WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

WATER QUALITY DIVISION

WATERSHED PROTECTION PROGRAM

QUALITY ASSURANCE PROGRAM PLAN FOR WATERSHED PROTECTION PROGRAM WATER QUALITY MONITORING

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Replaces Quality Assurance Project Plan (QAPP) for Beneficial Use Reconnaissance Project (BURP) Water Quality Monitoring (2001)

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2/1/2015	0	Not applicable	Not applicable	Creation of document; began document control/revision tracking.

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DISTRIBUTION LIST

The following individuals (or the current position holder) will receive a copy of this QAPP, along with any subsequent revisions. The QAPP will also be available online and is recommended reading for all DEQ partners and personnel within the WQD, Watershed Protection Program collecting, handling, or analyzing environmental data.

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ACRONYMS AND ABBREVIATIONS

CoC	Chain of Custody
CWA	Clean Water Act
DO	Dissolved Oxygen
DEQ	Department of Environmental Quality
DQI	Data Quality Indicator
DQO	Data Quality Objective
EPA (or USEPA)	United States Environmental Protection Agency
IR	Integrated Report
MOU	Memorandum of Understanding
NPS	Nonpoint Source
OSHA	Occupational Safety and Health Administration
QA	Quality Assurance
QA/QC	Quality Assurance and Quality Control
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project/Program Plan
QC	Quality Control
QMP	Quality Management Plan
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
TMDL	Total Maximum Daily Load
UAA	Use Attainability Analysis
UIC	Underground Injection Control
USEPA (or EPA)	United States Environmental Protection Agency
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WQD	Water Quality Division
WPP	Watershed Protection Program

INTRODUCTION AND SCOPE

The United States Environmental Protection Agency (USEPA or EPA) requires participation in a centrally managed quality assurance program by all agencies whose monitoring and measurement efforts are supported or mandated through contracts, grants, regulations, or other formalized agreements with the USEPA. To meet this requirement, the State of Wyoming (the State) Department of Environmental Quality (DEQ) documented its quality system in a Quality Management Plan (QMP). The QMP was approved by EPA in January 2016. Under the QMP, a Quality Assurance Project/Program Plan (QAPP) is developed for each EPA-funded DEQ program that performs data collection, generation, or acquisition activities. Each QAPP must be developed as specified in the latest approved version of EPA QA/R-5 "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations." This document meets that requirement for the Water Quality Division, Watershed Protection Program (WPP).

This QAPP documents how quality assurance and quality control (QA/QC) are applied to environmental data operations within WPP to ensure that the results obtained are of a known and suitable quality needed to meet the WPP's goals and objectives. This QAPP was prepared in accordance with the following EPA documents: *EPA Requirements for Quality Assurance Project Plans*, *EPA QA/R-5* (USEPA, 2001) and *EPA Guidance for Quality Assurance Project Plans*, *EPA QA/G-5* (USEPA, 2002). This QAPP addresses all of the elements suggested for inclusion by EPA (see **Table 1**). This document was also developed in accordance with the requirements outlined in DEQ's QMP.

This QAPP is meant to be an umbrella document outlining the minimum QA/QC requirements for environmental data collection within the Program. A Sampling and Analysis Plan (SAP) is a project-specific guide and reference for field personnel who are collecting samples, and for data QA/QC, validation, statistical analyses and archiving. The approved SAP is good for the life of a project, and does not have to be re-written annually or at the end of a sampling season. However, revisions to the SAP should be documented through amendments (see SAP guidance in **Appendix A** for more information on SAP amendments).

Due to the various and diverse monitoring and assessment projects, specific details for each environmental monitoring project that differ from this QAPP will be outlined in project-specific SAPs rather than requiring individual project-specific QAPPs. SAPs will be prepared before environmental data collection begins, and may be revised during the life of a project. A SAP may be written for a specific project, for activities at a specific sampling site, or for activities falling under a larger monitoring program.

Project-specific SAPs must align with this WPP QAPP. A project-specific SAP should address specific project aspects such as the purpose of monitoring, project-specific data quality objectives (DQOs) and measurement criteria, number and locations of

representative samples, frequency of sample collection, sample types and collection methods, analytical methods, sample handling and chain of custody, any project-specific quality assurance requirements such as type and frequency of quality control samples, assessment and review, record keeping, data handling and storage, and project team roles and responsibilities. SAPs from non-WDEQ entities may be used if approved by the WPP. Project-specific SAPs will be reviewed and approved by the WPP QAO.

Project managers are responsible for designing monitoring studies, setting project-specific DQOs, if needed, and developing project-specific SAPs. Project managers and supervisors are responsible for making sure all personnel involved with the project are briefed and/or trained on the procedures to be used. **Appendix A** of this QAPP is a WPP guidance document for the preparation of project-specific SAPs. The guidance document includes many helpful tools such as checklists to ensure that SAPs contain all of the informational requirements listed in this WPP QAPP. In addition, note that other WPP documents, such as *Wyoming's Methods for Determining Surface Water Quality and TMDL Prioritization,* establish requirements for SAPs. *(See the most current version of the Methods document on the DEQ website,* http://deq.wyoming.gov/wqd/water-quality-assessment/resources/guidance/*).* All data collected for use support determination must meet Credible Data Law (see **Appendix B**.)

Both the QAPP and SAPs will reference detailed standard operating procedures (SOPs). WPP generates SOPs for any sample collection, sample processing, sample handling, or data management procedures that become routine, even when published methods are utilized. The use of SOPs ensures data comparability, defensibility, accuracy, and reduced bias. *(See the most current version of the SOP manual on the DEQ website,* http://deq.wyoming.gov/wqd/qaqc/resources/manual/*)*

Table 1. List of QAPP elements.

Group A Elements: Project Management	Group B Elements: Data Generation and Acquisition	Group C Elements: Assessment and Oversight	Group D Elements: Data Validation and Usability
A1 Title and Approval Sheet	B1 Sampling Process Design (Experimental Design)	C1 Assessments and Response Actions	D1 Data Review, Verification, and Validation
A2 Table of Contents	B2 Sampling Methods	C2 Reports to Management	D2 Verification and Validation Methods
A3 Distribution List	B3 Sample Handling and Custody		D3 Reconciliation with User Requirements
A4 Project/Task Organization	B4 Analytical Methods		
A5 Problem Definition and Background	B5 Quality Control		
A6 Project/Task Description	B6 Instrument/Equipment Testing, Inspection, and Maintenance		
A7 Quality Objectives and Criteria	B7 Instrument/Equipment Calibration and Frequency		
A8 Training/Certifications	B8 Inspection/Acceptance of Supplies and Consumables		
A9 Documentation and Records	B9 Non-direct Measurements		
	B10 Data Management		

A. PROGRAM MANAGEMENT

This first section of the QAPP addresses program administrative functions and program concerns, goals, and approaches to be followed.

A.1 Title and Approval Sheet

See Pages 0-2.

A.2 Table of Contents

See Page 6.

A.3 Distribution List

See Page 5.

A.4 Project/Task Organization

The Water Quality Division administers water quality programs for the State of Wyoming. See **Appendix C** for a WPP QA/QC flowchart emphasizing how internally collected data are validated, managed, and evaluated.

The WQD lead on quality assurance matters is the Quality Assurance Officer (QAO), assisted by the Quality Assurance Officers for each program, as described in **Section A.4.1** below. The Project Manager is the staff member responsible for a specific project (or program) and has immediate managerial or technical control of that project. The Project Manager is responsible for developing SAPs and specifying the quality of the data required for each project. Whenever WPP data collection activities are performed by WPP personnel or WPP contractors, the Project Manager has responsibility for ensuring that all QA/QC requirements are met. The oversight and improvement of quality assurance implementation and performance is vested with Project Managers and also the WQD's QA Staff, the WPP manager and supervisors, and the WQD Administrator. Issues not resolved at the Project Manager or WPP QAO level will be taken to the appropriate WPP Supervisor; if still unresolved, the issue will be taken to the WPP Manager and lastly, if necessary, to the WQD Administrator. The WQD Administrator has the final authority regarding QA/QC-related decisions.

A.4.1 Quality Assurance Staff

Department-Level

The Wyoming DEQ Outreach Manager serves as the Quality Assurance Officer (QAO) and operates independently of direct environmental data generation. The WQD lead on quality assurance matters is the QAO, assisted by the QAOs for each program.

Program-Level

The WPP QAO is the point of contact for all data quality concerns for monitoring programs and handles all day-to-day QA/QC activities and tasks. The WPP QAO reviews, revises, and maintains the QA/QC documentation for the WPP including the QAPP and SOPs; reviews and approves SAPs, coordinates distribution of all QA documents (See **Section A.9.1**), performs data review, validation, and reporting, and assists the Project Managers in their QA/QC activities. The QAO is independent from data generation in that he or she does not generally perform environmental data collection. The QAO reports to the Nonpoint Source Program Coordinator.

