Final

Remedial Action Monitoring Plan

Milltown Reservoir Sediments Operable Unit

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1 Introduction

This document presents the Final Remedial Action Monitoring Plan (RAMP) to be conducted by the Settling Defendants (SDs) and the Missoula City-County Health Department (MCCHD) during Remedial Action (RA) construction activities as part of the Milltown Reservoir Sediments Operable Unit (MRSOU) of the Clark Fork River (CFR) Superfund Site in Milltown, Montana. Consistent with the requirements of the Record of Decision (ROD) (EPA, 2004a) and the Final Remedial Design/Remedial Action Statement of Work (SOW) for the MRSOU, monitoring during Remedial Action (RA) activities will include biological and water quality monitoring of the total amount of suspended sediments, inorganic nutrients, and dissolved and total metals and arsenic moving through the Clark Fork and Blackfoot Rivers as well as metals and arsenic in the local groundwater. The monitoring plan presented herein applies only to the RA construction phase and those general monitoring activities to be undertaken by the SDs along with certain groundwater monitoring activities to be performed by the MCCHD. Additional task-specific monitoring may also be performed during certain portions of the RA construction period as applicable to supplement the general RA monitoring described in this RAMP. Additional task-specific monitoring, if needed, will be identified in the applicable Task-Specific Remedial Action or Construction Quality Assurance Work Plans submitted as part of the Final Design Reports. Post-construction RA monitoring, including flow and stage monitoring, by the SDs will be addressed under a later, subsequent document.

RA construction will extend over multiple years and it is possible that unforeseen circumstances or events may occur, new information or data may be obtained, and/or changing field parameters or conditions may be observed by the agencies or others during this period that justify modifications to the monitoring plan identified herein. Therefore, it is understood that the RA monitoring plan needs to be flexible to add, change or reduce monitoring requirements as the project evolves.

In addition to the water quality and biologic monitoring to be performed by the SDs or MCCHD described in this document, the Environmental Protection Agency (EPA), State of Montana and NorthWestern Energy will also be responsible for other monitoring. A summary of monitoring responsibilities by entity, including identification of the specific regulatory requirement addressed by the monitoring, is provided in Table 1. Additional discussion on the RA monitoring responsibility breakdown between the SDs and others is provided in Section 2.2.8 of the SOW.

The purposes of the water quality and biological monitoring to be performed by the SDs during the RA construction activities are to:

- measure the overall and cumulative effects of the construction activities;
- provide the analytical feedback system to trigger consideration of additional operational controls and Best Management Practices (BMPs) during Milltown RA construction;

- provide information to ensure that groundwater used for drinking water purposes does not exceed the arsenic standard; and
- assess the effectiveness of engineering controls used during remedial construction activities and assess any adverse effects on aquatic habitat and organisms.

The EPA and Montana Department of Environmental Quality (DEQ) have established temporary construction-related surface water quality standards for the Clark Fork River in the ROD (EPA, 2004a) for the protection of human health and downstream aquatic life during the RA. These performance standards are presented in Table 2 and also in Table 1 of Section 1.2.2 of Attachment 1 to the SOW. To provide additional protection, warning limits set at 80% of the construction standards are also identified on Table 2. In the event that surface water monitoring conducted by the SDs identifies exceedances of the warning limits, the monitoring data may be used to determine if additional BMPs or other controls should be implemented during Milltown RA construction to reduce the exceedances. Additional BMPs or other controls to be considered are identified in the Contingency Plan for Exceedance of Downstream Surface Water Quality Standards/Warning Limits (Envirocon 2006a), submitted under separate cover. In addition, although not a specific trigger for implementation of BMPs and other controls, it is understood that EPA has the authority to require evaluation and implementation of project controls if a biological impact is observed and attributed to increased metals/TSS concentrations from RA activities.

1.1 Site Location and Description

The Milltown Reservoir was created in 1907 by the construction of the Milltown Dam at the confluence of the CFR and the Blackfoot River (BFR). The Milltown Dam is located approximately 7 miles east of Missoula, Montana and is adjacent to the small, unincorporated communities of Milltown and Bonner. The historic mining communities of Butte and Anaconda are upstream. During the past century, mine wastes and natural sediment materials have washed downstream, creating some 7 million cubic yards (mcy) of sediment accumulation behind the Milltown Dam. Only a portion of the reservoir sediments area, occupying much of Sediment Accumulation Area (SAA) I, has been identified as the primary source of the groundwater arsenic plume associated with the MRSOU.

The MRSOU includes the Milltown Reservoir and the adjacent areas of arsenic-impacted groundwater. The reservoir boundary is defined as the area inundated by a high pool elevation of 3,263.5 feet above mean sea level (amsl) in the local datum used by the dam operator which is equivalent to 3,265.5 feet amsl in the 1988 USGS datum. The high pool elevation is based on the reservoir operation as controlled by Clark Fork and Blackfoot, LLC's Milltown Dam. The reservoir open water and deposited sediment areas cover approximately 540 acres and extend a distance of approximately 2 miles southeast of the dam up the CFR valley.

EPA listed the MRSOU on the National Priorities List in 1982 based on arsenic detected in Milltown groundwater wells located adjacent to the reservoir sediments. Between 1982 and 1992, nine investigations were conducted in the Milltown area to identify the source/extent of the groundwater arsenic and to characterize the soils, groundwater, surface water, sediments and biological resources in, and around, the MRSOU. Results from the investigations completed through 1992 (as well as some additional data collected by Land and Water in 1993 as part of the Hellgate Aquifer Study) are summarized in the Final Draft Remedial Investigation (RI) Report, (ARCO, 1995). Shortly after completion of the RI, a Draft Feasibility Study (FS) Report (ARCO, 1996) was completed evaluating remedial alternatives focused on the groundwater arsenic plume. The 1996 FS built upon previous technology screening and alternative development work that had been ongoing at the site since the early 1990s.

In February 1996, an extended period of severely cold weather created thick ice on the CFR and BFR near, and upstream of Milltown. This was followed by a period of rapid warming with rainfall, which caused flows in the river to increase, thereby causing ice jams, which scoured large quantities of sediments from the Milltown Reservoir and transported the sediments downstream in the CFR. Based on water quality samples taken downstream during this event, EPA directed the development of an additional Focused FS (AERL, 2001) to address the potential impacts to surface water and aquatic life in the CFR below Milltown Dam during ice scour and high flow events. A Combined FS (AERL, 2002) was subsequently developed to incorporate the most effective components of the groundwater cleanup from the original 1996 Draft FS with the alternatives proposed for mitigating surface water impacts in the 2001 Focused FS. EPA released its Original Proposed Plan for the MRSOU on April 15, 2003 identifying a version of Alternative 7A2 from the combined FS (i.e., hydraulic dredge removal of SAA I sediments with slurry piping to a local disposal facility at Bandmann Flats) as the proposed action. Based on public comments, a Revised Proposed Plan was released on May 17, 2004 identifying a modification to the sediment removal, transportation and disposal scenario presented in the Original Proposed Plan where SAA I sediments would be excavated mechanically and transported by train to Opportunity Ponds for disposal. EPA's ROD, issued in December 2004, selected the remedy described in the Revised Proposed Plan as the final cleanup plan for the MRSOU.

2 Pre-Remedial Action Monitoring

Current surface water, streambed sediments, benthic macroinvertebrates, periphyton and nutrient monitoring activities and results for the CFR and its tributaries are described in various annual or quarterly monitoring documents and reports developed by the USGS, DEQ and EPA. A summary of these activities is provided in Clark Fork River Operable Unit: Draft Proposed Clark Fork River Basin-Wide Monitoring Plan (Atlantic Richfield Company, 2002). Current activities and the latest results for Milltown Reservoir area groundwater monitoring are presented in Milltown Reservoir Operable Unit: December 2005 Groundwater Monitoring Event, Data Summary Report (Atlantic Richfield Company, 2006). The procedures and results for the pre-RA monitoring described in these documents were used, in combination with the monitoring requirements of the SDs contained in Section 2.2.8.1 of the SOW, to develop this RAMP. The pre-remedial action monitoring will continue until Stage 1 drawdown activities begin.

3 Proposed Remedial Action Monitoring

The monitoring presented in this document is primarily intended to help assess the effect RA construction activities will have on the CFR, BFR, and the alluvial aquifer. EPA's Data Quality Objective (DQO) process was used to develop the sampling design particulars including: when and where to collect samples, the tolerance levels for decision errors, and how many samples to collect. Specific to the CFR and BFR surface water and as explained in Section 3.1, daily monitoring of turbidity at the downstream station and periodic sampling of TSS and dissolved and total recoverable metals at all stations will be conducted.

As described in the introduction, EPA and DEQ have established temporary, not-to-exceed, performance standards for surface water quality to protect human health and prevent acute impacts to downstream aquatic life in general and bull trout in particular during RA construction activities. These construction standards are shown in Table 2. In addition, Table 2 identifies warning levels where additional monitoring and/or mitigative actions may be triggered to help prevent exceedance of the temporary construction standards.

Annual measurements of the benthic macroinvertebrate community will also be conducted to evaluate impacts to aquatic life. Results from these monitoring activities may be used to assess the need to implement additional BMPs or other controls during construction to avoid acute impacts.

Negative impacts to groundwater quality resulting from RA activities are not anticipated and in fact improvements are expected as the RA progresses. Groundwater monitoring will be conducted in the Milltown area to assess groundwater quality during the RA activities. Compliance wells are all located within the current arsenic plume (except well 920) and will be monitored during the RA to track progress in restoring the Milltown alluvial aquifer. A series of early warning wells, located around the fringe of the current plume and along the CFR downstream of the MRSOU, will also be monitored to ensure that groundwater in existing drinking water wells is not unacceptably impacted by construction activities. Finally, certain existing public and private water supply wells will be monitored by MCCHD as public health monitoring wells.

Monitoring of air quality during the RA will be based on periodic personal monitoring of workers. Ambient air monitoring will only be considered if personal monitoring indicates airborne metals concentrations have reached levels of potential concern.

3.1 Proposed Surface Water Quality Monitoring

Surface water quality monitoring is intended to measure the impacts that construction activities have on surface water quality and to provide guidance on which, if any, BMPs or other controls should be implemented during construction and when to address those impacts.

3.1.1 Monitoring Locations

The primary objectives of the surface water monitoring are to:

- measure the overall and cumulative effects of the construction activities on downstream surface water quality;
- provide the analytical feedback system to trigger consideration of BMPs or other controls during Milltown RA construction;
- provide information to determine if/when elevated downstream surface water dissolved arsenic concentrations justify increasing the frequency of early warning well sampling to ensure that groundwater used for drinking water purposes does not exceed the arsenic standard; and
- provide data to help assess the water quality and biological impact related to construction activities.

Upstream water quality, flow and biologic data are also necessary to characterize the surface water entering the construction area. These data can then be compared with similar data collected downstream of the site to determine the extent and magnitude of potential site construction activity impacts. Two proposed surface water quality sampling locations are located upstream of the Milltown reservoir and one is located downstream of the reservoir. All three sampling locations are currently used as CFR basin-wide surface water quality monitoring locations. The sampling locations are shown in Figure 1.

The first upstream surface water quality sampling location is the CFR at Turah Bridge station with the USGS identification number 12334550. The potential exists for restoration construction and/or other activities/impacts along the CFR upstream of Duck Bridge but downstream of the CFR at Turah station to affect water quality entering the RA project area. Therefore, if available, results from a temporary sampling station located near Duck Bridge may be obtained from the sampling entity and used to supplement CFR at Turah monitoring results during periods of upstream restoration construction and/or other activities/impacts. (Note reference to obtaining potential sampling results for a temporary station near Duck Bridge during restoration construction does not imply that this location represents a point of surface water quality compliance for restoration activities. For the Temporary Surface Water Quality Standards, the restoration point of compliance is the same as the RA's [i.e., the CFR above Missoula station referenced below.])

The second upstream surface water quality sampling location is the BFR near Bonner station with the USGS identification number 12340000. Similar to the upstream CFR, the potential exists for restoration, bridge mitigation, Stimson cooling pond mitigation and/or other construction activities/impacts along the BFR upstream of the I-90 bridge but downstream of the BFR near Bonner station to affect water quality entering the RA project area. Therefore, if available, results from a temporary station located immediately downstream of the I-90 bridge (or at an alternate location that is downstream of the activity but upstream of the RA project area) may be obtained from the sampling entity and used to supplement BFR near Bonner monitoring results during periods of upstream construction activities.

The downstream surface water quality sampling location and point of compliance for RA surface water quality is the CFR above Missoula station with USGS identification number 12340500. This gaging station is located 2.8 miles downstream of Milltown Dam. This compliance point monitoring location will allow direct comparison to historic surface water quality data. Similar to the upstream stations if restoration and/or other construction activities are ongoing downstream of the RA project area but upstream of the CFR above Missoula station, results from a temporary station, located immediately downstream of Milltown Dam, may be obtained from the sampling entity and used to supplement CFR above Missoula station results.

Selection of two sampling locations immediately upstream of the reservoir, one on the BFR and one on the CFR, allows identification of the quality of the surface water entering the reservoir. Comparing the flow-weighted upstream water quality results to the downstream results provides a measure of the impact RA construction activities are having on the river downstream of the reservoir.

3.1.2 Monitoring Parameters and Frequency

The frequency of surface water monitoring and the parameters to be monitored have been developed following the DQO analysis process. From that analysis two sampling Regimes (1 and 2, see Figures 4 and 5) were developed, each triggered by the analytical results of the surface water samples. Procedures for surface water sample collection and analysis, including blanks and replicate samples, are to be conducted in accordance with the Clark Fork River Superfund Site Investigations (CFRSSI) Standard Operating Procedures (SOP) (ARCO, 1992a), Quality Assurance Project Plan (QAPP) (ARCO, 1992b) and the Laboratory Analysis Protocol (LAP) (ARCO, 1992c). The applicable sampling and analysis protocols from the CFRSSI documents and other protocols which differ from, or are not included in, the above-referenced CFRSSI documents are provided in Appendix A. Measurement quality objectives to meet DQO decision thresholds are also identified in Appendix A.

3.1.2.1 Turbidity Monitoring

The agencies have stated that public concerns about river turbidity appear when the TSS levels rise to the 70 mg/L range. The 2002 drawdown turbidity data indicated that TSS values in this range are encountered at about 12 nephelometric units (NTU) (see Figure 2). Therefore, this turbidity level will be used to guide additional water sampling under Regime 1 and Regime 2.

Figure 3 shows the initial flow chart for surface water sampling that determines if sampling Regime 1 or Regime 2 is followed. Commencing one week prior to the beginning of Stage 1 drawdown, turbidity measurement will be performed three times each day at the CFR above Missoula monitoring station. Grab measurements will be made, or if approved by EPA, the SDs may employ continuous turbidity monitoring. If the turbidity at the CFR above Missoula monitoring station does not exceed 12 NTU, then sampling Regime 1 will be followed.

If the turbidity at the CFR above Missoula monitoring station exceeds 12 NTU, then sampling Regime 2 will be added to Regime 1 and both will be followed. Additionally, the upstream BFR near Bonner and CFR at Turah stations will be monitored immediately after the CFR above Missoula station to provide comparison data to determine if turbidity is deemed to have been added[1] by the RA construction activities (Note: If restoration or other construction activities/impacts are ongoing along the CFR or BFR upstream of the RA project area, data from sampling of the anticipated temporary CFR near Duck Bridge and/or BFR near I-90 stations may be obtained from the sampling entity and used to represent upstream concentrations. Similarly, if restoration or other construction activities/impacts are ongoing along the CFR downstream of the RA project area but upstream of the CFR above Missoula, data from sampling of a temporary station, located near Milltown Dam, may be obtained from the sampling entity and used to represent downstream concentrations). If no turbidity is deemed to have been added by the RA construction activities, then no additional BMP or other control evaluation is required. However, if turbidity is deemed to have been added by RA construction activities then BMP or other controls (specified in [Envirocon, 2006a]) to manage turbidity will be evaluated by the SDs and implemented if determined appropriate by the EPA in consultation with the State. Note that if the exceedance of the turbidity warning level occurs outside the “user season” on the river (defined as July 1 through October 19) then greater consideration may be given by EPA in consultation with the State to cost, schedule and/or production rate impacts when deciding whether BMPs or other controls should be implemented during construction.

