DRAFT

Conceptual Plan for Long-Term Monitoring of Surface Water in the Tongue River and Powder River basins of Wyoming and Montana

Prepared by the U.S. Geological Survey,
in cooperation with the U.S. Environmental Protection Agency

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1.0 INTRODUCTION

1.1 Purpose of Monitoring Plan

This draft monitoring plan describes a conceptual data-collection network for surface-water quality and quantity in the Tongue and Powder River basins of Wyoming and Montana. The plan is being prepared by the USGS at the request of EPA and in consultation with numerous stakeholders in the basin. The purpose of this effort is to identify key sites to include in a watershed-scale network and to describe general features of an operational design that is long-term and systematic in its approach to obtaining stream data. This monitoring plan is intended to serve as a "guidance document" that can assist agencies in evaluating how their own monitoring priorities can be integrated into a larger watershed view. Integration of monitoring activities among various agency programs will be necessary to sustain the long-term operation of a comprehensive network. Ultimately, the data generated from a watershed-scale network can be used by multiple agencies having various resource-management responsibilities to make informed environmental assessments and decisions.

This monitoring plan is intended to have an objective design capable of providing high quality data that represents collective impacts on water quality from multiple natural or human sources over a broad geographic area. It is recognized that there currently are a number of sampling programs being independently conducted by Federal, State, Tribal, and private entities. All of these programs contribute to an overall characterization of water quality in the basins. Because these programs have their own specific objectives and requirements, this monitoring plan does not seek to replace any of the sampling programs currently in operation. Rather, this network plan incorporates a review of the types of monitoring being done and seeks to identify either data gaps or a subset of currently active sites that could be utilized in a unified watershed-scale network.

A primary goal of this plan is to advocate for the operation of a long-term monitoring network in a consistent manner over time, and to provide recommendations on data-collection strategies to meet various objectives. Ongoing operation of a network of key sites can provide a reliable basis for current data that may be critical when immediate resource-management decisions need to be made. Uninterrupted, long-term information is also necessary to document changes over time in a manner that can support statistical analysis of trends and enhance the confidence of conclusions on environmental impacts.

Securing funds to implement and maintain long-term operation of a watershed-scale network will be a difficult challenge. Although this conceptual monitoring network does not identify a specific funding process, it was felt that development of an objective monitoring plan that had stakeholder support was an essential first step toward articulating goals and tasks needed to achieve objectives that would benefit multiple agencies and the public interest. Therefore, it is hoped that this plan can be a reference for groups evaluating data needs and priorities in the Tongue and Powder River basins, and can enhance opportunities for collective efforts from multiple funding sources to support a watershed-scale monitoring effort.

1.2 Process of Monitoring Plan Development

The development of a monitoring plan was initiated by a review of current and former sampling programs to understand what types of data are available for use as historic reference, and what types of data currently are being collected. This effort was achieved by an in-house review of the sampling histories of USGS stations, plus a survey (in May 2003) of sampling programs being conducted by Federal, State, Tribal, and private data-collection entities. The results of the sampling-program surveys were compiled into tables that were used to review locations, types of data, and periods of record to define the historical and current monitoring status in the Tongue and Powder River watersheds.

The next major step in the process of network design was to convene a meeting of stakeholders from both basins in Montana and Wyoming. On June 5, 2003, a meeting was held in Sheridan, Wyoming to allow the approximately 40 participants to provide input on important monitoring locations, sampling strategies, and desired outcomes from monitoring efforts. Summaries of monitoring programs compiled from the survey were distributed to stakeholders to provide an overview of the numerous sampling efforts in the basins. Site locations, sampling intensity, and parameters were discussed and a general consensus was achieved on what sites would best represent a "core" network to provide stream data on an ongoing basis and at a practical scale of operation. Data gaps were identified, as well as existing programs that currently satisfy numerous monitoring objectives. Additional sampling and data-interpretation issues were raised that are beyond the scope of this network effort, but represent important considerations that warrant further discussion and examination of possible approaches to meet issue-specific or site-specific objectives (see "Supplemental Studies, Section 6.0).

Following the first meeting of stakeholders, the USGS assembled the recommendations on network design into tables listing the core sites and levels of sampling intensity needed to meet various environmental assessment objectives. *The "draft" monitoring plan is presented in the following sections of this document and is being distributed for review and comment by stakeholders.* The plan includes lists of sites in the proposed network, as well as discussions on monitoring objectives, sampling strategies, rationale for site selection, technical considerations for operating a network, and issues regarding how agencies can coordinate efforts to share information and pool resources to sustain the network. Upon receipt of comments and revisions to this draft, a final monitoring plan will be distributed in late summer of 2003. At that time, another stakeholder meeting is planned to present the network design and solicit ideas on how to proceed with implementation and funding.

2.0 MONITORING GOALS AND OBJECTIVES

2.1 Resource Management and Protection

The overall goal of long-term, systematic monitoring is to provide reliable and current information to support environmental assessments of stream health and to guide resource-management decisions necessary to protect aquatic resources and their associated beneficial uses. Specifically, the goal of this monitoring plan is to collect water-quality and quantity data at key sites on the mainstems and major tributaries in the Tongue and Powder River basins, as discussed and selected by consensus of stakeholders in the basins.

2.2 Environmental Assessment Objectives

Long-term data can be used for a variety of assessment objectives, depending on the intensity of data collection. Some examples of the types of assessments that could be achieved with a systematic program of data collection are:

- Identification of impaired streams that do not fully support beneficial uses
- Development of objective criteria for decisions on permits and water-quality standards by understanding the range of seasonal and annual variability
- Assessment of the effectiveness of Best Management Practices implemented to improve water quality
- Documentation of compliance or non-compliance with regulatory standards
- Ongoing tracking of the status of annual water-quality conditions, including average conditions, abrupt changes, or unusual extreme conditions
- Providing input data to watershed models used to simulate impacts from a range of hydrologic or land-use scenarios
- Determination of annual loads of constituents input at various points across the watershed that can be used to identify important source areas
- Detection of statistically significant trends in water quality over time that can be used to identify and quantify long-term degradation or improvement in the condition of the resource
- Assessment of stream ecosystem health and trends through systematic documentation of aquatic insect and algal characteristics over time
- Assessment of reservoir limnological health and trends through systematic sampling of water quality and algal productivity

Meeting these objectives requires a substantial amount of ongoing data to adequately characterize variations in conditions within and between years through various climatic and hydrologic cycles, seasons, and land-use activities. The effectiveness of decisions designed to protect and manage water resources for multiple beneficial uses is directly dependent on the adequacy of available data in terms of quality and quantity. Therefore, it was proposed that a sampling intensity be recommended for this network that is sufficient to generate data capable of meeting a wide range of environmental assessment objectives, yet represents a practical scale of cost and staff resources for long-term operation. The primary assessment objectives considered to be the focus of this monitoring plan are "Status and Trends" and "Source-Area Assessments".

2.2.1 Status and Trends

Ongoing data collection documents the status of current environmental conditions and is essential to tracking annual ranges of conditions and accumulating the long-term information necessary to eventually quantify and understand the response of aquatic resources to climatic and land-use activities. Evaluating long-term trends is one of the most desirable, yet most difficult, monitoring tasks to accomplish. It is extremely useful for assessing impacts of land-use practices on water quality, and can often infer linkages between cause and effect. Trend detection is a useful tool, whether it be for examining degradation of stream quality or effectiveness of remediation activities in improving stream conditions. But trends can be difficult to statistically verify because they are often very gradual and can be masked or misinterpreted by the effects of natural variations in environmental conditions. Thus, ample data need to be collected concurrently with streamflow data to distinguish between actual human-caused effects and transient "apparent" trends associated with naturally variable hydrologic cycles.

