PRAIRIE DOG CREEK WATERSHED INTERIM MONITORING PROJECT

Section 319 Water Quality Assessment

Sampling and Analysis Plan
May 2014

Prepared and Submitted by:
Sheridan County Conservation District
1949 Sugarland Drive, Suite 102
Sheridan, Wyoming 82801
Phone: (307) 672-5820
www.sccdwy.org

SIGNATURE PAGE

In February 2007, residents of the Prairie Dog Creek watershed agreed to initiate a watershed assessment and planning effort to address bacteria, sediment, and other concerns on the watershed. Following that effort, SCCD facilitated the 2007-2008 Prairie Dog Creek Watershed Assessment which resulted in the development of the Prairie Dog Creek Watershed-Based Plan. As directed in the Plan, the SCCD completed the 2011 Prairie Dog Creek Watershed Interim Monitoring project. SCCD will continue interim water quality monitoring in the Prairie Dog Creek Watershed until the Prairie Dog Creek Watershed Steering Committee revises the Prairie Dog Creek Watershed-Based Plan in 2015.

The Sheridan County Conservation District Board of Supervisors approved submission of the Sampling and Analysis Plan for the Prairie Dog Creek Watershed Interim Monitoring to the Wyoming Department of Environmental Quality (WDEQ) on May 1st, 2014.

_____ _____

John Kane, **Date**
SCCD Chairman

The Sampling and Analysis Plan for the Prairie Dog Creek Watershed Interim Monitoring project has been approved by the following employees and samplers of the SCCD.

_____ _____

Carrie Rogaczewski, **Date**
Project Coordinator/District Manager
Sheridan County Conservation District

_____ _____

Maria Steyaart **Date**
Field Sampler/Natural Resource Specialist
Sheridan County Conservation District

The Sampling and Analysis Plan for the Prairie Dog Creek Watershed Interim Monitoring project has been approved by WDEQ.

_____ _____

Cathy Norris, QA/QC Officer **Date**
Water Quality Division
Wyoming Department of Environmental Quality

PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

This Sampling and Analysis Plan (SAP) is written to meet the Quality Assurance/Quality Control requirements of the Wyoming Department of Environmental Quality (WDEQ), Water Quality Division, Watershed Protection Program and/or the United States Environmental Protection Agency (USEPA) for water samples collected under projects funded with Clean Water Act (CWA) Section 319(h) grants, and State of Wyoming grants to conservation districts for water quality monitoring which meets the requirements of Wyoming Statute (W.S.) 35-11-103(b) and (c) and W.S. 35-11-302, known as the Credible Data Law.

The SAP is intended as a field guide for personnel who will be conducting the water quality monitoring activities for this project, as a QA/QC plan, and as a data management plan.

The monitoring objectives of data collection on the Prairie Dog Creek Watershed are:

- To evaluate the effects high and low flow regimes have on bacteria loads; and
- To evaluate the effects land use and sediment have on stream habitat and macroinvertebrate community.

The purpose of interim monitoring is to complete monitoring milestones in the Prairie Dog Creek Watershed Plan (SCCD, 2011) and to analyze trends of bacteria levels and macroinvertebrate collections. The management objectives identified in the Prairie Dog Creek Watershed Plan are:

- To address bacteria and sediment controls on 13 septic systems, 1379 animal units on large acres, 79 animal units on small acres, and 32 animal units on rural ranchettes by 2015; and
- To reduce bacteria levels 10% by 2015.

Samples will be collected using the methods, procedures and/or protocols in the Sheridan County Conservation District, Water Quality Monitoring Project, and Quality Assurance Project Plan (QAPP), Revision 4 (SCCD, 2013); the Natural Resources Conservation Service National Handbook of Water Quality Monitoring (USDA NRCS, 2003); and the Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program Manual of Standard Operating Procedures (SOP) for Sample Collection and Analysis (WDEQ, 2011), and other accepted referenced methods. Activities included in the project will be in accordance with the Wyoming Nonpoint Source Management Plan Update (WDEQ, 2013) and the Wyoming Watershed Strategic Plan (WACD, 2000) incorporated by reference in this document.

This plan is a revised version of the previous SAPs (SCCD, 2007; SCCD, 2008; SCCD, 2011a). The original Prairie Dog Creek Watershed Assessment of 2007 and 2008 (SCCD, 2009), and subsequent SAP revisions, were submitted to and/or approved by WDEQ.

PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

SECTION		PAGE
CHAPTER 1	**PROJECT BACKGROUND, OBJECTIVES AND ORGANIZATION**	
1.1	Background	1
1.2	Project Purpose	2
1.3	Credible Data Legislation	3
1.4	Sampling Design	3
1.5	Key Personnel and Training	4
CHAPTER 2	**PROJECT AREA CHARACTERIZATION, DESIGNATED USES, AND IMPAIRED WATERS**	
2.1	Project Area Characterization	7
2.2	Designated Uses and Associated Water Quality Standards	10
2.3	Impaired Waters	11
CHAPTER 3	**SAMPLING LOCATIONS AND LANDOWNER PERMISSION**	
3.1	Site Descriptions and Land Use	13
3.2	Landowner Permission	18
CHAPTER 4	**2014 WATER QUALITY PARAMETERS AND STANDARDS**	
4.1	Study Design and Parameter Selection	19
4.2	Water Quality Standards	19
4.3	Sampling Parameters	21
4.3.1	Field Water Chemistry and Physical Parameters	21
4.3.1.1	Water Temperature	21
4.3.1.2	pH	22
4.3.1.3	Electrical Conductivity	22
4.3.1.4	Dissolved Oxygen	23
4.3.1.5	Staff Gage	23
4.3.1.6	Discharge	24
4.3.1.7	Habitat Assessment	24
4.3.2	Laboratory Analyzed Water Chemistry Parameters	25
4.3.2.1	Turbidity	25
4.3.3	Laboratory Analyzed Biological Parameters	26
4.3.3.1	*Escherichia coli*	26
4.3.3.2	Benthic Macroinvertebrates	27
4.3.4	Supporting Information	28
4.3.4.1	Meteorological Data	28
CHAPTER 5	**SAMPLING DURATIONS AND COLLECTION METHODS**	
5.1	Sampling Schedule	29
5.2	Sample Collections	30
5.2.1	Field Preparations and Methods	30

5.2.2	Water Quality	31
5.2.3	Staff Gage	33
5.2.4	Discharge	34
5.2.5	Continuous Temperature Loggers	34
5.2.6	Photopoints	35
5.2.7	Aerial Photograph Maps	35
5.2.8	Benthic Macroinvertebrates	36
5.2.9	Habitat Assessment	36
5.2.9.1	Substrate Composition	37
5.2.9.2	Semi-quantitative Embeddedness (silt cover)	38
5.2.9.3	Qualitative Habitat Assessment	38
5.2.10	Supporting Information	40
5.2.10.1	Meteorological Data	40
5.3	Contract Laboratories	40
5.3.1	Inter-Mountain Labs	40
5.3.2	Aquatic Assessments, Inc.	40
5.3.3	Aquatic Biology Associates, Inc.	41
5.4	Storage of Data Records and Laboratory Results	41
CHAPTER 6	**QUALITY ASSURANCE/QUALITY CONTROL (QAQC)**	
6.1	Corrective Actions	43
6.2	Equipment Maintenance	46
6.3	Documentation and Records	47
6.3.1	Field and Calibration Documentation	47
6.3.2	Sample Labeling	47
6.3.3	Sample Preservation	48
6.3.4	Chain of Custody Forms	48
6.4	Field Quality Control	49
6.4.1	Duplicates	49
6.4.2	Data Quality Objectives	49
6.4.2.1	Precision	50
6.4.2.2	Accuracy	50
6.4.2.3	Completeness	51
6.4.3	Trip Blanks	51
6.4.4	Field Blanks	51
6.4.5	Comparability	52
6.5	Data Validation and Verification	52
6.6	Field Audits	53
CHAPTER 7	**ANALYTICAL METHODS AND REPORTING**	
7.1	Statistical Design and Analyses	55
7.1.1	Field and Laboratory Analyzed Parameters	55
7.1.2	Macroinvertebrate Data Analyses	55
7.2	Reports	57

CHAPTER 8 **WASTE DISPOSAL, SAFETY AND EMERGENCY PROCEDURES**
8.1 Waste Disposal 59
8.2 Safety and Emergency Procedures 59

CHAPTER 9 **REFERENCES CITED** **61**

APPENDICES

APPENDIX A Project Area Maps
Map 1 Land Ownership as of January 2014
Map 2 Agricultural Land Use as of 2012
Map 3 Land Use
Map 4 WYPDES Discharge Permits as of March 2012
Map 5 Annual Precipitation (in Inches)
Map 6 Classifications of Streams
Map 7 Impaired Waters as of December 2012
Map 8 Wyoming Ecoregions
Map 9 Progress Register as of January 2014
APPENDIX B Stream Classifications, Listings, Standards, and Previous Work in the Prairie Dog Creek Watershed
APPENDIX C SCCD Standard Operating Procedures
APPENDIX D SCCD Field Sheets
APPENDIX E Benthic Macroinvertebrate Metric Information
APPENDIX F QA/QC Documentation Checklist

LIST OF FIGURES

2.1 Prairie Dog Creek Watershed Project Area 9
3.1 Map of Site Locations and Associated Parameters within Project Boundary 16

LIST OF TABLES

1.1	Key Personnel and Organizations Involved in the Project	4
1.2	SCCD Sampling Personnel and Qualifications	5
2.1	Classification of Streams in the Prairie Dog Creek Watershed	11
2.2	Wyoming's Final 2012 303 (d) Integrated State Water Quality Assessment Report	12
3.1	Planned Monitoring and Sample Site Descriptions	14
3.2	Land Use(s) per Sample Site	17
4.1	Numeric and Narrative Water Quality Standards for Wyoming Surface Waters Applicable for Waters in the Prairie Dog Creek Watershed	20
5.1	Sample Schedule for 2014 Prairie Dog Watershed Monitoring	30
5.2	Standard Field and Laboratory Methods for Monitoring	32
5.3	Stream Substrate Particle Size Classification	37
5.4	Embeddedness Rating Classification	38
5.5	Habitat Assessment Parameters	39
5.6	Storage and Location of Project Records	42
6.1	Calibrations, Quality Control Checks and Corrective Actions	44
6.2	Detailed Calibrations of pH, Conductivity, and Dissolved Oxygen Meters	46
6.3	Equipment Maintenance	47
6.4	Data Quality Objectives	50
7.1	Wyoming Stream Integrity Index (WSII) Biological Condition Scoring Criteria	56
7.2	Narrative Assessment Rating Criteria for Aquatic Life Use Support	56
8.1	Disposal of Waste	59
8.2	Emergency Contact Information	60

CHAPTER 1 PROJECT BACKGROUND, OBJECTIVES, AND ORGANIZATION

1.1 BACKGROUND

In early 1998, the Sheridan County Conservation District (SCCD) was approached by the Prairie Dog Ditch Company, the Meade Creek Ditch Company, and the Piney Cruse Ditch Company for assistance with the development of a watershed management plan relating to hydrologic flows and sediment. These requests were driven by concerns with sediment, erosion, channel stability, and declining real estate values due to land damage.

In the 1880's, three significant trans-basin water diversions were created that diverted water from an adjacent watershed into the Prairie Dog Creek Watershed. These diversions opened up thousands of acres to irrigation and helped build the stable agricultural economy. Despite these benefits to agriculture, these diversions have created an unnatural hydrologic condition. Because of the steepness of the upper portion of the watershed, the additional water has presented a serious erosion and safety hazard in some areas. In adjusting to the additional flows, watershed streams have experienced some accelerated down-cutting and lateral movement. Several individuals have complained over the years about accelerated stream bank erosion, erosive conveyance systems, excessive turbidity, sediment accumulation in irrigation systems, and visual impairments.

In 1998, SCCD attempted to secure three grant funding opportunities for a watershed assessment but all three attempts failed. Therefore in 1999, SCCD sponsored a Prairie Dog Creek Watershed Level I Study that would serve to address upstream erosion problems caused by the current irrigation delivery systems. This Level I Study was funded by the Wyoming Water Development Commission in 2000 and completed in November 2001 by EnTech, Inc. (Entech, 2001). EnTech identified 17 diversions on Jenks Creek and Prairie Dog Creek (known collectively as the Prairie Dog Canal) that may contribute to sediment concerns. In addition to extensive assessment on channel morphology and physical characteristics, EnTech collected some information on water quality. During 2000 and 2001, EnTech collected six individual fecal coliform bacteria samples on 11 sites. Although none of the samples included a geometric mean, there were samples with concentrations exceeding the 400 cfu/100 mL single sample maximum. These occurred in August and October of 2000 and June and August 2001.

In 2002 and then again in 2004, Prairie Dog Creek appears on the State of Wyoming's 303(d) List of Waters Requiring Total Maximum Daily Loads (TMDLs) for drinking water impairments due to elevated manganese concentrations. This listing came as a result of monitoring done by the United States Geological Survey (USGS) at Station Number 06306250 and was assigned a low priority for TMDL development (WDEQ, 2004). While the concentrations indicated impairments for aesthetic drinking water use (smell and color), the manganese concentrations are much lower than the human health criteria. In 2004, the entire Prairie Dog Creek watershed was placed on the 303(d) List for fecal coliform impairments exceeding the recreational designated uses criterion. This listing came as a result of WDEQ monitoring in 2003 (WDEQ,

2003) and was assigned a high priority for TMDL development because no local group had committed to develop a watershed plan to address bacteria concerns.

In February 2007, residents of the Prairie Dog Creek watershed, called the Prairie Dog Creek Watershed Committee (PDCWC), agreed to initiate a watershed assessment and planning effort to address bacteria, sediment, and other concerns on the watershed. Following that effort, SCCD received a Clean Water Act (CWA) 319 grant that facilitated a two year assessment (2007-2008 Prairie Dog Creek Watershed Assessment) of the baseline condition to provide the necessary framework for an examination of long-term trends in water quality improvement. This baseline data included 25 different parameters, along with several different pesticides and herbicides, at 14 different stations spread out over 40 randomly selected monitoring days. Macroinvertebrate collections and habitat assessments were also conducted at five sampling stations. The only parameters that exceeded State of Wyoming water quality standards were temperature, bacteria, and dissolved manganese. Other parameters that do not have a numeric surface water quality standard like conductivity, turbidity, total phosphorus, total alkalinity, Sodium Absorption Ratio (SAR), and total sulfate had high concentrations.

In 2011, following the two-year assessment, SCCD decided to limit water quality monitoring to the standard set of chemical parameters potentially affecting bacteria levels. These grab sample parameters include instantaneous temperature, pH, conductivity, dissolved oxygen (% and mg/L), *E. coli* bacteria, and turbidity at 14 stations spread out over 10 randomly selected monitoring days (5 during high flow regimes and 5 during low flow regimes). SCCD termed this type of trend sampling as Interim Monitoring. In 2012, WDEQ placed Meade, Dutch, and Wildcat Creek on the 303(d) List for bacteria impairments exceeding the recreational designated uses criterion. Water quality interim monitoring in the Prairie Dog Creek Watershed will continue to occur until total maximum daily loads are calculated for the development of a TMDL or the revision of the Prairie Dog Creek Watershed Plan.

1.2 Project Purpose and Objectives

The monitoring objectives of data collection on the Prairie Dog Creek Watershed are:

- To evaluate the effects high and low flow regimes have on bacteria loads; and
- To evaluate the effects land use and sediment have on stream habitat and macroinvertebrate community.

The purpose of interim monitoring is to complete monitoring milestones in the Prairie Dog Creek Watershed Plan (SCCD, 2011), and to analyze trends of bacteria levels and macroinvertebrate collections. The management objectives identified in the Prairie Dog Creek Watershed Plan are:

- To address bacteria and sediment controls on 13 septic systems, 1379 animal units on large acres, 79 animal units on small acres, and 32 animal units on rural ranchettes by 2015; and
- To reduce bacteria levels 10% by 2015.

Interim monitoring data collection is in a three year monitoring rotation currently conducted by the SCCD on the Tongue River, Goose Creek, and Prairie Dog Creek watersheds as indicated in the Sheridan County Watershed Improvements #3 Project funded by WDEQ through Section 319 of the Clean Water Act. This SAP is covered by the Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program Monitoring Quality Assurance Project Plan (QAPP), 2001 and by the SCCD, Water Quality Monitoring Program, Quality Assurance Project Plan (QAPP), Revision 4 (SCCD, 2013).

The objectives of interim monitoring fulfills the guidelines outlined by the Wyoming Nonpoint Source Management Plan Update (WDEQ, 2000 and 2013), which requires the Water Quality Division to "continue an ongoing assessment of the statewide condition of surface water…implement a proactive information and education program to enhance the public's knowledge of nonpoint source pollution,…[and to] achieve protection of the quality of Wyoming's water resources through the targeted application of regulatory and non-regulatory methods, but primarily through the organization and facilitation of local stakeholder groups which develop and implement watershed management plans."

1.3 Credible Data Legislation

This SAP is covered by the SCCD, Water Quality Monitoring Program, Quality Assurance Project Plan (QAPP), Revision 4 (SCCD, 2013) and the WDEQ, Water Quality Division, Watershed Program Quality Assurance Project Plan for Beneficial Use Reconnaissance Program (BURP) Water Quality Monitoring (WDEQ, 2001). This SAP will define all necessary field protocols and will be available to the sampling team for every sampling event.