If the turbidity at the CFR above Missoula monitoring station drops back below 6 NTU for three (3) consecutive days, then turbidity sampling frequency can be reduced to once per day. If the turbidity at the CFR above Missoula monitoring station subsequently exceeds 6 NTU, then the turbidity monitoring frequency will be increased to three times per day until it again drops below 6 NTU for three consecutive days.

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[1] Because of the difficulty in comparing turbidity levels, site RA construction activities will be deemed to have added turbidity if downstream TSS values are higher (with the error considered) than flow-weighted upstream TSS concentrations measured on the same day. The upstream TSS concentration will be flow-weighted by multiplying measured TSS concentration by discharge for each of the CFR at Turah (or potentially CFR near Duck Bridge if restoration construction or other activities/impacts are ongoing along the CFR upstream of the RA project area) and BFR near Bonner (or potentially BFR near I-90 if restoration construction or other activities/impacts are ongoing along the BFR upstream of the RA project area) stations, adding the two products together, and dividing by the discharge at the CFR above Missoula station. If the downstream CFR above Missoula (or potentially CFR near Milltown Dam if restoration construction or other activities/impacts are ongoing along the CFR downstream of the RA project area) measured TSS concentration is higher than the equivalent calculated upstream flow-weighted concentration, it will be necessary to determine if the increased concentration is outside the range of error in the data. To determine error propagation of the data sets, the measurement error and lab precision for each constituent must be considered. For discharge, an error of 5% is typical for stable channels (ref: 6-2-05 email from John Lambing, USGS). Based on 2003 USGS data, the standard deviation of field replicates for TSS is 2.2 mg/L (see: USGS report "Water-Quality, Bed-Sediment, and Biological Data [October 2002 through September 2003] and Statistical Summaries of Data for Streams in the Upper Clark Fork Basin, Montana", Open-File Report 2004-1340, Table 9). Combining the standard errors for discharge and concentrations, the downstream TSS concentration would be deemed higher, if it is greater than the sum of the upstream flow-weighted concentration and the calculated total standard deviation. The attached spreadsheet (see Appendix B, Table B-1) can be used to determine if site RA construction activities have “added” turbidity.

3.1.2.2 River Sampling Regime 1

Figure 4 shows the flow chart for Regime 1 sampling. In Regime 1 weekly grab samples will be collected from all three stations. Dissolved oxygen, pH, and temperature will be measured in the field during sample collection at all three monitoring stations. These weekly samples will be analyzed for TSS, hardness, and dissolved and total recoverable arsenic and the following metals:

- cadmium;
- copper;
- iron;
- zinc; and
- lead.

Additionally, total nitrate plus nitrite nitrogen and total phosphorous concentrations will be determined on a monthly frequency but only at the CFR above Missoula monitoring station. A maximum 4-day turnaround will be provided for the results of all samples analyzed under Regime 1. If any of the analytes exceed the warning levels shown on Figure 4 for samples collected at the CFR above Missoula monitoring station, Regime 2 will be added to Regime 1 and both Regimes will be followed. Otherwise Regime 1 will continue to be followed.

Additionally, if the exceedance occurs and TSS or any of the dissolved metals and arsenic are deemed to have been added[2] by RA activities, additional BMPs and other controls to manage TSS or dissolved metals and arsenic will be evaluated and, if

[2] Constituents will be deemed to have been added by RA construction activities if the measured TSS or any of the dissolved metals or arsenic at the CFR above Missoula (or potentially CFR near Milltown Dam if restoration or other activities/impacts are ongoing along the CFR downstream of the RA project area) station are higher (outside the error margin) than the sum of the calculated flow-weighted constituent levels sampled the same day at the CFR at Turah (or potentially CFR near Duck Bridge if restoration construction or other activities/impacts are ongoing along the CFR upstream of the RA project area) and BFR near Bonner (or potentially BFR near I-90 if restoration construction or other activities/impacts are ongoing along the BFR upstream of the RA project area) stations. The upstream concentration will be flow-weighted by multiplying the applicable constituent concentration by discharge for each of the CFR at Turah and BFR near Bonner stations, adding the two products together, and dividing by the discharge at the CFR above Missoula station. To determine error propagation of the data sets, the measurement error and lab precision for each constituent must be considered. For discharge, an error of 5% is typical for stable channels (ref: 6-2-05 email from John Lambing, USGS). Based on the 2003 USGS data, the standard deviation of field replicates is 2.2 mg/L, 0.15 ug/L, 0.01 ug/L, 0.13 ug/L, 1.3 ug/L, 0.38 ug/L and 0.02 ug/L for TSS and dissolved arsenic, cadmium, copper, iron, zinc, and lead respectively (see: USGS report "Water-Quality, Bed-Sediment, and Biological Data [October 2002 through September 2003] and Statistical Summaries of Data for Streams in the Upper Clark Fork Basin, Montana", Open-File Report 2004-1340, Table 9). The standard deviation of lab replicates is 0.16 ug/L, 0.00 ug/L, 0.08 ug/l, 1.6 ug/L, 0.24 ug/L and 0.02 ug/L for dissolved arsenic, cadmium, copper, iron, zinc and lead, respectively. Combining the standard errors of the discharge and constituents, the downstream measured constituent concentration would be deemed higher, if it is greater than the sum of the upstream flow-weighted concentration and the calculated total standard deviation. The attached spreadsheet (see Appendix B, Table B-2) can be used to determine if site RA construction activities have "added" TSS, dissolved arsenic or dissolved metals.

determined appropriate by the EPA in consultation with the State, implemented by the SDs as provided for in the applicable contingency plan.

3.1.2.3 River Sampling Regime 2

Figure 5 shows the flow chart for Regime 2 sampling. In Regime 2 daily grab samples will be collected at all three monitoring stations and analyzed for TSS, hardness and dissolved arsenic and copper. Also, if Regime 1 sampling results show any other dissolved metal(s) above its/their respective warning limit(s) then Regime 2 will also include analysis for the additional metal(s). One-day turnaround (i.e. no later than 5:00 PM MST on the day following sample collection and delivery to the laboratory) will be provided for the results of all samples analyzed under Regime 2. Also, dissolved oxygen, pH, and temperature will be measured in the field during sample collection.

If the TSS, dissolved arsenic, dissolved copper or, if applicable, other dissolved metal concentration exceeds its warning limit found in Figure 4 and TSS, dissolved arsenic, dissolved copper or, if applicable, other dissolved metal is deemed to have been added[3] by RA activities, additional BMPs and other controls to manage TSS, dissolved copper, dissolved arsenic or, if applicable, other exceeding metal will be evaluated and, if determined appropriate by the EPA in consultation with the State, implemented by the SDs as provided for in the applicable contingency plan. If the warning limits are not exceeded, Regime 1 sampling only will resume after seven (7) consecutive days of Regime 2 sampling without exceedance of the warning limits at the CFR above Missoula monitoring station.

3.1.3 Monitoring Schedule and Sequencing

Surface water quality sampling in accordance with this RAMP will be initiated one week prior to the start of Stage 1 drawdown and will continue until certification of Substantial Completion of the Grading Plan. Water quality sampling at the 3 surface water monitoring stations will be performed on the same day and in standard "clean" sequencing; sampling the potentially less contaminated stations first with the most contaminated last (generally the BFR station first, followed by the upstream CFR Station and the downstream CFR Station).

3.1.4 Discharge and Stage Monitoring

Discharge and stage monitoring are presently being performed by the USGS at CFR at Turah (above reservoir), BFR near Bonner (above reservoir) and CFR above Missoula

[3] TSS or dissolved arsenic or copper will be deemed to have been added by RA construction activities if measured concentrations at the CFR above Missoula station (or potentially CFR near Milltown Dam if restoration construction or other activities/impacts are ongoing along the CFR downstream of the RA project area) are higher than the sum of the calculated flow-weighted concentrations sampled on the same day at the CFR at Turah (or potentially CFR near Duck Bridge if restoration construction or other activities/impacts are ongoing along the CFR upstream of the RA project area) and BFR near Bonner (or potentially BFR near I-90 if restoration construction or other activities/impacts are ongoing along the BFR upstream of the RA project area) stations plus the calculated total standard deviation. Methodologies for determining if downstream TSS, dissolved arsenic or dissolved copper concentrations are higher (outside the error margin) than flow-weighted upstream concentrations are described in footnote 2 above.

(below reservoir) monitoring stations and will continue until certification of Substantial Completion of the Grading Plan. Post-construction RA monitoring, including flow and stage monitoring, by the SDs will be addressed under a later, subsequent document.

3.2 Proposed Benthic Macroinvertebrates Monitoring

Another method of determining possible contaminant impacts on the river is to assess the condition of benthic macroinvertebrate (BMI) communities in the river sediments. Yearly BMI surveys have been conducted by DEQ in the CFR basin since 1986. Included in these surveys have been BMI community monitoring at the three proposed surface water monitoring stations for the RA (USGS stations 12334550, 12340000, and 12304500, see Figure 1 for station locations).

BMI communities may respond to toxic stresses brought about by contaminated surface water with a differentiation of the expected community diversity and an overall reduction in population numbers. This biological reaction is somewhat delayed when compared to the onset of the toxic condition in the surface water. Yearly surveys then will provide data to document benthic community metrics as well as changes or trends in those metrics. As with the water quality data, the results of the yearly BMI will be used to help assess construction activity impacts.

No change will be made to the current yearly bioassay surveys being conducted, which will continue until certification of Substantial Completion of the Grading Plan. Reporting of BMI survey results will occur annually with the report distributed after the year's data has been compiled and checked.

3.3 Groundwater Monitoring

The purposes of remedial action groundwater monitoring are to:

- document progress towards the achievement of groundwater performance standards;
- monitor the potential impact of remedial action construction activities on the groundwater in the area and provide data to direct the application, if any, of BMPs or other controls during RA construction to reduce the potential impact of construction activities on the groundwater; and
- ensure no one using local groundwater for potable water purposes is utilizing water above 10 µg/L dissolved arsenic.

3.3.1 Monitoring to Document Achievement of Performance Standards

Since 1995, an extensive network of 63 monitoring and domestic water wells have been sampled semi-annually (in December and June) to monitor the concentration and areal extent of arsenic present in the alluvial aquifer in the vicinity of the Milltown reservoir. The current groundwater monitoring network is shown in Figure 6 and listed in Table 3. Because the arsenic plume is well defined and RA activities are expected to have an immediate positive impact on the arsenic concentration in the alluvial aquifer, the number of wells to be monitored for compliance will be reduced to ten (10). The compliance wells to be monitored semi-annually (in December and June) are: 11, 905, 907, 917B, 922D, 105C, 107C, 110B, HLA2 and 103B (see Figure 7 for well locations). As previously noted, during the RA monitoring results from these wells will be used to track progress towards cleanup of the Milltown alluvial aquifer arsenic plume. Post RA these same wells will also serve to document attainment of groundwater cleanup performance standards which as specified in Section 1.1.1 of Attachment 1 to the SOW is not required until 10 years after completion of all RA and restoration construction activities. A summary of historic sampling data for the compliance wells is provided in Table 4.

In addition to the ten general groundwater compliance wells described above, an additional well will be designated or installed and monitored semi-annually as a specific monitoring point for sediments left in place in SAA III-b. Historically groundwater was also monitored around the existing Upland Disposal Site (UDS) repository constructed to contain sediment and debris generated during 1986-1988 dam rehabilitation work. However, no impacts to groundwater have been observed in the UDS wells to date and no additional groundwater monitoring is proposed for this area during, or after, the RA. Similarly, in accordance with Administrative Rules of Montana no groundwater monitoring is required for the existing and proposed Class III inert dam debris disposal repositories which will be constructed during the RA.

These compliance wells will be monitored by the SDs until Certification of Completion of Remedial Action as that process is defined in the Consent Decree.

3.3.2 Early Warning Monitoring and Domestic Wells

Twenty-one wells, including 916A, 919A, 920, 923A, 923B, 923C, DB-001, DB-007, DB-039, DB-035, G, C-8 (a.k.a. the Auto Plaza well), C-21 (a.k.a. the River Grill well), , MW-5 (a.k.a. WQD-26), MW-7, HGS, HGD, DH1, DH2, MM2 and a new replacement well (tentatively identified as NRW) that EPA will be installing in Milltown will be monitored to detect unanticipated changes in the arsenic plume resulting from construction activities and provide an early warning that the arsenic plume extent may be changing because of those construction activities particularly in areas with existing groundwater use. Early warning well locations are shown in Figure 7. As shown by different symbols on Figure 7, early warning monitoring wells will be sampled by the SDs while early warning domestic wells will be sampled by MCCHD. The SDs will sample fourteen (14) wells: G, 919A, 916A, 920, 923A, 923B, 923C, MW-7, MW-5 (a.k.a.WQD26), HGS, HGD, DH1, DH2 and MM2. MCCHD will sample seven (7) wells: DB-039, DB-035, C21, C8, DB-001, DB-007 and NRW. A summary of historic sampling data for these early warning wells is provided in Table 4.

In addition to the twenty-one early warning wells already designated, the possibility exists that an additional well nest may be added to the network in the east Bandmann Flats area based on data collected at existing wells during the RA. Hydraulic modeling performed by the Clark Fork Coalition (CFC) for the area immediately downstream of the Milltown Dam suggests that a preferential groundwater flow path trending east-west along the existing railroad through Bandmann Flats may exist. Early warning wells 923 and 920 (shown on Figure 7) are expected to give adequate monitoring coverage of this potential preferential flow path. However the position of this preferential flow path is based on model results and wells 923 and 920 may not fully cover the actual preferential flow path if it shifts to the southwest. To address this unlikely scenario the following contingency plan has been prepared.

Early warning wells 923 and 920 will be monitored for construction-related impacts according to the flowchart in Figure 8. If the arsenic statistical trigger level shown in Table C-1 for wells 923 A, B, and C or 920 is exceeded during RA sampling, and follow up sampling of the well confirms the exceedance, then an assessment of the possible causes will be undertaken. Based on that assessment and the possibility that wells 923 and 920 may not provide adequate coverage of the flow path, the EPA, in consultation with the State, may require the SDs to install one additional monitoring well nest at the approximate location in East Bandmann Flats shown on Figure 7. This location was selected to cover the preferential flow paths shown for both dam-in and dam-out simulations in the CFC model and to be within the bedrock trough shown for this area in the Remedial Investigation bedrock surface map.

If installed, the well will be drilled to bedrock and multiple screened intervals (appropriately isolated from each other) will be installed. Based on existing information it is anticipated that, if installed, the well will be approximately 150 feet deep with three 10-foot long screened intervals set at approximately 70, 105 and 140 feet below ground surface (see Figure 9 for approximate well completion design). However, some adjustments may need to be made to the Figure 9 design to reflect field observations.

In order to be able to respond to EPA's request quickly, the SDs will, upon approval of the final RAMP, begin negotiations with the appropriate landowner(s) for access to drill the well. The finalized access agreement(s) will be in place prior to Stage 1 drawdown. Additionally, a contract will be executed with a qualified water well driller that provides for rapid response to a request to install the well. The length of the contract will cover the period of the RA after which the need to install additional monitoring in the Bandmann Flats area will have passed. The driller will be required to either stock the necessary supplies (e.g. well screens) or ensure that supplies are readily available.

