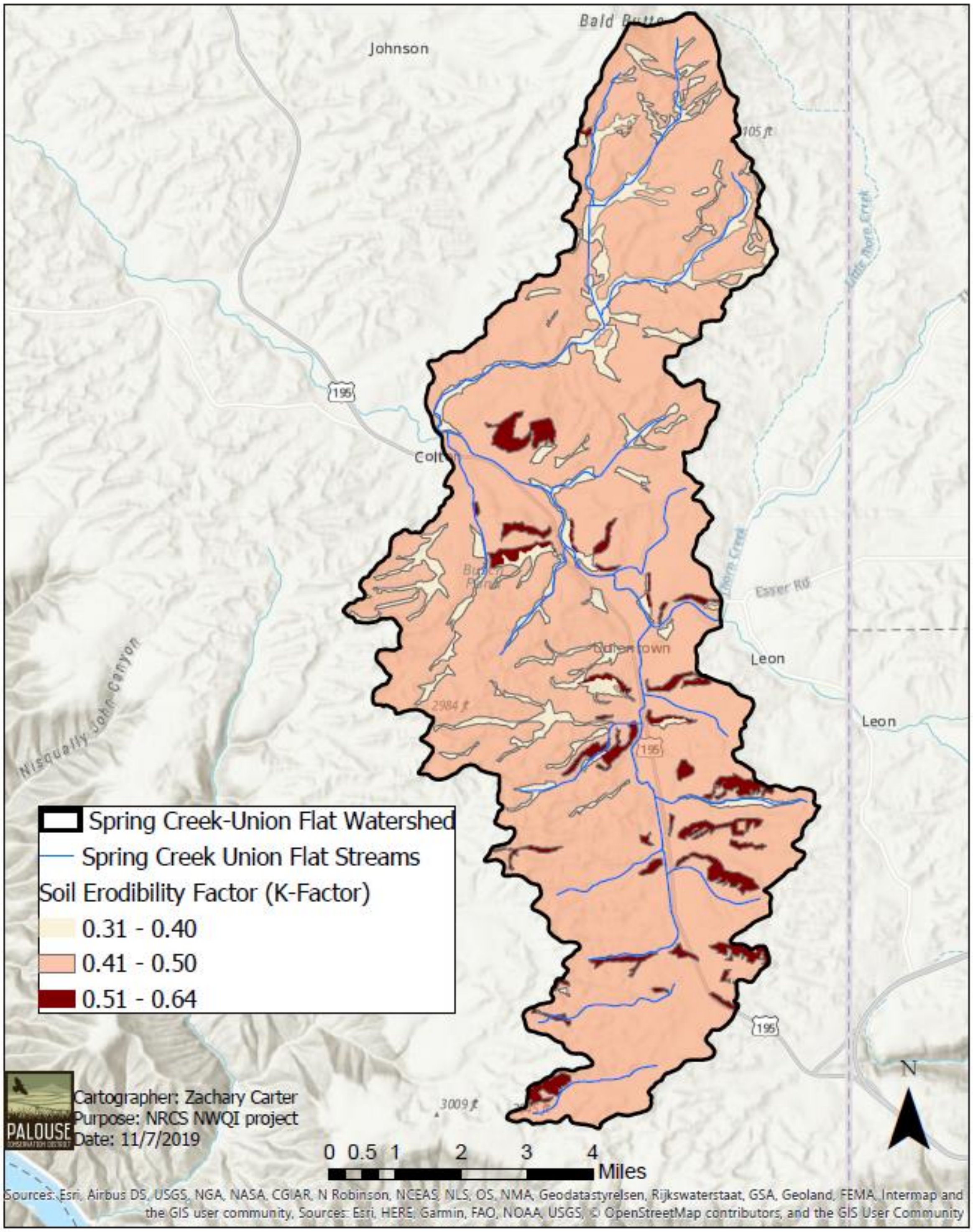


Cartographer: Zachary Carter
Purpose: NRCS NWQI project
Date: 11/7/2019

Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Figure 6. Soil series throughout the Spring Creek-Union Flat watershed (SSURGO).

Soil Erodibility of Spring Creek-Union Flat Subwatershed



Cartographer: Zachary Carter
Purpose: NRCS NWQI project
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Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Figure 7. Soil Erodibility in the Spring Creek-Union Flat watershed as estimated using the USLE K-factor.

Table 3. Soil series name and spatial distribution across Spring Creek-Union Flat subwatershed (SSURGO).

Soil Series	Area (Acres)	Percent Coverage (%)
Palouse	5603	31.1
Athena	5130	28.5
Thatuna	1561	8.7
Covello	1266	7.0
Naff	1043	5.8
Latah	738	4.1
Calouse	694	3.9
Konert	445	2.5
Caldwell	293	1.6
Schumacher	240	1.3
Staley	221	1.2
Other	767	4.3

Drainage Network

The primary streams that flow through this watershed are Union Flat Creek and Spring Creek. The headwaters of Union Flat Creek begin six miles southeast of Uniontown, WA and join Cow Creek, Thorn Creek, and Little Thorn Creek just east of Uniontown before entering into the Spring Creek-Union Flat subwatershed. Union Flat Creek flows for one mile before the confluence with Spring Creek in Uniontown. Union Flat Creek flows for approximately four miles until flowing out of the subwatershed near Colton, WA. Once Union Flat Creek exits the subwatershed, it flows for approximately 58 miles until its confluence with the Palouse River, which then drains into the Snake River.

There is one wastewater treatment plant in Uniontown, representing the only National Pollution Discharge Elimination System (NPDES) permit within the watershed (permit number ST0005371). This treatment plant covers 12 acres and is located near Union Flat Creek (Lat/Long: 46.543053, -117.075278). The treatment process includes lined aerated lagoons and engineered wetlands to treat wastewater, before allowing the effluent to infiltrate as groundwater. The treatment plant is positioned at a higher elevation as compared to the creek and was suspected of containment issues due to the treatment ponds leaking into groundwater. The facility was subsequently upgraded in 2012 to address the containment issues.

There are approximately 4.6 acres of potential herbaceous wetlands throughout Spring Creek-Union Flat, most of which occur at the northern portion of the watershed. Increased prevalence of wetlands in this portion of the watershed could be due to higher annual precipitation and finer textured soils in this area (Figure 8).

Hydrography of Spring Creek-Union Flat Subwatershed

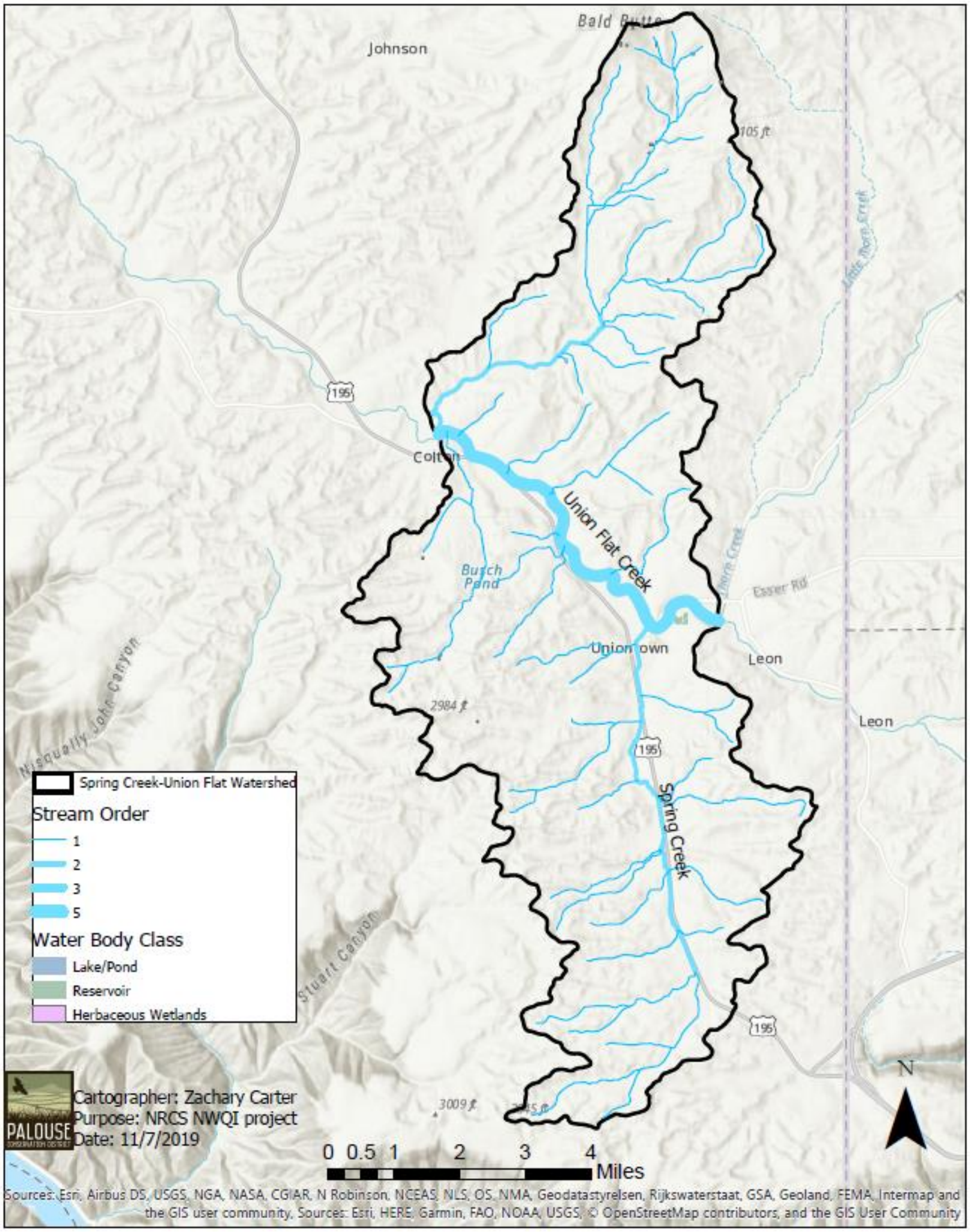

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Figure 8. Hydrography of the Spring Creek-Union Flat watershed.

Land Cover and Land Use

Whitman County land use practices can be observed in the 2017 Census of Agriculture put forth by the USDA National Agricultural Statistics Service (NASS) in Table 4. The mean farm size for Whitman County is 1,240 acres per operation, indicating that this county is predominantly large-scale agriculture. At the county level, conservation tillage is the prominent tillage practice, though no-till acres are comparable in spatial coverage to conventionally tilled acres.

The Spring Creek-Union Flat subwatershed is mostly composed of dryland agricultural systems and rural communities. The most common land cover type in this region is cultivated crops, which composes 94% of the spatial extent throughout the watershed. The remaining land cover types in the watershed are developed open spaces (4.5%) and developed low-intensity areas (~1%).

The typical cropping system in the Palouse region of Whitman County follows a three-year rotation, consisting of a cereal grain such as winter wheat, followed by spring wheat, spring barley, or canola, and ending with a pulse crop, such as garbanzos, lentils, or dry peas. The 2018 Cropland Data Layer produced by USDA NASS indicates that winter wheat is the dominant crop type in this watershed and composed 40% of the watershed area, followed by dry beans with 31% and spring wheat at 14% (Figure 9 and Table 5).

Though canola, peas, and lentils are grown as part of the traditional cropping rotation regionally, these crops only constitute around two percent of the land covered in this watershed. Winter wheat, dry beans, and spring wheat are the most prevalent crops in the Spring Creek-Union Flat watershed, which is reflective of the traditional cropping system throughout the region.

Land Use and Crop Type in Spring Creek-Union Flat Subwatershed

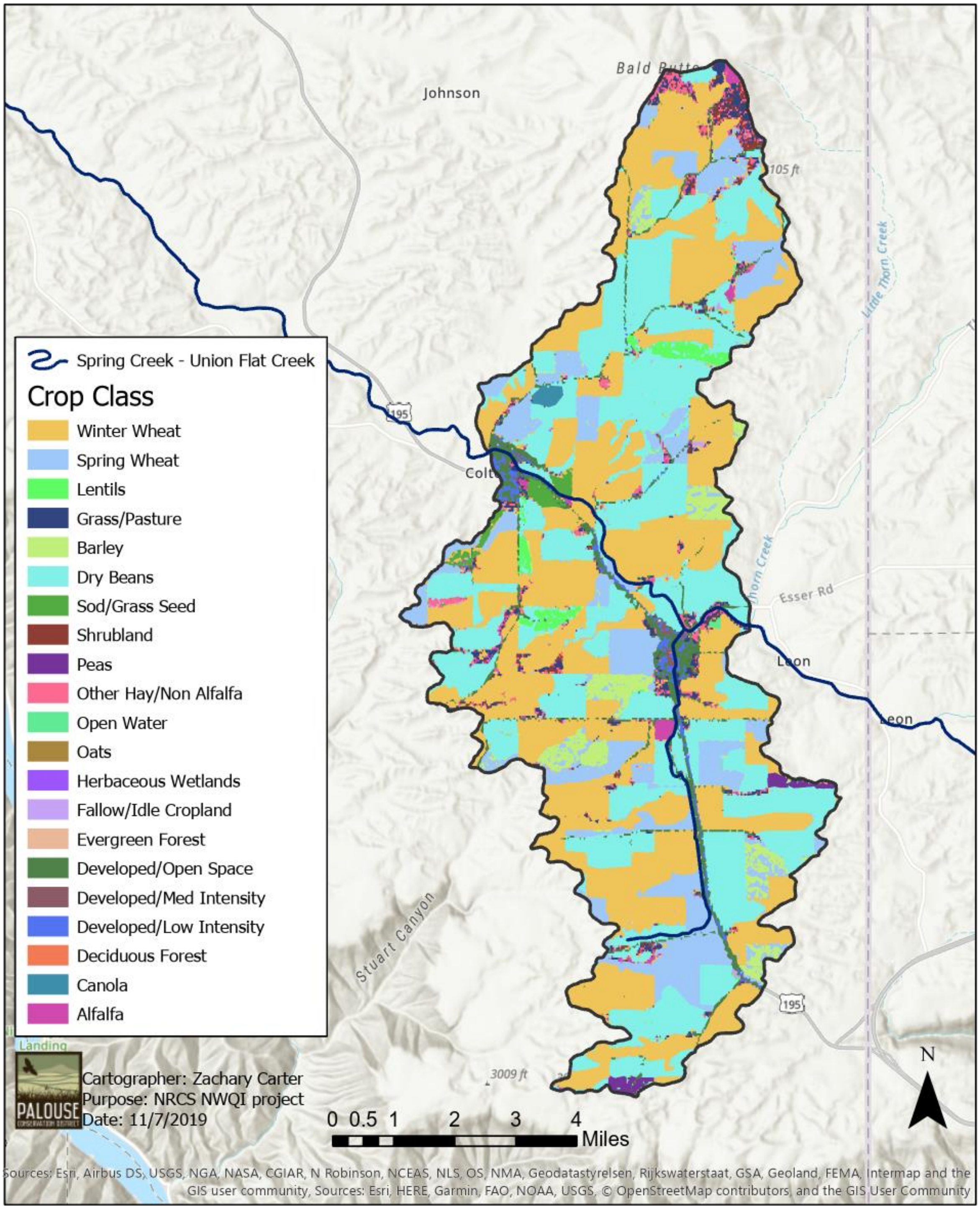

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Figure 9. Land use and crop type in the Spring Creek-Union Flat watershed.

Table 4. Land use practices for Whitman County (USDA National Agricultural Statistics Service, 2017).

Land Use Practices	Area (Acres)
Area Drained by Tile Lines	88,151
Area Drained by Artificial Ditches	44,716
Conservation Easements	8,838
Conservation Tillage, No-Till	177,677
Conservation Tillage, Excluding No-Till	579,846
Conventional Tillage	131,787
Cover Crops, Excluding CRP	2,439

Table 5. Land cover classes and total coverage across the Spring Creek-Union Flat watershed (NRCS National Agricultural Statistics Service, 2018).