The collection of data specified in this plan will comply with state law, Wyoming Statutes (W.S.) 35-11-103(b) and (c), which states credible data means "scientifically valid, chemical, physical, and biological monitoring data collected under an accepted sampling and analysis plan, including quality control, quality assurance procedures and available historical data," and W.S. 35-11-302 that states "the rules, regulations and standards shall prescribe: The use of credible data in determining water body's attainment of designated uses. The exception to the use of credible data may be in instances where numeric standards are exceeded or in ephemeral or intermittent water bodies where chemical or biological sampling is not practical or feasible."

1.4 Sampling Design

The Prairie Dog Creek Watershed has an approximate area of 231,000 acres (361 square miles). This interim monitoring project will include a total of 14 water quality sampling stations; nine sites on the mainstem of Prairie Dog Creek, four sites on the major tributaries that flow into Prairie Dog Creek, and one station located on Prairie Dog Ditch, a prominent diversion in the upper part of the watershed (Figure 3.1). The four tributaries include Dutch Creek, Jenks Creek, Meade Creek, and Wildcat Creek. 13 of the 14 stations will be equipped with a calibrated staff gage. Seven of the nine mainstem stations will contain a continuous temperature logger to

measure water temperature at 15 minute intervals; they will be launched May 1st, and removed around October 31st every sampling year. Grab samples of instantaneous temperature, pH, conductivity, dissolved oxygen (% and mg/L), and a staff gage measurement will be taken on-site five times during the high flow season (May-June) and the low flow season (August-September) for every site. In addition, grab samples of *E. coli* bacteria, and turbidity will be collected by SCCD personnel and analyzed by the designated contract laboratory. Three to five cross sectional discharge measurements will be calculated for 13 out of the 14 sites during the months of May through September. Macroinvertebrate collections and habitat assessments will be conducted on four mainstem sites of the Prairie Dog Creek during the month of October. All monitoring methods, standard operating procedures, and QA/QC protocols used for this project are described in the 2013 Quality Assurance Project Plan, Revision No. 4, previously approved by WDEQ (SCCD, 2013).

1.5 KEY PERSONNEL AND TRAINING

This project will involve various individuals from the SCCD, NRCS, WDEQ, and other local stakeholders or interested parties (Table 1.1). The District Manager will serve as the Project Coordinator with the Natural Resource Specialist serving as the Field Supervisor. The District Manager and Natural Resource Specialist will be responsible for the implementation of the Quality Assurance/Quality Control (QA/QC) procedures. Other SCCD and NRCS personnel will provide assistance to the project. WDEQ will provide assistance and oversight as well as administration of the funds provided through Section 319 of the Clean Water Act. Stakeholders and landowners will provide site access for sampling and other information.

Table 1.1 Key Personnel and Organizations Involved in the Project

Personnel/Organization	Project Role
Carrie Rogaczewski, SCCD District Manager	Project management/oversight; Field monitoring assistance; QA/QC oversight; Data review and validation; Reporting
Maria Steyaart, SCCD Natural Resource Specialist	Field monitoring; QA/QC protocol; Data validation assistance; Reporting
Amy Doke, SCCD Program Specialist	Assistance with data management and reporting
SCCD Board of Supervisors	Project review; Field monitoring assistance
NRCS Sheridan Field Office Staff	Field monitoring assistance
Wyoming Department of Environmental Quality (WDEQ)	Project review; QA/QC review; Report review, funding administration
Landowners/ Steering Committee	Project and data review; Sampling access

Water quality monitoring, data management, and reporting will be performed by the SCCD staff (Table 1.2). Other SCCD Supervisors and Associate Supervisors, NRCS employees, WACD (Wyoming Association of Conservation Districts) watershed coordinators, and volunteers may assist with field work during this project. Any personnel assisting the SCCD staff will be properly trained to follow the protocols in this SAP before the field work commences, and will be under the direct supervision of SCCD staff. Additional training may also be requested from WDEQ,

WACD, and other technically capable sources. This SAP will define all necessary field protocols and will be available to the sampling team for every sampling event.

Table 1.2 SCCD Sampling Personnel and Qualifications

Personnel	Qualifications
Carrie Rogaczewski, District Manager	M.S. University of Wyoming in Rangeland Ecology and Watershed Management with an emphasis in Water Resources; BKS Environmental; 15+ years of experience with the SCCD; attended WACD's 5 Module Water Quality Training in 1998 and 1999.
Maria Steyaart, Natural Resource Specialist	B.S. University of Vermont in Environmental Science with a concentration in Ecological Design; 6-month water quality intern with WDEQ in Sheridan; 2+ year of experience with SCCD conducting watershed monitoring; attended WACD's Water Quality Training for Module I in 2012 and Module II in 2014.
Amy Doke, Program Specialist	B.A. University of Wyoming in Environment and Natural Resources with an emphasis in international studies and ecology; 8+ years of experience with SCCD, assisting in other watershed efforts; attended WACD's Water Quality Training for Module III in 2011.

PAGE INTENTIONALLY LEFT BLANK

CHAPTER 2 PROJECT AREA CHARACTERIZATION, DESIGNATED USES, AND IMPAIRED WATERS

2.1 PROJECT AREA CHARACTERIZATION

The Prairie Dog Creek watershed is located in central Sheridan County, in north-central Wyoming (Figure 2.1) and is identified by hydrologic unit code (HUC) WYTR 10090101-020-2. The watershed has an approximate area of 231,000 acres (361 square miles). Prairie Dog Creek is a tributary to the Tongue River with the confluence being located near the Montana state line. Major tributaries to Prairie Dog Creek include Meade, Jenks, SR, Jim, Arkansas, Coutant, Wildcat, and Dutch Creeks. Most of these streams are ephemeral throughout much of their length. Jenks Creek was likely a steep ephemeral draw until the late 1800's, at which time three trans-basin diversions were constructed to divert water from the North Fork and South Forks of Piney Creek through tunnels located on the northern side of the present community of Story. The ridge through which the tunnels were constructed is known as Tunnel Hill. During the recreational season, as much as 100 cubic feet per second (cfs) can be diverted from the Piney Creek drainage into Prairie Dog Creek. The additional flows from the trans-basin diversions have contributed to habitat, stream channel and other impacts on the watershed (EnTech, 2001).

Land ownership within the watershed is approximately 80% privately owned, 19% owned by the State of Wyoming, and 1% federally administered by the Bureau of Land Management (BLM) (Appendix A, Map 1). In addition, the unincorporated Town of Story, Wyoming lies immediately adjacent to the watershed. While Story lies geographically in the Piney Creek/Powder River drainage, it is a significant hydrological part of the Prairie Dog Creek watershed due to the trans-basin diversions through Tunnel Hill.

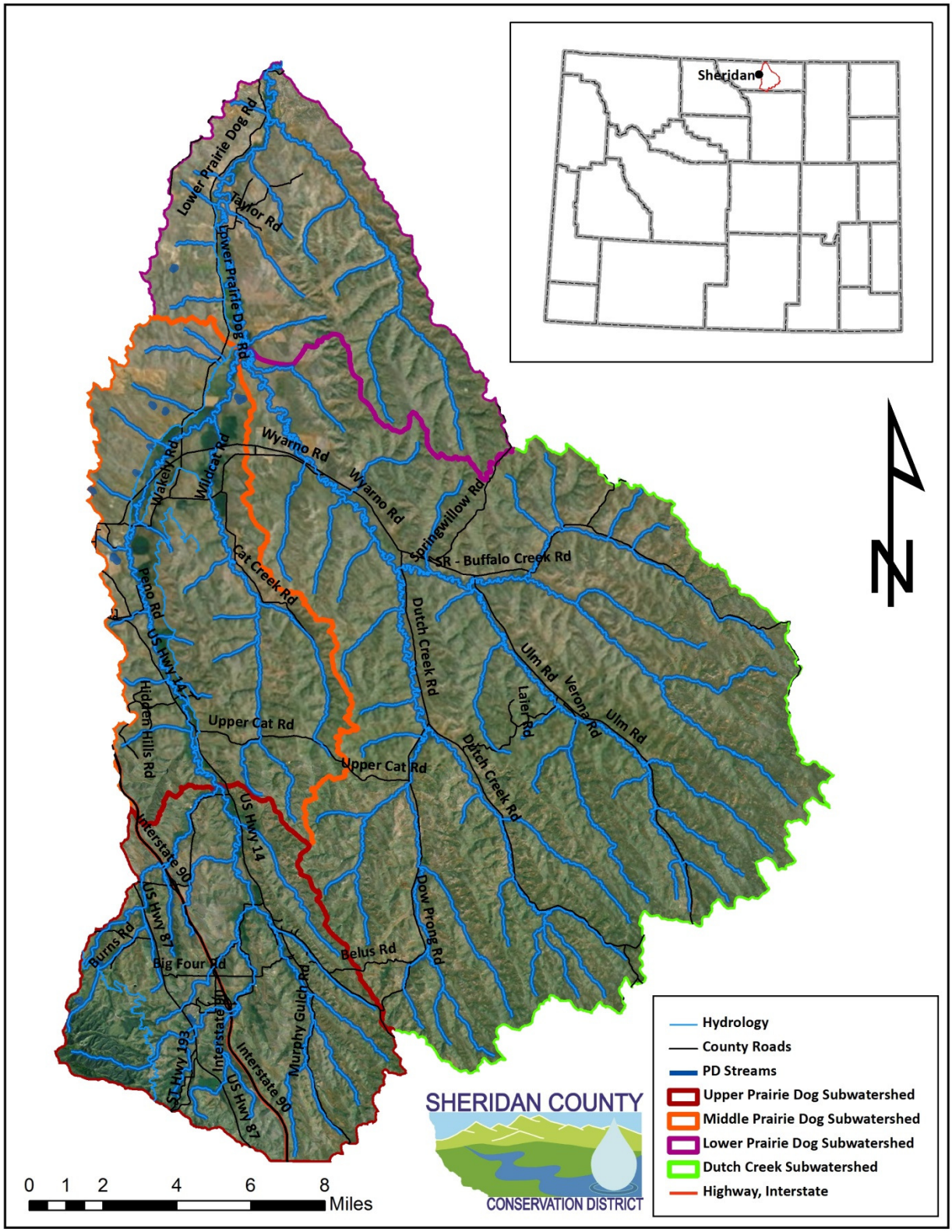
Land use in the Prairie Dog Creek Watershed is predominately rangeland, with a much smaller percentage along Prairie Dog Creek managed for irrigated hayland (Appendix A, Map 2). The majority of irrigated cropland seems to reside along the Prairie Dog Creek, and its major tributaries (Appendix A, Map 3). Other land uses include non-irrigated hayland, along with small pockets of residential areas, and energy development in the form of coal bed methane extraction, which obtain permits from the WDEQ to discharge into surface waters with the Prairie Dog Creek Watershed. As of March 2012, there were 170 coal bed methane discharge permits, and one industrial discharge permit in effect for the Prairie Dog Creek Watershed (Appendix A, Map 4). Most of these permits were located in the lower portions of the watershed. There are no municipal discharges within this watershed.

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, 2009). Elevation within the main stem of the project area starts at 4,440 feet in the uppermost Prairie Dog Creek site (PD10) and drops to 3,484 feet just above the confluence with Prairie Dog Creek and Tongue

River at PD01 - the furthest downstream location of the project area. Total elevation difference is 956 feet over a distance of approximately 52.76 miles (18 percent slope).

Annual precipitation at the upper portion of the watershed boundary is 16 to 18 inches of rainfall. For the majority of sites, precipitation is between 14 and 16 inches of rainfall annually (Appendix A, Map 5). Precipitation decreases to the lower portion of the watershed with annual precipitation between 12 to 14 inches of rainfall.

Figure 2.1 Prairie Dog Creek Watershed Project Map



2.2 DESIGNATED USES AND ASSOCIATED WATER QUALITY STANDARDS

Protection of waters under the Clean Water Act (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 main stem of Prairie Dog Creek is classified in the Wyoming Surface Water Classification List as a Class 2AB, cold water stream (WDEQ, 2001a). Meade Creek and Jenks Creek are also classified as 2AB; other tributaries in the Prairie Dog Creek watershed are classified as Class 3B (Table 2.1, and Appendix A, Map 6). Depending upon its classification, a stream is expected to support certain activities or beneficial uses (Table 2.1). The State of Wyoming has assigned designated uses to all of the surface waters in the state according to the classes outlined in Appendix B.

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 (Appendix B). 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, 2001a) classified all of the tributaries, except Meade and Jenks Creeks, as Class 3B streams (Table 2.1). Class 3B waters are intermittent and ephemeral streams that are not known to support fish populations or drinking water supplies (WDEQ, 2007). Class 3B surface waters are protected for all other 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).

It is important to understand that classifications in this watershed might not always indicate what is seen in the field due to the amount of diversion water that flows during summer months.

Table 2.1 Classifications of Streams in the Prairie Dog Creek Watershed

Stream Classifications		Beneficial Use Designations	
Class 2AB	**Class 3B**	**Class 2AB**	**Class 3B**
Prairie Dog Creek	Arkansas Creek	Drinking Water	
Jenks Creek	Coutant Creek	Game Fish	
Meade Creek	Dow Prong	Non-Game Fish	
	Dutch Creek	Fish Consumption	
	Jim Creek	Other Aquatic Life	Other Aquatic Life
	Murphy Gulch	Recreation	Recreation
	Pompey Creek	Wildlife	Wildlife
	SR Creek	Agriculture	Agriculture
	Stanley Creek	Industry	Industry
	Wagner Prong	Scenic Value	Scenic Value
	Wildcat Creek		

2.3 IMPAIRED WATERS

States are required to summarize water quality conditions in the state through section 305(b) of the Clean Water Act; this report is commonly known as the 305(b) Report. Section 303(d) of the Clean Water Act requires states to identify waters that are not supporting their designated uses, and/or need to have a Total Maximum Daily Load (TMDL) established to support their uses. A TMDL is the amount of a given pollutant a waterbody can receive and still meet water quality standards. If a waterbody exceeds narrative or numeric water quality standards, it is considered to be “impaired” or not meeting its designated uses. These waterbodies were included on the Wyoming 303(d) list of waters requiring TMDLs (WDEQ, 2006). Wyoming’s 305(b) Report and 303(d) List is published every two years.

Prairie Dog Creek is currently listed on the 303(d) list of waterbodies requiring TMDLs for *E. coli* bacteria impairments related to recreational use, and Manganese impairments for aesthetic drinking water use (discoloration, smell, etc.). The Manganese impairments are attributed to natural sources and WDEQ is considering a site specific criterion (WDEQ, 2010). The main tributaries (Dutch, Meade, and Wildcat Creek) of Prairie Dog Creek are also impaired for bacteria. The impaired waters in the Prairie Dog Creek Watershed are summarized in Table 2.3 (Appendix A, Map 7). For a detailed history of impairments within the Prairie Dog Creek Watershed refer to Appendix B.

Table 2.2 Wyoming's Final 2012 303 (d) Integrated State Water Quality Assessment Report (WDEQ, 2012)

Name	Class	Location	Miles	Uses	Use Support	Causes	Sources	List Date
Prairie Dog Creek (tributary to Tongue River)	2AB	From the confluence of Tongue River to an undetermined point upstream	47.2	Recreation	Not supporting	Unknown	Fecal Coliform	2004
Prairie Dog Creek (tributary to Tongue River)	2AB	From the confluence of Tongue River to an undetermined point upstream	47.2	Drinking Water	Not supporting	Natural Sources, Unknown	Manganese	2012
Prairie Dog Creek (tributary to Tongue River)	2AB	From the confluence of Tongue River to an undetermined point upstream	47.2	Cold Water Fishery	Not supporting	Unknown	Temperature	2012
Meade Creek (tributary to Prairie Dog)	2AB	From the confluence of Prairie Dog Creek to an unnamed tributary	1.1	Recreation	Not supporting	Unknown	*E. coli* bacteria	2012
Meade Creek (tributary to Prairie Dog)	2AB	From the confluence of Prairie Dog Creek to an unnamed tributary	1.1	Drinking Water	Not supporting	Natural Sources, Unknown	Manganese	2012
Wildcat Creek (tributary to Prairie Dog)	3B	From the confluence of Prairie Dog Creek to an undetermined point upstream	0.8	Recreation	Not supporting	Unknown	*E. coli* bacteria	2012
Dutch Creek (tributary to Prairie Dog)	3B	From the confluence of Prairie Dog Creek to an undetermined point upstream	1.9	Recreation	Not supporting	Unknown	*E. coli* bacteria	2012
Prairie Dog Creek (tributary to Tongue River)	2AB	From the confluence of Tongue River to an undetermined point upstream	6.7	Drinking Water	Not supporting	Natural Sources	Manganese	2002
Prairie Dog Creek (tributary to Tongue River)	2AB	From the confluence of Tongue River to an undetermined point upstream	6.7	Recreation	Not supporting	Unknown	Fecal Coliform	2004
Prairie Dog Creek (tributary to Tongue River)	2AB	From the confluence of Tongue River to an undetermined point upstream	6.7	Cold Water Game Fish	Not supporting	Unknown	Temperature	2012

CHAPTER 3 SAMPLING LOCATIONS AND LANDOWNER PERMISSION

3.1 SITE DESCRIPTIONS AND LAND USE

Sites were selected based on a review of the historical data, historical SCCD sampling sites, availability, and access (Table 3.1). Initial considerations for site selection included the ability to reveal types and regions of non-point source pollution at a level that would optimize landowner participation in the watershed planning process and would allow SCCD to direct remediation assistance in the most cost-effective and environmentally sound ways.