3.3.3 Public Health Monitoring Wells

Eleven existing supply wells (both private and small public systems) will also be monitored to provide information to ensure that residents are not exposed to levels of arsenic above the drinking water standard. These wells, which include GW (Greil West), GE (Greil East), Sunny Meadows, East View, Bonner School, Bonner Churches, DA-15, DA-10, Milltown Water Users Association (public water supply), C-2 (public water supply) and First Street (public water supply), will be sampled semi-annually by MCCHD (see Figure 7 for well locations).

3.3.4 Additional Groundwater Monitoring Programs

In addition to monitoring of compliance and some early warning wells on a set schedule by the SDs and other early warning wells and public health monitoring wells by the MCCHD, other monitoring programs that will be on-going during the RA include:

- A voluntary arsenic testing program run by MCCHD that provides free of charge arsenic testing for water samples brought in by local well water users.
- A Reservoir Drawdown/Private Well Impact Analysis to be conducted by EPA through MCCHD and the University of Montana which evaluates impacts to water levels and availability in private water supply wells around Milltown Reservoir that may be affected by reservoir drawdown associated with dam removal. If any of these wells are found to be made unusable by dam-removal-induced lowering of local groundwater levels then EPA will drill a replacement deeper well or connect the affected well user to an alternate water supply system.

3.3.5 Well Monitoring Frequency, Analytes and Triggers for Further Action

Figure 8 is the flow chart showing the well sampling frequency, the trigger for that frequency, the monitoring analyte list and the decision logic/trigger levels for further action to be considered based on monitoring results. Water samples from compliance and early warning wells will be collected and analyzed for dissolved arsenic, manganese and iron. Also, Eh, pH, temperature and conductivity will be measured in the field. Static water levels will be collected for the early warning monitoring wells monitored by the SDs while total arsenic concentrations will also be determined for the early warning domestic wells monitored by MCCHD. Public Health Monitoring well samples (to be collected by MCCHD) will only be analyzed for total and dissolved arsenic.

As mentioned in Sections 3.3.1 and 3.3.3 and as shown on Figure 8, compliance and Public Health Monitoring wells will be sampled semi-annually in June and December. Early warning wells will generally be sampled quarterly in March, June, September, and December with the potential, as detailed below, to increase to biweekly sampling depending on surface water arsenic concentrations and previous well sample arsenic concentrations.

<u>Surface Water above 8 µg/L Arsenic Warning Limit</u>

The sampling frequency of some of the early warning monitoring wells that are located near the CFR downstream of the reservoir is tied to the surface water quality measured at the CFR above Missoula station. Changes in surface water quality measure the impact of construction activities and provide advance notice that groundwater quality could also be affected by construction activities. If the dissolved arsenic at the CFR above Missoula station exceeds the warning level on Figure 4, then early warning wells 923A, 923B, 923C, 920, G, MW-5, MW-7, HGS, HGD, DH1, DH2 and MM2 would be sampled on a biweekly basis (once every two weeks) for dissolved arsenic while the other early warning wells listed in Section 3.3.2 would be sampled quarterly. Biweekly sampling of these “near river” early warning wells will continue for 2 months after the CFR above Missoula station arsenic concentration drops back below 8 µg/L. Note that in addition to triggering additional sampling of these wells, as discussed in Section 3.1.2.2, if arsenic is deemed to have been added to the CFR by RA activities, then surface water above 8 µg/L arsenic would also drive evaluations of BMPs or other controls to reduce river arsenic concentrations during construction as part of the river sampling regimes.

Well Concentrations above Statistically-determined Arsenic Trigger Level

If the dissolved arsenic level in any of the early warning wells exceeds its statistically-determined upper tolerance interval of historical concentrations trigger level (see Appendix C for a calculation determining the trigger levels for all the existing early warning wells) then the affected well, plus potentially other wells as designated by EPA, will be sampled biweekly. Biweekly monitoring of those early warning wells will continue for a minimum of two months without a value of dissolved arsenic at, or above, the statistical trigger level. At the end of the two month period the monitoring frequency of the well(s) will return to quarterly.

In addition to triggering increased monitoring, exceedance of statistically determined trigger levels, if confirmed by additional monitoring, will also trigger evaluation of BMPs or other controls during construction (specified in the Contingency Plan for Contamination of Drinking Water Supply or Early Warning Monitoring Wells [Envirocon, 2006b]) to manage dissolved arsenic in the CFR, reduce arsenic loading to groundwater and/or to otherwise prevent drinking water use of wells with elevated arsenic concentrations. This process of BMP evaluation will be undertaken to respond to changes in groundwater quality resulting from RA construction activities. The BMPs evaluation will also consider if the well arsenic concentration not only exceeded its trigger level but also exceeds 8 μg/L. If the dissolved arsenic concentration in the affected early warning well or wells do/does not exceed 8 μg/L then the BMPs evaluation may give greater consideration to possible schedule, cost and/or production rate impacts of implementing BMPs.

The early warning wells will be monitored until approval of Substantial Completion of the Grading Plan, as that process is defined in the Consent Decree.

Public Health Monitoring or Early Warning Domestic wells above 10 μg/L Arsenic Drinking Water Standard

As shown on Figure 8, if RAMP monitoring identifies dissolved arsenic concentrations above 10 μg/L in a public health or early warning domestic well that is currently used for drinking water, then the well owner will be notified and further action considered in accordance with Envirocon 2006b. This additional action could include providing a replacement water supply (for private and small public water systems) and/or evaluating BMP and other controls during construction (as specified in Envirocon 2006b). If arsenic concentrations between 5 and 10 μg/L are observed in these wells, EPA, MCCHD or the public water supply operator will contact the water user(s) and provide them with the information required under the Safe Drinking Water Act Consumer Confidence Reports.

3.4 Air Monitoring

Remedial actions involving the excavation and removal of contaminated sediments conducted on upper reaches of the CFR have had ambient and perimeter air monitoring conducted during the construction activities. Some of the remedial actions were being performed to remove more highly contaminated sediments than those present on the MRSOU site. The results of the monitoring indicated that airborne particulate metals concentration was within acceptable ranges at all times during the remedial action. Since the sediments at the MRSOU site have lower contaminant levels and the sediments are to be excavated while they are moist and dust control methods will be implemented, no perimeter or ambient air monitoring is required for the RA planned to take place at the MRSOU site. However, periodic personal monitoring of workers on the site will be performed as outlined in the approved Health and Safety Plan. If the personal monitoring indicates that airborne particulate metals contamination have reached a level of concern, air monitoring will be reevaluated, and, if necessary, dust control measures and perimeter and ambient air monitoring will be instituted. The need for ambient or perimeter air monitoring would also be re-evaluated if there are significant and persistent complaints from local residents that are not solved by operational controls within a reasonable period of time.

3.5 Data Management and Reporting Requirements

All data collected as part of RA monitoring will adhere to Atlantic Richfield data management and validation standard protocols (Clark Fork River Superfund Site Investigations, Data Management/Data Validation Plan Addendum, June 2000). Analytical results will be submitted to the EPA on a daily basis.

3.6 Health and Safety

A Health and Safety Plan (HSP) is being submitted as part of the Remedial Design Work Plan that details health and safety procedures for the RD and RA including RA monitoring. All monitoring activities will follow HSP requirements.

4 References

AERL, 2002, "Milltown Reservoir Sediments Site Final Combined Feasibility Study", Prepared by EMC^2, December.

AERL, 2001, "Milltown Reservoir Sediments Site Final Focused Feasibility Study", Prepared by EMC^2, April.

ARCO, 1996, "Milltown Reservoir Sediments Superfund Site, Final Interim Groundwater Monitoring Plan", October.

ARCO, 1996, "Milltown Reservoir Sediments Site Feasibility Study", Prepared by Titan Environmental Corp., October.

ARCO, 1995, "Milltown Reservoir Sediments Operable Unit Final Draft Remedial Investigation Report", Prepared by Titan Environmental Corp., February.

ARCO, 1992a, "Clark Fork River Superfund Site Investigations, Standard Operating Procedures", Compiled by Canonie Environmental Services, Inc., September.

ARCO, 1992b, "Clark Fork River Superfund Site Investigations, Quality Assurance Project Plan", Prepared by PTI Environmental Services, May.

ARCO, 1992c, "Clark Fork River Superfund Site Investigations, Laboratory Analysis Protocol", Prepared by PTI Environmental Services, April.

Atlantic Richfield Company, 2006, "Milltown Reservoir Operable Unit: December 2005 Groundwater Monitoring Event, Data Summary Report", Prepared by Land and Water Consulting, Inc., March.

Atlantic Richfield Company, 2002, "Clark Fork River Operable Unit: Draft Proposed Clark Fork River Basin-Wide Monitoring Plan", Prepared by EMC^2, November.

Envirocon, 2006a, "Contingency Plan for Exceedance of Downstream Surface Water Quality Standards/Warning Limits", April.

Envirocon, 2006b, "Contingency Plan for Contamination of Drinking Water Supply or Early Warning Monitoring Wells", April.

EPA, 2004a, "Milltown Reservoir Sediments Operable Unit Record of Decision", December.

EPA, 2004b, "Biological Assessment of the Milltown Reservoir Sediments Operable Unit Revised Proposed Plan and of the Surrender Application for the Milltown Hydroelectric Project (FERC No. 2543)", Prepared by CH2M Hill and the Clark Fork and Blackfoot L.L.C., August.

TABLES

Table 1 – Monitoring Responsibility Summary - Milltown Reservoir Sediments Operable Unit[1]

Item No.	Surface Water Monitoring	Satisfies	Responsibility
1	Turbidity monitoring of CFR at USGS Station No. 12340500	• **ROD**[2], p. 2-122 • **SOW**[3], p. 28 • **BO**[4] (RPM2 & TC7), p. ITS 4 & 5	SDs[5]
2	Sampling of TSS and dissolved and total recoverable As, Cd, Cu, Pb, Zn[6], and total nutrients.	• **ROD**, p. 2-122 • **SOW**, p. 28 and 29 • **BO**, (RPM2 & TC7), p. ITS 4 & 5	SDs[7]
3	Water quality immediately upstream of Thompson Falls reservoir	• **ROD**, p. 2-122 • **SOW**, p. 29 • **BO**, (RPM2 & TC7), p. ITS 4 & 5	EPA
4	Discharge and stage at Turah, Bonner and Deer Creek Bridge[8]	• **SOW**, p. 29. • **BO**, (RPM2 & TC7), p. ITS 4 & 5	SDs

[1] The Record of Decision requirements at p. 2-124 for post-RA construction surface water, groundwater, and aqueous biota monitoring will be addressed in subsequent monitoring plans.
[2] ROD = Record of Decision.
[3] SOW = Statement of Work.
[4] BO = Biological Opinion.
[5] SDs = Settling Defendants. See Section 3.1.2.1.
[6] This satisfies "real-time" monitoring of dissolved Cu required by BO, TC7, page ITS5. Includes the USGS monitoring conducted 8 times/year.
[7] See Section 3.1.2.2 and 3.1.2.3.
[8] Currently performed by USGS with funding from Atlantic Richfield. See Section 3.1.4. Not specifically required by ROD.

Table 1 – Monitoring Responsibility Summary - Milltown Reservoir Sediments Operable Unit

Item No.	Surface Water Monitoring (Continued)	Satisfies	Responsibility
5	Monitor river flow in bypass channel for bull trout passage	• **BO**, TC3, p. ITS 4	SDs
Item No.	**Ground Water Monitoring**	**Satisfies**	**Responsibility**
6	Groundwater	• **ROD**, p. 2-122–123 • **SOW**, p. 28	SDs and MCCHD[9]
Item No.	**Aqueous Biota Monitoring[10]**	**Satisfies**	**Responsibility**
7	Measurement of fish populations and additional monitoring of benthic macroinvertebrates metals body burden	• **ROD**, p. 2-122 • **SOW**, p. 29 • **BO**, TC7, p. ITS 5	EPA
8	Caged fish studies	• **ROD**, p. 2-122 • **SOW**, p. 29 • **BO**, TC7, TC7c, p. ITS 5	EPA
9	Annual benthic macroinvertebrate community monitoring	• **SOW**, p. 29 • **BO**, TC7, p. ITS 5	SDs[11]
10	Fisheries habitat monitoring including radio telemetry, mark and recapture	• **BO**, TC7d, p. ITS 5 • **SOW**, p. 29	EPA

[9] MCCHD = Missoula City-County Health Department. See Section 3.3.
[10] Items #7, #8, and #9 together satisfy the BO monitoring requirement of the impact of TSS, dissolved Cu and As on aquatic biota. Item #7 satisfies the ROD long term monitoring requirement of aquatic communities and evidence of sustainability.
[11] See Section 3.2.

Table 1 – Monitoring Responsibility Summary - Milltown Reservoir Sediments Operable Unit

Item No.	Terrestrial Biota Monitoring	Satisfies	Responsibility
11	Post-construction revegetation including woody vegetation survival and vegetation canopy cover– floodplain	• **ROD**, p. 2-123, 2-124	State
12	Post-construction revegetation – uplands, repositories, I-90 embankment (outside MDT[12] ROW) and SAA III-b	• **ROD**, p. 2-123, 2-124 • **SOW**, p. 29	SDs
Item No.	**Streambed, Streambank, Floodplain, and Upland Structural Monitoring**	**Satisfies**	**Responsibility**
13	General floodplain and streambank stability, channel complexity in accordance with DCRP	• **ROD**, p. 2-123, 2-124	State
14	Monitoring for erosional control – floodplain	• **ROD**, p. 2-124	State
15	Long term monitoring for erosional control – uplands, repositories, I-90 embankment (outside MDT ROW) and SAA III-b	• **ROD**, p. 2-124 • **SOW**, p. 29	SDs
16	Sampling of streambed sediment metals and arsenic concentrations[13]	• **NA**	SDs
Item No.	**Milltown Project[14] Monitoring**	**Satisfies**	**Responsibility**
17	Continue existing Milltown Project monitoring and inspection programs	• **CD**[15], p. 43-46	NorthWestern

[12] MDT = Montana Department of Transportation
[13] Currently performed by USGS with funding from Atlantic Richfield. Not specifically required by ROD
[14] As defined in the Consent Decree.
[15] CD = Consent Decree

Table 2
Temporary Construction-related Surface Water Quality Standards
Milltown Reservoir Sediments Operable Unit

Analyte	Construction Standard [1] (μg/L)	Warning Limit [2] (μg/L)	Duration
Cadmium - Acute AWQC [3]	2	1.6	short - term (1 hour)
Copper - 80% of the TRV [4] (dissolved, at hardness of 100 mg/L)	25	20	short - term (1 hour)
Zinc - Acute AWQC (dissolved)	117	94	short - term (1 hour)
Lead - Acute AWQC (dissolved)	65	52	short - term (1 hour)
DWS[5] (dissolved)	15	NA[6]	long - term (30-day average)
Arsenic - AWQC (dissolved)	340	NA	short - term (1 hour)
DWS (dissolved)	10	8	long - term (30-day average)
Iron - AWQC (dissolved)	1000	800	short - term (1 hour)
Total Suspended Solids (mg/L)	550	440	short - term (1 hour)
	170	NA	mid - term (week)
	86	NA	long - term (season)
Turbidity (NTU [7])	NA	12	short-term (1 hour)

NOTES:
1. Reference EPA, August 2004
2. Values based on 80% of Construction Standard
3. AWQC = Federal Ambient Water Quality Criteria, values assume a hardness of 100 mg/L
4. TRV = Toxicity Reference Value, used in Proposed Plan for the Clark Fork River Operable Unit
5. DWS = Federal Drinking Water Standard
6. NA = Not Applicable
7. NTU = Nephelometric Turbidity Units

Table 3
Current Groundwater Monitoring Locations
Milltown Reservoir Sediments Operable Unit

