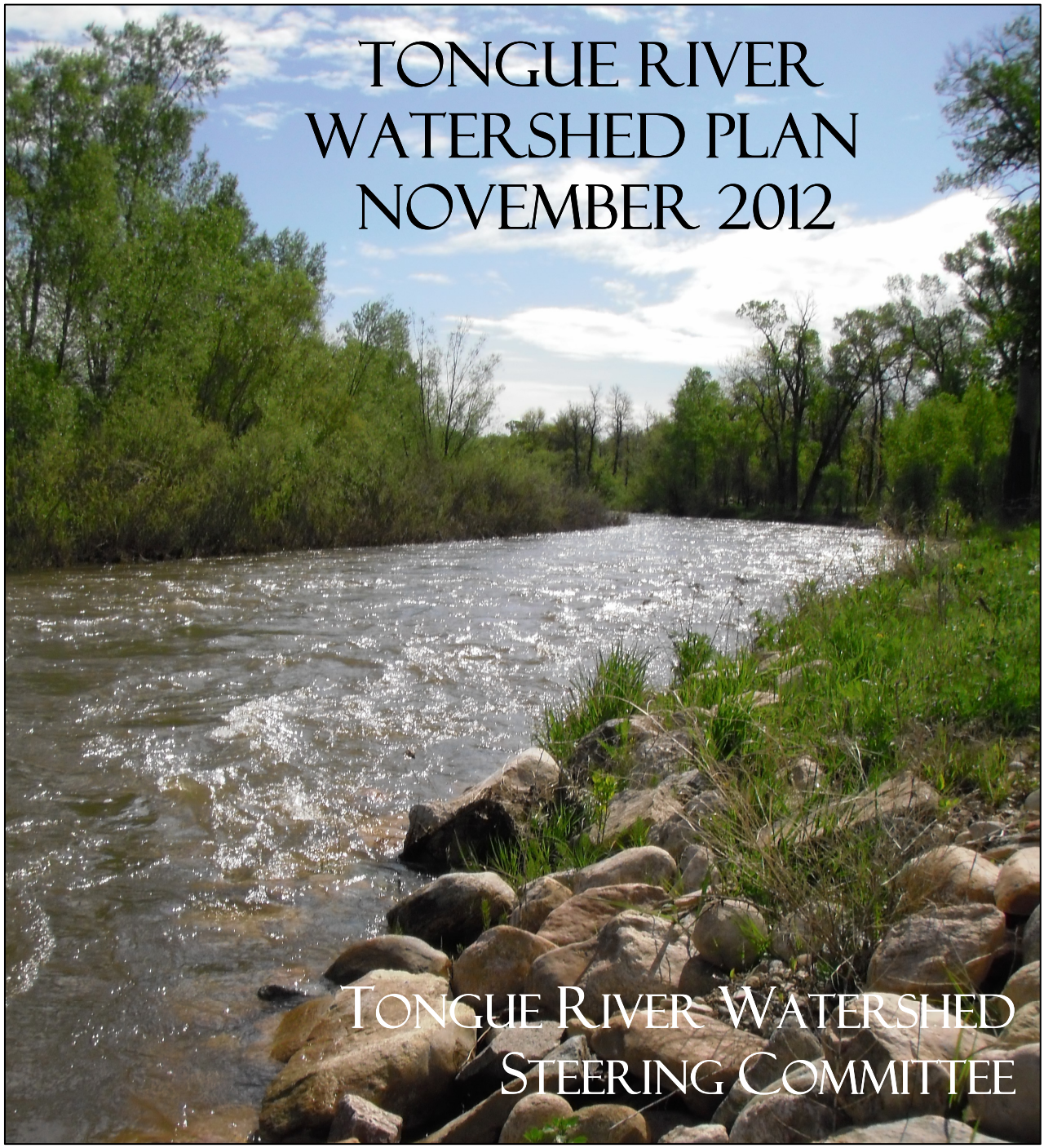

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SIGNATURE PAGE

In July 2005, the Tongue River Watershed Steering Committee (TRWSC) decided to revise the Tongue River Watershed Plan, originally approved in September 2000. This revision was submitted to the Wyoming Department of Environmental Quality in June 2007. In 2012, the plan was revised to include the "nine essential elements" of an EPA Watershed-Based Plan. All meetings of the TRWSC are open to the public and anyone in attendance had an equal opportunity to contribute to the revision. Following a 45-day public comment period, the TRWSC approved the Revised Tongue River Watershed Plan on October 30, 2012.

_____ _____

Emerson Scott III, Chairman

The Sheridan County Conservation District Board of Supervisors approved submission of the Revised Tongue River Watershed Plan to the Wyoming Department of Environmental Quality (WDEQ) on November 13, 2012.

_____ _____

John Kane, Chairman **Roger Reinke, Vice-Chairman**

_____ _____

Susan Holmes, Treasurer/Secretary **Emerson Scott III, Supervisor**

_____

Edith Heyward, Urban Supervisor

The Tongue River Watershed Plan has been approved by WDEQ.

_____ _____

John Wagner, Administrator **Date**
Water Quality Division
Wyoming Department of Environmental Quality

The Tongue River Watershed Plan has been filed with the Sheridan County Clerk.

_____ _____

Sheridan County Clerk **Date**

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EXECUTIVE SUMMARY

In 1996, the Sheridan County Conservation District (SCCD), in cooperation with the USDA Natural Resources Conservation Service (NRCS) and the Tongue River Watershed Steering Committee (TRWSC) recognized the importance of applying and measuring conservation treatments on a watershed scale, with water quality being considered as a key indicator of overall environmental health. The original Tongue River Watershed project area consisted of approximately 80,000 acres from the Bighorn National Forest (BNF) boundary near the mouth of Tongue River Canyon downstream to the Town of Ranchester (Appendix A, Map 1). In 2006, the TRWSC and SCCD/NRCS expanded the watershed boundary by 50,000 acres to include the mainstem and its tributaries down to the confluence with Goose Creek (Appendix A, Map 1). Major tributaries to Tongue River include Five Mile, Columbus, Smith, Little Tongue River, and Wolf Creeks, which are all within the original 1996 boundary. There are no perennial tributaries within the expanded boundary; however, intermittent draws may contribute stormwater/run-off during precipitation or snowmelt events. The largest of the these draws include Six-mile Creek, Earley Creek, North Dry Creek, Slater Creek, South Dry Creek, and Hidden Creek.

Primary land uses in the area include irrigated and non-irrigated hay meadows, cropland and pastures, livestock grazing, various recreational opportunities, wildlife habitat, rural residential development, and the urban areas of Dayton and Ranchester. The BNF, which is located directly upstream from the project area, supports wildlife habitat, livestock grazing, logging, recreation, and other uses. In addition, a small meat packing plant, and several small quarries are located with the project watershed and provide economic and recreational opportunities.

Annual precipitation in the project watershed ranges from 18 inches at the top of the watershed to 14 inches in the lower reaches of the watershed. Ponderosa Pine and Douglas Fir forests, and xeric upland shrub ecosystems occur higher in the watershed; deciduous forest-dominated riparian areas, mixed grasses, and Wyoming Big Sagebrush ecosystems occur further downstream.

The initial Tongue River Watershed Assessment (1996 to 1999) found that overall water quality was passable; pH, conductivity, macroinvertebrates, and dissolved oxygen were generally within expected ranges. However, all lower tributary stations as well as the Tongue River at Ranchester exceeded the Wyoming water quality standard for fecal coliform bacteria (SCCD, 2000). In 2000, the TRWSC developed the Tongue River Watershed Plan (TRWP) to address concerns with fecal coliform bacteria (SCCD, 2000a). After 5 years, all of the action items in the TRWP were either completed or otherwise addressed by the TRWSC; however, interim monitoring continued to identify unacceptable bacteria levels. During that five year period, Wyoming Department of Environmental Quality (WDEQ) placed several streams within the initial project area on the 2002 303(d) List of Waters Requiring TMDL's (Total Maximum Daily Loads) for fecal coliform. The streams listed in 2002 remained on the lists in 2004 and 2006 (WDEQ, 2004 and WDEQ, 2006); however, they were assigned a low priority for TMDL development because of the active watershed effort. As of 2012, Columbus Creek, Five Mile Creek, Little Tongue River, Wolf Creek, and Smith Creek are listed for bacteria, as are a segment of the Tongue River below the Wolf Creek confluence, and a segment of the North Tongue River

within the BNF. Additionally, the Tongue River below the confluence with Goose Creek is listed for temperature.

In 2001, WDEQ began the transition toward using *Escherichia coli* (*E. coli*) bacteria, instead of fecal coliform, as an indicator of potential pathogen contamination. Thus, in 2003 and again in 2006, SCCD collected samples for both *E. coli* and fecal coliform. By collecting both parameters, SCCD was able to compare previous fecal coliform data to *E. coli* data for the purpose of examining trends in bacteria levels over time. Using a linear regression equation, SCCD converted fecal coliform data from 1996-1999 to *E. coli* values. To fully achieve the primary contact recreation standard for *E. coli* levels in Class 2 waters, the geometric mean had to be at or below 126 cfu/100mL.

For the purpose of the watershed characterization, the Tongue River Watershed project area was divided into four subwatersheds: Upper Tongue River, Five Mile/Columbus Creek, Wolf Creek, and Lower Tongue River. These subwatershed divisions were based upon boundaries defined by the United States Geological Survey (USGS). Water quality data from individual sample sites were combined within their respective subwatershed to help define the areas of greatest concern within the Tongue River Watershed. Average geometric means in May and August were highest in the Five Mile/Columbus Creek Subwatershed and lowest in the Lower Tongue River Subwatershed. Total averages for all of the subwatersheds exceeded the Wyoming Water Quality Standard of 126 cfu/100mL (Table 3.4). To reduce bacteria levels, the TRWSC and the SCCD developed this watershed plan to outline potential pollutant sources, objectives for improving water quality, and specific action items that includes an implementation schedule to help reach those objectives.

The TRWSC recognizes bacteria levels as a major concern from a health safety standpoint. Non-point source pollution (NPS), like bacteria, enters waterbodies through surface water run-off, such as rainfall or snowmelt. As such, it is difficult, if not impossible, to quantify specific pollution sources with any confidence. Potential bacteria sources within the Tongue River Watershed have been identified as wildlife, livestock and other domestic animals, and humans. Although wildlife mammals are identified as sources of bacteria, it is extremely difficult to quantify wildlife numbers and potential contributions. In addition, the TRWSC determined that they had limited ability to address contributions from wildlife. As a result, many of the action items that address direct bacteria concerns focus on reducing the potential contributions from domestic animals and livestock and faulty septic systems. Activities and projects that address sediment and information and education activities are also included.

To fully achieve the objectives for improving water quality, in particular the primary contact recreation standard for *E.coli*, bacteria levels would need to be reduced by over 90%. The TRWSC desires to achieve full attainment of water quality standards within a 20-year timeframe and developed this watershed plan with that goal in mind. The TRWSC set reduction goals depending on the priority level given to each stream in each subwatershed (Table 5.1). For example, the load reduction goal for the Five Mile/Columbus Creek Subwatershed was 25% for every 5 years, while the reduction goal for the Lower Tongue River subwatershed was 10% within 5 years. If direct contribution amounts for each subwatershed are reached in each 5-year timeframe (see Table 5.1), bacteria levels are predicted to be within the primary contact

recreation standard by 2033. If future monitoring results show otherwise, the TRWSC will continue to adjust load reduction estimates.

This watershed plan also addresses all of the identified concerns on the watershed and is not limited to those issues that relate to water quality standards. Although Wyoming does not have any numeric water quality standards for sediment, excess sediment is a concern for watershed residents. The relationship between sediment and bacteria is not completely understood, though some research suggests a connection. In Sheridan County, eroding streambanks are a significant contributor of excess sediment in waterways. The plan addresses sediment contributions from unstable channels and annual channel modifications for irrigation diversions and/or inefficient and erosive irrigation conveyances. These issues are being addressed through increased emphasis on stream rehabilitation projects that not only stabilize stream channels, but also include improvements to habitat and provisions for fish passage.

The TRWSC, SCCD, and NRCS are committed to local watershed planning and improvement efforts. The voluntary nature of the program makes it difficult to determine specifically what types of improvement projects and/or assistance will be requested by landowners. The actual amount technical and financial assistance required to make improvements will depend on the types of projects that are requested. The TRWSC recognizes the success of the watershed improvement effort depends upon effective information and education strategies and their ability to encourage participation in the local improvement programs.

The watershed plan is a dynamic document, intended to represent changing conditions and attitudes. At a minimum, the TRWSC will update the plan every five years. If for some reason, an update/revision is necessary prior to that time, the TRWSC, in consultation with the landowners, can make necessary changes or open another revision process. In addition, the TRWSC, through the SCCD, will continue to monitor long-term trends in water quality through a 3-year monitoring rotation. Short term progress of the watershed effort will be documented through a progress register (Appendix A, Map 7).

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CHAPTER 1 INTRODUCTION

1.1 Purpose and Direction

Legislation known as the Federal Water Pollution Control Act was passed in 1948 to provide protection for surface waters in the United States. In 1972, it was renamed the Clean Water Act (CWA) and expanded to establish the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Section 303(d) of the CWA requires that each state submit a list of surface waters that fail to meet state water quality standards to the US Environmental Protection Agency (USEPA) every two years. In 1996, the Wyoming Department of Environmental Quality (WDEQ) started listing streams on the 303 (d) List of Impaired Waters. At that time sections of the Tongue River, Smith Creek, and Little Tongue River were the first to be listed.

Since 1996, sections of the Tongue River and several of its tributaries like the North Tongue and South Tongue River, along with Columbus Creek, Five Mile Creek, and Wolf Creek have been placed on (and sometimes removed from) the 303(d) List of Impaired Waters due, in part, to monitoring efforts by the SCCD. To date, two sections of the Tongue River remain on the list for temperature and *E. coli*, along with five of its tributaries for either *E. coli* or fecal coliform. For a more detailed description of these listings, refer to section 1.2.2.

The mission of the TRWSC and SCCD/NRCS has and will be to maintain and improve existing water quality, natural resource health, economic stability, and the quality of life on the Tongue River watershed through voluntary, financial, technical, and educational resources; thereby preventing the need for government regulatory agency enforcement actions.

This Tongue River Watershed Plan identifies impaired waters within the project area; characterizes the subwatersheds within the project area; quantifies existing pollutant loads from previous monitoring efforts; develops estimates of the load reductions required to meet water quality standards; and develops effective management action items to reduce pollutant loads. This document is under the direction of the Tongue River Watershed Steering Committee (TRWSC) and the Sheridan County Conservation District (SCCD) in partnership with USDA Natural Resources Conservation Service (NRCS) and funded in part by the WDEQ and USEPA through Section 319 of the CWA.

1.2 Resource Description

Tongue River originates in the Bighorn National Forest (BNF) on the eastern side of the Big Horn Mountains south of the Dry Fork Ridge, flows downstream through the towns of Dayton and Ranchester, and eventually becomes a tributary of the Yellowstone River in Montana. The original 1996 Tongue River watershed project area consisted of approximately 80,000 acres (125 square miles) located in northern Sheridan County, in north-central Wyoming (see Map 1). Two percent (1,607 acres) of the original project area is Bureau of Land Management (BLM) and 15 percent (11,713 acres) are State lands including the Amsden Creek Big Game Winter Range. The remaining 83 percent is privately owned. Land uses within the watershed include irrigated hay and crop lands, dry land pasture, livestock grazing, wildlife habitat, various types of recreation, and the urban areas of Dayton and Ranchester. The BNF is located directly

upstream from the project area, and also supports wildlife habitat, livestock grazing, logging, recreation, and other uses.

Major tributaries within the original boundary include Little Tongue River, Smith Creek, Columbus Creek, Five Mile Creek, and Wolf Creek. Wolf Creek is the largest tributary to the Tongue River within the project area with a drainage area of about 72.4 square miles. Columbus Creek is the secondary largest tributary to the Tongue River within the project area with a drainage area of about 17.9 square miles. All of these tributaries provide irrigation water to ranches and make up a portion of the water supply to rural and urban residents in the watershed. Diversions result in the transferring and mixing of waters from different areas of the watershed.

The main stem of the Tongue River and major tributaries contain numerous small to very large ranches. Status for domestic wastewater treatment at ranches and rural subdivisions is unknown. Agriculture related land use dominates the watershed. Agricultural operations center on cattle and hay production enhanced by irrigation water from the Tongue River and its tributaries during the summer growing season. There are approximately 17,430 acres (22%) of irrigated hay and crop land in the original project areas. Livestock tend to be fed and wintered along the creek bottoms since these areas provide the necessary shelter and water (SCCD, 2000). A more comprehensive, detailed description of the project area has been previously provided in the Tongue River Watershed Assessment Report (SCCD, 2000), which includes narrative descriptions of water uses, land uses, surface geology, soil types, and other factors.

In 2006, the TRWSC expanded the boundary to encompass additional segments of the Tongue River and improvement opportunities. The expanded area consists of approximately 55,000 additional acres (86 square miles) between the Towns of Ranchester and Acme (see Map 1). There are no perennial tributaries within the expanded boundary; however, intermittent draws may contribute stormwater and run-off during precipitation or snowmelt events. The largest of these draws include Six-mile Creek, Earley Creek, North Dry Creek, Slater Creek, South Dry Creek and Hidden Water Creek. The expanded watershed transitions to a dryer precipitation zone with a different plant community (see Map 3). Primary land uses in the area include: irrigated and non-irrigated hay meadows, cropland, pastures, livestock grazing, wildlife habitat, and rural residences. The historic coal mining community of Monarch has been almost entirely removed, with some remnant home sites, a church, and a water tower remaining. A railroad, local highway, and the interstate run parallel to the Tongue River throughout most of the expanded area. With the change in precipitation zones and differing land uses, the expanded area possesses its own unique resource concerns, including habitat for sensitive species such as warm water game and non-game fish, and sage grouse. Parts of the expanded area also contain heavy prairie dog populations.

These two areas combined equal approximately 135,000 acres (211 square miles) with 82 percent being privately owned, 14 percent State lands (18,739 acres), and the remaining 4 percent Federal land (5,315 acres). This project area provides outstanding year-round habitat for small and big game, furbearers, waterfowl, game birds, and songbirds. Prime wildlife habitat is concentrated along stream bottoms and brushy draws where riparian zones are intact (SCCD, 2000). Elevation within the main stem of the project area starts at 4,160 feet in the

Tongue River canyon and drops to 3,560 feet just above the confluence with Goose Creek, the furthest downstream location of the project area. Total elevation difference is 600 feet over a distance of approximately 28.86 miles (20.79 ft/mile or 0.4% slope). There are three permitted point source discharges (not including storm drains) within the combined areas; two from wastewater treatment municipalities, and one from a Concentrated Animal Feeding Operation (CAFO).

1.2.1 Designated Uses and Associated Water Quality Standards

Protection of waters under the CWA consists of three main components 1) designating uses, 2) establishing water quality criteria to protect those areas, and 3) anti-degradation policies and procedures. The Wyoming Surface Water Classification List (WDEQ, 2001) designates the main stem of the Tongue River, the main stem of the North Fork of the Tongue River, and the main stem of the South Fork of the Tongue River above the BNF boundary as Class 1. The combined project area starts just below the BNF boundary and does not contain these Class 1 streams. The remainder of the main stem of the Tongue River and all of the tributaries within the original project boundary, except for Five Mile Creek, are designated as Class 2AB streams (Table 1.1 and Map 5). Class 2AB surface areas are protected for all of the uses identified under Wyoming surface water use designations, including drinking water, game and non-game fish, fish consumption, other aquatic life, recreation, wildlife, agriculture, industry, and scenic value. Waters designated as Class 2AB are defined by the WDEQ as:

> Those known to support game fish populations or spawning and nursery areas at least seasonally and all their perennial tributaries and adjacent wetlands and where a game fishery and drinking water use is otherwise attainable. Class 2AB waters include all permanent and seasonal game fisheries and can be either "cold water" or "warm water" depending upon the predominance of cold water or warm water species present. All Class 2AB waters are designated as cold water game fisheries unless identified as a warm water game fishery by a "ww" notation in the "Wyoming Surface Water Classification List". Unless it is shown otherwise, these waters are presumed to have sufficient water quality and quantity to support drinking water supplies and are protected for that use. Class 2AB waters are also protected for nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture, and scenic value uses (WDEQ, 2007).

The Wyoming Surface Water Classification List (WDEQ, 2001) classified the draws within the expanded project area and Five Mile Creek as Class 3B streams (Table 1.1 and Map 5). Class 3B surface waters are protected for all of the uses identified under Wyoming surface water use designations, including aquatic life other than fish, recreation, wildlife, agriculture, industry, and scenic value. Waters designated as Class 3B are defined by the WDEQ as:

> Tributary waters, including adjacent wetlands that are not known to support fish populations or drinking water supplies and where those uses are not attainable. Class 3B waters are intermittent and ephemeral streams with sufficient hydrology to normally support and sustain communities of aquatic life including invertebrates, amphibians, or other flora and fauna which inhabit waters of the state at some stage of their life cycles. In general, 3B waters are characterized by

frequent linear wetland occurrences or impoundments within or adjacent to the stream channel over its entire length. Such characteristics will be a primary indicator used in identifying Class 3B waters (WDEQ, 2007).

Table 1.1 Classifications of Streams in the Entire Tongue River Watershed Project Area

Class 2AB Surface Waters	Class 3B Surface Waters
Tongue River (below BNF boundary)	Five Mile Creek
Amsden Creek	Earley Creek
Columbus Creek	Six Mile Creek
Little Tongue River	Slater Creek
Sheep Creek	South Dry Creek
Smith Creek	
Wolf Creek	

Depending upon its classification, a stream is expected to support certain activities or "uses". The State of Wyoming has assigned designated uses to all of the surface waters in the state according to the classes outlined in Table 1.2.

Table 1.2 Surface Water Classes and Use Designations (WDEQ, 2007)

Class	Drinking Water[2]	Game Fish[3]	Non-Game Fish[3]	Fish Consumption[4]	Other Aquatic Life[5]	Recreation[6]	Wildlife[7]	Agriculture[8]	Industry[9]	Scenic Value[10]
1[1]	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	Yes	Yes	Yes	Yes	Yes
2AB	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2A	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
2B	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2C	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2D	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3A	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3B	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3C	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
4A	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4B	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4C	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

[1] Class 1 waters are not protected for all uses in all circumstances. For example, all waters in the National Parks and Wilderness areas are Class 1, however, all do not support fisheries or other aquatic life uses (e.g. hot springs, ephemeral waters, wet meadows, etc.).

[2] The drinking water use involves maintaining a level of water quality that is suitable for potable water or intended to be suitable after receiving conventional drinking water treatment.

[3] The fisheries use includes water quality, habitat conditions, spawning and nursery areas, and food sources necessary to sustain populations of game and non-game fish. This does not include the protection of exotic species which are designated "undesirable" by the Wyoming Game and Fish Department or the U.S. Fish and Wildlife Service with their appropriate jurisdictions.