A.4.2 Data Collection Activities

The majority of environmental data collection within the WPP is performed by trained field personnel within the Monitoring Program. Other WPP staff (e.g., TMDL staff) also collect environmental data. WPP also utilizes data collected by non-WPP partners, such as Section 319 and 205(j) grant project sponsors. Core monitoring programs involve the collection of physical habitat, macroinvertebrates, algae, diatoms, and water chemistry samples in streams and lakes. Each of these activities is performed under specific programs/projects with unique monitoring and data quality objectives. Therefore, detailed collection information is provided in approved SAPs and related SOPs.

A.4.3 Laboratory Activities

Any laboratories contracted by the WPP must have documented quality assurance plans and methods approved by the WPP to ensure support of the WPP's data quality objectives. This documentation will be kept on file by the WPP QAO. It is highly recommended that project-specific QA/QC requirements be discussed between WPP staff and the laboratories before data collection begins. For project-specific analyses, QA/QC procedures should be documented in the project-specific SAP and the Project Manager should obtain a copy of the laboratory QAPP to be provided to the WPP QAO and filed with other QA/QC documentation.

The majority of water samples collected by WPP are analyzed for chemical constituents by the Wyoming Department of Environmental Quality, Water Quality Division Laboratory (hereafter referred to as the Water Quality Lab) (208 South College Drive, Cheyenne, Wyoming, 82002, 307-777-7317). The Water Quality Lab maintains an in-house Quality Assurance Program Plan.

Biological (macroinvertebrate, periphyton and phytoplankton) sample taxonomic identification and enumeration are not performed by field staff. Biological samples must be analyzed by a laboratory whose QA/QC procedures have been reviewed by the WPP QAO. *E. coli* samples are analyzed by WPP staff in-house or in the field, by the Water Quality Lab, or by a laboratory approved by WPP.

A.5 Problem Definition/Background

Environmental data collection by the WPP provides the core set of data and information for a variety of programmatic needs. The objectives, design, data analysis, assessment methods, and reporting requirements for these monitoring programs are each discussed in detail in DEQ's Integrated Report (IR) which can be accessed online at http://deq.wyoming.gov/wqd/water-quality-assessment/resources/reports/ and WPP's 10-year Monitoring Strategy, which can also be accessed online, at http://deq.wyoming.gov/wqd/surface-water-monitoring/resources/strategy-plan/. The Monitoring Strategy covers the period from 2010 to 2020 and organizes the WPP's anticipated monitoring activities using an adaptive tiered approach. Tier 1 consists of Probabilistic Surveys, Tier 2 consists of Targeted Monitoring, and Tier 3 consists of Programmatic Monitoring. For more details, refer to the Monitoring Strategy, Annual Monitoring Plan, or the IR.

A.5.1 Tier 1 - Probabilistic Surveys

Probabilistic Surveys are designed to meet the reporting requirements of the Clean Water Act's (CWA) 305(b) report to EPA which is an assessment of the condition of "all waters of the State" while working within the time and budget constraints of WPP staff and resources. Probabilistic surveys evaluate streams within a predefined target population by randomly selecting and monitoring stream sites within one of the major watersheds (management basins) in Wyoming for one water year. Conceptually, the Probabilistic Survey is revisited in that basin every 10 years. The information collected from the probabilistic surveys will be used to: (1) estimate the proportion of the targeted waters that fall in condition classes of least disturbed, most disturbed, and indeterminate for aquatic life conditions and for measured physical and chemical stressors, 2) identify streams that may not be attaining water quality standards and prioritize them for further evaluation, and (3) better understand pollutants of concern and the distribution of pollutants within a particular basin. For chemical stressors with numeric criteria, condition classes approximate attainment/nonattainment of those criteria.

A.5.2 Tier 2 - Targeted Monitoring - Streams

Environmental surveys within this tier are used to place streams into one of five designated use attainment categories as required by the EPA. Using the water quality concerns that are identified during monitoring efforts in Tier 1 as a guide, stream-specific monitoring plans in Tier 2 are developed to assess the biological and chemical

conditions of a specific waterbody. These more intensive surveys allow the WPP to better understand the scope and extent of water quality conditions in a given stream than is possible with a probability survey. Targeted stream surveys assess designated uses described in Chapter 1 of the Water Quality Rules and Regulations to assist with determining if the uses are meeting applicable criteria. Apart from the Tier 1 probabilistic surveys, lake monitoring has been conducted on the State's 13 largest reservoirs on a staggered schedule where each reservoir is sampled three consecutive years, followed by three years without sampling, then the cycle is repeated.

A.5.3 Tier 3 - Programmatic Monitoring

The implementation of Programmatic Monitoring is largely driven by WPP needs and schedules on an annual basis and strategies. WPP goals are discussed in individual Sampling and Analysis Plans (SAPs). The main objectives and goals of each monitoring program are described further in WPP's Monitoring Strategy and Annual Monitoring Plan. Programmatic monitoring includes but is not limited to the following:

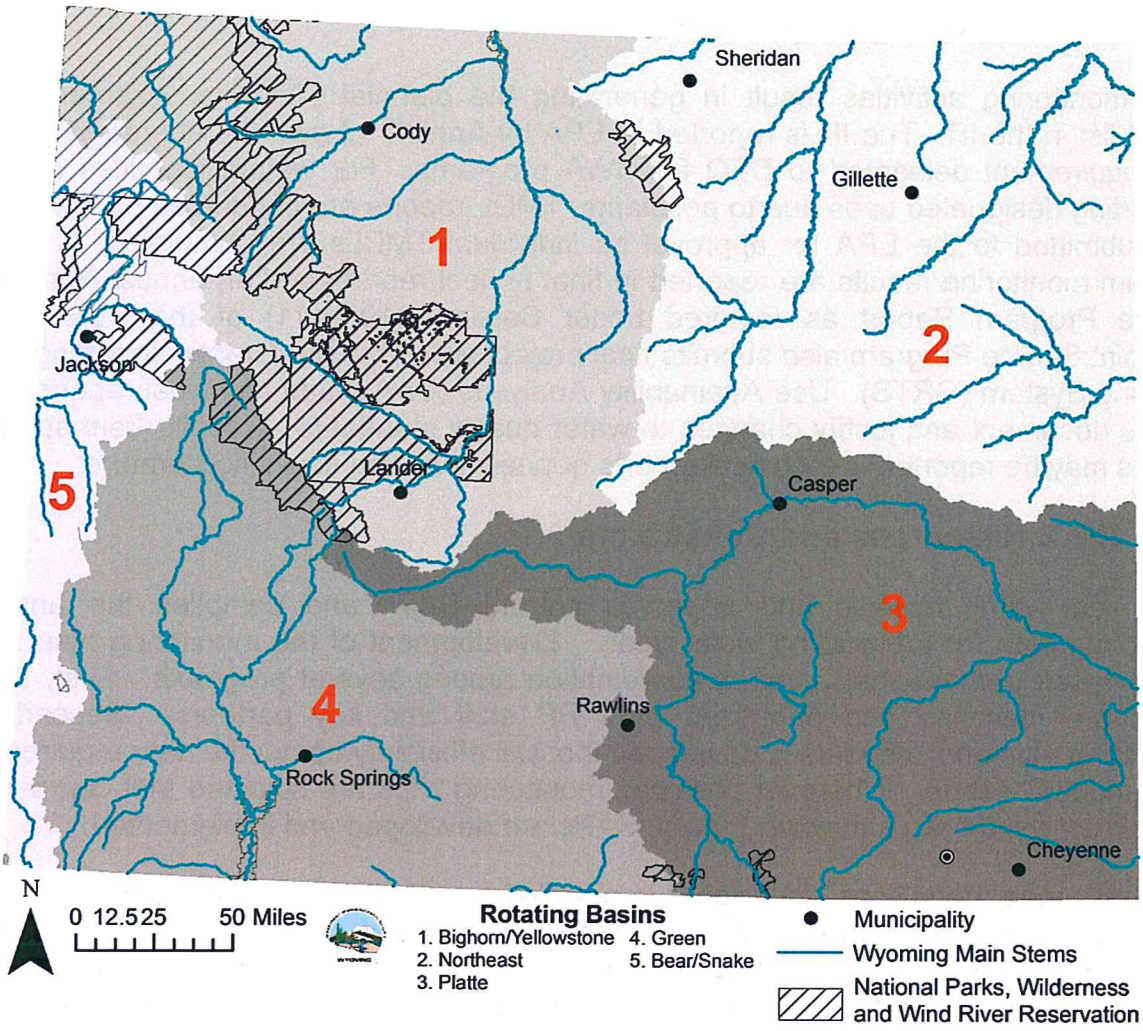
- Development and prioritization of Total Maximum Daily Load (TMDLs)
- Nonpoint source (NPS) pollution BMP effectiveness monitoring
- Point source investigations
- Reference stream monitoring to support evaluation of aquatic life uses
- Cooperative agency monitoring and citizen volunteer monitoring
- Water quality standards development, including UAAs and site-specific criteria
- Sampling methods development
- Monitoring for wasteload analysis models (i.e. Qual2K) and other model development
- Other special studies