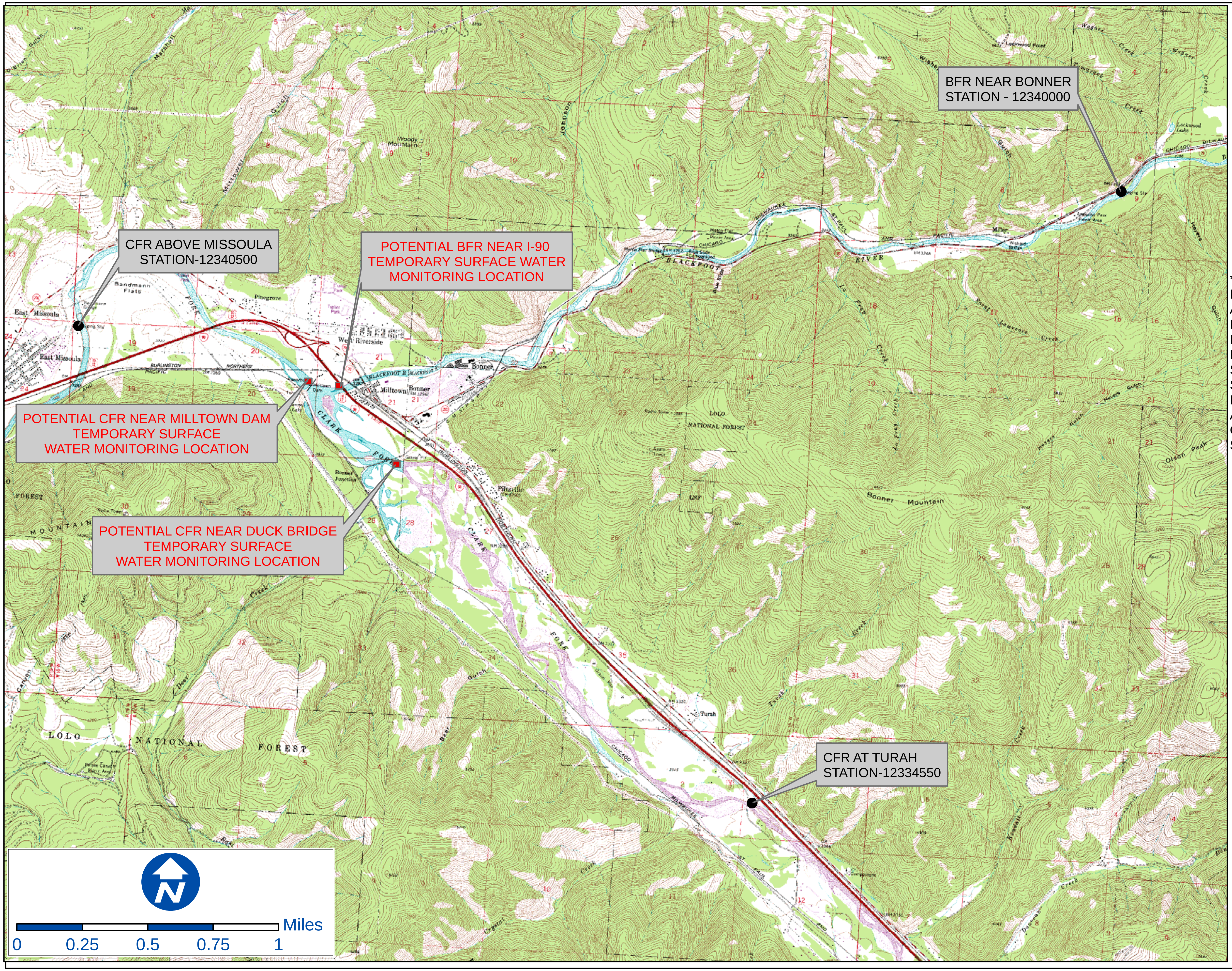
Monitoring Wells		Domestic Wells
11		BS
905		C21
907		C8
915		DA-010
920		DA-014
103A		DA-015
103B		DA-020
104A		DA-021
105A		DA-029
105B		DA-41
105C		DA-42
107A		DB-001
107C		DB-007
108A		DB-035
108B		DB-039
110A		GC
110B		GE
111A		GW
111B		HG-27
916A		SP
916B		
917A		
917B		
919A		
919B		
919C		
921A		
921B		
922A		
922B		
922C		
922D		
923A		
923B		
923C		
99A		
99B		
99C		
G		
HLA2		
J		
MW-7		

Table 4
Compliance and Early Warning Well Historical Data Summary
Milltown Reservoir Sediments Operable Unit

Monitoring Type	Well ID[1]	Min. Arsenic Concentration (mg/L)	Max. Arsenic Concentration (mg/L)	Ave. Arsenic Concentration (mg/L)	Date of First Sample	Date of Last Sample	Total # of Samples	Well Type
Compliance Well	103B	0.0750	0.230	0.105	12/14/1995	12/5/2005	21	Monitoring
	105C	0.0030	0.035	0.011	12/13/1996	12/1/2005	19	Monitoring
	107C	0.0845	1.390	0.695	12/14/1995	12/6/2005	21	Monitoring
	11	0.0099	0.034	0.025	12/15/1995	12/1/2005	19	Monitoring
	110B	0.0100	0.018	0.014	1/8/1997	12/5/2005	19	Monitoring
	905	0.0908	0.330	0.229	12/7/2001	12/1/2005	9	Monitoring
	907	0.0005	0.004	0.002	12/12/1995	6/7/2005	20	Monitoring
	917B	0.005	0.280	0.116	12/12/1995	12/6/2005	21	Monitoring
	922D	0.009	0.024	0.014	12/15/1995	12/2/2005	21	Monitoring
	HLA2	0.011	0.142	0.077	12/18/1995	12/5/2005	21	Monitoring
Early Warning Well	916A	0.0005	0.005	0.002	6/30/1997	11/30/2005	18	Monitoring
	919A	0.0005	0.004	0.003	1/17/1997	11/30/2005	19	Monitoring
	920	0.0005	0.004	0.001	12/13/1995	11/28/2005	21	Monitoring
	923A	0.0005	0.009	0.005	12/13/1995	12/1/2005	21	Monitoring
	923B	0.0005	0.008	0.006	12/13/1995	12/1/2005	21	Monitoring
	923C	0.003	0.011	0.008	12/19/1995	12/1/2005	21	Monitoring
	C8	0.001	0.003	0.002	6/22/2001	12/6/2005	10	Domestic
	C21	0.001	0.002	0.001	6/22/2001	12/6/2005	10	Domestic
	DB001	0.002	0.004	0.003	6/20/2001	12/6/2005	8	Domestic
	DB007	0.0007	0.003	0.001	1/5/2001	12/6/2005	11	Domestic
	DB035	0.001	0.003	0.002	1/6/2001	12/6/2005	9	Domestic
	DB039	0.002	0.005	0.004	1/3/2001	12/6/2005	11	Domestic
	DH1[2]	0.0006	0.0034	0.0024	10/17/2004	6/16/2005	10	Monitoring
	DH2[2]	0.0013	0.0020	0.0017	10/17/2004	6/16/2005	11	Monitoring
	NRW[3]	NA	NA	NA	NA	NA	NA	NA
	G	0.0005	0.015	0.005	12/11/1996	11/28/2005	19	Monitoring
	HGD[2]	0.0004	0.0021	0.0013	5/8/2004	6/16/2005	17	Monitoring
	HGS[2]	0.0010	0.0022	0.0018	5/5/2004	6/16/2005	32	Monitoring
	MM2[2]	0.0010	0.0031	0.0023	5/14/2004	6/16/2005	27	Monitoring
	MW5[4]	0.0009	0.002	0.001	6/27/1995	5/11/2005	23	Monitoring
	MW7	0.0030	0.008	0.004	12/11/1995	11/30/2005	21	Monitoring

NOTES:
1. Unless otherwise noted sampling data obtained from Land & Water Consulting on March 7, 2006.
2. Data obtained from MT CookThesis_Appendix.pdf on May 10, 2006.
3. NRW - New Replacement Well to be installed in Milltown by EPA. No arsenic data available since it is a proposed well.
4. Sampling data obtained from Missoula City-County Health Department Water Quality District.

FIGURES



LEGEND

● USGS SURFACE WATER MONITORING STATION

■ POTENTIAL TEMPORARY ADDITIONAL SURFACE WATER MONITORING LOCATION*

NOTES

* IF AVAILABLE, SAMPLE RESULTS FROM POTENTIAL TEMPORARY ADDITIONAL MONITORING LOCATIONS MAY BE OBTAINED FROM THE ENTITY RESPONSIBLE FOR SAMPLING AND USED TO SUPPLEMENT USGS MONITORING STATION RESULTS WHEN EVALUATING WHETHER RA ACTIVITIES ARE ADDING CONTAMINANTS TO DOWNSTREAM SURFACE WATER.

ENVIROCON
101 INTERNATIONAL WAY
MISSOULA, MONTANA 59808

REMEDIAL ACTION SURAFACE WATER QUALITY MONITORING LOCATINS
MILLTOWN RESERVOIR SEDIMENTS SITE

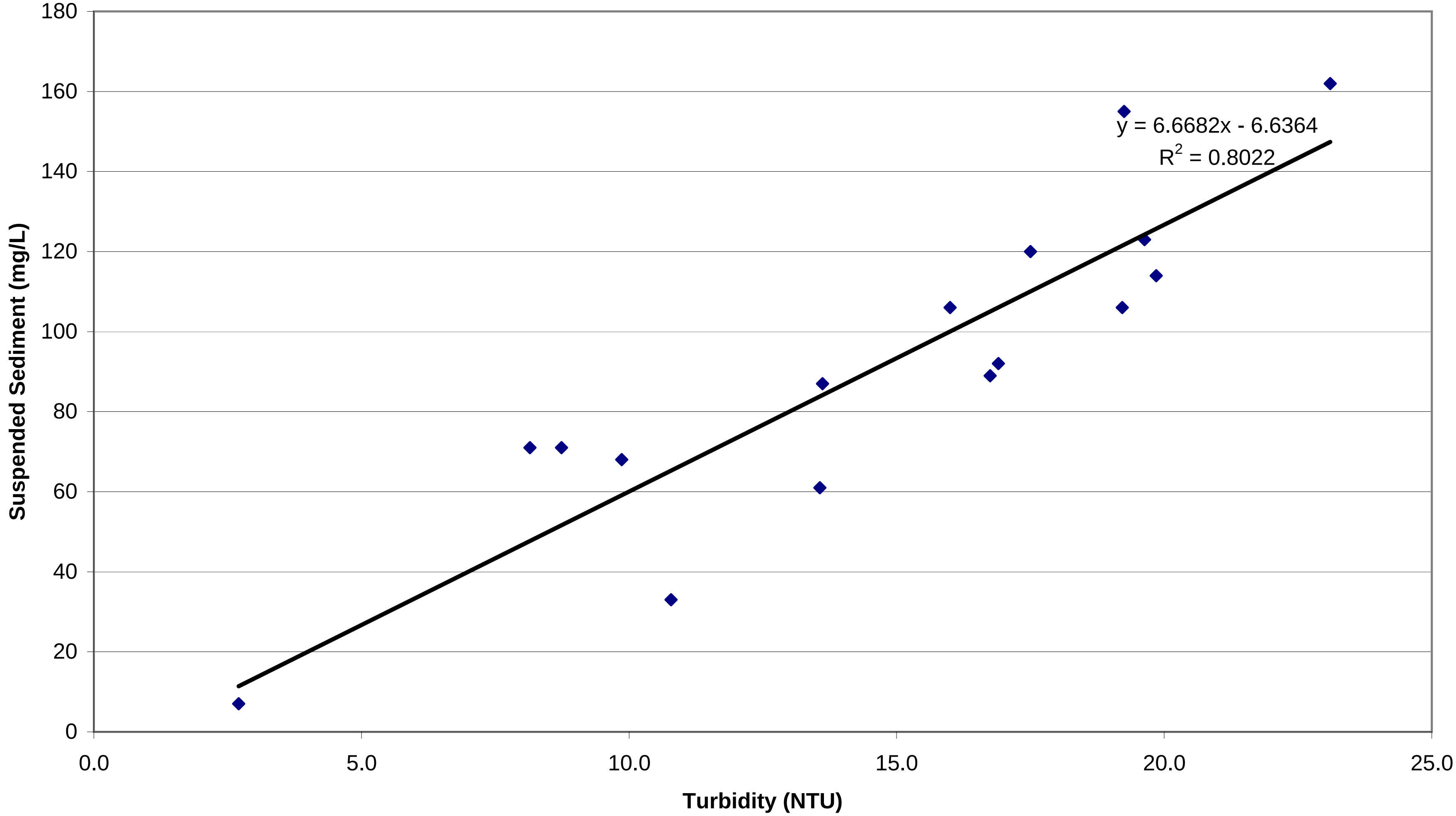
FIGURE 1

ISSUED FOR: REMEDIAL ACTION MONITORING PLAN MILLTOWN RESERVOIR SEDIMENTS OPERABLE UNIT

REVISION 2

Drawn: ZTC
Checked: DGB
Approved: DGB
Date: 5-11-06
Dwg. No. BG1089-B299

Figure 2
Regression Relationship Between Turbidity and Suspended Sediment
EPA Supplemental Data Summary Report, August 2002 Drawdown Event



I:\Projects\Milltown RD-RA\T13 Statement of Work\T13D RA Monitoring Plan\Jun 7 2005 Envirocon Submittal\Figures\Figure 2.xls-Chart1