In total, there will be 14 water quality sampling stations included in the Prairie Dog Creek Watershed Interim Monitoring project; nine stations are located on the mainstem of the Prairie Dog Creek, four stations are located on the major tributaries, and one station is located on Prairie Dog Ditch, a diversion at the upper portion of the watershed (Figure 3.1). The four tributaries include Dutch Creek, Jenks Creek, Meade Creek, and Wildcat Creek. Jenks Creek (JC01) will be the only new sampling station in 2014. Jenks Creek was added into the monitoring schedule to ensure all of the major 2AB tributaries within the Prairie Dog Watershed are sampled. To keep distances between mainstem stations relatively consistent, PD7A will be excluded in the 2014 interim monitoring project. To maintain a more consistent labeling system among watersheds, SCCD decided to change the sample site names in 2014. Table 3.1 indicates the name of each sample site used in 2007-2011. Macroinvertebrate collections and habitat assessments will be conducted on four mainstem sites of Prairie Dog Creek during the month of October.

All monitoring methods, standard operating procedures, and QA/QC protocols used for this project are described in the 2013 Quality Assurance Project Plan, Revision No. 4, previously approved by WDEQ. Detailed site and watershed descriptions for the existing Prairie Dog Creek Watershed stations were provided in the Assessment Report (SCCD, 2009) and the 2011 Sampling and Analysis Plan (SCCD, 2011a). By maintaining consistency in the existing monitoring sites, changes in water quality can be directly compared to the 2007-2008, and 2011 data. Table 3.1 provides descriptions for sites sampled since 2007. Easting and northing UTMs for each site were generated using the ESRI© program. More exact coordinates will be taken in by a Global Positioning System (GPS) during site set-up. Site elevations were predetermined based on 7.5 minute topography maps (Table 3.1).

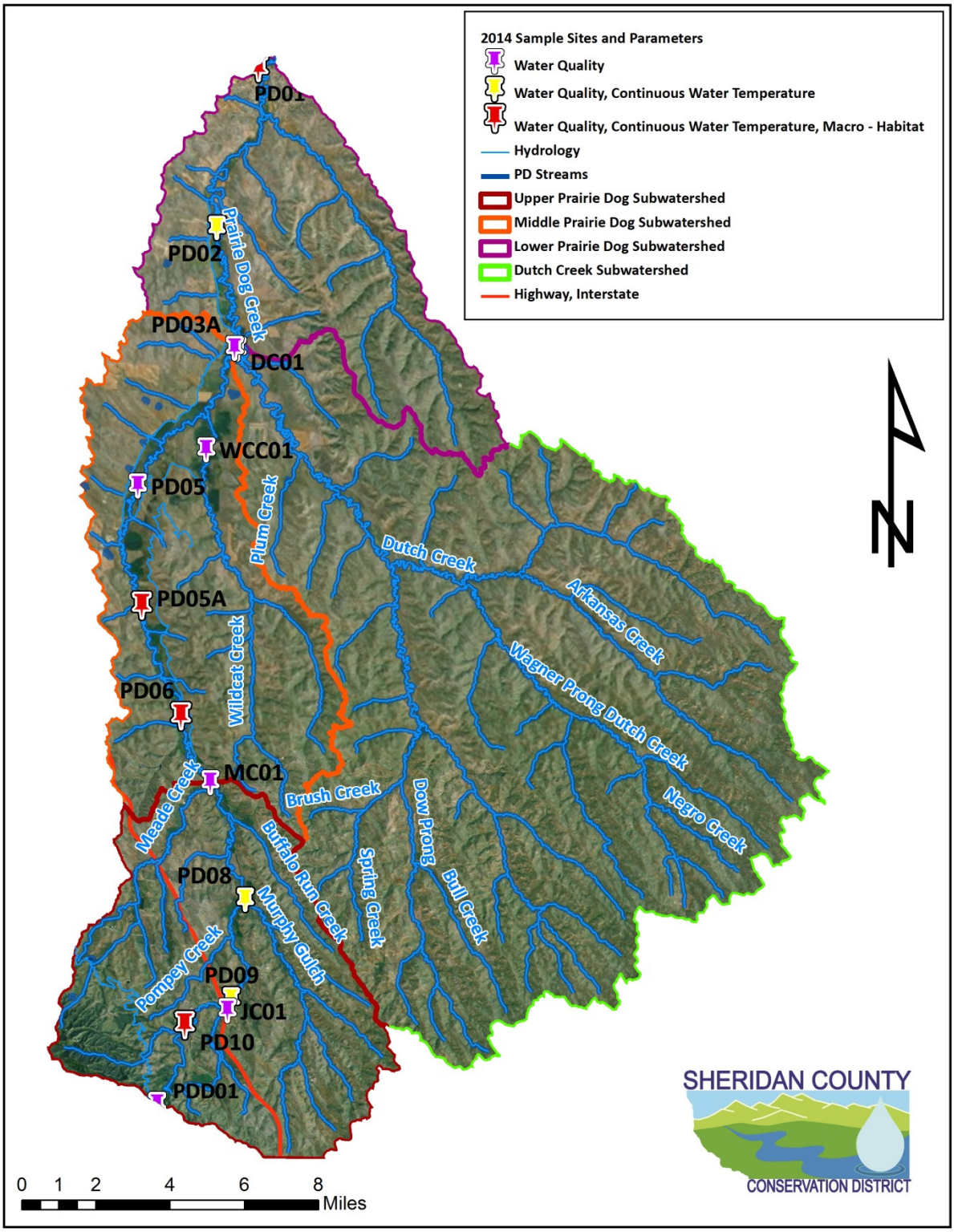
Table 3.1 Planned Monitoring and Sample Site Descriptions

Site	2007-2011 Site Name	Monitoring Parameters	Coordinates Zone 13 UTM (NAD83)	Land Ownership	Elevation (ft)	Water Quality Sampling	Benthic Macro-invertebrate Sampling	Year(s) Sampled
Prairie Dog Creek 01 (PD01)	PD1	Temperature (Continuous), Water Quality, Macro-Habitat	Northing: 4982922 Easting: 0355001	Public, State Lands	3,484	Approximately 150 yards downstream from USGS station No. 06306250	~200 feet downstream of USGS monitoring station No. 06306250	2007, 2008, 2011, 2013 (TRW)
Prairie Dog Creek 02 (PD02)	PD2	Temperature (Continuous), Water Quality	Northing: 4975920 Easting: 0353140	Private	3,536	Upstream of County Road 114 Crossing	N/A in 2014	2007, 2008, 2011
Prairie Dog Creek 03A (PD03A)	PD3A	Water Quality	Northing: 4969902 Easting: 0353648	Private	3,635	Upstream from road crossing approximately ¼ mile upstream from confluence with Dutch Creek	N/A in 2014	2008, 2011
Dutch Creek 01 (DC01)	PD3	Water Quality	Northing: 4970648 Easting: 0354031	Private	3,621	Upstream approximately 100 yards of confluence with Prairie Dog Creek	N/A in 2014	2007, 2008, 2011
Wildcat Creek 01 (WCC01)	PD4	Water Quality	Northing: 4966405 Easting: 0352650	Private	3,680	Approximately 100 yards downstream of Highway 336	N/A in 2014	2007, 2008, 2011
Prairie Dog Creek 05 (PD05)	PD5	Water Quality	Northing: 4964763 Easting: 0349709	Private	3,742	South of the railroad crossing off of Highway 336	N/A in 2014	2007, 2008, 2011
Prairie Dog Creek 05A (PD05A)	PD5A	Temperature (Continuous), Water Quality, Macro-Habitat	Northing: 4959487 Easting: 0349873	Private	3,840	Off of Peño Road, down private driveway	Approximately 100 feet upstream of WQ sampling location	2008, 2011
Prairie Dog Creek 06 (PD06)	PD6	Temperature (Continuous), Water Quality, Macro - Habitat	Northing: 4954698 Easting: 0351543	Private	3,969	Upstream from Highway 14 crossing	Approximately 100 feet upstream of Highway 14 crossing	2007, 2008, 2011
Meade Creek 01 (MC01)	PD7	Water Quality	Northing: 4951421 Easting: 0352645	Private	3,985	Approximately 50 yards south of confluence with Prairie Dog Creek and 400 yards north of County Rd 131	N/A in 2014	2007, 2008, 2011

3.1 (Continued). Planned Monitoring and Sample Site Descriptions

Site	Previous Site Name	Monitoring Parameters	Coordinates Zone 13 UTM (NAD83)	Land Ownership	Elevation (ft)	Water Quality Sampling	Benthic Macro-invertebrate Sampling	Year(s) Sampled
Prairie Dog Creek 08 (PD08)	PD8	Temperature (Continuous), Water Quality	Northing: 4946810 Easting: 0354334	Private	4,160	North of County Road 127	N/A in 2014	2007, 2008, 2011
Prairie Dog Creek 09 (PD09)	PD9	Temperature (Continuous), Water Quality	Northing: 4942369 Easting: 0353743	Private	4,355	Approximately 50 feet downstream of Fairbanks Road Crossing	N/A in 2014	2007, 2008, 2011
Jenks Creek 01 (JC01)	-----	Water Quality	Northing: 4941847 Easting: 353570	Private	4,375	Approximately 400 feet upstream of Fairbanks Road Crossing	N/A in 2014	New in 2014
Prairie Dog Creek 10 (PD10)	PD10	Temperature (Continuous), Water Quality, Macro - Habitat	Northing: 4941296 Easting: 0351759	Private	4,532	Approximately 100 yards upstream from Highway 87 crossing	Approximately 50 feet from steel bridge crossing	2007, 2008, 2011
Prairie Dog Ditch 01 (PDD01)	PD11	Water quality	Northing: 4937789 Easting: 0350556	Private	5,024	Approximately 50 yards from Prairie Dog Ditch	N/A in 2014	2007,2008, 2011

Figure 3.1 Map of Site Locations and Associated Parameters within Project Boundary



Intended water resource uses include recreation contact, irrigation, aesthetics, and fish. Land use activities identified in Table 3.2 were gathered from other previous PDWPs and SAPs. Watershed land use activities are important to understand in order to identify the appropriate water quality parameters, and water quality challenges associated with each land use activity. Land use in the Prairie Dog Creek Watershed is predominately rangeland, with a much smaller percentage along Prairie Dog Creek managed for irrigated hayland (Appendix A, Map 2 and 3). Other land uses that are unique to this watershed include energy development in the form of coal bed methane (CBM) extraction. Energy development companies obtain permits from the WDEQ to discharge into surface waters with the Prairie Dog Creek Watershed (Appendix A, Map 4).

During site reconnaissance, SCCD will identify current land use characteristics, determine the exact coordinates for the sample locations, and collect other valuable information.

Table 3.2 Land Use(s) per Sample Sites

Site	Waterbody	Land Use(s)
PD01	Prairie Dog Creek	Mainly horse grazing and irrigated haylands upstream. CBM production present in area.
PD02	Prairie Dog Creek	Irrigated haylands, wildlife habitat, and cattle grazing. CBM production present in area.
DC01	Dutch Creek	Wildlife habitat and pastureland for cattle grazing. CBM production present in area.
PD03A	Prairie Dog Creek	Irrigated haylands, wildlife habitat, and cattle grazing. CBM production present in area.
WCC01	Wildcat Creek	Irrigated agricultural land, and cattle grazing. CBM production present in area.
PD05	Prairie Dog Creek	Cattle grazing, and irrigated haylands. Railroad and HWY 336 parallel east side of Prairie Dog Creek downstream of sample site.
PD05A	Prairie Dog Creek	Rural residential, wildlife habitat, cattle grazing, and irrigated haylands.
PD06	Prairie Dog Creek	Rural residential, wildlife habitat, cattle grazing, and irrigated haylands. Hwy 14 parallels on east and west side.
MC01	Meade Creek	Wildlife habitat, cattle grazing, and irrigated haylands.
PD08	Prairie Dog Creek	Rural residential, cattle grazing, irrigated haylands, and wildlife habitat.
PD09	Prairie Dog Creek	Wildlife habitat, cattle grazing, pasture and irrigated hayland. Approximately 0.3 miles downstream of Interstate 90.
JC01	Jenks Creek	Wildlife habitat, cattle grazing, pasture and irrigated hayland. Approximately 0.4 miles downstream of Interstate 90.
PD10	Prairie Dog Creek	Wildlife habitat, cattle/horse grazing, pastures and irrigated hayland. Creek crosses Hwy 87 just downstream.
PDD01	Prairie Dog Ditch	Predominantly rural residential community.

3.2 LANDOWNER PERMISSION

Like in previous years, SCCD personnel requested and documented verbal permission by the landowner to access Prairie Dog Creek Watershed stations to: setup and calibrate staff gages, collect water quality samples, measure surface water flows, and at select mainstem sites collect macroinvertebrate samples.

On July 1, 2012, changes to the Wyoming Public Records Act (W.S. 16-4-201 through 16-4-205) resulted in a requirement to obtain a signed consent form before releasing any information (e.g. water quality, rangeland health) collected on agricultural operations. By signing this consent form, the landowner gives SCCD permission to access their property for water quality monitoring purposes, and understands that the water quality data collected on the surface water of the landowner's property will be retained in the Conservation District office, compiled in a reporting document submitted to funding agencies and other interested parties, and is subject to the Wyoming Public Records Act. SCCD mailed an individually addressed letter that formally asks each landowner for permission to access the water quality station and consent to publish the water quality results in a monitoring report. This letter included an unsigned consent form, a stamped self-addressed return envelope, and a map of the landowner's sampling station location. All landowners returned a signed consent form before the sampling season. If a landowner had refused to sign and return the consent form, SCCD would not sample at that location, and would either abandon the site or find a new site in a nearby location on the same surface water body. Signed consent forms, along with a driving route to each station, are kept on file at the Sheridan office.

CHAPTER 4 WATER QUALITY PARAMETERS AND STANDARDS

4.1 STUDY DESIGN AND PARAMETER SELECTION

Interim Monitoring for the Prairie Dog Creek Watershed will continue to monitor trends in water quality in relation to water quality improvement projects and watershed plan implementation activities. The Prairie Dog Creek Watershed Plan (SCCD, 2011) includes implementation of BMP's and education activities targeted to watershed residents.

As in the past monitoring years, sampling will be based on a random (unbiased) systematic sampling design and will focus on parameters that exceeded water quality standards during the initial assessment. Samplers will collect and analyze chemical, physical, bacteriological, biological, and habitat data. Sampling techniques will be based upon WDEQ sampling protocol (WDEQ, 2011) and modified as necessary in order to meet specific project goals and objectives (Appendix C). Parameters include those identified as a concern following the 2007-2008 Assessment, suggestions made by WDEQ personnel, and Prairie Dog Creek Steering Committee members.

At each of the 14 stations, water quality (physical and chemical) parameters will be obtained on-site. These parameters include instantaneous temperature, pH, conductivity, dissolved oxygen (% and mg/L), and stage height (when applicable). During this time, grab samples of *E. coli* bacteria and turbidity will be collected by SCCD personnel to be analyzed by designated contract laboratory. Seven of the nine mainstem stations will contain a continuous temperature logger attached to the staff gage for continuous temperature measurements. During the months of May through September, three to five cross sectional discharge measurements will be calculated for 13 out of the 14 sites to establish stage-discharge relationships. Macroinvertebrate collections and habitat assessments will be conducted on four mainstem sites of Prairie Dog Creek during the month of October. All monitoring methods, standard operating procedures, and QA/QC protocols used for this project are described in the 2013 Quality Assurance Project Plan, Revision No. 4, previously approved by WDEQ.

4.2 WATER QUALITY STANDARDS

Wyoming's surface waters are protected through application of narrative (descriptive) and numeric water quality standards described in Chapter 1 of the Wyoming Water Quality Rules and Regulations (WDEQ, 2007). For Class 2AB waters, the Human Health values for "Fish and Drinking Water" listed in Appendix B of Chapter 1 apply. The "acute" and "chronic" values for Aquatic Life apply to all Class 1, 2, and 3 waters. SCCD used the description of the narrative or numeric water quality standards applicable to the Prairie Dog Creek Watershed to determine attainment of beneficial uses of waterbodies within the project area (Table 4.1). For a complete list of Wyoming Water Quality Standards, refer to Appendix B.