A.5.4 Nonpoint Source Program Projects

The WPP administers CWA Section 319 and 205(j) projects under annual federal grants awarded from USEPA. Work selected for use of Section 319 and 205(j) funding requires developing individual project goal(s) that are detailed in Project Implementation Plans. Project sponsors may conduct monitoring activities, the objectives of which include, but are not limited to, determining the source and extent of nonpoint source pollutants, evaluating effectiveness of best management practices, determining long-

term water quality trends, and assessing compliance with water quality standards. As with other WPP monitoring activities, Section 319 and 205(j) projects that collect data are required to do so under an approved SAP and QAPP. The QAPP outlines the minimum QA/QC requirements that WPP activities, including Section 319 and 205(j) project monitoring, must meet. Specific details for each project are outlined in project-specific SAPs that must be approved by WPP before sampling begins. Project sponsors may prepare project-specific QAPPs if they choose; however, those QAPPs must, at a minimum, meet the requirements established in this QAPP. Section 319 and 205(j) project monitoring must meet provisions of the Credible Data Law (Wyoming Statute (W.S.) § 35-11-103(c)(xix).

Superbasins in Wyoming on the rotating basin schedule.



A.6 Project/Task Description

Project/task details are an essential component of project-specific SAPs. The following discussions in this QAPP are more general, and may be used for multiple projects.

A.6.1 General Project Schedule and Locations

Probabilistic Surveys cycle through the five super basins of Wyoming every 10 years. Targeted Monitoring occurs in the unit two years after that basin was sampled via the Probabilistic Survey, and generally takes two years to complete. This schedule allows WPP Monitoring and QA/QC staff to evaluate data quality, analyze the Probabilistic Survey data, identify and prioritize streams for future monitoring, target specific monitoring locations and select potential parameters of concern to collect/measure during the Targeted Monitoring cycle, and develop SAPs. Detailed monitoring

schedules for all 3 tiers are included in the annual monitoring plan and in project/program-specific SAPs.

A.6.2 Reporting Requirements

WPP monitoring activities result in generating the biennial 305(b) assessment and 303(d) list in the IR. The IR is reported to EPA by April 1st of even-numbered years as one requirement delegated to DEQ for CWA programs. For waters identified as not supporting designated uses due to pollutants, TMDL reports are conducted by the WPP and submitted to the EPA for approval as individual TMDLs are completed. NPS program monitoring results are reported in final project reports and an annual Nonpoint Source Program Report as required under Section 319(h)(11) of the CWA. The Nonpoint Source Program also submits final project reports to the Grants Reporting and Tracking System (GRTS). Use Attainability Analyses (UAAs) and technical reports and papers document and justify changes to water quality standards. Results from special studies may be reported in technical reports or peer-reviewed scientific literature.

A.6.3 Resources and Constraints

Each year WPP reviews and approves current SAPs and compiles the annual monitoring plan for the coming water year. Development of the monitoring plan is a multi-phased process that requires coordination among several programs. First, data needs are identified and prioritized by WPP staff and key partners. Second, a monitoring plan and schedule is developed that will efficiently obtain the data required to meet multiple needs. Wherever possible, monitoring sites are selected that can serve multiple programmatic functions. Finally, SAPs are developed and implemented.

Weather, road conditions, or high stream flows sometimes make sampling sites inaccessible or make sampling unsafe. Safety for the field personnel is of the utmost importance. Therefore, sampling may not occur at every planned site for every sampling event. Field personnel make the determination at the time of sampling if the conditions are safe for environmental data collection activities.

WDEQ monitoring personnel must follow WDEQ SOP: *Authorization to Access or Cross Private Lands (for Internal Use)* (Effective Date: January 2015). Permission to sample on private, State, and National Park Service lands must be documented. Permission to traverse private and National Park Service lands to access sample sites must also be documented.

A.7 Quality Objectives and Criteria for Measurement Data

A.7.1 WPP-Wide Quality Objectives

The ultimate goal of WPP water quality monitoring programs is to provide data of the appropriate type, quality, and quantity for the WPP's decision-making and assessment purposes, compliance functions, and other project-specific goals. Data quality

objectives (DQOs) are qualitative and quantitative statements derived from the systematic planning process that 1) clarify the study objective, 2) determine the most appropriate type of data to collect, 3) determine the most appropriate conditions from which to collect the data, and 4) specify the level of uncertainty that decision makers are willing to accept in the collected monitoring data while still meeting the project objectives, thereby establishing the quantity and quality of the data needed.

Many WPP programs have similar DQOs with a focus on assessing and ensuring attainment of Wyoming's water quality standards; Probabilistic Surveys and Targeted Monitoring are sometimes designed to meet the needs of multiple programs. For these standards, refer to Chapter 1 of the Wyoming Water Quality Rules and Regulations, online at http://soswy.state.wy.us/Rules/RULES/9176.pdf. However, some WPP projects/programs also have project-specific DQOs that must be included in project-specific SAPs. Each project manager can develop DQOs for their programs/projects and is encouraged to do so following EPA's *Guidance on Systematic Planning Using the Data Quality Objective Process*, *EPA QA/G-4* (USEPA, 2006).

All environmental data collected by and for WPP programmatic decisions must meet the minimum requirements discussed in the following sections. Environmental data must be collected and processed according to the Credible Data Law (see **Appendix B**) and appropriate standard operating procedures (SOPs) by well-trained staff. Laboratories must be certified for the specific methods used, or if a variation to any methods are necessary to meet project objectives (such as a lower detection limit), those methods must be evaluated against lab capabilities and approved by the appropriate WPP Supervisor.

A.7.2 Measurement Performance Criteria

Measurement performance criteria are expressed in terms of Data Quality Indicators (DQIs) which include precision, bias, accuracy, representativeness, completeness, comparability, and method sensitivity. Definitions for DQIs below come from *EPA's Guidance for Quality Assurance Project Plans, EPA QA/G-5* (USEPA, 2002). Although there are various types of monitoring projects within WPP, the DQIs for each are assessed similarly through quality control samples such as blanks, spikes, and replicates and through data quality checks. Each project-specific SAP should incorporate DQIs by reference to this QAPP or include a table listing any unique DQIs, how they will be measured, and the performance criteria against which they will be evaluated.

Precision is the degree of agreement among repeated measurements of the same property under identical, or substantially similar, conditions; expressed as the relative percent difference (RPD). Overall precision for sampling and analysis is assessed via field duplicates/replicates – co-located simultaneous or consecutive samples are collected, processed, and analyzed to obtain information on sample acquisition, handling, shipping, storage preparation, and analytical processes and measurements. Additionally, laboratories perform their own replicate analyses, initial precision and

recovery samples, and matrix spike/matrix spike duplicates to assess laboratory analytical precision. In the field, precision is maximized (variability is reduced) through strict adherence to SOPs for sampling methods and sample handling.

Water Chemistry and Field Parameters

Table 2. Water Chemistry and Field Parameter Precision Goals

Reporting Limit (RL) Range	Sulfate, Alkalinity, Total Suspended Solids (TSS) & Turbidity	Hardness & Chloride	Nitrate-Nitrite	Total Phosphorus & Total Nitrogen	Chlorophyll a	All Other Water Chemistry Parameters with Reporting Limits		Temperature, Conductance, & Dissolved Oxygen (DO)	pH
RL < 3X RL	None	None	None	None	None	20%		10%	+/- 0.3 S.U.
3X RL < 10X RL	None	None	20%	30%	None	20%			
≥ 10X RL	20%	10%	20%	20%	30%	20%			

Relative Percent Difference (RPD) for selected parameters (*see Appendix C in the current WPP SOP Manual for analysis and calculations, including Reporting Limit ranges*)

Macroinvertebrate samples

Precision for macroinvertebrate samples indicates the degree of agreement between simultaneous, and immediately adjacent, independent samples. Field duplicates are used to indicate the amount of variability in the data due to sampler collection techniques and training, though inherent spatial variability, even in side by side samples, is expected.

Field sampling precision of a macroinvertebrate data set requires field duplicate samples collected independently by different samplers working simultaneously at the same site. The minimum number of duplicate samples per field office per season is 10% of the total macroinvertebrate samples collected. Duplicates must be collected on an ongoing basis during the field season.

Macroinvertebrate sample precision is calculated for total abundance (number/square meter) and total number of taxa. The precision requirement for total abundance is ±50% and for total number of taxa it is ±15%. The precision measurement is calculated using the relative percent difference (RPD) between duplicate sample results per each parameter.