[4]The fish consumption use involves maintaining a level of water quality that will prevent any unpalatable flavor and/or accumulation of harmful substances in fish tissue.
[5]Aquatic life other than fish includes water quality and habitat necessary to sustain populations of organisms other than fish in proportions which make up diverse aquatic communities common to waters of the state. This does not include the protection of insect pests or exotic species which are designated "undesirable" by the Wyoming Game and Fish Department or the U.S. Fish and Wildlife Service with their appropriate jurisdictions.
[6]Recreational use protection involves maintaining a level of water quality that is safe for human contact. It does not guarantee the availability of water for any recreational purpose. Both primary and secondary contact recreation are protected in Class 2AB waters.
[7]The wildlife use designation involves protection of water quality to a level that is safe for contact and consumption by avian and terrestrial wildlife species.
[8]For purposes of water pollution control, agricultural uses include irrigation or stock watering.
[9]Industrial use protection involves maintaining a level of water quality useful for industrial purposes.
[10]Scenic value involves the aesthetics of the aquatic systems themselves (odor, color, taste, settleable solids, floating solids, suspended solids, and solid waste) and is not necessarily related to general landscape appearance.

The State of Wyoming sets water quality standards for individual pollutants and conditions specific to the designated use class. These standards consist of either a numeric limit, or a narrative description of a desired condition for each individual parameter. Water quality standards applicable to the sampling parameters for the Tongue River Watershed project area are summarized in Table 1.3.

Table 1.3 Narrative and Numeric Surface Water Quality Standards Applicable to the Designated Uses in the Tongue River Watershed Project Area (From WDEQ 2007, Water Quality Rules and Regulations, Chapter 1)

Non-Priority Pollutants[1]				
Parameter	**Reference**	**Standard / Description**		
		Human Health[2]	**Acute Aquatic Life[3]**	**Chronic Aquatic Life[3]**
pH	Sections 21 and 26; Appendix B			6.5-9.0 standard units
Dissolved Oxygen	Sections 21 and 30 Appendix D	For Class 1, 2AB, 2B, and 2C waters 1 day minima Early life: 5.0 mg/L intergravel concentration (8.0 mg/L water column) Other life stages: 4.0 mg/L		
E. Coli	Section 27	(a) Primary Contact Recreation. In all waters designated for primary contact recreation, during the summer recreation season (May 1 through September 30) concentrations of *E. coli* bacteria shall not exceed a geometric mean of 126 organisms per 100 milliliters based on a minimum of not less than 5 samples obtained during a separate 24 hour periods for any 30-day period. Table A of the Wyoming Surface Water Classification List are designated for primary contact recreation unless identified as secondary contact water by an "s" notation. Waters not specifically listed in Table A of the Wyoming Surface Water Classification List shall be designated as secondary contact waters. During the period October 1 through April 30, all waters are protected for secondary contact recreation only. (b) Secondary Contact Recreation: In all waters designated for secondary contact recreation, and in waters designated for primary contact recreation during the winter recreation season (October 1 through April 30), concentrations of *E. coli* bacteria shall not exceed a geometric mean of 630 organisms per 100 milliliters based on a minimum of not less than 5 samples obtained during separate 24 hour periods for any 30-day period. (c) Single-sample Maximum Concentration. During the summer recreation season, on all waters designated for primary contact recreation, the following single-sample maximum concentrations of E. coli bacteria shall apply: (i) High use swimming areas – 235 organisms per 100 milliliters (ii) Moderate full body contact – 298 organisms per 100 milliliters (iii) Lightly used full body contact – 410 organisms per 100 milliliters (iv) Infrequently used full body contact – 576 organisms per 100 milliliters Single-sample maximum values may be used to post recreational use advisories in public recreation areas and to derive single-sample maximum effluent limitations on point source discharges. An exceedance of the single-sample maxima shall not be cause for listing a water body on the State 303(d) list or development of a TMDL or watershed plan. The appropriate recreational use category (I through iv above) shall be determined by the administrator as needed, on a case by case basis. In making such a determination, the administrator may consider such site-specific circumstances as type and frequency of use, time of year, public access, proximity to populated areas, and local interests.		
Fecal Coliform Bacteria [4]	Section 27	During the entire year, fecal coliform concentrations shall not exceed a geometric mean of 200 organisms per 100 mL (based on a minimum of not less than 5 samples obtained during separate 24 hour periods for any 30 day period), nor shall the geometric mean of 3 separate samples collected within a 24 hour period exceed 400 organisms per 100 mL in any Wyoming surface water.		
Temperature	Section 25	Discharge shall not increase temperature by more than 2 degrees F; maximum allowable temperature is 68 degrees F/20 degrees C (cold water fisheries) except on Class 2D, 3 and 4 waters.		

Turbidity	Section 23	For cold water fisheries and drinking water supplies, discharge shall not create increase of 10 NTU's.
NARRATIVE STANDARDS		
Parameter	**Reference**	**Standard / Description**
Settleable Solids	Section 15	Shall not be present in quantities that could degrade aquatic life habitat, affect public water supplies, agricultural or industrial use, or affect plant and wildlife.
Floating and Suspended Solids	Section 16	Shall not be present in quantities that could degrade aquatic life habitat, affect public water supplies, agricultural or industrial use, or affect plant and wildlife.
Taste, Odor, Color	Section 17	Substances shall not be present in quantities that would produce taste, odor, or color in: fish flesh, skin, clothing, vessels, structures, or public water supplies.
Macroinvertebrates	Section 32 (WDEQ, 2001b); Hargett & Zumberge (2006)	Bighorn and Wind River Foothills Bioregion: Score 762.1 for full support; Score 41.4-62.1 for indeterminate support; and score <41.4 for partial/non-support.
ADDITIONAL PARAMETERS AND RECOMMENDED STANDARDS		
Habitat	King (1993); Stribling et al. (2000)	Habitat condition no less than 50 percent of reference; total habitat score >100 to qualify as reference
Specific Conductivity	King (1990)	Concentrations greater than 6900 umhos/cm may affect aquatic organisms in ponds in NE Wyoming.

[1] Priority pollutants are those pollutants listed by USEPA under section 307(a) of the Clean Water Act (WDEQ, 2007); Non-priority pollutants are substances other than those listed by USEPA

[2] The values that Class 1, 2AB, and 2A waters must meet; these are the "fish and drinking water" values (WDEQ, 2007). Because none of the waterbodies in the Tongue River watershed are designated as Class 2B, 2C, or 2D, values for consumption of fish (or "fish only")values are not reported here.

[3] Aquatic Life protection values apply to Class 1, 2A, 2B, 2AB, 2C, 3A, 3B, and 3C. Chronic values are 4-day averages while acute values are 1-day averages. Neither shall be exceeded more than once every 3 years.

[4] Original impairments were based on the former fecal coliform bacteria standard listed in WDEQ 2001b. Present bacteria impairments will be based on the *E. coli* parameters, not the fecal coliform parameter.

1.2.2 Impaired Waters

If a body of water exceeds water quality standards for a given pollutant, it is considered to be "impaired" or not meeting its designated uses. States are required by the CWA to submit a list of impaired surface waters to the US EPA every two years. This list is commonly known as the "Wyoming 303(d) list of Waters Requiring TMDLs" and is included within the 305 (b) reports that summarize water quality conditions in the state. The documents undergo a public comment period prior to being finalized. From 1998 to 2008, the 303(d) lists published by WDEQ, were organized as follows:

- Table A. Waterbodies requiring TMDL's, for which there are credible data that indicate the reach does not support all its designated uses. These are considered impaired.

- Table B. Waterbodies requiring Waste Load Allocations and/or TMDL's in the two years following publication due to the routine NPDES renewal process for permits containing Waste Load Allocations.

- Table C. Waterbodies requiring watershed plans or TMDL's, for which there are data indicating trends away from supporting beneficial use and where there are improvement plans or other corrective actions in progress. These are considered threatened.

- Table D. Waterbodies removed from the Table A, B, or C of the previous 303(d) lists of waterbodies requiring TMDL's.

- Table E. Waterbodies from the 1996 303(d) list requiring further monitoring to determine beneficial use attainment (published only in 1998 reports).

In 1999, the State of Wyoming enacted the Credible Data Law that required WDEQ to utilize "credible data" in its decisions concerning whether designated uses are impaired by pollutants. Since this legislation in 1999, WDEQ does not include Table E: Waters Requiring Further Monitoring into the 303(d) Lists because they did not have valid scientific data and documentation indicating use impairments or threats (WDEQ, 2000a). In 2008, the WDEQ combined Tables A and C into a single 303(d) List of Waters Requiring TMDLs.

The current, impaired waters in the Tongue River Watershed (see Map 6) are summarized in Table 1.4 and described below.

1.2.2.1 Tongue River

Tongue River is a 5th order stream (Strahler, 1957) that forms at the junction of the North Tongue River and the South Tongue River in the Big Horn Mountains. The North Tongue River, the South Tongue River, and the confluence of the Tongue River downstream to the BNF boundary are classified as Class 1 streams (WDEQ, 2007). This classification indicated that these streams were among the highest quality water bodies in Wyoming and no further water quality degradation by point source discharges other than from dams would be allowed (WDEQ, 2007). Wyoming Game and Fish Department (WGFD) classified this section of reach as having premier trout waters (WGFD, 1991). Between the BNF boundary and the confluence of the Yellowstone River in Montana, the WDEQ classification changes to a Class 2AB stream.

In 1996, WDEQ listed three segments of the Tongue River on the 303 (d) List of Impaired Waterbodies. A segment in the Bighorn National Forest was listed as a high priority for ammonia from point sources. The segments between the Montana State Line and the mouth of Prairie Dog Creek, and between Prairie Dog Creek and the mouth of Goose Creek were listed for silt from unknown non-point sources. These segments were assigned a medium and low priority, respectively. All three of the Tongue River segments listed in the 1996 305(b) report were included in the 1998 303(d) list on 'Table E: 1996 303(d) Waters Requiring Further Monitoring.' All three segments were outside of the project area.

In 2000, the Tongue River was listed on 'Table B: 303(d) Waterbodies with WLA Discharge Permits Expiring' for total residual chlorine and fecal coliform bacteria as a result of the Town of Ranchester WWTP NPDES permit renewal. This listing was moved to 'Table D: Waterbodies delisted from 2000 303(d) list' in 2002 because the permit was renewed.

In 2002, the Tongue River below the Goose Creek confluence was listed as a high priority for temperature based on data collected by WDEQ and USGS. This section is outside of the project area. The Tongue River below Dayton was listed on 'Table B: Waterbodies with NPDES Discharge Permits containing WLAs Expiring' for ammonia, fecal coliform bacteria, and chlorine as a result of the Town of Dayton WWTP NPDES permit renewal. It was moved to 'Table D: Waterbodies delisted from 2002 303(d) list' in 2004 because the permit was renewed.

In 2010, an additional segment of the Tongue River from Monarch to the confluence with Wolf Creek was placed on the 303(d) List of Waters Requiring TMDLs for *Escherichia coli (E.coli)*. The new listing is based on the SCCD's Tongue River 2006 Interim Monitoring, which included two sites below the Town of Ranchester. To date, Tongue River is listed for *E.coli* from Monarch Road upstream approximately 13.5 miles to Wolf Creek Road; and for temperature from the Montana line upstream approximately 22.1 miles to the confluence of Goose Creek.

1.2.2.2 North Tongue River

North Tongue River is a 4th order stream (Strahler, 1957) that forms in the Big Horn Mountains and is classified as a Class 1 stream (WDEQ, 2007). This classification indicated this stream to be among the highest quality water bodies in Wyoming and no further water quality degradation by point source discharges other than from dams would be allowed (WDEQ, 2007).

In 1996, the North Tongue River was listed as a medium priority for silt, nutrients, and habitat from unknown non-point sources. Tributaries to the North Tongue, Bull Creek and Big Willow Creek, were listed for silt and nutrients and assigned a low priority. All of these tributaries were included in the 1998 303(d) list on "Table E: 1996 303(d) Waters Requiring Further Monitoring."

In 1998, the North Tongue River was listed on "Table B: 303(d) Waterbodies with WLA discharge permits expiring" for total residual chlorine as a result of the USFS WWTP NPDES permit renewal. This listing was moved to "Table D: Waterbodies delisted from 1998 303(d) list" in 2000 because the permit was renewed.

In 2004, WDEQ added the North Tongue River in the Bighorn National Forest for fecal coliform from nonpoint sources. This determination was based on samples collected between July 2003 and October 2003 in response to a complaint about livestock use on the grazing allotments. The Bighorn National Forest initiated its own monitoring program and formed a steering committee to develop and implement a watershed management plan. Due to the Bighorn National Forest authority and separate steering committee over the North Tongue River, the TRWSC will not incorporate the North Tongue River into this watershed-based plan. The TRWSC will, though, stand ready to assist in any way possible to help resolve resource issues while sustaining beneficial uses. To date, the North Tongue River from Road 171 upstream to the confluence with Pole Creek remains on the 303(d) List for Impaired Waters Requiring TMDLs for fecal coliform bacteria related to grazing.

1.2.2.3 Little Tongue River

Little Tongue River is a 4th order stream (Stahler, 1957) and drains an area of about 26.2 square miles up to its confluence with the Tongue River in the Town of Dayton. The headwaters for the Little Tongue River are in the Big Horn Mountains near Black Mountain at an elevation of about 8,200 feet in the BNF. The stream disappears underground as it traverses the face of the mountain in the vicinity of a rock slide called Fallen City. The stream surfaces in the lower foothills on the Horseshoe Ranch, which is located within the project area. Dye studies suggest a portion of the underground stream flow discharges into the Tongue River Canyon to the north. Little Tongue River is classified by the WDEQ as a Class 2AB stream (WDEQ, 2001). Wyoming Game and Fish Department (WGFD) identified Little Tongue River to be a low productive trout water, a fishery frequently of local importance, but generally incapable of sustaining substantial fishing pressure (WGFD, 1991).

In 1996, Little Tongue River was included on the 1996 303 (d) List of Impaired Waters. Little Tongue River was listed as a low priority for silt and flow from non-point sources and was among the surface waters included in the 1998 303(d) list on "Table E: 1996 303(d) Waters Requiring Further Monitoring." It was excluded from WDEQ's 305(b) report in 2000.

In 2002, WDEQ listed Little Tongue River on "Table A: 303(d) Waterbodies with Water Quality Impairments" for fecal coliform bacteria from undetermined sources. This listing included the section from the confluence of the Tongue River upstream 4.8 miles to Frisbee Ditch, and was based on data collected by SCCD during the Tongue River Watershed Assessment (SCCD, 2000). It was assigned a low priority because of the local watershed effort. In 2008, the impairment cause was changed to *Escherichia coli (E.coli)* to reflect the change in state water quality standards. Little Tongue River has been listed on the 303(d) list since 2002 for bacteria impairments related to recreational use.

1.2.2.4 Smith Creek

Smith Creek is a 3rd order water body (Strahler, 1957) and is classified as a Class 2AB stream (WDEQ, 2001). The headwaters are found in the BNF at about 7,600 feet and it flows east until it merges with the Tongue River in the Town of Dayton. Smith Creek has a drainage area of about 11.6 square miles and is the smallest tributary of the Tongue River within the project area.

In 1996, Smith Creek was included on the 1996 303 (d) List of Impaired Waters as a medium priority for silt, nutrients, habitat, and pathogens from non-point sources. In 1998, Smith Creek was included on "Table D: Waterbodies delisted from 1996 303(d) list." Smith Creek was delisted because information collected by the Bighorn National Forest indicated it was meeting its beneficial use designations.

In 2002, WDEQ listed Smith Creek on "Table A: 303(d) Waterbodies with Water Quality Impairments" for fecal coliform bacteria from undetermined sources. This listing included the section from the confluence of the Tongue River upstream to an undetermined distance of around 5.8 miles, and was based on data collected by SCCD during the Tongue River Watershed Assessment. It was assigned a low priority because of the local watershed effort. Smith Creek

has been listed on the 303(d) list since 2002 for fecal coliform bacteria impairments related to recreational use.

1.2.2.5 Columbus Creek

Columbus Creek is a 3rd order water body (Strahler, 1957) and is classified as a Class 2AB stream (WDEQ, 2001). The headwaters are found in the BNF at an elevation of about 7,900 feet. The drainage area (approximately 17.9 square miles) is the second largest tributary of the Tongue River within the project area. The confluence with the Tongue River is located about halfway between the Town of Dayton and the Town of Ranchester near Halfway Lane. Columbus Creek is considered to be an important trout water and fishery of regional importance (WGFD, 1991).

In 2002, WDEQ listed Columbus Creek on "Table A: 303(d) Waterbodies with Water Quality Impairments" for fecal coliform bacteria from undetermined sources. This listing included the section from the confluence of the Tongue River upstream to an undetermined distance of around 3.1 miles, and was based on data collected by SCCD during the Tongue River Watershed Assessment. It was assigned a low priority because of the local watershed effort. Columbus Creek has been listed on the 303(d) list since 2002 for fecal coliform bacteria impairments related to recreational use.

1.2.2.6 Five Mile Creek

Five Mile Creek is a 4th order water body (Strahler, 1957) and is classified as a Class 3B stream (WDEQ, 2001). Five Mile Creek serves as a conduit to deliver irrigation water for agricultural land use. The creek receives the majority of flow from the diversion of Columbus Creek via Five Mile Ditch. A few springs exist in the drainage, but they would not provide sufficient discharge to allow maximum agricultural development without the diversion from Columbus Creek. Due to its insufficient flows, this creek is classified as a very low production trout water, often incapable of sustaining a trout fishery (WGFD, 1991).

In 2002, WDEQ listed Five Mile Creek on "Table A: 303(d) Waterbodies with Water Quality Impairments" for fecal coliform bacteria from undetermined sources. This listing included the section from the confluence of the Tongue River upstream 2.1 miles to the confluence of Hanover Ditch, and was based on data collected by SCCD during the Tongue River Watershed Assessment of 1996-1999. It was assigned a low priority because of the local watershed effort. Five Mile Creek has been listed on the 303(d) list since 2002 for fecal coliform bacteria impairments related to recreational use.

1.2.2.7 Wolf Creek

Wolf Creek is a 4th order water body (Strahler, 1957) and is classified as a Class 2AB stream (WDEQ, 2001). The headwaters start in the BNF at an elevation of about 8,800 feet with the confluence with the Tongue River just above the Town of Ranchester. This is the largest tributary to the Tongue River within the project area and has drainage area of about 72.4 square miles. Wolf Creek is indicated as a trout water and fisheries of regional importance (WGFD, 1991).

In 2002, Wolf Creek was listed on "Table C: 303(d) Waterbodies with Water Quality Threats" for fecal coliform bacteria from undetermined sources. The segment included the confluence with Tongue River upstream 10.6 miles to the confluence with East Wolf Creek. This was based on data collected by SCCD during the Tongue River Watershed Assessment. In 2004 and 2006, Wolf Creek continued to be listed on Table C. In 2008, Tables A and C were combined into one list. Wolf Creek has been listed on the 303(d) list since 2002 for fecal coliform bacteria impairments related to recreational use.

Table 1.4 Wyoming's Final 2012 303(d) Integrated State Water Quality Assessment Report

Name	Class	Location	Miles	Uses	Use Support	Causes	Sources	List Date
Tongue River (tributary to Yellowstone River)	2AB	From Monarch Road upstream to Wolf Creek Road	13.5	Recreation	Not supporting	Unknown	*E. coli*	2010
Tongue River (tributary to Yellowstone River)	2AB	From the confluence with Goose Creek downstream to the Montana border	22.1	Cold Water Fishery	Not supporting	Unknown	Temperature	2002
North Tongue River (tributary to Tongue River)	1	From Road 171 upstream to the confluence with Pole Creek	11.1	Recreation	Not supporting	Grazing	Fecal Coliform	2004
Little Tongue River (tributary to Tongue River)	2AB	From confluence with Tongue River upstream to the confluence with Frisbee Ditch	4.8	Recreation	Not supporting	Unknown	*E. coli*	2002
Smith Creek (tributary to Tongue River)	2AB	From the confluence with the Tongue River to a point 5.8 miles upstream	5.8	Recreation	Not supporting	Unknown	Fecal Coliform	2002
Columbus Creek (tributary to Tongue River)	2AB	From confluence with Tongue River to a point 3.1 miles upstream	3.1	Recreation	Not supporting	Unknown	Fecal Coliform	2002
Five Mile Creek (tributary of Tongue River	3B	From confluence with Tongue River upstream to the confluence with Hanover Ditch	2.1	Recreation	Not supporting	Unknown	Fecal Coliform	2002
Wolf Creek (tributary of Tongue River)	2AB	From confluence with Tongue River upstream to the confluence with East Wolf Cr	10.6	Recreation	Not supporting	Unknown	Fecal Coliform	2002

1.3 Planning Authority

Under Wyoming Statute 11-16-103 Legislative declarations and policy, the SCCD is to

> provide for the conservation of the soil, and water resources of this state, and for the control and prevention of soil erosion and for flood prevention or the conservation, development, utilization, and disposal of water, and thereby to stabilize ranching and farming operations, to preserve natural resources, protect the tax base, control floods, prevent impairment of dams and reservoirs, preserve wildlife, protect public lands, and protect and promote the health, safety and general welfare of the people of this state.

Wyoming Statute 11-16-122 grants Conservation Districts the ability to

> conduct surveys, investigations and research and disseminate information relating to . . . the conservation, development, utilization and disposal of water. . . . in cooperation with the government of this state or its agencies . . . [to] develop comprehensive plans for . . . conservation of soil and water resources . . .[that] specify in detail the acts, procedures, performances, and avoidances necessary or desirable to carry out the plans [and to] make public the plans and information and bring them to the attention of owners and occupiers of land within the district.

In 1996, the Wyoming Association of Conservation Districts, the NRCS, and the Wyoming Department of Agriculture saw an increasing need for Conservation Districts to represent local interests and take the lead in watershed planning efforts. As a result they developed the Watershed Strategic Plan, which was updated in 2000, to guide watershed planning efforts across the state (WACD, 2000). This document insists that "any watershed effort led by a conservation district should be landowner driven . . . [and] any participation on behalf of any landowner is strictly voluntary."

In addition, the Tongue River Watershed Plan meets the top priorities of the Wyoming Non-Point Source Management Plan Update (WDEQ, 2000) by conducting an assessment of the condition of surface water, implementing information and education programs that "encourage participation in voluntary efforts to prevent, reduce, and eliminate pollution of the state's water resources," and, through the involvement of the TRWSC and local landowners "developing and implementing watershed management plans."

By taking an active role in the planning process, the TRWSC, SCCD, and NRCS have adhered to this principle. The landowners followed the steps for watershed planning as outlined in the Watershed Strategic Plan. They identified and prioritized concerns, set goals and objectives, and outlined the activities they felt would achieve the objectives. Included in the 2012 Tongue River Watershed Plan are elements to solicit funds, implement the plan, and provide for periodic plan evaluation. This watershed plan was written to include the nine essential elements of an EPA Watershed Based Plan as described in the Thursday, October 23, 2003 Federal Register, Vol. 68, No. 205 (USEPA, 2003).

1.4 Previous and Ongoing Work in the Tongue River Watershed

Extensive work toward understanding the Tongue River Watershed and improving the water quality is ongoing. The consistent effort of the SCCD to collect water quality datasets throughout the years have been crucial in developing segment-specific bacteria loads and deriving load capacities for each critical stream with the watershed. Other historical monitoring efforts within the Tongue River Watershed have been conducted by the WDEQ, United States Geological Survey (USGS), WGFD, NRCS, Wyoming State Board of Control (WSBC), and the United States Forest Service (USFS). This data provided a valuable source of information to the SCCD for the initial Tongue River Watershed Assessment of 1996-1999.