Land Cover Class	Area (Acres)	Percent Coverage (%)
Winter Wheat	7165.2	39.8
Dry Beans	5616.1	31.2
Spring Wheat	2432.8	13.5
Developed/Open Space	643.7	3.6
Barley	590.8	3.3
Grass/Pasture	322.2	1.8
Other Hay/Non-alfalfa	250.6	1.4
Lentils	210.7	1.2
Other	764.2	4.2

Socioeconomic Factors

The Spring Creek-Union Flat watershed is predominantly composed of large-acreage dryland agriculture, with two small towns as centralized rural communities. These two communities are Uniontown, with an estimated population of 340 people as of 2018, and Colton, with an estimated population of 386 people as of 2017. Uniontown has approximately 134 households across a total area of 0.9 mi^2. The town of Colton has 182 households across a total area of 0.6 mi^2. The mean household income for both Colton and Uniontown is estimated to be around $33,400 per capita (U.S. Census Bureau, 2017). The entire watershed is served by the Colton Public School District, which offers education for levels K-12.

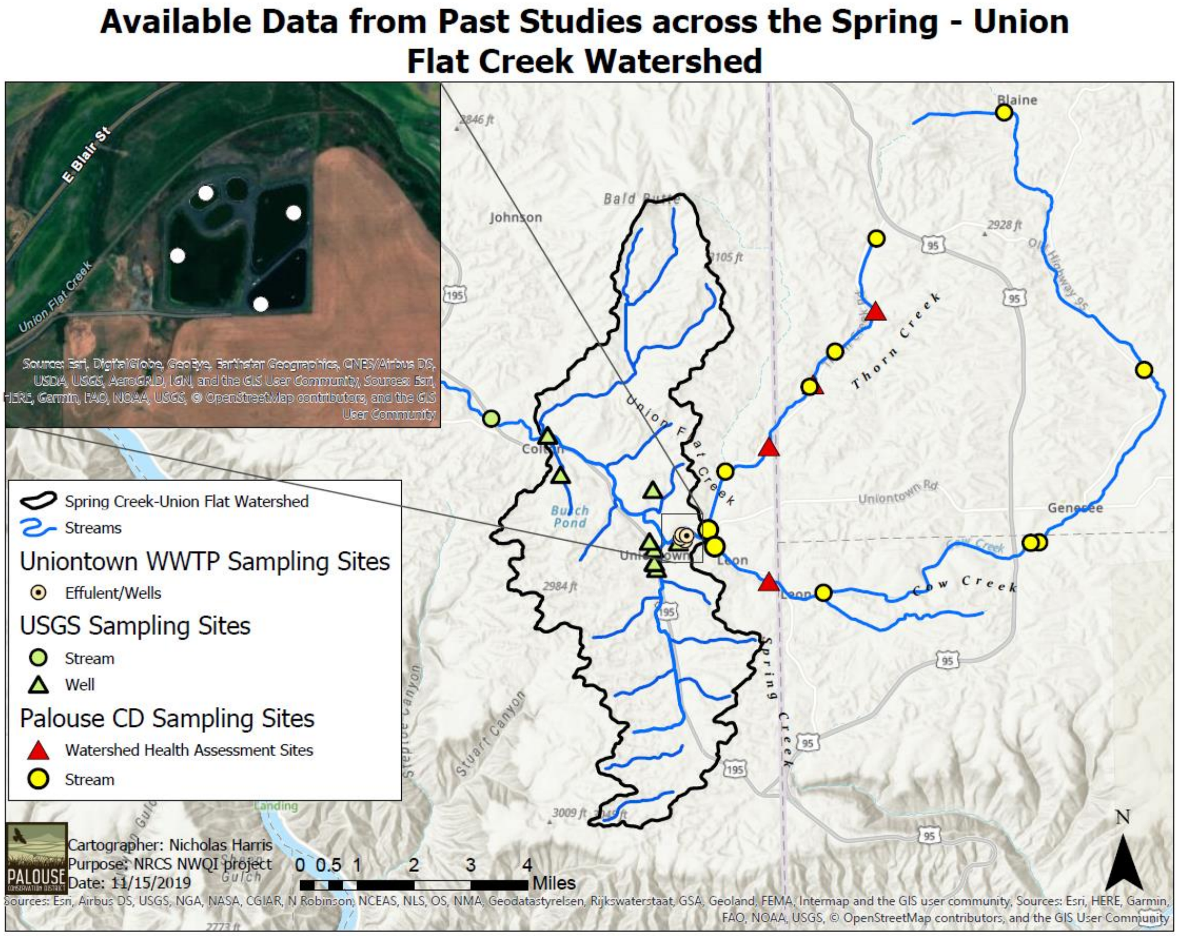
3. Hydrologic and Water Quality Characterization

3.A. Available Water Quality Data and Resources

Several state and federal agencies have collected water quality data in and around the Spring Creek-Union Flat watershed since the 1960s. The United States Geological Survey (USGS) collected water quality data twice in 1968 at the outlet of the watershed and monitored groundwater wells between 1993-1994 for legacy pesticides (Figure 10). In addition to the data collected by the USGS, the Uniontown wastewater treatment plant has held an NPDES permit (permit number: ST0005371) administered by the Washington State Department of Ecology since 2010. The permit requires monthly monitoring of both effluent and groundwater wells. The parameters collected include 5-day biological oxygen demand, total suspended solids, total organic and inorganic nitrogen, fecal coliform, nitrate, and total dissolved inorganic solids. The wastewater treatment plant monitoring locations can be seen in Figure 10, and the data can be found on the Department of Ecology's website: apps.ecology.wa.gov/paris/DischargeMonitoringData.aspx.

Aside from work completed by USGS and the City of Uniontown, there have not been any water quality studies that focus specifically on nonpoint source pollutants in Spring Creek-Union Flat watershed. There have been several studies in Cow and Thorn Creeks, two of the major tributaries that flow directly into the watershed. In 1998, Cow Creek was listed as "water quality limited" under section 303(d) of the Clean Water Act. Following the listing, the IDEQ addressed these impairments by developing the Cow Creek Subbasin Assessment and Nutrient TMDL (IDEQ, 2005). The assessment found that during summer low flow periods, Cow Creek experienced increased temperatures, low dissolved oxygen concentrations, and high nitrogen and phosphorus concentrations that were expected to contribute to aquatic plant growth (IDEQ, 2005). Targets, loading analysis, and load allocations were presented for nutrient management. Between 2006 and 2008, the Idaho Association of Soil Conservation Districts (IASCD) conducted a follow-up water quality study. Researchers at IASCD concluded that nitrate and phosphorus concentrations continued to exceed TMDL targets, evidence of erosion was widespread both instream and from adjacent farmland, and excessive stream temperatures were observed from April to July (Clark, 2008). In 2009, a TMDL implementation plan was developed for Cow Creek (IDEQ, 2009), and in 2013, a temperature addendum was added to the original nutrient TMDL (IDEQ, 2013).

PCD has also collected water quality data in the Cow and Thorn Creek watersheds to assess the effectiveness of BMPs installed throughout the drainages (Figure 10). The hydrologic data collected include a 15-minute continuous record of stage height, precipitation, turbidity, pH, dissolved oxygen, and specific conductivity, with monthly grab samples analyzed for suspended sediment concentrations, nitrate, nitrite, ammonia, total phosphorus, orthophosphate, and fecal coliform. A further discussion of the results can be found below in Section 3.C.



Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Figure 10. Water quality monitoring locations in and around Spring Creek-Union Flat watershed.

Gaging Stations in or near the Watershed

A gaging station was installed in in January of 2020 and has been operation since. PCD also maintains two other gaging stations at the outlet of the Cow and Thorn Creek watersheds, which feed directly into Union Flat Creek from the east (Figure 11).

Gaging Stations in Spring Creek-Union Flat Creek Watershed

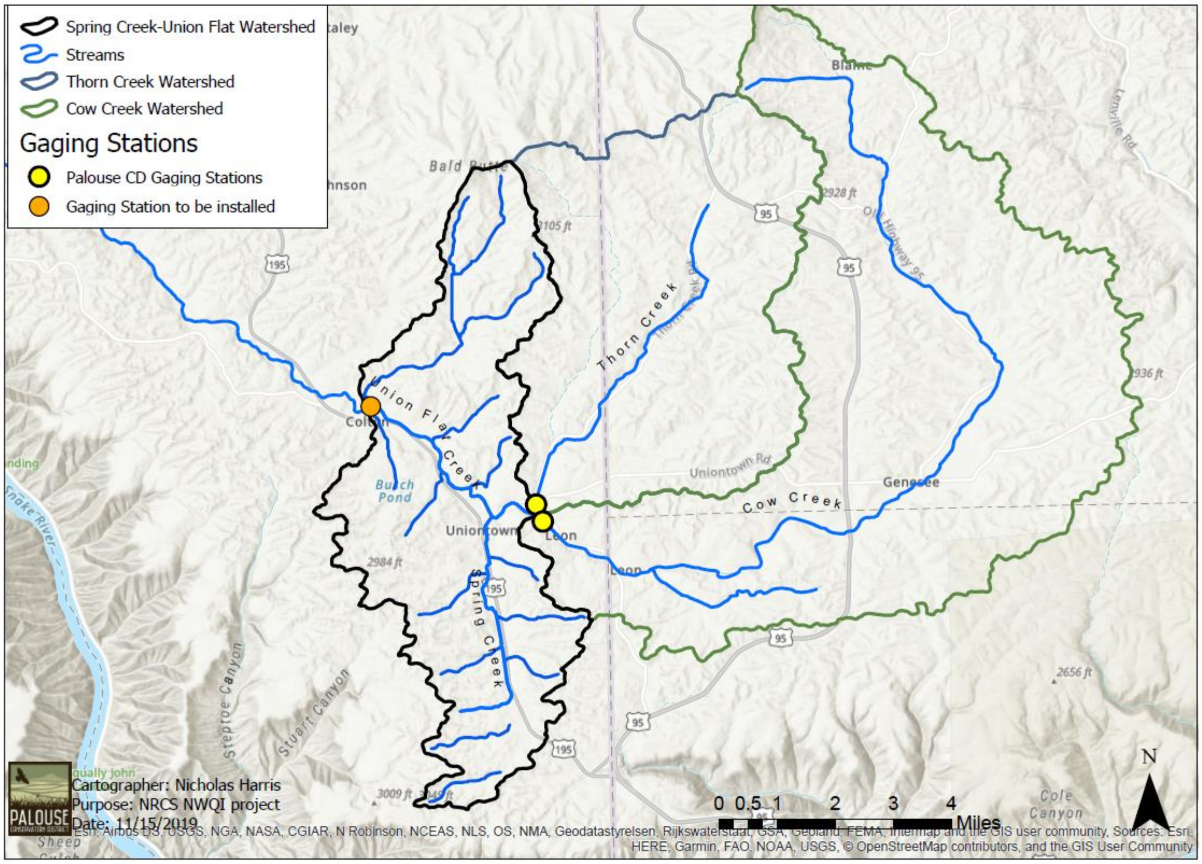


Figure 11. Current and proposed gaging stations in Spring Creek-Union Flat watershed.

<u>Biological Data</u>

Limited biological data exist specifically within the Spring Creek-Union Flat watershed. Conservation Planners at PCD have utilized the NRCS Stream Visual Assessment Protocol as a pre-planning tool for riparian restoration projects. Two of these assessments within the watershed indicate a score between 0 and 1, on a scale of 0 to 10, for “barriers to aquatic species movement,” “fish habitat complexity,” and “aquatic invertebrate habitat.” The low scores indicate that instream habitat has been degraded and the sites are good candidates for riparian restoration.

Two studies focused on identifying fish populations in the region, which included sampling sites on Union Flat Creek outside of the Spring Creek-Union Flat watershed boundaries. The dominant fish species identified included Northern pikeminnow (*Ptychocheilus oregonensis*), Palouse finescale sucker (*Catostomus catostomus*), Chiselmouth (*Acrocheilus alutaceus*), and western dace or speckled dace (*Rhinichthys osculus*) (Maughan *et al.*, 1980 and Havens, 1998). A third study, which identified parasites that affect fish species in the Palouse area, included Union Flat Creek as a study site. The results indicated that 83% of Palouse finescale suckers collected in Union Flat Creek carried either one or a combination of tapeworms (*Cestodes*), thorn-headed tapeworms (*Ancanthocephala*), or Copepods (Griffith, 1953). The Washington Department of Fish and Wildlife reports that they stock Union Flat Creek with Rainbow trout (*Oncorhynchus mykiss*). The average annual stocking rate for the last five years has been 501 fish (https://wdfw.wa.gov/fishing/reports/stocking/trout-plants/archive).

3.B. Hydrologic Processes Driving Runoff

The hydrology of the Spring Creek-Union Flat watershed can be characterized by the region's climate, steep slopes, and range in soil depths. The climate of the watershed consists of warm, dry summers and cool, wet winters. The majority of precipitation falls between October and May, with infrequent storms during the summer months. There are three primary hydrological mechanisms generating runoff during the wetter months that have been well-documented for the region: saturation excess, subsurface lateral flow, and rain or snow and frozen soils. Runoff generated from saturation excess occurs when the total water added to the soil exceeds the soil’s water-storage capacity (Brooks *et al*., 2012). When the soil is fully saturated, water moves over and down steep slopes as runoff and either ponds at toe slopes or drains into adjacent water bodies.

One of the most important soil-forming factors on the Palouse is effective precipitation (or monthly precipitation minus evapotranspiration). Areas with greater effective precipitation experience leaching of carbonates and finer clays, resulting in layers that restrict water movement (Brooks *et al*., 2012). The restrictive layers in the soil profile greatly decrease hydraulic conductivity. During the wet season, perched water tables form, causing water to flow laterally along steep slopes found throughout the region. Ponding of water is often observed at the toe slope of areas with restrictive soil layers. Runoff tends to be flashier in areas with restrictive layers and perched water tables, and can be activated by very small storms (Brooks *et al*., 2012). The northern portions of the Spring Creek-Union Flat watershed contain soils with identified restrictive layers.

Freezing temperatures in winter will blanket the rolling hills of the Palouse with snow, and can cause some of the largest storm events due to rain on frozen soils. As temperatures increase, rain inevitably falls directly on frozen soil or snowpack. Frozen soils have severely decreased hydraulic conductivity at the surface and, as a result, most precipitation moves over the landscape as runoff (McCool *et al*., 2000).

The mentioned hydrologic processes tend to create flashy hydrographs that peak between December and May. An example of this can be seen at gaging stations on Cow and Thorn Creeks, two major tributaries feeding into the Spring Creek-Union Flat watershed (Figure 12).