Escherichia coli (E. coli) samples

Precision indicates the degree of agreement between side-by-side independent samples at a site, collected by applying the same collection method. The minimum number of duplicate samples is 10% of the samples collected per day and at least one duplicate per sampling event when less than 10 samples are collected.

E. coli duplicate precision is calculated for the number of Colony Forming Units per 100 ml value and is set at ±50% for MPNs greater than 100. The precision measurement is calculated using the relative percent difference (RPD) between duplicate sample results of the same aliquot. For MPNs less than 100, the inherent variability precludes the use of RPDs.

Project specific requirements may vary from the default value due to other considerations.

The equation used for calculating sample precision is given below:

Calculated as Relative Percent Difference (RPD):

RPD (in %) = ((|A-B|)/((A+B)/2)) x 100

Where: A = first measured value and B = second measured value

Bias is a statistical measurement of correctness and includes multiple components of systematic error. Systematic error includes bias and imprecision associated with sampling methodology, specification of the sampling unit, sample handling, storage, preservation, identification, instrumentation, etc. A measurement is considered unbiased when the value reported does not differ from the true value. Bias is defined in the WPP SOP manual as a deviation of a test result value from the true value, which is caused by systematic errors in a procedure (field or laboratory). For example, choosing sample locations which are all within fifty feet of a road introduces bias. Probabilistic Survey site locations are chosen randomly to reduce bias in sampling site selection for assessing basin-wide water quality conditions. Field instruments are calibrated, maintained, and checked against standard reference materials to ensure bias is not introduced during measurement of water quality parameters. Bias is also reduced in the field through the use of and adherence to SOPs. Field audits of field personnel collecting data are used to qualitatively assess bias. Laboratories test their instruments with reference materials and analyze spiked matrix samples to ensure that instruments/instrument calibration or reagents and matrix effects, respectively, do not introduce bias during analysis.

Accuracy is the degree to which a recorded measurement varies from a true or expected value such as a reference or standard. It includes a combination of random

error (precision) and systematic error (bias), components of both sampling and analytical operations. Field instruments are calibrated, maintained, and checked against standard reference materials to ensure accurate measurement of water quality parameters. Accuracy is also improved in the field through the use of, and adherence to, SOPs. Laboratories test their instruments with reference materials to ensure accurate results and analyze spiked matrix samples to assess accuracy (expressed as percent recovery). Lab splits (split a sample in the field and submit both subsamples for analysis to two different laboratories using identical analytical methods) can also address accuracy, precision, and bias between labs. A routine goal for laboratory accuracy for water samples is 85%-115%, but will depend on the analytical method and matrix interferences. Typically, ranges are wider (75%-125%) for non-water samples such as soil/sediment. Project specific requirements may vary from the default value due to other considerations.

Representativeness is a qualitative term that expresses "the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition" (ANSI/ASQC 1995). Representativeness is addressed through standardized sample collection procedures (SOPs) and adherence to the sample locations, times, and hydrologic conditions determined during development of the monitoring plan and the SAP. Site photos and field notes are also important for describing any unusual conditions at the sampling location (e.g. extreme high or low flow, a contamination event, ice cover, etc.) that may affect the representativeness of the sample collected during that time. Samples are also evaluated for contamination introduction by the collector or analyzing laboratory through field and equipment blanks.

Comparability is a qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made. Data collected with the same or equivalent collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols will be comparable. A later section of this QAPP discusses the extent to which data from outside sources (collected by volunteers/partners) is comparable with data collected by WPP.

Completeness is a measure of the amount of valid data obtained from a monitoring program/project compared to the amount of valid data expected to be obtained. Completeness is calculated by dividing the number of valid measurements completed (samples collected and/or analyzed) by the total number of measurements planned for the project's dataset, and is expressed as a percentage. Completeness is especially important when a certain number of samples are required for assessment purposes, to populate a model, or when project funds are limited, and should be addressed in a project-specific SAP. The WPP's goal for completeness of environmental data sets is 95%. Project-specific requirements may vary from the default value due to other considerations.

Sensitivity is the capability of a laboratory method or instrument to discriminate between measurement responses representing different levels of the variable of interest. Sensitivity should be based on the action, or comparison values, specified in the DQOs. These are typically the numeric criteria defined in Wyoming's Water Quality Standards; however, they may be different for special studies (e.g. lower limits may be needed for criteria development). Laboratories utilized for WPP projects will have verified and/or determined the minimum concentration of attribute that can be measured by a method (method detection limit), by an instrument (instrument detection limit), and by the laboratory (quantitation limit or reporting limit). The laboratory analysis method chosen for a specific project must have a sufficient sensitivity (i.e. low enough detection and reporting limits) to meet project goals. This is especially important if laboratory results are being compared to numeric water quality criteria for assessment purposes. Project-specific SAPs should clearly define action limits and required laboratory detection/quantitation limits.

Table 3. Data Quality Indicators for WPP environmental data collection.

Data Quality Indicator	QC Check/QC Sample[2]	Evaluation Criteria	Recommended WPP Goal[1]
Precision - measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions; random error	Field duplicate/replicate pairs	RPD	See **Precision** section above, or the applicable SOP
	Laboratory duplicates	RPD	Approve or modify percent RPD for laboratory duplicates established by the analyzing laboratory
	Matrix spike/matrix spike duplicate (MS/MSD)	RPD	Approve or modify percent RPD for MS/MSD established by the analyzing laboratory
Accuracy/Bias – measure of the overall agreement of a measurement to a known value such as a reference or standard; it includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations (**continued on next page**)	Randomized site selection for Tier 1 Probabilistic Surveys	Randomized process must be used for site selection	100% compliance; any relocating of sample site due to conditions on the ground must be documented
	Calibration and reference checks for field water quality instruments	Documentation of successful calibration and checks of instruments; documentation of recalibration if needed	100% compliance
	SOPs for environmental data collection	Qualitative determination of SOP adherence and field audits	All data collected following SOPs
	Field blanks	RL	< RL
	Equipment blanks	RL	< RL
	Trip blanks	RL	< RL
	Method blanks	RL	< RL

Data Quality Indicator	QC Check/QC Sample[2]	Evaluation Criteria	Recommended WPP Goal[1]
Accuracy/Bias – measure of the overall agreement of a measurement to a known value such as a reference or standard; it includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations (**continued from previous page**)	Laboratory Control Spike (LCS)	Percent Recovery of LCS	Approve or modify percent recovery limit for LCS established by the analyzing laboratory, usually 85-115%
	Matrix spike/matrix spike duplicate (MS/MSD)	Percent Recovery	Approve or modify percent recovery limit range for MS/MSD established by the analyzing laboratory
	Split samples	RPD	See **Precision** section above
	Performance Evaluation Samples (Ampule Single Blind or Double Blind prepared in site-specific matrix)	Percent Recovery and RPD from known value	Lab should meet target RPD for MS/MSD and lab duplicates and attain percent recovery in the established range
Representativeness - the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition	SOPs	Qualitative determination of SOP adherence and field audits	All data collected following SOPs
	SAP requirements	Adherence to sampling design, location, time, and conditions	100% compliance unless approved by the Project Manager and documented in the field notes
	Photos/field notes	Document any variation from SAP or SOP	100% compliance
	Hold times	Hold times	100% compliance
	Field replicate pairs (co-located samples)	RPD	See Table 3 above or applicable SOP
	Field/trip/equip. blanks	RL	< RL

Data Quality Indicator	QC Check/QC Sample[2]	Evaluation Criteria	Recommended WPP Goal[1]
Comparability - qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made	SOPs (sample collection and sample handling)	Qualitative determination of SOP adherence and field audits	All data collected following SOPs
	Holding Times	Holding times	100% compliance
	Analytical Methods	EPA or WPP-approved methods	100% use of approved methods
	Similar frequency and types of QC samples (field duplicates, blanks, lab QA, etc.)	Verify	Evaluate for comparability
Completeness - measure of the amount of valid data obtained from a measurement system compared to the amount of valid data expected to be obtained	Complete sampling	Percent valid data	95% completeness with respect to planned data set
Sensitivity - the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest; primarily a laboratory parameter	Laboratory DL or RL	Must be below action level required by SAP (numeric water quality criteria or other research-based level)	100% compliance

This table adapted from UDEQ-DERR QAPP.
Abbreviations: DL – Detection Limit, RL – Reporting Limit, RPD – Relative Percent Difference, MS/MSD – Matrix Spike/Matrix Spike Duplicate, LCS – Laboratory Control Spike, DPM – Designated Project Manager, MRL – Minimum Reportable Limit
[1] Unless otherwise justified and approved in a project-specific SAP
[2]This list is not inclusive of all of the QC checks/samples run by analyzing laboratory, see laboratory QAPP

A.8 Training/Certifications

WPP field personnel must be experienced field team members; or have received training from a field team leader or project manager on requirements for sampling including proper use and maintenance of all sampling equipment, sample processing and handling, field documentation, file management, and database entry. WPP field personnel must read this WPP QAPP, SOPs they will perform, and SAPs they will work from annually and acknowledge that they have done so via a signature sheet kept on-file at the WPP Field Offices. Each WPP field and laboratory team member will have applicable health and safety training and will comply with Occupational Safety and Health Administration (OSHA) regulations (see the DEQ Safety Policy (#20) and the WPP Safety Policy). WPP field personnel and other staff will also participate in training workshops intended as refreshers or reviews, including information on new or updated SOPs and SAPs.

