

2011

WATER QUALITY MONITORING ANNUAL WORK PLAN



**WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY DIVISION
WATERSHED MANAGEMENT PROGRAM**

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Introduction

Regulatory Framework (Clean Water Act)

The current regulatory framework for water programs in the United States began with the Water Pollution Control Act of 1948. This was the first comprehensive statement of federal interest in clean water programs. In 1972, congress passed the Federal Water Pollution Control Act (Public Law 92-500), which is also known as the Clean Water Act (CWA). The goal of the Clean Water Act was to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. In 1977, an amendment was passed that established a goal of protecting and managing waters to insure "fishable and swimmable" conditions. The Act of 1972, the amendment of 1977, and the various other amendments that have occurred over the years together provide the basis for comprehensive water quality monitoring (beyond chemical parameters alone).

The United States Environmental Protection Agency (EPA) was assigned the dominant role in administering clean water programs across the Nation. The Wyoming Department of Environmental Quality (WDEQ) implements the CWA in Wyoming, while EPA provides oversight and direction to State programs and certifies the fulfillment of CWA requirements in the State. Wyoming is responsible for assessing all waters of the State to evaluate overall water quality condition and determine if they support designated uses.

The WDEQ monitoring program is responsible for collecting scientifically sound water quality monitoring data using established data collection methods, and assessing those data in a consistent manner. Approved assessment methods (WDEQ 2008a) provide guidance on using the monitoring data to determine designated use support of a waterbody. Wyoming water quality standards are the rules concerning designated uses and the associated water quality criteria (WDEQ 2007). Wyoming water quality standards consist of three parts: 1) surface water classes and associated uses; 2) numeric and narrative water quality criteria; and 3) antidegradation policy.

History of the Monitoring Program

The initiation of reference stream monitoring in 1992 marked the beginning of the WQD/WQD surface water monitoring program (hereinafter referred to as the monitoring program). The purpose of reference stream monitoring primarily is to obtain benchmark chemical, physical, and biological data from least anthropogenic-impacted stream sites within each ecoregion (Omermick and Gallant, 1987) of Wyoming. This data is used for assessing condition of other streams in the State. Reference stream data also is used to develop and revise the Wyoming Stream Integrity Index and the Wyoming RIVPACS models, both of which are tools used for assessing the biological integrity of Wyoming streams. Reference stream monitoring continues today, although now is a smaller, but still important, part of the overall monitoring program.

In the 1997 Total Maximum Daily Load (TMDL) work plan, the Monitoring Program was charged with collecting scientifically sound chemical, biological and physical monitoring data for determining designated use support for over 300 stream segments, lakes, and reservoirs that, in 1996, had only

anecdotal data suggesting that designated uses may not be fully supported. WDEQ committed to collect data from each waterbody within five years, followed by timely assessments of those data resulting in, where possible, determinations of designated use support. The large number of waterbodies requiring monitoring data for making use-support determinations within a period of five years necessitated a rapid screening type of approach.

The Beneficial Use Reconnaissance Project was implemented in 1998 to meet the needs of the 1997 TMDL workplan. This was essentially the first monitoring strategy. The purpose of this project was to collect the necessary monitoring data described previously using a rapid screening-type approach, similar to EPA's Rapid Bioassessment Protocol (RBP), that ultimately could be used to make designated use-support determinations. The monitoring program was founded on RBP and monitoring protocols developed for reference streams and Wyoming's National Pollutant Discharge Elimination System (WYPDES) permitting and compliance program. These protocols were later updated with several new components and summarized in a document entitled Standard Operating Procedures for Sample Collection and Analysis (WDEQ 1999 and revisions).

From 1998 to 2003, the monitoring program worked through the monitoring directive of the 1997 TMDL workplan using the RBP-like approach, and where possible made designated use-support determinations. However, it was quickly realized that the assumption that most waters could be assessed with data from one rapid based monitoring event was impractical. Designated use determinations proved to be more complex than originally anticipated, and many streams required a more intensive, multi-year assessment than what the RBP-approach entailed, particularly when dealing with habitat degradation, stream channel instability and sediment pollution.

In 2004, a second monitoring strategy was implemented to guide the program for the subsequent five years (2004-2008). This strategy followed the recently published EPA guidance "Elements of a state water monitoring and assessment program (EPA, 2003)." While the monitoring program already possessed most of the ten elements, the EPA guidance was used as the template for the structure of the strategy document that built upon the 1997 TMDL work plan and incorporated multiple new approaches that together led WDEQ toward a more complete, comprehensive monitoring program that addressed all waters of the State. In 2008, the strategy was amended to include the 2009 field season and to transition into a new strategy that will be implemented in 2010.

The current ten year monitoring strategy (2010-2019) builds upon the successes of the 2004-2008 (and amended 2009) strategy with a new focus on a probabilistic rotating-basin approach. The probabilistic rotating-basin approach will significantly improve the ability of WDEQ to assess all waters in the State of Wyoming using an objective statistically randomized design.

Purpose of the Annual Work Plan

In addition to providing background on the Monitoring Program, the annual work plan describes and lists annual monitoring objectives. The plan is a means of providing the public, as well as government, non-profit and other groups a list of waterbodies to be sampled and statewide and regional contact information for questions about regional monitoring activities.

Designated Uses of Water in Wyoming

Designated uses for waterbodies (Table 1) are those that either currently or have the potential to exist and are based on their associated surface water classifications as specified in Chapter 1 of Wyoming Water Quality Rules and Regulations (WDEQ 2007).

Table 1 - Designated uses of Wyoming waters as described in Chapter 1 of the Wyoming Water Quality Rules and Regulations (WDEQ 2007).

| Designated Use | Description |
|------------------------------|---|
| Agriculture | For purposes of water pollution control, agricultural uses includes irrigation or stock watering |
| Fisheries | Fisheries includes water quality, habitat conditions, spawning and nursery areas, and food sources necessary to sustain populations of game and nongame fish. |
| Industry | Industrial use protection involves maintaining a level of water quality useful for industrial purposes. |
| Drinking water | Drinking water use involves maintaining a level of water quality that is suitable for potable water or intended to be suitable after receiving conventional treatment |
| Recreation | Recreational use protection involves maintaining a level of water quality that is safe for human contact. |
| Scenic value | Scenic value use involves the aesthetics of the aquatic systems (odor, color, taste, settleable and floating solids, etc.) and not necessarily related to landscape appearance. |
| Aquatic life other than fish | This use includes water quality and habitat necessary to sustain communities of aquatic life that are not significantly different than the communities expected to occur under minimal human disturbance for that watershed or ecological region. |
| Wildlife | Wildlife use includes protection of water quality to a level that is safe for contact and consumption by avian and terrestrial wildlife. |
| Fish Consumption | Fish consumption use involves maintaining a level of water quality that will prevent any unpalatable flavor and/or accumulation of harmful substances in fish tissue. |

Designated Use Support

The Monitoring Program gathers both core and supplemental water quality parameters that are used to determine designated use support for Wyoming's streams, rivers, lakes, and reservoirs. Designated use determinations will indicate whether a waterbody is in compliance with water quality standards and, where appropriate, is comparable to local and/or regional reference conditions. Reference stations represent stream locations that do not necessarily represent pristine water quality or biological conditions, but rather waters that are minimally or least impacted by human activities within a geographic or ecological region, watershed, or area of interest. Reference condition (an aggregation of reference station data) is the baseline against which monitoring data from non-reference streams is compared. Reference conditions represents realistic, attainable expectations for other streams and

rivers; therefore a significant departure from reference condition can indicate impairment of designated uses, such as aquatic life.