The Tongue River Watershed Assessment of 1996-1999 was initiated by the Tongue River Watershed Steering Committee (TRWSC) in 1996. The Assessment served as the foundation of a local watershed planning and improvement effort. The TRWSC, which consisted of stakeholders representing rural, urban, and other local interests, recognized bacteria levels as a major concern. Possible causes and sources of the bacteria were identified to be wildlife, livestock and other domestic animals, and humans. The Tongue River Watershed Plan (TRWP) was developed to address these concerns and was approved by WDEQ in 2000. The TRWP outlined the goals, objectives, and action items for improving water quality with the Tongue River Watershed, along with prioritizing best management practices (BMP), and providing future recommendations.

To address water quality and other natural resource concerns identified through the assessment and planning processes, the SCCD (with support from NRCS) initiated a water resources improvements program. This program began in 2001 with a single grant to provide assistance for improvements to livestock operations that had an impact on water quality. The program has expanded to include work on septic systems, irrigation diversions, and other stream rehabilitation and riparian improvement projects. Federal CWA Section 319 grant monies administered by the Wyoming Department of Environmental Quality (WDEQ) are supplemented by state grants from WACD and WDA, the WGFD, the Wyoming Wildlife and Natural Resource Trust, USDA program funds (including the Environmental Quality Incentives (EQIP) and the Agriculture Management Assistance (AMA) Programs), and landowner contributions of cash or labor. The overriding priority for project selection is the potential benefit to water quality. The ability of an individual project to encourage widespread participation in the program is also considered. The improvement effort also includes an educational component to increase awareness about impacts and concerns and to encourage additional participation.

After five years, several improvement projects were completed and all of the action items in the TRWP were either completed or otherwise addressed by the TRWSC (Table 1.5 and see Map 7). However, interim monitoring continued to identify unacceptable bacteria levels. As a result, in the summer of 2005 the TRWSC began an update of the TRWP, which was submitted to WDEQ in 2007. Bacteria continued to be a primary concern in the TRWP-Revision 1. As a result, many of the action items in the TRWP Revision 1 addressed bacteria concerns that focused on reducing the potential contributions from domestic animals and livestock, and faulty septic systems. Since 2007, two additional livestock facility improvements, one riparian stockwater project, and three septic system improvements have been accomplished in the

Tongue River Watershed (Table 1.5 and see Map 7). The ability to address wildlife contributions was limited to information and education activities.

Although excess sediment was not identified by WDEQ as an impairment in the Tongue River watershed, it was a concern for watershed residents. In Sheridan County, eroding stream banks are a significant contributor of excess sediment in waterways. As a result, the TRWSC addressed sediment contributors from unstable channels and annual channel modifications for irrigation diversions and/or inefficient and erosive irrigation conveyances in the TRWP. Increased emphasis on stream rehabilitation projects that not only stabilize stream channels, but also included improvements to habitat and provisions for fish passage, were included as action items within the TRWP-Revision 1. Since 2007, three stream rehabilitation and two diversion projects have been completed in the Tongue River Watershed (Table 1.5 and see Map 7).

The mission of the TRWSC and SCCD/NRCS has and will continue to be to maintain and improve existing water quality, natural resource health, economic stability, and the quality of life on the Tongue River watershed through voluntary financial, technical, and educational resources; thereby preventing the need for government regulatory agency enforcement actions. As part of the TRWP-Revision 2 (2012), SCCD/NRCS will implement the following recommendations from the TRWSC (see Chapter 5 for a comprehensive summary of implementation action items in the watershed):

- Continue a watershed improvement effort by providing leadership and project oversight;
- Reduce bacteria contributions by an average of 18% over the entire Tongue River Watershed by 2017;
- Reduce water quality impacts, other than bacteria, such as nutrient concentrations, organic matter, temperature, and sediment loads*;*
- Increase awareness and encourage participation in the watershed improvement efforts*;* and
- Increase awareness and understanding about water quality impacts and relationships among water quality parameters.

Table 1.5 Summary of SCCD Improvement Projects Accomplished From 1997 to 2011 within the Tongue River Watershed (Map 7)

	Improvement Project	Location	Year
Diversion Projects	Diversion with Fish Passage	Tongue River	2011
	Diversion with Stream Stabilization	Tongue River	2009
	Diversion with Stream Restoration	Tongue River	2005
	Diversion with Stream Stabilization	Wolf Creek	2005
	Diversion with Stabilization	Tongue River	2004
Livestock Facility Related Projects	Livestock Facility Improvement	Wolf Creek	2009
	Livestock Facility Improvement	Tongue River	2009
	Livestock Facility Improvement	Bonanza Creek	2006
	Livestock Facility Improvement	Wolf Creek	2005
	Nutrient Management Plan Update	Tongue River	2005
	Livestock Facility Improvement	Tongue River	2003
	Livestock Facility Improvement	Columbus Creek	2003
	Livestock Facility Improvement	Wolf Creek	2002
Riparian or Reservoir Projects Related to Livestock	Riparian Stockwater	Five Mile Creek	2010
	Riparian Stockwater	Wolf Creek	2004
	Rousey Draw Reservoir	Columbus Creek	2001
	Riparian Fencing	Wolf Creek & East Wolf Creek	1998
	Riparian Improvement	Little Tongue River	1997
Riparian Forest Buffer Projects	37 ac. Riparian Forest Buffer	Five Mile Creek	2003
	50 ac. Riparian Forest Buffer	Five Mile Creek	2001
	75 ac. Riparian Forest Buffer	Columbus Creek	2000
Septic System Projects	Septic System Improvement	Smith Creek	2011
	Septic System Improvement	Tongue River	2008
	Septic System Improvement	Wolf Creek	2007
	Septic System Improvement	Wolf Creek	2006
	Septic System Improvement	Tongue River	2005
	Septic System Improvement	Tongue River	2005
Stream Rehabilitation Projects	Stream Rehabilitation	Tongue River	2010
	Stream Rehabilitation	Tongue River	2009
	Stream Rehabilitation	Wolf Creek	2009
	Stream Rehabilitation	Tongue River	2006
	Stream Rehabilitation	Tongue River	2004
	Streambank Bioengineering	Tongue River	1998

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CHAPTER 2 WATERSHED CHARACTERIZATION

For the purpose of the watershed characterization, the Tongue River Watershed project area has been divided into four subwatersheds: Upper Tongue River, Five Mile/Columbus Creek, Wolf Creek, and Lower Tongue River (see Map 4). Subwatershed divisions within the Tongue River watershed are based upon boundaries defined by the United States Geological Survey (USGS). Each hydrologic unit or drainage area is identified by a unique hydrologic unit code (HUC) that ranges from 2-12 digits, depending upon the level of division. SCCD used the smallest of the HUC divisions, the 12 digit or 6th level subwatershed divisions as a starting point. The subwatersheds are further delineated based upon hydrological similarities and/or differences within each HUC 12 division. Delineation of the subwatersheds into smaller drainages for analyzing load capacities is discussed in Chapter 4.

2.1 Upper Tongue River Subwatershed

The Upper Tongue River subwatershed has an area of 25,228 acres (39.4 square miles). The headwaters of this subwatershed start in the Big Horn Mountains within the BNF boundary, and flow downstream through Tongue River Canyon. The western and upstream boundary of this subwatershed starts at the base of BNF boundary line. The easternmost boundary line uses the USGS HUC 12 division for its boundary with the Wolf Creek subwatershed. The boundary separating the Upper Tongue River subwatershed from the Five Mile/Columbus Creek subwatershed extends east from Columbus Creek. The Upper Tongue River subwatershed includes five tributaries: Little Tongue River, Smith Creek, Whitetail Creek, Amsden Creek, and Currant Draw. There are seven manmade ditches within this subwatershed; a majority of them are diverting water from the Tongue River or the Little Tongue River (see Map 15). Land cover is dominated by a mixed grass prairie with a small amount of Ponderosa Pine forest along the southwestern edge (see Map 8). Irrigated cropland and riparian vegetation are mostly adjacent to the main stem of the Tongue River, Smith Creek, and Little Tongue River (see Map 9). Annual precipitation is mostly between 16 and 18 inches with slightly higher precipitation further upstream (see Map 3). The water quality sample sites in this subwatershed are SCL (on Smith Creek), LTRL (on Little Tongue River) and TRU - the upper most sample site on the mainstem of the Tongue River at a USGS Gauging Station (No. 06298000) located in the mouth of Tongue River Canyon.

The Upper Tongue River Subwatershed is approximately 73% privately owned lands, 20% State lands, and the remaining 7% federal Bureau of Land Management (BLM) lands (see Map 10). The subwatershed land use consist of rangeland (82%), irrigated cropland (8%), residential (9%), and urban (1%). Rangeland and irrigated cropland make up 90% of the land use but parcels of 40 acres and larger in size only constitute 12% of the parcel numbers. Residential and urban land areas, parcels less than 40 acres in size, make up the remaining 10% of the land area but constitute 88% of the parcel numbers due to the Town of Dayton. Upper Tongue River Subwatershed also has seven rural subdivisions: Eagle Ridge, Gold Reef, Woodrock Estates, Owl's Roost, Elk Meadows, Horseshoe Estates, and Horizon Estates.

US Highway 14 runs parallel to the main stem of the Tongue River for about 1.5 miles until it turns south and heads up into the Big Horn Mountains. Several unpaved, county roads can be

found in this subwatershed, most of them following the contours of the Tongue River and tributary drainages. There are no permitted point source discharges in this subwatershed but there have been two permitted mining sites, both less than 10 acres each (see Map 16).

2.2 Five Mile/Columbus Creek Subwatershed

The Five Mile/Columbus Creek Subwatershed has an area of 32,530 acres (50.8 square miles). The headwaters of this subwatershed start in the Big Horn Mountains within the BNF boundary. The northern and upstream boundary of this subwatershed starts at the base of BNF boundary line. The southern boundary separates the Five Mile/Columbus Creek Subwatershed with the Wolf Creek Subwatershed which uses the USGS HUC 12 division line. The eastern boundary separates the Five Mile Creek and Sixmile Creek drainages. The boundary separating the Upper Tongue River subwatershed from the Five Mile/Columbus Creek subwatershed extends east from Columbus Creek to incorporate similarities between Five Mile Creek and Columbus Creek watersheds. Five Mile Creek is classified by the USGS as an intermittent stream. However, it behaves more perennially as water is brought to Five Mile Creek from Columbus Creek via the Five Mile Ditch. This subwatershed includes three tributaries of the Tongue River: Five Mile Creek, Columbus Creek, and South Fork. Land cover is 50% of mixed grass prairie and 25% Wyoming big sagebrush (see Map 8). The remaining 25% is a combination of irrigated cropland and riparian vegetation that can be found adjacent to the main stem of the Tongue River, Columbus Creek, Five Mile Creek, and Five Mile Ditch. There are nine ditches located in this subwatershed; the majority of them are drawing water from Columbus Creek or Tongue River to irrigated cropland downstream (see Map 15). Annual precipitation is mostly between 16 and 18 inches with slightly lower precipitation of 14 to 16 inches around the main stem of the Tongue River (see Map 3). There are four water quality sample sites located within this subwatershed. Two are located on the mainstem of the Tongue River (TRL and TRM), with a sample site on each tributary (FMCL and CCL).

Five Mile/Columbus Creek Subwatershed is approximately 91% privately owned lands, 8% State lands, and the remaining 1% federal lands (see Map 10). The subwatershed land use consist of rangeland (62%), irrigated cropland (30%), residential (7%), and urban (1%). Rangeland and irrigated cropland make up 92% of the land use but parcels of 40 acres and larger in size only constitute 14% of the parcel numbers. Residential and urban land areas, parcels less than 40 acres in size, make up the remaining 8% of the land area but constitute 86% of the parcel numbers due to parcels within the Town of Ranchester. Five Mile/Columbus Creek Subwatershed also has eight rural subdivisions: Five Mile M, Wyoming Log home Estates, Spirit Ridge, Owl Crest, and Parkman Hills.

US Highway 14 runs through the entire subwatershed (about 5.5 miles); all, of which, is parallel to the mainstem of the Tongue River. State Highway 343 and 345 are slightly parallel to the east and west boundaries of the subwatershed but merge near the Five Mile Ditch, and run out of the subwatershed parallel to South Fork. Interstate 90 runs directly on the eastern boundary line of this subwatershed (see Map 1). Other transportation corridors include several paved and unpaved, county roads, and the Burlington Northern Santa Fe Railroad. There are two point source discharge permits, Padlock Ranch Company Feedlot (WYPDES #WY0022462), and the Dayton Wastewater Treatment Plant (WYPDES #WY0020435), which services the Town of Dayton (population 1,073). The Padlock Ranch Feedlot has a direct discharge into Columbus

Creek approximately 4.5 miles upstream from where Columbus Creek enters Tongue River. The Dayton Wastewater Lagoon has a direct discharge into Tongue River, approximately 2 miles downstream from the Town of Dayton. There have been four permitted mining operations within this subwatershed but all of them have been less than 10 acres each (see Map 16).

2.3 Wolf Creek Subwatershed

The Wolf Creek Subwatershed is the smallest subwatershed within the project area with 22,581 acres (35.3 square miles). The headwaters of this subwatershed start in the Big Horn Mountains within the BNF. The western and upstream boundary of this subwatershed starts at the base of BNF boundary line. The northern, southern, and eastern boundary uses the USGS HUC 12 division line. The only tributary of the Tongue River that is within this subwatershed is Wolf Creek (see Map 4). Although, the smallest subwatershed, it has as many manmade ditches as Five Mile/Columbus Creek subwatershed (see Map 15). Land cover is roughly 50% mixed grass prairie and 35% Wyoming big sagebrush (see Map 8). The remaining 15% is a combination of Ponderosa Pine in the southern corner of the subwatershed and riparian vegetation that can be found adjacent to Wolf Creek. Annual precipitation in the upper subwatershed is mostly between 16 and 18 inches with slightly lower precipitation of 14 to 16 inches in the lower half of the subwatershed (see Map 3). The only sample site in this subwatershed is WCL, which is located on Wolf Creek, approximately 0.45 miles before the confluence of Wolf Creek and Tongue River.

The Wolf Creek Subwatershed is approximately 82% privately owned lands, and 18% State lands (see Map 10). The subwatershed land use consist of rangeland (74%), irrigated cropland (25%), and residential (1%). Rangeland and irrigated cropland make up 99% of the land use and parcels greater than 40 acres constitute 71% of the parcel numbers. Residential land areas, parcels less than 40 acres, make up the remaining 1% of the land area but constitute 29% of the parcel numbers. There are no subdivisions or permitted point source discharges in the Wolf Creek Subwatershed. The only transportation corridors are unpaved, county roads, and there has only been one permitted mining operation in this subwatershed (see Map 16).

2.4 Lower Tongue River Subwatershed

The Lower Tongue River subwatershed encompasses approximately 55,342 acres (86.5 square miles), making it the largest subwatershed in the Tongue River watershed project area. The northern, eastern, southern, and part of the western boundary (except for the northwestern section that follows the Interstate), uses the USGS HUC 12 division for its border. There are no perennial tributaries within this subwatershed boundary; however, intermittent draws may contribute stormwater and run-off during precipitation or snowmelt events. The largest of these draws include Six-mile Creek, Earley Creek, North Dry Creek, Slater Creek, South Dry Creek and Hidden Water Creek. Due to the low abundancy of perennial surface water, this subwatershed only has one ditch that draws out of the Tongue River and runs parallel to it (see Map 15). Land cover is dominated by Wyoming big sagebrush with a smaller amount of mixed prairie grass along the northern and eastern edge (see Map 8). Riparian vegetation is only adjacent to the main stem of the Tongue River. Annual precipitation is mostly between 14 and 16 inches with slightly higher precipitation further north (see Map 3). This subwatershed

includes TR1 and TR2 water quality sample sites. A USGS Gauging Station (No. 06299980) is located at the TR1 sample site.

The Lower Tongue River Subwatershed is approximately 86% privately owned lands, 9% State lands, and the remaining 5% is Bureau of Land Management (BLM) lands (see Map 10). The subwatershed land use consists of rangeland (91%), irrigated cropland (7%), and residential (2%). Rangeland and irrigated cropland make up 98% of the land use and parcels of 40 acres and larger in size constitute 74% of the parcel numbers. Residential land areas, parcels less than 40 acres in size, make up the remaining 2% of the land area but constitute 26% of the parcel numbers. There are no subdivisions within this subwatershed.

Interstate 90 runs parallel to the main stem of the Tongue River for about 1.5 miles until it turns north toward the Montana line (see Map 1). The Burlington Northern Santa Fe Railroad and several paved and unpaved, county roads can be found in this subwatershed. This area does include the Ranchester Wastewater Treatment Plant (WYPDES #WY0022161), for the Town of Ranchester (population 1,153), which discharges into the Tongue River 2.4 miles downstream of the Town of Ranchester. Mining activity has been the highest in this subwatershed, but most of these activities have been reclaimed and are below TR1, SCCD's lowest sampling location (see Map 16).

Table 2.1 Summary of Tongue River Subwatershed Characterizations

	Upper	Five Mile/Columbus	Wolf	Lower
Size (acres)	25228	32530	22581	55342
Tributaries	Little Tongue River Smith Creek Whitetail Creek Amsden Creek Currant Draw	Columbus Creek Five Mile Creek South Fork	Wolf Creek	Sixmile Creek Earley Creek North Dry Creek Slater Creek South Dry Creek Hidden Water Creek
Sample Sites	TRU LTRL SCL	CCL TRM FMCL TRL	WCL	TR2 TR1
Impaired Waters	Little Tongue River Smith Creek	Columbus Creek Five Mile Creek Section of Tongue River	Wolf Creek	Lower Section of Tongue River
Diversions/Ditches	South Side Ditch Frisbie Ditch Mock Ditch #2 Tongue River Ditch #1 (upper portion) Owens Ditch 2 Unknown Ditches	Tongue River Ditch #1 Hanover Ditch South Side Ditch York Ditch Oz Ditch Mock Ditch Mikado Ditch Brand Point Ditch Fivemile Ditch	York Ditch (small section) West Wolf Ditch Dye-Shields Ditch Old Reliable Ditch Decker Ditch Garrand Ditch P K Ditch Grinnell Ditch 1 Unknown Ditch	Tongue River Ditch
Land Ownership	73% Private 20% State (4964 acres) 7% Federal (1708 acres)	91% Private 8% State (2453 acres) 1% Federal (453 acres)	82% Private 18% State (4092 acres) 0% Federal (13.7 acres)	86% Private 9% State (5192 acres) 5% Federal (2727 acres)
Land Uses[1]	82% Rangeland 8% Irrigated Cropland 9% Residential 1% Urban	62% Rangeland 30% Irrigated Cropland 7% Residential 1% Urban	74% Rangeland 25% Irrigated Cropland 1% Residential	91% Rangeland 7% Irrigated Cropland 2% Residential
Land Cover	Mixed Grass Xeric upland shrubs Ponderosa Pine Douglas Fir Forest-dominated riparian Irrigated crops	Mixed grass Irrigated Crops Wyoming big sagebrush Forest-dominated riparian	Mixed grass Ponderosa Pine Forest-dominated riparian Wyoming big sagebrush	Mixed grass Wyoming big sagebrush Forest-dominated riparian
Annual Precipitation	Mostly 16-18 inches	14-18 inches	Mostly 14-18 inches	Mostly 14-16 inches
Residential Parcels < 5 acres in City Limits (#)	417	378	0	0
Residential Parcels < 5 acres outside of City Limits (#)	74	97	6	65
Ranchette Parcels 5 - 40 acres (#)	111	134	15	55
Small Acre Parcels 40 - 100 acres (#)	31	25	7	94
Large Acre Parcels > 100 acres (#)	54	72	43	255
Density Areas Subdivisions	Eagle Ridge Elk Meadows Horseshoe Estates Horizon Estates	Five Mile M Wyoming Log Home Est. Spirit Ridge Owl Crest Parkman Hills		
Transportation Corridors	US Highway 14 County Roads	US Highway 14 State Highway 343 and 345 Interstate 90 (on boundary) Railroad County Roads	County Roads	Interstate 90 Railroad County Roads
WDEQ Quarry Permits	2	4	1	9
Other Activities	Country Club Golf Course	Padlock Ranch Feedlot Town of Dayton WWTP		Town of Ranchester WWTP

[1]Land Use classification are estimated based on best available data and were based upon Sheridan County Assessor parcels ownership data of 2011, aerial photos, and local knowledge. Residential land uses include residential lots and rural ranchette land parcels less than 40 acres in size. Urban lands were parcels found within the town's city limits. These acres were then subtracted from the residential land acres. Residential areas may be used for some small scale irrigated or non-irrigated hay production and/or livestock production. Irrigated cropland or hayland may also be used for late season aftermath grazing and/or winter livestock feed grounds. Rangeland includes native rangeland and non-irrigated improved pasture and is used primarily for livestock grazing, though may also include small areas used for dryland hay production.

CHAPTER 3 MONITORING DESIGN AND SUMMARY

3.1 Monitoring Parameters

Monitoring from 1996-1999 occurred monthly from April-October, with only one 30-day geometric mean calculated for fecal coliform bacteria in late summer 1999. Samples were collected from 3 sites on the Tongue River and upper and lower tributary sites on Wolf Creek, Columbus Creek, Smith Creek, and Little Tongue River and one lower site on Five Mile Creek for a total of 10 stations. Several parameters were sampled and included instantaneous water temperature, pH, conductivity, discharge, turbidity, nitrate, total phosphorus, bacteria, and macroinvertebrates. A pesticide screen was conducted in 1996. The 2003 monitoring included the same lower tributary and Tongue River stations but fewer parameters including: bacteria, turbidity water temperature, pH, conductivity, dissolved oxygen, discharge, and macroinvertebrates. Bacteria 30-day geometric means were collected in May and August of each year, in addition to monthly samples. Continuous temperature data loggers were used for the first time in 2003 on Tongue River stations. With the expansion of the watershed boundary in 2006, two additional Tongue River sites were added in 2006 and 2010. The parameters were the same as those collected in 2003 and included 30-day geometric means in May and August. In 2003, and 2006 fecal coliform continued to be collected and analyzed along with *E. coli.*

3.2 Sample Site Descriptions

As of 2010, five stations were located on Tongue River and five stations were located near the mouths of the five tributaries—Wolf Creek, Five Mile Creek, Columbus Creek, Smith Creek, and Little Tongue River. Detailed site and watershed descriptions were provided in the Assessment Report (SCCD, 2000) and the 2010 Sampling and Analysis Plan (SCCD, 2010). Table 3.1 provides descriptions for sites sampled since 2006. By maintaining consistency in the monitoring sites used, changes in water quality can be directly compared to the 1996-1999, 2003, 2006, and 2010 data.