All laboratories analyzing WPP samples maintain their own documented quality assurance procedures which include training and certification requirements for their staff.

Non-DEQ project managers are responsible for ensuring that field staff collecting data for their programs/projects are notified of any special conditions and have received the appropriate technical and safety training. For DEQ projects, the Monitoring Program Supervisor is responsible for ensuring and documenting that staff has appropriate technical and safety training. WPP safety training includes wilderness first aid/CPR, and boat, bear, and ATV safety.

Field audits, whether internal or EPA-led, are additional training opportunities to ensure that field personnel are following SOPs as well as project-specific requirements outlined in the SAP.

A.9 Documentation and Records

A.9.1 QA Documentation Dissemination and Maintenance

The WPP QAO is responsible for maintaining, updating, and editing this QAPP and its associated quality documents, including SOPs. The QAO is responsible for making sure that WPP personnel receive the most recently approved QAPP, SOPs, and other documents applicable to environmental data collection. Electronic copies will be distributed and posted online and notifications will be sent out via email. The QAO officially reviews the WPP QAPP every five years; however, the QAPP and SOPs are periodically reviewed within the WPP and revised, if needed. WPP Staff are encouraged to make suggestions for changes throughout the year. The most current version of the QAPP will be posted on the WPP's webpage (http://deq.wyoming.gov/wqd/qaqc/resources/qapp/).

A.9.2 Field Documentation

Field records shall be generated and stored as specified in method-specific SOPs and project-specific SAPs. Any deviation in an SOP when obtaining, processing, or holding environmental samples must be documented and explained in field notes and/or project or site files. Chain-of-Custody (CoC) forms are to accompany each sample to the analyzing laboratory. Handwritten field data sheets, field notes, and copies of CoC forms may be scanned and stored on the WQD server while hard copies are filed for storage at WQD. Electronic field data is stored on the WQD server.

A.9.3 Laboratory Documentation

Laboratory documentation procedures and requirements are discussed in each laboratory's QAPP (for in-house lab documents). The project manager and the analytical laboratories to be utilized determine the laboratory documentation that is to be provided to the WPP in a data package along with the sample results. WPP meets with the Water Quality Lab on a regular basis and data package requirements are discussed. Required data package contents may at times be included in a service contract or Memorandum of Understanding (MOU).

A.9.4 Record Storage and Retention

All field and lab data is stored on DEQ servers which are backed up routinely by the Wyoming Department of Enterprise Technology Services (ETS). After field and lab data have been verified they are uploaded and stored permanently in the Surface Water Monitoring (SWM) data system. SWM is also stored and backed up on DEQ servers. Electronic data (including scanned copies of hand-written documents) may be stored indefinitely. Hard copies of hand-written records will be stored at least as long as required by the WPP retention schedule. However, project-specific SAPs may define a longer or indefinite retention schedule.

B. DATA GENERATION AND ACQUISITION

This section of the WPP QAPP addresses data generation and data acquisition and management activities.

B.1 Sampling Process Design

Sampling processes are designed during the project planning and DQO process and are individualized to each WPP monitoring project/program. The monitoring strategy, annual monitoring plans and IR outline the general sampling design for WPP's ongoing monitoring programs. However, project-specific SAPs should outline sampling design details for specific projects and should include the items covered in **Appendix A**.

The annual monitoring plan includes the combined detailed schedule of all planned monitoring activities for the WPP for the current monitoring year. This flexible planning document is subject to change during the field season.

B.2 Sampling Methods

The use of standardized methods and trained personnel help to ensure samples are collected consistently both between sampling locations and teams. Although there are several sampling programs/projects within WPP, sampling methods employed by the WPP are standardized, consistently applied, and follow EPA or EPA-approved methods unless a modification has been scientifically justified and approved by the Monitoring Program Supervisor or the QAO. All project-specific SAPs must list all sampling/field methods to be used for the program/project.

SOPs are written for each WPP sampling method (or field sample processing method); with the possible exception of methods used only infrequently or for research projects that test new sample collection methods. In these cases, sampling methods are carefully documented and kept on-file at WPP. If any method gains routine use within the WPP, an SOP is developed. An SOP may be drafted by any WPP staff member but must be approved by the QAO. WPP SOPs are written in accordance with EPA's Guidance for Preparing Standard Operating Procedures (SOPs) (EPA, 2007). WPP's SOPs are available online at http://deq.wyoming.gov/wqd/qaqc/resources/manual.

B.2.1 Corrective Actions for Problems Occurring in the Field

Backup plans should always be made in case of equipment malfunction, breakage or loss, vehicle breakdowns, dropped bottles, etc. WPP field personnel carry contact numbers for vehicle problems and for reaching technical support for specialized equipment. Tool kits are packed to allow battery replacement, probe replacement, and maintenance to field instruments. Additional calibration standards are packed to allow for recalibrations of field water quality meters. Additional bottles are packed in case of bottle breakage or sample loss. Additionally, corrective actions and equipment and supply lists are included in individual SOPs and project-specific SAPs. The Monitoring Program Supervisor is the point-of-contact for all issues that arise in the field that cannot be readily solved by the field staff.

B.3 Sample Handling and Custody

Sample handling requirements (bottle type, sample label, preservation and storage, holding times, delivery to the laboratory or shipping instructions) are discussed in detail in each WPP SOP (where applicable), project-specific SAPs, and some laboratory QAPPs.

Each sample is associated with a Sample ID. In addition to Sample ID, samples are also labeled with a unique date and time of collection.

Each sample or batch of samples delivered or shipped to a laboratory must be accompanied by a chain of custody form. Individual SOPs indicate the type of custody documentation required for the analyzing laboratory. Each project-specific SAP should include all necessary sample-tracking documentation as an attachment.

B.4 Analytical Methods

Analytical methods appropriate for the sample matrix and range of expected values for the constituents being analyzed will be used. For water chemistry analysis, it is important that reporting limits be at or below numeric water quality criteria. All compliance-related water/soil chemistry samples must be analyzed at a laboratory meeting the minimum standards. Each laboratory utilized by WPP must also have analytical method protocol documentation available for WPP to review. Routinely-used analytical methods are also described in many WPP SOPs for sample collection. All project-specific SAPs must list all analytical methods for the program/project. When analytical failures occur, whether recognized by the project manager or by WPP's QAO, the issue will be addressed with the analyzing laboratory to remedy the error/issue. In addition, any issues with analytical data will be communicated to the Monitoring Supervisor so that he/she is able to isolate potentially problematic data before it is uploaded to the water quality database.

B.5 Quality Control

B.5.1 Field Quality Control Activities

Field QC checks and samples will be performed at a frequency defined either by reference to this QAPP or by a project manager in a project-specific SAP. If the QAPP is not referenced, each project-specific SAP should list each required QC check or sample, the associated performance goal, and corrective actions in the case that the performance goal is not met.

B.5.2 Field QC Samples

Quality control samples are used to estimate the precision, representativeness, and accuracy/bias of field activities or field plus lab activities. At a minimum, the following quality control samples should be collected at the frequency described below. Field quality control samples will be prepared in accordance with EPA-approved procedures or WPP SOPs, and labeled, documented, handled, and analyzed the same as regular samples. Field and/or equipment blank samples are primarily applied to chemistry samples and are inappropriate or unnecessary for some types of biological samples. This should be noted in WPP's SOPs and project-specific SAPs. At a *minimum*, quality control samples should consist of:

- (For *E. coli)* One **field blank** must be prepared, using sterile reagent water or deionized water, for each cooler used to transport samples collected during a sampling trip. If *E. coli* samples are analyzed in-house, a minimum of one

laboratory blank, using sterile reagent water or deionized water, must be prepared for each sample test run or uninterrupted series of analyses. A test run is defined as either an individual or group of samples prepared and incubated as one lot during an uninterrupted time period.

- (For all other analytes) A minimum of 10% of the samples collected by one sampling crew in one sampling season must be a **field** or **trip blank**.

  Field blanks are used to assess potential sample contamination due to sample bottles, preservative, ambient site conditions, or cross-contamination during transport. Sample bottles should be filled at a sampling location with analyte-free water, and handled in the same manner as other samples. Bottles containing preservative are not to be rinsed. Unpreserved bottles should be triple-rinsed with analyte-free water before filling. Trip blanks are prepared by the laboratory or field staff using analyte-free water, transported to the field, and handled in the same manner as other samples; they are not to be opened in the field.