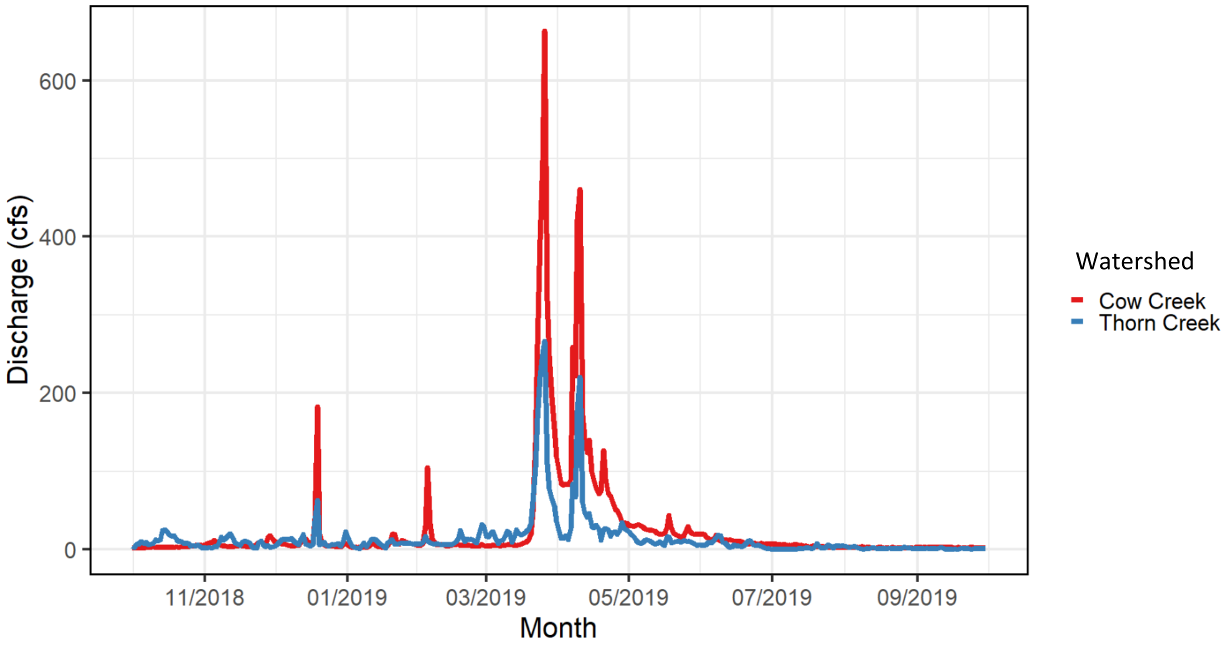


Figure 12. Hydrographs for Cow and Thorn Creeks (Palouse Conservation District internal data).

<u>Methods Used to Estimate Hydrologic Conditions</u>

There are currently no gaging stations within the Spring Creek-Union Flat watershed that would enable accurate measurements of hydrologic conditions. Estimates of watershed-level hydrologic processes were modeled with the Water Erosion Prediction Project (WEPP). The WEPP model was developed in the 1980s to predict runoff and erosion at both field and watershed scales (Flanagan *et al*., 1995, Laflen *et al*., 1997). WEPP models many important hydrologic processes including infiltration, runoff, lateral flow, and percolation, as well as perched water tables, complex topography, and the inherent heterogeneity of soils. The watershed version of WEPP simulates a series of processes, including soil detachment, transport and deposition of soil on hillslopes and in channels, and runoff and sediment yields at the watershed outlet under various land use and environmental conditions (Ascough *et al.*, 1997). The WEPP model has been extensively tested in small agricultural watersheds (Laflen and Elliot, 1991, Liu and Nearing, 1997, Pandey *et al*., 2008, Williams *et al*., 2010) and has been utilized in the inland Pacific Northwest's dryland grain-producing region, focusing on winter hydrologic process (Greer *et al*., 2006, Singh *et al*., 2009).

Inputs into the model include: a 30-meter resolution digital elevation model (DEM), SSURGO soils data, a 30-year climate file derived from PRISM data, and management files specific to the watershed. The Spring Creek-Union Flat watershed was broken into 728 hillslopes which were then assigned location-specific slopes, soil types, climate, and management files that corresponded to land use type. With the majority of the watershed in dryland agriculture (94%), all agricultural lands were assumed to be managed under mulch tillage in this scenario to best represent the area using a single input. A full sensitivity analysis of management practices will be conducted in the *Resource Analysis and Source Assessment* section. The results in the next two sections were modeled with WEPPcloud, an online version of the WEPP model (https://wepp1.nkn.uidaho.edu/weppcloud/).

Precipitation-Runoff Budget

The WEPP model was used to predict yearly water balances for a 30-year simulation period. The 30-year average precipitation ranged from 26 to 36.5 inches, with an average of 31 inches across the entire watershed. Thirty-year average estimates for rain plus melt, evapotranspiration, percolation, storage, and runoff can be seen in Table 6 below.

Table 6. Thirty-year average water balance estimates with standard deviations for the Spring Creek-Union Flat watershed.

Water Balance Component	Average (30-year)
Precipitation (in)	31.9 ±5.5
Rain+Melt (in)	31.1 ±5.5
Runoff (in)	5.9 ±2.3
Evapotranspiration (in)	9.1 ±2.2
Percolation (in)	3.5 ±1.8
Storage (in)	11.4 ±1.5

Thirty-year annual watershed-scale runoff to precipitation ratios are estimated to be 0.18, with a range between 0.03 in dry years and 0.28 in extremely wet years. The heterogeneous landscape of the watershed is covered with many soil types that tend to become more shallow moving from south to north. Shallow northern soils with restrictive layers, along with higher average annual precipitation in the northern portions of the watershed, generate greater 30-year average runoff to precipitation ratios in northern portions than those estimated for the southern portions of the watershed. Ratios ranged from 0.11 in the northern portion of the subwatershed to 0.06 in the Spring Creek-Union Flat subwatershed draining the southern end.

Spatial Distribution of Runoff

Projecting a 30-year annual average estimated runoff on a hillslope basis for the entire watershed enables planners to identify areas that are most prone to runoff. The WEPP model estimated that average annual runoff ranges from 0.01 inch to 4.06 inches. Higher concentrations of runoff-prone areas are found in the northern portions of the watershed, following gradients in soil depth and annual precipitation (Figure 13). There are also several hillslopes in the central and eastern portions of the watershed that had estimated runoff rates greater than 2 inches (Figure 13).

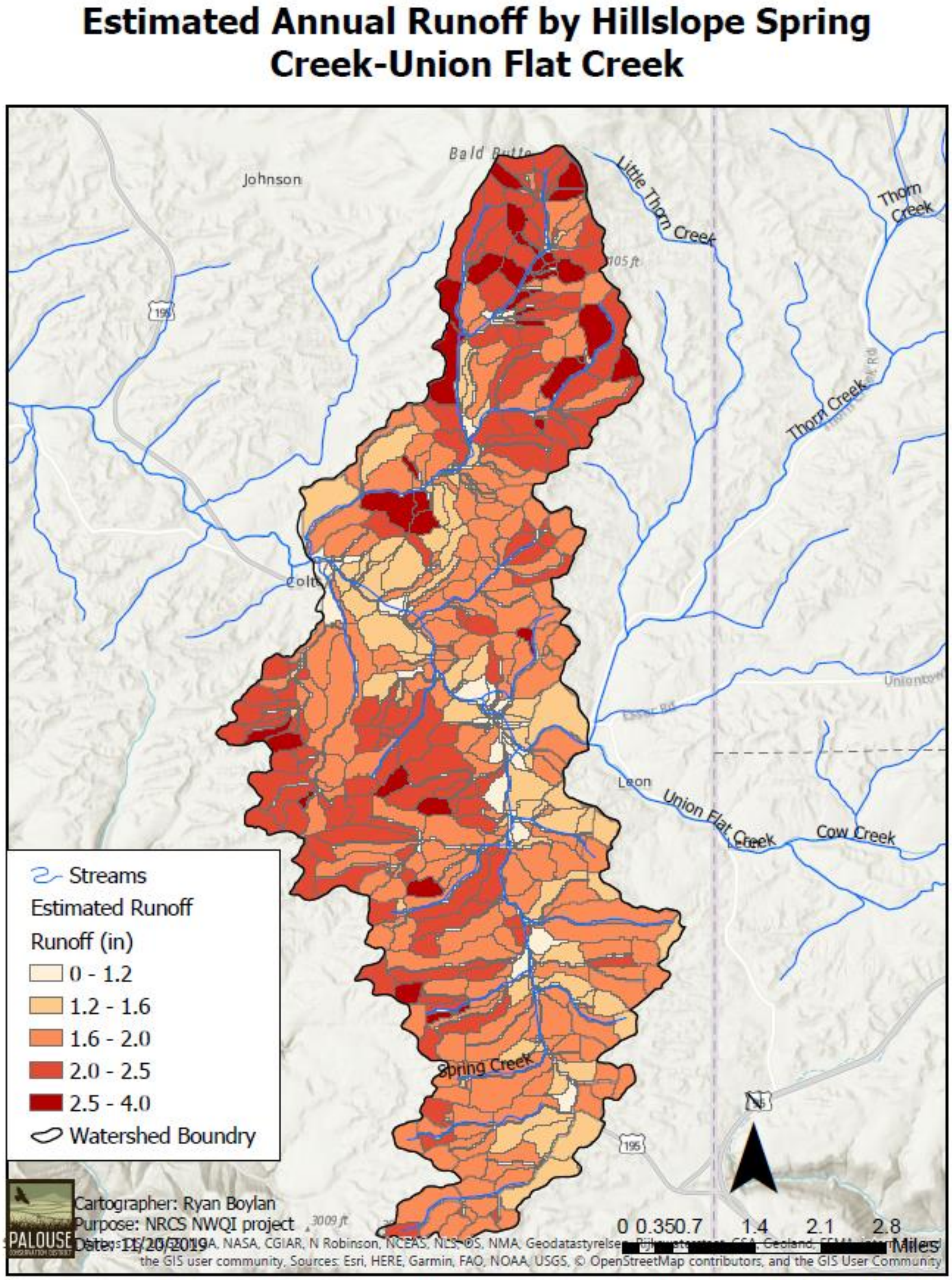


Figure 13. Thirty year-average annual estimates of runoff by hillslope for the Spring Creek-Union Flat watershed (WEPP).

3.C. Water Quality Conditions in the Watershed

PCD collected water quality data on two tributaries to Union Flat Creek directly upstream from the Spring Creek-Union Flat watershed boundary near Uniontown. Water quality and discharge data have been collected on Cow and Thorn Creeks since September 2018. The data includes ammonia-N (NH_3-N), nitrite and nitrate-N (NO_2/NO_3-N), orthophosphate (OP), total phosphorus (TP), suspended sediment concentration (SSC), fecal coliform bacteria (FC), dissolved oxygen (DO), pH, and temperature. Discharge data were collected monthly and stage data were collected at 15-minute intervals with pressure transducers. Preliminary hydrographs and load calculations have been generated for Cow and Thorn Creeks from this data. Land use adjacent to the two creeks is very similar to Spring Creek-Union Flat watershed and could provide a good picture of what is entering the watershed, as well as the relative pollutant concentrations and loads that can be expected.

Sediment

Tillage practices in the Palouse Region strongly influence erosion rates on agricultural land and can determine the quantity of sediment entering a waterway. Suspended sediment concentrations for Cow and Thorn Creeks typically peak during high flow events driven by snowmelt and frozen soils, occurring between March and May. During spring runoff in March and April 2019, suspended sediment concentrations on Thorn Creek exceeded 700 mg L^{-1}, while concentrations in Cow Creek were approximately 200 mg L^{-1} (Figure 14). In the 2019 water year, Thorn Creek produced over 20 times the amount of sediment load per acre as compared to Cow Creek (Table 7).

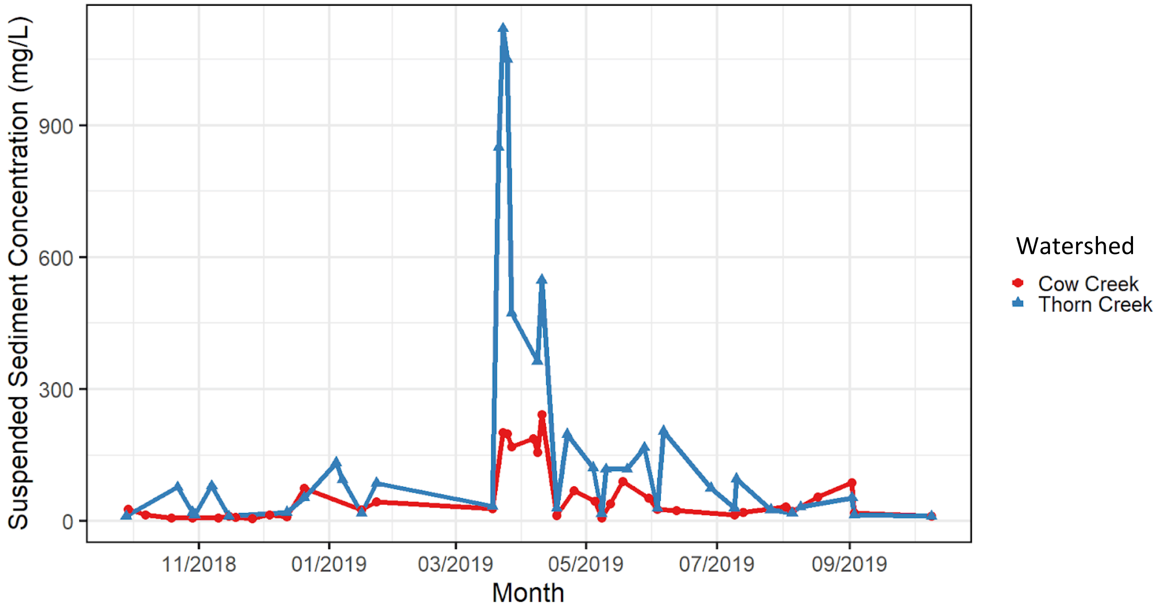


Figure 14. Suspended sediment concentrations (mg L^{-1}) on Cow and Thorn Creeks for the water year 2019 Palouse Conservation District internal data.

Table 7. The water year 2019 constituent load estimates for Cow and Thorn Creeks (Palouse Conservation District internal data).

Constituent Load	Cow Creek	Thorn Creek
FC (cfu ac^{-1} yr^{-1})	6.46E+09	4.61E+09
NH_3-N (lbs ac^{-1} yr^{-1})	3.19	0.70
NO_2/NO_3-N (lbs ac^{-1} yr^{-1})	333.79	304.41
TP (lbs ac^{-1} yr^{-1})	7.13	6.76
OP (lbs ac^{-1} yr^{-1})	5.09	4.63
SSC (tons ac^{-1} yr^{-1})	2.29	7.41

Nitrogen

Ammonia load trends indicate that the Cow Creek drainage produced 4.5 times the amount of ammonia load compared to Thorn Creek (approximately 3.19 and 0.70 lbs ac^{-1} yr^{-1}, respectively). However, monthly ammonia concentration trends indicate that Cow Creek experienced elevated levels of ammonia between December 2018 and April 2019 before returning to concentrations less than that of Thorn Creek (Table 7).

Nitrite and nitrate concentrations were comparable between both creeks throughout the monitoring period. Cow and Thorn Creek nitrite/nitrate levels both spiked once at the end of January and again in April/May during the spring runoff event (Figure 15). Annual loads of nitrite and nitrate indicate that Cow Creek transported 10% more nitrite and nitrate as compared to Thorn Creek (Table 7). Total nitrite and nitrate loads entering into Spring Creek-Union Flat watershed from Cow and Thorn Creeks were measured at 638.2 lbs ac^{-1} yr^{-1}.