2.2.1.1 Water Quality

"Statistically" detecting water-quality trends is difficult because water quality can vary naturally to a great degree, both within a given year and between years, due to wide shifts in climatic and hydrologic conditions. These natural variations can be cyclical and give the appearance of a trend in concentrations or loads that can be misleading and erroneously attributed to various land uses. When the hydrologic pattern moves in the other direction, "apparent" water-quality trends may also reverse, thus indicating that there may have been no actual change in environmental processes (such as the supply of a contaminant or its rate of transport through the watershed). Further complicating this scenario of natural fluctuations in water quality is the fact that human activities can cause either subtle or distinct changes in water quality that are superimposed on the natural variations of water quality, thereby making it difficult to discern the extent of effect from either cause.

To be able to distinguish the effect of human activities on water quality from natural variations requires a substantial amount of data. Within a given year, sufficient data need to be collected to characterize seasonal variations associated with streamflow conditions, instream biological productivity, and changes in land-use activities. Between years, data need to be collected for a sufficient number of years to encompass a wide range of flow conditions so that the response of water quality to drought, floods, and normal flows is adequately characterized. This response to hydrologic variation is critical, and a rigorous assessment of trends requires that flow conditions and water-quality conditions be evaluated simultaneously to account for the effect of flow.

Because of the numerous types of influences on water quality (natural, agricultural, urban/residential, resource development, etc.), the relatively intense level of sampling needed to detect water-quality trends was considered to be the most useful for characterizing potential impacts from multiple sources. In this monitoring plan, most sites are recommended for this primary level of water-quality sampling. The advantage of an intense level of sampling is that the data are suitable for meeting almost all environmental assessment objectives common to most sampling programs. The disadvantage is the high cost associated with the intensive data-collection effort.

2.2.1.2 Stream Biology

Determining stream ecosystem health requires systematic documentation of the biological taxa present at the site and their relative abundance. Sampling of two components of the aquatic ecosystem – benthic macroinvertebrates and algae – provides information on basic components of the aquatic food chain. Because aquatic biota present in the stream represent the integrated response to continual exposure to ambient stream conditions (flow, water chemistry, temperature, substrate condition, etc.), they are excellent indicators of sustained stream health or impairment. Coupling information on the biological communities with supporting information provided by streamflow gaging and water-quality sampling can lead to more definitive assessments of stream health, and help to identify factors that may be causing biological impairment. Repeating biological sampling on an annual basis provides the basis for detecting long-term trends in community structure that can be used as a supporting line of evidence in interpreting long-term trends in water-quality data.

2.2.1.3 Reservoir Limnology

Similar to streams, reservoir ecosystem health can be assessed through both chemical and biological sampling. Due to the physical dynamics of reservoir processes, such as thermal stratification, nutrient cycling associated with seasonal turnover, sedimentation, and phytoplankton production and die-off, water quality can vary at different locations and at different depths within a reservoir. Documentation of these variations can describe the current health of the reservoir system, and help to understand the patterns of seasonal variation. A long-term record of reservoir limnology can identify trends in water-quality or algal productivity, which may in turn be useful to understanding or predicting the response of the fishery to seasonal and annual variations. Also, because reservoirs are depositional environments, the loading data available from input and outflow stations can be used to determine the mass of constituents that are annually accumulating in the reservoir, and whether the long-term buildup of consituents can pose a potential risk to future water quality degradation or biological impairment.

2.2.2 Source-Area Assessments

Annual loads for a network of sites can be used to identify the relative contributions of constituent loads from various source areas within the basin. The determination of annual loads requires a fair amount of data, but somewhat less than that needed for trend analysis. The calculation of annual loads at a sampling site requires a continuous streamflow gage and moderately intense sampling that is conducted for enough years to develop mathematical relations (regressions equations) between associated variables such as flow and concentration. These relations, if statistically significant, enable the estimation of annual constituent loads by incorporating the daily record of streamflow. Application of the regression model to a daily record of flow is necessary to account for the high degree of hydrologic variation, especially during runoff periods. It is during these relatively short periods of high flow that the bulk of the annual load typically is transported past a sampling site; thus, data on the magnitude and duration of flow conditions, especially high flow, is essential for quantifying the seasonal variations in load. Annual loads estimated for a minimum of five years are also essential to have a meaningful long-term average load that represents the large range in annual flows that can occur and which provides a basis for comparison of load contributions among subbasins.

An accounting of average annual loads for a network of sites distributed across an entire watershed allows source-area assessments, whereby the portion of the basin contributing a large or disproportionate amount of constituent load can be identified. The benefit of identifying important source areas is that these subbasin areas can either be examined in greater detail to pinpoint discrete sources, or they can be prioritized for remedial actions to decrease their input to the mainstem. All sites sampled at the intensity sufficient to detect water-quality trends will generate data sufficient to determine annual loads. In addition to these “trend” sites, a small number of sites are recommended for the less intensive level of sampling necessary to determine annual loads. These secondary sites are intended to allow an indication of relative differences in water quality and loads between the upper and lower portions of major tributary basins. The moderate sampling intensity needed for estimating annual loads is also generally adequate to characterize current status, although with less resolution that that of more intensively sampled sites.

2.3 Limitations of Network Data

The level of data obtained from a broadly distributed network of sites cannot answer all questions regarding localized effects, discrete source contributions, ground water-surface water interactions, or other complex environmental processes such as detailed geochemical or biological interactions. Such interpretive objectives would need to be achieved through a data-collection effort specifically designed to generate data of sufficient resolution to address the issues in question. However, long-term systematic data from key locations in a watershed network can benefit detailed investigations by providing quantitative information to supplement research efforts. The examination of data patterns at key index sites can reveal temporal patterns or other features in the data that can be used to extrapolate potential trends to other sites or calibrate models to fit observed conditions. Therefore, systematic data from a distributed network can be coupled with data from targeted, site-specific studies to facilitate interpretation of data influenced by multiple water-quality effects over a broad geographic area. Potential types of supplemental studies to address specific hydrologic or geochemical processes are described in Section 6.0 “Supplemental Studies”.

3.0 SAMPLING STRATEGY TO MEET OBJECTIVES

3.1 SAMPLING INTENSITY

Different levels of sampling intensity are required to meet objectives for various types of water-quality assessments. The greater the need to identify the duration and magnitude of short-term variations in water quality, the higher the sampling frequency that is required. Increased sampling frequency can improve characterization of temporal variations in water quality that may be missed if samples are widely spaced in time. Many things can lead to water-quality fluctuations, such as changes in flow conditions, land-use activities, and seasonal variations in biological productivity. Where such variations in flow or water quality are continually integrated into a system response, such as in the composition and abundance of biological communities, a lower sampling frequency is required. Regardless of the within-year sampling frequency, the continuation of sampling over multiple years is essential to describe a wide range of hydrologic conditions associated with climatic cycles. Because these hydrologic variations can exert a predominant influence on water quality and annual loads, short-term data programs can potentially misrepresent longer-term average conditions. A very generalized set of guidelines for levels of water-quality sampling intensity (frequency and duration) necessary to meet a variety of monitoring objectives is provided Table 1.