Table 4.1 Numeric and Narrative Water Quality Standards for Wyoming Surface Waters Applicable for Waters in the Prairie Dog Creek Watershed (WDEQ, 2007)

NUMERIC STANDARDS				
Priority Pollutants[1]				
		Standard / Description		
Parameter	**Reference**	**Human Health[2]**	**Acute Aquatic Life[3]**	**Chronic Aquatic Life[3]**
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	Primary Contact Recreation: Geometric mean of at least 5 samples obtained during separate 10 day periods within a 60 day timeframe shall not exceed 126 organisms per 100 ml (May 1-Sept 30). Secondary Contact Recreation: Geometric mean of at least 5 samples obtained during separate 10 day periods within a 60 day timeframe shall not exceed 630 organisms per 100 ml.		
pH	Sections 21 and 26; Appendix B			6.5-9.0 standard units
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 Hargett and Zumberge (2006)	Big Horn and Wind River Foothills Bioregion: Score 62.1 for full support; Score 41.4-62.1 for indeterminate support; and score <41.4 for partial/non-support.		

[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 are designated as Class 2B, 2C, or 2D, (suitable for fish consumption but not drinking water), 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 (WDEQ, 2007). Neither shall be exceeded more than once every 3 years.

Table 4.1 (continued). Numeric and Narrative Quality Standards for Wyoming Surface Waters Applicable for Waters in the Tongue River Watershed (From WDEQ, 2007)

ADDITIONAL PARAMETERS AND RECOMMENDED STANDARDS				
		Standard / Description		
Parameter	Reference	Human Health[2]	Acute Aquatic Life[3]	Chronic Aquatic Life[3]
Habitat	King (1993); Stribling et al. (2000)	Habitat condition no less than 50 percent of reference; total habitat score >100 to qualify as reference		
Electrical Conductivity	King (1990)	Concentrations greater than 6900 µmhos/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 are designated as Class 2B, 2C, or 2D, (suitable for fish consumption but not drinking water), 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 (WDEQ, 2007). Neither shall be exceeded more than once every 3 years.

4.3 SAMPLING PARAMETERS

The following sample parameters were chosen to meet the monitoring objectives and purposes within the interim monitoring projects of the Prairie Dog Creek Watershed.

4.3.1 Field Water Chemistry and Physical Parameters

4.3.1.1 Water Temperature

Water temperature affects the growth, distribution, and survival of aquatic organisms including trout, and other cold water fish species. These organisms are cold-blooded and thus assume the temperature of the water in which they reside. Water temperature is affected by seasonal changes in air temperature, solar radiation, and other factors. Physical factors may also affect stream temperature through loss of vegetative cover caused by disruption of the riparian zone and variation in stream flow due to diversion and irrigation returns.

High summer water temperatures are most critical to trout, and other game and non-game fish species. Cold water fish, especially trout, are mobile and may migrate to cooler upstream reaches. However, low stream flow may prevent trout movement and result in death when lethal temperatures of 25.6°C (78°F) are attained (Garside and Tait, 1958).

Except for Class 2D, 3, and 4 waters, Wyoming surface water quality standards prohibit temperature increases that change natural water temperatures to levels deemed harmful to existing cold water fish life, which is considered by WDEQ to be 68°F (20°C) (WDEQ, 2007). In addition, the standards prohibit activities that cause temperature changes in excess of 2°F

(1.1°C) from ambient water temperatures in Class 1, 2AB, and 2B cold water fisheries (WDEQ, 2007). There are no temperature standards for Class 3B waters, which are not known to support fish populations.

Instantaneous temperature samples normally collected during routine water quality monitoring are insufficient to detect maximum daily temperatures in streams (SCCD, 2000 and SCCD, 2003). Continuous temperature recorders monitor temperature ranges more effectively than the instantaneous temperature samples. Instantaneous temperature samples collected during each sampling event allow for comparisons and correlations with other parameters.

4.3.1.2 pH

A low-cost measurement that is routinely conducted in water quality monitoring is the collection of pH data. Values for pH range from 0 to 14 standard units (SU). The pH of pure water at 24°C (75.2°F) is 7.0 SU, which is neutral. Water greater than 7.0 SU is considered basic and water with a pH below 7.0 SU is considered acidic. The pH for most mountain streams in northeast Wyoming ranges from near neutral to slightly basic while plains streams are usually basic.

Daily fluctuations in stream pH are common and may be quite pronounced when considerable in stream plant growth is present. The pH usually rises during daylight hours in response to plant photosynthesis, which reduces the buffering capacity of water. Reduction in pH normally occurs during the night when plant photosynthesis is reduced.

USEPA has set a pH range from 6.5 SU to 9.0 SU to protect aquatic life (USEPA, 1986). Wyoming water quality standards also set limits from 6.5 SU to 9.0 SU (WDEQ, 2007).

4.3.1.3 Electrical Conductivity

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge) (USEPA, 2012). The primary purpose for measurement of conductivity is to estimate the relative concentration of Total Dissolved Solids (TDS). TDS is a measure of the amount of total substances that are dissolved in water and, although not entirely correct, has also been referred to as salinity. Electrical conductivity is not directly proportional to the TDS concentration; however, the higher the concentrations of dissolved substances present in water, the higher the conductivity measurement. Thus, electrical conductivity is a reliable, inexpensive estimator of TDS. Electrical conductivity is measured in the field whereas determination of TDS concentration requires a more expensive laboratory analysis.

Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows. TDS may pollute streams due to irrigation delivery system seepage (Riggle and

Kysar, 1985) and poor quality irrigation return flows (MacDonald et al., 1991). High conductivity may affect aquatic organisms. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µhos/cm (APHA, 1992). Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates. King (1990) reported that aquatic organisms in several northeast Wyoming ponds were affected when conductivities were greater than 6,900 µmhos/cm. USEPA (1988) found that high conductivity and chloride concentrations resulted in lower diversity of stream macroinvertebrate taxa. Lower diversity of stream macroinvertebrates used as a food source for stream fish may negatively affect fish populations.

There are no Wyoming surface water standards for electrical conductivity or TDS since these parameters generally pose no significant threat to surface water supplies, beneficial use, fisheries, and aquatic organisms. However, quality standards are established for Wyoming groundwater such that TDS concentrations for domestic, agriculture, or livestock use shall not exceed 500 mg/l, 2000 mg/l, or 5000 mg/l, respectively (WDEQ, 2005).

4.3.1.4 Dissolved Oxygen

Dissolved oxygen (DO) is the amount of free oxygen available to fish and aquatic organisms. A minimum of 4 milligrams per liter (mg/l) is required for maintenance and survival of most aquatic organisms (WDEQ, 2007). One mg/l is equivalent to one part per million (ppm). Trout and other cold water fish require a minimum of 5 mg/l dissolved oxygen. Temperature and DO are inversely related. As water temperature rises, DO concentration decreases. DO depletion rarely occurs in shallow, well mixed, aerated streams (Hynes, 1970).

Wyoming surface water quality standards for DO in Class 1, 2AB, 2B, and 2C streams are designed to protect both the early life stages for cold water fish (eggs, larvae and juveniles) and other life stages (adults). A 1 day minimum DO concentration of 5.0 mg/L is set to protect early life stages and a 1 day minimum DO concentration of 4.0 mg/L is set to protect adult cold water fish (WDEQ, 2007). For early life stages, WDEQ recommends a 1 day minimum DO concentration in the water column of 8.0 mg/L to achieve intergravel DO concentrations of 5.0 mg/L (WDEQ, 2007).

4.3.1.5 Staff Gage

Staff gages are used to identify the horizontal water movement at an exact moment. The depth of flow (in feet) is most commonly measured as stage, the elevation of the water surface relative to an arbitrary fixed point. Stream stage is an important parameter of stream flow measurement. Instantaneous stage data can be easily collected by noting the elevation of the water surface on the graduations of the staff gage. Stage is important because peak stage may exceed the capacity of stream channels, culverts, or other structures, while both very low and very high stage may stress aquatic life (USGS, 2005).

The greatest utility of stage measurements, however, is in the construction of a stage-discharge relationship, also known as a stream rating. A stage-discharge relationship is an equation determined for a specific site that relates discharge to stage based on a linear regression of a series of concurrent measurements of stage and discharge (USGS, 2005). This equation should be based on measurements taken over a full range of stream flow conditions (low, moderate, and high flow regimes).

4.3.1.6 Discharge

Discharge, also interchanged with surface water flow, is defined as the rate of flow or the volume of water that passes through a channel cross section in a specific period of time and is usually expressed as cubic feet per second (cfs) (USGS, 2005). Measuring the mean flow velocity across a cross section and multiplying it by the area at that point will calculate the flow rate. To create a stage-discharge relationship, also known as a stream rating, a staff gage measurement must be taken at the time of flow measurements. This relationship equation should be based on measurements taken over a full range of stream flow conditions (low, moderate, and high flow regimes).

Discharge is an important physical parameter monitored during water quality sampling because it may affect the quantities of pollutants present. For example, in most Wyoming streams TSS, turbidity, nitrate, and phosphorus will normally increase with increasing stream discharge while conductivity, chlorides, sulfates, and other ions will normally decrease with increasing stream discharge. Discharge is also the most critical flow-related variable when assessing habitat conditions for fish and benthic organisms in streams with flows of up to 5 cubic feet per second, while velocity is more important in streams and rivers with greater flows (Plafkin et al., 1989).

Discharge may also be used to estimate the load, or amount, of a pollutant by combining measured stream flow with the concentration of a pollutant, called a pollutant load calculation. Pollutant loads are critical elements of TMDL development and implementation, and reduction in pollutant load is often an important measure of success in nonpoint source watershed projects. Estimates of pollutant loads evaluate pollutant response to stream flows and provide information to identify sources of pollutants (USGS, 2005). The relationship between discharge and pollutant concentrations is often used in both SCCD's planning and assessment phases of watershed projects.

4.3.1.7 Habitat Assessment

Evaluation of stream habitat is a necessary component of the total water quality monitoring program. Disruption of upland, riparian, and instream habitat can adversely affect stream water quality and biological communities. Good habitat quality is necessary for sustainable fish populations and healthy aquatic biological communities. Soil compaction, loss of ground cover, and eroding stream banks can result in increased discharge, erosion, sedimentation, and water temperature in the stream. Fish spawning and rearing habitat may be lost and macroinvertebrate populations, which serve as food for fish, may be reduced. Habitat

assessments may be quantitative (habitat parameters measured) or qualitative (subjective with no measurements).

There are no numeric standards for habitat quality in Wyoming water quality standards. However, Section 15 (Settleable Solids) and Section 16 (Floating and Suspended Solids) in the Wyoming water quality standards refer to narrative (non-numeric) standards for Settleable Solids, Floating and Suspended Solids which shall not be present in quantities which could result in significant aesthetic degradation, significant degradation of habitat for aquatic life, or adversely affect other beneficial uses (WDEQ, 2007).

In addition to using the habitat assessment to address narrative Wyoming water quality standards, the habitat assessment will be used to determine if changes in benthic macroinvertebrate populations are due to changes in water quality or to changes in habitat quality. Habitat Assessment data collected during the project will be compared to habitat assessment data collected from "reference" stream reaches identified during WDEQ Reference Stream Project monitoring at similar stream types in the Northwestern Great Plains ecoregion and Middle Rockies ecoregion of Wyoming.

4.3.2 Laboratory Analyzed Water Chemistry Parameters

4.3.2.1 Turbidity

Turbidity is a common parameter measured in water quality monitoring studies since analysis of samples is inexpensive and results may be used as an indicator of suspended sediment concentration. Turbidity is based on a comparison of the intensity of light scattered by a water sample with the intensity of light scattered by a standard reference solution under the same conditions (APHA, 1975).

A strong, direct correlation may exist between turbidity and suspended sediment. Therefore, the higher the turbidity values in a sample, the higher the suspended sediment concentration. High turbidity values may be caused by substances other than sediment. Presence of natural water color due to high mineral content (i.e. sulfates, chlorides) or to significant amounts of algae entrained in water may affect turbidity values.

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

Narrative water quality standards for turbidity in Class 1, 2AB, 2A, and 2B water bodies prohibits discharge of substances attributable to or influenced by the activities of man to be

present in quantities that would result in a turbidity increase of more than 10 nephelometric turbidity units (NTU's). The WDEQ may allow short-term increases in turbidity subject to approval from the Administrator (WDEQ, 2007). Although Prairie Dog Creek is not currently listed for sediment or turbidity, the PDCWC and SCCD considers sediment to be a contributing factor to bacteria levels in Prairie Dog Creek.

4.3.3 Laboratory Analyzed Biological Parameters

4.3.3.1 Escherichia coli

Fecal coliform bacteria are present in the digestive tracts of humans and mammals. Sampling for fecal coliform bacteria may be considered as one of the most important tests conducted in water quality monitoring programs because of public health and safety concerns. Cholera, typhoid fever, bacterial dysentery, infectious hepatitis, and cryptosporidiosis are some of the well-known diseases that spread through contact with contaminated water. Eye, ear, nose, and throat infections may also result from contact with contaminated water.

Presence of fecal coliform bacteria in water indicates that the water is contaminated with fecal material and suggests the possible presence of pathogenic organisms harmful to humans. Animals and humans may be carriers of these pathogens. Because of this, domestic sewage from wastewater treatment systems and runoff from land may contaminate water with pathogens.

Escherichia coli (*E. coli*) are a species of fecal coliform bacterium commonly used as an indicator of fecal contamination. *E. coli* comprises many different strains of which the vast majorities are not pathogenic to humans (Hinton, 1985). However, particular strains of *E. coli* (i.e. *E. coli* 0157:H7) and other very toxic strains may be responsible for haemorraghic colitis (severe diahhrea) and hemolytic uremic syndrome (kidney failure) in humans, which may be fatal if left untreated. *E. coli* is considered to be a superior indicator of pathogens originating from fecal matter; the fecal coliform test may also detect non-fecal bacteria (USEPA, 1986). Epidemiological studies have also demonstrated that *E. coli* concentration is more strongly correlated with incidents of gastrointestinal illnesses than fecal coliform concentration. Consequently, *E. coli* is considered a better indicator of public health risk than fecal coliforms (WDEQ, 2011). For this reason, WDEQ replaced fecal coliform with *E. coli* as the indicator species for Wyoming surface water quality standards (WDEQ, 2007).

The *E. coli* standards are based on use during the summer recreation season (May 1st through September 30th) of surface waters and the degree of body contact likely occurring within these waters. These standards are intended to maintain a level of water quality that is safe for human contact by protecting humans from fecal associated pathogens, including bacteria, viruses and protozoa (WDEQ, 2014). Limits for primary contact recreation waters are set at 126 organisms per 100 mL and at 630 organisms per 100 mL for secondary contact (WDEQ, 2007). Primary contact recreation means any recreational or other surface water use that could be

expected to result in ingestion of the water or immersion (full body contact). Secondary contact recreation refers to any recreational or other surface water use in which contact with water is either incidental or accidental and that would not be expected to result in ingestion of the water or immersion (WDEQ, 2001 and 2014). All of the streams in this Prairie Dog Creek Watershed project boundary are considered primary contact recreation waters.

Because *E. coli* concentrations can be highly variable, these standards are based on a 60 day geometric mean of *E. coli* samples. In order to represent the entire 60-day period, WDEQ requires that a minimum of five samples be collected and that they be separated by a minimum of 10 days (WDEQ, 2014). However, WDEQ recommends collecting more than five samples when resources allow. When more than five samples are collected, samples within ten day periods must be averaged before being used to calculate the 60 day geometric mean.

E. coli bacteria concentrations are known to vary due to a number of different water quality and water quantity factors, including discharge, temperature, and sediment. These variations are not well understood and may be affected by inputs from other sources, dilution from precipitation events, die-off or multiplications within the water column or sediments. Discharge information is necessary to estimate the load, or amount, of a pollutant by combining measured stream flow with the concentration of a pollutant. Estimates of pollutant loads assist to evaluate pollutant response to variable temporal and spatial stream flows and provide information to identify sources of pollutants.

4.3.3.2 Benthic Macroinvertebrates

Aquatic macroinvertebrates reside in and on the bottom substrate of streams and provide another valuable tool for assessment of water quality. They are small but visible to the naked eye and large enough to be retained in a U.S. Standard No. 30 sieve. Water chemistry sampling provides information for the quality of water at the time of sample collection. In contrast, macroinvertebrates serve as continuous monitors of stream water quality since they live in the water during the majority of their life cycle and are exposed to variable concentrations of pollutants over extended periods of time. This is an important concept because instantaneous water quality sampling may miss important changes in water quality due to normal seasonal and spatial variability, changes in land use, water management, or accidental pollutant spills that macroinvertebrates may detect.

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

Wyoming has developed biological criteria for streams statewide, but they have not been adopted as numeric, enforceable standards (Stribling et al., 2000). As such, they may be used as a narrative standard to determine beneficial use for protection and propagation of fish and wildlife, and aquatic life use.

4.3.4 Supporting Information

4.2.4.1 Meteorological Data

Precipitation and air temperature are essential components in watershed scale monitoring projects. The timing and magnitude of water yield may affect chemical, physical, biological, and habitat parameters in a waterbody. Precipitation and temperature analyses may indicate whether observed water quality changes among years are related to normal annual fluctuations rather than anthropogenic (man-caused) effects.

CHAPTER 5 SAMPLING DURATION AND COLLECTION METHODS

5.1 SAMPLING SCHEDULE

There will be a total of 14 water quality sampling stations. Of the 14, 13 will have staff gages, seven will have continuous temperature recorders, and four will be used for macroinvertebrate collection and habitat assessments (Table 5.1). The continuous recorders will monitor in-stream temperatures from May 1st - October 31st every sampling year. Since the same sites and similar monitoring periods will be used, continuous temperature data collected can be directly compared to data collected during the 2007-2008 Assessment, along with all interim monitoring data.