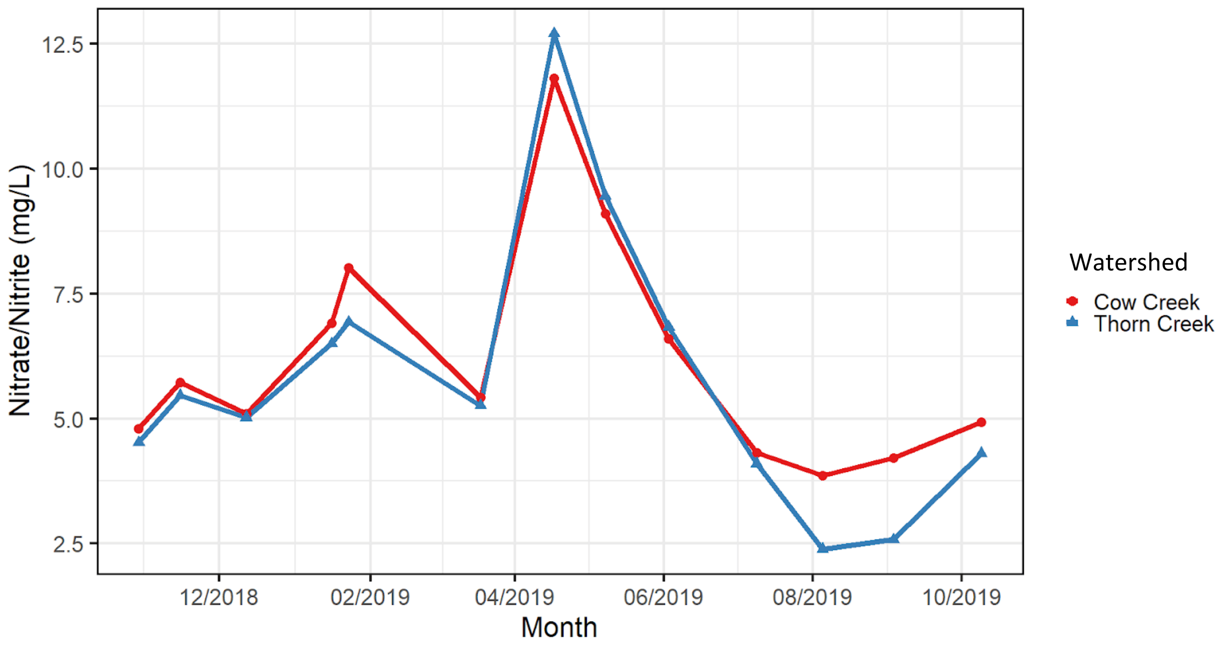


Figure 15. Nitrite/nitrate concentrations (mg L^{-1}) in Cow and Thorn Creeks for the water year 2019 (Palouse Conservation District internal data).

Phosphorus

Total phosphorus and orthophosphate concentrations follow similar trends in both Cow and Thorn Creeks. Concentrations of both TP and OP are at their greatest in December before tapering off in late winter, after which concentrations tend to remain below 0.2 mg L^{-1} for the remainder of the year (Figure 16). Little difference in annual loads of TP and OP was observed between Thorn and Cow Creeks. Total phosphorus load entering into Spring Creek-Union Flat watershed from Cow and Thorn Creeks is 13.9 lbs ac^{-1} yr^{-1} (Table 7).

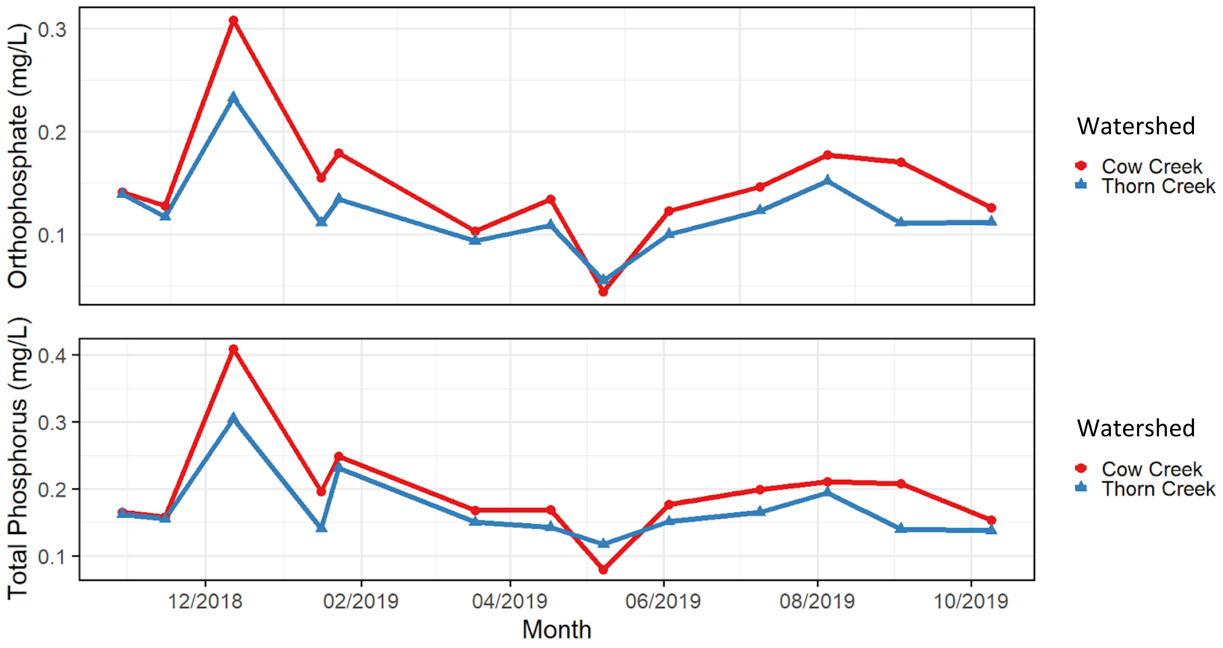


Figure 16. Orthophosphate and total phosphorus concentrations (mg L^{-1}) in Cow and Thorn Creeks for the water year 2019 (Palouse Conservation District internal data).

Fecal Coliform

Fecal coliform data are not available for each month during the monitoring period; however, some trends can be identified in what data are available. Fecal coliform bacteria concentrations remained around 32 cfu 100 mL^{-1} for Cow and Thorn Creeks from January through July 2019. In August and September, when stream discharge is at its lowest, fecal coliform concentrations in Thorn Creek were double the Department of Ecology's water quality criteria (250 cfu 100 mL^{-1}) for those waterways (Figure 17).

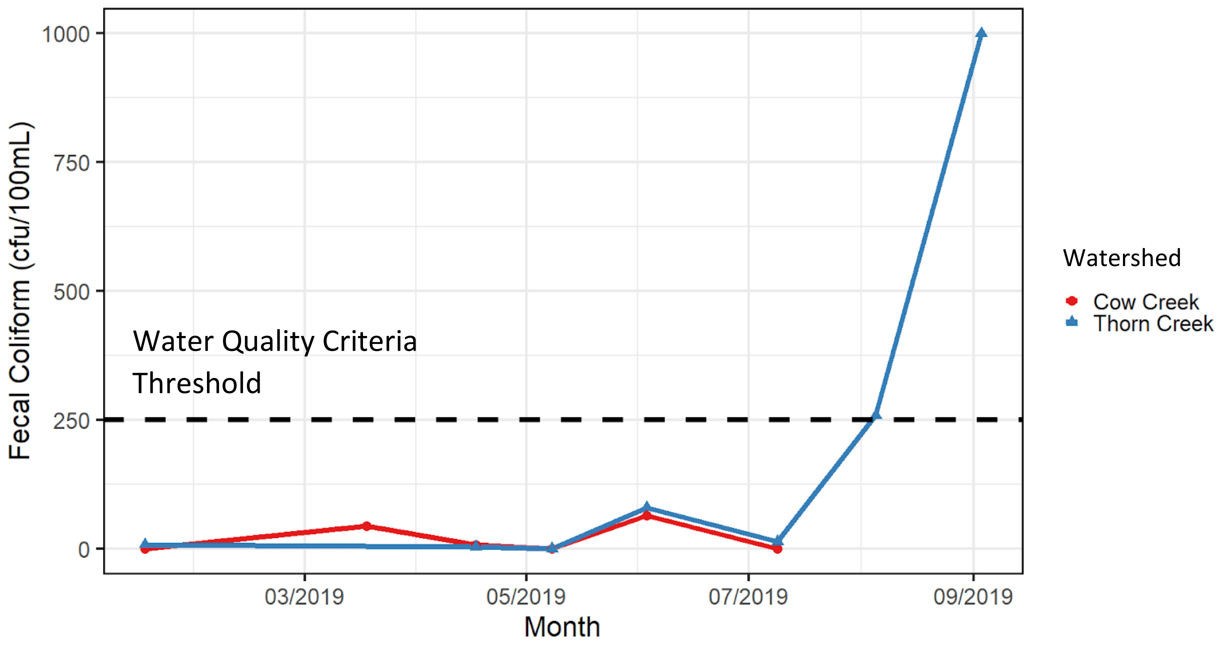


Figure 17. Fecal coliform bacteria concentrations (cfu 100 mL^{-1}) in Cow and Thorn Creeks for since January 2019 (Palouse Conservation District internal data).

<u>Temperature and Dissolved Oxygen</u>

Water contributing to the Spring Creek-Union Flat watershed fluctuates seasonally and is at its lowest in January when temperatures are around 0 °C. Temperatures exceeded the 17.5 °C water quality criteria in summer 2019 on Cow Creek for 45 days and Thorn Creek for 70 days (Figure 18). Cow and Thorn Creeks have comparable annual trends for dissolved oxygen. DO levels peak between 13-14 mg L^{-1} following colder temperatures in winter, then decline through the warmer temperatures in summer, then increase again in the fall when temperatures cool off. Dissolved oxygen levels dropped to 6.5-7.5 mg L^{-1} in August and September, which is below the Department of Ecology's water quality criteria minimum threshold of 8 mg L^{-1} (Figure 19).

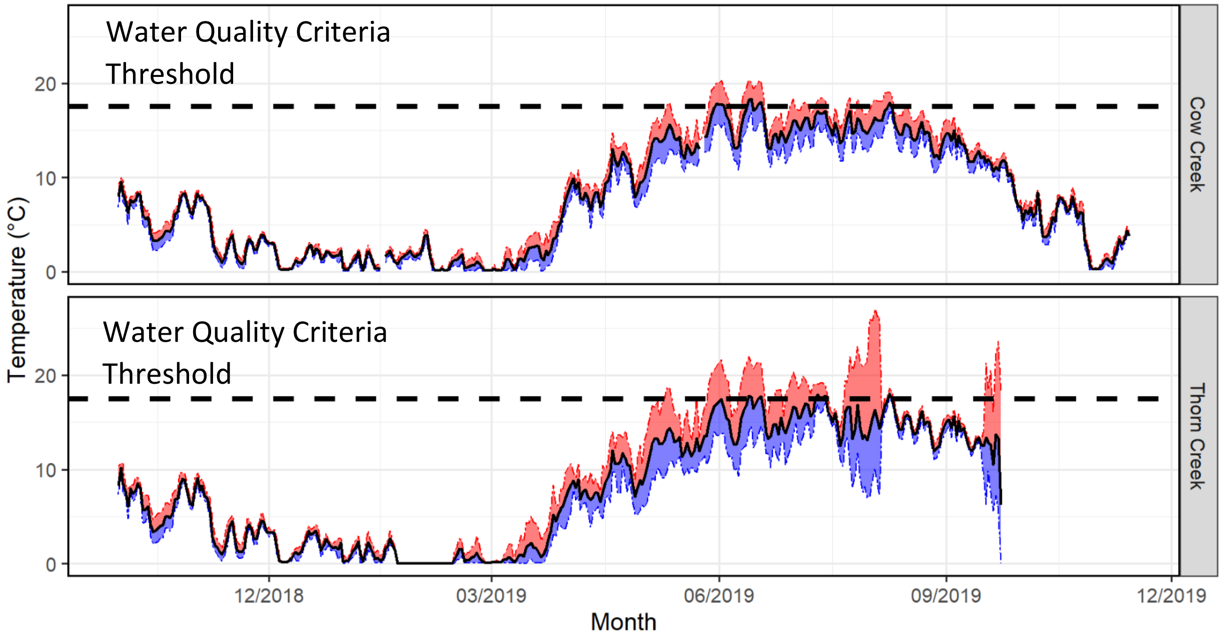


Figure 18. Water temperatures (°C) in Cow and Thorn Creeks for the water year 2019 (Palouse Conservation District internal data).

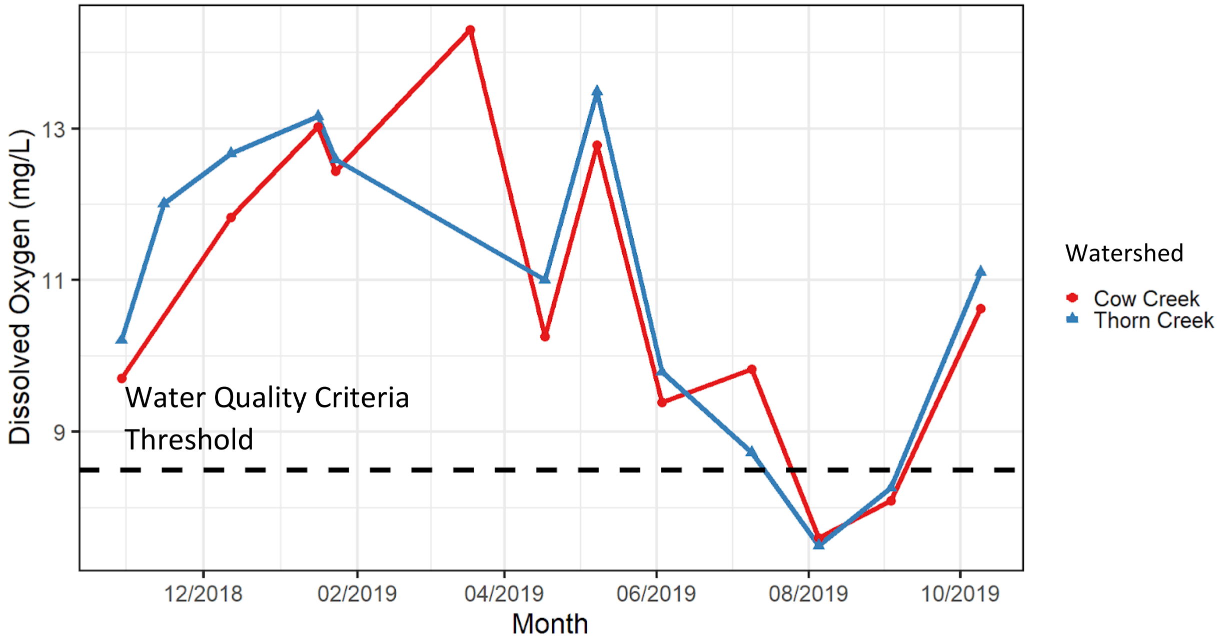


Figure 19. Dissolved oxygen concentrations (mg L^{-1}) in Cow and Thorn Creeks for the water year 2019 (Palouse Conservation District internal data).

pH

Cow and Thorn Creek's pH levels remain relatively consistent throughout the year, ranging between 7.5 and 8.0 units. Over the monitoring period, pH in both Cow and Thorn Creeks peaked in May (8.2 and 9 units, respectively), but only Thorn Creek exceeded the Department of Ecology’s water quality criteria of 8.5 units (Figure 20).

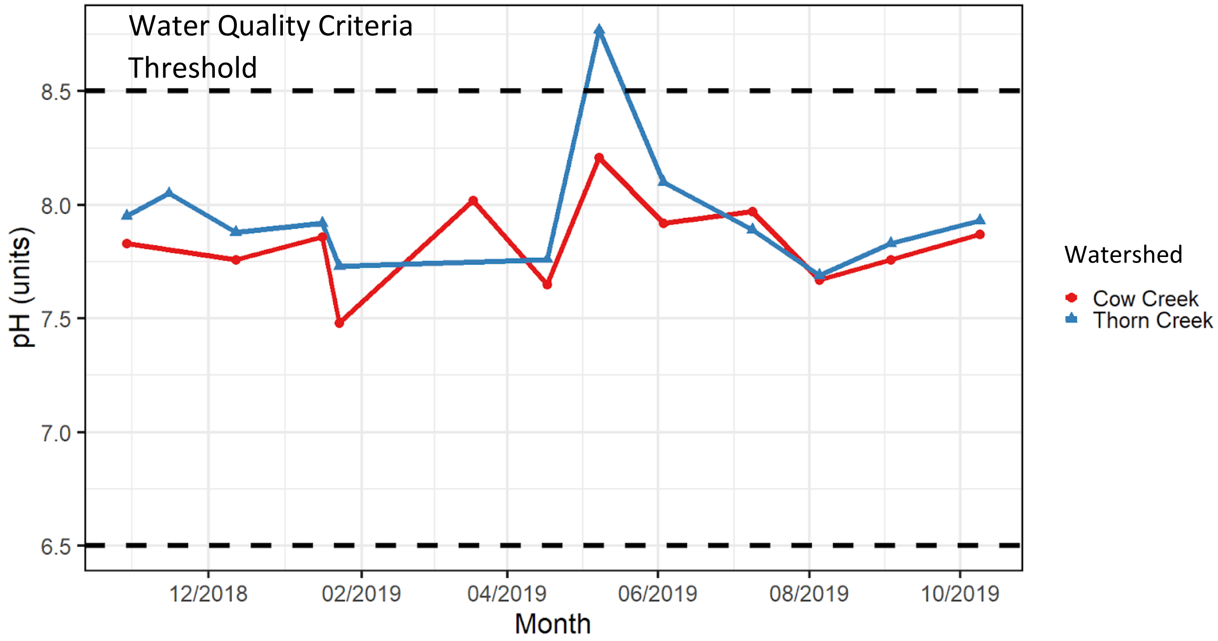


Figure 20. pH levels (units) in Cow and Thorn Creeks for the water year 2019 (Palouse Conservation District internal data).