Table 1. RECOMMENDED WATER-QUALITY SAMPLING INTENSITY FOR VARIOUS MONITORING OBJECTIVES

Objective	Assessments supported by data	Recommended sampling intensity to meet objective	
		Sampling frequency (per year)	**Program duration (years)**
Baseline	General reference to range of conditions (max, min), but resolution is inadequate to support much interpretation.	2-4	2 +
General Status	Descriptive statistics (mean, max, min); identifies moderate range of seasonal and flow variability; useful to identify relative differences between sites.	4-6	5 +
Annual Loads	Mathematical relations (flow vs. conc., flow vs. load, etc.) can be developed to describe response to flow. Gage required to compute annual loads. Higher sampling frequency may be required for basins with variable hydrology dominated by rainfall runoff.	6-8	5 +
Long-term Trends	Frequent, long-term sampling sufficiently describes variability to statistically detect trends and distinguish natural variability from human-induced changes.	8-12	10 +

To accommodate many types of environmental assessment objectives, the relatively intense level of sampling considered necessary to monitor long-term trends is recommended for most sites. This high level of sampling intensity for stream chemistry is referred to as Level I in this monitoring plan. Level I sampling is recommended for mainstem locations on the Tongue and Powder Rivers, plus sites near the mouths of major tributaries that were identified by stakeholders as having the greatest importance from a watershed perspective

In addition to the primary sites selected for intensive stream-chemistry sampling, several sites were identified within major tributary basins as being important for characterizing changes over smaller distances where differences might be attributable to a single type of land use. For the most part, these sites are at mid-basin or upper-basin locations on major tributaries. The data from these secondary types of stations represent areas above the bulk of developed land and may provide some indication of local reference conditions. A moderate level of sampling intensity would be conducted at these secondary sites that would be adequate to characterize a fairly wide range of flow and seasonal conditions. With streamflow gages at these secondary sites, annual loads also could be computed to allow comparison to downstream loads at the site near the mouth for determining net differences. The moderate level of sampling intensity for upper tributary sites is referred to as Level II in this monitoring plan.

To supplement environmental assessments based on stream chemistry, biological sampling is recommended at selected sites to provide multiple lines of evidence that can support or refute conclusions drawn from chemistry data. The advantage of biological sampling is that the resident communities represent an integration of continual exposure to the full range of instream conditions, whereas water-quality assessments rely on a statistical summarization of instantaneous measures of ambient conditions at the time of sampling. Valid water-quality assessments, therefore, are highly dependent on the sampling frequency and the ability of the data distribution to adequately represent the pattern of variation and extreme conditions throughout a year. The benefit of collecting the additional biological data is that it can be evaluated simultaneously with stream chemistry and flow data to offer stronger support for environmental assessments of stream health and long-term trends. Stream biology sampling intensity is referred to as Level III in this proposal.

A less-frequently encountered hydrologic setting in the Tongue and Powder River basins is that of a large reservoir that is used to store irrigation water, support a lake fishery, and provide public recreation. Only one such reservoir is considered in this monitoring plan – Tongue River Reservoir near Decker, Montana. Because of it's importance to various beneficial uses, this reservoir is recommended for systematic, long-term sampling to assess possible impacts from upstream land uses. Reservoir limnology sampling is referred to as Level IV in this proposal.

A brief description of the various sampling strategies for stream chemistry, stream biology, and reservoir limnology considered to be adequate for a long-term watershed monitoring network is provided in the following sections.

3.1.1 Level I – Stream Chemistry (Trends)

The intensity of water-quality sampling considered adequate to statistically detect long-term trends in streams in the Tongue and Powder River basins is a frequency of 12 times per year, and for a duration of at least 10 years. Although determination of adequate sampling intensity is somewhat subjective, this frequency and duration is similar to the intensity used in other trend studies, and is based on the degree of within-year and between-year hydrologic variability typical of these basins, which can be large. The 12 per year frequency may be a little higher than necessary for characterizing water-quality variability in most basins, but the potential for year-round discharge of CBM production waters, municipal wastewater, or subsurface irrigation return flows warrants additional sampling during traditional low-flow months when routine sampling might otherwise be curtailed.

The temporal distribution of the 12 per year frequency is recommended to be once-monthly. This uniform time interval and high frequency should be adequate to characterize natural hydrologic variation, plus capture any year-round inputs that may be associated with land uses that are independent of seasonal hydrologic cycles.

3.1.2 Level II – Stream Chemistry (Annual Loads)

A moderate intensity of water-quality sampling considered adequate to generally characterize seasonal variability in the Tongue and Powder River basins and develop statistical relations between streamflow and constituent loads is a frequency of about 6 times per year, and for a duration of at least 5 years. This level of sampling intensity is recommended only for several secondary sites near mid-basin or upper-basin locations in major tributary basins. Although it is assumed that hydrologic and water-quality variability will be less at these sites than at mainstem sites or near the mouths of tributaries, the sampling frequency of 6 per year may be inadequate if the runoff is flashy and events are difficult to capture, or if flow-constituent relations are complex. These types of considerations may need to be evaluated on a case-by-case basis.

Supplemental sampling at selected tributary sites will possibly provide a measure of reference conditions if located above intensive land uses, and may provide increased resolution on water-quality and load differences over relatively short reaches of a tributary where potential water-quality impacts may be related to only one primary land use. This information could thus provide a clearer picture of stream response to a specific type of land use.

The temporal distribution of the 6 per year frequency is recommended to follow the annual hydrograph, with somewhat greater intensity during the runoff period of spring and early summer. Low flows of late summer and fall would be sampled to characterize conditions during periods when constituent concentrations may be elevated due to the lack of dilution. Winter sampling would be done occasionally to document conditions during extended periods of ice cover when dissolved oxygen can become depleted.

3.1.3 Level III – Stream Biology

Because the composition of biological communities represent an integration of year-round exposure to ambient instream physical and chemical conditions, sampling can be limited to a once-annual frequency. The important feature in this type of annual sampling is to obtain samples in the same season every year in order to provide equivalent data for comparison between years. The typical types of biological data collected for baseline reference is taxonomic composition and relative abundance of the benthic macroinvertebrate and attached algae (periphyton) communities. The timing of the once-annual sampling for stream biology would typically be during the August-September base flow period, which is commonly the period of peak algal production. It is recommended that Level III stream biology sampling be conducted at all of the Level I stream chemistry sites. The ongoing sampling of stream biota every year for at least ten years can provide a concurrent measure of biological conditions at the core network sites during the same period and under the same hydrologic conditions described by the water-quality and streamflow data.

3.1.4 Level IV – Reservoir Limnology

Because of the physical processes unique to reservoirs, limnological sampling entails several modifications relative to stream sampling. To document potential spatial differences in water quality that could be associated with deposition of influent sediment and suspended chemical constituents, it is recommended that two sites be sampled – one at the shallower end of the lake near the inflow to the reservoir and one at the deeper end of the lake near the dam and the outflow from the reservoir. In addition, because reservoirs can thermally stratify into layers of water having distinctly different temperature and density, circulation patterns can be non-uniform, resulting in varying water quality with depth. Thus, it is recommended that samples be collected at two depths at each site to characterize differences that may exist between the near-surface and near-bottom water layers. In addition, it is also recommended that a depth profile of field parameters (water temperature, pH, specific conductance, and dissolved oxygen) be done at each sampling location to characterize depth-dependent variations in water quality. The depth intervals for recording these field measurements will depend on the total depths encountered at each sampling site, but will generally be about every 1 ft. A sampling frequency of 4 per year is proposed to characterize seasonal variability associated not only with variations in inflow volumes, but also with internal circulation patterns within the reservoir that can affect nutrient cycling, vertical mixing, biological productivity, and potential geochemical reactions. The distribution of the four samplings would be one in each season (spring, summer, fall, winter).

3.2 Parameters Proposed for Analysis

The water-quality parameters of concern routinely indicated through various meetings, agency communications, landowners, and citizen groups generally include the common ions (dissolved) associated with salinity and sodium adsorption ratio (SAR), and nutrients (dissolved and total recoverable) associated with stream enrichment and nuisance algal growth. Common ions and nutrients, therefore, constitute the primary constituents of concern in the Tongue and Powder River basins and would represent the “core” constituents to be sampled at every site in the network.