Grab samples for bacteria and turbidity will be collected five times each in separate 60 day periods from the high flow season (May to June) and low flow season (August to September) so that geometric means can be established and compared to Wyoming water quality standards (Table 4.1). Other grab sample parameters include: pH, instantaneous temperature, specific conductivity, dissolved oxygen, and stage height. These parameters will be recorded in the field at each sampling station during each of the randomly selected sampling days (Table 5.1). Staff gages will be calibrated such that discharge can be estimated from the stage height measurements, using a stage-discharge relationship equation. Staff gage and bench mark locations will be surveyed before or throughout the high flow sampling (May - June) and after the low flow season (August – September). Upstream and downstream photos of every station will be taken during of high flows during May or June, during low flow events in August or September, and during habitat assessments. Additional photos will be taken as needed to document special conditions.

Reach level habitat assessments will be conducted in conjunction with benthic macroinvertebrate sampling at each of the sites specified in Table 5.1. This monitoring, also known as Macro-Hab, will be conducted in early October after the irrigation season, to capture low and natural flow events. Macroinvertebrate samples are collected easier and more accurately during low flows because the collection net measures only 12 inches high. On Prairie Dog Creek, flows often are too high for macroinvertebrate sampling during the irrigation season. There will be four Macro-Hab sites in the Prairie Dog Creek Watershed monitoring schedule.

Supporting data, consisting of meteorological data of mean and normal precipitation and air temperatures, will be collected from basic daily climate data recorded at the Sheridan County Airport in Sheridan, Wyoming during May 1st through October 31st of each interim monitoring year. This data is stored on NOAA's (National Oceanic and Atmospheric Administration) National Weather Service Forecast Office website, and will be downloaded onto SCCD's server.

Table 5.1 Sample Schedule for 2014 Prairie Dog Creek Watershed Monitoring

Date(s)	Sites	Parameters
May 1st – October 31st, 2014	PD01, PD02, PD05A, PD06, PD07, PD08, PD09	Continuous Temperature - Data will be transferred once per month
May 8th	PD01, PD02, DC01, PD03A, WCC01, PD04, PD05A, PD06, MC01, PD07, PD08, JC01, PD09, PDD01	Instantaneous Temperature, pH, Cond, DO, Q, T, and *E. coli.* Upstream and downstream photos will be taken once in the timeframe during high flows
May 20th		
June 4th		
June 18th		
July 1st		
July 31st	PD01, PD02, DC01, PD03A, WCC01, PD04, PD05A, PD06, MC01, PD07, PD08, JC01, PD09, PDD01	Instantaneous Temperature, pH, Cond, DO, Q, T, and *E. coli.* Upstream and downstream photos will be taken once in the timeframe during low flows
August 14th		
August 28th		
September 9th		
September 24th		
October, 2014	PD01, PD05A, PD06, PD09	Macroinvertebrates, Habitat, Photo

Sampling dates were randomly selected and may be subject to modification. Changes will be described in field log.
Abbreviations include: Instantaneous Temperature = Instantaneous water temperature, pH = pH, Cond = electrical conductivity, DO = Dissolved oxygen, Q = Discharge, T = Turbidity, *E. coli* = *Escherichia coli*, Macroinvertebrates= Benthic macroinvertebrates, Habitat = Habitat assessment, Photo = Panoramic reach photographs, and upstream and downstream riffle photographs.

5.2 SAMPLE COLLECTIONS

5.2.1 Field Preparations and Methods

Prior to leaving the office for field sampling, samplers will ensure that all equipment is available, in proper working condition, and calibrated properly, if needed. Field checklists identify the equipment and other supplies needed for each type of monitoring (Appendix D). Ice for sample preservation may be purchased prior to sampling and stored in the freezer at the SCCD office. Monitoring instruments, with the exception of the Marsh-McBirney Flow-Mate meter, will be calibrated at least once in the office prior to leaving for sampling and as needed while sampling. Calibration and maintenance logs will be maintained for all instrumentation. These logs are bound and are maintained for the life of the instrument. Containers and preservatives will be picked up from the contract laboratory on the morning of sampling, or the day before sampling. To prevent contamination, sample containers will be left unopened until the time of collection.

Prior to entering the stream, samplers will make careful observations as to the sampling conditions. If conditions are suitable, samples should be collected following the protocols outlined in this SAP. However, if there is any doubt as to the safety of the samplers, sampling protocol may be adjusted and recorded on the field data sheet (Appendix D). Once samples are

collected and before leaving the sampling site, the sampler will ensure all required data were collected and recorded on the field data sheet and/or the field log. Any questionable data, problems encountered, and general observations will be noted on the field data sheet before leaving the site.

5.2.2 Water Quality

To minimize disturbance to stream substrate to prevent the introduction of bed load sediment into the grab sample containers, *E. coli* bacteria and turbidity grab samples will be collected before measuring field water chemistry parameters. The goal is to collect samples that are representative of the site conditions at the time the sample was collected. Grab samples will be taken in moderate flowing water and preferably in the middle of the stream at 0.6 the depth of the water column when discharge and adequate depth allows (Ponce, 1980). Water samples of *E. coli* and turbidity that require laboratory analysis will be immediately preserved (if required), placed on ice, and hand delivered to the contract laboratory. Samplers will adhere to preservation and holding time requirements (Table 5.2). Chain of custody (COC) forms will be prepared and signed by sampler prior to delivery to the laboratory.

The appropriate sample containers and necessary preservatives will be provided by the contract laboratory. Trip blanks will be prepared by the contract laboratory and provided with each daily sample set. The laboratory will be notified at least 3 days in advance of sampling in order to provide adequate time to prepare trip blanks. Empty turbidity and *E. coli* whirlpack bottles will be provided by the contract laboratory and used as field blanks. Samples requiring preservation will be immediately preserved, placed on ice and kept between 1-4°C, and hand delivered to the contract laboratory with the appropriate chain of custody forms (WDEQ, 2011; SCCD, 2013). SCCD personal will request lab blanks be conducted from the contract laboratory while analyzing the field samples. The laboratory will analyze samples according to their respective Standard Operating Procedures and Quality Assurance Project Plan (QAPP) (Appendix G). Results of data analyses will be sent to the SCCD.

Table 5.2 Standard Field and Laboratory Methods for Monitoring

Parameter	Sample Method	Units	Reference[1]	Location of Analyses	Preservative	Holding Time
Instantaneous Temperature	In situ	Degrees Celsius (ºC)	USEPA 1983 170.1	On-site	None; field measurements	n/a
Continuous Temperature	Onset Hobo Waterproof Temperature Logger connected to staff gage	Degrees Celsius (ºC)	continuous recorder	On-site download; office analysis	None; field download using Onset Waterproof Shuttle	n/a
pH	In situ	Standard Unit (SU)	USEPA 1983 150.1	On-site	None; field measurements	n/a
Electrical Conductivity	In situ	µS/cm	USEPA 1983 120.1	On-site	None; field measurements	n/a
Dissolved Oxygen	In situ	mg/l	USEPA 1983 360.1	On-site	None; field measurements	n/a
Turbidity	Grab	NTU	SM2130[3]	IML[2]	Ice; at or below 4ºC	48 hours
E. coli	Grab	col/100 ml	SM9223B[3]	IML[2]	Ice; at or below 4ºC	6 hours
Staff Gage	In situ	cfs	Calibrated staff gage	On-site	None; field measurements	n/a
Flow	Stable, uniform cross section close to sample site	cfs	Mid-Section Method	On-site	None; field measurements	n/a
Macroinvertebrates	Riffle habitat collection using modified dip net (described in 5.2.8)	Metrics	King 1993	AA[4] ABA[5]	Formalin (10%), Ethyl alcohol (90%) mixture; see SOP for macroinvertebrate sample preservation	Indefinite; samples may need to be decanted and re-preserved
Habitat (Reach level)	Reach habitat observations (described in 5.2.9)	n/a	King 1993	On-site	None; field measurements	n/a

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

After collecting grab samples, a five gallon plastic bucket will be rinsed at least twice with ambient stream water. Facing upstream, the bucket will be filled with stream water, returned to the stream bank, and field water quality parameters will be analyzed immediately with portable monitoring instruments. Field water quality parameter measurements will be recorded on appropriate field data sheets (WDEQ, 2011; SCCD, 2013).

Field parameters include: instantaneous temperature, pH, conductivity, and dissolved oxygen. Instantaneous temperature and pH will be measured with a Hanna Instruments meter Model No. HI 9025. Conductivity will be measured with a Hanna Instruments conductivity meter Model No. HI 9033. Dissolved Oxygen will be measured with an YSI Model Pro20 meter; this instrument also measures temperature. All instrumentation will be calibrated according to the manufacturer's instructions prior to field sampling. Calibration requirements for these field instruments can be found in Table 6.1.

During high water when stream entry may be considered hazardous, samples and field parameters should be collected from shore.

5.2.3 Staff Gage

Like in previous years, each sampling site will be equipped with a staff gage for flow measurements, except for PD01, which contains a USGS monitoring station. The staff gage consists of a rigid metal plate graduated in feet. The plat is screwed onto a wooden plank attached to a metal u-post, which has been installed in the streambed or attached to the bank. During site reconnaissance, previous gages will be inspected, surveyed, and replaced if needed; gages will be installed at any new sites. Upon installation and/or inspection, gages will be surveyed and compared with a permanent bench mark (e.g. a bridge wing-wall, positioned rebar stake, or some other permanent, easily identifiable spot) so that the elevation of the gage can be checked periodically and re-established if it has been disturbed. This will confirm the stability of the gage to ensure consistent calibration. Should the staff gage be vandalized, destroyed, or otherwise modified, the gage will be re-installed and re-calibrated using the corresponding benchmark as a reference.

Gages will be located in a straight channel section, upstream of a stable control structure. Gages will also be placed in a stable area of the stream, perpendicular to the water column, in an area where the horizontal water movement is minimal, and water is present even at low flow events. Staff gage measurements will be recorded during every water quality sampling event at every station. The USGS Station No. 06306250 will be used to collect flow data for PD01. At the end of the season, staff gauges will be resurveyed to ensure consistent measurements throughout the season. If beginning and end-of-season staff gage calibrations are off by less than 0.5 feet, the staff gage needs to be evaluated for the following:

- Did the staff gage move?
- If yes, discard staff gage measurements and stage-discharge relationships
- If not, ask the following questions: Was the first staff gage reading misread? Was there an error/confusion on the benchmark, was the benchmark measurement misread, or did the benchmark move?

If staff gage does not appear to have moved, and calibration measurements are off less than 0.5 feet, judgment to discard staff gage data is up to the Field Supervisor. If staff gage does not

appear to have moved, but beginning and end calibration measurements are off more than 0.5 feet, discard staff gage measurements and stage-discharge relationships.

5.2.4 Discharge

Discharge measurements for calibration purposes will be in a stable, straight channel section with uniform flow that is not affected by turbulence or obstructions. Samplers will stretch a measuring tape across the channel. Based upon the width of the channel, the samplers will determine the appropriate distance interval between measurements. Ideally, the selected interval will include 20 measurements across the channel. However, on smaller tributaries, this may not be possible. Preferably, no single subsection should contain more than 10% of the total discharge. At each location, the sampler shall record the tape distance, the depth of the water (using the top-setting rod), and the velocity. If depth is less than 2.5 feet, velocity measurements will be taken at 0.6 the depth of the water column. If depth exceeds 2.5 feet, two velocity measurements should be taken; one at 0.2 and one at 0.8 the depth of the water column. Gage height will be measured by reading the water level on the staff gauge and recording the information on the appropriate data sheet (Appendix D). The gauge height will be incorporated into a stage-discharge equation to estimate discharge. SCCD will discard all emerged or submerged staff gage measurements in the monitoring reports, unless other measurements are made available by USGS gauges or other instruments. Fixed gage stations operated by USGS will provide additional discharge data.

In order to develop stage-discharge relationships, discharge will be measured at each calibrated staff gage three to five times to capture various flow regimes. When flows are wadeable, samplers will use the mid-section method (WDEQ, 2011) to measure velocity with a Marsh-McBirney Flow-Mate 2000 portable current velocity meter and top setting rod at each sampling station. Before, during, and after every field season, or after battery replacement, SCCD will conduct a “zero check” using a five-gallon plastic bucket of water. If the Marsh McBirney Flow-Mate fails the bucket test, it will then be sent to the manufacturer for a factory calibration. The last factory calibration on the Marsh-McBirney Flow-Mate was in April 2013.

5.2.5 Continuous Temperature Loggers

Onset HOBO temperature data loggers, used for continuous temperature monitoring, were factory calibrated and completely encapsulated. These loggers are considered disposable; when the enclosed battery is depleted, it cannot be replaced. To verify the accuracy of the factory calibration, the loggers will be checked by utilizing the manufacturers “crushed-ice test” at the beginning and end of the season to ensure the loggers will perform or has performed accurately.

The manufacturer’s instructions for this ice test will be adhered to and followed accordingly. A seven pound bag of crushed ice will be emptied into a 2.5 gallon bucket. Distilled water will be added to just below the level of the ice, and then the mixture will be stirred. The data loggers will be submerged in the ice bath and the bucket will then be placed in a refrigerator to

minimize temperature gradients. If the ice bath is prepared properly and if the loggers have maintained their accuracy over the winter, the loggers should read the temperature of the ice bath as 0°C ±0.232°C. If a logger does not read 0°C ±0.232°C, the logger will be deemed unusable for the 2014 field season.

If a continuous temperature logger is deemed usable, it will be brought out into the field and secured around the base of the staff gage. Continuous water temperature data loggers will be deployed at seven stations to measure water temperature at 15 minute intervals during May through October. Collection of the temperature logger data will be transferred to a waterproof Onset HOBO Shuttle and subsequently downloaded onto the SCCD server roughly once per month.

5.2.6 Photopoints

Photopoints will be established at the base of the stream reach and will correspond to those used in previous monitoring efforts. Upstream and downstream photographs will be taken to aid in station relocation, provide a visual record, and assist in interpretation of habitat assessment data. Photographs will be taken once during high flow season (May-June) and once during the low flow season (August-September), and at select stations during habitat assessments. Photos will consist of one horizontal photograph facing upstream and one horizontal photograph facing downstream.

During the macroinvertebrate collections and habitat assessments, one photograph will be taken at the bottom of the riffle looking upstream, and one at the top of the riffle looking downstream. In addition, a multiple shot panorama will be taken from a spot that displays the sampled riffle and upstream reach characteristics and habitat. In addition to the regular photo documentation, photographs should be taken of any observation regarding the channel or adjacent uplands that requires special notation in the field log or datasheets.

Photograph descriptions will be recorded on the data sheets and in the field log book. The printed photographs will be kept in the watershed data sheet binder organized by site location at the SCCD office, and will also be attached in an appendix of the watershed report. Digital photos will be stored on the District's server. Each printed photo will be labeled with the date, time, site identification, and description within the appendix album.

5.2.7 Aerial Photograph Maps

Aerial photograph maps will be created, stored in the District's server files, and printed for storage in the corresponding watershed data sheet binder. Aerial photograph maps will be created for every water quality sampling and Macro-Habitat site. Each map will display parcel boundaries, site location (if applicable, both macroinvertebrate and water quality station), and any permitted point source discharge locations, if applicable.

Once macroinvertebrate sample collection and habitat assessment have been conducted, an additional aerial photograph map will be created to indicate the section of reach analyzed in the habitat assessment, the riffle length and location of where the macroinvertebrate sample was collected, and the location of the water quality site that will be referenced to the macroinvertebrate site.

5.2.8 Benthic Macroinvertebrates

Benthic macroinvertebrate sample collection and analysis will follow WDEQ protocol (WDEQ, 2004; King, 1993). Benthic macroinvertebrate samples will be collected at four sample sites in October. At each site, eight samples will be collected from a representative riffle/run reach and composited into a single sample. Sampling will begin at the downstream portion of the riffle and proceed upstream to prevent substrate disturbance and incidental sampling of drift. A surber sampler, equipped with a 500 micron, 3 foot extended net, will be used. A random number table will be used to select individual square foot quadrants for sampling. Refer to Appendix C, Macroinvertebrate Sampling – Targeted Riffle Method for random number table description.

Surber samplers will be firmly seated on the stream bottom facing upstream into the stream flow. Before disturbing substrate surrounded by the Surber sampler, ocular estimates of substrate composition and embeddedness will be recorded (Section 5.2.91). After completion of substrate and embeddedness observations, larger cobble and gravel within the Surber will be scraped by hand and soft brush, visually examined to ensure removal of all organisms, then discarded outside the sampler. Remaining substrate will be thoroughly disturbed to a depth of approximately 2-3 inches (5-8 cm) to allow organisms to be transported into the net. Net contents will be placed into a tub and rinsed into a U.S. Standard No. 35 (500um) sieve. Sieve contents will be placed into labeled plastic jars and preserved with a 10% formalin mixture (King 1993). This mixture is obtained through mixing 1 cup formaldehyde with 1 gallon of 90% isopropyl alcohol.