Table 3.1 Sample Site Descriptions and Location Information

Site	Monitoring Parameters	Coordinates	Water Quality Sampling	Benthic Macro-invertebrate Sampling
Tongue River 1 (TR1)	Temperature (continuous), water quality, and BURP	Lat-44°54'00" Long-107°01'15"	Upstream Monarch Road bridge	Upstream Monarch Road bridge
Tongue River 2 (TR2)	Temperature (continuous), water quality, and BURP	Lat-44°54'00" Long-107°01'15"	Upstream Kooi Road bridge	Upstream Kooi Road bridge
Tongue River Lower (TRL)	Temperature (continuous), water quality, and BURP	Lat-44°54'25" Long-107°09'55"	Upstream Ranchester Water Treatment Plant intake	Upstream County Road 67 bridge crossing
Tongue River Middle (TRM)	Temperature (continuous), water quality, and BURP	Lat-44°53'26" Long-107°12'38"	Downstream Halfway Lane County Road bridge	First riffle upstream Halfway Lane County Road bridge
Tongue River Upper (TRU)	Temperature (continuous), water quality	Lat-44°50'58" Long-107°18'14"	Riffle at USGS Station No. 06298000	Riffle at USGS Station No. 06298000
Little Tongue River Lower (LTRL)	Water quality	Lat-44°52'37" Long-107°15'54"	300-400 yards upstream from Tongue River confluence	300-400 yards upstream from Tongue River confluence
Columbus Creek Lower (CCL)	Water quality	Lat-44°53'35" Long-107°14'10"	Downstream Hwy 14 bridge crossing	Downstream Hwy 14 bridge crossing
Smith Creek Lower (SCL)	Water quality	Lat-44°52'41" Long-107°16'03"	Downstream County Road 92 bridge crossing	Downstream County Road 92 bridge crossing
Wolf Creek Lower (WCL)	Water quality	Lat-44°53'54" Long-107°10'18"	Upstream County Road 67 bridge crossing	Downstream County Road 67 bridge crossing
Five Mile Creek Lower (FMCL)	Water quality	Lat-44°54'23" Long-107°10'08"	Upstream Hwy 14 in Ranchester	Upstream Hwy 14 in Ranchester

3.3 Sampling and Analysis Methods

Water quality samples, discharge measurements, and BURP monitoring were collected by the methods described in the Sampling Analysis Plan (SAP), developed each year of monitoring (SCCD, 2010) according to accepted analytical methods (Table 3.2). Instrument calibration, equipment maintenance, and documentation were performed. Water quality and macroinvertebrate samples were obtained from representative sample riffles.

Continuous temperature data were collected by anchoring the data loggers near the bottom of pools to simulate the water temperatures of trout habitat. Discharge measurements at all sites, except Tongue River Upper, and Tongue River 1 were obtained using calibrated staff gauges. Discharge data from USGS Station No. 06298000, Tongue River near Dayton, and USGS Station No. 6299980, Tongue River near Monarch, were used for Tongue River Upper and Tongue River 1, respectively. Staff gauge calibrations were performed by measuring instantaneous discharge with a Marsh-McBirney 2000 current meter. Turbidity and *E. coli* samples were hand delivered to Inter-Mountain Laboratories (IML) in Sheridan, Wyoming for analysis. Macroinvertebrate samples were sorted by Aquatic Assessments, Inc. (AA) in

Sheridan, Wyoming and analyzed by Aquatic Biology Associates, Inc. (ABA) in Corvallis, Oregon. Other parameters were measured on-site with portable Hach and YSI field meters.

Table 3.2 Standard Field and Laboratory Methods

Parameter	Units	Method / Reference[1]	Location of Analyses	Preservative	Holding Time
Temperature	°C	grab/EPA 1983 170.1	On-site	n/a	n/a
Temperature	°C	continuous recorder	On-site	n/a	n/a
pH	SU	grab/EPA 1983 150.1	On-site	n/a	n/a
Conductivity	µmhos/cm	grab/EPA 1983 120.1	On-site	n/a	n/a
Dissolved Oxygen	mg/l	grab/EPA 1983 360.1	On-site	n/a	n/a
Turbidity	NTU	grab/EPA 1983 180.1	IML[2]	Ice; at or below 4ºC	48 hours
Fecal Coliform	col/100 ml	grab/SM 9221E[5]	IML[2]	Ice; at or below 4ºC	6 hours
E. coli	col/100 ml	grab/SM 9222G[5]	IML[2]	Ice; at or below 4ºC	6 hours
Flow	cfs	Calibrated staff gauge	On-site	n/a	n/a
Flow	cfs	Mid-Section Method	On-site	n/a	n/a
Macroinvertebrates	Metrics	King 1993	AA[3] ABA[4]	formalin	n/a
Habitat (Reach level)	n/a	King 1993	On-site	n/a	n/a

[1]Method references for laboratory analyses were provided by the contract laboratories and defined in their SOPs.
[2]IML refers to Inter-Mountain Laboratories in Sheridan, Wyoming
[3]AA refers to Aquatic Assessments, Inc. in Sheridan, Wyoming.
[4]ABA refers to Aquatic Biology Associates, Inc. in Corvallis, Oregon.
[5] SM refers to Eaton et. al., 1995. Standard Methods for the examination of water and wastewater. Washington, D.C.

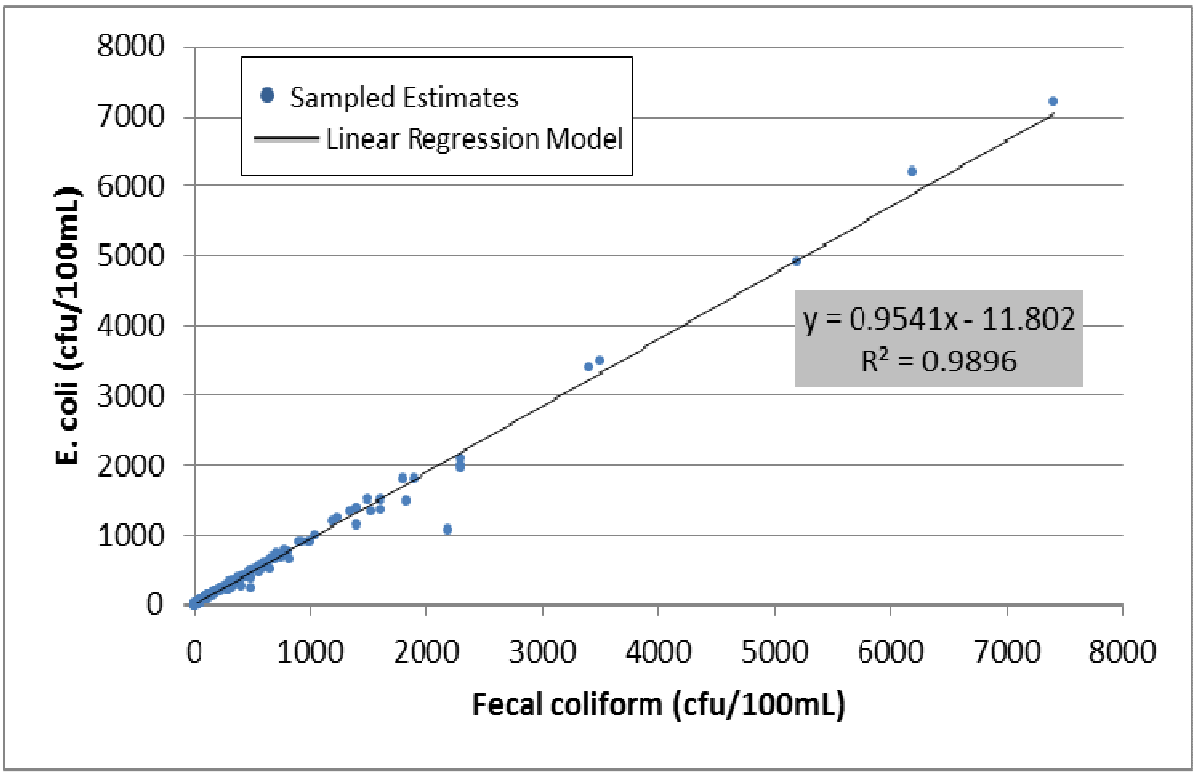
3.4 Correlation between *E.coli* and Fecal Coliform Bacteria

It has been documented that *E.coli* can make up a percentage of fecal coliform when associated with stream waters (Dufour, 1977). In 2003 and 2006 both *E.coli* and fecal coliform bacteria were analyzed in all 10 of the Tongue River Watershed sampling sites. This positive relationship between *E. coli* and fecal coliform bacteria (Elmund et al. 1999) produced a linear regression model from the *E.coli* and fecal coliform paired data samples of 2003 and 2006 (Figure 3.1). Fecal coliform concentrations ranged from 2.0 to 7,400 cfu/100mL, and *E.coli* concentrations ranged from 2.0 to 7,200 cfu/100mL. Two datasets were removed from the regression model due to abnormally high concentrations: SCL and FMCL on May 1st, 2003. The final regression dataset contained 233 paired cases of fecal coliform and *E. coli* concentrations. The results of the linear regression model resulted in the following equation:

$$E.\ coli = 0.9541 \times \text{fecal coliform} - 11.801$$

This linear regression equation allows for the estimation of *E. coli* concentrations during the 1996 through 1999 years when only fecal coliform data were collected. However, because the constant (11.801) is negative, the model predicts negative values of *E.coli* when fecal coliform values are below 13 cfu/100mL. These 116 calculated negative *E.coli* values were not used during the load capacity estimates. The model may underestimate *E. coli* values when fecal coliform concentrations are higher than the regression line (Figure 3.1).

Figure 3.1 *E. coli* and Fecal Coliform Bacteria Concentrations Regression Model



3.5 Water Quality Summary

Complete results and summary statistics for each monitoring station are available in the Tongue River Watershed 2010 Interim Monitoring Report (SCCD, 2012). Overall, water quality data from the Tongue River Watershed Assessment, indicated that water quality in the Tongue River watershed is acceptable. The primary regulatory concern is *E. coli* bacteria concentrations in excess of Wyoming Water Quality Standards for primary contact recreation. Water temperatures were recorded in excess of 20^{o} C in portions of the watershed. Because of the many factors affecting water temperature (weather, water quantity, channel geometry, and turbidity), this TRWP-Revision 2 will not attempt to address this parameter directly. However, activities to address bacteria concerns could also be expected to benefit water temperature.

E. coli samples were taken over seven 30 day periods in 1999, 2003, 2006, and 2010. Geometric means were calculated for each 5 sample-30 day period. All sampled sites had at least one 30 day geometric mean that exceeded the Wyoming Water Quality Standard of 126 colony forming units (cfu) per 100 mL, except the sites at Tongue River Middle and Tongue River Upper (Table 3.3)

Table 3.3 Summary of *E. coli* Geometric Means for May and August 1999, 2003, 2006, and 2010 (Units are colonies per 100mL)

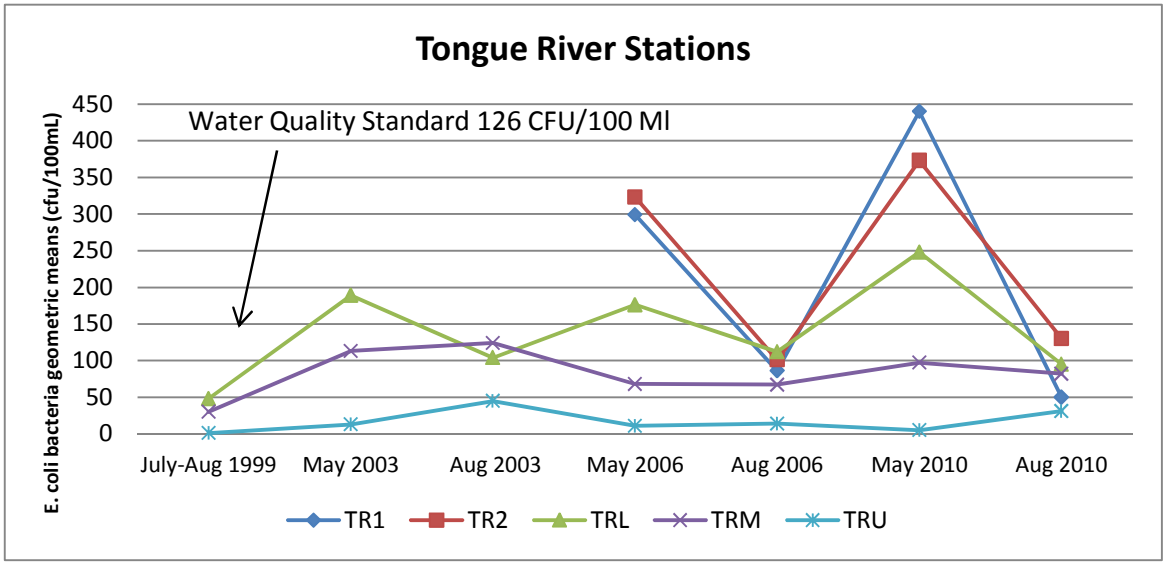
Site	Month	*1999 E. Coli*	*2003 E. Coli*	*2006 E. Coli*	2010 *E. Coli*
	May	N/A*	N/A*	**299**	**440**
TR1	August	N/A*	N/A*	86	50
	May	N/A*	N/A*	**323**	**373**
TR2	August	N/A*	N/A*	101	**130**
	May	N/A	**189**	**176**	**248**
TRL	August	48	104	112	95
	May	N/A	113	68	97
TRM	August	30	124	67	82
	May	N/A	13	11	5
TRU	August	1	45	14	31
	May	N/A	74	72	**136**
LTRL	August	**260**	**1191**	**308**	**273**
	May	N/A	**768**	**163**	**516**
SCL	August	**495**	**598**	**298**	**1337**
	May	N/A	89	**176**	**572**
CCL	August	**373**	**377**	**128**	**291**
	May	N/A	**339**	**145**	**427**
WCL	August	**128**	**253**	**145**	**257**
	May	N/A	**2713**	**640**	**861**
FMCL	August	**519**	**689**	**250**	**378**

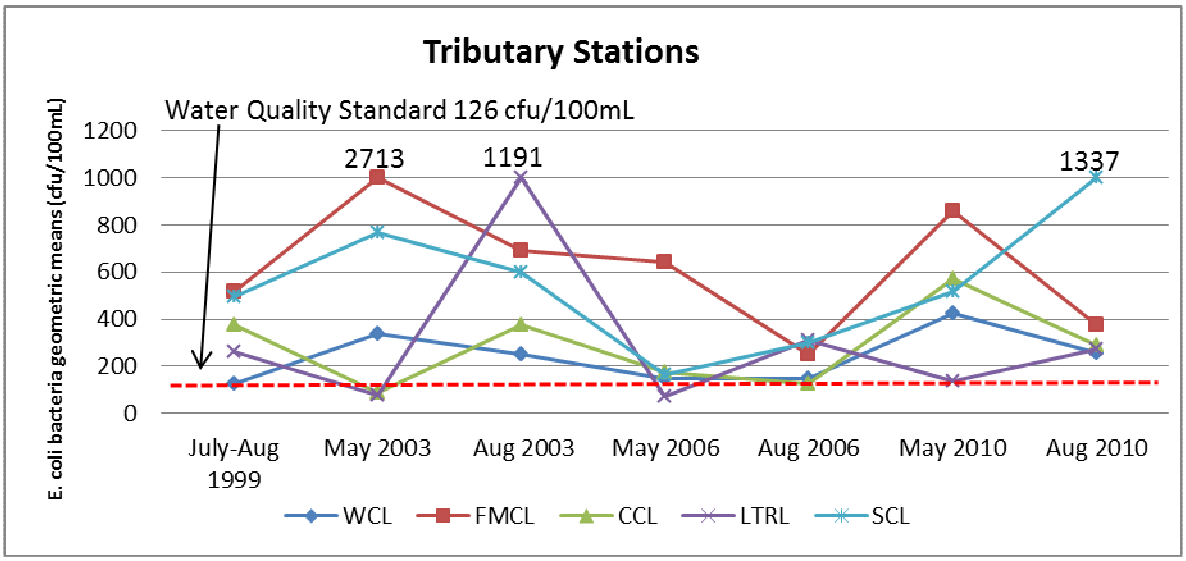
*N/A = station was not established in 1999 and 2003, thus no data are reported

Bacteria concentrations at the mainstem sites were typically lower than tributary sites, with no exceedances of the geometric mean standard on TRU and TRM (Table 3.3). At TRL, geometric means that exceeded the standard were only observed in May of 2003, 2006, and 2010. Sites TR1 and TR2, which were not sampled until 2006, exceeded the standard in May of 2006 and 2010; TR2 also exceeded the standard in August 2010. All lower tributary stations exceeded the standard in May and August of all years, with the exception of LTRL, which did not exceed the standard in May of 2003 and 2006, and CCL, which did not exceed the standard in May 2003.

Generally, the lower Tongue River sites (TR1, TR2, and TRL) had higher geometric means in May of each year, TRU had higher geometric means in August of each year, and TRM had similar geometric means in May and August of the same year. Sites on tributaries were more variable with FMCL having higher geometric means in May of each year and CCL and LTRL having higher geometric means in August. With the exception of May 2003, SCL also had higher geometric means in August of each year. WCL had higher geometric means in May during 2003 and 2010; in 2006, geometric means for WCL were the same in May and August.

Figure 3.2 *E. coli* Bacteria Trends in the Tongue River Watershed





While there was much variability in the *E. coli* geometric means both between sample sites and between 30-day geometric mean sample periods, the highest geometric means on the Tongue River generally occurred in the lower areas of the watershed. The uppermost Tongue River site (TRU) had the greatest number of 30 day geometric means in compliance with the Water Quality Standard of any main stem site. All of the geometric means were well below 126 cfu/100 mL. TRM, though never exceeding the 126 standard, approached the standard in May and August 2003. Geometric means at the sampled tributary sites were also variable. The LTRL site returned the lowest geometric means of any tributary sample site, with 74 and 72 cfu/100mL in May of 2003 and 2006, respectively.

Combined water quality data from all the individual sample sites within each subwatershed also helped to identify areas of concern within the Tongue River Watershed. Table 3.4 combines *E.coli* geometric means of each sample site into their respective subwatershed. The highest

average *E.coli* geometric mean for May was in Five Mile/ Columbus Creek Subwatershed (495.17 cfu/100mL), and the lowest for May was in the Upper Tongue River Subwatershed (195.33 cfu/100mL). The highest average *E.coli* geometric mean for August was in the Upper Tongue River Subwatershed (404.25 cfu/100mL), and the lowest was in the Lower Tongue River Subwatershed. The combination of geometric means for both the months of May and August gave Five Mile/Columbus Creek Subwatershed the highest average total (362.18 cfu/100mL), and gave Lower Tongue River Subwatershed the lowest average total (225.25 cfu/100mL). The total averages in all subwatersheds exceeded the Wyoming Water Quality Standard of 126 cfu/100mL (Table 3.4).

Table 3.4 Average *E.coli* Geometric Means for Each Subwatershed (Units are colonies per 100mL)

Subwatershed	Average *E.coli* Per Subwatershed (May)	Average *E.coli* Per Subwatershed (August)	Average *E.coli* Total (May & August)
Lower Tongue River (TR1, TR2)	358.75	91.75	225.25
Five Mile/ Columbus Creek (TRL, TRM, FMCL, CCL)	**495.17**	229.19	**362.18**
Upper Tongue River (TRU, LTRL, SCL)	195.33	**404.25**	299.79
Wolf Creek (WCL)	303.67	195.75	249.71

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CHAPTER 4 POLLUTANT LOAD ANALYSIS AND SOURCE IDENTIFICATION

This section discusses load duration curves, estimates load reductions needed for each subwatershed, identifies impaired segments and prioritizes specific reaches. Potential pollutant sources, the prioritization of nonpoint pollutant sources, and the best management practices for these nonpoint pollutant sources within the Tongue River Watershed are also addressed. Sources of nonpoint pathogen discharge loading in the Tongue River Watershed include (listed alphabetically):

- Domestic Animals and Livestock;
- Run-off Relating to Irrigation and Stormwater;
- Sediment from Streambanks and Irrigation Diversion;
- Septic Systems; and
- Wildlife (including birds and big game).

4.1 Flow and Load Duration Curves

The load duration curve method was used in this plan both because of the preference for its use in developing EPA Watershed Plans, but also for its ability to quantify water quality parameters at varied flow regimes. A key benefit to the duration curve methodology is the visual representation it provides to the relationship between *E. coli* load capacity and stream flow within each subwatershed, tributary or main stem area. Methodologies for the development of load duration curves used in developing this Watershed Plan are found in "An Approach for Using Load Duration Curves in the Development of TMDLs" (USEPA, 2007), the "Handbook for Developing Watershed Plans to Restore and Protect Our Waters" (USEPA, 2008a), "Goose Creek Watershed TMDLs" (WDEQ, 2010a), Prairie Dog Creek Watershed Plan (SCCD, 2011), and other approved TMDLs and watershed plans.

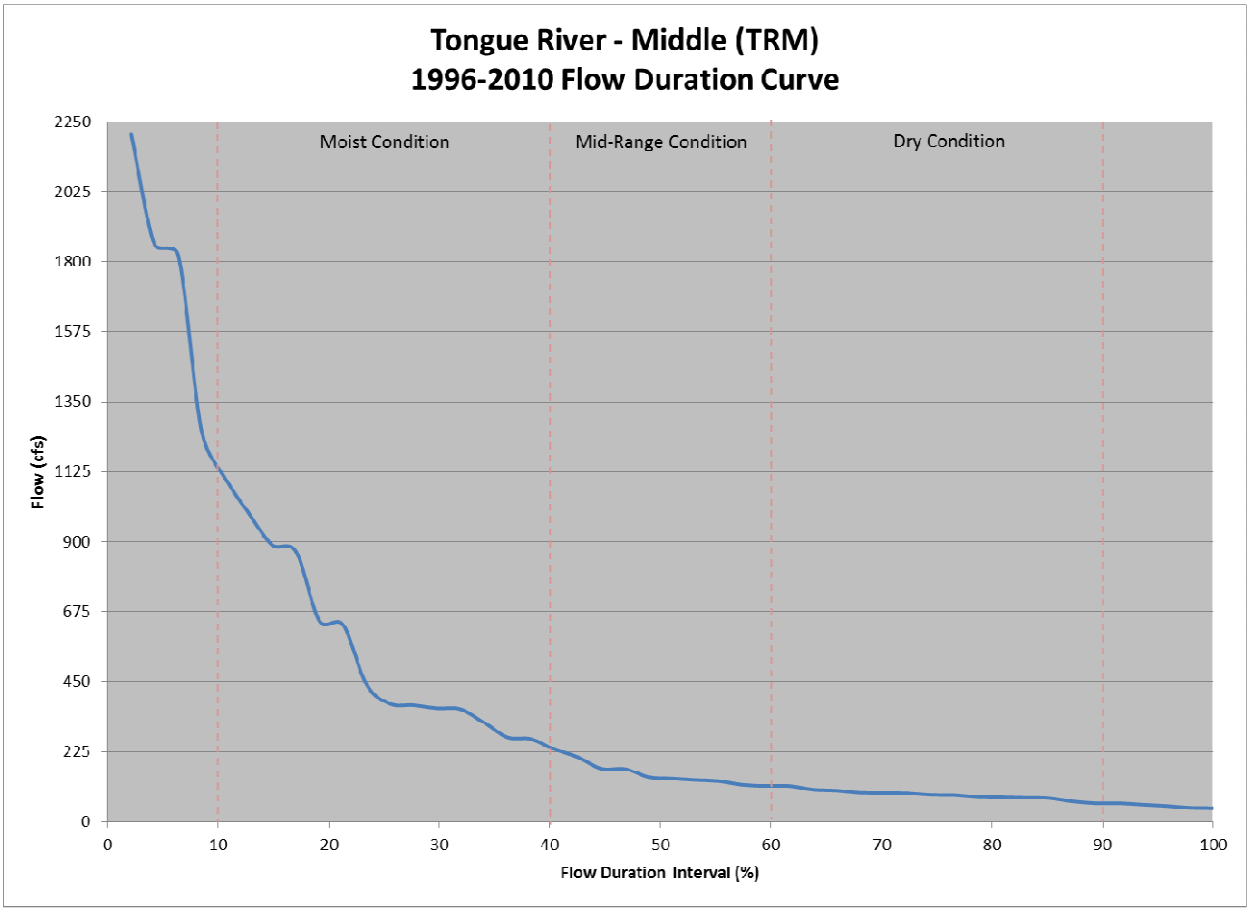
The flow and load estimates along with the reduction estimates in the TRWP-Revision 2 were developed with the SCCD's available information and will be revised in the future as additional data are collected. By plotting actual measured data against the water quality standard at a given flow rate, it is possible to see in what flow conditions most of the high *E. coli* values occur. The TRWP-Revision 2 divides flow conditions into three categories: moist condition flows (10-40% of flows exceeded); mid-range condition flows (40-60% of flows exceeded); and dry condition flows (60-90% of flows exceeded). Low flow (drought) and high flow (flood) conditions (<10% and >90% of flows exceeded) are excluded from load reduction estimates (USEPA, 2007). These are considered the extreme conditions where load reduction efforts would be least effective.