Prior to the collection of water quality data for Spring Creek-Union Flat watershed, Cow and Thorn Creeks were analyzed to understand water quality issues of incoming water. This information combined with the installation of a monitoring station located near the town of Colton will provide a valuable resource in the process of conservation planning.

4. Resource Analysis and Source Assessment

4.A. Tools to Identify Resource Problems

Objective

The goal of the *Resource Analysis and Source Assessment* section of this project is to estimate sediment and nutrient loading, as well as to identify CSAs runoff and erosion within the watershed. Rather than taking a uniform outreach approach in this watershed, targeting outreach to CSAs allows for more effective implementation of BMPs by mitigating pollutants before they enter streams and focusing available resources to assist landowners in meeting their conservation goals. Physical characteristics of the landscape, such as slope and soil type, combined with tillage practices can generate higher concentrations of pollutants due to elevated surface runoff and sediment erosion. Therefore, targeting CSAs to implement conservation tillage practices may lead to a reduction in pollutant loading in the Spring Creek-Union Flat watershed.

The watershed assessment tool used for this project produces both tabular and spatial data. This spatial data is used to identify CSAs based on the resulting estimation of constituents and management practice.

Modeling CSAs with the Watershed Erosion Prediction Project (WEPP) Model

Similar to what was done in the *Hydrologic and Water Quality Characterization* section, the Watershed Erosion Prediction Project (WEPP) model was used to estimate runoff and sediment erosion within the Spring Creek-Union Flat watershed for all agricultural lands. The WEPP model includes multiple interfaces, both on- and offline. For this project, both the online WEPP interface, WEPPCloud, and the offline Windows interface were used (USDA-ARS, 2017).

WEPP Model Inputs

The WEPP Model utilizes four input files to generate results. These four files include: watershed topography, soils, land use and management, and climate. Descriptions of these input files and how they were created can be found below.

Watershed Topography

Topography is determined through the use of a 30-meter resolution Digital Elevation model (DEM) to determine slope length, gradient, and aspect of a single hillslope. WEPPCloud uses this input to delineate specific hillslopes. A feature is also available to clip hillslope lengths to a maximum length. In total, 1,201 hillslopes were generated in WEPPCloud, using a maximum hillslope length of 300 meters.

Soil

The soil input file includes several parameters, including erodibility, depth, and texture. Soil data for the WEPP model is derived from the NRCS Soil Survey Geographic Database (SSURGO). Figures 5 and 6 depict the soil characteristics from SSURGO.

Land Management Practices

WEPPCloud generates land cover using the USGS National Landcover dataset (NLCD). Management is initially pre-set from WEPPCloud, but specific land use can be selected by the user. In the case of the Spring Creek-Union Flat watershed, land management practices were selected on a field-by-field basis based on an observational approach that will be explained further in the following section.

Climate

Climate data is typically derived from the CLIGEN weather generator, which can generate data for non-mountainous terrain from a database of nearly 2,000 station records. The climate file includes daily precipitation, temperatures, solar radiation, and wind speed and direction. Other climate options from WEPPCloud include Daymet database, gridMET database, and PRISM. For this project, the gridMET with PRISM revision method was used and the model was run for 30 years (1990 –2019).

4.B. Calibration and Results from the WEPP Model for Spring Creek-Union Flat Watershed

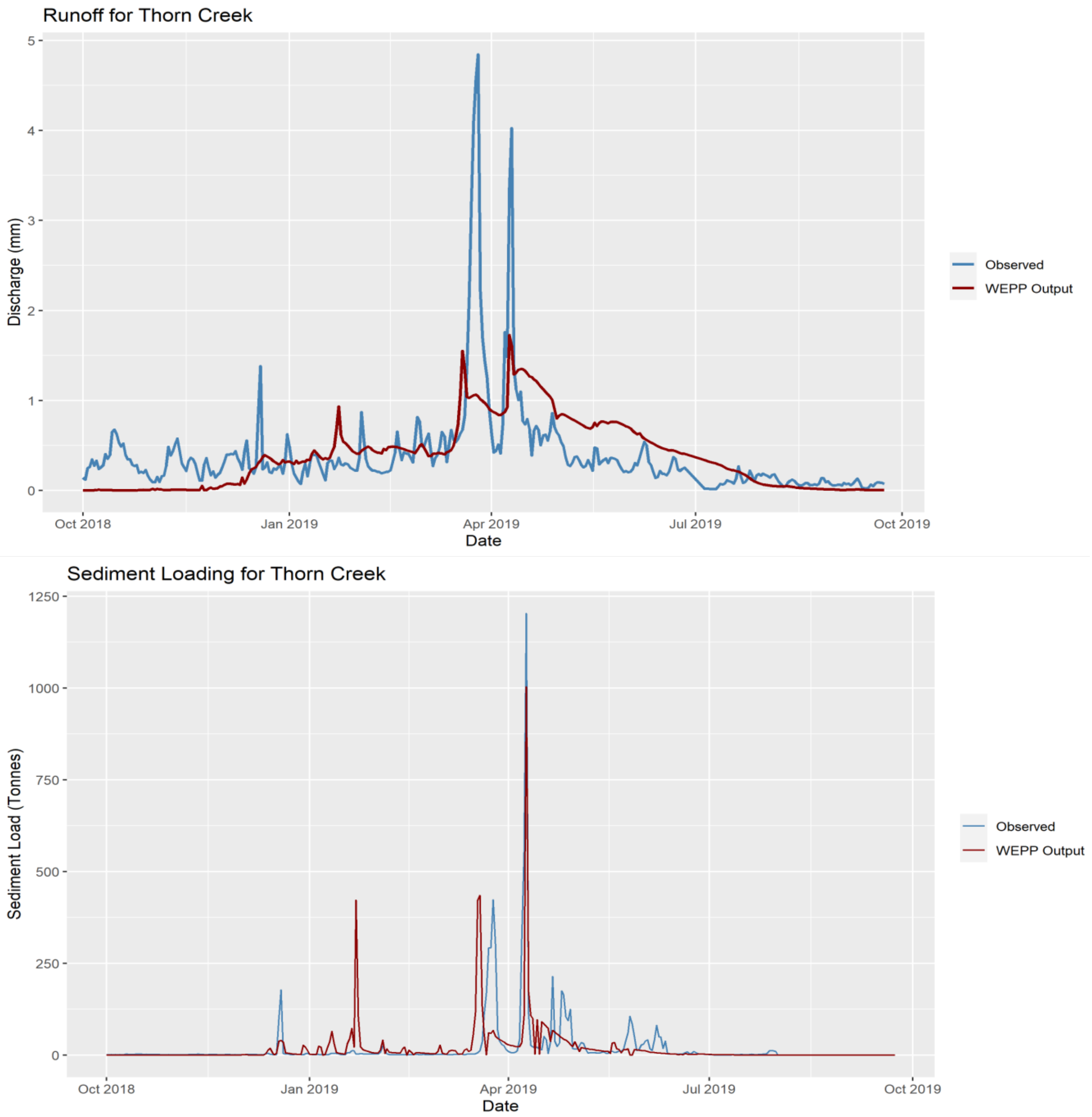


Figure 21. Output of both runoff and sediment loading calculated from the WEPP model, compared with observed data for water year 2019.

Calibration - Model Fitting from Observed Data

Before running the WEPP model for Spring Creek-Union Flat watershed, the model was calibrated to Thorn Creek, a neighboring watershed with observed data. Thorn Creek is located upstream from the Spring Creek-Union Flat Watershed. Both Thorn Creek and Spring Creek-Union Flat watersheds have similar topography, climate, soils, and land use and management practices. Observed data for discharge, sediment, nitrate-nitrite, and phosphorus have been collected monthly since May 2018 in Thorn Creek. Daily discharge measurements were created using a stage discharge rating curve. A power fit equation was created between discharge and suspended sediment concentration measurements to estimate annual sediment loading. The WEPP model was run for the Thorn Creek Watershed and calibrated to match observed data for water year 2019. Figure 21 shows observed data, along with the calibrated WEPP outputs.

Calibrating the model to Thorn Creek included changing specific soil characteristics and land use management parameters in the input files. The parameters that were altered from the default soil inputs generated in WEPPCloud included hydraulic conductivity, bedrock hydraulic conductivity, anisotropy, and field capacity (Appendix A). The default input for land use management in the watershed was defined as continuous winter wheat covering over 98% of the watershed modeled. This area is known primarily for a three-year winter wheat, spring grain, and legume rotation. A management input to represent this rotation was created and used as the management input in lieu of the default.

For climate, the model was run using a 3-year climate produced from the gridMET database, which is automatically revised using PRISM in WEPPCloud before the model is initiated (Abatzoglou, 2012; NASCE, 2021). WEPPCloud's default values were used for all other input parameters.

To assess the effectiveness of modeled results versus observed data, the Nash-Sutcliffe method for calculating model efficiency was used. Results for Nash-Sutcliffe Efficiency coefficients (NSE) range from negative infinity to positive one, with an NSE = 0 indicating the model predictions are just as accurate as the mean of the observed, and an NSE = 1 corresponding to a perfect match of the model to the observed data. The resulting NSE were 0.29 for discharge, or runoff, and 0.43 for sediment loading (Nash and Sutcliffe, 1970). The calibrated model produced an output for both water yield and total sediment yield with errors of 13.7% and 9.5%, respectively, compared to the observed yields.

With these results, the inputs from the calibrated model for Thorn Creek were then used as inputs for running the WEPP model for the Spring Creek-Union Flat Watershed.

Ground Truthing Land Management Practices

Prior to running the WEPP model for the Spring Creek-Union Flat watershed, windshield surveys were conducted across the area to identify land management for specific fields. Not all fields in the watershed were surveyed; only fields that could be seen from public roads were observed and recorded. Around 8,794 acres were surveyed, covering nearly 53% of the Spring Creek-Union Flat watershed. An estimate of percent residue covering the field was recorded at each of the surveyed fields, along with other notes, including observations of other possible land management practices. Figure 22 represents these survey results, which were then used to identify the management of each surveyed field. The assumption was made that a field with over 30% residue coverage was considered no-till. Anything under 30% would then be deemed conventionally tilled. The remainder of the watershed was assumed to be conventionally tilled as well.

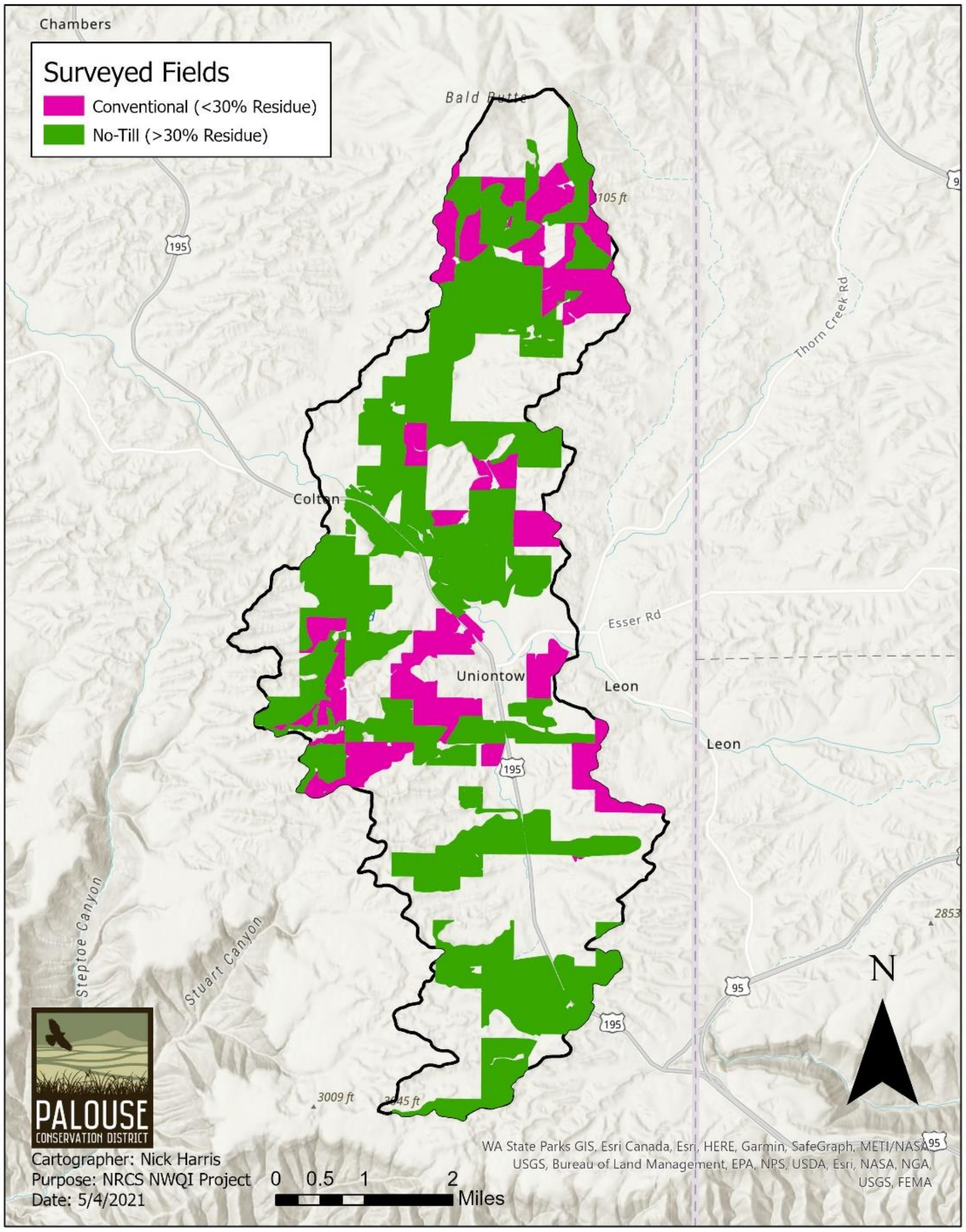


Figure 22. Map of surveyed fields from windshield survey

Running the WEPP Model

Inputs into the WEPP model for the Spring Creek-Union Flat watershed included the calibrated parameters from Thorn Creek watershed and modified inputs that would represent areas with observed no-till management as based on windshield surveys. All other fields were assumed to be conventionally tilled. Figure 23 represents the process of calibrating Thorn Creek parameters and utilizing these values for running the model for Spring Creek-Union Flat. The Spring Creek-Union Flat watershed was represented with the same crop rotation management file as Thorn Creek. The crop rotation used for both scenarios was a 3-year rotation of winter wheat, barley, and peas. The climate files used were the same gridMET PRISM revision data, but generated for 30 years (1990-2019). To produce more accurate results, hillslope lengths were limited to 300 meters, allowing for more hillslopes to be identified, which produced finer spatial estimates. In total, there were 1,604 hillslopes identified by WEPPCloud representing 15,040 acres (91% of agricultural land) in the watershed. Due to the limitations of the WEPPCloud interface, areas adjacent to Union Flat Creek were unable to be modeled. Out of the approximately 16,500 acres within the watershed, 15,040 acres were modeled in WEPP.