There is often interest regarding trace-element concentrations, partly because of concern about potential toxicity to aquatic life and partly because of a more limited knowledge of existing concentrations and potential inputs associated with various land uses. Therefore, analysis of a broad suite trace elements is recommended for Level I sites for a period of several years to obtain a consistent level of baseline data for subsequent evaluations of the presence or absence of concentrations of concern. After an initial period of several years, a decision could be made on whether to continue sampling for trace elements, or what specific elements to continue to analzye. It is also recommended that both the dissolved and total-recoverable concentrations of trace elements be analyzed in order to accommodate various bioavailability and regulatory considerations. In addition to chemical constituents, it is recommended that suspended-sediment concentration be analyzed at all stream sites due to the potential for sediment impairment to aquatic life or streambed habitat, and the need to assess the primary source areas in the basin contributing sediment.

Biological parameters recommended for the Level III sampling intensity would include the taxonomic composition and relative abundance of benthic macroinvertebrates and periphyton algae. Taxonomic identification and enumeration of invertebrates would be performed at a consistent level for all samples in order to allow for valid comparisons between sites and between years within a site. Periphyton algae taxonomy also would be identified to a consistent level between sites, and ash-free biomass determined as a measure of abundance. In addition, chlorophyll A would be analyzed as a measure of productivity in both stream and reservoir sites.

Selected parameters would be continuously recorded to provide a high level of temporal resolution where rapid variations of short duration may not be adequately described by periodic sampling. A continuous record of streamflow is considered to be essential to quantify the magnitude and duration of hydrologic conditions, which have a significant effect on water quality. Continuous streamflow, therefore, is recommended for all sites. In addition to flow, water temperature can be a critical stressor to aquatic biota. Because temperature displays substantial seasonal and diurnal variation, it also is best quantified through continuous monitoring, at least seasonally through the warm-weather months, and is recommended for all Level I sites. Finally, a continuous record of specific conductance is important at sites where salinity is a critical issue with regard to suitability of water for irrigation, or for preventing impacts to the aquatic or riparian ecology. Specific conductance can serve as a surrogate indicator of salinity and this parameter has numeric regulatory standards in the Montana portion of the Tongue and Powder Rivers. Consequently, a continuous record of specific conductance is recommended for selected sites that have naturally high salinity, represent an important decision point in the basin (State boundaries), or receive inflows from areas where land uses may increase the concentration of salts in water draining from those areas.

Other parameters could be added at specific sites on a case-by-case basis. If a parameter is subsequently identified as important throughout the watershed, it could be universally added to all sites for consistency. A list of proposed parameters and sampling frequency associated with each Level of sampling intensity is provided in Table 2.

Table 2. Parameters and sampling frequency for Levels I – IV sampling intensity

Level	Parameters	Frequency
I	***STREAM CHEMISTRY:*** ***Field measurements:*** streamflow, specific conductance, pH, dissolved oxygen, water temperature ***Common Ions (dissolved):*** calcium, magnesium, sodium, potassium, alkalinity, sulfate, chloride, fluoride, silica. Calculated: sodium adsorption ratio (SAR), total dissolved solids (TDS) ***Nutrients (dissolved and total):*** Total nitrogen, nitrite, nitrite plus nitrate, ammonia, total phosphorus, orthophosphate ***Trace Elements (dissolved and total recoverable):*** aluminum, arsenic, barium, beryllium, boron, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, zinc	12/year
II	***STREAM CHEMISTRY:*** ***Field measurements:*** (same as for Level I) ***Common Ions:*** (same as for Level I) ***Nutrients:*** (same as for Level I)	6/year
III	***STREAM BIOLOGY:*** ***Benthic macroinvertebrates:*** taxonomic identification and enumeration ***Periphyton algae:*** taxonomic identification and ash-free biomass ***Chlorophyll A (periphyton):*** concentration	1/year
IV	***RESERVOIR LIMNOLOGY:*** ***Field measurements:*** depth profiles of water temperature, specific conductance, pH, dissolved oxygen ***Common Ions:*** (2 depths) Same as for Level I ***Nutrients:*** (2 depths) Same as for Level I ***Chlorophyll A (phytoplankton):*** (2 depths) concentration	4/year

4.0 PROPOSED SURFACE-WATER MONITORING SITES

To represent a feasible scale of operation across a large geographic area, the network is limited to sites on the mainstems of the Tongue and Powder Rivers, and on selected major tributaries. It is felt that this distribution of sites allows for detection of incremental downstream changes along the mainstem reaches, and for characterization of water quality in the tributaries that represent the major hydrologic inputs expected to have the most influence on mainstem changes. The relatively broad spacing between mainstem sites only allows for assessments of “net” differences that reflect the cumulative contributions of tributaries, ground water, and land uses within the intervening reach between mainstem sites. Quantification of net differences between mainstem sites, however, can be used to identify unusual patterns and possibly justify the need for more detailed examination of sources within the intervening reaches. Greater resolution on specific sources contributing to downstream changes in the mainstems would require additional sampling sites that bracket discrete tributaries or land-use areas.

Based on discussions and input from stakeholders on the selection of key sites within the Tongue River and Powder River watersheds, the following tables present a list of sites within each basin, along with a rationale for each site’s selection and a proposed sampling intensity. All stream sites will be presumed to either have an existing streamflow gage, or to have one installed to accompany the water-quality data.

4.1 Tongue River Basin

Sites proposed for inclusion in a long-term water-quality network in the Tongue River basin are listed in Table 3, along with proposed sampling intensity and types of continuous data. The locations of the proposed sampling sites in the Tongue River basin are shown on Figure 1.

Table 3. Proposed sampling sites for long-term monitoring in the Tongue River basin

Definitions for Sampling Intensity:
Level I – Stream Chemistry (12/year) – field parameters, common ions, nutrients, trace elements, suspended sediment.
Level II – Stream Chemistry (6/year) – field parameters, common ions, nutrients, suspended sediment.
Level III - Stream Biology (1/year) – macroinvertebrates, algae, chlorophyll A, periphyton ash-free biomass.
Level IV– Reservoir Limnology (4/year at 2 locations) – depth profiling of field parameters, 2-depth (near surface/near bottom) sampling for common ions, nutrients, chlorophyll A.

Abbreviations: Continuous Record -- F, flow; T, temperature; C, conductance.

Map No.	Station Name and Identification No.	Rationale for site selection	Proposed Data Collection[1]	
			Sampling Intensity (Level)	Contin-uous Record
1	Tongue R. near Dayton, WY (06298000)	Headwater reference site above most development.	I, III	**F** ,T
5	Tongue River at Monarch, WY (06299980)	Upstream of confluence with Goose Creek; below area of changing land use.	I, III	F,T
9	Goose Creek below Sheridan, WY (06305500)	Major tributary to upper Tongue River; receives inputs from urban area (Sheridan)	**I,** III	F,T
12	Prairie Dog Creek near Acme, WY (06306250)	Major tributary to upper Tongue River; drains areas of multiple land uses.	**I,** III	**F**,T
13	Tongue River at State Line near Decker, MT (06306300)	Interstate crossing point; below collective effects of multiple tributaries and land uses. Represents input conditions for Tongue River Reservoir.	**I, III**	**F**,T,**C**
R1, R2	Tongue River Reservoir near Decker, MT (2 sites)	Moderately large reservoir used to store irrigation water and support a recreational fishery. Two locations (upper and lower ends) sampled seasonally, with depth-profiling of field parameters to characterize stratified water-quality variations.	IV	--
16	Tongue River at Tongue River Dam, MT (06307500)	Represents outflow quality from Tongue River Reservoir to characterize change relative to input quality; initial quality of water prior to extensive irrigation use in downvalley areas.	I, III	**F**,T
25	Hanging Woman Cr. below Horse Creek nr Birney, MT (06307570)	Mid-basin site in major tributary basin above most development; serves as reference to land-use impacts relative to site 26 near mouth of tributary.	II	F
26	Hanging Woman Cr. near Birney, MT (06307600)	Near mouth of major tributary to Tongue River; represents cumulative quality of entire basin and reference to change relative to mid-basin site 25.	**I, III**	**F**,T

Table 3. Proposed sampling sites for long-term monitoring in the Tongue River basin (cont.)