4.1.1 Flow Duration Curves

The load duration curve methodology begins with the development of a flow duration curve for each water quality sample site. Figure 4.1 plots stream flow in cubic feet per second (cfs) on the vertical 'y' axis, against a ranked flow percentage on the horizontal 'x' axis. The ranked flow percentage was derived from the measured stream flows ranked highest to lowest, by dividing an individual rank by the total number of ranked measured flows, to create a percentage of the

time that the stream flow exceeded a given measurement. Thus, a ranked flow percentage of 0 would indicate that 0 percent of the measured flows exceeded this measurement, and a ranked flow percentage of 100 would indicate that 100 percent of the measured flows exceeded this measurement.

Figure 4.1 Flow Duration Curve for Tongue River – Middle (TRM) Sample Site



Unique flow duration curves were developed for each sample site in the Tongue River Watershed and are provided in Appendix B. Flow ranges associated with each hydrologic flow regime for each sampling site are summarized in Table 4.1. In relation to load reductions, SCCD is only focused on the moist, mid-range, and dry conditions (highlighted in gray on Table 4.1).

Table 4.1 Flow Range (cfs) for Hydrologic Regime for the Tongue River Sampling Sites

	Hydrologic Regime	Tongue River Upper (TRU)	Smith Creek (SCL)	Little Tongue River (LTRL)	Tongue River Middle (TRM)	Columbus Creek (CCL)	Five Mile Creek (FMCL)	Tongue River Lower (TRL)	Wolf Creek (WCL)	Tongue River 2 (TR2)	Tongue River 1 (TR1)	Average Main Stem of Tongue River
Flow Range (cfs)	Extremely Moist	>515	>6.3	>28.5	>1105	>16	>17.5	>839.0	>72.0	>305.0	>971	>747
	Moist	145-515	2.7-6.3	4.1-28.5	233-1105	4.7-16	4.5-17.5	225-839.0	20.5-72.0	174-305.0	229-971	201-747
	Mid-Range	118-145	0.6-2.7	1.0-4.1	115-233	2.7-4.7	1.6-4.5	125-225	3.2-20.5	90-174	71-229	104-201
	Dry	55-118	0.1-0.6	0.5-1.0	60-115	1.0-2.7	0.15-1.6	49-125	0.5-3.2	16.5-90.0	23-71	40.7-104
	Extremely Dry	0-55	0.0-0.1	0.0-0.5	0-60	0.0-1.0	0-0.15	0-49	0.0-0.5	0.0-16.5	0.0-23.0	0-40.7

4.1.2 Load Duration Curves

A load duration curve is calculated by multiplying the flows from a flow duration curve by a water quality target concentration, and a conversion factor. The water quality target concentration for a pollutant is used to determine the loading capacity for that pollutant at different flow regimes. A load duration curve was developed for each sample station in the project area. The curves provide a visual representation of the individual data points in relation to water quality standards. The curves were used to determine the critical flow condition for each station, to designate priority reaches, and demonstrate how daily loads vary across flow regimes.

For the purpose of this plan, *E.coli* is SCCD's main pollutant of concern. The *E.coli* target concentration used to calculate the loading capacity is 126 cfu/100mL, which is the primary contact standard for the 5-day geometric mean. This standard was used rather than the single sample maximums identified in Chapter 1, Wyoming Water Quality Standards (WDEQ, 2007). The single sample maximums are to be used in advisory postings but not for the purpose of "listing a water body on the State 303(d) list or development of a TMDL or watershed plan (WDEQ, 2007)." To include a 10% margin of safety (MOS), 113 cfu/100mL was used in the calculations instead of 126 cfu/100mL.

To develop the *E. coli* load capacity curve, the target concentration (113 cfu/100mL) was multiplied by the measured flows (discharge) used to generate the load duration curves. To simplify presented load reduction estimates, SCCD used GIGA cfu. This is a simple conversion where 1 GIGA cfu is equivalent to 1,000,000 (10^9) cfu. The measured and target instantaneous loads were converted to a daily load (USEPA, 2007) using a unit conversion factor (24,465,525) according to the following equation:

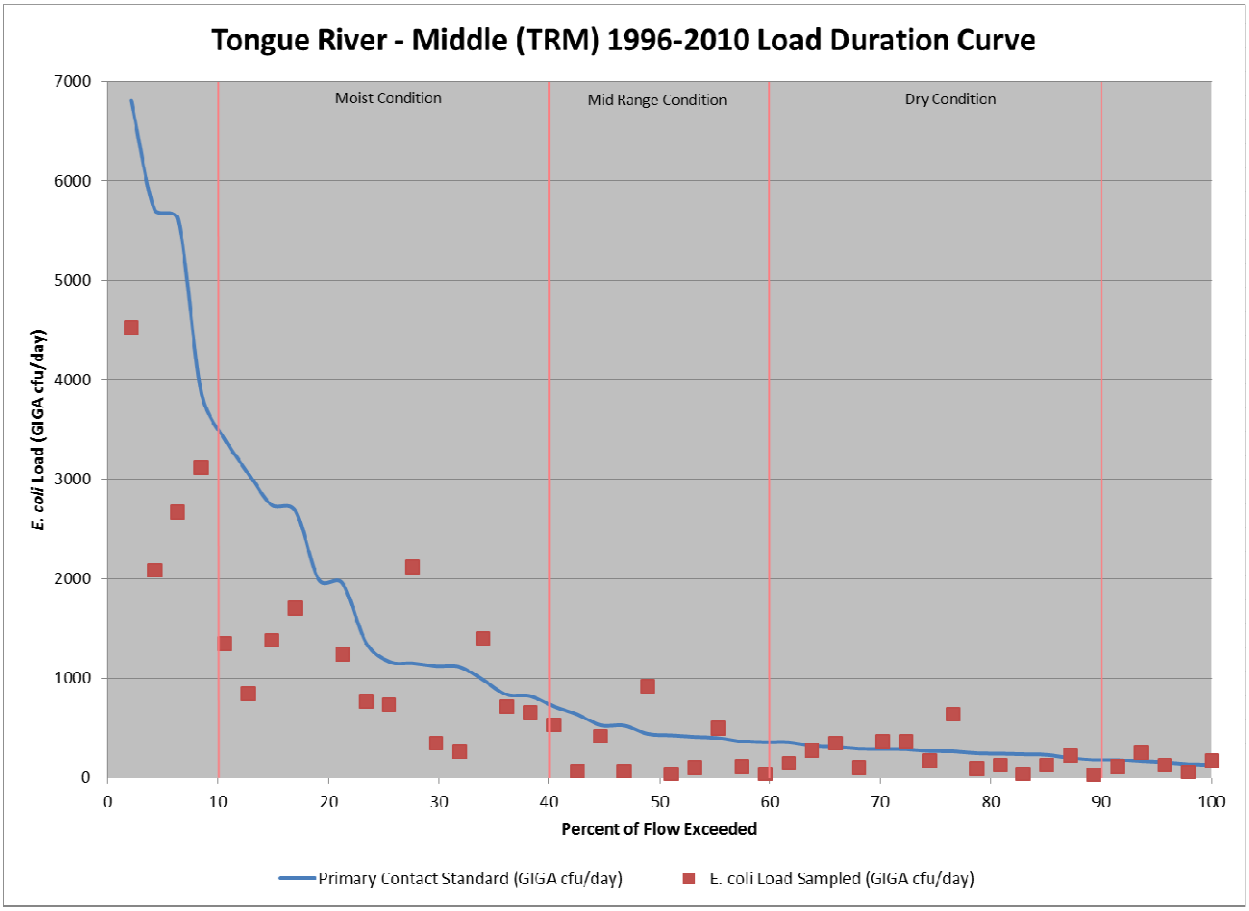
$$\textit{E. coli}\ \text{Load Capacity}\ [\textit{GIGA}\ \text{cfu/day}] = \frac{113\ [\text{cfu/100 ml}] * \text{flow rate}\ [\text{ft}^3/\text{sec}] * 24{,}465{,}525\ [\text{ml*s / ft}^3\ \text{*day}])}{1{,}000{,}000{,}000}$$

Instantaneous loads for each sample were calculated with the same basic equation by using the sampled *E. coli* concentrations instead of the water quality standard as follows:

$$\text{Sampled}\ \textit{E. Coli}\ \text{Load [GIGA cfu/day]} = \frac{\text{sample [cfu/100 ml]} * \text{flow rate}\ [\text{ft}^3/\text{sec}] * 24{,}465{,}525[\text{ml*s / ft}^3\ \text{*day}])}{1{,}000{,}000{,}000}$$

There are seven years of monitoring data for fecal coliform and/or *E. coli* within the Upper Tongue River, Five Mile/Columbus Creek, and Wolf Creek Subwatersheds' sampling sites: 1996, 1997, 1998, 1999, 2003, 2006, and 2010. Lower Tongue River Subwatershed sampled sites (TR1 and TR2) were only monitored for *E. coli* in 2006 and 2010. Fecal coliform values for 1996-1999 were converted to *E.coli* estimates (refer to Section 3.4). These four years of *E.coli* estimates were utilized, along with the 2003, 2006, and 2010 *E. coli* data, for establishing daily loads. The calculated *E.coli* daily load values for each sampling site were plotted on the correlated load duration curve. Figure 4.2 is an example of an *E.coli* load duration curve for Tongue River – Middle (TRM) sample site with its respective instantaneous loads. Unique load duration curves were developed for all of the sampling sites in the Tongue River Watershed and are provided in Appendix B.

Figure 4.2 Load Duration Curve and instantaneous *E.coli* results for Tongue River – Middle (TRM)



Like the flow duration curves, the load duration curves and respective instantaneous *E.coli* loads are divided into hydrologic regimes based on the flow duration interval. The TRWP-Revision 2 divides flow conditions into three categories: moist condition flows (10-40% of flows exceeded); mid-range condition flows (40-60% of flows exceeded); and dry condition flows (60-90% of flows exceeded). Low flow (drought) and high flow (flood) conditions (<10% and >90% of flows exceeded) are excluded from load reduction estimates (USEPA, 2007). These are considered the extreme conditions where load reduction efforts would be least effective. In some cases, conclusions can be made regarding the hydrologic conditions most associated with impairment. In the instance of Tongue River – Middle (Figure 4.2), calculated *E. coli* loads are higher above the load duration curve during the moist flow condition. This indicates a higher load reduction needed during the moist flow condition to bring *E.coli* loads down to the load capacity levels.

4.2 Load Reductions for Sample Sites

In order to identify critical areas within the Tongue River Watershed, E. coli load reductions were calculated for each sample site during each hydrologic regime (Table 4.3). Using the primary contact standard load capacity and the *E. coli* load for each sample at each site, a load reduction can be calculated. These samples were separated into hydrologic regimes and

averages of the load capacity, and *E. coli* loads were calculated. Load reductions were determined by a simple arithmetic calculation that compared the average *E.coli* load and the average load capacity for samples within each hydrologic flow regime. The load reduction for each hydrologic regime at each sample site was calculated using the following equation:

$$\text{Load Reduction (\%)} = \frac{\text{(Average } \textit{E. coli} \text{ Daily Measured Load – Average Daily Load Capacity)}}{\text{Average } \textit{E. coli} \text{ Daily Measured Load}} \times 100$$

A summary of the average *E.coli* load, load capacity, and load reduction for each hydrologic regime at the Tongue River – Middle (TRM) site is provided in Table 4.2. All negative load reductions were converted to zero. In order to use resources wisely, SCCD will focus only on the moist, mid-range, and dry hydrologic regimes (highlighted in gray on Table 4.2). As Table 4.2 shows, the greatest *E. coli* reduction on TRM is needed during moist conditions. Moist conditions tend to capture the effects of storm events or seasonal snow melts.

Table 4.2 Averaged *E.coli* Load, Averaged Load Capacity, and Calculated Load Reduction Summary for Tongue River – Middle (TRM)

		Average *E.coli* Load	Average Load Capacity	Load Reduction	Reduction Corrected (-#s made 0)
Site	**Hydrologic Regime**	**(GIGA cfu/day)**	**(GIGA cfu/day)**	**%**	**%**
Tongue River - Middle (TRM)	Extremely Moist	3099	4933	-59%	0%
	Moist	3225	1563	52%	52%
	Mid-Range	279	433	-55%	0%
	Dry	219	240	-10%	0%
	Extremely Dry	143	141	1%	1%

Current loads for the Tongue River Watershed project area for each hydrologic regime are provided in Table 4.3. Sampled *E. coli* and flow data used to develop load duration curves help identify Critical Hydrologic Flow Conditions for each sample site. The critical hydrologic condition for a sample site is the flow condition requiring the greatest *E. coli* load reduction. There are six sample sites (3 on tributaries and 3 on the main stem) that require the highest *E. coli* reduction during the moist hydrologic conditions, two tributary sites (SCL and LTRL) that require the highest *E. coli* reduction during the dry hydrologic conditions, one tributary site (WCL) that requires the highest *E. coli* reduction during the mid-range condition, and one main stem site (TRU) that does not require any *E. coli* reduction.

The tributary that has the highest percent reduction (95%) is Five-Mile Creek, and the lowest percent reduction (62%) is Wolf Creek. The sample sites located on the main stem of the Tongue River have the highest percent reduction (90%) at Tongue River 1 which is the lowest downstream site sampled by the SCCD. Tongue River – Upper (TRU) sample site has the lowest percent reduction (0%) and is the furthest upstream in the watershed. The next main stem sample site downstream of TRU is Tongue River – Middle (TRM) which has the second lowest E. coli reduction of 58%. All main stem sample sites have their highest percent *E. coli* reduction during the moist hydrologic regime.

Table 4.3 Load Reduction Summary for Tongue River Watershed Sample Sites by Hydrologic Regime

	Hydrologic Regime	Tongue River Upper (TRU)	Smith Creek (SCL)	Little Tongue River (LTRL)	Tongue River Middle (TRM)	Columbus Creek (CCL)	Five Mile Creek (FMCL)	Tongue River Lower (TRL)	Wolf Creek (WCL)	Tongue River 2 (TR2)	Tongue River 1 (TR1)
Average *E.coli* Load (GIGA cfu/day)	Extremely Moist	344	2012	78	3099	831	1513	24665	3628	3035	4387
	Moist	170	25	52	3225	79	439	3535	244	2913	14310
	Mid-Range	35	16	13	279	20	48	428	66	324	654
	Dry	81	5	9	219	8	15	168	5	183	78
	Extremely Dry	13	0	5	143	2	1	98	3	31	36
Average *E. coli* Load Capacity (GIGA cfu/day)	Extremely Moist	2233	77	111	4933	102	76	3864	305	1039	3843
	Moist	809	11	54	1563	21	24	1310	110	611	1458
	Mid-Range	363	4	5	433	10	8	428	26	330	514
	Dry	235	1	2	240	5	2	210	3	134	140
	Extremely Dry	120	0	1	141	2	0	96	1	38	54
Reduction Required (including negative %s)	Extremely Moist	-549%	96%	-42%	-59%	88%	95%	84%	92%	66%	12%
	Moist	-376%	56%	-4%	52%	73%	95%	63%	55%	79%	90%
	Mid-Range	-937%	75%	62%	-55%	50%	83%	0%	61%	-2%	21%
	Dry	-190%	80%	78%	-10%	38%	87%	-25%	40%	27%	-79%
	Extremely Dry	-823%	0%	80%	1%	0%	100%	2%	67%	-23%	-50%
Reduction Required (negative % changed to zero)	Extremely Moist	0%	96%	0%	0%	88%	95%	84%	92%	66%	12%
	Moist	0%	56%	0%	**52%**	**73%**	**95%**	**63%**	55%	**79%**	**90%**
	Mid-Range	0%	75%	62%	0%	50%	83%	0%	**61%**	0%	21%
	Dry	0%	**80%**	**78%**	0%	38%	87%	0%	40%	27%	0%
	Extremely Dry	0%	0%	80%	1%	0%	100%	2%	67%	0%	0%

4.2.1 Load Reductions for Subwatersheds

For planning purposes, the Tongue River Watershed was separated into four subwatersheds: Upper Tongue River, Five Mile/Columbus Creek, Wolf Creek, and Lower Tongue River (refer to Chapter 2 and Map 4). For load reductions, SCCD averaged the load reductions of each sample site within the Wolf Creek subwatershed, and the Lower Tongue River subwatershed. For the Upper Tongue River and Five Mile/Columbus Creek subwatersheds, mainstem and tributary site within their respective subwatersheds were averaged separately (Map 11). Several factors were identified for separating Upper Tongue River subwatershed's and Five Mile/Columbus Creek subwatershed's load reductions on tributaries and main stem sites. First, Tongue River – Upper (TRU) site is located directly below Tongue River Canyon and is used as a reference site for the Tongue River Watershed. Load reduction levels were well below the load capacity which greatly reduced the overall Upper Tongue Subwatershed load reduction average. Second, Five Mile/Columbus Creek Subwatershed contained two main stem sites (TRM, TRL) that also showed *E. coli* loads well below the load capacity. The load reductions for these two main stem sites' (TRM and TRL) within the Lower Tongue River Subwatershed were averaged separately from the two tributary sites (FMCL and CCL). Table 4.4 summarizes the load reductions for each subwatershed (the gray highlighted areas indicates separation of the two subwatersheds).

Table 4.4 Summary of Load Reductions for Tongue River Watershed Project Area

Subwatershed	Average Sampled *E.coli* Load (GIGA cfu/day)	Average Daily *E. coli* Load Capacity (GIGA cfu/day)	Reduction Required (from Averages) (%)
Tongue River - Upper (TRU) Average (n=1)			
Moist Condition	170	809	0%
Mid Range Condition	35	363	0%
Dry Condition	81	235	0%
Little Tongue River (LTRL) & Smith Creek (SCL) Average (n=2)			
Moist Condition	39	33	16%
Mid Range Condition	15	5	69%
Dry Condition	***7***	***2***	***79%***
Fivemile-Columbus Creek Only (FMCL & CCL) Average (n=2)			
Moist Condition	***259***	***23***	***91%***
Mid Range Condition	34	9	74%
Dry Condition	12	4	70%
Tongue River - Middle and Lower Only (TRM & TRL) Average (n=2)			
Moist Condition	***3380***	***1437***	***58%***
Mid Range Condition	354	431	0%
Dry Condition	194	225	0%
Wolf Creek (WCL) Average (n=1)			
Moist Condition	244	110	55%
Mid Range Condition	***66***	***26***	***61%***
Dry Condition	5	3	40%
Lower Tongue River (TR2 & TR1) Average (n=2)			
Moist Condition	***8612***	***1035***	***88%***
Mid Range Condition	489	422	14%
Dry Condition	131	137	0%

When tributary sites and main stem sites are averaged separately within their respective subwatersheds, three zones require *E. coli* reduction during the moist hydrologic condition, one zone requires *E. coli* reduction during the mid-range condition, and one zone requires *E.coli* reduction during the dry conditions. Upper Tongue River zone does not require any *E. coli* reduction. The highest percent load reduction (91%) is found within the Five-Mile/Columbus Creek zone, and the lowest percent load reduction of 58% (excluding Tongue River – Upper) is found on the main stem of the Tongue River between TRM and TRL sample sites. The highest and lowest percent load reductions are both found within the moist hydrologic regime.

The remaining main stem sampling sites (TRM, TRL, TR2, and TR1) required the highest load reductions during the moist hydrologic regime. The reach segment with the greatest increase of *E.coli* is between the TRU and TRM sites. TRU required no load reduction, while 7.1 miles downstream the TRM site required a reduction of 58% or a 7.3% increase per mile. The reach segment on the main stem of the Tongue River that required the least load reduction is between TRL and TR2. This reach, which is approximately 8.665 miles long, had a 16 % increase in required reductions between TRL and TR2. This is equivalent to a 1.8% increase per mile.

4.3 Priority Reaches

Priority reaches for *E. coli* bacteria load reduction were established to represent the areas of the watershed that would benefit the most from mitigation efforts. To determine priority reaches, SCCD and the TRWSC considered a variety of factors, including sample data, necessary load reductions, critical flow conditions, and land use patterns. The TRWSC determined that Smith Creek, Little Tongue River, Columbus Creek, and Five Mile Creek, along with their tributaries, are the highest priority reaches within the Tongue River Watershed (see Map 12). This level of priority was assigned to Tongue River's tributaries due to their location within the upper reaches of watershed, and the necessary load reductions. TRWSC assigned Tongue River from TRU to TRL a medium priority level and Tongue River from TRL to Acme a low priority even though sections of the Tongue River have generated load reduction levels above 75%. Mitigation efforts in these upper tributaries would be expected to result in lower bacteria levels downstream. Wolf Creek subwatershed recorded an average load reduction of 61%, the lowest reduction needed for the major tributaries, which resulted in a medium priority level. Table 4.5 identifies where each sample site ranks in the priority levels.

Table 4.5 Priority Reach Levels by Sample Site (see Map 12)

Sample Site	Average Percent Reduction by Critical Flow Condition			Priority
	Moist	Mid-Range	Dry	
TRU	0%	0%	0%	**L**
TR2	**79%**	0%	27%	**L**
TR1	**90%**	21%	0%	**L**
TRL	**63%**	0%	0%	**M**
TRM	**52%**	0%	0%	**M**
WCL	55%	**61%**	40%	**M**
FMCL	**95%**	83%	87%	**H**
CCL	**73%**	50%	38%	**H**
SCL	56%	75%	**80%**	**H**
LTRL	0%	62%	**78%**	**H**

4.4 Potential Load Sources

The critical flow conditions identified through the load duration curves and reduction estimates correspond to types of run-off and/or precipitation scenarios and provide information about the potential pollutant sources (Table 4.6) for a given site. The identification of critical hydrologic conditions assisted in assessing potential source categories and in determining mitigation efforts that may have the greatest potential in effectively reducing *E. coli* bacteria load in watershed streams.