  - Performance Goal: below reporting limit

- (For *E. coli)*) One **duplicate/replicate** sample per 10 samples collected, or one per sampling day if less than 10 samples are collected.

- (For all other analytes) A minimum of 10% of the samples collected by one sampling crew in one sampling season must be a **duplicate/replicate** sample.

  The sampling conditions, volume of sample needed, and whether or not a sampling device is used will determine whether sample pairs are duplicates (homogenized and split into bottle pairs) or replicates (not homogenized, co-located samples) and should be defined in the project-specific SAP.

  - Performance Goal: < RPD listed in Table 3 above or the project-specific SAP

There are other optional field quality control samples such as field split samples to assess accuracy and comparability of results between two analytical methods or laboratories and field matrix spikes to determine the effect of the sample preservation, shipment, storage, and preparation on analyte recovery efficiency for a given matrix. Project-specific SAPs may specify a higher frequency of quality control sample collection than listed above. When planning QC sample type, frequency, and collection locations, project managers should consider performing additional equipment blanks if a "dirty" site must be sampled in the middle of a trip (ideally less contaminated sites are sampled before more contaminated sites during a trip) or targeting contaminated sites for duplicate/replicate and field split samples to evaluate the effect of challenging matrices on target analyte recovery (ask for MS/MSD to be performed on those samples).

B.5.2.1 Field QC Checks

Field-based QC checks should include at a minimum:

- Calibration of water quality field meters per manufacturer specifications and post-calibration checks using unexpired and certified calibration standards or standard reference materials (SRMs).
    - Performance Goal: 100% compliance and completed documentation, SOPs followed
- Review of data from field water quality parameters for reasonable values.
- Review of all field documentation for accuracy and completeness before leaving the sampling location. Field sheets for routine monitoring projects should include checklists to ensure all samples are collected and all field measurements are performed.

B.5.2.2 Corrective Actions

Field personnel are responsible for performing immediate corrective action in the field if a QC issue is found during field QC checks; typically this corrective action will involve instrument maintenance, recalibration, or re-sampling. Field personnel will document this type of corrective action in the field notes. Other corrective actions are the responsibility of the project manager and, when they involve monitoring staff, the Monitoring Program Supervisor. Each failure must be investigated and addressed for the cause of non-compliance if possible (for example, decontamination procedures, inadequate training of staff, improper sample handling). The project manager must address the quality control issue and any actions taken to resolve the matter (retraining of field staff, purchase of new reagent/bottles, replacement of equipment, etc.) should be documented in the project files. The project manager may perform re-sampling and analysis, amendment of sampling and/or analysis procedures, or may accept the data with acknowledgment of the level of uncertainty surrounding the analytical results. The QAO will be notified for any systemic problems unable to be addressed by the project manager alone.

B.5.3 Laboratory Quality Control Activities

Laboratory quality control samples will be performed as defined in each laboratory's quality assurance manual and corrective actions are the responsibility of the laboratory. Results of these QC tests will be reported to WPP in the data report package as agreed upon during contraction of service. WPP and its analyzing laboratories will cooperate to ensure laboratories receive ample sample to run QC tests such as lab duplicates, matrix spikes, and matrix spike duplicates if the SAP specifies they should be run on WPP samples.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

WPP SOPs describe maintenance, inspection, and testing procedures for flow meters, water quality meters, sampling equipment, and other instruments/equipment. Individual WPP field personnel are assigned to these tasks and are responsible for sending equipment out when it needs repair and for ordering replacement parts. Calibration and maintenance logs are kept with each meter or in the appropriate WPP project files. Individual WPP field personnel are also assigned to vehicle maintenance and inspection tasks, including boats and all-terrain vehicles. WPP field personnel with these duties report to the Monitoring Program Supervisor. In addition, field personnel are required to record instrument/equipment problems or needs in the project field notes as a reminder to address the issues upon returning from the field and notify the project manager and Monitoring Program Supervisor.

B.7 Instrument/Equipment Calibration and Frequency

Instrument/equipment calibration and calibration frequency are described in WPP SOPs. The primary instruments requiring calibration are water quality meters. Individual field personnel are responsible for calibrating the equipment they will be using according to the applicable WPP SOP. SOPs indicate when recalibration may be needed. The SOP should indicate that calibration should occur at least as often as the user manual recommendation. Calibration and maintenance logs are kept with each meter or in the appropriate WPP project files. A NIST-traceable thermometer will be used annually to check all thermistors. SOPs are not a substitute for the instrument user manual and manufacturer's instructions; the user manual should be kept with the instrument at all times for reference.

B.8 Inspection/Acceptance of Supplies and Equipment

Individual WPP field personnel are assigned to ordering and maintaining stocks of supplies and equipment. These individuals interact with the vendor, track receipt of supplies/equipment, verify that supplies/equipment are in the condition expected, are responsible for maintaining and restocking these supplies/equipment, pay close attention to product expiration dates, and interact with the Monitoring Supervisor to anticipate supply/equipment needs during the field season. Analyzing laboratories prepare bottles for water chemistry analyses and WPP field personnel frequently pick up batches of bottles to use in the field. Deionized reagent-free water used during instrument calibration and equipment rinsing in the field is prepared and provided to WPP by the Water Quality Lab or prepared in the field office laboratory.

B.9 Non-direct Measurements and Data from External Sources

The majority of data from outside sources is water quality monitoring data from cooperating government agencies using standard State or Federal sampling procedures, coupled with chemical and biological analyses performed at State or Federally-certified labs. In general, these data sources are expected to be of sufficient

quality to be comparable with WPP data, such that they could be used for assessment purposes, provided all QA/QC and sampling methodology requirements are met. If it is determined that data are not of sufficient quality and comparability to be used by WPP directly for assessment, they will be summarized and used to augment other data sources, in a weight of evidence approach; to make assessment decisions, or used to prioritize waters for sampling by the WPP. Data, regardless of source, must meet credible data requirements in order to be used for assessment purposes.

Some WPP monitoring or modeling projects, or assessment methods, incorporate existing data obtained from secondary (non-WPP) measurement sources including climatological/meteorological, stream discharge, GIS (geographical information system) data, and also rates/constants/values published in the scientific literature. Secondary data, whether obtained from federal, state, or local governmental agencies, universities, or other entities, must be approved for use by the WPP. Secondary data, at a minimum, must have been collected and validated using documented procedures and must include the appropriate associated metadata so that the WPP may assess its content, characteristics, quality, and condition.

B.10 Data Management

B.10.1 General

Environmental database systems are maintained by DEQ. Each system is fully backed up each Wednesday and incremental back-ups occur on other days.

The chemical, biological (benthic macroinvertebrates) and geomorphic data of the Watershed WPP are compiled, validated, and checked for completeness prior to being stored in the Surface Water Monitoring (SWM) data system. With a .NET webfront accessible through all DEQ offices, this SQL server database is integrated within the Wyoming Department of Enterprise Technology Services (ETS). ETS oversees data backups, network function, and provide technical support. The SWM system enables advanced biometric analyses, QAQC procedures and multiple querying functions. Three levels of user access are supported; administrative, read/write, and read-only. To minimize hand entry, digital lab results (biological and chemical data) are imported through customized tools. The database supports EPA's national Water Quality Exchange (WQX) schema, exporting water quality data directly to the EPA using a standardized data flow in XML (eXtensible Markup Language). The periphyton data collected by the Watershed WPP are housed in a separate stand-alone Microsoft Access database, which both stores results and calculates numerous biometrics.

Each project manager is responsible for making sure data relevant to their program/project have been managed and stored properly. Any data management procedures specific to a monitoring project/program should be described in the project-specific SAP. Once received, data and database management is the responsibility of the database manager.

B.10.2 Field Data

Field data management is discussed in **Section A.9**, in individual WPP SOPs, and in project-specific SAPs.

B.10.3 Laboratory Results

B.10.3.1 Chemistry Data

The Water Quality Lab is utilized for the majority of water chemistry analyses as well as chlorophyll analyses (water column or periphyton). The Water Quality Lab provides WPP with various documents which are stored in WPP files and data are stored in SWM. Organic chemistry data, when provided by the Water Quality Lab in hard copy format, is hand entered into SWM by WPP staff and data entry is checked by another staff member or the database manager.

B.10.3.2 Biological Data

Biological sample results (macroinvertebrates, diatoms, zooplankton, phytoplankton, *E. coli*, etc.) are received by WPP in various formats and are stored electronically on WPP's server and in SWM.

B.10.4 Compliance Data for Permitted Sites

Compliance-related data collected by WPP field personnel and other WPP staff at permitted sites is stored and maintained like other water chemistry and field data collected by WPP, although not generally stored in SWM.

C. ASSESSMENT AND OVERSIGHT

This section of the WPP QAPP addresses assessments or evaluations to occur both during and after data collection in order to determine whether the project plan is being implemented as approved.