Annual Work Plan, 2011 Field Season

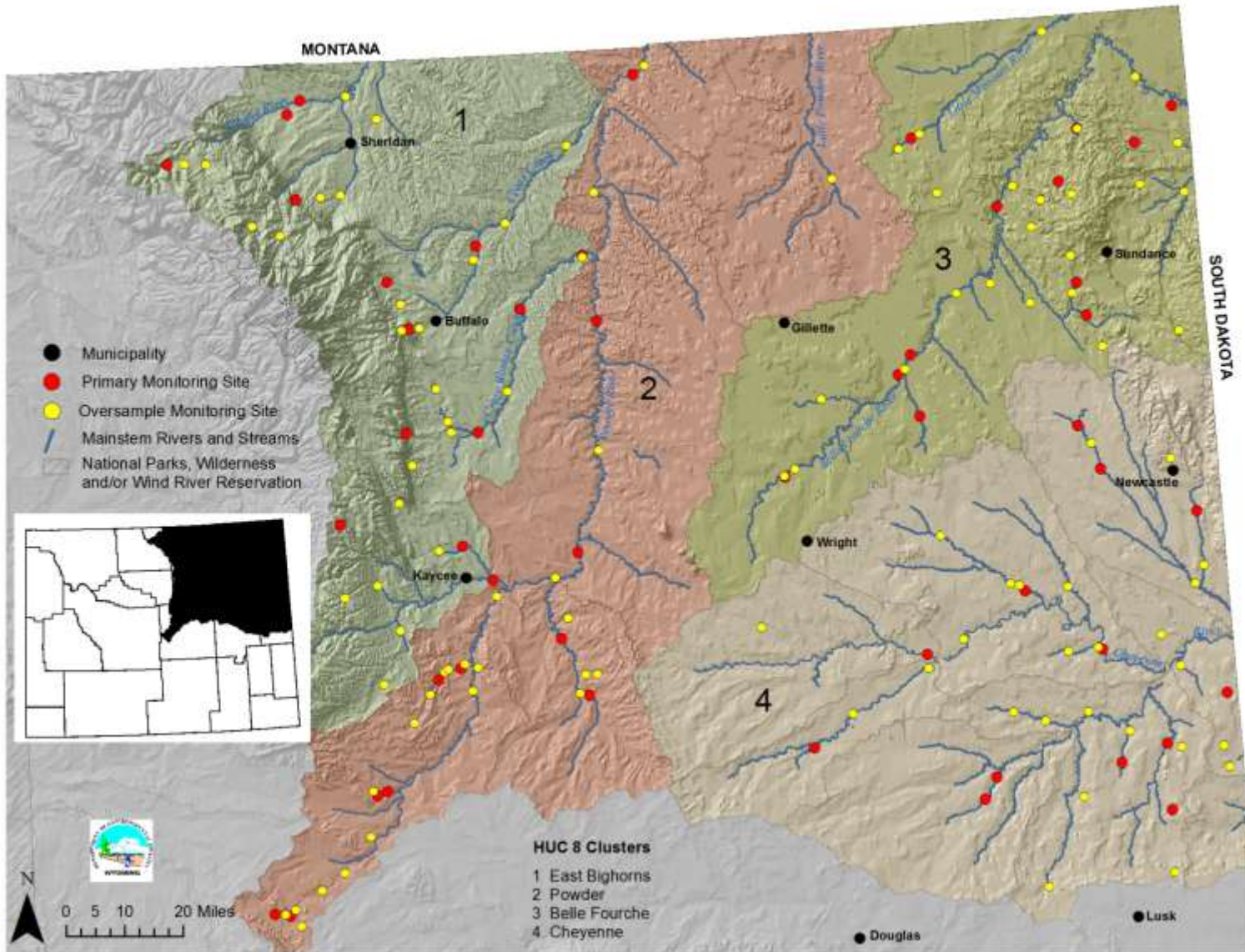
Objectives

The primary objectives for the 2011 field season are:

- 1) Implement the probabilistic rotating basin survey in the Northeast ‘superbasin’
- 2) Collect supplemental data for streams where existing data is not sufficient for a conclusive determination of designated use support
- 3) Identify and sample new reference stations to fill data gaps
- 4) Collect data in support of future nutrient criteria development
- 5) Sample all remaining stations selected with the second statewide probabilistic (random) survey design
- 6) Conduct reservoir monitoring as part of the large reservoir sampling rotation

Probabilistic rotating basin surveys will serve as the primary method for assessing the current water quality condition of Wyoming’s rivers and streams as required by all States under §305(b) of the Federal Clean Water Act. Probabilistic rotating basin surveys are based on a stratified random survey design that selects a total of 50 primary sites on perennial, non-headwater (>1st Strahler order) rivers and streams that are not located in national parks, United States Forest Service wilderness areas and the Wind River Reservation within each superbasin. The design further stratifies site selection into aggregations of HUC 8 units or “HUC 8 clusters” within each superbasin. This additional stratification results in equal spatial allocation of the 50 primary sites among all HUC 8 clusters within a superbasin. Following the same design, a population of 100 oversample sites is generated for each superbasin that are used as replacements when a primary site cannot be sampled. Oversample sites generated for a HUC 8 cluster within a superbasin are only used as replacements for primary sites within the same HUC 8 cluster to maintain representativeness and minimize logistical complexities of sampling. Data from the randomly selected 50 sites for each superbasin are used to make statistical inferences of the water quality condition within each superbasin. The incorporation of the probabilistic rotating basin surveys into the Monitoring Program will enable WDEQ, over time and at various scales, to better estimate statewide water quality condition, as well as determine trends in water quality condition. Results from these surveys will also allow WDEQ to identify waters of high quality and those where designated use-support may be limited and are candidates for future targeted monitoring. Waterbodies designated for targeted monitoring will be based on a priority ranking derived from findings of the probabilistic rotating basin survey where results suggest impairments to designated use-support. 2011 is the second year of probabilistic rotating basin surveys implemented by the Monitoring Program. The focus of probabilistic rotating basin surveys in 2011 will be the Northeast superbasin (Figure 1). Fifty random sites within the Northeast superbasin will be sampled in 2011 followed by analyses of the data in 2012, and targeted monitoring of priority waterbodies in 2012 and 2013.