Table 4.6 Potential Load Sources Under Given Critical Hydrologic Flow Condition

Contributing Source Area	Duration Curve Zone		
	Moist Condition	Mid-Range Condition	Dry Condition
Point Source			M
On-site Wastewater (Septic) Systems		H	H
Riparian Areas	H	H	H
Upland Stormwater Runoff	H	M	
Bank Erosion	M		

Note: H: High Priority; M: Medium Priority
Adapted from "An Approach for Using Load Duration Curves in the Development of TMDLs" (USEPA, 2007).

4.4.1 Point Source Pollution

Point source water pollution refers to contaminants that enter a waterway from a single, identifiable source, such as a pipe or ditch. Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain. The CWA defines point source for regulatory enforcement purposes (CWA, Section 502). Point sources that are

discharged into Wyoming surface waters are regulated under the WDEQ's Wyoming Pollutant Discharge Elimination System (WYPDES) Program. Through this program, operators of a point source discharge are required to receive coverage under a WYPDES discharge permit. The permits contain limitations and conditions that will assure that the state's surface water quality standards are protected (WDEQ website). SCCD's Tongue River Watershed project area includes the following WYPDES discharge permits (listed from upstream to downstream):

- Town of Dayton Wastewater Treatment Plant (Dayton WWTP)
- Padlock Ranch Company Concentrated Animal Feeding Operation (Padlock CAFO)
- Town of Ranchester Wastewater Treatment Plant (Ranchester WWTP)

Permitted point sources will only be addressed as a narrative in this watershed-based plan. The purpose of this plan is to address bacteria contributions from non-point pollution sources.

4.4.1.1 Dayton WWTP

Dayton's WWTP treats the wastewater from the Town of Dayton (Permit Number WY0020435). The system consists of a three cell lagoon system with ultra-violet disinfection, and aeration in the first cell. The discharge point 001 is the outfall from the final lagoon. In addition, there is an underground drain system for the on-site building, and discharge point 002 is the outfall from the under drain system (WDEQ, 2012a). Both of these outfalls drain into the Tongue River (see Map 13). Water-quality-based limits with the WYPDES permit are set to ensure that the quality of the receiving water is protected. Potential contaminants in municipal wastewater include *E. coli*, ammonia, and total residual chlorine.

4.4.1.2 Padlock CAFO

Padlock Ranch Company is the owner and operator of a confined cattle feeding operation. The feedlot is located near the Town of Ranchester and has the capacity to hold approximately 9,000 animals. Columbus Creek flows through the feedlot. The permit does not allow for a discharge of process wastewater to navigable waters except in the case of a chronic or catastrophic storm event that causes an overflow from the runoff and/or wastewater control structures. These facilities are to be designed, constructed and operated to contain all process generated wastewaters plus the runoff from a 25-year/24 hour storm event (3.3 inches). The permit requires other operational standards and maintenance requirements such as isolation of manure disposal sites, and proper disposal of pest control wastes. This disposal discharge, if used, flows into Columbus Creek (see Map 13). Under this permit, this facility implements a site-specific nutrient management plan (WDEQ, 2012a).

4.4.1.3 Ranchester WWTP

Ranchester's WWTP treats the wastewater from the Town of Ranchester (Permit Number WY0022161). It consists of a three cell aerated lagoon system with chlorine disinfection equipment. The chlorine disinfection equipment has never been used. The WYPDES permit allows for five points of discharge into the Tongue River (see Map 13): 1 primary effluent discharge from the third cell of the lagoon system; one alternate effluent discharge to a trench from the third cell of the lagoon system that is used when water levels in the Tongue River are too high to allow a gravity discharge; and three dewatering discharges that occur when any of

the twelve dewatering wells are pumped to protect the lagoon liners. Sampling of the discharge is done for leak detection as well as for WYPDES compliance monitoring. Effluent limitations are stricter than for the primary and alternate discharge points to protect the receiving waters from degradation and to ensure that, in case of significant leakage from the lagoon liners, untreated sewage is not discharged into the receiving water during well dewatering (WDEQ, 2012a). Expected contaminants in municipal wastewater include *E. coli*, ammonia, and total residual chlorine.

4.4.2 Non-point Source Pollution

Non-point source (NPS) pollution refers to diffuse contamination that does not originate from a single discrete source. Typically, it is an accumulation of small amounts that exist throughout the watershed. By definition, NPS pollution problems are difficult to associate with any single source or point of origin. NPS pollution, like bacteria, enters waterbodies through surface water run-off, such as rainfall or snowmelt. As such, it is difficult, if not impossible, to quantify specific pollution sources with any confidence. It is possible, perhaps beneficial, to make qualitative assumptions on the probable sources for a given area based on an understanding of the watershed features and land uses. Potential contributors of NPS pollution within the Tongue River Watershed consist of:

- Domestic Animals and Livestock;
- Run-off Relating to Irrigation and Stormwater;
- Sediment from Streambanks and Irrigation Diversion;
- Septic Systems; and
- Wildlife (including birds and big game).

Results derived from a set of calculations or other quantitative approach need to be viewed and, if necessary, adjusted, to reflect the qualitative assessment of the watershed residents. Evaluating potential sources can provide some information on the relative contributions to ensure that funds and resources are being directed efficiently.

To estimate the relative priority for each pollutant source, SCCD used information from the Wyoming State Engineer's Office, the Wyoming Agriculture Statistics, the Wyoming Game and Fish Department, the USDA Natural Resources Conservation Service, and knowledge of the watershed from landowners, residents, and others. The figures presented are estimates based on the best available data; there have been no studies to determine the actual contributions from these sources to bacteria loads in the Tongue River Watershed.

4.4.2.1 Domestic Animals and Livestock

Animal wastes from domestic animals and livestock can contribute *E. coli* bacteria through direct discharges (water gaps, etc.) or through run-off from corrals or feed grounds. Areas adjacent to stream courses as well as upland areas are potential source areas. Specially, E. coli can enter waterways through

- Extended livestock occupation or corrals on areas adjacent to streams;

- Stock water gaps;
- Winter feed areas or other areas of livestock concentration; and
- Upland livestock occupation in areas with inadequate runoff mitigation.

E. coli contributions from livestock in the Tongue River watershed are difficult, if not impossible, to quantify; accurate information on the number of any type of livestock, specific to the watershed is not available. In addition, many of the cattle spend a portion of the summer recreation season away from the watershed on permitted allotments in the BNF or in other watersheds. Residents within the watershed also have horses, sheep, llamas, goats, hogs/pigs, chickens, and others. The number of animals per resident varies. For the purposes of this plan, SCCD used the 2009 Wyoming Agriculture Statistics and the 2007 US Census of Agriculture to estimate a per acre density for beef cattle (0.06/acre), sheep (0.01/acre), and horses (0.003/acre). There were no documented numbers for the other types of animals. These estimated numbers were used to calculate the potential loads from those sources using documented loading rates for those animals (Table 4.7). Because the loading rates were for fecal coliform instead of *E. coli*, SCCD used 63% of the referenced rate (126 cfu/day E. *coli* is 63% of 200 cfu/day of fecal coliform). *E. coli* is a subset of fecal coliform and site-specific correlation among the two parameters can be made; an *E. coli* value of 126 cfu/day and a fecal coliform value of 200 cfu/day are expected to result in approximately 8 illnesses/1000 swimmers at freshwater beaches (USEPA, 1986).

The number of acres was estimated by reviewing the 2011 County parcels layer (see Map 10). Federal, State, and private lands were considered in the calculation of the large (>100 acres), small (40 – 100 acres), and ranchette (5 – 40 acres) parcels. Parcels with less than 5 acres were considered to be rural residential; it was assumed that these acreages do not contain livestock, though that may not always be true. Although treated the same, it should be recognized that large acreage parcels may have less of an impact than the small acreage or rural ranchettes. Smaller parcels do not provide sufficient space to manage livestock use without diligent oversight and often are characterized by more bare ground than larger parcels. Additionally, compared to larger landowners, a higher percentage of small acreage landowners are less knowledgeable and/or less dependent upon basic natural resource processes. The lifestyle benefits connected with small acreage livestock often outweigh the resource degradation that occurs, especially when not dependent upon the resource to provide household income.

Table 4.7 Potential *E. coli* Contribution from Domestic Animals, excluding Pets and Birds, in the Tongue River Watershed Project Area

			Beef Cattle (0.06/acres)[2]		Sheep (0.01/acres)[2]		Horses (0.03/acres)[2]		**TOTAL** Potential *E. coli* Contribution for Cattle, Sheep, and Horse (GIGA cfu/day)
Subwatershed	Parcels	Acres[1]	Estimated Number	Potential Contribution 69.3 GIGA cfu/day[3]	Estimated Number	Potential Contribution 7 GIGA cfu/day[4]	Estimated Number	Potential Contribution 0.3 GIGA cfu/day[5]	
Upper Tongue River	Large Acreage	20993	1260	87289	210	1470	630	189	88947
	Small Acreage	1754	105	7292	18	123	53	16	7431
	Ranchette Acreage	2167	130	9012	22	152	65	20	9184
TOTAL		24914	1495	103593	249	1744	747	224	105561
Five Mile/ Columbus Creek	Large Acreage	28564	1714	118767	286	1999	857	257	121024
	Small Acreage	1517	91	6309	15	106	46	14	6429
	Ranchette Acreage	2095	126	8710	21	147	63	19	8875
TOTAL		32175	1931	133786	322	2252	965	290	136327
Wolf Creek	Large Acreage	21776	1307	90543	218	1524	653	196	92264
	Small Acreage	575	34	2390	6	40	17	5	2436
	Ranchette	221	13	917	2	15	7	2	935
TOTAL		22571	1354	93851	226	1580	677	203	95634
Lower Tongue River	Large Acreage	48987	2939	203690	490	3429	1470	441	207560
	Small Acreage	5074	304	21096	51	355	152	46	21497
	Ranchette	1195	72	4969	12	84	36	11	5064
TOTAL		55256	3315	229755	553	3868	1658	497	234120
				Total Potential E. coli Contribution for Watershed Project Area:					571643

1 All State, Federal, and private lands were used in the calculations.
2 Animals per acre estimated from information in the 2009 Wyoming Agricultural Statistics (USDA NASS, 2009) for 2007 and 2008 for cattle and calves, sheep, and the 2007 Census of Agriculture (USDA NASS, 2007) for horses and ponies.
3 The potential *E. coli* contribution from beef cattle is based on 63% of 110 fecal coliform GIGA cfu/day per cow (ASAE 1998 in USEPA, 2001).
4 The potential *E. coli* contribution from sheep is based on 63% of 12 fecal coliform GIGA cfu/day per sheep (ASAE 1998 in USEPA, 2001).
5 The potential *E. coli* contribution from horses is based on 63% of 0.42 fecal coliform GIGA cfu/day per horse (ASAE 1998 in USEPA, 2001).

The highest potential *E. coli* contribution from domestic animals and livestock is estimated to come from the largest acreages within the Lower Tongue River subwatershed because it contains the highest acreage within the entire Tongue River Watershed. It is important to point out that even though Wolf Creek subwatershed contains the smallest total acreage (22,571) within the Tongue River Watershed, the potential contribution from large acreage parcels is similar to that of the Upper Tongue River subwatershed.

Because of the variability and unreliability of the numbers, SCCD chose to convert the numbers of individual animals to animal units (Table 4.8). The animal units (AU) from cattle, sheep, and horses are used to represent all of the domestic animals, excluding pets, in the watershed. The animal units presented are based on the combined individual numbers for cattle, horses, and sheep where a cow/calf pair is equivalent to 1.0 AU, a horse is equivalent to 1.25 AU, and a sheep is equivalent to 0.2 AU (NRCS, 1997). This way of reporting and tracking will allow the SCCD and TRWSC to include improvements to address any domestic livestock including llamas, hogs/pigs, goats, etc.

Table 4.8 Conversion from the Number of Cattle, Sheep, and Horses to Animal Units within Each Subwatershed

		Beef Cattle		Sheep		Horses		Total Animal Units
Subwatersheds	Parcels	Estimated Number	Animal Units (@ 1.0)	Estimated Number	Animal Units (@ 0.2)	Estimated Number	Animal Units (@ 1.25)	
Upper Tongue River	Large Acreage	1260	1260	210	42	630	787	2089
	Small Acreage	105	105	18	4	53	66	175
	Ranchette Acreage	130	130	22	4	65	81	216
TOTAL		1495	**1495**	249	**50**	747	**934**	**2479**
Five Mile/ Columbus Creek	Large Acreage	1714	1714	286	57	857	1071	2842
	Small Acreage	91	91	15	3	46	57	151
	Ranchette Acreage	126	126	21	4	63	79	208
TOTAL		1931	**1931**	322	**64**	965	**1207**	**3201**
Wolf Creek	Large Acreage	1307	1307	218	44	653	817	2167
	Small Acreage	34	34	6	1	17	22	57
	Ranchette	13	13	2	0	7	8	22
TOTAL		1354	**1354**	226	**45**	677	**846**	**2246**
Lower Tongue River	Large Acreage	2939	2939	490	98	1470	1837	4874
	Small Acreage	304	304	51	10	152	190	505
	Ranchette	72	72	12	2	36	45	119
TOTAL		3315	**3315**	553	**111**	1658	**2072**	**5498**
				Total Animal Units for Watershed Project Area:				**13424**

Note: It is recognized that the relative number of horses on small acreage and ranchette parcels is greater than the number estimated using the density estimates and relative land area

The total number of animal units within large acreage, small acreage, and ranchette acreage are 11972, 887, and 565, respectively. Lower Tongue River subwatershed has the highest amount of animals units (5,498) because it has more acres in large acre parcels (48,987 acres).

4.4.2.2 Septic Systems

Septic systems have the potential to contribute *E. coli* bacteria and other pollutants to the stream courses in the watershed. Potential contributing septic systems are those that discharge directly into the Tongue River or tributaries, those that are improperly installed due to insufficient size or treatment capacity (leachfield too small, system overloads treatment media), inadequate or antiquated design (systems lacking leachfields, septic system smaller that needed for present demand), poorly or improperly installed (leachfield not on grade, leachfield above tank elevation, system installed in flood prone area), or systems installed that have interface with seasonal groundwater or subterranean flows.

To estimate potential load contributions from septic systems, SCCD determined the number and location of domestic wells and assumed that each domestic well serviced a residence that was also connected to a septic system. Septic systems within a 500 foot distance from the priority stream reaches were considered potential contributors (Table 4.9 and see Map 13). The 500 foot distance was based on the WDEQ requirement for a system to be considered eligible for funding assistance. Systems outside of this distance are considered to be less of a contributor "due to infiltration, UV radiation exposure, and residence time in an inhospitable

environment (WDEQ, 2008a). The potential contribution was calculated by multiplying the number of systems within the 500' buffer with 6.6 GIGA cfu/day [1].

Table 4.9 Estimated Septic System Contribution to *E.coli* in Each Subwatershed

Subwatershed	Area (acres)	Total Systems (#)	System Density (#/acre)	Systems within 500' (%)	Systems within 500' (#)	Potential Contribution (GIGA cfu/day)[1]
Upper Tongue River	25228	102	0.0040	43%	44	290.4
Five Mile/Columbus	32530	144	0.0044	25%	36	237.6
Wolf Creek	22581	34	0.0015	47%	16	105.6
Lower Tongue River	55342	113	0.0020	67%	76	501.6

1The potential contribution from septic systems is based on 2.5 persons per house at 265 liters/day (Horsley and Witten, 1996 in Indiana Department of Environmental Management, 2004), and 1,000,000 col/100 ml (Powelson and Mills, 2001 in Indiana Department of Environmental Management, 2004).

4.4.2.3 Run-off Relating to Irrigation and Stormwater

Irrigation waste water and irrigation induced runoff can be a contributor of sediment to streams. Irrigation systems can transport bacteria and other pollutants through overland run-off in areas where animal waste is present. The Tongue River Watershed project area has approximately 21,300 acres (16%) of irrigated lands (see Map 9). There are approximately 22 irrigation ditches within the project watershed (see Map 15). Many of these have been conveyed to their points of use through natural streams and draws. The additional water from rainwater reservoirs used for irrigation also returns to the stream as irrigation wastewater. Run-off from irrigation systems can be the result of inefficient irrigation systems, poorly managed irrigation systems (excessive application, improper timing, or inadequate experience), lands that are difficult to adequately water with present irrigation systems, or the failure of irrigation conveyances or watering equipment.

Stormwater from seasonal rainfall can also transport bacteria and other pollutants through overland run-off within city limits, in rural subdivisions, or in rural residential areas. There are two municipalities within the SCCD's Tongue River Watershed project area: Ranchester, and Dayton. Storm drains are located throughout these two municipalities, and stormwater transported through these drains flow directly into the Tongue River. Water transported into these storm drains could carry pollutants other than bacteria such as fertilizers for lawns, pesticides for weeds or pests, and oil or other fluids from automobiles. There are also many rural subdivisions, and rural residential areas within the watershed project area (see Table 2.1) that could carry stormwater runoff from their gutters or driveways directly into nearby drainages. It is important for rural and urban residents to understand that practices or activities that they participate in could drain and affect stream conditions downstream.

4.4.2.4 Sediment from Streambanks and Irrigation Diversions

Though not completely understood, there is some indication that sediment can affect bacteria levels in stream channels. Sediment can trap heat, which can improve reproductive conditions for bacteria in the water column. There is some evidence that bacteria can survive longer in the

bottom sediments of the channel. Rangeland studies in Idaho have shown that *E. coli* concentrations can be 2 to 760 times greater in bottom sediment than in the water column (Stephenson and Rychert, 1982). SCCD observed up to 3-fold increases in fecal coliform bacteria when disturbing the bed sediment on the Goose Creek watershed in Sheridan County (SCCD, 2003). Although streams within the Tongue River Watershed are not currently listed for sediment or turbidity, the SCCD and TRWSC consider sediment to be a contributing factor to bacteria concerns in the watershed.

Streambank erosion is the most immediate source of in-stream sediment. This can result from unstable streambanks due to natural changes in channel alignment, removal of riparian vegetation, excessive livestock occupation, and manipulation of stream channels by humans. Resuspension of in-channel sediment can be a result of natural or human induced events. Heavy storm or snowmelt runoff, augmentation of stream flow beyond its natural capacity, disturbance of channel bed material, and natural changes in channel shape or alignment can all result in resuspension of in-channel sediment. The watershed contains roads, construction areas and homesites, and limited amounts of dry cropland, which may become sediment sources during certain high run-off periods.

Seasonal irrigation diversions can also contribute excess sediment to stream systems. Seasonal push-up dams are constructed by using heavy machinery to push-up streambed, gravel material, or rubble in the main stream channel in order to divert the flow of water into the irrigation channel. The construction and subsequent wash-out cycles of push-up dams resuspends sediment into the channel that then deposits downstream. Many irrigation diversions in the Tongue River Watershed project area (see Map 15) require push-up dams to operate, especially during low flows.

4.4.2.5 Wildlife

The Tongue River watershed is home to a variety of large and small mammals and birds, including waterfowl (Table 4.10). As warm-blooded animals, wildlife can also be potential contributors of *E. coli* bacteria. Riparian areas frequently provide important habitat and food for wildlife and thus, much of a watershed's wildlife habitation occurs in close proximity to streams. Estimating contributions from wildlife presents several difficulties. Some wildlife numbers exist through Wyoming Game and Fish Big Game Job Completion Reports and Migratory Bird Job Completion Reports. As the information for livestock, the numbers presented are not confined to the watershed boundary. Information is presented on a statewide or hunt area/herd unit basis. Species identified in these reports include, elk, pronghorn antelope, mule deer, white-tailed deer, moose, sage-grouse, sharp-tailed grouse, ducks, and geese. The most likely big-game animals that may contribute to bacteria loads in the Tongue River Watershed project area include (but are not limited to) elk, pronghorn antelope, mule deer, moose, and white-tailed deer (personal communication from Tim Thomas, Wyoming Game and Fish). There have been no documented active sage-grouse leks in the project watershed by the Northeast Wyoming Sage Grouse Local Working Group. There is, though, 1 active sage-grouse lek in Youngs Creek drainage, and 2 active sage-grouse leks in Badger Creek drainage which are both located several miles downstream of the project watershed. In addition, the project watershed is home to a variety of small mammals and other wildlife for which there are not population estimates.

Table 4.10 Wildlife Species Present in the Tongue River Watershed

Big Game/ Large Mammal	Birds	Small Mammals
Elk	Coot	Badger
Moose	Cormorant	Beaver
Mule Deer	Eagles	Bobcat
Pronghorn Antelope	Geese	Coyote
White-tailed Deer	Grebe	Fox
Bear (mostly in the Upper Subwatershed)	Hawks	Mink
Mountain Lion (mostly in the Upper Subwatershed)	Heron	Muskrat
Wolf (few, non-resident)	Owls	Prairie Dog
	Partridge	Rabbit
	Pheasant	Raccoon
	Puddle Ducks	Skunk
	Sage-grouse	
	Sharp-tailed Grouse	
	Shorebirds	
	Migrant & Resident Songbirds	

4.4.3 Prioritization of Pollutant Sources

Ultimately, the purpose of quantifying and allocating potential pollutant is to ensure that financial and personnel resources are being applied in the most effective manner. While this process is more difficult with a variable, non-point source pollutant such as *E. coli*, there is some value to prioritizing the potential sources using all of the available information and common sense. For example, in watersheds where the most obvious source may be related to septic systems, it does not make sense to direct all of the available resources to developing grazing management plans. On the other hand, if there is an obvious contribution from livestock or a septic system, it should be addressed, regardless of the source allocation.

To estimate the potential contribution for each source in the Tongue River Watershed, SCCD used a variety of quantitative and qualitative information to characterize and prioritize the potential sources in each subwatershed, including:

- The potential load calculations for septic systems and domestic animals (cattle, horse, and sheep);
- The number and size of parcels within each subwatershed;
- Critical flow conditions, priority reaches, and measured bacteria loads; and
- Other information including land cover, soil types, grazing patterns, precipitation.

Within each subwatershed, each source category was assigned a high, medium, or low priority based on its potential contribution to the overall pollutant load (Table 4.11) similar to the method used in TMDLs for Total Dissolved Solids in Utah (UDEQ, 2007). It is important to recognize that all individual projects will be evaluated on their potential benefit to water quality. Thus, a better project in a Medium or Low Priority area or category may be done prior to a marginal or poor project in a High Priority area or category.

Table 4.11 Summary Table of Pollutant Sources and Priority Ranking

Subwatershed	Critical Condition	Priority Load Level	Pollutant Sources	Priority Ranking
Upper	Dry	High	Septic Systems	**High**
			Small Acre Domestic Animals	**High**
			Large Acre Domestic Animals	Medium
			Run-off (Irrigation/Stormwater)	Medium
			Sediment – Streambanks	Medium
			Sediment – Diversions	Medium
Five Mile/ Columbus Creek	Moist	High	Large Acre Domestic Animals	**High**
			Septic Systems	**High**
			Run-off (Irrigation/Stormwater)	**High**
			Small Acre Domestic Animals	Medium
			Sediment – Diversions	Medium
			Sediment - Streambanks	Medium
Wolf Creek	Mid-Range	Medium	Run-off (Irrigation/Stormwater)	Medium
			Large Acre Domestic Animals	Medium
			Sediment - Diversions	Low
			Septic Systems	Low
Lower	Moist	Low	Large Acre Domestic Animals	Medium
			Septic Systems	Medium
			Small Acre Domestic Animals	Medium
			Run-off (Irrigation/Stormwater)	Low
			Sediment - Streambanks	Low

Implementation of the watershed-based plan and Best Management Practices (BMPs) are strictly voluntary. While there is some assistance available for private and municipal entities, there will be instances where improvements will be made by individuals or municipalities on their own. SCCD, NRCS, and the TRWSC will continue to provide information on potential BMPs to address pollutant sources (Table 4.12).