Figure 3. River Turbidity Sampling

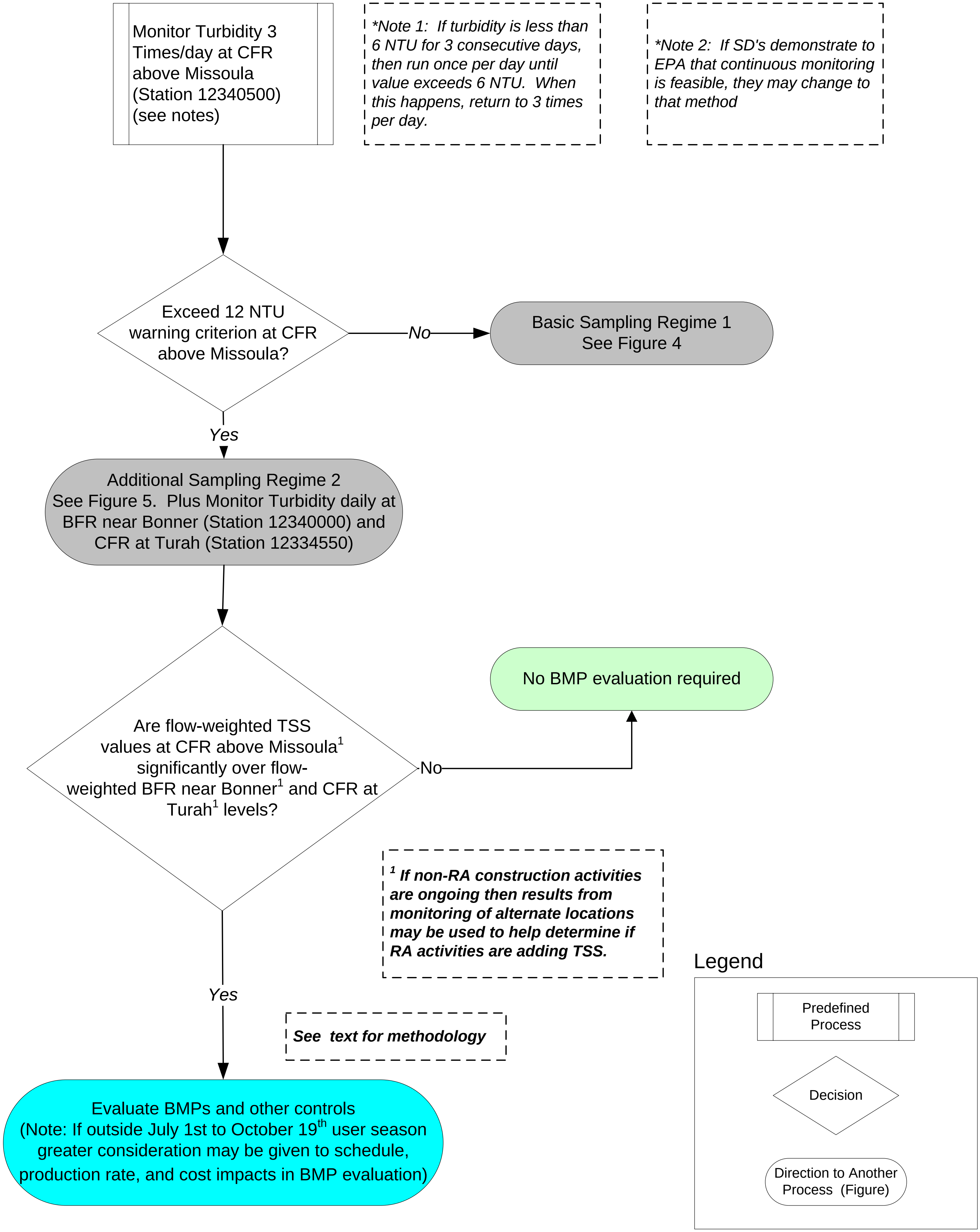


Figure 4. River Sampling Regime 1

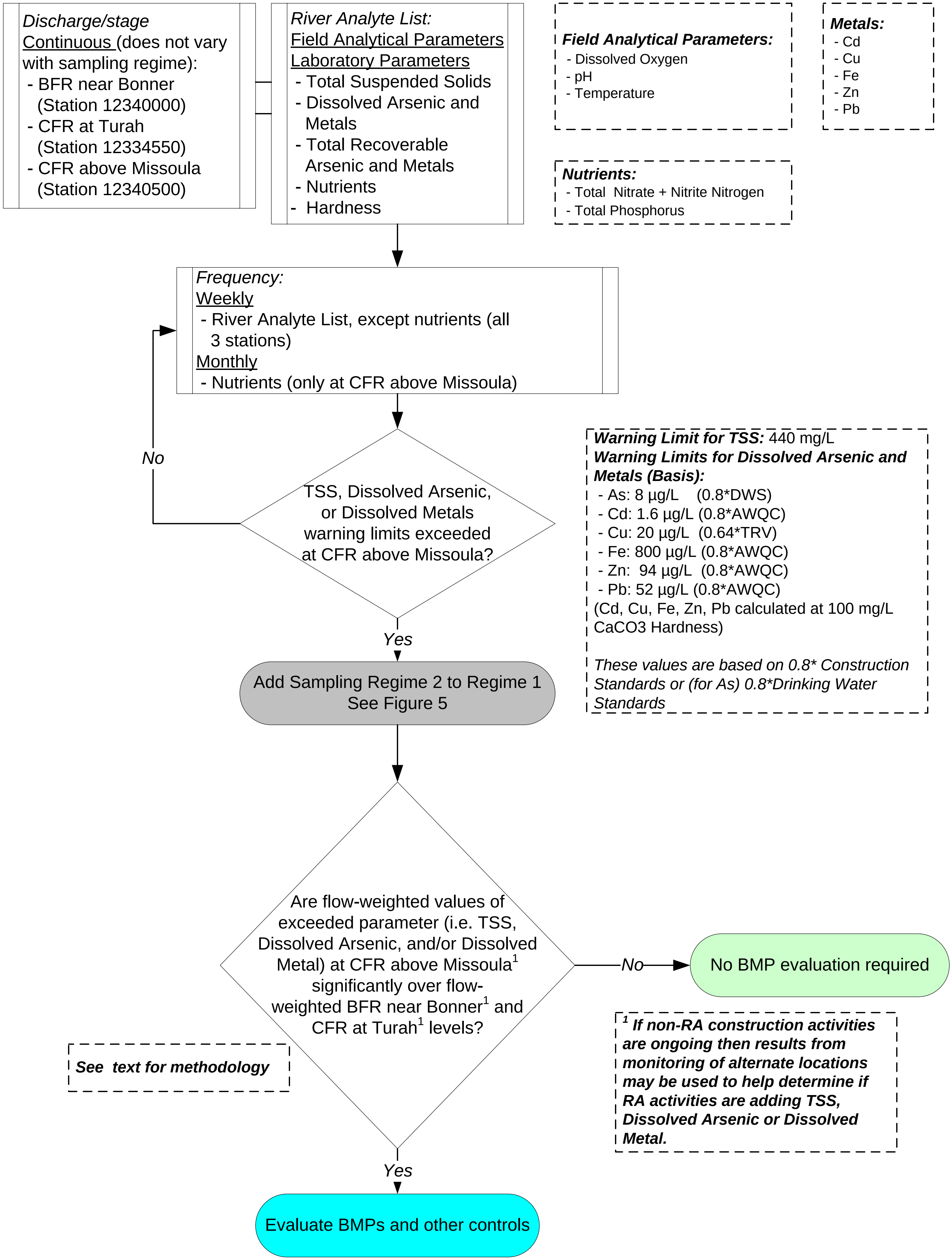
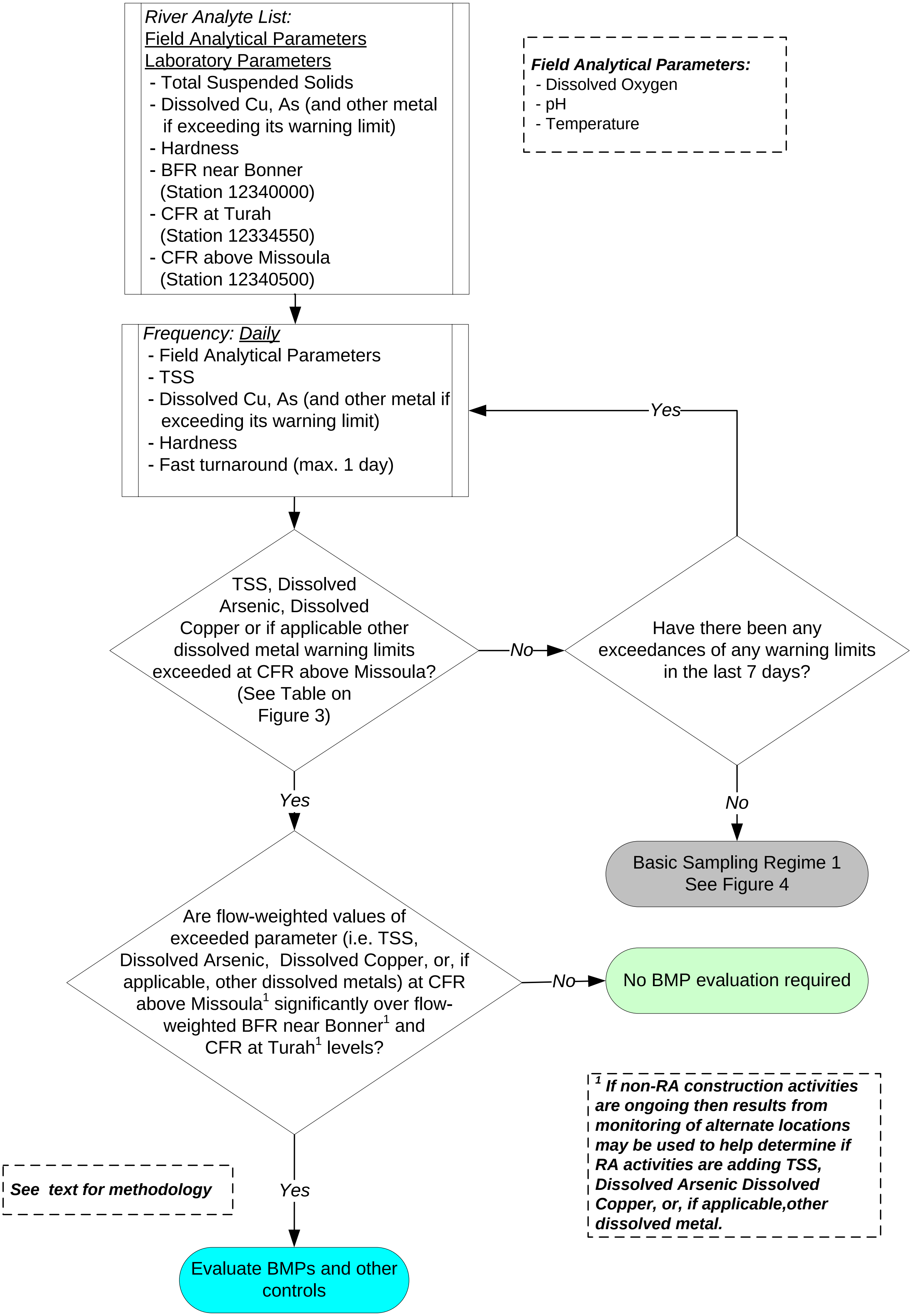
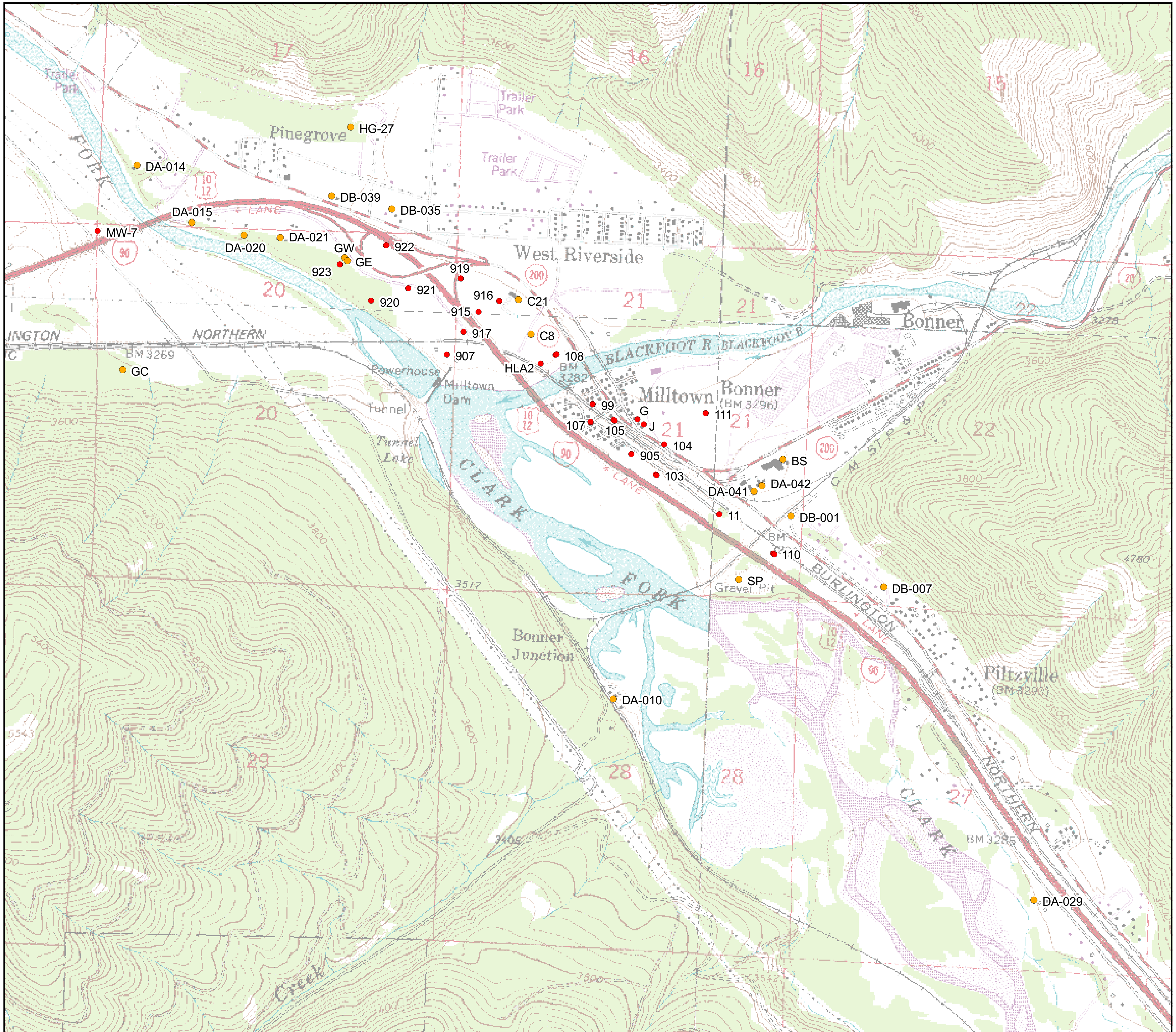