After macroinvertebrate collection, stream current velocity will be measured in feet per second (ft/s) by placing a portable current meter at 0.6 times the water depth at each sample quadrate. The meter will be placed where the front of the Surber sampler was located. The purpose for velocity measurement is to determine if differences in sediment deposition and embeddedness among stations may be due to differences in current velocity.

5.2.9 Habitat Assessment

Habitat assessments will be conducted at the same riffle and stream reach where macroinvertebrates are collected after biological sampling is completed, with the exception of the substrate embeddedness which is completed before the biological sampling. The habitat assessment will be conducted using a condensed version of WDEQ protocols following methods found in Platts et al. (1983), Plafkin et al. (1989) and Hayslip (1993) compiled and modified by King (1993) for use in Wyoming. The habitat assessment includes semiquantitative substrate

particle size composition and embeddedness evaluation, qualitative habitat assessment for the stream reach, and photopoints.

5.2.9.1 Substrate Composition

Evaluation of substrate is required because substrate particle size is an important factor controlling the composition and density of benthic macroinvertebrate populations. A station dominated by diverse cobble and gravel substrate will normally have a diverse benthic macroinvertebrate population (in the absence of water pollution). Stream reaches dominated by sand and silt substrate will exhibit different benthic community composition when compared to reaches dominated by cobble and gravel. Population density and diversity is usually reduced because favorable habitat for colonization of organisms has been reduced. Water quality monitoring programs must include evaluation of substrate to determine whether observed change in benthic macroinvertebrate populations are due to water pollution or merely to change in stream substrate. Evaluation of differences in substrate particle size among stations may reveal disruptions in the watershed often evidenced by increased sand and sediment deposition.

Immediately after the Surber sampler is seated and before substrate is disturbed, the percent area occupied by cobble, gravel, fine gravel, sand, and silt (Table 5.3) will be estimated for each of the eight Surber sample quadrates (DeBrey and Lockwood, 1990; Platts et al., 1983). A piece of Plexiglas is used to reduce surface glare to aid in observation of substrate.

Table 5.3 Stream Substrate Particle Size Classification (Plafkin et al., 1989 and Burton, 1991)

Type	Size
Boulder	Greater than 10 inches
Cobble	2.5 inches to 10 inches
Coarse Gravel	1 inch to 2.5 inches
Fine Gravel	.3 inch to 1 inch
Silt[1]	.3 inch and below (texture soft, fine)
Sand	.3 inch and below (texture gritty, coarse)
Hard Pack Clay	.3 inch and below (solid, slick)

[1] When silt is greater than approximately 1/4 inch (about 6 millimeters) in depth, the substrate is classified as silt. When silt is less than approximately 1/4 inch, the substrate underneath the silt is classified.

5.2.9.2 Semi-quantitative Embeddedness (silt cover)

Embeddedness is a measure of the degree to which cobbles and gravels are covered or surrounded by fine silt. Embeddedness will be classified at the same time as substrate particle size classification for each of the eight Surber sample quadrates. The observer will assign a rating to each quadrate based on the percent of the cobble and gravel surfaces that are covered by silt (Table 5.4).

Table 5.4 Embeddedness Rating Classification (Platts et al., 1983)

Rating	Description
5	Less than 5 percent of surface covered by silt
4	Between 5 to 25 percent of surface covered by silt
3	Between 25 to 50 percent of surface covered by silt
2	Between 50 to 75 percent of surface covered by silt
1	Greater than 75 percent of surface covered by silt

5.2.9.3 Qualitative Habitat Assessment

The habitat assessment is a qualitative assessment comprised of thirteen (13) components (Table 5.5). Because of the subjective nature of the assessment, results must be interpreted with caution. The majority of habitat assessment parameters are "discharge dependent". This means many habitat parameters rate higher during periods of higher discharge and rate lower during periods of low discharge.

The qualitative habitat assessment methods to be used are described in King (1993), which was based on compilation of methods presented in Plafkin et al. (1989), USEPA (1991), and Hayslip (1993). The length of stream reach assessed will be determined by multiplying the bankfull width times 20, or a minimum of 360 feet (WDEQ, 2011; Burton, 1991).

Table 5.5 Habitat Assessment Parameters

Primary Parameters (each 20-0 points)	
Bottom substrate / Percent fines	Estimates the percent of combined sand and silt **only** within the riffle/run sampled.
Embeddedness (silt cover)	Estimates the degree to which cobble and gravel were covered or surrounded by silt **only** within the riffle/run sampled.
In stream cover (for fish)	Estimates the amount of in stream features serving as habitat and cover for fish for the entire reach.
Velocity / Depth	Estimates the relative contribution for four different velocity and depth regimes within the entire reach (Fast and deep, Slow and deep, Fast and shallow, Slow and shallow). A stream reach with equal mixtures of each is desirable and would score high. A stream reach dominated by one velocity/depth regime (which may naturally occur in some stream types) would score low.
Channel Flow Status	Estimates how much of the stream channel and in stream structures are covered by water within the entire reach. Complete inundation of the channel and in stream structures would rate highest.
Secondary Parameters (each 15-0 points)	
Channel shape	Evaluates the approximate shape of the stream channel at the bankfull stage for the entire reach A stream channel may normally be comprised of an admixture of two shapes. **Trapezoidal** (undercut banks) will rate highest; **Rectangular** will rate high; **Triangular** will rate lower, and **Inverse trapezoidal** (obvious deposition and bars in channel) will rate lowest.
Pool / Riffle Ratio	Estimates the approximate ratio for the distance between pools and riffles. A consistent pool and riffle sequence within the entire reach is desired. A variety of pool and riffle habitat would rate high. Lack of a pool and riffle sequence and dominance by all pool or all riffle would rate low.
Channelization/alteration	Estimates the amount of man-caused channelization (straightening) and channel disruption (dredging) in the entire reach. The length of time in years since channelization will be an important element for assessing this parameter
Width to Depth Ratio	The approximate average "wetted" channel width divided by average water depth within the entire reach. This provides an estimate for the amount of channel that may support fish and aquatic life. A low width to depth ratio, less than 7, is optimal and a high width to depth ratio, greater than 25, will rate low.
Tertiary Parameters (each 10-0 points)	
Bank Vegetation Protection	Estimates the amount of stream bank (at the bankfull stage) within the entire reach covered by vegetation, large cobble, boulder and larger woody debris serving to provide bank stability. The rating would increase as bank area covered by protective bank features increases.
Bank Stability	Estimates the amount of bank erosion (at the bankfull stage) within the entire reach evidenced by raw, sloughing, or unstable banks. A stream reach dominated by unstable banks would rate low.
Disruptive Pressures	Estimates the degree that vegetation was cropped or removed from the stream bank immediately adjacent to the stream along the entire reach. Presence of all vegetation expected for the ecoregion, stream channel type and seasonal development would rate high. Significant removal of vegetation would rate lower.
Zone of Influence	Estimates the width of the riparian zone within the entire reach. Consideration is given to the degree of human impact within the riparian zone. A wide riparian zone with negligible human impact provides an adequate buffer zone to filter water pollutants and would rate high. A narrow riparian zone impacted by man related activity would rate low.

5.2.10 Supporting Information

5.2.10.1 Meteorological Data

Measurements of mean and normal precipitation and air temperature for each day during May 1st through October 31st are recorded at the Sheridan County Airport in Sheridan, Wyoming and will be downloaded from the NOAA's (National Oceanic and Atmospheric Administration) National Weather Service Forecast Office website. These data will be compiled for inclusion in the monitoring report and housed on SCCD's server.

5.3 CONTRACT LABORATORIES

The following laboratories will provide analytical services for samples collected as part of the Prairie Dog Creek Watershed Interim Monitoring described in this SAP:

5.3.1 Inter-Mountain Labs

Inter-Mountain Labs (IML) in Sheridan, Wyoming will be the primary provider of analytical services for *E.coli* and turbidity samples collected as part of this project. The WQD lab will provide customized packages of bottles, labels, and preservatives prior to samples being collected as requested by the samplers. Samplers will deliver samples directly to IML lab within the current sampling day. SCCD will provide the chain of custody (COC) forms and fill out the site ID, date and time sample was taken, and the amount of E. coli and turbidity bottles was collected each site. SCCD and IML personnel will sign COC form at the time of hand delivery. IML will analyze samples in accordance with established standards for holding time, analytical method, and data quality assurance and control. Results of analyses will be returned to samples within one month of receipt of samples by IML. IML's QAPP and SOP Manual specific to the parameters contracted by SCCD can be found in Appendix G.

5.3.2 Aquatic Assessments, Inc.

Aquatic Assessments, Inc. (AA), in Sheridan, Wyoming will perform the sorting of the macroinvertebrate samples, and the analysis of Chironomidae larvae. Samples, along with completed chain of custody forms, and the macroinvertebrate and habitat assessment forms, will be hand delivered to AA. Samples received by Aquatic Assessments, Inc., will be evaluated for sample integrity and proper preservation. In the laboratory, at least 500 organisms (usually 500 to 550) will be removed from randomly selected squares in a gridded tray (Caton 1991). When organism density is high (greater than 300 organisms per square), the next square or subsample will be subdivided into quarters by placing an X-shaped frame over the petri dish or sorting container. A random number from 1 to 4 will be selected and all organisms removed from the corresponding quarter. The entire sample will be analyzed if less than 500 organisms are present. After subsampling is completed and 500 to 550 organisms removed, the sorter will re-distribute the remaining sample within the gridded tray and spend approximately 5 minutes looking for large and rare organisms (Vinson and Hawkins, 1996). Organisms removed during the large and rare search will be placed in a separate vial and assigned an occurrence of one (1)

for the correction factor, density and metric calculations. Organisms will be hand-picked from preserved samples with the aid of a stereo binocular dissecting scope at magnifications of 6X to 12X. No flotation methods will be employed. Vials containing organisms will be sealed inside a container along with chain of custody forms and shipped to Aquatic Biology Associates, Inc. (ABA), in Corvallis, Oregon, for analysis. Aquatic Assessments' QAPP and SOP Manual specific to the parameters contracted by SCCD can be found in Appendix G.

Aquatic Assessments Inc. will also analyze habitat parameter measurements and write-up the results of the macroinvertebrate analyses into the monitoring report. Habitat parameters are weighted according to their influence on aquatic organisms. *Primary parameters* receive the greatest weight and describe microhabitat characteristics which have a direct influence on macroinvertebrates. *Secondary parameters* describe macroinvertebrate habitat characteristics through stream channel morphology, which indirectly influence macroinvertebrates. *Tertiary parameters* are weighted less than primary and secondary parameters. These parameters describe surrounding land use characteristics that affect stream bank and riparian zone stability. The higher the individual or cumulative score, the better the habitat. The maximum habitat assessment score is 200 points.

5.3.3 Aquatic Biology Associates, Inc.

Aquatic Biology Associates, Inc. (ABA), in Corvallis, Oregon will perform the taxonomic identification services for the sorted sample (excluding Chironomidae larvae) and large and rare macroinvertebrates. ABA will open the container and perform a visual check for the number and general conditions of the samples. The majority of organisms will be identified to genus or species with the exception of taxonomically indistinct worms and certain difficult Dipteran taxa. The microcrustaceans Cladocera, Copepoda, and Ostracoda; microfauna such as rotifers and protozoa; semi-aquatic, water surface and water column macroinvertebrates; and vertebrates such as fish and amphibians may be noted, but will not be included in taxa lists and metric calculations. A consistent Standard Level of Identification will be used during the project to provide comparable data among years (Appendix E). Density estimates will be expressed as number per square meter (No./m2). AA's QAPP and SOP Manual specific to the parameters contracted by SCCD can be found in Appendix G.

5.4 Storage of Data Records and Laboratory Results

Originals of all data sheets and the master database will be maintained at the SCCD office (Table 5.6). Other collected data (historical and current) will also be kept at the SCCD office. Electronic backups of data will be stored on the SCCD server. This server is backed up to a central server every 15 minutes.

Table 5.6 Storage and Location of Project Records

Record Type	Data Storage	Location	Storage Type
Water Quality Field Data Sheets	Hard copy, and pdf	SCCD	binder file and SCCD server
Macroinvertebrate/Habitat Field Data Sheets	Hard copy, database, and pdf	SCCD	binder file and SCCD server
Discharge Field Data Sheets	Hard copy, spreadsheet, and pdf	SCCD	binder file and SCCD server
Calibration Logs	Hard Copy	SCCD	Instrument specific log books
Staff gage survey notes	Hard Copy	SCCD	Orange survey book
Field Log Book	Hard Copy	SCCD	Yellow waterproof notebook
Chain of Custody Forms	Hard Copy, pdf	SCCD	binder file and SCCD server
Laboratory results	Hard Copy, pdf	SCCD	binder file and SCCD server
Maps	Hard Copy Electronic Copy	SCCD	binder file/SCCD server
Digital Photos	Hard copy, SCCD server, pdf	SCCD	printed photos in data sheet binder & final watershed report/ digital files on SCCD server
Raw Data	Hard copy, database, and spreadsheet	SCCD	binder file/SCCD server
Data analyses	Hard copy, database, spreadsheet, and pdf	SCCD	binder file/SCCD server
Reports etc.	Hard Copy Electronic Copy	SCCD	binder file/SCCD server
SAP/SOPs	Hard Copy Electronic Copy	SCCD	binder file/SCCD server

All data will be stored indefinitely. Upon completion of the project, all computerized data, reports, digital photos, and other information will be stored on the SCCD server system. The project database will consist of electronic computer files constructed with reportable data. Prior to being entered into the database, all data will be subject to QA/QC procedures.

CHAPTER 6 QUALITY ASSURANCE/QUALITY CONTROL (QAQC)

Quality Assurance (QA) may be defined as an integrated system of management procedures designed to evaluate the quality of data and to verify that the quality control system is operating within acceptable limits (Friedman and Erdmann, 1982; USEPA, 1995). Quality control (QC) may be defined as the system of technical procedures designed to ensure the integrity of data by adhering to proper field sample collection methods, operation and maintenance of equipment and instruments. Together, QA/QC functions to ensure that all data generated is consistent, valid, and of known quality (USEPA, 1980; USEPA, 1990). QA/QC should not be viewed as an obscure notion to be tolerated by monitoring and assessment personnel, but as a critical, deeply ingrained concept followed through each step of the monitoring process. Data quality must be assured before the results can be accepted with any scientific study. The QA/QC procedures for the SCCD Watershed Program are described in the SCCD QAPP (SCCD, 2013).

6.1 CALIBRATIONS AND CORRECTIVE ACTIONS

The sampler will be responsible for the proper and consistent calibration and quality control checks of instrumentation. All equipment will be calibrated and checked according to the manufacturer's instructions (Table 6.1 and 6.2). A complete and updated bound calibration log will be maintained by the sampler for all equipment used. Any calibrations made in the field will be recorded on the field calibration logs and transcribed into the bound permanent record for each instrument.

Project evaluations and reviews will be performed throughout the project to confirm that QA/QC criteria are being met. If concerns or issues are discovered during the project, the appropriate corrective actions should be taken for the data to be used (Table 6.1). Data collected without the appropriate QA/QC checks and/or corrective actions will be discarded.

Any necessary changes to this monitoring plan will be documented. Any changes to this document will be incorporated as a new revision. All project samplers will be notified about the content and rationale for any such revisions.