Table 4.12 Potential Best Management Practices (BMPs) to Address Pollutant Sources

Potential Contributor	Issue	Potential BMPs
Septic Systems	No Tank/Leachfield; discharge to stream	Permit and install system
	System located too close to stream	Replace System
	System located within groundwater table	Replace System
	System not functioning	Maintain/replace System
	System not maintained	Provide Information/Education Maintain System
Domestic Animals and Livestock	Corrals/Feed grounds located on stream	Relocate or buffer facilities Provide off-channel water
	Run-off from corrals and/or feed grounds discharges to stream	Divert run-off to filtration area Retain run-off (ponds) Maintain well-vegetated buffer
	Poor Grazing distribution	Develop Grazing Plans Develop Management Guidelines Provide stockwater/fencing Provide Information/Education
Irrigation Diversions	Temporary; requires in-channel construction	Replace with permanent
	Erosion/cutting at diversion	Replace diversion Bank stabilization with vegetation Direct flow with structures
Bank/Channel Erosion	Unstable channel dimensions	Structural enhancements Bank shaping/revegetation
Run-off	Irrigation wastewater run-off	Irrigation System upgrades Irrigation Water Management Plans Provide Information/Education
	Residential/Stormwater run-off	Maintain well-vegetated buffers Divert run-off to filtration areas Provide Information/Education

CHAPTER 5 WATERSHED IMPROVEMENT ACTIONS AND RECOMMENDATIONS

5.1 Non Pollutant Source Measures/Action items

This section describes several factors that have been organized into broad categories that may be directly or indirectly responsible for affecting the overall health of the Tongue River watershed. For each of the concerns identified, the TRWSC developed objectives and action items. The action items include providing incentives for on-the-ground improvements, information and education activities, monitoring/documentation, and other activities. Each action item includes information on the subwatershed priority, responsibility for the completion of the activity, and the amounts and potential sources of funding needed. The subwatershed priority is to be used as a way to direct information/education activities and as a tool for prioritization of project when resources (financial and technical) are limited. It is not intended to be used as a way to discourage improvement projects in other subwatersheds. Any project will be considered based on its potential to benefit water quality.

It is difficult to quantify strong positive correlations between individual improvement projects, practices, or educational activities and water quality improvements in the short term. Bacteria impairments on the watershed are the result of a combination of sources, including humans, domestic animals, and wildlife; it is impossible to address the impairments by focusing on a single source. In order to expect tangible improvements in water quality, it is necessary to address as many potential contributors as possible. The SCCD attempts to accomplish this through an incentive-based, voluntary program that encourages widespread cooperation and participation from landowners. The education that comes from individual projects may do more, in the long term, than the projects and more for water quality improvement than short term monitoring can demonstrate.

5.1.1 Timeline, Targeted Reductions, and Estimated Contributions Needed to Meet Load Reductions

To fully achieve the primary contact recreation standard throughout the watershed, bacteria levels would need to be reduced by over 90%. The TRWSC desires to achieve full attainment of water quality standards within a 20-year timeframe and developed this watershed plan with that goal in mind. The TRWSC set reduction goals depending on the priority level given to each stream in each subwatershed (Table 5.1). For example, the load reduction goal for the Five Mile/Columbus Creek Subwatershed was 25% for every 5 years, while the reduction goal for the Lower Tongue River subwatershed was 10% within 5 years. If direct contribution amounts are reached in each 5-year timeframe, bacteria levels are predicted to be within the primary contact recreation standard by 2033.

The Lower Tongue River Subwatershed contains the lower section of the Tongue River which was assigned a low priority level. Due to this ranking, the targeted reduction in pollutant contributions was only 10% for every 5 years, even though the maximum reduction needed is 90%. Mitigation efforts upper tributaries are expected to result in lower bacteria levels downstream. Bacteria contribution reduction goals are higher in the upstream subwatersheds;

the TRWSC expects the Lower Tongue River Watershed to benefit from reduced bacteria contributions in upstream watersheds. If future monitoring results show otherwise, the TRWSC will continue to adjust load reduction estimates.

Table 5.1 Estimated Contribution Reductions Needed to Meet *E. coli* Load Reductions in a 5 - year Timeframe

	Upper	Five Mile/ Columbus	Wolf	Lower
Critical Condition	Dry	Moist	Mid-Range	Moist
Maximum Reduction Required to Meet DEQ Standards	80%	95%	61%	90%
Phase 1 Targeted Reduction (5-Year Timeframe)	**20%**	**25%**	**15%**	**10%**
Direct Contributions				
Septic Systems to be Addressed	9	9	2	8
Large Acre Animal Units to be Addressed	418	711	325	487
Small Acre Animal Units to be Addressed	35	38	9	51
Rural Ranchette Animal Units to be Addressed	43	52	3	12
Indirect Contributions				
In-Stream Irrigation Diversions	TBD	TBD	TBD	TBD
Bank Erosion and Channel Stability	TBD	TBD	TBD	TBD
Riparian Corridors	TBD	TBD	TBD	TBD
Inefficient Irrigation Systems	TBD	TBD	TBD	TBD

The TRWSC also recognized the limitations in the reduction estimates as presented. To fully understand the dynamics of the watershed, especially for bacteria, many more years of data, encompassing many different flow and climate conditions, are needed. The TRWSC will continue to adjust load and load reduction estimates as additional data are collected; it may be beneficial to develop separate curves for different years to determine whether progress is being made. At some point in the future, it may also be necessary to consider the standards and whether they are appropriate for the watershed. This would require careful coordination with WDEQ, USEPA, and other entities on the watershed.

5.1.2 Watershed Plan Implementation Action Items

The TRWSC and SCCD intend to implement the action items contained within this plan. However, SCCD and the USDA NRCS have been impacted by reductions in staffing and limited personnel resources. Full implementation of this watershed plan will require coordination with and assistance from other resources, such as County government and University of Wyoming Cooperative Extension, and the private sector. Establishing and maintaining partnerships with these outside entities will be needed to provide technical assistance and/or engineering services for projects and conservation planning.

As implementation proceeds, some action items may not be necessary or may not be able to be completed as planned, or there may be others items that have not yet been considered. In addition, as more information becomes available, SCCD may need to adjust load information

and reduction estimates. Therefore, the plan needs to be dynamic and ever-changing to meet the needs of current and future watershed issues.

Objective 1. Maintain a viable watershed improvement effort by providing leadership and project oversight.

Action Item	Subwatershed Priority	Responsible Parties	Funding Needed	Funding Sources
1. Maintain an active steering committee to guide the implementation of the TRWP.	All	TRWSC SCCD	$5,000	319 CWA[1]
2. Review/Revise the TRWP every five years or more often, if needed.	All	TRWSC SCCD	$1,000	319 CWA
3. Continue interim water quality monitoring for bacteria, turbidity, temperature, and other parameters to observe long-term trends.	All	SCCD	$30,000	319 CWA WDA[2]
4. Maintain progress register to document progress in the short-term.	All	TRWSC SCCD NRCS	$3,000	319 CWA
5. Perform before, after, and follow-up monitoring on completed projects.	All	SCCD	$5,000	319 CWA WDA

1 – Section 319 of Clean Water Act, Environmental Protection Agency
2 – Wyoming Department of Agriculture water quality grant funds

5.1.3 Water Quality Action Items

The TRWSC and SCCD recognize levels of bacteria are a concern from a regulatory and human health standpoint and are committed to reducing contributions of bacteria from various sources in the watershed using a voluntary, incentive-based program. Whether or not Wyoming Water Quality Standards are attainable, there is room for improvement. Bacteria contributions in the watershed come from a variety of non-point pollutant sources, and three permitted point source discharges. Point source discharges are regulated through WDEQ's Wyoming Pollutant Discharge Elimination System (WYPDES) Program, and thus will not be considered in any of the following action items. Non-point sources of bacteria, the focus of the water quality action items, include septic systems, small and large livestock operations (though no permitted operations), and wildlife (Objective 2).

Although not a concern from a regulatory standpoint, sediment was identified as a concern on the watershed. Tongue River, as many of the waterbodies in Sheridan County, has been subject to years of physical and hydrologic modification. These modifications are resulting in channel instability and bank erosion that contribute sediment. Other potential sediment sources include seasonal run-off and irrigation returns. Because of the potential relationship between sediment and bacteria levels, the TRWSC will also address sources of sediment, where appropriate (Objective 3).

Objective 2. Reduce bacteria contributions by an average of 18% over the entire Tongue River Watershed by 2017.

Action Item	Subwatershed Priority	Responsible Parties	Funding Needed	Funding Sources
6. Provide financial and/or technical assistance to evaluate and replace/repair **28** septic systems that affect water bacteria concentrations through direct discharge to Tongue River or tributaries or through indirect discharge through poor soils or seasonal groundwater interaction (Note: Systems must meet eligibility requirements as directed by the Wyoming Department of Environmental Quality to qualify for funding assistance).	9 for Upper 9 for 5Mil/Col 2 for Wolf 8 for Lower	SCCD NRCS	$150,000	319 CWA WDA Landowner
7. Provide financial and/or technical assistance to evaluate and relocate livestock facilities, improve run-off management, improve grazing management/grazing plans, and/or provide off-channel stock water to address **2184** animal units.	496 for Upper 801 for 5Mil/Col 337 for Wolf 550 for Lower	SCCD NRCS	$175,000	319 CWA WDA USDA* Landowner
8. Provide technical and financial assistance to improve vegetative density, diversity, and health in riparian corridors to reduce run-off, improve filtering and infiltration capacity, and increase shade.	TBD	SCCD NRCS	$50,000	319 CWA WDA USDA Landowner

* United States Department of Agriculture, Natural Resource Conservation Services

Objective 3. Reduce water quality impacts, other than bacteria, such as nutrient concentrations, organic matter, temperature, and sediment loads.

Action Item	Subwatershed Priority	Responsible Parties	Funding Needed	Funding Sources
9. Identify reaches where bank stabilization efforts may be successful in returning a more natural hydrologic function to the system	2013: 5Mil/Col 2014: Upper 2015: Wolf 2016: Lower 2017: 5Mil/Col	SCCD NRCS	$40,000	205j CWA*
10. Provide technical and financial assistance to: stabilize and protect streambanks and channels; repair/replace irrigation diversions; improve irrigation practices/management; Install other projects as determined.	TBD	SCCD NRCS	TBD	TBA

* Section 205j of the Clean Water Act, Environmental Protection Agency

5.1.4 Awareness and Education Action Items

For a watershed improvement effort to be successful in the long term, there must be watershed-wide support and participation. A watershed program must include not only education on potential watershed impacts, but also awareness of the watershed improvement effort itself, including opportunities for improvement. Successful improvement projects are the most effective way to encourage additional participation; however, without an understanding of the issues and opportunities, people will not be motivated to participate. Many people may not be interested in or qualify for financial assistance programs; education activities can ensure they are aware of the potential impacts and of practical solutions they can do on their own.

As with many areas of Sheridan County and Wyoming, the Tongue River Watershed is seeing continued growth and development and an increase in the amount of small acreage landowners. These smaller acreages are more difficult to manage, especially for those with limited experience in land management and irrigation practices. The small acreage does not have sufficient space for grazing distribution. Small acreage subdivisions can result in a high density of septic systems. There is little room to disperse and filter run-off or excess irrigation water, prior to entering the stream channel. An awareness and education campaign will be critical for reaching these landowners.

The most effective strategy to encourage participation is the neighbor-neighbor discussions that occur after successful completion of a project. For this to occur, however, SCCD and TRWSC need to be able to generate enough interest and awareness about the programs and watershed issues. There is an on-going need for education and understanding on the interaction between land uses and watershed condition, as well as between water quality and overall natural resource health. SCCD will continue to use a combination of efforts to educate, publicize, and encourage participation in the programs. The Tongue River Watershed Plan includes a variety of information and education activities that have been successful on other Sheridan County watersheds, including information on SCCD's website and watershed newsletters that provide information on water quality impacts and improvement opportunities.

Objective 4. Increase awareness and encourage participation in watershed improvement efforts.

Action Item	Subwatershed Priority	Responsible Parties	Funding Needed	Funding Sources
11. Publicize completed projects and recognize "outstanding efforts" by producers in a highly visible way through the SCCD newsletter, SCCD website, articles in the Sheridan Press, and other means.	All	SCCD	$1,000	319 CWA
12. Distribute annual watershed newsletter, in color, to watershed residents to provide general information, highlights of improvement projects, and monitoring results to watershed residents.	All	SCCD	$3,000	319 CWA
13. Provide updates to the Towns of Dayton and Ranchester and Sheridan County Commissioners.	All	SCCD	$1,000	319 CWA
14. Identify creative ways to use events such as the Co-op summer burger day, Dayton Days, the Rodeo or the Sheridan County Fair, to publicize projects, funding sources, and improvement efforts.	All	SCCD	$1,000	319 CWA
15. Provide presentations/lecture series about SCCD's water quality reports, improvement projects, and cost-share programs.	All	SCCD	$1,000	319 CWA
16. Provide 5 "Pay It Downstream" Postcards to each participate/client after they have completed an improvement project for distribution to 5 neighbors and/or friends that may benefit from programs.	All	SCCD	$5,000	319 CWA
17. Attend meetings of other groups, such as ditch companies, Stock growers, etc.	All	SCCD	$1,000	319 CWA

Objective 5. Increase awareness and understanding about water quality impacts and relationships among water quality parameters.

Action Item	Subwatershed Priority	Responsible Parties	Funding Needed	Funding Sources
18. Provide information and education on the proper management of domestic animal waste (including livestock, pets, and other domestic animals)	Five Mile/Col Lower	SCCD	$1,000	319 CWA
19. Provide information on the potential impacts of winter feeding grounds	Five Mile/Col Lower	SCCD	$1,000	319 CWA
20. Provide information on grazing management to large and small acreage landowners as well as rural residential landowners	Five Mile/Col Lower	SCCD	$1,000	319 CWA
21. Provide information on the potential impacts of septic systems, proper function and maintenance	Upper	SCCD	$1,000	319 CWA
22. Provide information on efficient water use practices and irrigation water management	All	SCCD	$1,000	319 CWA
23. Provide information on riparian management and the benefit of stable channels, importance of maintaining natural channels, and the negative effects and regulatory impacts of improper manipulation	All	SCCD	$1,000	319 CWA
24. Provide information on proper pesticide/fertilizer use and other Hazardous Household Wastes	All	SCCD	$1,000	319 CWA
25. Provide information about urban run-off and the impacts of dumping in storm drains	Upper Lower	SCCD	$1,000	319 CWA
26. Provide information about feeding and concentrating wildlife near waterways	All	SCCD	$1,000	319 CWA

5.2 Technical and Financial Assistance

The estimated amount needed to implement this plan is $481,000 over the next five years. This is based on cost estimates of previous projects completed. The SCCD currently has a grant through section 319 of the Clean Water Act for $449,310 to be used on the Tongue River, Prairie Dog Creek, and Goose Creek watersheds. Additional funding will have to be secured, either through additional 319 grants, landowner match or other sources to fully implement this plan. Additional funding sources may include:

- Grants from the US EPA/WDEQ through section 319 of the Clean Water Act;
- Grants from the Wyoming Department of Agriculture;
- USDA Program Funds, including Environmental Quality Incentives Program (EQIP), Wetland Reserve Program (WRP), Agriculture Management Assistance (AMA), and Wildlife Habitat Incentives Program (WHIP);
- Grants from the Wyoming Game and Fish Department, Fish Passage Program;
- Grants from the Wyoming Wildlife and Natural Resource Trust; and
- Local assistance and appropriations from Sheridan County, City of Sheridan, Sheridan County Weed and Pest, and others.

No single funding source is perfectly suited for each project or activity. A combination of funds makes projects more feasible for landowners and encourages additional participation. Federal and State grants can fund components that are not eligible for funding through USDA program funds and vice versa. Grants administered through SCCD can be more flexible, especially in terms of projects that do not fit within sign-up dates/timelines of USDA programs. State and local grants and appropriations, as well as contributions from landowners, provide the non-federal match necessary for the federal grant funds provided through US EPA and WDEQ.

The amount of funding available for improvement projects or watershed programs is typically not the limiting factor in Sheridan County. SCCD-NRCS has been able to secure funding for most, if not all, eligible projects. The biggest shortfall in local watershed improvement efforts is the lack of technical assistance to initiate and complete projects in a timely manner. Regulatory programs and permitting processes are necessary; however, they do not provide the technical expertise and support to complete a project. The SCCD and NRCS have tried to fill this void, but do not always have the resources to do so. There is a need for on-the-ground planning and other assistance to landowners and homeowners.

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CHAPTER 6 SCHEDULE FOR COMPLETION

To fully achieve the primary contact recreation standard, bacteria levels would need to be reduced by over 90%. The TRWSC felt that to it was important to see the full attainment achieved within a 20-year timeframe. The TRWSC developed this watershed plan to reduce bacteria loads depending on the priority level given to each stream in each subwatershed (see Table 5.1). For example, Five Mile/Columbus Creek Subwatershed that contains Five Mile Creek and Columbus Creek, both high priority streams that had the highest tributary load reductions needed, were given an aggressive targeted reduction of 25% in 5 years. If direct contribution amounts are reached in each 5-year timeframe, bacteria levels are predicted to drop to the primary contact recreation standard by 2033. The TRWSC developed a timeline for completion of the action items needed to meet this goal (Table 6.1).

6.1 Interim Milestone

Because water quality changes may not be a useful indicator of progress in the short term, the TRWSC developed interim milestones or tasks to be completed and assessed for each action item (Table 6.1). The process for evaluating progress is described in Chapter 7.

Table 6.1 Milestone Table

Objective 1: Maintain a viable watershed improvement effort by providing leadership and project oversight.					
Action Item/Interim Item	**2013**	**2014**	**2015**	**2016**	**2017**
1. Maintain an active steering committee					
invite new members (including town officials)	Jan	Jan	Jan	Jan	Jan
elect chairperson	Feb	Feb	Feb	Feb	Feb
determine other topics of interest	Jan	Jan	Jan	Jan	Jan
meet annually and include topics of interest	Feb	Feb	Feb	Feb	Feb
2. Review/Revise Plan					
review plan and track interim milestones	Feb	Feb	Feb	Feb	Feb
update/renew plan					Dec
3. Continue interim water quality monitoring					
develop monitoring plan					
conduct field sampling and data management	May/Aug			May/Aug	
write monitoring report and relate results to improvement projects, where possible		Jan - April			Jan-April
publish summary of results in newsletter/website		June			June
4. Maintain Progress Register					
update GIS layer, and spreadsheet annually	Dec	Dec	Dec	Dec	Dec
identify areas that need additional attention	Feb	Feb	Feb	Feb	Feb
5. Perform follow-up project monitoring					
send survey/letters to past participants	WA	WA	WA	WA	WA
photo document before, after, and follow-up conditions	WA	WA	WA	WA	WA
assist with sample collection, if requested/needed	WA	WA	WA	WA	WA

Objective 2: Reduce bacteria contributions by an average of 18% by 2017					
Action Item/Interim Item	**2013**	**2014**	**2015**	**2016**	**2017**
6. Replace/repair septic systems					
evaluate/restructure program	Jan	Jan	Jan	Jan	Jan
evaluate and repair/replace septic systems (systems)	6	6	6	6	4
7. Relocate/improve livestock facilities					
evaluate/restructure program	Jan	Jan	Jan	Jan	Jan
provide assistance to address animal units (AUs)	437	437	437	437	436
8. Improve riparian corridors					
provide education through the tree program	Nov-Mar	Nov-Mar	Nov-Mar	Nov-Mar	Nov-Mar
determine subwatershed for projects	TBD	TBD	TBD	TBD	TBD
improve riparian corridors (miles)	1	1	1	1	1

Objective 3: Reduce water quality impacts, other than bacteria, such as nutrient concentrations, organic matter, temperature, and sediment loads.					
Action Item/Interim Item	**2013**	**2014**	**2015**	**2016**	**2017**
9. Survey reaches for bank stabilization projects					
Subwatershed to identify per year	FM/C	Upper	Wolf	Lower	FM/C
10. Assistance with other improvement projects					
subwatershed to identify per year	TBD	TBD	TBD	TBD	TBD
number of bank/channel stabilization projects per year	TBD	TBD	TBD	TBD	TBD
number of irrigation diversion projects per year	TBD	TBD	TBD	TBD	TBD
miles of stream improved	1	1	1	1	1

Objective 4: Increase awareness and encourage participation in the watershed improvement efforts.					
Action Item/Interim Item	**2013**	**2014**	**2015**	**2016**	**2017**
11. Publicize projects in newsletter, website, article					
Annually publish	Aug-Oct	Aug-Oct	Aug-Oct	Aug-Oct	Aug-Oct
Number of improvement projects recognized in publication	1	1	1	1	1
12. Distribute newsletter to watershed residents					
Annually distribute	Sept	Sept	Sept	Sept	Sept
13. Provide updates to Town and County Officials					
Annually attend Council meetings	March	March	March	March	March
14. Identify events/places to educate public					
Ask advice from TRWSC annually	Feb	Feb	Feb	Feb	Feb
Review past presentations/educational programs	Feb	Feb	Feb	Feb	Feb
15. Provide presentations/lecture series					
Number of presentations	1	1	1	1	1
16. Provide "Pay It Downstream" Postcards to clients					
Send postcards to clients after project is completed	TBD	TBD	TBD	TBD	TBD
17. Attend meetings of other groups					
Meetings per year	TBD	TBD	TBD	TBD	TBD

Objective 5: Increase awareness and understanding about water quality impacts and relationships among water quality parameters.					
Action Item/Interim Item	**2013**	**2014**	**2015**	**2016**	**2017**
18. Provide information on proper management of domestic animals					
domestic animals/pet topics in newsletter/column				July-Sept	
horse/livestock management topic in newsletter	July-Sept				
manure management topic in newsletter		July-Sept			
develop and publish brochure on horse management	Sept-Nov				
19. Provide information on impacts from winter feeding grounds					
explore partnership with Cooperative Extension	Jan				
winter feeding grounds topic in newsletter			July-Sept		
20. Provide information on grazing management to large and small acreage landowners					
survey interest in "Barnyards and Backyards"	Feb				
host small acreage management workshops		April			
consider separate mailing to small acreage owners			Feb		
overall impacts topic in newsletter/column		July-Sept			July-Sept
21. Provide info on impacts from septic systems					
distribute homeowner info packets	TBD	TBD	TBD	TBD	TBD
septic system impacts/maintenance topic in newsletter	July-Sept			July-Sept	
22. Provide info on irrigation practices/ management					
irrigation management topic in newsletter			July-Sept		
23. Provide information on riparian management					
make & distribute brochure with tree program packet	Jan-Mar	Jan-Mar	Jan-Mar	Jan-Mar	Jan-Mar
riparian buffers topic in newsletter				July-Sept	
host streamside stewardship workshop	April				
24. Provide information on proper pesticide/fertilizer use/disposal					
provide info on HHW impacts and disposal on website	June				
pesticide/fertilizer use/disposal on website	June				
25. Provide info on urban run-off and storm drains					
host streamside stewardship workshop	April				
Classroom education in Dayton or Ranchester	May	May	May	May	May
Have booth at specific events		TBD		TBD	
26. Provide info on feeding wildlife near waterways					
wildlife feeding/concentration topic in newsletter					July-Sept

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CHAPTER 7 MONITORING AND EVALUATION PLAN

7.1 Criteria for Evaluation

While water quality changes may not be observed in the short term, the TRWSC will review progress towards plan completion and meeting water quality standards in a variety of ways.