C.1 Assessments and Response Actions

Project managers are responsible for assessing the quality of the work done for their program/project. Assessment activities may be initiated by project managers, the QAO, or the Monitoring Program Supervisor. Examples of assessment activities that may be performed for WPP environmental data operations include independent assessments of field and lab activities conducted by a third party, internal WPP field and lab audits, data validation of selected data sets by WPP or contractor staff, or internal audits performed by contractors themselves. In addition, any project manager or the QAO/Monitoring Program Supervisor may initiate an assessment activity at any time throughout the course of a project/program. Any improvement needs will be addressed at the staff level with the project manager. Issues that cannot be resolved at this level shall be brought to the attention of the WPP QAO. Changes will be made to environmental data

collection operations to improve quality. These corrective actions will be documented and kept in project files by the project manager, or if systematic changes are made, they will be documented and kept on file by the QAO.

C.1.1 Field Assessments

Field audits will be performed as often as is appropriate and practical during field sampling, at a frequency defined by a Project Manager in a project-specific SAP or as initiated by the QAO or Monitoring Program Supervisor. The recommended frequency is annually for each field office. If field audits reveal systemic field data quality issues, the QAO and the Monitoring Program Supervisor will be notified. Results of field audits will be documented by the QAO and maintained by the Project Manager in the project files.

Field data is assessed continuously by field personnel, in the field and back in the office. If temperature, dissolved oxygen or pH readings are found to be illogical (based on best judgment) for the site being sampled, staff will check or recalibrate the field instrument to be certain of the values measured. Recalibration guidelines may depend on the instrument being used and the best judgment of the field personnel. Upon returning from the field, field personnel review their field data and sample collection completion using checklists.

C.1.2 Laboratory Audits

Internal and external laboratory audits will be performed as defined in each laboratory's quality assurance manual and are the responsibility of the lab. Results of these audits are kept on file by the laboratory but may be requested by a Project Manager as part of the project-specific SAP. Audits relating to project-specific performance criteria should be discussed with the laboratory during project planning stages, if possible. In addition, WPP may also perform laboratory audits or submit Performance Evaluation samples which are commercially purchased target analytes at known concentrations submitted "blind" by WPP to the laboratory for analysis.

The Water Quality Lab passes bi-annual proficiency test (PT) samples purchased from a PT provider on analytical parameters that are analyzed in the Water Quality Lab. At the start of a monitoring project, the project manager should discuss laboratory audits with the analyzing laboratories, especially for laboratories performing new, non-EPA-approved, or research methods.

C.1.3 Record Checks

Record checks will be performed by the Monitoring Group at a frequency defined by a Project Manager in a project-specific SAP, or at a minimum, on an annual basis. If record checks reveal systemic data management issues, the QAO will be notified.

C.2 Reports to Management

The project-specific SAP should identify the authors, recipient, contents, frequency, and distribution of reports issued to inform management of project status and QA issues. Projects of a short duration may have only one final report. Ongoing monitoring projects may have regular reporting such as quarterly or semi-annual reports. If stated in the SAP, the Project Manager will analyze data against water quality standards on a regular basis per project-specific requirements. If reports reveal data quality issues or identify that DQOs are not being met, the Project Manager will make the appropriate changes to improve quality. Issues that cannot be resolved at the Project Manager level shall be brought to the attention of the QAO.

D. DATA VALIDATION AND USABILITY

The final section of this WPP QAPP addresses the final project checks to determine if the data obtained will conform to the project's objectives (DQOs), and to estimate the effect of any deviations.

D.1 Data Review, Verification, and Validation

The level of detail and frequency for performing data review, verification, and validation activities will depend on the complexity of the monitoring project, and the importance of the decision to be made based on the data.

D.1.1 Data Review

Data review, as defined by EPA, is the in-house examination to ensure that data have been recorded, transmitted, and processed correctly and includes the following activities: checking for data entry, transcription, calculation and reduction, and transformation errors. Activities also include generating a list of all samples collected (regular samples, blanks, duplicates) as well as the sample information (shipping dates, verification of sample receipt, verification that proper preservatives were used and holding times were met) to ensure that the samples/parameters planned are the same number and type as those actually collected. Data review may occur on a frequent basis for ongoing data collection programs or may only occur a few times during a shorter data collection project. The Project Manager is ultimately responsible for ensuring that all data is reviewed, but the data review tasks can be assigned to WPP field personnel, the database manager and other Monitoring Group staff, as well as the Project Manager.

D.1.1.1 Laboratory Data

Laboratory results are initially reviewed and reported by the analyzing laboratory. The reviewed data package is then submitted by the laboratory to the WPP Project Manager, the Monitoring Group Supervisor, and the QAO. The Project Manager and QAO each conduct their own review of the lab data. Some (not all) of these checks

include making sure Sample IDs are correct, reviewing laboratory comments, comparing total to dissolved values, checking for the presence of expected detection/quantitation limits based on the analytical method, reviewing non-detect data, checking to see if/when dilutions were performed, making sure holding times were met, making sure all analyses for a sample are complete, looking for duplicate records or incorrect dates, etc. The QAO will follow up with the laboratory QA officer or individual analysts if any missing or suspect data are identified.

Laboratory results passing this initial level of scrutiny are then uploaded for storage in SWM and the raw data files are saved on the WPP server indefinitely.

D.1.1.2 Field Data

WPP field personnel will verify quality of field data (electronic and hard copy). Field data for the entire trip will be reviewed by a member of the field team both during and after the trip. This review includes the following: checking field documentation and electronic field data for data entry, transcription, calculation and reduction, and transformation errors as well as completeness, proper format, and initial filing into the proper location. Next, the field documentation may be sent to the QAO for review, or it may be submitted at the same time as the final report. The QAO will perform a secondary check of the above-listed items, follow up on questionable data points, and provide a QA/QC report.

D.1.2 Data Verification

Data verification, as defined by EPA, is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. It essentially evaluates performance against pre-determined specifications, for example, in an analytical method, or a software or hardware operations system.

D.1.2.1 Laboratory Data

Some analytical data verification occurs concurrently with data review as discussed above and is performed by both the analyzing laboratory and WPP. Data verification is also supported by laboratory audit activities. During the verification and review process, results of any audits can be discussed, and any systemic data quality issues can be addressed. Project Managers should initiate communication with analyzing laboratories other than the Water Quality Lab and may ask the WPP QAO to participate in these discussions.

D.1.2.2 Field Data

Field data verification occurs concurrently with data review as discussed above and is also supported by field audit activities. Project Managers should ensure that data is being collected according to the appropriate SOP. The Project Manager should

continuously be assessing the completeness, representativeness, and comparability of the dataset during data collection.

D.1.3 Data Validation

Data validation, as defined by EPA, is an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set. It focuses on the project's specifications or needs, is designed to meet the needs of the decision makers/data users and should note potentially unacceptable departures from the SAP or QAPP. Data validation is primarily the responsibility of the Project Manager because he is the most familiar with the project-specific goals, although some data validation tasks general enough to apply to all monitoring will be performed by the database manager and other staff. The specific criteria for deciding to accept, reject, or qualify project data in an objective and consistent manner must be determined for each program/project if different from what is prescribed in the QAPP and discussed in the program/project SAP. These decisions are based on the quality criteria set forth for each program/project in its DQOs. The minimum performance criteria listed in **Sections A.7 and B.5** should generally be met for all monitoring programs/projects unless otherwise justified and described in the SAP. The project manager or QAO may flag or qualify results or add result comments to data records in the database. Data in the database will never be deleted, although if it does not pass data validation, it will be given a "Rejected" result status. The result status of the data in SWM that passes validation will be changed from "Accepted" to "Validated".

The potential effects of any deviation from ideal data quality will be evaluated during the final data quality assessment (see below). But initial data validation should be performed in the earliest stages of a project or on an ongoing basis for long-term monitoring programs, in order for Project Managers to perform any necessary corrective actions or adjustments to the project-specific SAP before the rest of the dataset is collected. For example, the first batch of analytical data for a project should be reviewed by the Project Manager immediately to determine if reporting limits are adequate to perform comparisons to action levels, such as numeric water quality criteria. The quality control samples and activities as prescribed in the SAP should be evaluated by the Project Manager, with the help of the field crew, and should continue to be evaluated on at least a quarterly basis throughout the life of the project. If there are issues, the Project Manager, QAO, or Monitoring Program Supervisor will follow up with corrective actions as necessary. Blanks will be evaluated immediately after data is received from the laboratory and the results reported by the Project Manager to the laboratory personnel so they may follow up with immediate corrective action if needed to address sample contamination issues.

D.2 Verification and Validation Methods

See also the previous section. Any verification and validation methods to be used other than those mentioned in Section D.1 should be described explicitly in the project-

specific SAP. There are specific data verification activities (e.g. outlier analyses) that may be described in the final report for a monitoring project or program, such as those performed for the IR, Qual2K modeling, or a TMDL analysis. Those methods must be thoroughly documented in those reports and explain any changes that were made to the dataset to enable analysis.