Figure 1 – Primary and oversample sites selected for the probabilistic rotating basin survey of the Northeast superbasin.



Since 1998, the Monitoring Program has been implementing targeted monitoring for making designated use-support determinations on over 300 waterbodies that were part of the original monitoring directive set forth in the 1997 TMDL workplan. In many cases, data from the initial monitoring effort was not sufficient to make a determination on the level of designated use support. As of 2011, designated use determinations have been made on approximately 67% of the sampled waterbodies. Interim determinations of “inconclusive data” had been made on many of the remaining 35%. Targeted monitoring for some of the remaining 35% was concluded in 2010. A few additional targeted waters that were not part of the original 1997 TMDL workplan but have been monitored in the recent past because of ongoing water quality concerns are also scheduled for 2011. All targeted waterbodies scheduled for 2011 were previously monitored in 2010 and/or 2009. The additional year of monitoring will help to validate findings from previous years and provide information on temporal variability and for making designated use support determinations on these waterbodies.

Several of the existing WDEQ reference stations have been sampled only once, some of which were sampled over ten years ago. WDEQ has and will continue to rotate through existing reference stations to determine if they still meet reference criteria and to collect another set of data on each stream. Having multiple data sets from each reference station will assist in gaining a better understanding of conditions at these stations and to help understand how these stations vary in condition over time under relatively natural environmental conditions. This information will make WDEQ better able to formulate more accurate and precise criteria for assessing biological condition of streams. However, 2011 will see a temporary stay in existing reference site re-visits to provide sufficient time and resources for the probabilistic rotating basin survey in the Northeast superbasin and other priorities in the Monitoring Program. The current reference station network has gaps in the spatial coverage of Wyoming. Specifically, more reference data is needed in the interior areas of the plains and basin ecoregions. Filling these gaps will help facilitate better determinations of designated use support by helping to establish realistic goals for water quality and biological condition in these ecoregions. 2011 will provide an opportunity to identify and sample new reference sites in the interior plains ecoregions as part of the probabilistic rotating basin survey for the Northeast superbasin.

A potential future revision to Wyoming’s water quality standards involves development of numeric nutrient criteria (WDEQ 2008b, 2009). The Monitoring Program has and will continue in 2011 to acquire the data necessary to support development of numeric nutrient criteria for Wyoming. Nutrient and associated response variable data will be collected at all reference and probabilistic sites and select targeted sites. Nutrient data from reference sites are especially important as it defines background or attainable conditions on which numeric criteria can be based.

In 2004, the Monitoring Program initiated the first statewide probabilistic survey to assess the current water quality condition of Wyoming’s rivers and streams, evaluate trends over time, and to satisfy requirements under §305(b) of the Federal Clean Water Act. The design of the statewide probabilistic survey was similar to that described previously for the probabilistic rotating basin survey. The first statewide probabilistic survey resulted in 64 stream sites sampled from 2004 to 2007. A second similar statewide survey was implemented in 2008. 2011 marks the fourth and final year of the second statewide probabilistic survey. With implementation of the probabilistic rotating basin survey that achieves the same goal of assessing the quality of the State’s waters, statewide probabilistic surveys

after 2011 will be suspended indefinitely. However, completion of the second statewide survey is important in that it will provide information on temporal variation in statewide water quality condition between the first statewide survey and implementation of the probabilistic rotating basin surveys. It is anticipated the results from the first and second statewide probabilistic surveys will be incorporated into WDEQ's 305(b)/303(d) Integrated Water Quality Assessment Report in the future.

Lake and reservoir monitoring was originally initiated as part of the original 1997 TMDL workplan directive. The need for additional data for these reservoirs, combined with the CWA directive of assessing all waters led to development of a sampling program for the ten largest reservoirs in the State. The ten largest reservoirs are sampled on a rotation where approximately four are sampled in any given year. Each reservoir is sampled for three consecutive years, followed by three years without sampling. The effort on major reservoirs will focus on identifying trends in water quality over time using various indicators. The four reservoirs scheduled for monitoring in 2011 are either beginning or into their second three-year monitoring periods.

Stream and Reservoir Sampling

The 2011 monitoring schedule is shown in Appendices 1 - 7. Hydrologic Unit Codes (HUCs) can be cross-referenced with Figure 2 to show locations of the watersheds. WDEQ regional offices in Cheyenne, Sheridan, and Lander will have sampling crews in the field in 2011. Contact information is shown below:

Statewide: Jeremy Zumberge, Monitoring Supervisor, Wyoming Dept. of Environmental Quality, Water Quality Division, 2100 W. 5th, Sheridan, WY 82801, phone: 307-673-9337, email jzumber@wyo.gov

Cheyenne region: Lanny Goyn or Eric Hargett, Wyoming Department of Environmental Quality, Water Quality Division, Herschler Bldg, 122 West 25th Street, Cheyenne, WY 82001, phone: 307-777-7781, email: lgoyn@wyo.gov or ehargett@wyo.gov

Lander region: Tavis Eddy, Wyoming Department of Environmental Quality, Water Quality Division, 510 Meadowview Drive, Lander, WY 82520, ph. 307-332-3144, email: teddy@wyo.gov

Sheridan region: Jason Martineau or Chad Rieger, Wyoming Department of Environmental Quality, Water Quality Division, 2100 W. 5th, Sheridan, WY 82801, Ph. 307-673-9337, email: jmarti5@wyo.gov or criege@wyo.gov

Crews will typically sample arid, lowland areas early in the season, followed by high elevation streams, foothill streams, and finally larger, lowland streams or rivers. The plan is to sample each stream during what is considered summer low flow conditions, while at the same time avoiding potential early snows at high elevations, and dry streams in more arid areas during late summer and early fall. Appendices 1 through 5 contain a list of waterbodies scheduled for sampling during the 2010 field season, including the regional office to which it is assigned, and the assessment category within which it falls. These appendices include:

Appendix 1 – Reservoirs.

Appendix 2 - Previously monitored targeted waters, however, there remains insufficient data to make conclusive designated use-support determinations.