Figure 5. River Sampling Regime 2





LEGEND

- MONITORING WELL
- DOMESTIC WELL

DRAFT

0 750 1,500 3,000 Feet

ENVIROCON
101 INTERNATIONAL WAY
MISSOULA, MONTANA 59808

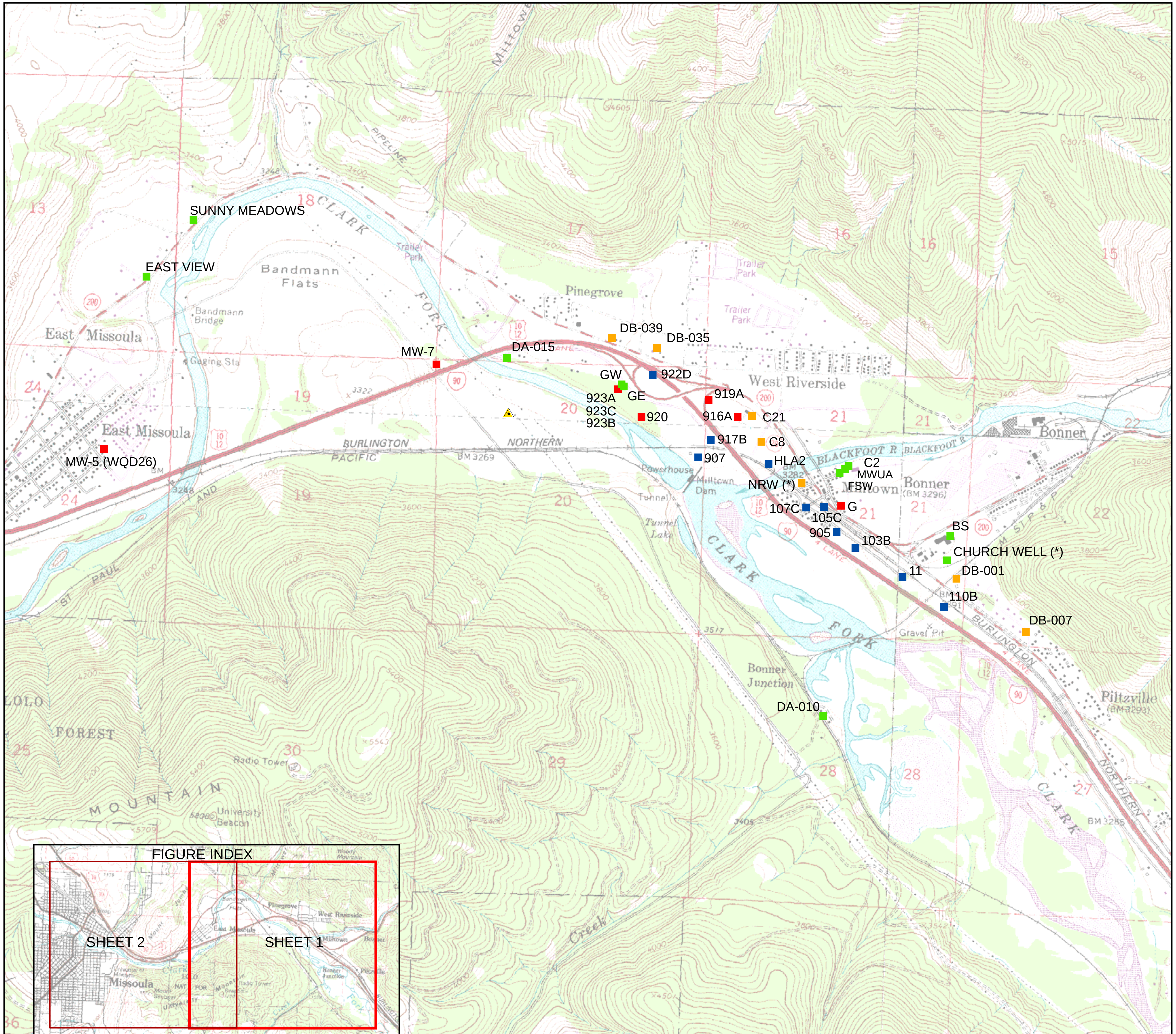
PRE-REMEDIAL ACTION GROUNDWATER MONITORING LOCATIONS
MILLTOWN RESERVOIR SITE

FIGURE 6

REVISION 2

ISSUED FOR: REMEDIAL ACTION MONITORING PLAN, MILLTOWN RESERVOIR SEDIMENTS OPERABLE UNIT

Drawn: CDK
Checked: DGB
Approved: DGB
Date: 6-6-05
Dwg. No: BG1089-B195



LEGEND

- EARLY WARNING DOMESTIC WELL TO BE SAMPLED QUARTERLY BY MISSOULA COUNTY (FOR WELL ANALYTE LIST, EXCEPT STATIC WATER LEVELS, PLUS TOTAL ARSENIC)
- EARLY WARNING MONITORING WELL TO BE SAMPLED QUARTERLY BY SDs (FOR WELL ANALYTE LIST) AND POSSIBLY BIWEEKLY (FOR DISSOLVED ARSENIC) IF CFR SURFACE WATER SAMPLES EQUAL OR EXCEED 8 µg/L ARSENIC
- COMPLIANCE WELL TO BE SAMPLED SEMI-ANNUALLY BY SDs (FOR WELL ANALYTE LIST)
- PUBLIC HEALTH MONITORING WELL TO BE SAMPLED SEMI-ANNUALLY BY MISSOULA COUNTY (FOR TOTAL AND DISSOLVED ARSENIC)
- POSSIBLE ADDITIONAL EARLY WARNING WELL TO BE INSTALLED AND SAMPLED QUARTERLY BY SDs IN EAST BANDMANN FLATS AREA IF SIGNIFICANT INCREASES ARE OBSERVED IN UPGRADIENT WELLS' ARSENIC CONCENTRATIONS

NOTES

* APPROXIMATE LOCATION

SDs - Settling Defendants

NRW - New Replacement Well to be installed by EPA in Milltown

MWUA - Milltown Water Users Assn.

FSW - First Street Well

BS - Bonner School

DRAFT

0 1,000 2,000 4,000 Feet

1:24,000

ENVIROCON
101 INTERNATIONAL WAY
MISSOULA, MONTANA 59808

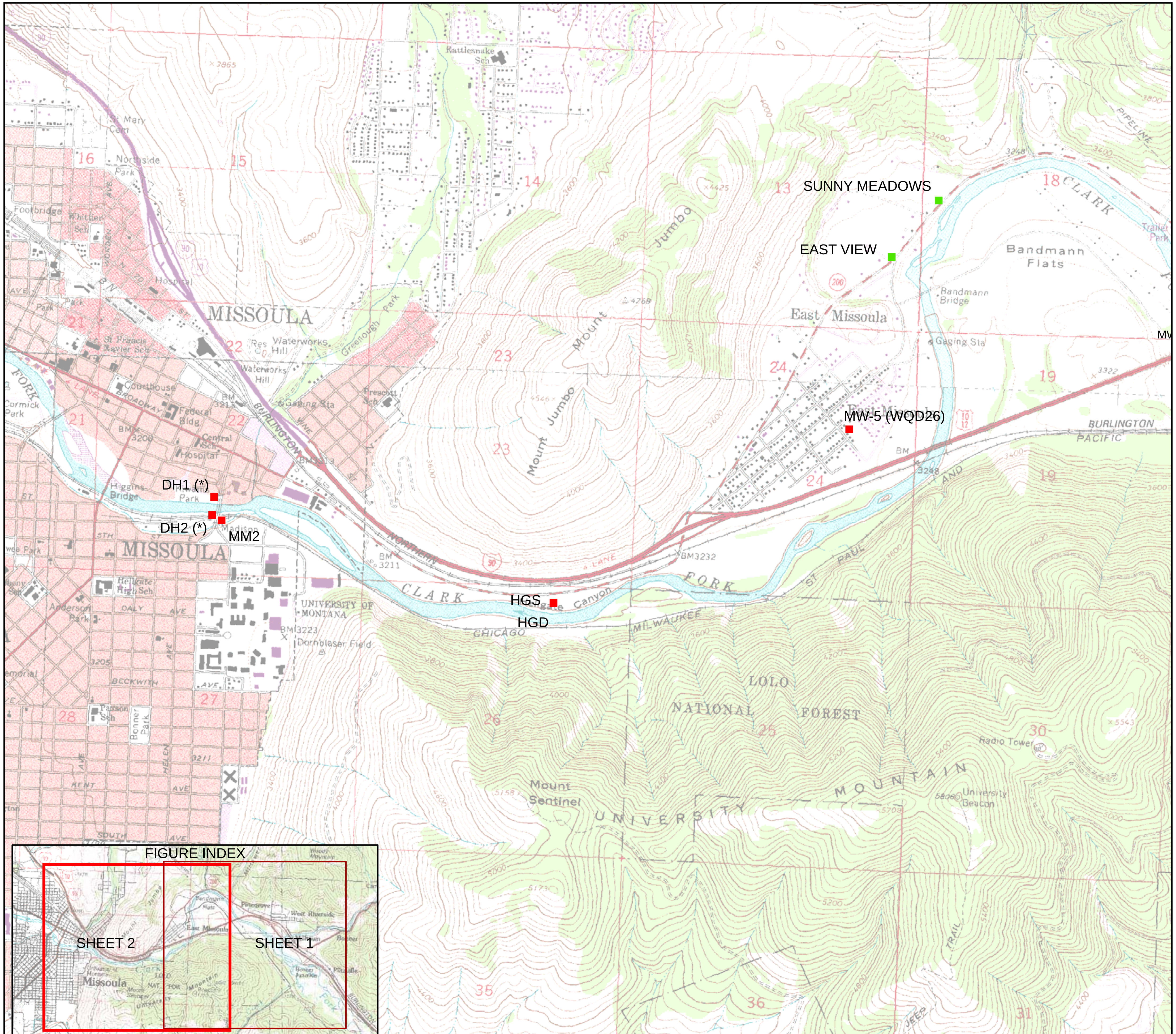
REMEDIAL ACTION GROUNDWATER MONITORING LOCATIONS
MILLTOWN RESERVOIR SITE

FIGURE 7
SHEET 1 OF 2

REVISION 5

ISSUED FOR: REMEDIAL ACTION MONITORING PLAN, MILLTOWN RESERVOIR SEDIMENTS OPERABLE UNIT

Drawn: ZTC
Checked: TW
Approved: DGB
Date: 5-11-06
Dwg. No: BG1089-B287



LEGEND

EARLY WARNING DOMESTIC WELL TO BE SAMPLED QUARTERLY BY MISSOULA COUNTY (FOR WELL ANALYTE LIST, EXCEPT STATIC WATER LEVELS, PLUS TOTAL ARSENIC)

EARLY WARNING MONITORING WELL TO BE SAMPLED QUARTERLY BY SDs (FOR WELL ANALYTE LIST) AND POSSIBLY BIWEEKLY (FOR DISSOLVED ARSENIC) IF CFR SURFACE WATER SAMPLES EQUAL OR EXCEED 8 µg/L ARSENIC

COMPLIANCE WELL TO BE SAMPLED SEMI-ANNUALLY BY SDs (FOR WELL ANALYTE LIST)

PUBLIC HEALTH MONITORING WELL TO BE SAMPLED SEMI-ANNUALLY BY MISSOULA COUNTY (FOR TOTAL AND DISSOLVED ARSENIC)

POSSIBLE ADDITIONAL EARLY WARNING WELL TO BE INSTALLED AND SAMPLED QUARTERLY BY SDs IN EAST BANDMANN FLATS AREA IF SIGNIFICANT INCREASES ARE OBSERVED IN UPGRADENT WELLS' ARSENIC CONCENTRATIONS

NOTES

* APPROXIMATE LOCATION

SDs - Settling Defendants

NRW - New Replacement Well to be installed by EPA in Milltown

MWUA - Milltown Water Users Assn.

FSW - First Street Well

BS- Bonner School

DRAFT

0 1,000 2,000 4,000 Feet

1:24,000

ENVIROCON

101 INTERNATIONAL WAY
MISSOULA, MONTANA 59808

REMEDIAL ACTION GROUNDWATER MONITORING LOCATIONS
MILLTOWN RESERVOIR SITE

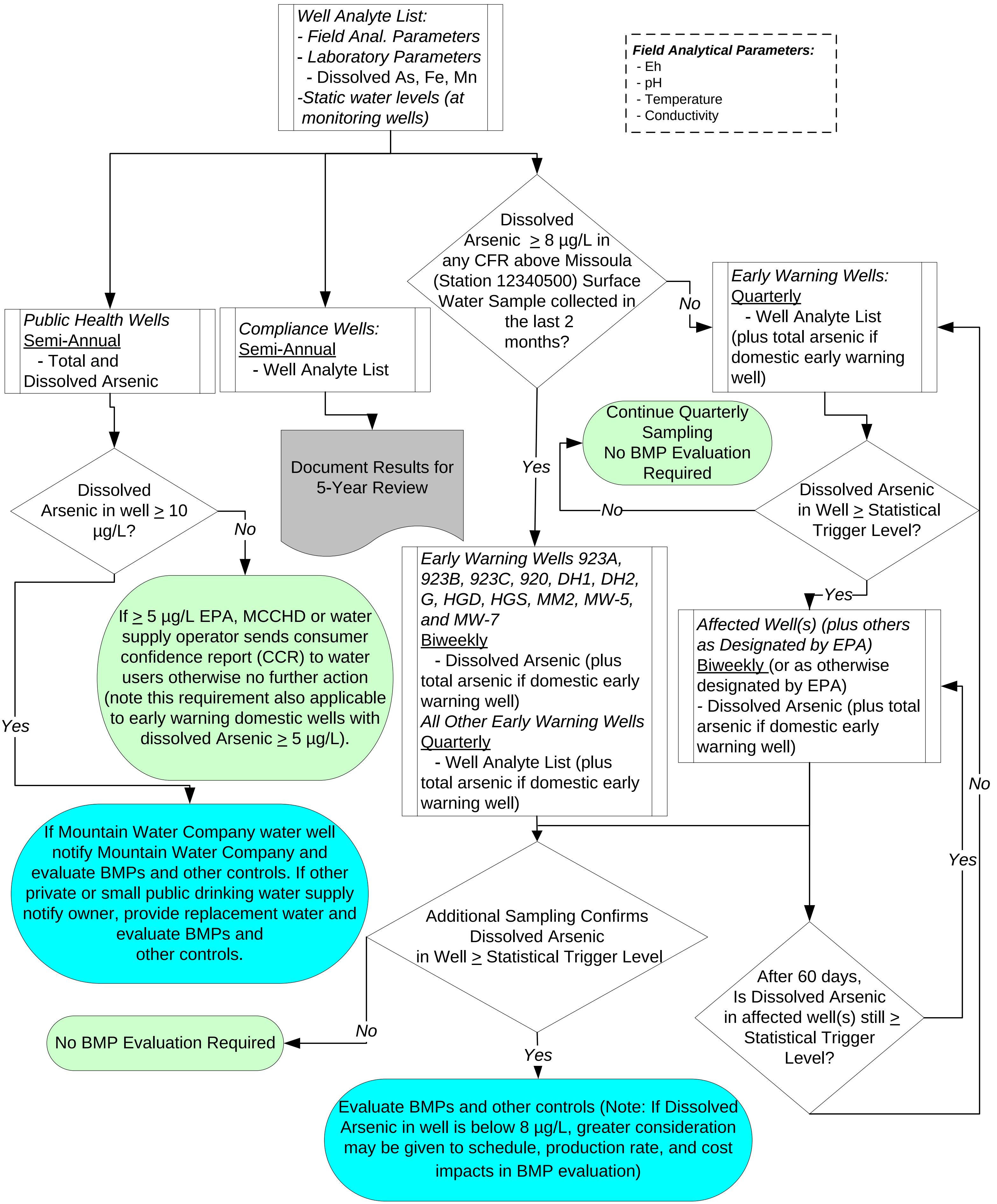
FIGURE 7
SHEET 2 OF 2

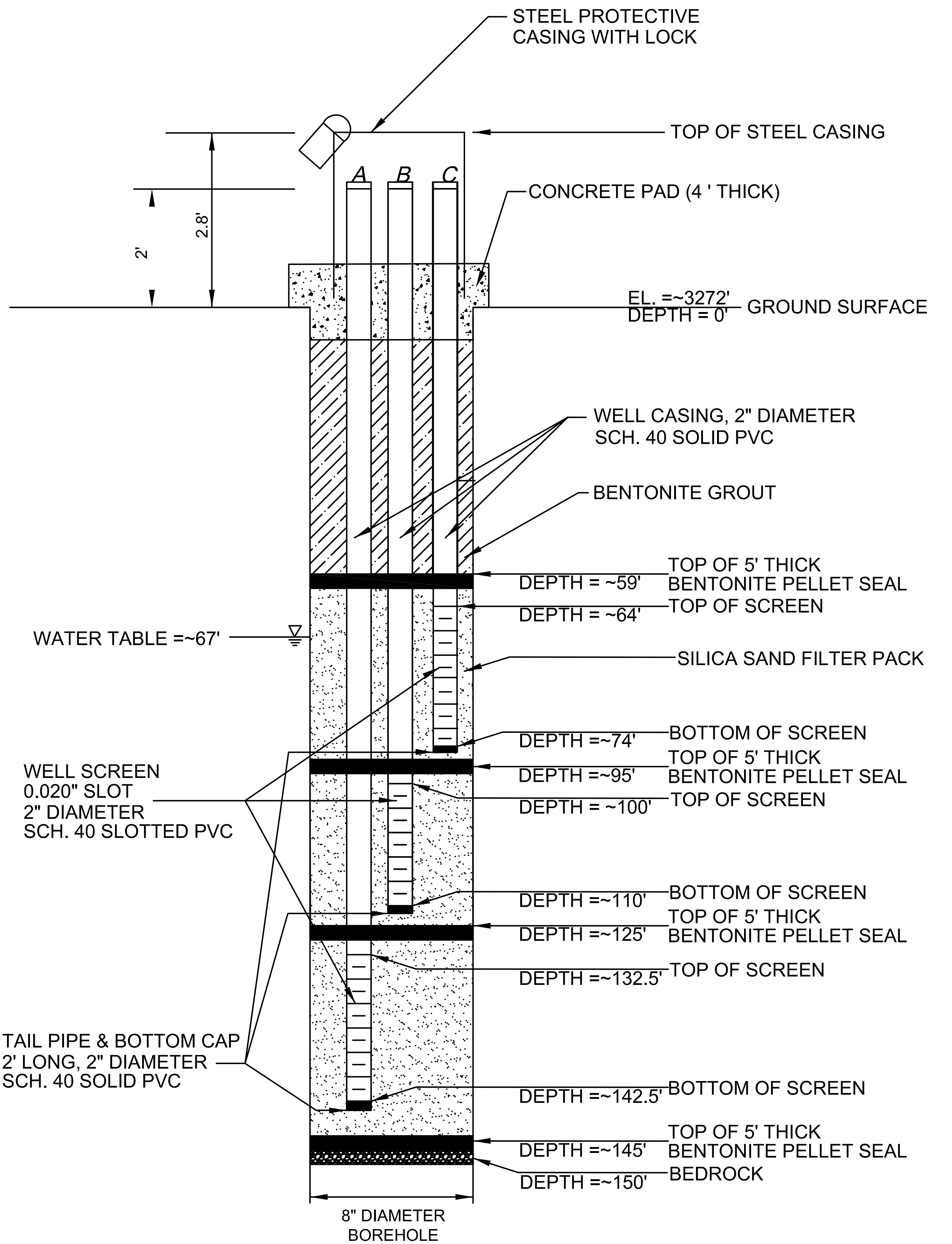
REVISION 5

ISSUED FOR: REMEDIAL ACTION MONITORING PLAN, MILLTOWN RESERVOIR SEDIMENTS OPERABLE UNIT

Drawn: ZTC
Checked: TW
Approved: DGB
Date: 5-11-06
Dwg. No: BG1089-B286

Figure 8. Well Sampling





NOTES:

1. THIS DRAWING IS NOT TO SCALE.
2. BOREHOLE DATA IS APPROXIMATE.
3. COMPLETION DESIGN SHOWN MAY BE MODIFIED BASED ON FIELD OBSERVATIONS.