D.3 Reconciliation with Data Quality Objectives and User Requirements

This data quality review is the culmination of the entire QA process for a monitoring project/program. DQOs for each WPP program/project should be clearly defined and documented. An evaluation of the usability and limitations of all data collected and validated, with respect to the original DQOs, must be documented after completion of data collection activities, or for ongoing projects, once a year following the field season. The QAO is ultimately responsible for performing this final review of the data quality but will be assisted by Monitoring Program staff. For ongoing monitoring programs, this process is critical for future planning purposes and addressing systemic data quality issues. The final data quality review should be documented as a stand-alone document.

REFERENCES

American National Standards Institute/American Society for Quality Control (ANSI/ASQC). 1995. Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs (E4-1994). American National Standard.

USEPA. 2001. EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5 (EPA/240/B-01/003)

USEPA. 2002. Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8) (EPA/240/B-02/004, November 2002)

USEPA. 2002. EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5 (EPA/240/R-02/009).

USEPA. 2007. Guidance for Preparing Standard Operating Procedures (SOPs), EPA QA/G-6 (EPA/600/B-07/001).

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APPENDICES

Appendix A *SAP Guide*

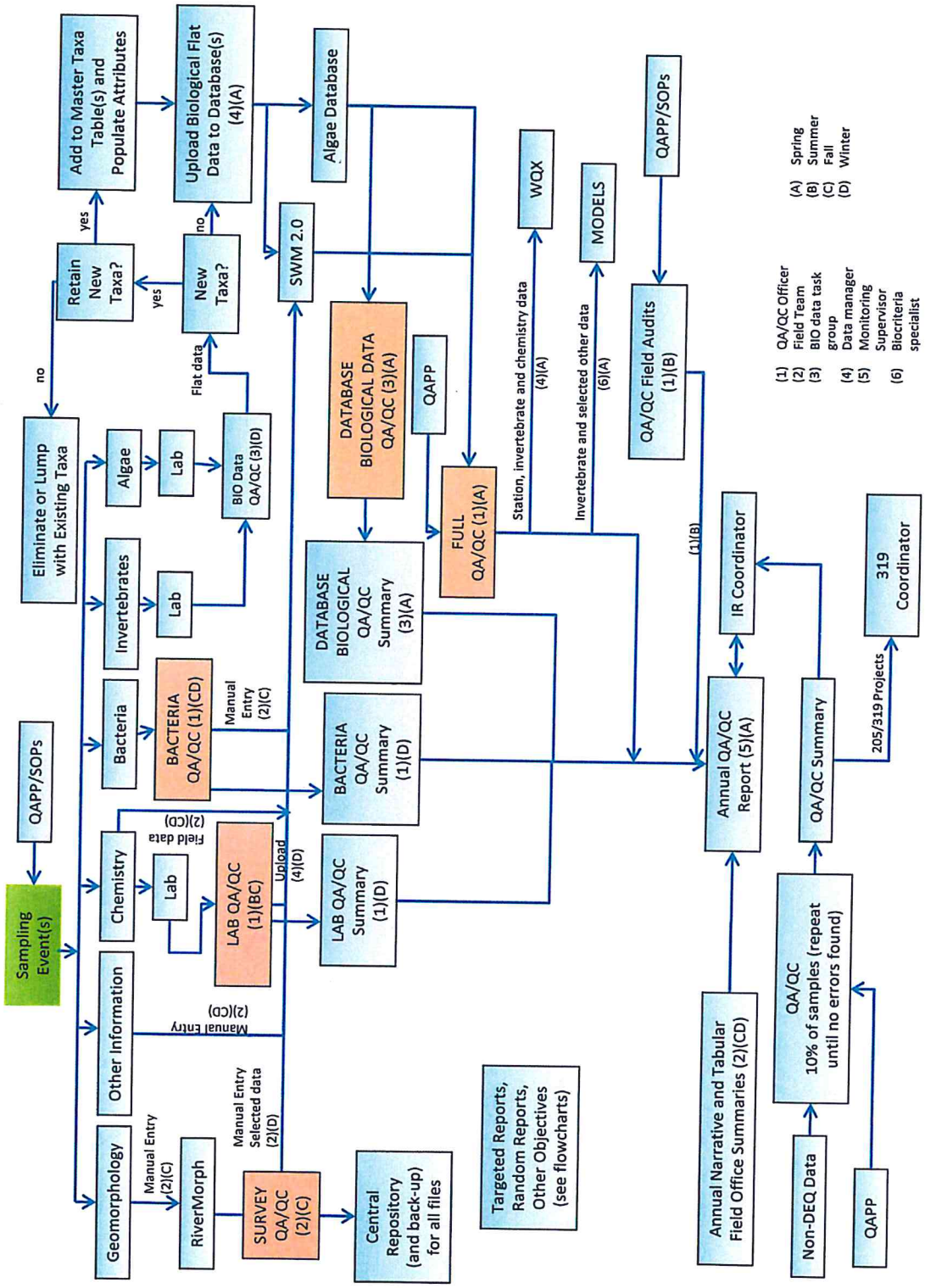
Appendix B *Credible Data Law*

Credible Data

The Wyoming Environmental Quality Act (WDEQ, 2012), Wyoming Statute (W.S.) § 35-11-103(c)(xix), and Section 2(a)(i) of Chapter 1 define credible data as *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*. Section 35(b) of Chapter 1 requires that *credible data be collected on each water body, and shall be considered for purposes of characterizing the integrity of the water body including consideration of soil, geology, hydrology, geomorphology, climate, stream succession and the influences of man upon the system. These data in combination with other available and applicable information shall be used through a weight-of-evidence approach to designate uses and determine whether those uses are being attained*. Chapter 1, Section 35(d) requires that *credible data shall be utilized in determining a water body's attainment of designated uses*, although a less than complete set of data may be used to make a decision on designated use support (i.e. attainment) *in instances where numerical standards contained in these rules are exceeded or on ephemeral or intermittent water bodies where chemical or biological sampling is not practical or feasible* (Chapter 1, Section 35(b)). Hereafter, within this document, the use of the term credible data bill refers to the definition above.

As described in Section 35(a)(i) of Chapter 1, data must be collected *using accepted referenced laboratory and field methods employed by a person who has received specialized training and has field experience in developing a monitoring plan, a quality assurance plan, and employing the methods outlined in such plans; or works under the supervision of a person who has these qualifications. Specialized training includes a thorough knowledge of written sampling protocols and field methods such that the data collection and interpretation are reproducible, scientifically defensible, and free from preconceived bias*. Section 35(a)(ii) of Chapter 1 states that *data must include documented quality assurance, consisting of a plan that details how environmental data operations were planned, implemented, and assessed with respect to quality during the duration of the project*.

Appendix C *QA/QC Process Flowchart*


Sampling Event(s)
QAPP/SOPs
Geomorphology
Manual Entry (2)(C)
RiverMorph
Other Information
Manual Entry (2)(CD)
Chemistry
Lab
Field data (2)(CD)
LAB QA/QC (1)(BC)
Upload (4)(D)
SURVEY QA/QC (2)(C)
Manual Entry Selected data (2)(D)
Central Repository (and back-up) for all files
Bacteria
Invertebrates
Algae
Lab
BACTERIA QA/QC (1)(CD)
Manual Entry (2)(C)
BIO Data QA/QC (3)(D)
Flat data
Eliminate or Lump with Existing Taxa
no
Retain New Taxa?
yes
New Taxa?
yes
no
Add to Master Taxa Table(s) and Populate Attributes
Upload Biological Flat Data to Database(s) (4)(A)
SWM 2.0
Algae Database
DATABASE BIOLOGICAL DATA QA/QC (3)(A)
QAPP
FULL QA/QC (1)(A)
DATABASE BIOLOGICAL QA/QC Summary (3)(A)
BACTERIA QA/QC Summary (1)(D)
LAB QA/QC Summary (1)(D)
Station, invertebrate and chemistry data (4)(A)
WQX
Invertebrate and selected other data (6)(A)
MODELS
QAPP/SOPs
QA/QC Field Audits (1)(B)
(1)(B)
IR Coordinator
319 Coordinator
Annual QA/QC Report (5)(A)
205/319 Projects
QA/QC Summary
QA/QC 10% of samples (repeat until no errors found)
Non-DEQ Data
QAPP
Annual Narrative and Tabular Field Office Summaries (2)(CD)
Targeted Reports, Random Reports, Other Objectives (see flowcharts)
(1) QA/QC Officer
(2) Field Team
(3) BIO data task group
(4) Data manager
(5) Monitoring Supervisor
(6) Biocriteria specialist
(A) Spring
(B) Summer
(C) Fall
(D) Winter

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