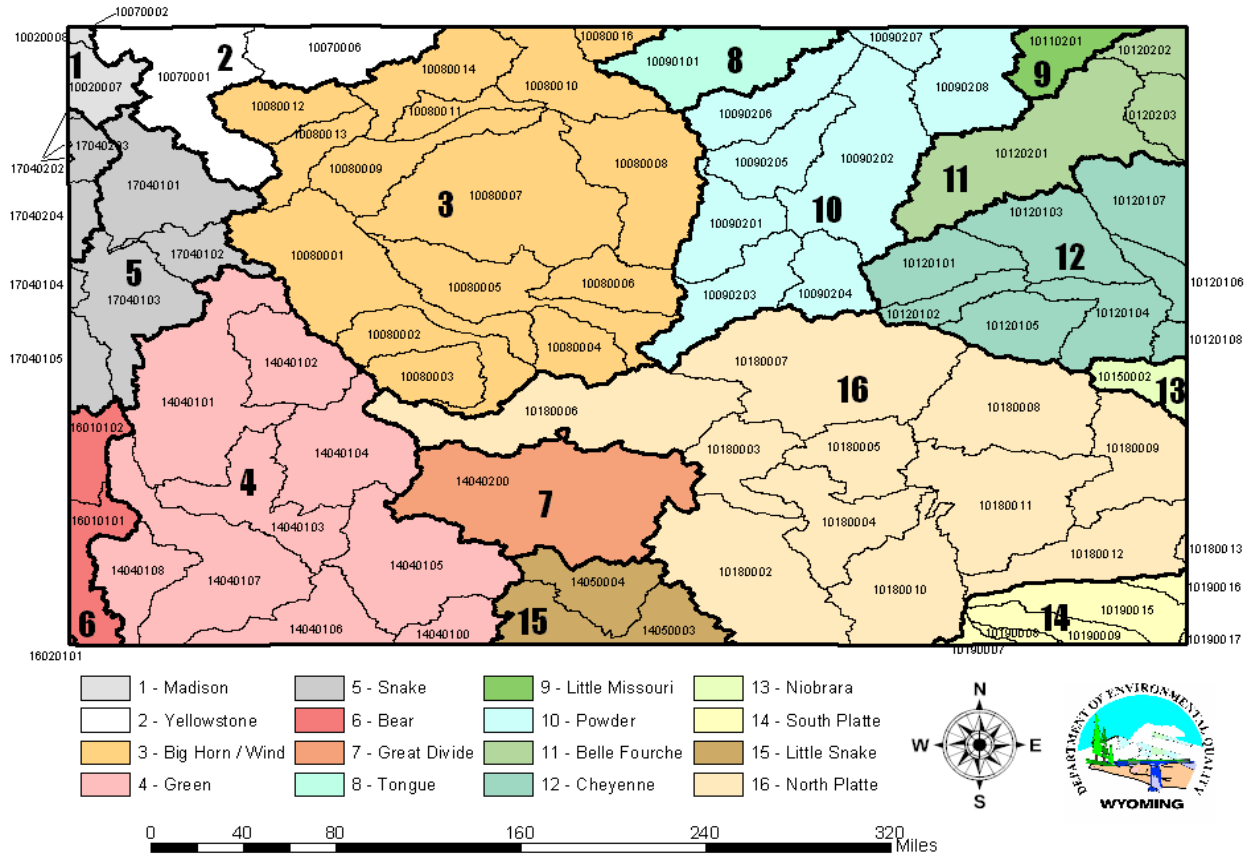
Appendix 3 - Existing or candidate reference streams. Reference streams represent the minimal or least-impacted condition for an ecological region or area of interest. Reference stream data are used as benchmarks against which non-reference stream condition is compared.

Appendix 4 - Sites selected for the probabilistic rotating basin survey in the Northeast superbasin. The list includes the 50 primary sites in addition to oversample sites used as substitutes when primary sites cannot be sampled. A total of 50 sites will be sampled in 2011. Sites on private land are contingent on receiving landowner permission.

Appendix 5 - Sites selected for the second statewide probabilistic survey. The list includes the remaining sites that can be sampled for the statewide survey. Approximately 5 sites will be sampled in 2011. Sites on private land are contingent on receiving landowner permission.

Figure 2 – Hydrologic basins of Wyoming.

HYDROLOGIC BASINS OF WYOMING



Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) procedures are a critical aspect of the WDEQ Monitoring Program. QA/QC affects the use, repeatability, and validation of monitoring data. QA/QC is involved in all aspects of the Monitoring Program, including:

- education and training of monitoring program field staff;
- sample collection and analysis;
- field audits
- data entry, management, and analysis;
- application, interpretation, and reporting of the data.

The Monitoring Program quality assurance plan (WDEQ 2001) can be obtained at: <http://deq.state.wy.us/wqd/watershed/Downloads/QA/10573-doc.pdf>.

Other WDEQ-Supported Monitoring Projects

USGS “Ambient” Fixed Station Water Quality Monitoring Network

WDEQ contracts with the United States Geological Survey (USGS) to sample 16 locations across the state (Appendix 6). Sampling is generally conducted four times per year on a quarterly basis. Specific sampled parameters vary by site depending on objectives, but include field parameters, major ions, trace metals, nutrients, sediment, and/or bacteria. Sample locations are chosen for a variety of reasons, including monitoring of currently impaired waters, waters associated with Wyoming Pollutant Discharge Elimination System (WYPDES) permits, or trends in large river system water quality.

USGS “CBM” Fixed Station Water Quality Monitoring Network

WDEQ also contracts with the USGS to sample 40 locations in regions where coal-bed methane (CBM) development is present, most of which are in northeast Wyoming (Appendix 6). This project monitors water quality in areas affected by CBM development to determine trends and patterns, establish baseline data in areas that have received minimal or no CBM development, and to determine compliance with existing water quality standards and WYPDES permit conditions.

Coal Bed Natural Gas – Interagency Work Group Monitoring in NE Wyoming

The PRB Interagency Working Group (PRB IWG) was established as the forum for government agencies to address and discuss issues of common concern to all parties involved in permitting and monitoring of CBM development. Attention will also be given to issues that may result in cross-border effects requiring close coordination among the State and Federal agencies in Montana and Wyoming, and with Tribal governments. Through this cooperative management effort, each agency will achieve greater operational efficiency, enhanced resource protection and will better serve the public.

To address one of the components of the PRBIWG mission, task groups were formed to address monitoring of natural resources potentially affected by CBM development (water quality and quantity, aquatic life, wildlife, and air). WDEQ employees are members of the water quality and aquatic life

monitoring task groups. Both the water quality and aquatic life task groups have developed monitoring plans for the affected areas of northeast Wyoming. The water quality and aquatic life monitoring plans can be found at the following two links:

<http://www.wy.blm.gov/bfo/prbgroup/04minutes/surfacewatermonitoring06-16.pdf>.

<http://www.wy.blm.gov/prbgroup/docs/aquatics>

The USGS has been contracted to do most of the water quality and aquatic life monitoring in northeast Wyoming. A USGS web site and Fact Sheet describing the aquatic life monitoring plan can be found at <http://wy.water.usgs.gov/projects/atg/index.htm>. The USGS recently completed two reports (Peterson et al. 2009 and 2010) that combined; describe findings from the 2005-2008 data collections in the Powder River structural basin of Wyoming and Montana. These reports are available at <http://pubs.usgs.gov/sir/2009/5023/> and <http://pubs.usgs.gov/sir/2010/5124/>, respectively. Most of the sites shown in Appendix 7 are part of the water quality task group monitoring plan. A Fact Sheet describing the water quality monitoring plan can be found at <http://pubs.water.usgs.gov/fs2005-3137>.