Map No.	Station name and Identification No.	Rationale for site selection	Proposed Data Collection[1]	
			Sampling Intensity (Level)	Contin-uous Record
29	Tongue River at Birney Day School near Birney, MT (06307616)	Mainstem site below Hanging Woman Creek; indicates incremental change along mainstem due to tributary influences, plus multiple land uses along mainstem valley.	I, III	**F**,T
32	Otter Cr. below Fifteenmile Cr, near Otter, MT (06307717)	Mid-basin site in major tributary basin above most development; serves as reference site for potential land-use impacts relative to site 36 near mouth.	II	F
36	Otter Creek at Ashland, MT (06307740)	Near mouth of major tributary to Tongue River; represents cumulative quality of entire basin and reference to change relative to mid-basin site 32.	**I, III**	**F**,T
38	Tongue River below Brandenberg Bridge, near Ashland, MT (06307830)	Mainstem site below Otter Creek; indicates incremental change along mainstem due to tributary influences, plus multiple land uses along mainstem valley.	**I, III**	**F**,T,**C**
40A	Tongue River above T-Y Diversion	Mainstem site above point of major irrigation withdrawal; serves as indicator of incremental downstream change prior to significant hydrologic modification of instream flow.	I, III	F,T
43	Pumpkin Creek near Volborg, MT (06308190)	Mid-basin site in major tributary basin above most development; serves as a reference site for potential land-use impacts relative to site 44 near mouth.	II	F
44	Pumpkin Creek near Miles City, MT (06308400)	Near mouth of major tributary to Tongue River; represents cumulative quality of entire basin and reference to change relative to mid-basin site 43.	I, III	F,T
45	Tongue River at Miles City, MT (06308500)	Mouth of Tongue River basin, represents influence of Pumpkin Creek on mainstem, plus cumulative quality of entire basin at point of discharge to the Yellowstone River. Quantity is substantially affected by T-Y Diversion.	**I,** III	**F,T**

[1] Bold indicates data type currently (2003) being collected, but not necessarily at proposed intensity

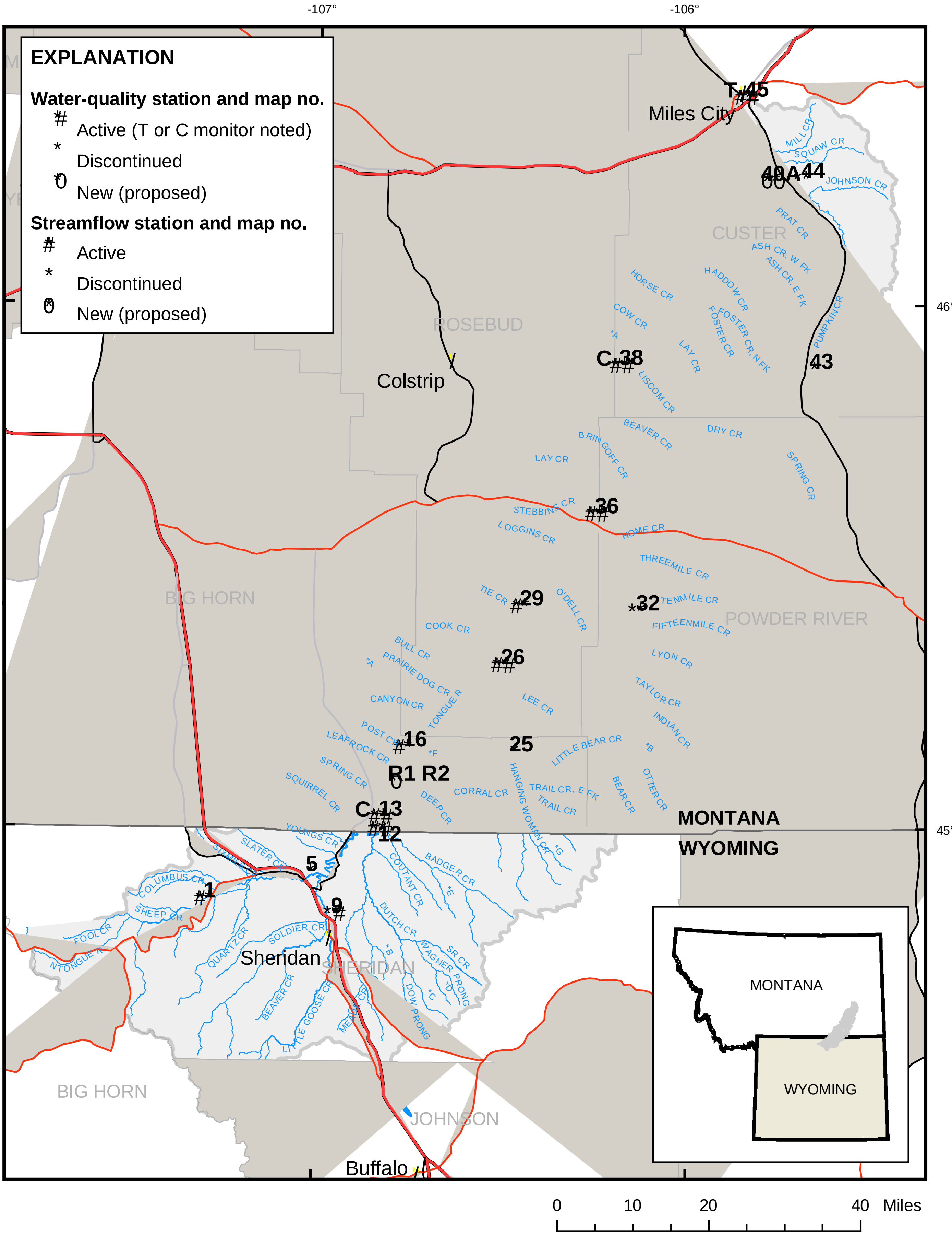

Figure 1. Locations of proposed sampling sites, Tongue River basin, Wyoming and Montana.

4.2 Powder River basin

Sites proposed for inclusion in a long-term water-quality network in the Powder River basin are listed in Table 4, along with a proposed sampling intensity and type of continuous data. The locations of the proposed sampling sites in the Powder River basin are shown on Figure 2.

Table 4. Proposed sampling sites for long-term monitoring in the Powder River basin

Definitions for Sampling Intensity:
Level I - Stream Chemistry (12/year) – field parameters, common ions, nutrients, trace elements, suspended sediment.
Level II - Stream Chemistry (6/year) – field parameters, common ions, nutrients, suspended sediment.
Level III - Stream Biology (1/year) – macroinvertebrates, algae, chlorophyll A, periphyton ash-free biomass.

Abbreviations: Continuous Record – F, Flow; T, Temperature; C, Conductance.