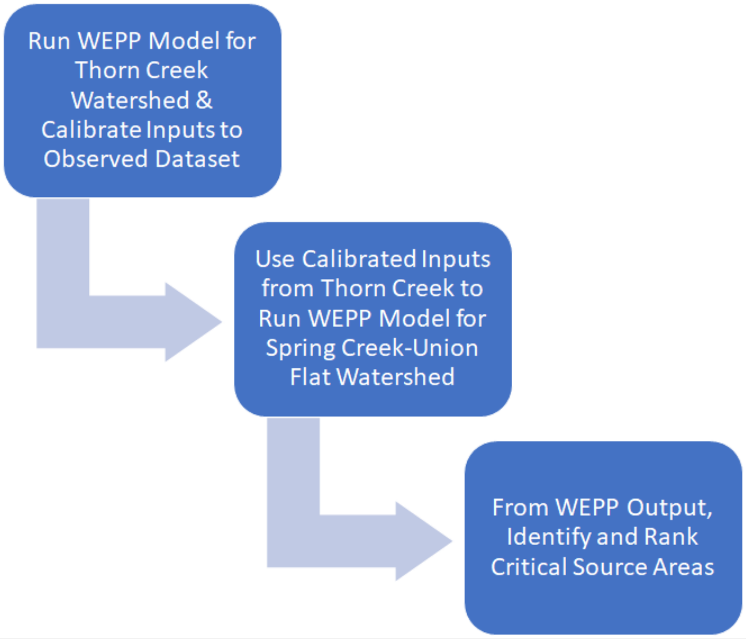


Figure 23. Process diagram for calibrating, running, and analyzing the output of the WEPP model for Spring Creek-Union Flat watershed

Results from the WEPP Model for Spring Creek-Union Flat Watershed

The results from the WEPP model include both runoff in cubic meters (m^3) and sediment erosion in kilograms (kg). The results are represented spatially by hillslope. These values were then normalized by the area of each hillslope to represent runoff in millimeters (mm) and sediment erosion as tons per acre. Since the model simulated runoff and erosion for 30 years, the results shown in Figure 24 represent the 30-year average of both runoff and sediment erosion.

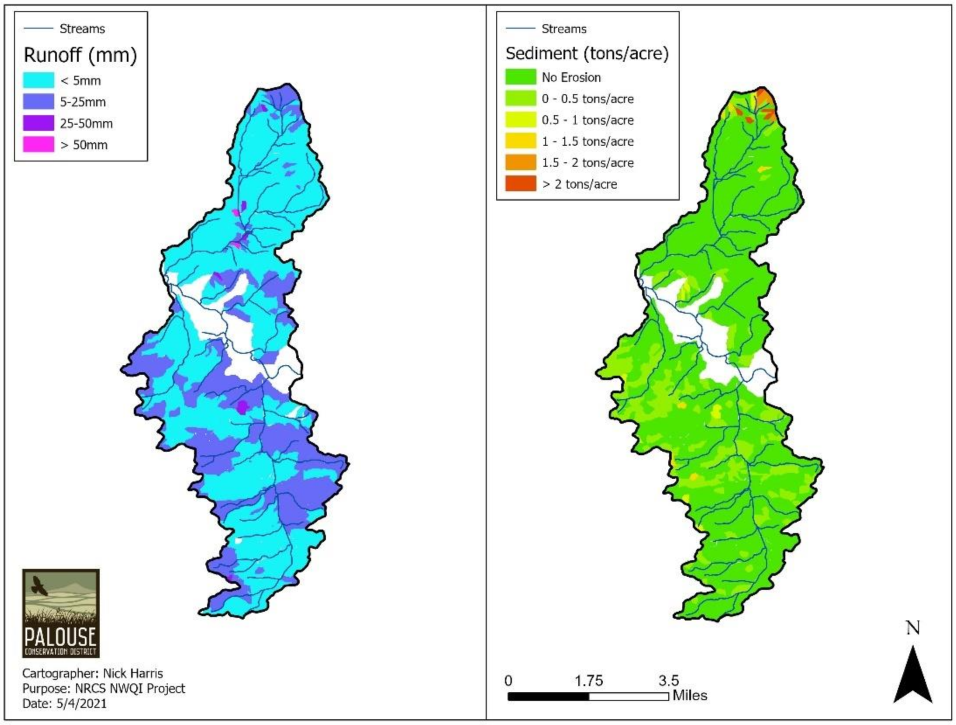


Figure 24. WEPP model output for both runoff and sediment erosion

4.C. Identifying CSAs

Potential CSAs

CSAs are specific zones in a watershed that are more prone to runoff. With increased runoff, there is also an increased risk that sediment and nutrients (such as nitrogen and phosphorus) will be carried from a CSA to neighboring waterways. Critical source areas in the Spring Creek-Union Flat watershed were identified through a ranking of runoff and sediment erosion. Outputs of phosphorus and nitrite-nitrate loads were also used to identify the CSAs and ultimately cover the scope of all pollutant loading in the watershed. Transport of excess nitrogen can be driven by increased runoff (Coniff, 2017). Therefore, runoff estimates were used to help identify areas with greater potential for nitrogen loading, even though the WEPP model did not produce nitrogen loading estimates directly. Phosphorus readily attaches to and is transported and deposited with soil particles (Kaiser, 2018). Using a similar method to runoff and nitrogen’s relationship, sediment erosion and phosphorus were linked for the sake of the simplicity in this analysis.

Ranking Methodology

The initial ranking of CSAs is broken into two parts: runoff and sediment erosion. Each method consists of ranking from 0 – 5, with each individual hillslope assigned a ranking that is generated from the WEPP model. Hillslopes predicted to have no runoff or sediment erosion are assigned a 0. Both runoff and sediment erosion rankings are combined to assign a total ranking to each hillslope. For example, a hillslope with a runoff of 0.1 mm and sediment erosion of 0.1 tons per acre would have a total ranking of 4, from a runoff ranking of 1 and a sediment erosion ranking of 3. Additionally, a multiplier of 1.5 was added to fields where conventional tillage was observed through the windshield surveys to result in a higher priority ranking for these fields. Therefore, the possible range for a hillslope ranking is 0 – 15, with a higher ranking resulting in higher priority for targeted outreach.

After running this ranking across the entire watershed, the highest combined ranking value was 9. With this in mind, the ranking criteria were adjusted to reflect the true range of rankings in the watershed. Final ranking values of 0 were considered “No Ranking.” “Low Ranking” was assigned to hillslopes with a value of 1 – 3, “Medium Ranking” was 3 – 6, and “High Ranking” was 6 – 9. The spatial distribution of the ranking criteria for Spring Creek-Union Flat Creek watershed can be seen in Figure 25. Finally, the 2020 USDA Cropland Data Layer was used to determine which areas were considered to be cultivated crops. Any areas not deemed to be cultivated cropland were omitted from the final ranking.

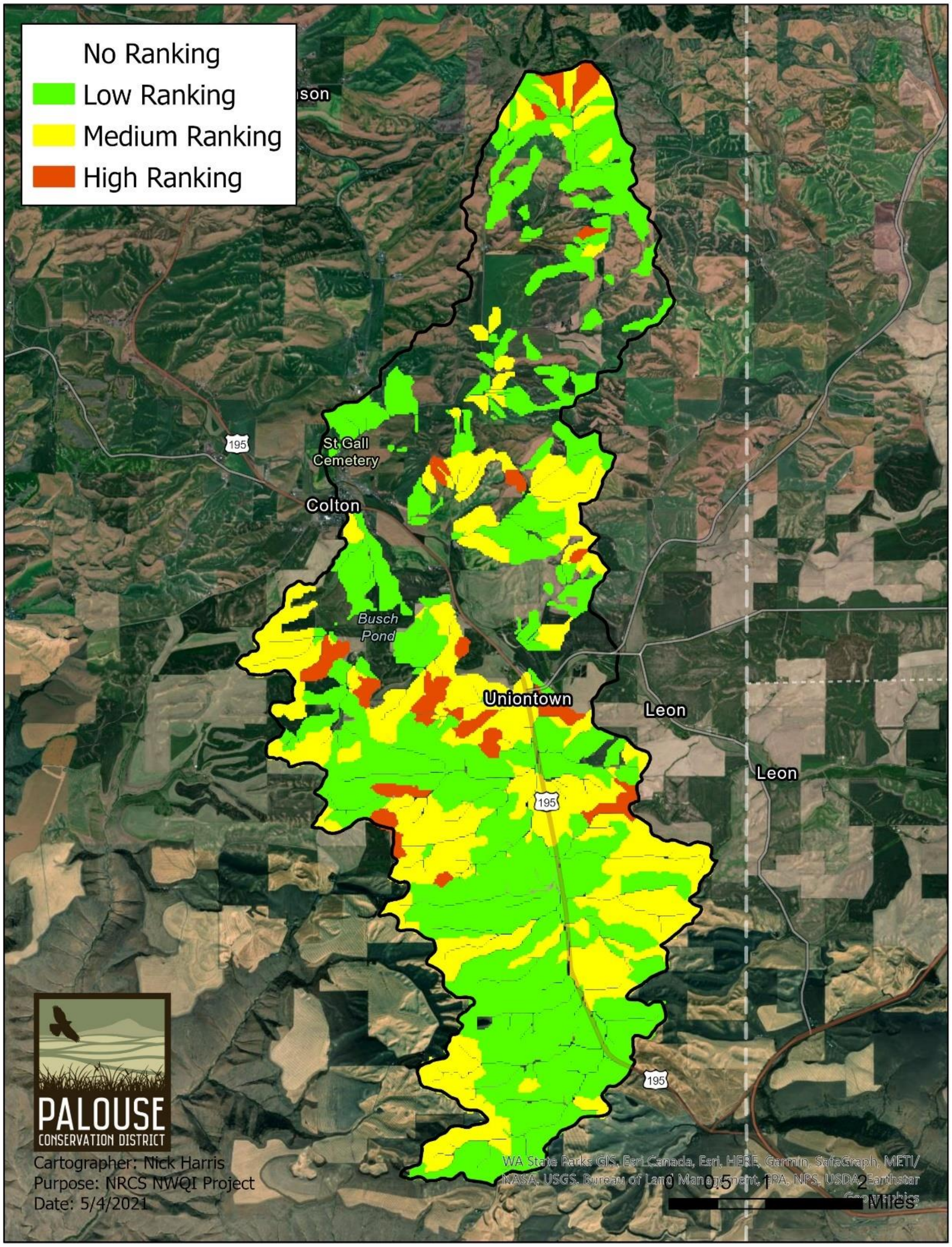


Figure 25. Map of ranked CSAs

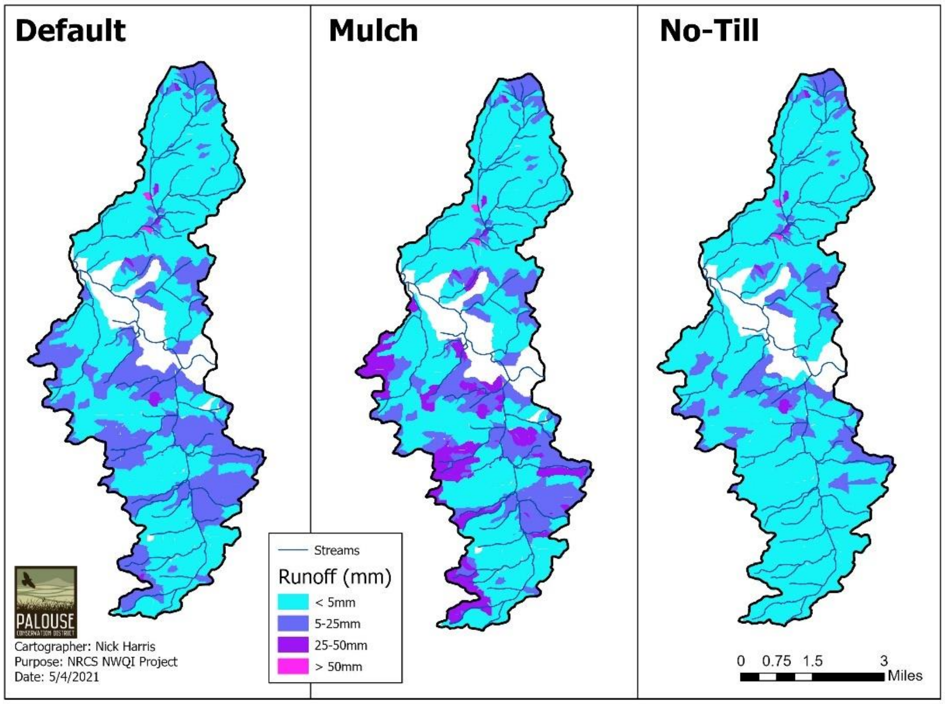
The ranking approach was chosen for its capacity to consider both nitrate and phosphorus as pollutant sources. Addressing both runoff and sediment erosion allows for an even prioritization for each source. The multiplier, when added to areas where conventional tillage is observed, weighs the ranking to prioritize CSAs where it is known that conservation practices are absent. Overall, this approach is considered to be the most effective method for identifying fields and prioritizing them for the implementation of conservation practices. All hillslopes with a medium or high ranking from the output of the CSA analysis are considered priority areas.

4.D. Treatments and Opportunities

Management Scenarios

Three management scenarios were assessed using WEPP to highlight the effects of management on runoff and sediment yields. The first scenario is the default run used for the CSA identification. This scenario utilized the calibrated WEPP model and windshield survey data for the Spring Creek-Union Flat watershed to represent observed conventional tillage and no-till areas. The rest of the watershed was represented as conventional tillage.

The second scenario represents mulch tillage. The entire watershed was assumed to be mulch tillage, including the range of land management practices that can be seen in Figures 26-1 and 26-2. The first scenario represents our default run with a mixture of conventional and no-till fields, the second represents all land management as mulch tillage, and the third represents no-till. All scenarios show the 30-year averages for both runoff and sediment erosion.



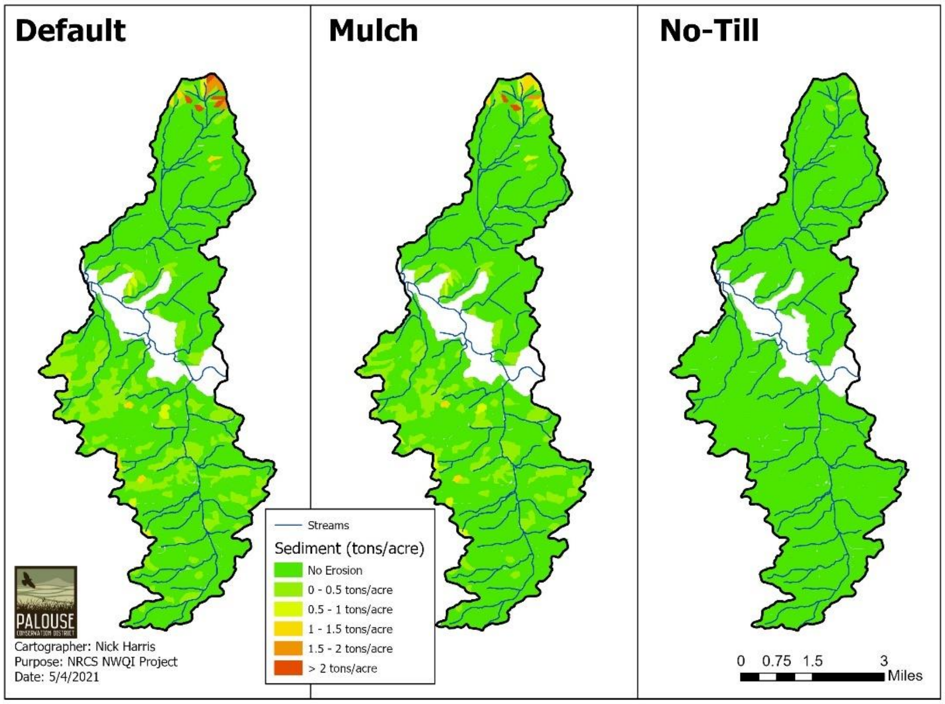


Figure 26-1 (top), 26-2 (bottom). Maps representing runoff and sediment erosion for three land management scenarios: conventional tillage (default), mulch tillage, and no-till.