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Peterson, D.A., Wright, P.R., Edwards, G.P, Hargett, E.G., Feldman, D.L., Zumberge, J.R., and Dey, P. 2009. Ecological assessment of streams in the Powder River Structural Basin, Wyoming and Montana, 2005-06. U.S. Geological Survey Scientific Investigations Report 2009-5023, 139p.

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WDEQ. 2008b. Wyoming nutrient criteria development plan. Wyoming Department of Environmental Quality, Water Quality Division, Cheyenne, Wyoming.

WDEQ. 2009. Wyoming nutrient criteria sampling and analysis plan. Wyoming Department of Environmental Quality, Water Quality Division, Cheyenne, Wyoming.

Appendix
2011 Monitoring Schedule

Appendix 1 – Reservoirs

| Basin | Reservoir Name | HUC | Crew |
|--------------|----------------------|----------|--------------------|
| North Platte | Alcova Reservoir | 10180007 | Lander/Sheridan |
| North Platte | Glendo Reservoir | 10180008 | Cheyenne/ Sheridan |
| North Platte | Pathfinder Reservoir | 10180003 | Lander/Sheridan |
| North Platte | Seminole Reservoir | 10180003 | Lander/Sheridan |

Appendix 2 – Targeted waters

| Basin | Stream | HUC | Crew |
|-------|-------------|----------|--------|
| Snake | Crow Creek | 17040105 | Lander |
| Green | Brooks Lake | 10080001 | Lander |

Appendix 3 – Reference stations

No existing reference station re-visits or sampling of previously identified reference station candidates are scheduled for 2011.

Appendix 4 – Rotating Basin Probability Survey- Northeast superbasin.

| Survey ID | Stream | Type | Longitude | Latitude | HUC 8 Cluster | Crew |
|-----------|-----------------------|------------|-------------|-----------|---------------|----------|
| WY09C-051 | Middle Fork Hay Creek | Base | -104.247653 | 44.670383 | Belle Fourche | Sheridan |
| WY09C-052 | Beaver Creek | Base | -104.442518 | 44.717028 | Belle Fourche | Sheridan |
| WY09C-053 | Belle Fourche River | Base | -105.533168 | 43.909653 | Belle Fourche | Sheridan |
| WY09C-054 | Benton Creek | Base | -104.487122 | 44.336862 | Belle Fourche | Sheridan |
| WY09C-055 | Oak Creek | Base | -104.106959 | 44.753165 | Belle Fourche | Sheridan |
| WY09C-056 | Belle Fourche River | Base | -104.739168 | 44.539400 | Belle Fourche | Sheridan |
| WY09C-057 | Belle Fourche River | Base | -105.075413 | 44.188745 | Belle Fourche | Sheridan |
| WY09C-058 | Spring Branch | Base | -104.461616 | 44.254512 | Belle Fourche | Sheridan |
| WY09C-059 | Prairie Creek | Base | -105.017891 | 44.723157 | Belle Fourche | Sheridan |
| WY09C-060 | Blacktail Creek | Base | -104.521523 | 44.590000 | Belle Fourche | Sheridan |
| WY09C-061 | Belle Fourche River | Base | -105.122320 | 44.142356 | Belle Fourche | Sheridan |
| WY09C-062 | Four Horse Creek | Base | -105.057818 | 44.035960 | Belle Fourche | Sheridan |
| WY09C-301 | Cold Springs Creek | Oversample | -104.148109 | 44.198543 | Belle Fourche | |
| WY09C-302 | Oak Creek | Oversample | -104.628139 | 44.482853 | Belle Fourche | |
| WY09C-303 | | Oversample | -104.538095 | 44.960883 | Belle Fourche | |
| WY09C-304 | Lytle Creek | Oversample | -104.680426 | 44.586986 | Belle Fourche | |
| WY09C-305 | Belle Fourche River | Oversample | -104.902924 | 44.332584 | Belle Fourche | |
| WY09C-306 | Mule Creek | Oversample | -104.783823 | 44.350064 | Belle Fourche | |
| WY09C-307 | Little Missouri River | Oversample | -104.943933 | 44.584288 | Belle Fourche | |

| | | | | | | |
|-----------|-----------------------------|------------|-------------|-----------|---------------|-----------------|
| WY09C-308 | Beaver Creek | Oversample | -104.442437 | 44.714963 | Belle Fourche | |
| WY09C-309 | Arch Creek | Oversample | -104.651766 | 44.295644 | Belle Fourche | |
| WY09C-310 | Belle Fourche River | Oversample | -105.535926 | 43.909926 | Belle Fourche | |
| WY09C-311 | Prairie Creek | Oversample | -104.989122 | 44.731965 | Belle Fourche | |
| WY09C-312 | Middle Fork Hay Creek | Oversample | -104.097886 | 44.660058 | Belle Fourche | |
| WY09C-313 | Beaver Creek | Oversample | -104.504345 | 44.311149 | Belle Fourche | |
| WY09C-314 | Belle Fourche River | Oversample | -105.498105 | 43.925944 | Belle Fourche | |
| WY09C-315 | Blacktail Creek | Oversample | -104.480428 | 44.554536 | Belle Fourche | |
| WY09C-316 | Sand Creek | Oversample | -104.090379 | 44.538118 | Belle Fourche | |
| WY09C-317 | Belle Fourche River | Oversample | -105.099268 | 44.154130 | Belle Fourche | |
| WY09C-318 | Houston Creek | Oversample | -104.501878 | 44.403696 | Belle Fourche | |
| WY09C-319 | Prairie Creek | Oversample | -105.066192 | 44.698038 | Belle Fourche | |
| WY09C-320 | Redwater Creek | Oversample | -104.241281 | 44.566369 | Belle Fourche | |
| WY09C-321 | Mason Creek | Oversample | -104.414800 | 44.175139 | Belle Fourche | |
| WY09C-322 | Caballo Creek | Oversample | -105.390824 | 44.094700 | Belle Fourche | |
| WY09C-323 | Lytle Creek | Oversample | -104.587522 | 44.547085 | Belle Fourche | |
| WY09C-324 | Belle Fourche River | Oversample | -104.226637 | 44.830989 | Belle Fourche | |
| WY09C-088 | Beaver Creek | Base | -104.520421 | 43.982842 | Cheyenne | Cheyenne |
| WY09C-089 | Walker Creek | Base | -104.885809 | 43.130577 | Cheyenne | Cheyenne |
| WY09C-090 | Black Thunder Creek | Base | -104.743989 | 43.586229 | Cheyenne | Cheyenne |
| WY09C-091 | Walker Creek | Base | -104.930582 | 43.078298 | Cheyenne | Cheyenne |
| WY09C-092 | Buck Creek | Base | -104.459896 | 43.143306 | Cheyenne | Cheyenne |
| WY09C-093 | Old Woman Creek | Base | -104.30154 | 43.181653 | Cheyenne | Cheyenne |
| WY09C-094 | | Base | -104.303208 | 43.017779 | Cheyenne | Cheyenne |
| WY09C-095 | Beaver Creek | Base | -104.455100 | 43.872806 | Cheyenne | Cheyenne |
| WY09C-096 | South Fork Moss Agate Creek | Base | -104.086160 | 43.295432 | Cheyenne | Cheyenne |
| WY09C-097 | Dry Fork Cheyenne River | Base | -105.493929 | 43.234755 | Cheyenne | Cheyenne |
| WY09C-098 | Stockade Beaver Creek | Base | -104.139418 | 43.748802 | Cheyenne | Cheyenne |
| WY09C-099 | Cheyenne River | Base | -104.494750 | 43.426511 | Cheyenne | Cheyenne |
| WY09C-100 | Antelope Creek | Base | -105.090843 | 43.445717 | Cheyenne | Cheyenne |
| WY09C-375 | | Oversample | -104.313470 | 42.863146 | Cheyenne | |
| WY09C-376 | Horse Creek | Oversample | -104.963666 | 43.477234 | Cheyenne | |
| WY09C-377 | Cheyenne River | Oversample | -104.510029 | 43.431560 | Cheyenne | |
| WY09C-378 | Black Thunder Creek | Oversample | -104.790969 | 43.605004 | Cheyenne | |
| WY09C-379 | South Cottonwood Creek | Oversample | -104.099720 | 43.112947 | Cheyenne | |
| WY09C-380 | Bates Creek | Oversample | -105.647252 | 43.540108 | Cheyenne | |
| WY09C-381 | Snyder Creek | Oversample | -104.613149 | 43.428398 | Cheyenne | |
| WY09C-382 | Lodgepole Creek | Oversample | -104.598142 | 43.588253 | Cheyenne | |
| WY09C-383 | Bills Creek | Oversample | -104.738730 | 42.850416 | Cheyenne | |