Map No.	Station name and Identification No.	Rationale for site selection	Proposed Data Collection [1]	
			Sampling Intensity (Level)	Contin-uous Record
10	Salt Creek near Sussex, WY (06313400)	Major tributary to upper Powder River; drains historic and active oil and gas production areas.	**II,** III	F,T
11	Powder River at Sussex, WY (06313500)	Upper mainstem site below confluence with Salt Creek. Can provide a reference to composite quality of the North, Middle, and South Forks of Powder River by subtraction of Salt Creek loads.	**II,** III	**F,T,C**
12A [2]	Powder River above Burger Draw, near Buffalo, WY (06313590)	Mainstem site below area of changing multiple land uses.	**II,** III	**F**,T,C
17	Crazy Woman Creek at upper station near Arvada, WY (06316400)	Major tributary to middle Powder River; drains areas of multiple land uses and diverse physiography (mountains and plains).	**II,** III	**F,T,C**
18	Powder River at Arvada, WY (06317000)	Middle mainstem site below confluence with Crazy Woman Creek; drains changing multiple land uses.	**II,** III	**F**,T,C
23	Clear Creek above Kumer Draw, near Buffalo, WY (06320210)	Upper reach of major tributary to Powder River; below municipal discharges of urban area (Buffalo). Serves as reference to change relative to site 28 near mouth.	**II,** III	F,T
27	Piney Creek at Ucross, WY (06323500)	Major tributary to Clear Creek that influences incremental change in water quality. Drains changing multiple land uses.	I, III	F,T
28	Clear Creek near Arvada, WY (06324000)	Near mouth of major tributary to Powder River; represents cumulative quality of entire basin and reference to change relative to upper-basin site 23.	**II,** III	**F,T,C**
29	Powder River at Moorhead, MT (06324500)	Near interstate crossing point; below collective effects of multiple tributaries and land uses.	**II,** III	**F**,T,**C**

Table 4. Proposed sampling sites for long-term monitoring in the Powder River basin (cont.)

Map No.	Station name and Identification No.	Rationale for site selection	Proposed Data Collection [1]	
			Sampling Intensity (Level)	Contin-uous Record
32	Little Powder River near Weston, WY (06324925)	Upper reach of major tributary to Powder River; reference site for change relative to downstream sites 33 and 35.	II	F
33	Little Powder River above Dry Creek near Weston, WY (06324970)	Near interstate crossing point. Below Wildcat Creek and several other tributaries that drain changing multiple land uses.	**II, III**	**F**,T,C
35 [3]	Little Powder River near Broadus, MT (06325500)	Near mouth of major tributary to Powder River; represents cumulative quality of entire basin and reference to change relative to upstream sites 32 and 33.	**II,** III	F,T
37	Powder River near Powderville, MT (06325650)	Mainstem site below Little Powder River; receives inputs from small urban area (Broadus), plus land uses in mainstem valley.	I, III	F,T
39	Mizpah Creek at Olive, MT (06326050)	Upper basin site in major tributary basin above most development; serves as reference site for potential land-use impacts relative to site 41 near mouth of tributary.	II	F
41	Mizpah Creek near Mizpah, MT (06326300)	Near mouth of major tributary to lower Powder River; represents cumulative quality of entire basin and reference to change relative to upper basin site 39.	I, III	F,T
42	Powder River near Locate, MT (06326520)	Near mouth of Powder River basin; represents influence of Mizpah Creek on mainstem, plus cumulative quality of entire basin near point of discharge to Yellowstone River.	**II,** III	**F**,T,C

[1] Bold indicates data type currently (2003) being collected, but not necessarily at proposed intensity

[2] Original proposed site "below" Burger Draw does not have a suitable gaging location for long-term operation; thus, the new site "above" Burger Draw is recommended as a replacement.

[3] Site is immediately below East Fork Little Powder River; original sampling location at mouth (06325550) was discontinued in 2002 due to backwater conditions and heavy silt deposition in channel.

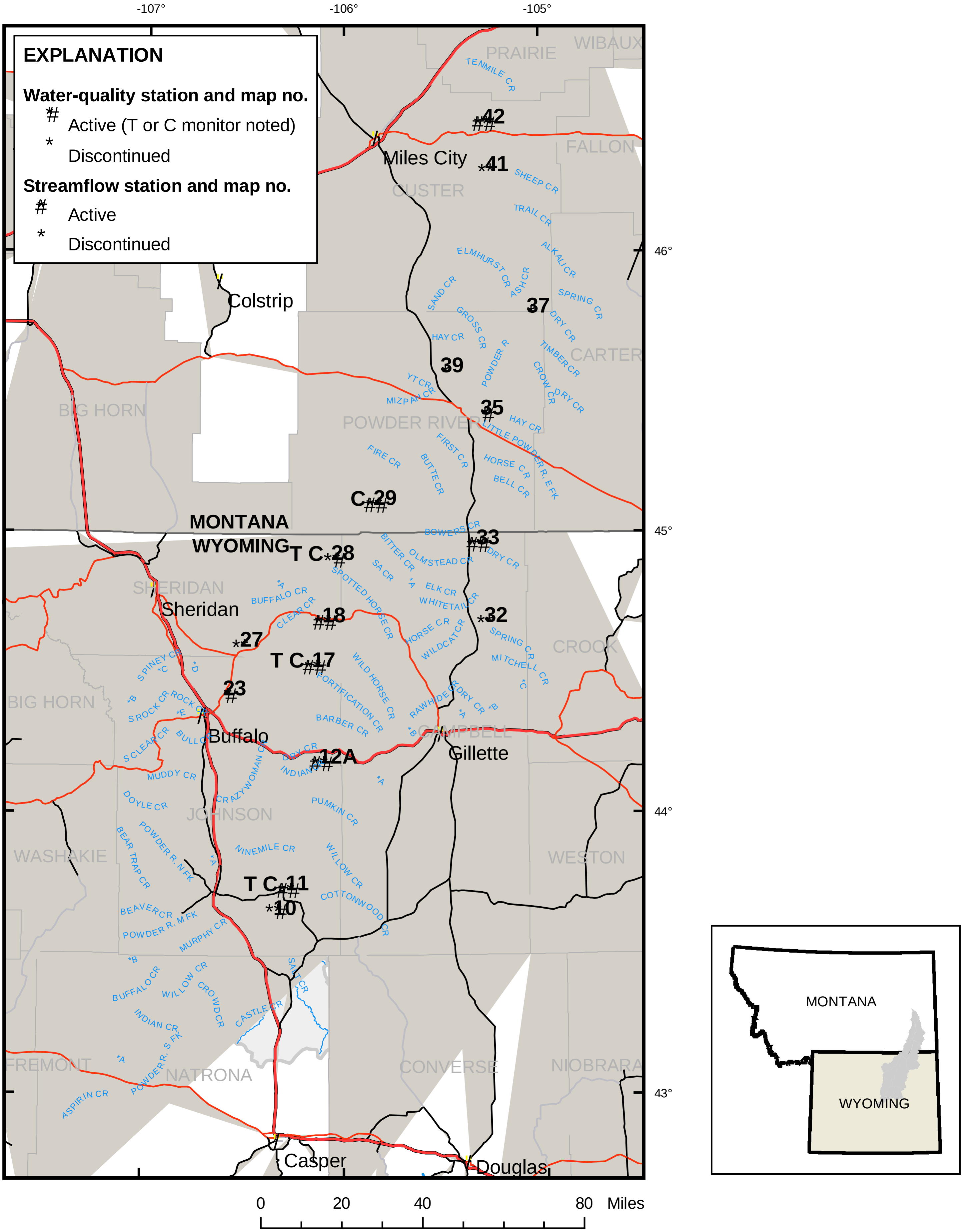

Figure 2. Locations of proposed sampling sites, Powder River basin, Wyoming and Montana.