The results show a reduction in average runoff with the no-till scenario, as well as a reduction in sediment erosion with both the mulch and no-till scenario (Table 8). These scenarios are not an accurate depiction of the watershed; rather, they are a hypothetical representation of what the watershed might look like if priority areas are treated with conservation tillage practices.

Table 8. Results showing the 30-year averages for runoff in millimeters, and sediment erosion in tonnes from the management scenarios ran in the WEPP model.

30-Year Average		
Management	Runoff (mm)	Sediment (tonnes)
Default	76.52	210,455.33
Mulch	72.61	179,458.01
No-Till	73.82	9,336.89

4.E. Summary and Recommendations

Watershed Assessment Summary

The Spring Creek-Union Flat watershed was examined and modeled to identify the sources of nonpoint source pollution. These modeling efforts allowed for the prioritization of fields that would have significantly reduced pollutant loading with the implementation of conservation practices. Priority areas were defined through CSA analysis, targeting specific fields with medium- or high-ranking hillslopes. These priority areas will be used in a targeted outreach campaign. Furthermore, areas with a high ranking in CSA analysis will be approached by conservation planners who will initiate discussion of the implementation of conservation practices.

Recommendations for Implementing Conservation Practices

All of the identified priority areas have land use practices that would benefit from the implementation of conservation practices. Using these results and the modeled management scenarios for the watershed, mulch-tillage and no-tillage management practices could reduce sediment erosion in the watershed by as much as 30,000 tons/acre per year on average. The WEPP modeling work done in the *Resource Analysis and Source Assessment* section can help us conclude that mulch- and no-till practices can be effective in improving water quality in the Spring Creek-Union Flat watershed.

While the modeling work done through the *Resource Analysis and Source Assessment* section concluded that adopting mulch tillage (NRCS Practice Code 345) or no-tillage (NRCS Practice Code 329) practices would improve water quality, other data can be used to assess water quality benefits. As mentioned in Section 3.A. of the *Hydrologic and Water Quality*

Characterization section, there was a paired watershed assessment performed on two creeks just upstream of the watershed in focus. Thorn Creek has riparian buffers along a large portion of the creek, while Cow Creek has very minimal buffers. Data from these two streams have been collected since May 2018 and include streamflow, water temperature, fecal coliform, nutrients data, as well other water quality data. Table 7 in Section 3.C. show the differences in fecal coliform, nitrate/nitrite, and phosphorus per acre per year between both watersheds. Thorn Creek was found to have lower averages in all three. These preliminary results show that riparian buffers (NRCS Practice Code 391) may have an effect on nutrient loading in streams with similar land use managements as the Spring Creek-Union Flat watershed and can be recommended to landowners who are eligible and interested. A normalized difference vegetation index (NDVI) was created along all streams in the watershed, with a buffer of 150 feet on each side (Figure 27). This index represents four different classes of vegetation cover and shows which areas may benefit from the implementation of riparian buffers.

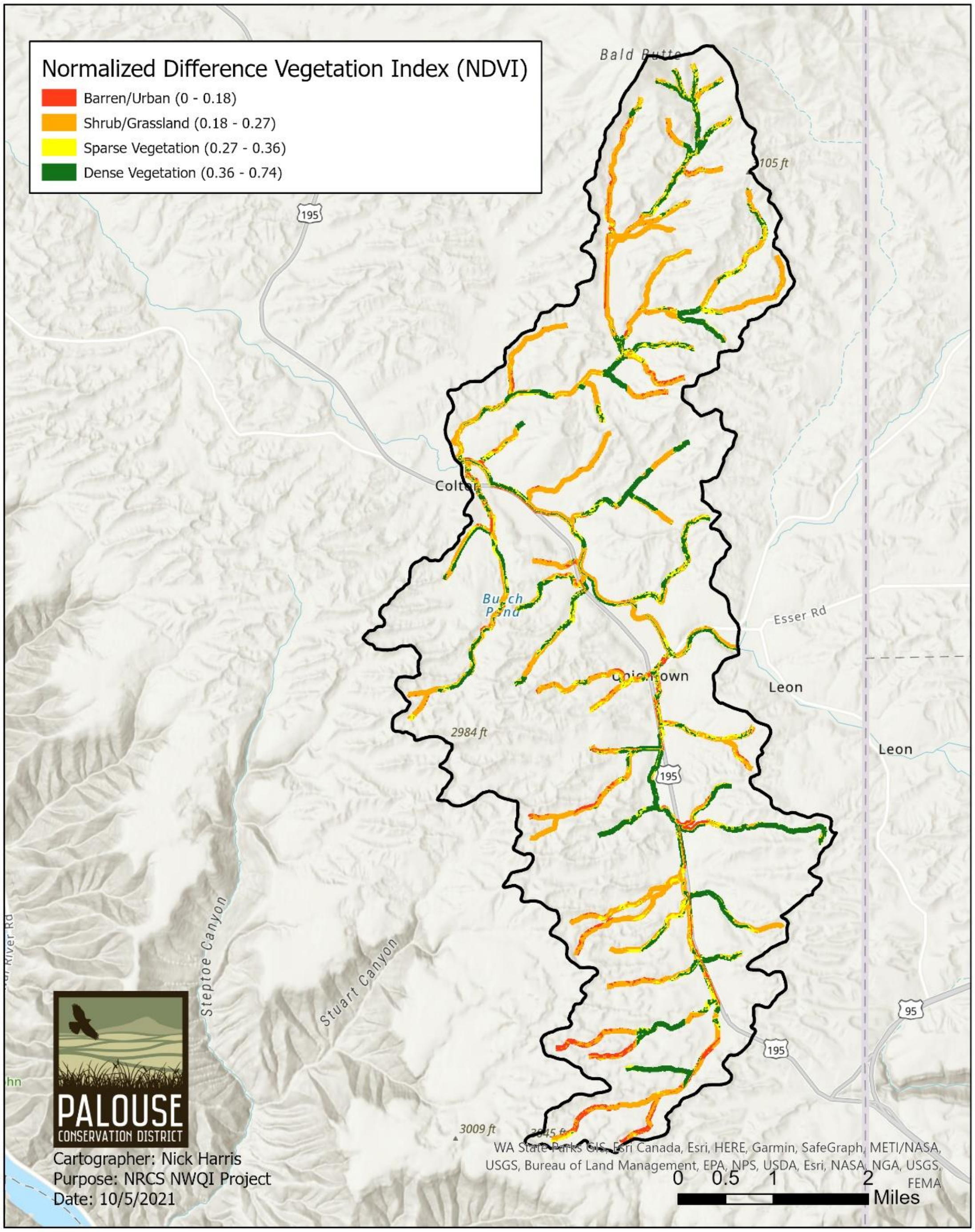


Figure 27. Map representing a Normalized Difference Vegetation Index (NDVI) ran on a 150-foot buffer across all streams in the Spring Creek-Union Flat watershed. Data for NDVI derived from Sentinel-2 images taken on 2021-07-23.

Table 9. Percent of each class from the Normalized Difference Vegetation Index (NDVI) ran in Figure 27.

Normalized Difference Vegetation Index (NDVI) Percent Classification	
Class	% Cover
Barren/Urban	7.4%
Shrub/Grassland	47.2%
Sparse Vegetation	16.6%
Dense Vegetation	28.8%

Other potentially beneficial conservation practices that were not covered during the *Resource Analysis and Source Assessment* section are livestock management practices. These could include fencing to exclude livestock from entering waterways (NRCS Practice Code 382) or a livestock pipeline for alternate water access (NRCS Practice Code 516).

Effectiveness Monitoring

As mentioned in Section 3.A. in the *Hydrologic and Water Quality Characterization* section of this report, a gaging station was installed in January of 2020. This station has a pressure transducer that collects water level and water temperature measurements every 15 minutes. Sediment (SSC) and nutrient (nitrate-nitrite-N, total phosphorus, ortho-phosphate) samples are collected monthly, as well. With this in place, baseline data can be collected for both sediment and nutrients. Over time, with continued monitoring and with the possible adoption of conservation land management practices, there should be measurable metrics for water quality for the Spring Creek-Union Flat watershed.

5. Outreach

5.A. Outreach Goals and Strategy

The Spring Creek-Union Flat Watershed Plan outreach goals are to:

1. Cultivate an awareness of water quality issues throughout the watershed, and
2. Collaborate with landowners to encourage land stewardship and implement conservation practices located in CSAs

This outreach approach was guided by social science best management principles in survey development and behavioral change outlined in Community Based Social Marketing (McKenzie-Mohr, 2011) and the Social Indicator Planning and Evaluation System (Genskow, 2011). Steps for this process can be found in the figures below.

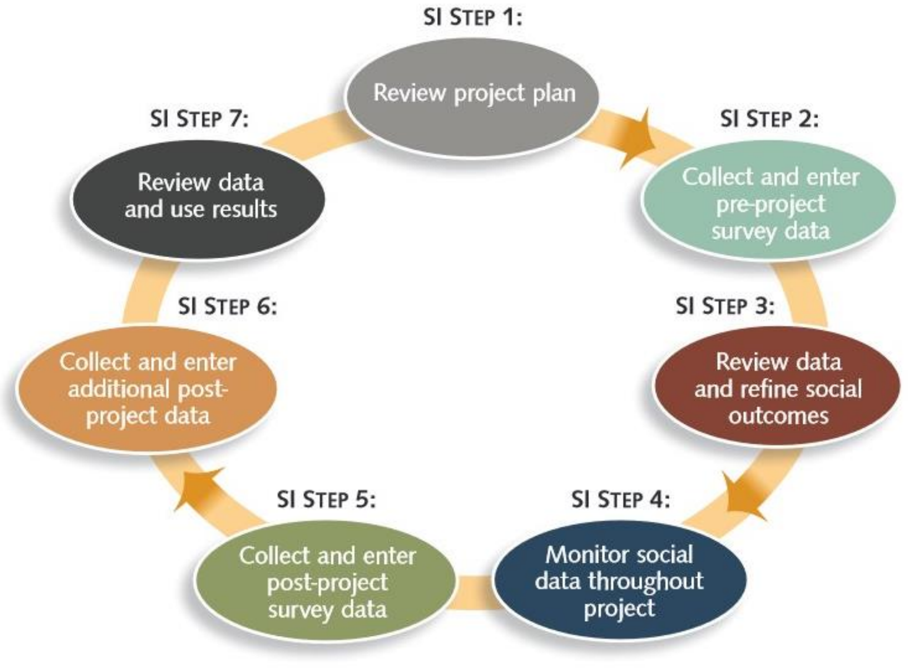


Figure 28-1 (top), 28-2 (bottom). Figures represent the steps for both the principles of the Community Based Social Marketing and the Social Indicator Planning and Evaluation System (SIPES), respectively.

The initial watershed analysis and resource assessment identified CSAsand characterized the targeted audience and behavior selection criteria. Land use was characterized as primarily large-scale dryland agricultural (94%), cultivating cereal grains and pulse crops in a three-year rotation, with some rural residential. This information helped to identify the top four target audiences: agricultural production more than 500 acres, agricultural production fewer than 500 acres, livestock, and residential. As this watershed is identified as primarily rural residential with agricultural production, exploring avenues for responsive engagement was key. A structured outreach strategy was needed to support the diversity of socio-economic distribution, communication barriers, and worldviews. Information received through the Social Indicator Survey evaluated trusted sources of information on land management and identified barriers to adoption.

Initial project objectives included hosting a series of in-person focus groups at rural community centers. Unfortunately, due to the onset of COVID-19 health restrictions, in-person events were not possible and alternative outreach methods were explored and utilized to foster engagement from residents. The social indicator survey was accomplished through a series of postcard mailers, postmarked survey mailings, social media engagement, and personal phone calls. A total of 200 producers and residents were identified and were contacted to participate in the Social Indicator Survey.

5.B. Stakeholder Engagement

PCD worked closely with Whitman County NRCS to include local stakeholders who were involved in the process and invested in the outcomes. NRCS agreed to partner on the Social Indicator Survey with logos and contact information. Both entities agreed to support efforts associated with the research outcomes and highlighted funding available to offer for assistance.

5.C. Survey Results

Participants in the Social Indicator Survey provided responses through multiple avenues, including an online form housed on PCD’s website, postmarked surveys distributed through mail, and personalized phone calls. Survey123, an ArcGIS form-centric data gathering software, provided a platform for survey submissions online. Survey participants provided feedback on six questions regarding current practices, natural resource concerns, and opportunities for improvement that currently exist in the Spring Creek-Union Flat watershed, as well as ideal future management strategies, barriers to conservation goals, the role of conservation agencies, and the participant’s interest in attending an in-person informative meeting. These questions were selected to identify current practices and potential barriers to BMP adoption. Participants were asked to select all that applied to their operation and future management goals. A total of 25 surveys were returned. Results from the survey are detailed below by target audience group (Figure 29).

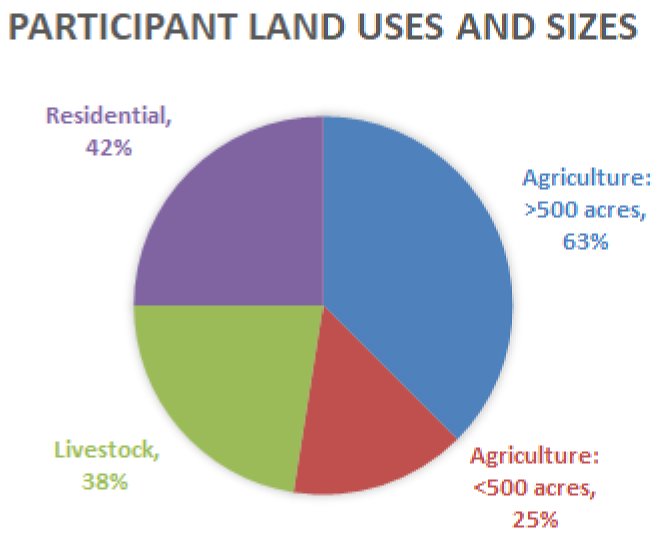


Figure 29. Land use and size as identified by survey participants.

<u>Land Use Type: Agricultural Production ≥500 acres</u>

Fifteen producers who identified with managing a land use type of ≥500 acres prioritized the top conservation practices currently used as 1) conservation till: no-till; 2) conservation crop rotation; 3) grass waterway; 4) precision agriculture; and 5) conservation till: mulch-till. Other notable practices include cover crops and conservation till: strip till (Figure 30). Of the 15 respondents who identified with this land use type, six respondents identified as livestock and residential.

Respondents noted the following natural resource concerns and opportunities for improvement that currently exist in the Spring Creek-Union Flat watershed: 1) soil erosion/minimal tillage; 2) nutrient management/chemical use; and 3) vegetative buffers along draws and waterways.

<u>Land Use Type: Agricultural Production <500 acres</u>

Six producers who identified with managing a land use type of <500 acres prioritized the top conservation practices currently used as 1) conservation till: mulch-till; 2) conservation crop rotation; 3) no conservation practices; and 4) planting on eyebrows (Figure 30). Of the 6 respondents who identified with this land use type, 4 respondents identified as livestock and residential.

Respondents noted the following natural resource concerns and opportunities for improvement that currently exist in the Spring Creek-Union Flat watershed: 1) vegetative buffers along draws and waterways; 2) wildlife habitat; and 3) flooding management.

<u>Land use type: Livestock and Residential</u>

Three landowners who identified as livestock and/or residential land use types prioritized the top conservation practice currently used as 1) residue grazing.

Respondents noted the following natural resource concerns and opportunities for improvement that currently exist in the Spring Creek-Union Flat watershed: 1) water quantity.