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|-----------|------------------------------|------------|-------------|-----------|---------------|----------|
| WY09C-384 | Beaver Creek | Oversample | -104.479880 | 43.937131 | Cheyenne | |
| WY09C-385 | Cow Creek | Oversample | -104.707097 | 43.261100 | Cheyenne | |
| WY09C-386 | Eldrige Draw | Oversample | -104.113410 | 43.164811 | Cheyenne | |
| WY09C-387 | Black Thunder Creek | Oversample | -105.018127 | 43.736159 | Cheyenne | |
| WY09C-388 | Cambria Creek | Oversample | -104.214208 | 43.883890 | Cheyenne | |
| WY09C-389 | Buck Creek | Oversample | -104.426431 | 43.220432 | Cheyenne | |
| WY09C-390 | Alkali Creek | Oversample | -104.293504 | 43.451201 | Cheyenne | |
| WY09C-391 | | Oversample | -104.598019 | 43.066669 | Cheyenne | |
| WY09C-392 | Cow Creek | Oversample | -104.814593 | 43.288041 | Cheyenne | |
| WY09C-393 | Beaver Creek | Oversample | -104.164465 | 43.570806 | Cheyenne | |
| WY09C-394 | Black Tail Creek | Oversample | -104.255895 | 43.171385 | Cheyenne | |
| WY09C-395 | Dry Fork Cheyenne River | Oversample | -105.357760 | 43.311903 | Cheyenne | |
| WY09C-396 | Lance Creek | Oversample | -104.560592 | 43.274998 | Cheyenne | |
| WY09C-397 | Dry Fork Cheyenne River | Oversample | -105.089853 | 43.411224 | Cheyenne | |
| WY09C-398 | Black Thunder Creek | Oversample | -104.761682 | 43.599431 | Cheyenne | |
| WY09C-399 | Stockade Beaver Creek | Oversample | -104.129986 | 43.614281 | Cheyenne | |
| WY09C-400 | Mule Creek | Oversample | -104.237901 | 43.371013 | Cheyenne | |
| WY09C-063 | | Base | -107.063585 | 43.853652 | East Bighorns | Cheyenne |
| WY09C-064 | Clear Creek | Base | -106.794495 | 44.329740 | East Bighorns | Sheridan |
| WY09C-065 | Clear Creek | Base | -106.548666 | 44.525012 | East Bighorns | Sheridan |
| WY09C-066 | North Fork Powder River | Base | -106.647179 | 43.784875 | East Bighorns | Cheyenne |
| WY09C-067 | Crazy Woman Creek | Base | -106.574692 | 44.065036 | East Bighorns | Sheridan |
| WY09C-068 | Rock Creek | Base | -106.860928 | 44.447694 | East Bighorns | Sheridan |
| WY09C-069 | Tongue River | Base | -107.133195 | 44.907698 | East Bighorns | Sheridan |
| WY09C-070 | Rapid Creek | Base | -107.163224 | 44.661891 | East Bighorns | Sheridan |
| WY09C-071 | Crazy Woman Creek | Base | -106.406532 | 44.363577 | East Bighorns | Sheridan |
| WY09C-072 | North Tongue River | Base | -107.603588 | 44.764052 | East Bighorns | Sheridan |
| WY09C-073 | Poison Creek | Base | -106.822115 | 44.071224 | East Bighorns | Sheridan |
| WY09C-074 | Crazy Woman Creek | Base | -106.181522 | 44.487434 | East Bighorns | Sheridan |
| WY09C-075 | Wolf Creek | Base | -107.178662 | 44.875363 | East Bighorns | Sheridan |
| WY09C-325 | Tongue River | Oversample | -106.972569 | 44.911852 | East Bighorns | |
| WY09C-326 | North Fork Powder River | Oversample | -106.730135 | 43.775304 | East Bighorns | |
| WY09C-327 | North Fork Crazy Woman Creek | Oversample | -106.711808 | 44.176672 | East Bighorns | |
| WY09C-328 | Clear Creek | Oversample | -106.213910 | 44.761113 | East Bighorns | |
| WY09C-329 | | Oversample | -106.869814 | 44.852918 | East Bighorns | |
| WY09C-330 | Buffalo Creek | Oversample | -106.940829 | 43.452193 | East Bighorns | |
| WY09C-331 | | Oversample | -106.807032 | 43.990913 | East Bighorns | |
| WY09C-332 | Clear Creek | Oversample | -106.557776 | 44.491167 | East Bighorns | |
| WY09C-333 | Big Willow Creek | Oversample | -107.544515 | 44.763016 | East Bighorns | |