5.0 TECHNICAL CONSIDERATIONS FOR NETWORK OPERATION

This section describes some basic features of how a comprehensive network might be operated to obtain data of high quality and to disseminate information to the public. Depending on what entity actually performs the data collection, specific practices would need to be documented in appropriate methods reports or project sampling plans. The purpose of this overview is to outline features of network operation that could serve as a general guide for consistency in data quality. Similarity in data-collection methods and sampling intensity will lead to comparable levels of data among sites that can facilitate data interpretation. Complete consistency can be difficult to achieve when the network represents a combined effort of multiple entities and programs, each having potentially different monitoring objectives. However, an outline of some basic operational features may provide a common basis for network designs among agencies.

5.1 Data Collection

5.1.1 Sampling Methods

The goal of water-quality sampling is to obtain water from the stream in a manner that is fully representative of the average composition of the entire stream cross section at the sampling location. Sampling methods can vary greatly among agencies, consultants, university researchers, and volunteer monitoring groups. While each method of sampling may be valid for the specific objectives of the individual group's program, substantial differences in methods can complicate the comparability of the data among a large network of sites. Ideally, a single entity using a standard method of data collection would produce the most consistent data quality over time. Where this is not feasible, multiple entities utilizing identical or very similar methods would produce generally comparable results that would presumably be capable of supporting between-site comparisons necessary for environmental assessments. At a minimum, the entities that are enlisted to conduct sampling should have their methods fully documented and available for outside review in order to evaluate the suitability of the data for meeting various objectives.

The most commonly used stream sampling method is "grab" sampling, which provides an easily obtainable aliquot of water in a manner that is inexpensive and requires no specialized equipment or staff training. Although widely used, it should be cautioned that such sampling has limitations when dealing with large rivers, or with any stream during periods of high flow. To fully account for potential variability due to incomplete mixing of upstream inflows, unequal distribution of suspended particles, and other biases inherent in the fluvial transport of dissolved or suspended constituents, it is necessary to use sampling methods that can provide representative data over the full range of hydrologic and seasonal conditions. This will usually involve obtaining a discharge-weighted composite sample that represents depth-integrated aliquots of water collected from multiple verticals across a stream transect, with each vertical being sampled from water surface to streambed. Discharge-weighted sampling methods result in the volume of sample water obtained at each vertical being proportional to the percentage of total flow passing that individual subsection. Discharge-weighted sampling methods and the specialized isokinetic sampling equipment can be reviewed in various USGS reports (Edwards and Glysson, 1999; Wilde and others, 1998).

In addition to the physical collection of the sample, there will typically be onsite processing of that sample to prepare it for subsequent laboratory analysis. This can involve filtration to remove suspended material, preservation with various chemicals, or chilling to stabilize the constituents. Special handling protocols for all equipment used during sample collection, and of all materials used to process the sample onsite, are necessary to prevent any extraneous contamination that could be erroneously interpreted to represent an environmental concentration. Clean sample collection and processing methods are described in USGS reports (Horowitz and others, 1994; Wilde and others, 1998).

5.1.2 Analytical Methods

Numerous government and private laboratories can analyze environmental concentrations of a wide range of chemical constituents found in water. Many laboratories either utilize standard EPA drinking-water methods (EPA,) or use agency methods that are documented and approved by rigorous testing to produce accurate results for environmental concentrations (Fishman, 1993). Whatever laboratory is used, all methods should be documented, analytical capabilities should be available for all constituents of interest, and minimum reporting levels should be adequate to either allow uncensored quantification of ambient concentrations or be substantially lower than any relevant water-quality standard.

5.1.3 Quality Assurance

Quality assurance is essential to produce reliable data of known quality and should be integrated into all aspects of sample collection, laboratory analysis, data management, and data reporting. An important component of quality assurance is to have documented methods that can be referred to as a guide for proper application of procedures. Written methods should supplement formal training of staff in specialized procedures that may be needed to accommodate a wide range of stream conditions.

Quality-assurance practices should include a systematic plan for testing the performance of data-collection and laboratory analytical methods in order to detect, quantify, and evaluate data-quality problems. This is commonly done through a process of routinely collecting test samples (such as blanks and replicates) that are handled and processed in the same manner and with the same equipment used for stream samples. These samples can then be submitted to the laboratory for analysis of the same constituents analyzed in the routine samples. The results of these test samples are used to compile a record of bias and precision associated with the routine samples and which can be reviewed in context with environmental data to evaluate data quality. In addition to field practices to verify data quality, analytical laboratories should also employ rigorous quality-assurance practices to ensure the quality of analytical results. Precision estimates should be available for each method, and the laboratory should participate in external quality-assurance testing. The laboratory also should provide analytical reruns for questionable results, have documented internal quality-assurance practices, and be able to provide data that documents the analytical performance of internal quality-assurance testing. Ultimately, quality assurance is intended to confirm data quality, prevent or minimize problems, and to provide insight on how to resolve problems when they occur. Examples of quality-assurance practices are provided in various USGS reports (Moreland, 1991; Knapton and Nimick, 1991; Lambing and Dodge, 1993; White and others, 1998; Pritt and Raese, 1995; and Matthes and others, 1991; Wilde and others, 1998).

5.2 DATA MANAGEMENT AND REPORTING

The data generated from a large-scale, long-term monitoring program will need to be managed efficiently in order to ensure that the information is accurately recorded, archived in a secure system, and accessible to the public. All primary data should be stored in computerized databases that can be backed up and retrieved upon request or accessed via web pages. All data and ancillary information generated during the sequence of steps from sample collection through laboratory analysis should be stored in either computer or hard-copy files. Organized site files permit the tracking, retrieval, and transmittal of data, as well as maintain a record of station history. The laboratory data need to be reviewed promptly for completeness and technical adequacy, and analytical reruns may be necessary to verify anomalous values. Reviews and approval of laboratory data should incorporate various acceptance criteria, such as ionic balance, comparison of recent results to historical data to identify outliers or extreme values, comparison of data to that of nearby sites to assess consistency in patterns of variation, and review of field notes to identify any unusual local land-use, climatic, or other factors.

The reporting of data represents the final step in delivering information to resource-management agencies and the public. This is the interface between the data-collection entity and the data users that is crucial to maintaining a system of equal access to information. The lack of such equal access can bear on the credibility of the data and objectivity of the monitoring program. The capabilities of different entities to disseminate data will vary, but ideally, all data should be transmittable via electronic files. Data might also be disseminated through reports that are published at regular intervals, such as an annual report series. In some instances, it may be preferred to provide additional summarization of the data to illustrate data patterns (statistical distributions or time series) that are more descriptive than a simple tabulation of data. More detailed analysis of the data that is used to support interpretations such as source-area load assessments, long-term trends, modeling of potential impacts, or description of geochemical processes is an ultimate goal that will enable meaningful environmental assessments to be made. Such detailed intepretive efforts are generally undertaken after sufficient data have been generated over a number of years to adequately characterize water-quality conditions over a broad range of streamflow.

6.0 SUPPLEMENTAL STUDIES

As a result of discussions during the June 2003 meeting of stakeholders, and subsequent correspondence with several individuals, there appears to be substantial interest in acquiring data to examine either localized conditions or environmental processes in more detail than can be accomplished with a broadly distributed network of sites. Although the proposed long-term network described in this monitoring plan cannot fully address all environmental issues in these basins, the data from a core set of sites can support more targeted studies with valuable information. If the targeted studies established additional monitoring sites to obtain increased spatial resolution, it is possible that either the sampling intensity of selected sites in the long-term network could be increased, or additional parameters be analyzed, to facilitate meeting the objectives of other studies. Further discussions regarding other types of studies, as represented by several examples given below, may be warranted among the stakeholders to evaluate the feasibility and benefits of pursuing additional monitoring.