Table 6.1 Calibration, Quality Control Checks, and Corrective Actions (WDEQ, 2011)

Parameter	Calibration	Frequency of Calibration or QA/QC Check	QA/QC Check	Acceptable Range	Corrective Action
Blanks, trip, field, and lab	None	10% of samples for E. coli and turbidity parameters per blank	contamination which might affect analytical results; QA/QC Check on analyzed samples	required	notify sampler and appropriate management; lab may repeat blank with another bottle from same sampler and retest; find contamination source; Project Coordinator decides whether data associated with blank is useable for project
Chain of Custody form	None	each group of samples shipped or hand delivered to the lab	errors and omissions on sheet; SCCD receives original signed COC form, and laboratories get copy	no errors or omissions	notify sampler and appropriate management; audit and train the field sampler; results from samples which are sent to the laboratory without a COC form are not suitable for use in legal actions
Conductivity	calibration according to manufacturer's instructions using 1413 conductivity solution	once a day before sampling or more if meter is drifting	Once daily at end of sampling event with 100 µS/cm standard	± 1% of full scale (1.999 mS/cm)	repeat field check; if still not correct return meter and calibration log book to Project Coordinator for repair or replacement
Marsh McBirney Flow-Mate Meter	inspect meter before each use for damaged parts; Perform bucket test. If meter fails bucket test, send to factory for calibration	Perform bucket test once before field season, once during field season, and once after field season.	None	required	if still not correct do not use; ship to factory for calibration and/or repair/replacement
Dissolved Oxygen	meter measures temperature and auto-calibrates	once a day before sampling or more if meter is drifting	None	instrument specific; generally ±0.1 mg/l	verify barometer and change membrane caps; if still not correct return meter and calibration log book to Project Coordinator for repair or replacement
Duplicates	None	10% of samples for all parameters	required	required	notify sampler and Project Coordinator if missing; audit and train field sampler; Data without this Quality Check will not be used
Macro-invertebrate Sampling	None	10% of all samples	duplicate samples submitted as a blind test to contract laboratory	required	audit and train field sampler and/or sample processing technician
pH	2 point meter check with pH 7.01 and 10.01 buffer standards supplied by appropriate distributor	once a day before sampling or more if meter is drifting	Once daily at end of sampling event with pH 7 standard	±0.1 Standard Units	repeat field check; if still not correct return meter and calibration log book to Project Coordinator for repair or replacement

Parameter	Calibration	Frequency of Calibration or QA/QC Check	QA/QC Check	Acceptable Range	Corrective Action
Sample Preservation	None	all samples	Write approved preservative on sample label. Water quality samples, samples should be no more than 4°C when submitted to laboratory for analysis	no errors or omissions	notify sampler and management; audit and train sampler; resample; data is flagged to indicate that it should not be entered in a database or used for decision making
Sample Labeling	None	all labels	labels contain required information, clear and easy to read	no errors or omissions	audit and train sampler
Staff Gages	survey and calibrate each staff gage using a referenced bench mark	once in the beginning of season and once at the end of the season	None	±0.5 feet	if survey at end of season is off by more than ±0.5 feet, discard site specific gage measurements, and staff-discharge relationships
Temperature	calibration against a thermometer traceable to an NBS thermometer (by IML)	annually or as needed	None	± 0.4 °C	repeat measurement with different thermometer; if not correct contact Project Supervisor
Transcription Review of Data	None	all entered data	review of entered data from field/ lab sheets	required	correct errors; Project Coordinator will reconcile with data quality objectives and determine if further review is necessary

Table 6.2 Detailed Calibration of pH, Conductivity, and Dissolved Oxygen Meters

Type	Calibration	Schedule
pH Meter-Hannah 9025	Immerse electrodes into pH 7.01 buffer solution and shake briefly. Press the CAL key. Press the upper arrow key twice to change display to 7.01. When the display flashes "ready" and "con" press the CFM key to confirm. Immerse the electrodes into pH 10.01 solution and shake briefly. Press the arrow until the display reads 10.01. When the display flashes "ready" and "con", press the CFM key to confirm.	Daily on sample events
Electrical Conductivity Meter-Hannah 9033	Immerse probe into the solution and tap lightly to remove air bubbles. Select appropriate conductivity range. Wait about 5 minutes for temperature to calibrate. Use the small screwdriver to adjust reading to match the conductivity of the standard solution.	Daily on sample events
DO Meter- YSI Pro20	Ensure sponge inside calibration sleeve is moist and insert probe. Power on and wait for readings to stabilize (~15 minutes). Verify barometer reading (see below). Press and hold the CAL key. Highlight "%" and press ENTER. The screen will display the current DO%, temperature, and the % calibration value. Wait until readings are stable (at least 3 seconds), record the values, and press ENTER. "Calibration Successful" will display. To verify barometer reading convert the corrected barometric pressure from the Sheridan County Airport to the "true" barometric pressure {Corrected BP mmHG–(95)}, where 95 is 2.5 * altitude (ft)/100, using 3800 feet at the office and mmHG is inchesHG/0.0394.	Daily on sample events
Current Meter-Marsh McBirney 2000	First clean the sensor because a thin film of oil on the electrodes can cause noisy readings. Then place the sensor in a five gallon plastic bucket of water. Keep it at least three inches away from the sides and bottom of the bucket. To make sure the water is not moving, wait 10 to 15 minutes after you have positioned the sensor before taking any zero readings. Use a filter value of 5 seconds. Zero stability is ± 0.05 ft/sec.	Beginning of the season, and after replacing battery.

6.2 EQUIPMENT MAINTENANCE

The sampler will be responsible for the proper and consistent maintenance of instrumentation. All equipment will be maintained according to the manufacturer's instructions (Table 6.3). A complete and updated maintenance log will be maintained by the sampler for all equipment used.

Table 6.3 Equipment Maintenance

Type	Make / Model	Maintenance	Schedule
Continuous Temperature Meter	HOBO Pendent Temperature 64 Data Logger	Keep logger free of debris, and clean apparatus, check battery	Monthly
pH and Temperature Meter	Hannah 9025	Check/Change Battery, keep probe moist and store in cap	Monthly
Conductivity Meter	Hannah 9033	Check/Change Battery, remove precipitate/debris	Monthly
Dissolved Oxygen	YSI Pro 20	Change Membrane caps Check/Change Battery Inspect O-rings/sensors	Monthly during use Prep for long-term storage
Current Meter	Marsh-McBirney 2000	Check/Change Battery Clean Sensor with soap and water Remove precipitate/debris	Before each trip for gage calibration
GPS Unit	Garmin GPSMAP 62SC	Change Batteries	Annually or as needed
Surber Sampler	Mesh 500 um	Physical Inspection of net; remove any leftover debris	Each use
Digital Camera	Olympus Stylus Waterproof	Check/Re-charge Batteries	As needed

6.3 DOCUMENTATION AND RECORDS

6.3.1 Field and Calibration Documentation

Equipment Checklists will be reviewed prior to leaving the office for a sampling event to ensure all necessary supplies are available (Appendix D). Samplers will carry a field data sheet, log book, and complete entries for each site during each sampling event. Entries will include name of sampler and data recorder, date, time, weather conditions, general observations of the environment (include any run-off events that may have occurred recently), parameters sampled, notes on working condition of equipment (if applicable), difficulties encountered and how remedied, photo record, notes on the need to modify any aspect of the SAP of a specific SOP, and other comments or issues that may need to be noted (general appearance, oil sheen, odors etc.). Calibration logs will be completed for each instrument every time a calibration is performed. Hard copies of the data will be collected in the field and from the laboratories for QA/QC purposes. Original hard copies of the data and laboratory results will be maintained at the SCCD office.

6.3.2 Sample Labeling

Water quality samples will be labeled with a permanent, waterproof marking pen on paper labels. Labels will include: 1) sampling agency (SCCD); 2) date and time using the 24 hour clock;

3) sample identification code (SCCD sample site ID); and 4) preservatives, if applicable. Sample identification information will be recorded on the sample, on the chain of custody forms, on the laboratory's analytical report, and on the field data sheet. IML provides sample bottles with labels that allow for the above specified label contents.

For macroinvertebrate samples, labels will be placed inside and on the outside of the sample containers. The inside labels should be written on heavy paper/card stock with a soft lead pencil. The sample preservative, formalin, will dissolve labeling written in ink. Inside and outside labels will include: 1) client/project (SCCD), 2) sample identification code (SCCD sample site ID); 3) date and time (mm/dd/yy; 24:00), 4) sampler's initials, and 5) bottle number and total number of bottles for that site (e.g. 1 of 3). Sample identification information will be recorded on the inside and outside sample labels, on the COC forms, on the laboratory's analytical report, and on the field data sheet.

6.3.3 Sample Preservation

Water samples requiring laboratory analysis will be immediately preserved (if required), placed on ice and kept at 1-4°C until hand delivered to the contract laboratory. Benthic macroinvertebrate samples will be immediately preserved in the field by a 6% formalin solution obtained by mixing 1 cup formaldehyde with 1 gallon 90% isopropyl alcohol mixture, placed in a cooler, and transported to the SCCD office in Sheridan.

6.3.4 Chain of Custody Forms

Sample custody shows how and when samples were collected, preserved (if required), stored, transported to the laboratory, treated, and tracked during the analytical processes. Chain of custody (COC) forms will be completed by samplers prior to delivery to the laboratory or shipment center. Copies of completed original forms will be maintained at the SCCD office.

Project field measurements will be recorded on field data sheets. The COC form will be prepared and signed by the sampler before samples enter laboratory custody. After samples change custody, laboratory internal COC procedures will be implemented according to their Quality Assurance Plan.

A project-specific macroinvertebrate COC form (Appendix D) will be completed. After all macroinvertebrate samples are collected, samples and COC forms will be sealed inside a cooler and shipped to the contract analytical laboratory. The analytical laboratory will open the coolers, perform a visual check for the number and general condition of samples, and then sign the COC form. The completed original COC form will be returned to SCCD by the analytical laboratory after completion of analyses.

6.4 FIELD QUALITY CONTROL

6.4.1 Duplicates

Duplicate samples are defined as: two or more samples taken consecutively at the same site or two or more measurements made consecutively with a field instrument. Procedures for each duplicate sample must be documented on field data sheets. At the start of the sampling season, the number and approximate schedule for the collection of duplicate samples will be determined. If samples are representative and the sampling methods are consistent, differences between samples and duplicates should be within acceptable ranges for the selected parameter.

Because the established sites will be scheduled for multiple sampling events, each site will be duplicated at least once and at least 10% of the total number of samples will be duplicated. Duplicate samples of laboratory analyzed parameters will consist of two sample bottles filled sequentially at the same site by the same person. To duplicate the on-site analyzed parameters, a sample bucket will be filled and parameters measured and recorded with the field meters. The meters will then be turned off, probes will be removed from the sample buckets, excess water will be shaken off from the probes, and the probes will be returned to the sample bucket. The sampler will then measure and record the duplicate field measurements. At least 10 percent of all macroinvertebrate sampling locations will be sampled in duplicate. Duplicate macroinvertebrate samples will consist of two samplers, each equipped with a Surber net, collecting samples simultaneously adjacent to one another. At least 10 percent of field habitat assessments will be in duplicate by two or more field samplers performing independent assessments without communication at the same site and same time.

6.4.2 Data Quality Objectives

Data Quality Objectives (DQO's) are qualitative and quantitative specifications used for water quality monitoring programs. DQOs function to limit data uncertainty to an acceptable level. DQO's were established for each monitoring parameter for precision, accuracy, and completeness (Table 6.4) as described in the SCCD QAPP (SCCD, 2013).

Table 6.4 Data Quality Objectives

Parameter	Precision (%)	Accuracy (%)*	Completeness (%)	Minimum Detection Limit
Temperature	10	10	95	0.2 ^{O}C
pH	5	5	95	0.01 S.U.
Conductivity	10	10	95	1 µmho/cm
Dissolved Oxygen	20	20	95	0.2 mg/L
Turbidity	20	10	95	0.1 NTU
E. coli	50	NA	95	1 CFU/100 mL
Macroinvertebrates	NA	NA	95	NA
Total Taxa	15	NA	95	NA
Habitat Assessment	NA	NA	95	NA
Intra-Crew	15	NA	10	NA
Discharge	NA	NA	90	NA
Stage-Discharge Relationships	NA	NA	90	Minimum r^2 = 0.90

*The accuracy values shown are acceptable departures from 100 percent accuracy. A 10 percent accuracy value means accuracy values of 90 to 110 percent are acceptable.

6.4.2.1 Precision

Precision is defined as the degree of agreement of a measured value as the result of repeated application under the same condition. The Relative Percent Difference statistic (RPD) will be used to calculate the precision between duplicate samples (SCCD, 2013) as follows:

$$RPD = [(A-B) / (A+B)] X 200.$$

Precision will be determined for chemical, physical (excluding staff and discharge), biological, and habitat measurements by conducting duplicate samples at a minimum of 10 percent of the samples.

6.4.2.2 Accuracy

Accuracy is defined as the degree of agreement of a measured value with the true or actual value. Accuracy for water quality parameters measured in the field can be assured by calibration of equipment to known standards. The contract laboratories will follow their internal QA/QC procedures for water quality samples requiring laboratory analysis. There are no current laboratory methods for determining the accuracy of biological samples, including *E. coli*. In addition, accuracy cannot be determined for macroinvertebrate samples or habitat assessments because the true or actual values are unknown. Precision will serve as the primary QA check for biological and habitat samples.

6.4.2.3 Completeness

Completeness refers to the percentage of measurements that are determined to be valid and acceptable compared to the number of samples scheduled for collection. This DQO is achieved by avoiding loss of samples due to accidents, inadequate preservation, holding time violations, and proper access to sample sites for collection of samples as scheduled.

6.4.3 Trip Blanks

As part of Quality Control, blanks for water samples will be required for all sampling activities. Procedures and the use of blanks will be recorded in the field log book. If samplers have any reason to suspect that sampling bottles may contribute contamination, they should be discarded.

Trip blanks will be included with each delivery of samples to the contract laboratory. Trip blanks will be provided by the contract laboratory for turbidity and *E. coli*. Trip blanks ensure that samples are not contaminated by the sample container, preservatives, and/or storage and transport conditions. Trip blanks will be prepared for each type of sample container and/or preservative by the laboratory. Trip blanks will consist of laboratory de-ionized water or distilled water and the appropriate preservative. The trip blank will remain unopened with the samples until delivery to the laboratory. The parameter to be analyzed for each type of blank will be rotated among sample events.

6.4.4 Field Blanks

As part of Quality Control (QC), field blanks for water samples will be required for all water quality laboratory sampling activities. Field blanks are different from trip blanks in that sterilized laboratory bottles are filled with de-ionized or distilled water while *in the field* and treated as a sample. It is used to identify errors or contamination in sample collection while in the field. If samplers have any reason to suspect that sampling bottles may contribute contamination, they should be discarded.

Sterilized and empty *E. coli* and turbidity field blank bottles will be will be provided by the contract laboratory. At the end of each field day, field blanks will be delivered back to the contract laboratory for analysis. Field blanks will consist of de-ionized water or distilled water and the appropriate preservative. After field blanks have been filled with de-ionized or distilled water, it will remain closed with the samples until delivery to the laboratory. The parameter to be analyzed for each type of blank will be rotated among sample events.

Table 6.5 Field Quality Control (QC)

Field QA/QC Samples	Collection Frequency	Parameters
Trip Blank	1 per 10 samples	Laboratory water quality parameters
Field Blank	1 per 10 samples	Laboratory water quality parameters
Lab Blank	1 per 10 samples	Laboratory water quality parameters
Duplicate	1 per 10 samples	All parameters

Note: See WDEQ SOP for *Quality Control Measures (WDEQ, 2011)*

6.4.5 Comparability

Comparability refers to the degree to which data collected during this project are comparable to data collected during other past, present, or future studies to detect water quality changes. To ensure data comparability, samplers, will:

- collect samples at previously used monitoring stations;
- collect samples during the same time of year;
- collect samples using the same field sampling methods and equipment;
- use the same reporting units and significant figures;
- use the same data handling and reduction methods (i.e. rounding and censoring); and
- use the same QA/QC processes.

It is sometimes necessary to make adjustments to locations, timing, equipment, and protocols. When these adjustments are needed, the changes and reasons for the change will be documented in the reporting documents. When data comparisons are possible, potential issues with comparability will be disclosed.

6.5 DATA VALIDATION AND VERIFICATION

Data generated by the contract laboratories is subject to the internal contract laboratory QA/QC process before it is released to SCCD. This data is assumed valid because the laboratory should adhere to internal QA/QC procedures. Field data generated by SCCD personnel is considered valid and usable only after the QA/QC procedures and process have been applied, evaluated, and determined acceptable. Data determined to be invalid will be rejected and not used in preparation of the final report. The QA Plans for the contract water quality laboratory (Inter-Mountain Laboratories) and the contract macroinvertebrate sample analysis laboratory (Aquatic Biology Associates) are available at the SCCD office.

All computer data entries will be checked for mistakes. If mistakes are suspected, the original field or laboratory data sheet will be re-examined and necessary corrections made. Suspect data that are not resolved will not be entered into the database or will be deleted from the database once detected. Two databases will be maintained to house all water quality data. An *uncensored (raw)* database will contain data reported from field measurements and data

reported by the analytical laboratory including all values that are less than the detection limits. A *censored (statistical)* database will contain data which was censored to allow various statistical procedures to be performed. If a small number of values are below the detection limit, they will be reported as ½ the value of the detection limit (Gilbert, 1987). If over 20 percent of reportable values for a given parameter were below the detection limit, random numbers will be generated to assist in the assignment of censored values. Random number values will replace the original reported value in the censored database (Gilbert, 1987). If *E. coli* samples are reported as less than 1 colony/100 mL or greater than 2419 colonies/100 mL, SCCD will use 1 colony/100 ml or 2420 colonies/100 mL, respectively, for calculating geometric means and other summary statistics, but the uncensored (raw) database will include the data as reported by the laboratory. Data that is determined to be invalid or non-reportable through QA/QC procedures will be discarded and deleted from both the uncensored (raw) and the censored (statistical) database.

Data will first be reviewed by SCCD for comparison to DQOs and project goals. This review will ensure that the DQOs outlined in SCCD's SAP and QAPP are met. The review will consist of reviewing data sheets and field log books, identifying errors in sampler and sample identification codes, decimal placement, dates, times, units, inconsistencies, and comments. In addition, the reviewer will evaluate the raw data received from the contract laboratories. Numerical outliers, totals, unusual species, and odd numbers will be thoroughly investigated. If inconsistencies or outliers are found, the data will be compared with the field data or laboratory sheets, calibration logs, and field logs. If there were no discrepancies in the calibration and if the SAP and SOP were followed, the data will be accepted. Errors found during the data proofing will be corrected. If errors are due to improper calibration methods, or if the SAP and SOP were not followed, the data will be considered invalid and rejected. Invalid data will be deleted from the database and the deletion will be documented in the data validation log.

The reviewer will document how the data were checked, what errors (if any) were found, and whether they were corrected or considered invalid. This documentation will be maintained in the project files and a summary included in the final report.