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|-----------|-------------------------------|------------|-------------|-----------|---------------|-----------------|
| WY09C-334 | Beaver Creek | Oversample | -107.058162 | 43.670013 | East Bighorns | |
| WY09C-335 | North Fork Crazy Woman Creek | Oversample | -106.677246 | 44.094758 | East Bighorns | |
| WY09C-336 | Johnson Creek | Oversample | -106.819733 | 44.390937 | East Bighorns | |
| WY09C-337 | Buffalo Creek | Oversample | -106.874882 | 43.583412 | East Bighorns | |
| WY09C-338 | East Fork Big Goose Creek | Oversample | -107.223844 | 44.574280 | East Bighorns | |
| WY09C-339 | Clear Creek | Oversample | -106.818922 | 44.325455 | East Bighorns | |
| WY09C-340 | Hanna Creek | Oversample | -107.008951 | 44.669140 | East Bighorns | |
| WY09C-341 | South Tongue River | Oversample | -107.469435 | 44.759988 | East Bighorns | |
| WY09C-342 | Middle Fork Crazy Woman Creek | Oversample | -106.666505 | 44.067261 | East Bighorns | |
| WY09C-343 | Coney Creek | Oversample | -107.31837 | 44.601271 | East Bighorns | |
| WY09C-344 | Jackson Creek | Oversample | -107.077595 | 44.665392 | East Bighorns | |
| WY09C-345 | Beaver Creek | Oversample | -106.944592 | 43.697465 | East Bighorns | |
| WY09C-346 | Clear Creek | Oversample | -106.441736 | 44.578301 | East Bighorns | |
| WY09C-347 | Coachy Creek | Oversample | -106.857411 | 43.898623 | East Bighorns | |
| WY09C-348 | Crazy Woman Creek | Oversample | -106.182971 | 44.484012 | East Bighorns | |
| WY09C-349 | Clear Creek | Oversample | -106.758449 | 44.32984 | East Bighorns | |
| WY09C-350 | Crazy Woman Creek | Oversample | -106.467215 | 44.161395 | East Bighorns | |
| WY09C-076 | | Base | -106.328637 | 43.542141 | Pow der | Cheyenne |
| WY09C-077 | Willow Creek | Base | -106.753254 | 43.456635 | Pow der | Cheyenne |
| WY09C-078 | Okie Draw | Base | -106.978595 | 43.177468 | Pow der | Cheyenne |
| WY09C-079 | Pow der River | Base | -106.550609 | 43.697272 | Pow der | Cheyenne |
| WY09C-080 | Salt Creek | Base | -106.243516 | 43.399450 | Pow der | Cheyenne |
| WY09C-081 | | Base | -107.344054 | 42.895981 | Pow der | Cheyenne |
| WY09C-082 | Okie Draw | Base | -106.944640 | 43.186754 | Pow der | Cheyenne |
| WY09C-083 | Pow der River | Base | -106.255498 | 43.753841 | Pow der | Cheyenne |
| WY09C-084 | Willow Creek | Base | -106.674871 | 43.482704 | Pow der | Cheyenne |
| WY09C-085 | Landon Creek | Base | -107.291227 | 42.890156 | Pow der | Cheyenne |
| WY09C-086 | Pow der River | Base | -106.144601 | 44.323405 | Pow der | Sheridan |
| WY09C-087 | L X Bar Creek | Base | -105.967921 | 44.927998 | Pow der | Sheridan |
| WY09C-351 | | Oversample | -107.307661 | 42.893632 | Pow der | |
| WY09C-352 | Willow Creek | Oversample | -106.785419 | 43.421132 | Pow der | |
| WY09C-353 | Pow der River | Oversample | -106.128206 | 44.641477 | Pow der | |
| WY09C-354 | Salt Creek | Oversample | -106.275610 | 43.405052 | Pow der | |
| WY09C-355 | Wallace Creek | Oversample | -107.257142 | 42.861823 | Pow der | |
| WY09C-356 | | Oversample | -107.008670 | 43.076139 | Pow der | |
| WY09C-357 | South Fork Pow der River | Oversample | -106.640123 | 43.424435 | Pow der | |
| WY09C-358 | Coal Draw | Oversample | -106.214155 | 43.449094 | Pow der | |
| WY09C-359 | Wallace Creek | Oversample | -107.103607 | 42.989014 | Pow der | |

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|-----------|--------------------------|------------|-------------|-----------|---------|--|
| WY09C-360 | South Fork Pow der River | Oversample | -106.540671 | 43.655125 | Pow der | |
| WY09C-361 | Willow Creek | Oversample | -106.661589 | 43.492892 | Pow der | |
| WY09C-362 | Meadow Creek | Oversample | -106.301837 | 43.592636 | Pow der | |
| WY09C-363 | Wallace Creek | Oversample | -107.182891 | 42.949026 | Pow der | |
| WY09C-364 | Pow der River | Oversample | -106.338865 | 43.694241 | Pow der | |
| WY09C-365 | Willow Creek | Oversample | -106.730937 | 43.475207 | Pow der | |
| WY09C-366 | Little Pow der River | Oversample | -105.303479 | 44.637334 | Pow der | |
| WY09C-367 | Wallace Creek | Oversample | -107.273710 | 42.903316 | Pow der | |
| WY09C-368 | Okie Draw | Oversample | -106.993364 | 43.189003 | Pow der | |
| WY09C-369 | South Fork Pow der River | Oversample | -106.617932 | 43.481778 | Pow der | |
| WY09C-370 | Coal Draw | Oversample | -106.254644 | 43.449678 | Pow der | |
| WY09C-371 | Alkali Creek | Oversample | -106.842761 | 43.353105 | Pow der | |
| WY09C-372 | Pow der River | Oversample | -106.164625 | 44.003302 | Pow der | |
| WY09C-373 | Willow Creek | Oversample | -106.719999 | 43.481229 | Pow der | |
| WY09C-374 | Dead Horse Creek | Oversample | -105.928295 | 44.947790 | Pow der | |

Appendix 5 – Second statewide probabilistic (random) survey stations

| Survey ID | Stream | Type | Longitude | Latitude | HUC | Crew |
|--------------|---------------------------|------------|-------------|-----------|----------|----------|
| WYS08706-061 | Little Bighorn River | Oversample | -107.678582 | 44.945405 | 10080016 | Sheridan |
| WYS08706-064 | Sand Creek | Oversample | -104.109424 | 44.493341 | 10120203 | Sheridan |
| WYS08706-065 | Hoback River | Oversample | -110.705326 | 43.318890 | 17040103 | Lander |
| WYS08706-066 | Little Missouri River | Oversample | -104.890992 | 44.792823 | 10110201 | Sheridan |
| WYS08706-068 | Henrys Fork | Oversample | -109.667273 | 41.004119 | 14040106 | Lander |
| WYS08706-069 | North Fork Fish Creek | Oversample | -110.099194 | 43.694133 | 17040102 | Lander |
| WYS08706-070 | Middle Fork Pow der River | Oversample | -107.060100 | 43.585971 | 10090201 | Sheridan |
| WYS08706-072 | North Pney Creek | Oversample | -110.177840 | 42.597411 | 14040101 | Lander |
| WYS08706-073 | Meeteetse Creek | Oversample | -109.229070 | 44.259028 | 10080009 | Lander |
| WYS08706-074 | Shell Creek | Oversample | -107.968780 | 44.527543 | 10080010 | Sheridan |
| WYS08706-076 | Salt River | Oversample | -110.976681 | 42.722259 | 17040105 | Lander |
| WYS08706-077 | North Alkali Creek | Oversample | -108.876094 | 44.738827 | 10080014 | Sheridan |
| WYS08706-080 | Belle Fourche River | Oversample | -104.383293 | 44.899152 | 10120202 | Sheridan |
| WYS08706-081 | Fall River | Oversample | -111.034019 | 44.118191 | 17040203 | Lander |
| WYS08706-082 | Miller Creek | Oversample | -104.636791 | 44.482015 | 10120201 | Sheridan |
| WYS08706-084 | Killpecker Creek | Oversample | -110.246300 | 42.807128 | 14040101 | Lander |