Some examples of the types of targeted studies that could provide valuable information in the basins are:

1) ***Ephemeral tributary monitoring***: This approach was predominantly considered for the Powder River basin where large portions of the basin have soils that are enriched in salts, but which are leached by precipitation runoff only sporadically and typically for short duration. However, some of the short-duration runoff is of considerable magnitude and potentially can contribute large salt and sediment loads to the mainstem. There are no gages on these ephemeral drainages, and sampling is essentially non-existent due to the unpredictable nature of the runoff. Such sporadic runoff makes systematic sampling impossible and, thus, these types of drainages were not included in the long-term network. But given the recognition that their input may be substantial, albeit infrequent, a study designed to accommodate the irregular flow frequency may provide valuable insight on the relative impact of naturally occurring salt and sediment loads on the mainstem relative to those loads draining from basins with perennial flow.

2) ***Quantification of irrigation return flow loads***: There was concern expressed about how to determine what percentage of the total constituent load measured at a sampling site is attributable to irrigation return flow versus other sources of contribution. Unfortunately, a distributed network of sites cannot provide this detailed level of resolution regarding load apportionment among specific sources. That would require supplemental sampling, such as synoptic sampling at numerous locations along a stream reach and irrigation ditches, to understand the effect on instream loads and concentrations directly resulting from irrigation activities. Additionally, targeted constituents such as isotopes and agri-chemicals could be included to support conclusions on an agricultural source. The loads determined at network sites can be used to represent the net

differences in loads between sites that result from the collective inputs from multiple sources. This type of information can help to identify those portions of the basin that contribute a disproportionate amount of load and which may warrant additional sampling to help refine the specific sources. The core network of sites may be considered a baseline of information from which to design more detailed studies, but in itself cannot answer questions of individual sources.

3) ***Characterization of local effects in intermittent tributaries***: There are numerous land-use activities throughout tributary basins, sometimes concentrated in relatively small areas, that generate concern regarding localized effects on water quality. These are very legitimate issues and may warrant focused monitoring efforts, such as synoptic sampling along the streams in question, to characterize site-specific sources. Although sampling at these intermittent smaller streams may not be within the scope of a watershed-scale network, the collective impacts from the contribution of affected intermittent streams will be included in the overall water quality measured at downstream network sites. The increased spatial resolution desired for specific areas of concern is a good example of how targeted monitoring can be built around one or more sites in the long-term network.

4) ***Characterization of local ground-water effects on instream quality***: A question arose regarding groundwater gains and losses and how seasonal variations in stream stage would affect subsurface irrigation return flows. Similar to surface irrigation return flows, this network cannot by itself quantify the contributions from the groundwater component of flow. Such a detailed analysis of surface water – ground water interactions would require the installation of monitoring wells to determine local head and flow gradients. Although beyond the scope of this surface-water network, such an approach to characterize shallow groundwater conditions might be coupled with synoptic sampling/flow measurement of irrigation ditches and streams to determine irrigation effects within specific valley segments. It appears that there is much interest in quantifying irrigation effects, and a multi-discipline surface water/ground water study may offer the best approach to resolving site-specific issues of quantity and quality.

5) ***Metals analysis of bed sediment***: Some discussion occurred at the June meeting regarding the need to characterize the metal content in bed sediments to determine if there is any exposure risk to aquatic biota. It was generally agreed that this issue did not necessarily warrant systematic sampling at this time, but that a one-time reconnaissance level sampling would be useful to document the magnitude of concentrations in order to evaluate the need for further sampling.

7.0 AGENCY COLLABORATION AND COORDINATION

To successfully implement and operate a watershed-scale monitoring network, it will be necessary to work with the Federal, State, Tribal, and local agencies that have resource-management responsibilities. Monitoring activities will be directed toward meeting the needs of these agencies, whose missions involve serving the needs of a diverse range of public interests. Although the broadly distributed network described in this document cannot meet the specific needs of all agencies, it can be a framework of consistent, long-term data across a large geographic area that can serve as a foundation upon which other studies can build.

An example of an inter-agency effort that serves as a forum for government agencies to address and discuss issues of concern regarding potential environmental impacts is the recently established Powder River Basin Interagency Working Group administered by the BLM to assess numerous aspects of Coal Bed Methane (CBM) development. The mission of this working group is to collect and integrate the information necessary to protect environmental quality, while providing for sound development of energy resources. It is anticipated that a watershed-scale network of the type described in this document could support some of the objectives of the Powder River Basin Working Group and other groups that have a need to obtain data in specific areas for targeted objectives.

7.1 Information Exchange

The primary means of coordinating efforts among numerous agencies is to have a regular exchange of information. This can be accomplished in a number of ways, including email correspondence of new developments, periodic meetings where agency personnel and stakeholders provide input on issues of concern, announcements of recent publications relevant to water quality in the basins, and participation in committee meetings. There are currently a number of committees already established to deal with water-quality issues in the basin and their meetings may be adequate to allow stakeholders to provide input on concerns. To stay abreast of new developments, it was suggested at the June meeting that an annual meeting, in the form of a symposium, be convened to allow agency staff, industry, university researchers, and others to present recent findings from their studies. This type of forum would help to facilitate awareness of the types of work being conducted in the basins. Several conference venues already exist that could allow for this type of information exchange, but if there was a consensus that a Tongue River - Powder River symposium that deals with issues specific to these two basins is desirable, then discussions regarding the logistics of such a conference could be pursued.

7.2 Funding and Implementation

With this network design to serve as a guidance document for recognizing priority sites and parameters in the basin, the initial challenge will be to secure the funding necessary to begin implementation of the monitoring network. Ultimately, maintaining funding to operate the network over the long term will be an ongoing challenge. It should not be expected that any single funding source will be able to pay for all data types at all of the sites. Realistically, individual sites, or possibly only individual components of data collection, will be funded through a number of different agencies, grant programs, congressional allocations, etc., so that the bulk of the network can be in place and operating in a concurrent time period. With the guidance provided in this document, it is hoped that a consistent set of core parameters will be analyzed, regardless of who provides the funding or who collects the samples. This base level of consistency will eventually allow a coherent set of data to be available for a large geographic area, and potentially for similar time periods, wherein the data from all sites represent a relatively equivalent hydrologic regime.

At this time (2003), about one-third of the proposed sites in the Tongue River basin and about one-half of the proposed sites in the Powder River basin have some level of active water-quality sampling. Similar percentages apply to the number of active streamflow gages. Recent developments in the summer of 2003 include funding provided by BLM to reactivate former gaging stations and initiate water-quality and biological sampling at four sites in Montana. A Congressional bill submitted through Senator Burns (Mont.) office has earmarked funding for sampling in the Tongue River and Rosebud Creek basins in Montana. Although not approved yet, this is a positive step towards implementation. The USGS will likely be able to provide some matching funds to support streamflow gaging and sampling activities wherever cooperating State, Tribal, or local agencies can secure 50 percent or more of the costs. Various EPA grant programs exist where State, Tribal, and local agencies can submit proposals for short-term funding. Although grant funds may be limited to a single year or a short-term period, the collective effort to secure funds may be patched together for priority sites and possibly result in an uninterrupted period of data collection. At a minimum, short-term funding can provide baseline data for new sites or updated information for former sites. The long-term aspect of data collection has always been the most difficult to maintain, but as the awareness of the benefits to resource management becomes better known, the chances for success may increase.

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