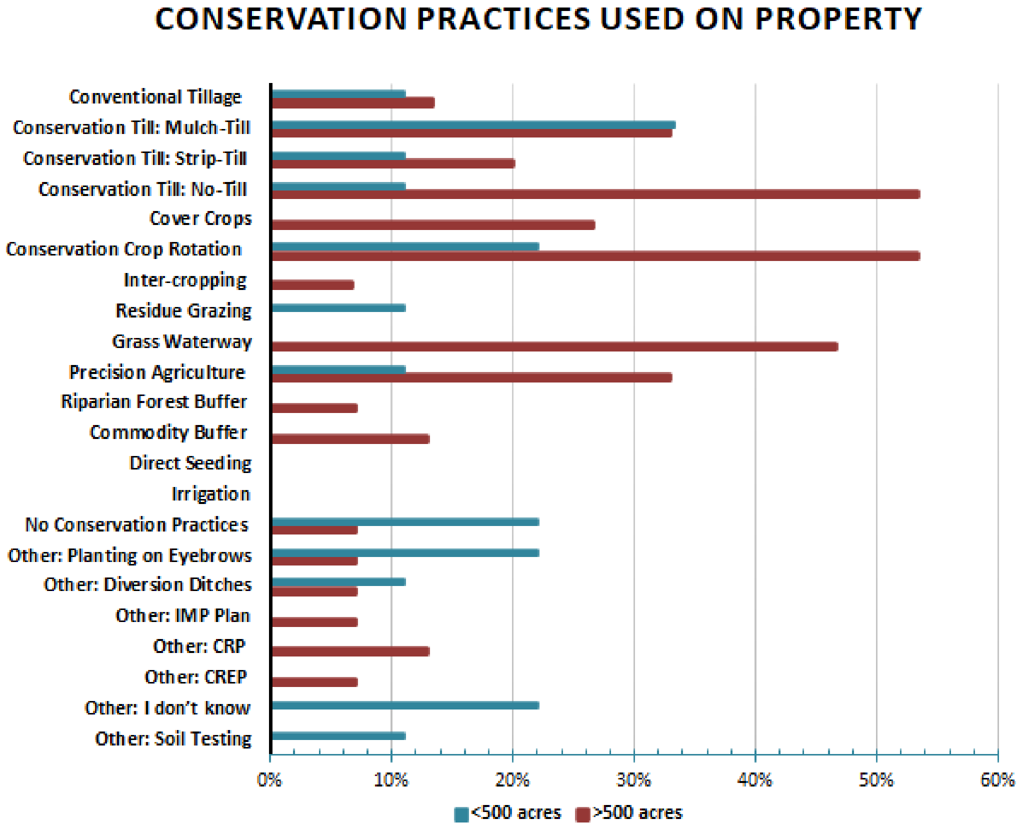


Figure 30. Conservation practices currently used by agricultural producers on >500 acres and <500 acres (n=21) in the Spring Creek-Union Flat watershed.

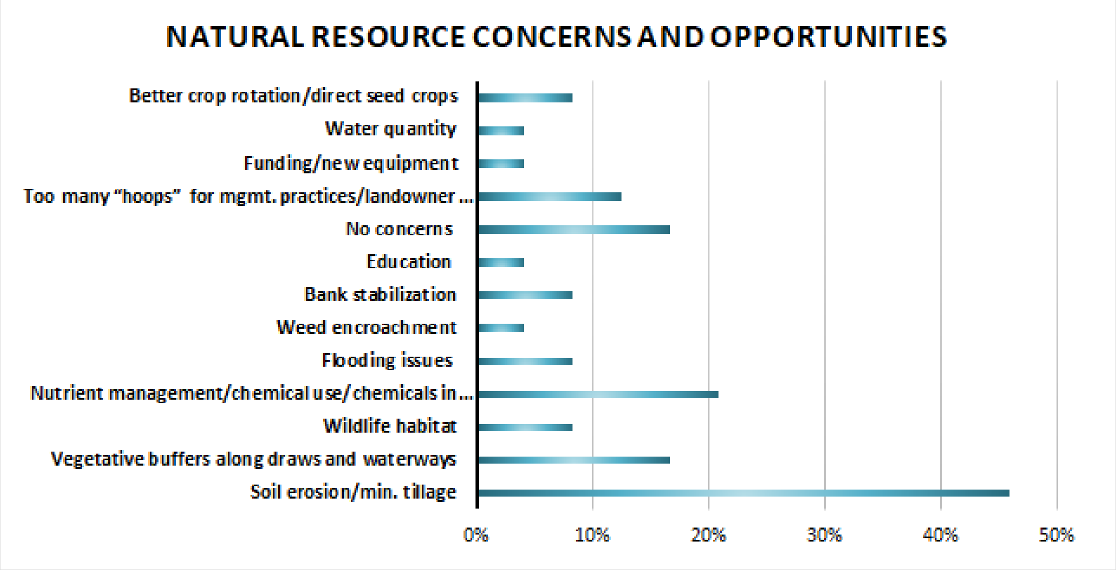


Figure 31. Natural resource concerns and opportunities for all surveyed land use types in Spring Creek-Union Flat watershed.

Future Management

Respondents were asked to envision which conservation/resource management projects they would prioritize on their property or agricultural systems if they had unlimited financial resources over the next three years. The main themes of the responses included 1) no till/reduce till; 2) grassed waterways, improve creek/water quality; 3) equipment; 4) wildlife cover/habitat; and 5) pollution/nutrient management. Respondents recognized the ecological and environmental benefits of adopting conservation practices within the watershed. Respondents discussed ecological benefits, including improved water quality, reduced erosion, and improved wildlife habitat (Figure 32).

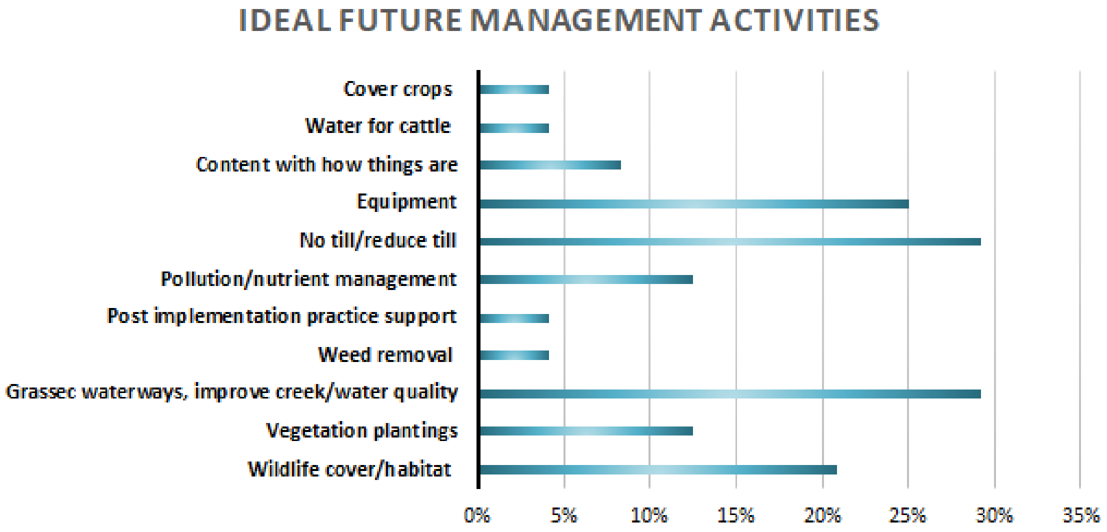


Figure 32. Ideal future management activities of for all surveyed land use types in Spring Creek-Union Flat watershed.

Barriers to Achieving Conservation Goals

Respondents were asked to select any barriers to using natural resource management practices, such as working with conservation agencies or using specific funding sources. Fifteen respondents noted money as the most significant barrier to adoption, followed by time, access to resources, and working with the government. Other notable barriers included the inflexibility of programs or practices on the landscape, sacrificing profitability, and physical ability (Figure 33).

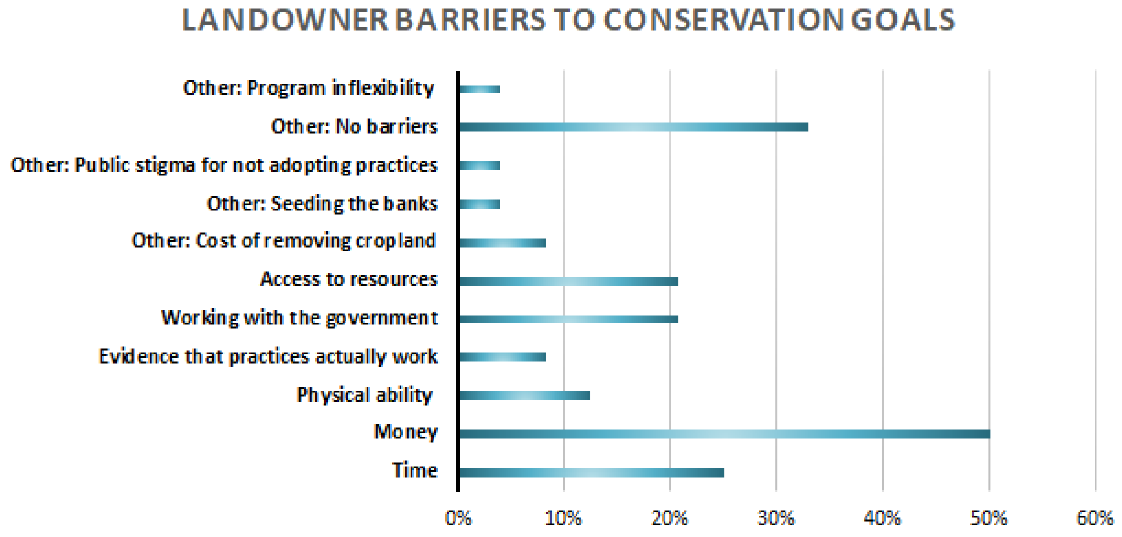


Figure 33. Barriers to conservation goals for all surveyed land use types in Spring Creek-Union Flat watershed.

Role of Conservation Agencies

Twenty-one respondents indicated the role that conservation agencies (PCD, NRCS, or partners) should play in helping producers and residents achieve conservation goals or objectives as 1) identify priority areas for conservation; 2) demonstrate value of protecting soil and water resources; 3) technical assistance; 4) financial assistance; 5) educational resources; 6) intermediary between regulatory agencies (EPA and Washington State Department of Ecology); 7) local implementation strategies; 8) facilitate discussions around conservation issues; 9) data collection; 10) soil health strategies; and 11) improve habitat.

Informational Meetings

Seventeen respondents expressed interest in attending an informational meeting with PCD and NRCS that would serve to inform them and their neighbors about the planning process. Winter was identified as an opportune meeting time for producers, while residents expressed availability for a summer meeting. Respondents would like to be directly notified of upcoming meetings and appreciated communication from the District through flyers, mailings, and newspaper announcements.

5.D. Implementation of Outreach Plan

Results disseminated from the Social Indicator Survey and other outreach in the Spring Creek-Union Flat Watershed will guide the method, messaging, and content for targeted outreach efforts. A multi-faceted strategy will focus outreach efforts on agricultural producers in or near CSAs, encouraging behavior change in adopting BMPs in land management. Self-identified survey results provide contact information and land use data, as well as barriers for implementation, directing outreach to a specified user group. Survey results will guide outreach designed to address attitudes, motivators, limitations, and value systems.

For the target agricultural audience, methods may include but are not limited to:

- Land management workshops, shop talks, or tours
- On-farm demonstration trials
- Neighborhood demonstrations
- Newsletters or e-newsletters
- Targeted mailings via mail or email
- Radio announcements
- Press releases or advertisements in local media outlets
- Social media campaigns
- Informational signage
- Incentives

For the general public or non-agricultural audience, methods may include but are not limited to:

- Newsletters or e-newsletters
- Radio announcements
- Press releases or advertisement in local media
- Social media campaigns
- Community events
- Volunteer opportunities

5.E. Measuring Success

Addressing water quality challenges may take decades and measuring water quality data may not be an effective strategy in a short time frame. Recognizing that attitudes and awareness are changing and that behaviors are being adopted may be an effective tool to demonstrate that progress is being made toward achieving water quality goals. Social Indicator Survey results will be applied in a variety of ways as the information is used to develop social outcomes and metrics. According to Genskow, social outcomes are the social or behavioral changes needed to reach water quality improvement goals (2011). Effective outreach strategies have built-in metrics to measure success, such as number of attendees or participants and engagement metrics. These strategies will provide insight into levels of engagement, and a follow-up survey or assessment will be used to determine social outcomes.

For the target agricultural audience, project outcomes include:

- Reduced barriers and limitations to behavior
- Increase awareness of available technical and financial assistance
- Increase adoption of BMPs to improve water quality
- Increased abilities to support practices that protect CSAs

For the general public or non-agricultural audience, project outcomes include:

- Increased awareness of water quality issues
- Changes in attitude toward water quality improvements
- Prioritization and support of water quality improvement projects and practices

5.F. Sustainability of Outreach Efforts

In order to ensure sustainability of the general and targeted outreach plan, collaboration among partner organizations will ensure the plan is supported and promoted. The following is a list of partners who may engage in outreach efforts:

Natural Resource Conservation Service (NRCS)

The Natural Resource Conservation Service (NRCS) Resource and Soil Conservationists provide technical expertise and conservation planning and distribute financial assistance for farmers, ranchers, and forest landowners wanting to make conservation improvements to their land. The Whitman County Office based out of Colfax, WA provides services for all of Whitman County, including Spring Creek-Union Flat Watershed. The NRCS is committed to “helping people help the land” by providing resources to farmers and landowners to aid their conservation efforts. For information on programs and services in Washington State, visit the NRCS website: www.nrcs.usda.gov/wps/portal/nrcs/main/wa/programs/.

Palouse Conservation District (PCD)

The Palouse Conservation District (PCD) mission is to foster the voluntary conservation of natural resources by providing the tools, education, technical expertise, and financial assistance to support our local community. A staff of highly qualified individuals guides District programs and services, works closely with landowners to develop local solutions for their conservation goals, and provides financial and technical resources to the community. Conservation Districts are Washington's only grassroots, locally-driven conservation delivery system that identifies local problems and develops local voluntary solutions. For more information on programs and services, visit the PCD website: www.palousecd.org.

Washington State Conservation Commission

The Washington State Conservation Commission (SCC) is the coordinating state agency for all 45 conservation districts (CDs) in Washington State. Together, the SCC and CDs provide voluntary, incentive-based programs that empower people to practice conservation and ensure healthy natural resources and agriculture for all. For more information, visit www.scc.wa.gov.

Whitman County Voluntary Stewardship Program (VSP)

The Voluntary Stewardship Program (VSP) is an innovative approach for Washington counties to participate in a watershed-based, collaborative planning process that protects critical areas while promoting agricultural viability. Whitman County is one of 28 counties in the State of Washington participating in this program. The Whitman County Work Group developed a local watershed work plan that includes voluntary, incentive-based tools to protect CSAs and maintain the viability of agriculture. The Work Group is comprised of key stakeholders and agricultural groups within Whitman County, with a vested interest in securing the future of agriculture and recognizing individual stewardship. For more information on VSP, visit www.whitmancountyvsp.com or see those who shared their stewardship at https://whitmancountyvsp.mapseed.org.

Washington State Department of Ecology

The Washington State Department of Ecology is the State of Washington's environmental regulatory agency. The Department administers laws and regulations pertaining to water quality, water rights and water resources, shoreline management, toxics clean-up, nuclear waste, hazardous waste, and air quality. It also conducts monitoring and scientific assessments. For more information, visit https://ecology.wa.gov/.

Washington State Department of Agriculture

The Washington State Department of Agriculture (WSDA) is a cabinet-level agency in the government of Washington that regulates, advocates, and provides services for the state's agricultural industry. For more information, visit https://agr.wa.gov/.

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