ENVIROCON
101 INTERNATIONAL WAY
MISSOULA, MONTANA 59808

POSSIBLE ADDITIONAL BANDMANN FLATS
WELL NEST COMPLETION DETAIL
MILLTOWN RESERVOIR SEDIMENTS SITE

FIGURE 9

Revision: REV 2

ISSUED FOR:
REMEDIAL ACTION MONITORING PLAN
MILLTOWN RESERVOIR SEDIMENTS OPERABLE UNIT

Drawn:	ZTC
Checked:	DGB
Approved:	DGB
Date:	5-18-06
Dwg. No.	BC1089-A300

APPENDIX A

Remedial Action Monitoring Sampling and Analysis Procedures

Draft

REMEDIAL ACTION MONITORING SAMPLING AND ANALYSIS PROCEDURES

Milltown Reservoir Sediments Site

Prepared by:

ENVIROCON

May 18, 2006

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1.0 Introduction

This appendix identifies the procedures to be used for the surface and ground water sampling and analysis to be performed by the Settling Defendants (SDs) during the Milltown Reservoir Sediments Operable Unit (MRSOU) remedial action. Procedures for groundwater sampling to be done by Missoula City/County Health Department, if different from those described for SDs sampling, will be added to this plan when they are obtained. Procedures for ongoing annual benthic macroinvertebrate community monitoring funded by the SDs but overseen by Montana Department of Environmental Quality (MDEQ) are described elsewhere in applicable MDEQ reports. Similarly, procedures for the MRSOU-related sampling that the U.S. Environmental Protection Agency (EPA), U.S. Geological Survey (USGS) or the State of Montana are responsible for (see Table 1 of the RAMP for a listing) are, or will be, described in other reports.

Generally, the SDs surface water sampling will follow the procedures outlined in the: Clark Fork River Superfund Site Investigations (CFRSSI) Standard Operating Procedures (SOP) (ARCO, 1992a), Quality Assurance Project Plan (QAPP) (ARCO, 1992b) and Laboratory Analysis Protocol (LAP) (ARCO 1992c). The procedures outlined in these documents have already been approved for use on all CFR basin superfund sites by the EPA and MDEQ and are provided by reference for completeness. Some of the standard laboratory analysis methodologies and their associated QA requirements specified in the LAP and QAPP have been updated since the early 1990s when these documents were developed. For updated methodologies and associated QA requirements this appendix references the Data Quality Objectives Process Steps (DQOPS) developed for the MRSOU RA by the U.S. Army Corp of Engineers and provided to the SDs as Attachment 1 to EPA's comments on the DRAMP. Where neither the CFRSSI nor the DQOPS documents cover a required procedure, or where an alternate method is proposed for MRSOU RA surface water monitoring, the required procedures are detailed in Section 3.0 of this appendix.

For consistency with other local sampling, groundwater sampling procedures will generally follow the Missoula Valley Water Quality District's (MVWQD) Standard Operating Procedures, Groundwater Sampling (MVWQD, 1995). Where the MVWQD document does not cover a required procedure or where an alternate method is proposed for MRSOU RA groundwater monitoring, the required procedures are detailed in Section 4.0 of this appendix.

2.0 General Requirements

Field information collected during surface and groundwater sampling will be recorded in various forms, including bound logbooks, sample tags, chain-of-custody records and field sample data sheets. Document control in accordance with SOPs G-3 and G-4 will be followed to ensure that all documents related to sampling are trackable and accounted for when the project is completed. Identification of samples will follow a uniform standard consistent with the requirements detailed in SOP G-11. Sample packaging, shipping and custody procedures will follow SOPs G-5 and G-7.

3.0 Surface Water Sampling

The RAMP requires weekly surface water quality sampling at three United States Geological Survey (USGS) stations (CFR at Turah, BFR near Bonner and CFR above Missoula; see Figure 1 of the RAMP for station locations) with the potential for increasing to daily sampling if the downstream station sample exceeds warning limit concentrations or levels. Stations will be sampled in order from cleanest to most contaminated (generally the BFR station first followed by the CFR at Turah and then the CFR above Missoula). The RAMP also requires 3 times a day sampling for turbidity at the downstream CFR above Missoula station with the potential to reduce frequency to daily if 3 consecutive days of monitoring shows turbidity to be less than 6 NTU (i.e., half the warning limit) at the downstream station.

The warning limits (for total suspended solids [TSS], metals and arsenic) or criterion (for turbidity) that determine whether weekly or daily surface water sampling is required are defined in Figures 3, 4 and 5 of the RAMP. However, the timing for revising surface water quality sampling frequency based on an observed exceedance of these limits or criterion differs depending on whether: (1) the change is driven by exceeding the downstream turbidity criterion (in which case daily sampling with 1 day turnaround of results would be initiated the same day); or (2) the TSS, metals or arsenic warning limits are exceeded (in which case daily sampling with 1 day turnaround of results would be initiated the day laboratory results are received).

Surface water sampling and field measurement procedures will follow the general sampling (including field quality control and equipment decontamination) and measurement procedures identified in SOPs G-6, G-8 and HG-1 through HG-10 and field sampling of streams procedures identified in SOPs SW-1 through SW-8 with the following exceptions:

1. Channel-width-integrated composite sampling procedures described in SOP SW-1 will not be used because of the health and safety concerns associated with repeatedly attempting to access the entire channel width by wading and the USGS's stated inability to allow private entities use of their cable ways to replace the need for wading. Instead, a grab sample will be collected at each station from a single point located as far out from the bank as can be safely accessed by wading. Consistent with SOP SW-1 (but inconsistent with current USGS depth integrating sampling procedures) the sample will be collected from the midpoint of depth between the stream bed and the water surface. The sampled location's distance from the bank and depth of water will be noted in the field log book. In order to evaluate the potential effect of this sampling procedure modification on data quality it is proposed to coordinate RA sampling dates, to the degree practicable, with USGS's long-term monitoring schedule to allow comparison between results collected on the same day.

2. Discharge and stage at each of the sampling stations is already being automatically monitored every 15 minutes by USGS and is available on a real time basis. Therefore, rather than following CFRSSI SOPs SW-6 through SW-8 for collecting stage and discharge data at each station during each surface water monitoring event, USGS discharge and stage measurements from the time interval nearest to when the sample is collected will be downloaded from the USGS website at: http://waterdata.usgs.gov/mt/nwis.

3. For the purposes of determining field QC sampling requirements the weekly or daily water quality sampling that will be ongoing during the RA will be considered one extended sampling event. Therefore, the requirement identified in SOP G-6 to collect field QC samples for every event or for every 20 samples, whichever is greater will be met by obtaining one complete set of field QC samples for every 20 natural surface water samples. Field QC samples will include a cross-contamination blank (to help identify possible contamination from the sampling environment or equipment such as collection container or filter apparatus; consistent with USGS standard protocols, detectable concentrations in these blanks equal to or greater than twice the laboratory reporting levels will be noted) and a field replicate. Consistent with the requirements of Table 5-7 of the QAPP, the data quality objective used to evaluate precision of results for field replicates will be a relative percent difference (RPD) of 20%. Trip blanks, reference material and laboratory split field QC samples will not be collected.

4. Selection and preparation of sample containers, preservation and handling of aqueous samples, and instrumentation and procedures for the field measurement of dissolved oxygen, pH, temperature, and turbidity will be in accordance with SOPs HG-3 through HG-10 except:

    a. Turbidity – A LaMotte model 2020 turbidity meter will be used in place of the Hach Model 168000 PortaLab Turbidimeter referenced in SOP HG-10 (Note: The SDs reserve the option to utilize an alternate instrument provided it meets the detection and reporting limits described below. In addition, the SDs reserve the option to switch to a continuous turbidity monitoring system at a future time if continuous monitoring can be demonstrated to be feasible. In this case specific procedures for continuous turbidity monitoring will be provided as an Addendum to this Appendix).

       Consistent with the requirements identified in the DQOPS the instrument detection limit shall not exceed 2 NTU with a reporting limit not exceeding 5 NTU for range of 0-15 NTU. In addition, calibration of the turbidity field instrument from 1 - 40 NTU will be done on a weekly basis and at 1, 10 and 40 NTU levels every 2 days (instead of one calibration standard range cell run at every use as identified in HG-10) with an additional sample collected and the average used to determine whether the river is above or below 12 NTU when the initial sample results is between

10 and 15. Measurement and instrument decontamination procedures will be as described in SOPs HG-10 and G-8, respectively.

b. Temperature and pH – A YSI model 3500 will be used in place of the ORION SA-210 and YSI model 33 S-C-T instruments specified in SOPs HG-7 and HG-8 to measure temperature and pH, respectively. (Note: the SDs reserve the option to utilize an alternate instrument provided it meets the accuracy requirements described below). The instrument's temperature measurement will be accurate to within 1 degree C confirmed by an annual check against a National Institute of Standards and Technology-certified field laboratory thermometer. The instrument's pH measurements will be accurate to 0.1 SU confirmed by daily checks against certified standards. Instrument calibration requirements will follow manufacturer's recommendations while measurement and decontamination procedures will be as described in SOPs HG-7, HG-8 and G-8.

c. Dissolved Oxygen – A YSI model 57 will be used in place of the ORION SA-210 instrument specified in HG-8 to measure dissolved oxygen. (Note: the SDs reserve the option to utilize an alternate instrument provided it meets the accuracy requirements described below). The instrument's dissolved oxygen measurement will be accurate to within 0.2 mg/l confirmed by an annual check against a laboratory split sample. Instrument calibration requirements will follow manufacturer's recommendations while measurement and decontamination procedures will be as described in SOPs HG-8 and G-8, respectively.

Laboratory analysis methods, including type, implementation frequency and acceptance criteria for laboratory quality control checks/data quality indicators (DQI) and reporting requirements for surface water sampling will follow the protocols identified in the LAP/QAPP and/or EPA's DQOPS except:

1. EPA methods 200.7 (for elemental analysis by ICP) or 200.8 (for elemental analysis by ICP-MS) may be used instead of the method 6010 (or equivalent ICP method from SW-846 such as 6020) referenced in the DQOPS. Methods 200.7 and 200.8 provide similar accuracy as 6010 and 6020 but because of their more frequent use by local laboratories may be more cost-effective.

2. Results will be reported using a level 3 QA/QC package report which has some detail and format differences from the CLP SOW 788 data package specified in the LAP data reporting requirements. The reports would include the sample results with units, method, date/time analyzed, analyst, and appropriate qualifiers. The QA/QC package would include the results of the blanks, calibration verifications, matrix spikes, matrix spike duplicates, and laboratory control samples. Other QA/QC elements listed in Table 1 of the DQOPS, will not be routinely reported, but can be provided on request.

3. QA/QC elements for ICP metals analysis will meet the DQI requirements identified in Table 1 of the DQOPS (see attached Tables A-1 and A-2 for a complete listing of QA/QC parameters and acceptance criteria for methods 200.7/6010 and 200.8/6020, respectively) with the following differences:

    a. Acceptance criteria for low level contract required detection limit (CRDL) standard instrument precision will be equal to or greater than 50% recovery;

    b. Blanks values that exceed the practical quantification limit (PQL) of the method will be flagged;

    c. Acceptance criteria for matrix spikes will be 70 to 130% recovery;

    d. Acceptance criteria for matrix spike duplicates will be 20 RPD; and

    e. Acceptance criteria for serial dilutions will be 14 RPD.

4. In accordance with the DQOPS, EPA method 353.2 will be used for nitrate plus nitrite testing and EPA method 365.1 will be used for total phosphorus testing. QA/QC elements for nitrogen testing are identified on attached Table A-3. Table A-4 provides a listing of QA/QC parameters and acceptance criteria for phosphorus testing.

5. Hardness will be calculated from concentrations of dissolved calcium and magnesium as determined by the ICP methodology described in item 1 above for metals analysis.

The above analysis methods meet the measurement quality objectives identified in the DQOPS of a method quantification limit that is no more than 0.5 times the "Warning Limits for Dissolved Inorganics" identified in the inset box on Figure 4 of the RAMP. They will also meet the required analysis turnaround times of 4 days under Sampling Regime 1 and 1 day under Sampling Regime 2.

4.0 Groundwater Sampling

The RAMP requires semi-annual groundwater quality sampling at ten compliance wells (i.e., 103B, 105C, 107C, 11, 110B, 905, 907, 917B, 922D and HLA2; see Figure 7 of the RAMP for well locations) and quarterly, with the potential for increasing to biweekly sampling if well or surface water samples exceed trigger level concentrations, at the 14 Early Warning Wells (i.e., 916A, 919A, 923A, 923B, 923C, 920, G, MW-7, MW-5, HGS, HGD, DH1, DH2 and MM2 see Figure 7 of the RAMP for well locations) to be monitored by the SDs. Wells will be sampled in order from cleanest to most contaminated (generally the downstream Early Warning Wells HGS, HGD, DH1, DH2, MM2 and MW-5, followed by the reservoir arsenic plume fringe Early Warning Wells, followed, during semi-annual sampling events, by the compliance wells). Where well construction allows it water levels will be monitored during each sampling event.

Groundwater water sampling procedures including equipment decontamination requirements will follow the MVWQD's standard procedures for groundwater sampling (see Attachment 1 to this appendix) with the following modifications designed to maintain consistency with current monitoring:

1. During purging temperature, pH and conductivity will measured at least one time per well volume instead of at least three times per well volume as described in MVWQD's step 9. Consistent with current monitoring at the site the minimum purge of 3 volumes, and the requirement to continue purging until consecutive measurements show pH and temperature within 0.1 units of each other and specific conductance within 10% of each other, will continue to be followed.

2. Field Quality Assurance/Quality Control – Trip blanks and field split samples will not be collected.

3. Samples for metals analysis will be preserved (after filtering in the case of dissolved metals samples) with nitric acid to a pH less than 2.

4. Groundwater samples will be collected directly from the pump instead of purging with a pump and then sampling with a bailer (Note: although different from MVWQD standard procedures this methodology is consistent with both current sampling procedures and SOP GW-1).