The TRWSC will meet annually and review the action items and interim milestones in the watershed plan. If planned tasks or interim milestones have not been completed, the TRWSC will discuss the reasons and take one of the following actions:

a) Extend the action item or milestone into the next year or adjust the timing;
b) Abandon the action item or milestone completely if not possible or practical; or
c) Modify the action item or milestone so it can be completed.

The TRWSC will track the types and number of improvement projects being requested, initiated, and/or completed, annually during the review of the watershed plan. If the desired numbers/types of projects are not being requested and completed, the TRWSC will discuss the reasons and take one of the following actions:

a) If the types of projects are not being requested, the group may consider additional information and education;
b) If the types of projects are not being requested, but the group feels that enough information and education has been completed, the group may consider adjusting the numbers to something more reasonable; or
c) If the types of projects are being requested but not initiated or completed in a timely manner, the group will consider whether it is from a lack of technical or financial assistance and look for sources to fill the gaps.

The TRWSC will collect additional water quality samples during and following the implementation of this plan. In five years, the TRWSC expects to see a minimum reduction of 10%-25%, depending on the subwatershed. If this reduction is not observed, the TRWSC will consider the following actions during future plan revisions:

a) Increase the number of improvement projects in areas not meeting the goals, which may require additional information and education; or
b) Adjust the percent reduction expected and/or load estimates.

If minor modifications are needed, the TRWSC will make the changes and notify watershed residents, landowners, and WDEQ. Minor modifications include adjusting the number of projects, information and education activities, and changes to the schedule within the 5-year timeline. If changes are more extensive, such as changes to the loads and reduction estimates, potential sources, and the overall timeline, the revised plan will be subject to the 45-day public comment period and submitted to WDEQ for approval.

7.2 Monitoring Plan

The TRWSC recognized that it may be several years before any changes in water quality can be observed, especially with the limited data presently available and the limitations in the reduction estimates as presented. To fully understand the dynamics of the watershed,

especially for bacteria, many more years of data, encompassing many different flow and climate conditions, are needed. The TRWSC will continue to adjust load and load reduction estimates as additional data are collected. Continued monitoring will also enable the TRWSC to evaluate long term trends in water quality. Currently SCCD conducts water quality monitoring on a three year rotation, with Tongue River Watershed monitoring scheduled for 2013 and 2016. This interim monitoring focuses on bacteria, turbidity, macroinvertebrates, and field parameters (discharge, pH, conductivity, DO and temperature). Prior to each monitoring season, SCCD develops a detailed Sampling Analysis Plan (SAP). After all of the data is collected and analyzed, a monitoring report will be completed within the year following sampling, thus two monitoring reports will be completed by TRWSC's 5-year timeframe.

CHAPTER 8 PUBLIC PARTICIPATION

In February 2008, representatives from WDEQ met with the TRWSC to discuss changes needed in future watershed plans. The 2007 Tongue River Watershed Plan contained most of the "nine essential elements" that WDEQ and EPA believed were necessary to meet the requirements of the Clean Water Act, but needed to take a more focused, quantitative approach. The TRWSC decided to move forward with an update of the 2007 plan to meet the Clean Water Act requirements. However, the actual update of the plan was delayed until the completion and approval by WDEQ of the Prairie Dog Creek Watershed Plan in 2011. The plan attempts to satisfy all of the required elements while meeting the needs of the watershed landowners/residents. Without the support and participation of the landowners, it would be impossible to implement any action items, regardless of the attempts to quantify sources.

When the 2011 update was initiated, landowners and public were invited to participate in the TRWSC through the Tongue River Watershed annual newsletter, which is distributed to all residents through a postal patron mailing. Members of the TRWSC participated in a series of meetings to review material of the plan as it was developed. They were encouraged to participate and provide feedback throughout the entire process. These meetings were held at Ranchester's Town Hall Chambers; all meetings were open to the public, with notification provided to those individuals who expressed interest and/or requested notice. Only a limited number of community members attended, but a core group remained dedicated to the process. The dates and discussion topics for each steering committee meeting are summarized as follows:

- The first meeting was held on November 1st, 2011 and focused on the overview of a watershed-based plan process by referring to the recently finalized Prairie Dog Creek Watershed Plan, discussion on the slight increase in bacteria from 2006 to 2010, and an acceptance of the next phase of the process.
- The second meeting was held on February 2nd, 2012 and summarized load duration curves for each watershed site, load reductions needed for each subwatershed, impaired streams within the project watershed, and a rough outline of the watershed characterization.
- The third meeting was held on March 8th, 2012 and reviewed the revised watershed characterization, commented and finalized the priority reaches by reviewing the load reductions, and decided on the timeline, targeted reductions, and estimated contributions needed to meet load reductions. Action items were also discussed in brief detail.
- The fourth meeting was held on August 30th, 2012 and discussion was had on the proposed draft and initial comments by WDEQ. The TRWSC decided to start the 45-day public comment period as soon as possible.

The Tongue River Watershed Management Plan public draft was completed on August 31, 2012 and made available for public review on September 5, 2012. To meet current WDEQ and Administrative Procedures Act (W.S. 16-3-101) requirements, the TRWP had a 45-day public comment period from September 5th to October 19th, 2012. It was advertised in The Sheridan

Press, other local media, and was posted on the SCCD websites. WDEQ provided comments in August of 2012. WDEQ and public comments were incorporated into the document when appropriate and the TRWSC finalized the plan document on October 30, 2012. Once approved by WDEQ, the plan was filed with the Sheridan County Clerk.

CHAPTER 9 REFERENCES CITED

Clean Water Act (CWA) 502(14). Water Pollution, Prevention, and Control: General Definitions. 33 U.S.C. § 1362.

Dufour, A.P. 1977. *Escherichia Coli*: The Fecal Coliform, Bacterial Indicators/Health Hazards Associated with Water, American Society for Testing and Materials, Ed. A.W. Hoadley and B.J. Dutka, ASTM Special Technical Publication 635, pp. 48-58.

Elmund, G. Keith; Allen, Martin J.; Rice, Eugene W. 1999. Comparison of *Escherichia coli,* Total Coliform, and Fecal Coliform Populations as Indicators of Wastewater Treatment Efficiency. Water Environment Research. Volume 71, Number 3. May/June 1999. Pp. 332-339(8).

King, K.W. 1993. A bioassessment method for use in Wyoming stream and river water quality monitoring. Wyoming Department of Environmental Quality Water Quality Division. Cheyenne, WY. 85pp.

Sheridan County Conservation District. 2000. Tongue River Watershed Assessment 1996-1999: Final Report. Sheridan, WY.

Sheridan County Conservation District. 2000a. Tongue River Watershed Plan. Sheridan, WY.

Sheridan County Conservation District. 2003. Goose Creek Watershed Assessment 2001-2002 Final Report. Sheridan, WY.

Sheridan County Conservation District. 2010. Water Quality Monitoring Program Quality Assurance Project Plan Revision Number 3. Sheridan, WY.

Sheridan County Conservation District. 2011. Prairie Dog Creek Watershed Plan. Sheridan, WY.

Sheridan County Conservation District. 2012. DRAFT Tongue River Watershed 2010 Interim Monitoring Report. Sheridan, WY.

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

Strahler, Arthur N. 1957. *Quantitative analysis of watershed geomorphology: Transactions of the American Geophysical Union 8* (6): 913–920.

Stribling, J.B., B.K. Jessup and J. Gerritsen. 2000. Development of biological and physical habitat criteria for Wyoming streams and their use in the TMDL process. Report to U.S. EPA Region 8, Denver, CO prepared by Tetra Tech, Inc., Owings Mills, MD.

U.S. Department of Agriculture. National Agricultural Statistics Service. 2007. Census of Agriculture, Wyoming State and County Data. AC-07-A-50. Washington, D.C.

U.S. Department of Agriculture, National Agricultural Statistics Service. 2009. Wyoming Agricultural Statistics. Cheyenne, WY.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1986. Major Land Resource Areas Map and Descriptions for Wyoming from Sheridan Field Office Technical Guide; Section 1. Sheridan, WY.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1986a. Soil Survey for Sheridan County Area, WY.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1995. Map of precipitation zones for Ecological Site descriptions from Sheridan Field Office Technical Guide; Section 2. Sheridan, WY.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1997. National Range and Pasture Handbook, Chapter 6.

U.S. Environmental Protection Agency. 1986. Ambient Water Quality Criteria for Bacteria-1986. EPA 440/5-84-002, Office of Water Regulations and Standards Criteria and Standards Division. Washington, D.C.

U.S. Environmental Protection Agency. 2001. Protocol for Developing Pathogen TMDLs. First Edition. EPA 841-R-00-002. Office of Water (4503F). Washington, D.C.

U.S Environmental Protection Agency. 2003. 2004 §319 National Nonpoint Source Program and Grants Guidelines for States and Territories. Federal Register, Vol. 68, No. 205.

U.S. Environmental Protection Agency. 2007. An Approach for Using Load Duration Curves in the Development of TMDLs. EPA 841-B-07-006. Washington, D.C.

U.S. Environmental Protection Agency. 2008. DRAFT Handbook for Developing Watershed TMDLs. Office of Wetlands, Oceans, and Watersheds. Washington, D.C.

U.S. Environmental Protection Agency. 2008a. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. EPA 841-B-08-002. Office of Water. Washington, D.C.

Utah Department of Environmental Quality by Tetra Tech, Inc. 2007. TMDLs for Total Dissolved Solids in the Duchesne River Watershed. Fairfax, VA.

Wyoming Association of Conservation Districts, 2000. Watershed Strategic Plan. Cheyenne, WY.

Wyoming Department of Environmental Quality, 1996. Wyoming's 1996 305(b) report and 1996 303(d) List of Waters Requiring TMDLs. Cheyenne, WY.

Wyoming Department of Environmental Quality, 1998. Wyoming's 1998 305(b) report and 1998 303(d) List of Waters Requiring TMDLs. Cheyenne, WY.

Wyoming Department of Environmental Quality. 2000. Wyoming Nonpoint Source Management Plan Update. Water Quality Division. Cheyenne, WY.

Wyoming Department of Environmental Quality, 2000a. Wyoming's 2000 305(b) report and 2000 303(d) List of Waters Requiring TMDLs. Cheyenne, WY.

Wyoming Department of Environmental Quality. 2001. Surface Water Classification List. Cheyenne, WY.

Wyoming Department of Environmental Quality, 2002. Wyoming's 2002 305(b) report and 2002 303(d) List of Waters Requiring TMDLs. Cheyenne, WY.

Wyoming Department of Environmental Quality, 2004. Wyoming's 2004 305(b) report and 2004 303(d) List of Waters Requiring TMDLs. Cheyenne, WY.

Wyoming Department of Environmental Quality. 2005. Water Quality Rules and Regulations Chapter VIII, Quality standards for Wyoming Groundwaters. Cheyenne, WY.

Wyoming Department of Environmental Quality, 2006. Wyoming's 2006 305(b) report and 2006 303(d) List of Waters Requiring TMDLs. Cheyenne, WY.

Wyoming Department of Environmental Quality, 2007. Water Quality Rules and Regulations Chapter 1, Wyoming Surface Water Quality Standards. Cheyenne, WY.

Wyoming Department of Environmental Quality. 2008. Total Maximum Daily Load Work Plan Update. Cheyenne, WY.

Wyoming Department of Environmental Quality. 2008a. Memorandum on the Clarification on the General Septic Eligibility Criterion. Lander, WY.

Wyoming Department of Environmental Quality. 2010. Wyoming's Water Quality Assessment and Impaired Waters List (2010 Integrated 305(b) and 303(d) Report.). Cheyenne, WY.

Wyoming Department of Environmental Quality by SWCA Environmental Consultants. 2010a. Goose Creek Watershed TMDLs. Sheridan, WY.

Wyoming Department of Environmental Quality. 2012. Wyoming's Water Quality Assessment and Impaired Waters List (2012 Integrated 305(b) and 303(d) Report.). Cheyenne, WY.

Wyoming Department of Environmental Quality. 2012a. WYPDES Issued Permits for Padlock, Town of Dayton, and the Town of Ranchester. http://deq.state.wy.us/wqd/WYPDES_Permitting/WYPDES_PNs_and_appr_permits/Pages/issued_permits.asp.

Wyoming Game and Fish Department. 1991. Wyoming Trout Stream Classification Map.

Wyoming Game and Fish Department personal communication with Tim Thomas, June 2012.

APPENDIX A TONGUE RIVER WATERSHED PROJECT MAPS

APPENDIX B FLOW DURATION CURVES AND LOAD DURATION CURVES

APPENDIX C WDEQ AND PUBLIC COMMENTS RECEIVED

The following comments were provided by two employees from the Wyoming Department of Environmental Quality once they had reviewed the draft 2012 Tongue River Watershed Plan. During the 45-day public comment period, three public notices, one press release, and an article in the Little Bighorn Trout Unlimited October Newsletter were generated to encourage participation; however, SCCD still did not receive any public remarks, statements, or clarifications during the 45-day time period.

C.1 WDEQ Comments

Provided By: Kevin Hyatt, WDEQ TMDL Coordinator

8/3/12

The Tongue River Watershed Plan that was created by the TRWSC was reviewed to evaluate if this document and it components could be used to support the development of a TMDL. It was also evaluated to determine the strengths and weaknesses of the technical aspects.

This document was well written and thoughts and ideas presented in the plan had effective flow and the document was easily followed. Most components had either good reasoning or good documentation of thoughts and ideas. This document shows that a great deal of effort was put forth to help understand the problem and ensure that actions taken to address the problems would be highly effective.

Over all the plan is a good example of what is needed for a Watershed-Based Plan, but it would require some additional work to meet the requirements for a TMDL. Many components could be used to help develop a TMDL. The following comments and suggestions would help clarify this plan. Additional comments could be developed to determine what additional components and analysis would be needed for TMDL development.

Below are comments to specific sections of the document. These comments for the most part are suggestions that would be more in line with a TMDL document.

1) Most TMDL documents contain a summary table at the beginning. The executive summary provides a good narrative summary, but for quick reference a table at the beginning that identified the impaired reaches, current criteria and loads, load reductions needed, priority areas and management actions would be beneficial.

2) On page iv in the executive summary, the document stated that TRWSC recognizes the bacterial levels are a major concern from a regulatory standpoint. This statement lends itself to bias. I would remove it or change it to reflect the concern from a health standpoint.

3) On page 3, section 1.2, paragraph 4, the word areas after the word surface should be replaced with waters.

4) On page 7, section 1.2.2 and continuing throughout the document, all listed stream segments should be identified using the 305(b) stream identification number from the most recently approved Integrated Report.

5) When referencing listed streams ensure that the descriptions used in the document are consistent with the most recently approved Integrated Report.

6) Over all Chapter 1 satisfies the following TMDL requirements:

- Identification of the waterbody, impairments, and water quality standards. The water quality sections thoroughly states all applicable standards and uses.

7) Chapter 2 provides great description of the study area and all appropriate features that are relevant to understanding the problem.

8) Chapter 3 satisfies the data set description requirement of a TMDL. Section 3.4 provides great detail and references to support the link between Fecal Coliform and *E. coli*. The summarized data provides the level of detail needed to understand the remaining analysis. The only thing that would be need is the complete data set used in an appendix or electronic format to be included to ensure that other reviewers or readers could replicate the analysis.

9) Water quality targets are supposed to be identified in a TMDL. When an impairment is due to a pollutant with a numeric standard, the water quality criterion, in this case bacteria with a 126cfu/100ml standard is the target. For sediment, a target would have to be developed that can be associated with ensuring the beneficial use is being attained. This requires very complicated analysis and would need substantial work for a TMDL.

10) On page 33, section 4.1.2 paragraph 3, the report states that measured flow was used to generate the "flow" duration curve. This is correct. To develop a Load Duration Curve (LDC) a Flow Duration Curve (FDC) is first created. The FDC displays the percentage of time any given flow is exceeded. The lowest flows are exceeded most of the time. In this case they should either change this to better describe the FDC to LDC curve development or change flow to load.

11) Section 4.2.1 provides very good technical reasoning for the development of the Margin of Safety (MOS). The MOS is explicit and consistent with EPA direction on amount (10%). Typically with bacteria an explicit MOS applied to the standard is not used in this manner because the 126 cfu/100ml standard is a 5 day geometric mean, which is conservative in its self. Usually using the median or a percentile of data to calculate load and load reductions are used as the MOS.

12) On page 34, section 4.2 did they use the 126 or the 113 (MOS) criteria to calculate LDC in Figure 4.2. Since the MOS was 10% then the blue line needs to be calculated with the 113 value.

This would be the TMDL. Reductions need would need to have the TMDL (using the 113 value) subtracted from the current load.

13) The remaining portion of section 4 does a great job of describing the potential source but there is no analysis to link the sources to the observed impairment. Additionally, a TMDL includes a Waste Load Allocation to ensure that the amount of pollutant that permitted facilities are discharging is appropriately shared amongst all sources. The load reductions calculated for the nonpoint sources might be higher due to part of the current instream load coming from point sources. In most TMDLs the Load Allocation is determined by subtracting the WLA from the TMDL and the WLA is calculated based on permit limits. If a permitted source's permit limit is causing exceedances, determined through linkage analysis, then lower limits will be placed on the point source and thus reducing the reductions needed by the nonpoint sources.

The remainder of the plan contains information that would either completely satisfy TMDL requirements or provide substantial information to use with very little extra work needed. The document as a whole contains areas with strong technicality and the areas that lack the technical rigor has great narrative support that would aid in satisfying all requirements of a TMDL.

Element	Met	Comments
Element 1: Causes and Sources Clearly define the causes and sources of impairment (physical, chemical, and biological).	Yes	Status (cause) of impairments described for each waterbody in Section 1.2.2. Section 4.4 identifies potential point and nonpoint sources of pollution. Point source pollution is only described narratively per discussion with and instruction from WDEQ. Nonpoint sources of pollution include domestic animals and livestock, run-off relating to irrigation and stormwater, sediment from streambanks and irrigation diversion, septic systems, and wildlife. While impairments are due to E. coli/fecal coliform, SCCD makes case for sediment levels corresponding to high bacteria levels; in addition, sediment is major watershed concern. Therefore, addressing sediment is included in the watershed-based plan. A load duration curve approach was used (Section 4.1). Load reduction calculations are described in Section 4.2 with a summary of load reduction estimates by subwatershed presented in Table 4.4. SCCD does an excellent job of interpreting this data (along with land use patterns and other factors) to evaluate and identify stream reaches that are a priority for mitigation efforts (Section 4.3). Furthermore, SCCD uses critical flow conditions to better identify potential pollutant sources (Section 4.4). SCCD ties all this information together in Section 4.4.3 to prioritize pollutant sources based on estimated quantitative load calculations for septic systems and domestic animals, land use information, critical flow conditions, priority reaches, measured bacteria loads, and other watershed characteristics. Table 4.11 summarizes pollutant source priority by subwatershed.
Element 2: Expected Load Reductions An estimate of the load reductions expected for each of the management measures or best management practices to be implemented (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time).	Yes	Table 4.4 summarizes load reductions needed for each subwatershed. Table 4.12 shows suggested BMPS to address the pollutant sources that are prioritized in Table 4.11, and Section 5 goes on to establish BMPs and an implementation schedule needed to achieve load reductions established for each subwatershed. Quantitative estimates of domestic animal and septic system contributions in Sections 4.4.2.1 and 4.4.2.2 respectively, provide information to help understand the extent of BMPs necessary to achieve load reductions. The methods used to identify load reductions, identify critical stream reach priority areas, prioritize pollutant sources, estimate contributions from subcategories

		of pollutant sources, and schedule BMP implementation provide confidence that mitigation efforts will address the identified water quality problem in an effective and efficient manner.
Element 3: Management Measures A description of the management measures or best management practices and associated costs that will need to be implemented to achieve the load reductions estimated in this plan and an identification (using a map or a description) of the critical areas where those measures are needed.	Yes, with comments	List of potential BMPs presented in Table 4.12. BMP schedule presented in Table 5.1 and in action items of Objective 2, Section 5.1.3. SCCD still working to identify funding needed (associated costs) for all action items. Critical areas are identified in Section 4.3 and BMPs are prioritized in Table 4.11. Map 12 shows locations of critical reaches. Table 1.5 and Map 7 show improvement projects completed before 2012.
Element 4: Technical and Financial Assistance An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.	Pending	See action items in Section 4, SCCD still working to compile funding amounts needed and funding sources. Section 5.2 narratively describes technical and financial assistance needs for plan implementation.
Element 5: Information/education Component An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing management measures.	Yes	See Section 5.1.4. A wide variety of education/awareness activities are proposed under this plan. SCCD has evaluated past education efforts to target future efforts where they will be most effective.
Element 6: Schedule A schedule for implementing management measures identified in this plan that is reasonably expeditious.	Yes	See Table 5.1 and Section 6—Schedule for completion. This watershed-based plan establishes a goal to achieve full watershed restoration in 20 years. The plan breaks that goal down into five year increments, with load reduction goals for each subwatershed for each five year period. Plan will be updated every five years.
Element 7: Measurable Milestones A schedule of interim, measurable milestones for determining whether the management measures, best management practices, or other control actions are being implemented.	Yes	Table 6.1 provides a detailed set of milestones by showing, for each objective, when each action/interim item will be completed over the five year period of this plan. SCCD plans to maintain progress register to track mitigation efforts over time.
Element 8: Evaluation of Progress	Yes	As described above, this plan sets a series of 5 year load reduction

A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised or, if a TMDL has been established, whether the TMDL needs to be revised.		goals in order to meet the long-term 20 year goal of full watershed restoration. Intensive watershed monitoring on a three year rotation will be used to evaluate progress towards meeting this goal. This plan will be revised every 5 years and updated accordingly based on progress towards achieving load reductions and implementation of programmatic milestones. Section 7.1 provides criteria for evaluation.
Element 9: Effectiveness Monitoring A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established in the Evaluation of Progress element.	Yes	See Section 7. SCCD has a very effective monitoring program which has provided the data that allowed for the calculations used in this watershed-based plan. SCCD will continue to implement this monitoring program.

Other Comments/Revisions:

1. JZ's minor suggested edits on electronic copy of draft plan.
2. Appendix A includes an excellent set of maps to help understand the information presented in the plan.
3. Flow and load duration curves included in Appendix B.
4. Plan does a good job of presenting background context and watershed characterization information without overwhelming the reader with too much information.
5. Think that plan does a good job of using both technical analysis and local working knowledge to develop an effective implementation plan.