6.6 FIELD AUDITS

A field audit is an in-person observation period of sampling activities, QA/QC, and records to ascertain that the activities, procedures, methods, QA/QC, and analysis described in your SAP are being followed, SOPs are being followed, and the records are kept as stated. The auditor compiles a report, which SCCD would submit to WDEQ along with SCCD's data or annual report. Field audits should be conducted every four years. If requested, the SCCD will work with the Wyoming DEQ QA/QC officer or other third-party entity to complete a field audit.

PAGE INTENTIONALLY LEFT BLANK

CHAPTER 7 ANALYTICAL METHODS AND REPORTING

7.1 STATISTICAL DESIGN AND ANALYSES

After data validation and data base construction, data will be interpreted using various statistical methods. The monitoring report for this project may include, but will not be limited to interpretive statistics, graphs and the following summary statistics that will be calculated for both the high (May-June) and low flow (August-September) seasons, and the combination of those two seasons:

- Average;
- Coefficient of Variance;
- Count;
- Geometric mean;
- Maximum;
- Median; and
- Minimum.

7.1.1 Field and Laboratory Analyzed Parameters

Water quality data will be evaluated spatially (among stations), temporally (among seasons), and compared to historical data when appropriate. In addition, data will be evaluated according to Wyoming water quality standards. Variation in data will be linked to possible land uses and potential contributing sources when appropriate.

7.1.2 Macroinvertebrate Data Analyses

A series of metrics will be calculated for each macroinvertebrate sample (Appendix E). A metric is a descriptor of one facet of the benthic population that responds to water quality and habitat change in a predictable fashion (King, 1993; Barbour et al., 1999).

Biological condition will be determined by comparison of the benthic macroinvertebrate community sampled to the Wyoming Stream Integrity Index (WSII) developed by Jessup and Stribling (2002), and revised by Hargett and ZumBerge (2006). The WSII is based on the analysis of benthic macroinvertebrate monitoring data collected by WDEQ from 1993 through 2001 from multiple reference and non-reference quality streams statewide. The WSII compares metric values for the sample benthic macroinvertebrate community to optimal benthic macroinvertebrate metric values from combined reference (least impacted) sample stations (Table 7.1). Metrics from the sample are compared to the optimal metric value and expressed as a percent. The percentages are summed for each sample metric to provide a biological condition rating.

Table 7.1 Wyoming Stream Integrity Index (WSII) Biological Condition Scoring Criteria

Macroinvertebrate Metric	Bighorn and Wind River Foothills Bioregion (5th or 95th %ile)
Number Ephemeroptera taxa	9
Number Trichoptera taxa	11
Number Plecoptera taxa	7
% Non-insect	0.3
% Plecoptera	19
% Trichoptera (less Hydropsychidae)	100
% Collector-gatherer	16.5
% scraper	50.3
HBI	1.8
Semi-Voltine Taxa (less semivoltine Coleoptera)	5

Note: Scoring criteria for benthic macroinvertebrate communities developed for the Bighorn and Wind River Foothills bioregion of Wyoming from Hargett and ZumBerge, (2006).

The biological condition rating is used to rate the biological community as Full Support, Indeterminate, or Partial/Non-Support (Table 7.2). The biological condition rating of Full Support indicates full support for aquatic life use, and the rating of Indeterminate indicates additional monitoring and information is required to determine whether the biological condition is either in the Full Support or the Partial/Non-Support category. A station with an indeterminate biological condition rating will require additional sampling. The biological condition rating of Partial/Non-Support indicates that substantial anthropogenic (related to activity by man) activity is occurring at and/or upstream of the sample station and negatively influences biological condition (Hargett and ZumBerge, 2006). Non-support indicates the aquatic community is stressed and water quality or habitat improvement is needed to restore the stream to Full Support for aquatic life use.

Table 7.2 Narrative Assessment Rating Criteria for Aquatic Life Use Support

Rating of Biological Condition (Aquatic Life Use Support)	Bighorn and Wind River Foothills Bioregion WSII (% of Reference)
Full Support	>62.1
Indeterminate	41.4-62.1
Partial/Non - Support	<41.4

Note: Rating criteria for benthic macroinvertebrate communities based on the Wyoming Stream Integrity Index (WSII) from Hargett and ZumBerge (2006).

Prairie Dog Creek benthic macroinvertebrate sample stations are located in the Mesic Dissected Plains (43q) – Northwestern Great Plains ecoregion (Appendix A, Map 8) (Chapman, 2004).

Benthic macroinvertebrate communities will also be compared by station among years (temporal comparison) and between stations (spatial or locational comparison). Biological condition will be compared to certain water quality, physical (including discharge), and habitat variables to determine significant associations that may affect biological condition. To evaluate change in biological condition over time, benthic macroinvertebrate data may be compared to historical benthic macroinvertebrate data when the data is determined to be comparable.

7.2 REPORTS

A monitoring report will be developed after all data are collected and subjected to QA/QC procedures. The report will summarize water quality data collected and compare any changes in water quality to the conditions found during previous monitoring activities. This report will summarize current water quality conditions with comparisons made to previous monitoring efforts. The monitoring report will be submitted to WDEQ.

PAGE INTENTIONALLY LEFT BLANK

CHAPTER 8 WASTE DISPOSAL, SAFETY AND EMERGENCY PROCEDURES

8.1 WASTE DISPOSAL

Buffers, calibration standards, and preservative solutions need to be disposed of properly. Table 8.1 indicates the solutions used during water quality and macroinvertebrate sampling and the proper disposal methods.

Table 8.1 Disposal of Waste

Solution	Used for	Disposal Method
pH Buffers 7.01 and 10.01	Calibration of pH meter	Sewage or sink drain
Conductivity standard 1413	Calibration of Conductivity meter	Sewage or sink drain
6% Formalin: Formaldehyde 90% Isopropyl Alcohol	Macroinvertebrate preservative	Make an appointment and bring to City of Sheridan Landfill during Hazardous Waste designated days

8.2 SAFETY AND EMERGENCY PROCEDURES

The top priority for the project is to maintain the health and safety of all members of the sampling team. Samplers will follow general safety procedures which include:

- If possible, two samplers should be present in all sampling situations;
- Use of safety equipment in appropriate situations; and
- Use of the best professional judgment to avoid potentially hazardous situations such as high flows or unsuitable traveling conditions.

If a hazardous situation is encountered, samplers should cease and depart immediately and notify the District Manager. If situations result in the need to abandon sampling, such situations will be noted in the field log.

Material Safety Data Sheets (MSDS) for all hazardous chemicals applicable to this project are maintained in the District files and will be kept in all sampling vehicles. MSDS's will be maintained for all calibration standards and solutions, preservatives, and other materials should emergency procedures need to be implemented. Formalin, formaldehyde, and isopropyl alcohol will be treated as hazardous substances and appropriate care should be taken when handling.

In the event that an emergency occurs, the field sampler(s) will follow the established Emergency Procedure. Field sampler(s), depending upon the urgency of the situation should notify the SCCD District Manager, the Hospital, and/or the Sheriff (Table 8.2). In the event that

the return of the samplers is questionable, the District Manager should first contact the family or contact person for the samplers and then the Hospital and/or Sheriff.

Table 8.2 Emergency Contact Information

Carrie Rogaczewski, District Manager	1949 Sugarland Drive, Suite 102 Sheridan, WY 82801 Office: 672-5820 Home: 672-6384 Cell: (307) 763-0242
Maria Steyaart, Natural Resource Specialist	1949 Sugarland Drive, Suite 102 Sheridan, WY 82801 Office: 672-5820 Cell: (907) 305-0430
Amy Doke, Program Specialist	1949 Sugarland Drive, Suite 102 Sheridan, WY 82801 Office: 672-5820 Home: 683-3133
Andrew Cassiday, NRCS District Conservationist	1949 Sugarland Drive, Suite 102 Sheridan, WY 82801 Office: 672 -5820 Cell: (308) 430 - 2689
Memorial Hospital of Sheridan County	1402 W. 5th Street Sheridan, WY 82801 Emergency Telephone: 672-1000
Sheridan Search and Rescue/ Sheridan County Sheriff	54 W. 13th Street Sheridan, WY 82801 Main Office Telephone: 672-3455 Emergency Telephone: 911

CHAPTER 9 REFERENCES CITED

American Public Health Association. 1975. Standard methods for the examination of water and wastewater. 14th Edition., Washington, D.C. 1193pp.

American Public Health Association. 1992. Standard methods for the examination of water and wastewater. 18th ed. American Public Health Association, Washington, DC.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton benthic macroinvertebrates, and fish. Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency: Office of Water. Washington, D.C.

Burton, T.A. 1991. Protocols for evaluation and monitoring of stream/riparian habitats associated with aquatic communities in rangeland streams. Water Quality Monitoring Protocols Report No. 4. Idaho Department of Health and Welfare Water Quality Bureau. Boise, ID. 88pp.

Caton, L.W. 1991. Improved subsampling methods for the EPA "Rapid Bioassessment" benthic protocols. Bulletin of the North American Benthological Society 8(3): 317-319.

Chapman, S.S., Bryce, S.A., Omernik, J.M., Despain, D.G., ZumBerge, J., and Conrad, M., 2004, Ecoregions of Wyoming (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,400,000).

DeBrey, L.D. and J.A. Lockwood. 1990. Effects of sediment and flow regime on the aquatic insects of a high mountain stream. Regulated Rivers: Research and Management 5: 241-250.

Eaton, A., L. Clesceri, A. Greenberg. 1995. Standard Methods for the examination of water and wastewater. Washington, D.C.

EnTech, Inc. 2001. Prairie Dog Creek Watershed Master Plan – Level 1 Study. Sheridan, WY.

Friedman, L.C. and D.E. Erdmann. 1982. Quality assurance practices for the chemical and biological analyses of water and fluvial sediments. Techniques of water-resources investigations of the United States Geological Survey. Book 5, Laboratory analysis; Chapter A6. Washington, D.C.

Garside, E.T., and J.S. Tait. 1958. Preferred temperature of rainbow trout (*Salmo gairdneri* Richardson) and its unusual relationship to acclimation temperature. Canadian Journal of Zoology. 36(3): 563-567.

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

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

Hayslip, G.A. 1993. EPA Region 10 in-stream biological monitoring handbook (for wadeable streams in the Pacific Northwest). EPA-910-9-92-013. United States Environmental Protection Agency Region 10, Environmental Services Division, Seattle, WA.

Hinton, M. 1985. The subspecific differentiation of *Escherichia coli* with particular reference to ecological studies in young animals including man. Journal of Hygiene 95: 595-609.

Hynes, H.B.N. 1970. The ecology of running waters. University of Toronto Press, Toronto. 555p.

Jessup, B.K. and J.B. Stribling. 2002. Further evaluation of the Wyoming Stream Integrity Index, considering quantitative and qualitative reference site criteria. Report prepared for U.S. EPA Region 8, Denver, CO. by Tetra Tech, Inc. Owings Mills, MD.

King, K.W. 1990. Effects of oil field produced water discharges on pond zooplankton populations. Wyoming Department Environmental Quality Water Quality Division. Cheyenne. 26pp.

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.

MacDonald, L.H., A.W. Smart and R.C. Wissmar. 1991. Monitoring guidelines to evaluate effects of forestry activities on streams in the Pacific Northwest and Alaska. EPA/910/9-91-001. United States Environmental Protection Agency Region 10, Water Division. Seattle, WA.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M.Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers. EPA/444/4-89-001. United States Environmental Protection Agency Office of Water (Wh-553), Washington, D.C.

Platts, W.S., W.F. Megahan, and G.W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. General Technical Report INT-138. United States Department of Agriculture Forest Service. Ogden, UT.

Ponce, S.L. 1980. Water quality monitoring programs. United States Department of Agriculture Forest Service. Technical Paper WSDG-TP-00002. Fort Collins, CO. 66pp.

Riggle, F.R., and L.N. Kysar. 1985. Salinity control in the Grand Valley of Colorado. *In*: Perspectives on nonpoint source pollution. United States Environmental Protection. Office of Water, EPA 440/5-85-001. Washington, D.C. pp.359-361.

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

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

Sheridan County Conservation District. 2007. Prairie Dog Watershed Monitoring Project: Sampling and Analysis Plan. Sheridan, WY.

Sheridan County Conservation District. 2008. Prairie Dog Watershed Monitoring Project: Sampling and Analysis Plan. Sheridan, WY.

Sheridan County Conservation District. 2009. Prairie Dog Creek Watershed Assessment 2007-2008 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. 2011a. Prairie Dog Creek Watershed Monitoring Project: Sampling and Analysis Plan. Sheridan, WY.

Sheridan County Conservation District. 2013. Water Quality Monitoring Program Quality Assurance Project Plan Revision Number 4. Sheridan, WY.

Sheridan County Conservation District. 2013a. Tongue River Watershed Monitoring Project: Sampling and Analysis Plan. Sheridan, WY.

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, Natural Resources Conservation Service. 2003. National Water Quality Handbook, Part 614 & 615. Washington, D.C.

U. S. Environmental Protection Agency. 1980. Interim guidelines and specifications for preparing quality assurance project plans. QAMS-005/80. Office of Monitoring Systems and Quality Assurance, Office of Research and Development. Washington, D.C.

U.S. Environmental Protection Agency. 1983. Methods for chemical analysis of water and wastes. 600/4-79-020. Environmental Monitoring and Support Lab., Cincinnati, OH.

U.S. Environmental Protection Agency. 1986. Quality criteria for water: 1986. Office of Water Regulation and Standards. Washington, D.C.

U.S. Environmental Protection Agency. 1988. Martha oil field study, Martha, Kentucky. Environmental Services Division Report. Athens, GA. 18pp.

U.S. Environmental Protection Agency. 1990. Biological criteria: national program guidance for surface waters. Office of Water. EPA/440/5-90-004. Washington, D.C.

U.S. Environmental Protection Agency. 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. Office of Water. Washington, DC. http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/decisions_index.cfm

U.S. Environmental Protection Agency. 1995. Generic quality assurance project plan guidance for programs using community-level biological assessment in streams and wadeable rivers. EPA 841-B-95-004. Office of Water, Washington, D.C.

U.S. Environmental Protection Agency. 2012. Water: Monitoring and Assessments. Office of Water. Washington, DC. http://water.epa.gov/type/rsl/monitoring/vms59.cfm

U.S. Geological Survey. 2005. U.S. Geological Survey Streamgaging, from the National Streamflow Information Program. http://water.usgs.gov/nsip/definition9.html

Vinson, M.R. and C.P. Hawkins. 1996. Effects of sampling area and subsampling procedure on comparisons of taxa richness among streams. Journal of the North American Benthological Society 15(3): 392-399.

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

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

Wyoming Department of Environmental Quality. 2001. Quality Assurance Project Plan for Beneficial Use Reconnaissance Project Water Quality Monitoring. Water Quality Division, Watershed Program. Cheyenne, WY.

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

Wyoming Department of Environmental Quality. 2003. Prairie Dog Creek Beneficial Use Reconnaissance Program Monitoring and Assessment Report. Cheyenne, WY.

Wyoming Department of Environmental Quality. 2004. Manual of Standard Operating Procedures for Sample Collection and Analysis. 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 Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report). Cheyenne, WY.

Wyoming Department of Environmental Quality. 2007. Water Quality Rules and Regulations Chapter 1, Quality standards for Wyoming surface waters. Cheyenne, 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/Water Quality Division. 2011. Manual of Standard Operating Procedures for Sample Collection and Analysis. Wyoming Department of Environmental Quality, Water Quality Division, Watershed Program, Cheyenne, 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/Water Quality Division. 2013. Wyoming Nonpoint Source Management Plan Update. Wyoming Department of Environmental Quality, Water Quality Division, Watershed Program, Cheyenne, WY.

Wyoming Department of Environmental Quality/Water Quality Division. 2014. Wyoming's Methods for Determining Surface Water Quality Condition and TMDL Prioritization DRAFT. Wyoming Department of Environmental Quality, Water Quality Division, Watershed Program, Cheyenne, WY.

Sheridan County Conservation District
2014 Prairie Dog Creek Watershed Interim Monitoring
Sampling and Analysis Plan

APPENDIX A

PROJECT AREA MAPS

Sheridan County Conservation District
2014 Prairie Dog Creek Watershed Interim Monitoring
Sampling and Analysis Plan

APPENDIX B

STREAM CLASSIFICATIONS, LISTINGS, STANDARDS, AND PREVIOUS WORK IN THE PRAIRIE DOG CREEK WATERSHED

Sheridan County Conservation District
2014 Prairie Dog Creek Watershed Interim Monitoring
Sampling and Analysis Plan

APPENDIX C

SCCD STANDARD OPERATING PROCEDURES

Sheridan County Conservation District
2014 Prairie Dog Creek Watershed Interim Monitoring
Sampling and Analysis Plan

APPENDIX D

SCCD FIELD SHEETS

Sheridan County Conservation District
2014 Prairie Dog Creek Watershed Interim Monitoring
Sampling and Analysis Plan

APPENDIX E

BENTHIC MACROINVERTEBRATE METRIC INFORMATION

Sheridan County Conservation District
2014 Prairie Dog Creek Watershed Interim Monitoring
Sampling and Analysis Plan

APPENDIX G

QA/QC DOCUMENTATION CHECKLIST