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|--------------|----------------|------------|-------------|-----------|----------|----------|
| WYS08706-085 | Elk Fork | Oversample | -109.633591 | 44.456531 | 10080012 | Sheridan |
| WYS08706-086 | Gloom Creek | Oversample | -107.322537 | 44.720173 | 10090101 | Sheridan |
| WYS08706-087 | Conant Creek | Oversample | -108.060349 | 42.832451 | 10080004 | Lander |
| WYS08706-088 | La Barge Creek | Oversample | -110.561522 | 42.407272 | 14040101 | Lander |
| WYS08706-089 | Buffalo Fork | Oversample | -110.405106 | 43.838724 | 17040101 | Lander |
| WYS08706-092 | Muddy Creek | Oversample | -110.552827 | 41.929546 | 14040107 | Lander |

Appendix 6 – WDEQ/USGS Non-CBM Fixed Station Monitoring Network for 2011

| USGS Station Number | Station Name | Constituents | Frequency | Basis |
|---------------------|---|---|-----------|------------|
| 06259000 | Wind River below Boysen Reservoir | Field, CBM, nutrients | 12/yr | monthly |
| 06264700 | Bighorn River at Luceme | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 06274300 | Bighorn River at Basin | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 06276500 | Greybull River near Meeteetse | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 06279500 | Bighorn River at Kane | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 06285100 | Shoshone River at Lovell | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 06630000 | North Platte River above Seminoe, near Sinclair | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 06639000 | Sweetwater River near Alcova | Field, Common Ions, Nutrients, Sediment | 4/yr | quarterly |
| 06645000 | North Platte River below Casper | Field, Bacteria, Nutrients, Common Ions, Trace metals | 4/yr | quarterly |
| 06652000 | North Platte River near Orin | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 06670500 | Laramie River at Fort Laramie | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 06674500 | North Platte River at WY-NE State line | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 09209400 | Green River nr La Barge | Field, CBM, Nutrients, Sediment | 4/yr | quarterly |
| 09224050 | Hams Fork River near Diamondville | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 09224700 | Blacks Fork nr Little America | Field, Bacteria, Nutrients, Sediment | 4/yr | quarterly |
| 09259050 | Little Snake River below Baggs | Field, Common ions, Sediment | 4/yr | hydrograph |

Appendix 7 – WDEQ/USGS CBM Fixed Station Monitoring Network for 2011

| Station | Name | Code | Freq |
|----------|---|------------------------|-------|
| 06299980 | Tongue R at Monarch | CBM | 12/yr |
| 06304500 | Little Goose Cr at Sheridan | CBM | 12/yr |
| 06305500 | Goose Cr bel Sheridan | CBM | 12/yr |
| 06306020 | Tongue R bel Youngs Cr nr Acme | CBM, FIL Se, FIL Hg | 12/yr |
| 06306200 | Prairie Dog Cr at Wakely Siding nr Sheridan | CBM | 24/yr |
| 06306250 | Prairie Dog Cr nr Acme | CBM | 24/yr |
| 06313400 | Salt Cr nr Sussex | CBM and FIL Se | 12/yr |
| 06313500 | Powder R at Sussex | CBM and FIL Se | 24/yr |
| 06313605 | Powder R bel Burger Draw nr Buffalo | CBM | 12/yr |
| 06316400 | Crazy Woman Cr at Upper Station nr Arvada | CBM Sediment | 24/yr |
| 06317000 | Powder R at Arvada | CBM Nutrients | 24/yr |
| 06320210 | Clear Cr ab Kumor Draw nr Buffalo | CBM | 12/yr |
| 06324000 | Clear Cr nr Arvada | CBM | 24/yr |
| 06324970 | Little Powder R ab Dry Cr nr Weston | CBM Nutrients | 12/yr |
| 06369500 | Cheyenne R nr Dull Center | CBM | 12/yr |
| 06386500 | Cheyenne R nr Spencer | CBM | 12/yr |
| 06425900 | Caballo Cr at mouth nr Piney | CBM Nutrients | 12/yr |
| 06426400 | Donkey Cr nr Moorcroft | CBM | 12/yr |
| 06426500 | Belle Fourche R bel Moorcroft | CBM Nutrients | 12/yr |
| 06428050 | Belle Fourche R bel Hulett | CBM | 12/yr |
| 06635000 | Medicine Bow R ab Seminoe Res nr Hanna | CBM Nutrients Sediment | 12/yr |
| 06636000 | N Platte R ab Pathfinder Res | CBM Sediment | 12/yr |
| 06313590 | Powder R ab Burger Draw nr Buffalo | CBM | 12/yr |
| 06313540 | Willow Cr nr mouth nr Sussex | Cations | 12/yr |
| 06313560 | Pumpkin Cr nr mouth nr Sussex | Cations | 12/yr |
| 06313585 | Beaver Cr at mouth nr Sussex | Cations | 12/yr |
| 06313604 | Burger Draw at mouth nr Buffalo | Cations | 12/yr |
| 06313633 | Van Houten Draw at mouth nr Buffalo | Cations | 12/yr |
| 06313750 | Barber Cr at mouth nr Buffalo | Cations | 12/yr |
| 06316900 | Cottonwood Cr at mouth nr Arvada | Cations | 12/yr |
| 06317030 | Wild Horse Cr at mouth at Arvada | Cations | 12/yr |
| 06317095 | Spotted Horse Cr at mouth nr Arvada | Cations | 12/yr |
| 06317100 | Powder R ab Clear Cr nr Arvada | Cations | 12/yr |
| 06323550 | Clear Cr ab Double Crossing Cr nr Clearmont | Cations | 12/yr |
| 06324200 | L X Bar Cr at mouth nr Moorhead MT | Cations | 12/yr |
| 06324300 | S A Cr at mouth nr Moorhead MT | Cations | 12/yr |
| 06324870 | Rawhide Cr at mouth nr Gillette | Cations | 12/yr |
| 06324940 | Horse Cr at mouth nr Weston | Cations | 12/yr |
| 06324950 | Little Powder R bel Elk Cr nr Weston | Cations | 12/yr |
| 06425720 | Belle Fourche R bel Rattlesnake Cr nr Piney | Cations | 12/yr |

1. CBM parameters: common ions, select filtered trace metals, arsenic