Instrumentation and procedures for the field measurement of water level elevations, Eh, pH, temperature and conductivity will be in accordance with SOPs GW-5, HG-7 and HG-8 and through HG-10 except:

1. Water level measurement – A Solinst Model 10535 will be used in place of the Soiltest Model No. BR-760A identified in SOP GW-5. (Note: the SDs reserve the option to utilize an alternate instrument as long as it provides equivalent accuracy). Instrument calibration requirements will follow manufacturer's recommendations while measurement and decontamination procedures will be as described in SOPs GW-5 and G-8, respectively. All water level measurements during a monitoring event will be taken by the same water level indicator to minimize variability. Water level measurements will be recorded to the nearest 0.01 foot and consistent with SOP GW-5 will be verified by repeating the measurement until the difference between measured readings stabilizes to not vary by more than 0.02 foot.

2. Temperature, conductivity, Eh and pH – A YSI model 3500 will be used in place of the ORION SA-210 and YSI model 33 S-C-T instruments specified in SOPs HG-7 and HG-8 to measure temperature/conductivity and pH/Eh, respectively. (Note: the SDs reserve the option to utilize an alternate instrument provided it meets the accuracy requirements described below). The instrument's temperature and pH measurement accuracy will be as described under Section 3.0. Conductivity and Eh measurements will be accurate to within 10 mS and 10 mV, respectively. Instrument calibration requirements will follow manufacturer's

recommendations while measurement and decontamination procedures will be as described in SOPs HG-7, HG-8 and G-8.

Laboratory analysis methods, including type, implementation frequency and acceptance criteria for laboratory quality control checks and reporting requirements for groundwater sampling will follow the applicable protocols for ICP analysis identified in Section 3.0. These methods will meet the measurement quality objective for arsenic which is the lesser of no more than 0.5 times the 8 ug/l warning level or the well-specific trigger level.

5.0 References

ARCO, 1992a, "Clark Fork River Superfund Site Investigations, Standard Operating Procedures", Compiled by Canonie Environmental Services, Inc., September.

ARCO, 1992b, "Clark Fork River Superfund Site Investigations, Quality Assurance Project Plan", Prepared by PTI Environmental Services, May.

ARCO, 1992c, "Clark Fork River Superfund Site Investigations, Laboratory Analysis Protocol", Prepared by PTI Environmental Services, April.

MVWQD, 1995, "Standard Operating Procedures Groundwater Sampling" Prepared by Missoula Valley Water Quality District, May.

Tables

Table A-1

METHOD QA/QC PARAMETERS ELEMENTAL ANALYSES BY ICP by EPA Method 200.7/6010B for Water, Waste, and Soil Analyses				
QA INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS/REPORTING
Sample Preparation	Soils: 3050 Digestion Waters: Turbidity <1 Analyze direct, Turbidity >1 digest using 200.2	Meet method QC criteria for each matrix.	1) Reanalyze sample	
Instrument Initial Calibration (IC)	Daily, or when needed. 1 point calibration and blank	None	None	Calibration of instrument. Calibration validity Tested by ICV and ICB.
Initial Calibration Verification (ICV)/Instrument Performance Check (IPC)	Immediately follows calibration. Use Second source standard.	R% =90-110 as continuing calibration check 200.7 R%=95-105 immediately after IC	For continuing calibration check: 1) Recalibrate and rerun 2) Prepare fresh IC or ICV standards.	Evaluates accuracy/bias in calibration standards.
Initial Calibration Blank (ICB)	Immediately follows ICV	Larger of +1 to- 1 * lowest reporting limit or <2.2xMDL	1) Re-pour Blanks, recalibrate and rerun. 2) Prepare fresh blank	Evaluates instrument calibration and also reagent contamination and instrument carryover.
Low Level Calibration Verification (CRI)	Reporting limit standard analyzed at beginning and end of run. Count as sample for CCV's.	R%= 50-150	1) None	Verifies instrument ability to quantitate analytes at the reporting limit.
Interference Check Sample "A" (ICSA)	Run at beginning and end of run. Count as sample for CCV's	R%=80-120 for interferents +/- 2* reporting limit for analytes	1) Evaluate sample data. Results near reporting limit suspect if failing. 2) Rerun sample as indicated.	Evaluates spectral interference correction factors.
Interference Check Sample "AB" (ICSAB)	Run at beginning and end of run. Count as sample for CCV's	R%=80-120 for interferents	1) Re-determine IEC's if failures persist. 2) Rerun sample as indicated	Evaluates spectral interference correction factors.
Continuing Calibration Verification (CCV)	Run every 10 samples and at end of run.	R%= 90-110	1) Recalibrate and rerun all samples since last valid CCV 2) Check for sample matrix problems.	Evaluates instrument calibration drift.
Continuing Calibration Blank (CCB)	Run after every CCV	Larger of +1 to - 3*lowest reporting limit or <2.2xMDL	1) Check for high concentration sample. 2) Reanalyze CCB. 3) Reanalyze affected samples	Measures analyte carryover in instrument.
Analytical DuplicateSample (Instrument duplicate)	Non-digested waters only - Minimum 1/20 Samples in instrument sequence.	Larger of 3* PQL or 20%RPD	1) Select other duplicate. 2) Rerun duplicate.	Measures method precision
Analytical Spike Sample (post-digestion spike for digested samples	Minimum 1/20 samples or for each batch whichever is more frequent.	200.7: R%=70-130 6010B: R%-75-125	1) Select other spike sample 2) Rerun spike or spike other sample.	Evaluates affect of matrix on method performance.
Serial Dilution Sample	when new matrix is encountered	%R=90-110 for analytes >50*PQL	1) Rerun samples 2) Run samples on dilution	Used for screening analyses and for evaluating new matrices.
Laboratory Reagent Blank (LRB) (Digested samples only)	Minimum 1/20 samples or for each batch whichever is more frequent.	Larger of +/-1*lowest reporting limit or at < 10% of sample concentration Or <2.2xMDL	1) Re-digest samples from batch which fail acceptance criteria.	Evaluates possible contamination in reagents and glassware.

Table A-1

METHOD QA/QC PARAMETERS ELEMENTAL ANALYSES BY ICP by EPA Method 200.7/6010B for Water, Waste, and Soil Analyses				
QA INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS/REPORTING
Lab Fortified Blank (LFB)	Waters: 1/20 samples or 1/digestion batch, whichever is more frequent.	Waters: %R= 85-115 Soils: Provider defined QC limits.	1) Repeat analyses 2) Re-digest sample batch or flag data.	Evaluates method precision and accuracy.
Laboratory Control Sample	1/20 samples or 1/digestion batch whichever is more frequent.	Within established acceptance ranges for certified material.	1) Repeat analyses 2) Re-digest sample batch or flag data.	Evaluates method precision and accuracy.
Digestion duplicate sample (may be matrix spike duplicate)	1/20 samples or 1/Digestion Batch whichever is more frequent	Larger of 3*PQL or 20% RPD (Waters) Larger of 10XPQL or 20%RPD (Soils)	1) Repeat analyses 2) Select other duplicate 3) Flag data or re-digest batch.	Evaluates method precision.
Pre-digestion Laboratory Fortified Sample Matrix (LFM)	200.7 1/10 samples or 1/digestion batch whichever is more frequent 6010B: 1/20 samples or 1/Digestion Batch whichever is more frequent.	%R= 70-130 (Waters) %R= 75-125 (Wastes) or established per matrix	None – Performance varies considerably according to matrix. See LFB.	Evaluates digestion extraction efficiency and sample matrix effects on analyses.
MDL Studies	Annually, or whenever instrument changes might affect sensitivity.	<PQL and comparisons to prior studies.	1) Repeat 2) Correct problem 3) Adjust reporting limit to >MDL	Evaluates method detection limits in clean sample matrix. Actual samples may have higher detection limits.
Inter-element correction Factor Studies	Annually , or whenever instrument changes might affect inter-element corrections.	Comparison to historical data	1) Repeat 2) Correct problem	Correction factors to account for spectral overlap between differing elements.
Upper Linear Range Studies	Semi-annually, or whenever instrument changes might affect sensitivity.	Comparison to historical data	1) Repeat 2) Correct problem 3) Adjust upper calibration limit	Used to determine the upper linear calibration range for the instrument.
External PE Samples	Semi-annually, WS and WP study samples and internal blind samples.	Within specified inter-laboratory control limits	1) Repeat 2) Correct problem	External review of analytical method accuracy. Historically, excellent performance.
Control Charting and Proof of Competency	Annual, statistical review of method QC data for each analyst. or as needed	Data statistically within control limits.	1) Correct method problem 2) Adjust control limits 3) Replace analyst	For statistical process control.

Acronyms and abbreviations

%R or R% = Percent of expected concentration recovered. 100% is perfect recovery.
IDL = Instrument Detection Limit. This is the same as method detection limit but is determined for a specific instrument.
MDL = Method Detection Limit. The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is not zero.
MSD = Matrix Spike Duplicate.
PE Samples are synthetic samples prepared to measure the reliability of the laboratory analysis system. USEPA and State regulators use Water Supply (WS) and Water Pollution (WP) PE sample studies to measure a laboratory's ability to correctly analyze waters under the Safe Drinking Water Act and the Clean Water Act.
PQL or LLD = Practical Quantitation Limit. The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.
r = correlation coefficient. Values of *r* close to 1 indicate excellent linear reliability.
RPD = Relative Percent Difference. An RPD of 0 between duplicates is perfect duplication.

Table A-2

METHOD QA/QC PARAMETERS
ELEMENTAL ANALYSES BY ICP-MS by EPA Method 200.8/6020
for Water, Waste, and Soil Analyses

QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS/REPORTING
Sample Preparation	Soils: 3050 Digestion Waters: Turbidity <1 Analyze direct , >1 digest using 200.2	Meet method QC criteria for the matrix.	1) Reanalyze sample	Reporting: Audit review
Instrument Tuning	Daily – before calibration, analyze tuning solution 4X, conduct mass calibration, and mass resolution check.	Signal RSD <5% Mass Calibration +/- 0.1 amu, and resolution <0.75 amu at 10% peak height.	1) Rerun tuning solutions 2) Adjust instrument parameters and retune 3) Correct Problems	Set instrument parameters for accurate qualitative elemental identification. Tuning solution varies according to matrix and targeted analytes. Reporting: Audit review
Instrument Initial Calibration (IC)	Daily, or when needed. 2 point calibration and blank	None	None	Calibration of instrument. Calibration validity Tested by ICV and ICB. Reporting: In data validating report package
(ICV) Initial Calibration Verification	Immediately follows calibration. Use second source standard.	R% =90-110	1) Recalibrate and rerun 2) Prepare fresh standards or/ ICV.	Evaluates accuracy/bias in calibration standards. Reporting: In data validating report package
Initial Calibration Blank (ICB)	Immediately follows ICV	+/-1*lowest reporting limit or < 10% of sample concentration 200.8 <2.2xMDL or <10% of sample concentration	1) Repour Blanks, recalibrate and rerun. 2) Prepare fresh blank	Evaluates reagent contamination and instrument carryover and background.. Reporting: In data validating report package
Low Level Calibration Verification (CRI)	Reporting limit standard analyzed at beginning and end of run. Count as sample for CCV's.	R%= 50-150	1) None	Verifies instrument ability to quantitate analytes at the reporting limit. Reporting: Audit review
Interference Check Sample "A" (ICSA)	Run at beginning and end of run. Count as sample for CCV's	R%=80-120 for interferents +/- 2* reporting limit for analytes	1) Evaluate sample data. Results near reporting limit suspect if failing ICSA. 2) Rerun sample as indicated.	Reporting: Audit review
Interference Check Sample "AB" (ICSAB)	Run at beginning and end of run. Count as sample for CCV's	R%=80-120 for interferents	1) Evaluate sample data. Results near reporting limit suspect if failing ICSB. 2) Rerun sample as indicated.	Reporting: Audit review
Continuing Calibration Verification (CCV)	Run every 10 samples and at end of run.	R%= 90-110	1) Recalibrate and rerun all samples since last valid CCV 2) Check for sample matrix problems.	Evaluates instrument calibration drift. Reporting: In data validating report package
Continuing Calibration Blank (CCB)	Run before every CCV and after high level samples as needed.	+/-1*lowest reporting limit and < 10% of sample concentration 200.8 Same as ICB	1) Check for high concentration sample 2) Reanalyze CCB. 3) Reanalyze affected samples	Measures analyte carryover in instrument and also evaluates possible contamination in reagents and glassware. Reporting: In data validating report package
Analytical Duplicate Sample (Instrument duplicate)	Minimum 1/20 Samples in instrument sequence.	Either 3* PQL or 10%RPD	1) Rerun duplicate 2) Select other duplicate	Measures method precision Reporting: Routine data reporting package for waters, data validating reporting package for soils and wastes.
Analytical Matrix Spike Sample (post-digestion spike for digested samples)	6020: Minimum 1/20 samples /matrix and for each batch ,whichever is more frequent. 200.8: Minimum 1/10 samples and for each batch.	%R =80-120	1) Rerun spike 2) Select other spike 3) Evaluate LFB performance.	Evaluates affect of matrix on method performance. Reporting: Routine data reporting package

Table A-2

METHOD QA/QC PARAMETERS ELEMENTAL ANALYSES BY ICP-MS by EPA Method 200.8/6020 for Water, Waste, and Soil Analyses				
QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS/REPORTING
Laboratory Reagent Blank (LRB) (Digested samples only)	Waters: Instrument Blanks 1/20 samples. Soils/Wastes: Minimum 1/20 samples or for each batch whichever is more frequent	+/-1*lowest reporting limit and < 10% of sample concentration 200.8 <2.2xMDL	1) Re-digest samples in batch which fail acceptance criteria.	Evaluates possible contamination in reagents and glassware. Reporting: Routine data reporting package
Lab Fortified Blank (LFB) or QC Check Sample	Waters: 1/Digestion batch. Use same standard for spiking as initial calibration. Soils: Use certified reference material.	6020: %R= 80-120 200.8 %R=85-115 Soils: Within established acceptance ranges for certified material.	1) Repeat analyses 2) Prepare new standards 3) Recalibrate 4) Re-extract and re-analyze samples associated with LFB. 5) Flag data or re-digest batch	Evaluates method precision and accuracy. Reporting: Routine data reporting package
Digestion duplicate sample	1/20 samples or 1/Digestion Batch whichever is more frequent	Either +/- 3*LLD or 10% RPD.	1) Repeat analyses 2) Select other duplicate 3) Flag data or redigest batch.	Evaluates method precision. Reporting: Routine data reporting package
Pre-Digestion Laboratory Fortified Sample Matrix	For soils and digested water samples. 6010: 1/20 samples or 1/Digestion Batch whichever is more frequent. 200.8: 1/10 samples or per batch whichever is more frequent.	%R= 80-120	None	Evaluates digestion extraction efficiency and sample matrix effects on analyses. Reporting: Audit review
Internal Standards	Monitor in all standards, samples, and QC samples.	60-120% of IC for all standards, blanks, and samples.	1) Reanalyze sample 2) Dilute sample and reanalyze. 3) Evaluate associated QC samples in sequence. 4) Reanalyze sequence	Internal standards compensate for instrument drift and sample matrix affects. Internal standards used depend on parameters and sample matrix. Reporting: Audit review
MDL/IDL Studies	Quarterly, or whenever instrument changes which might affect sensitivity.	<PQL and comparisons to prior studies.	1) Repeat 2) Correct problem 3) Adjust reporting limit to >MDL	Evaluates overall method detection limits in clean sample matrix. Actual samples may have higher MDL. Reporting: Audit review
Upper Linear Range Studies	Annually, or whenever there are instrument changes which might affect sensitivity.	Comparison to historical data	1) Repeat 2) Correct problem 3) Adjust upper calibration/quantitation limit	Used to determine the upper linear calibration range for the instrument. Reporting: Audit review
External PE Samples	Semi-annually, WS and WP study samples and internal double blind samples.	Within EPA/ERA specified interlaboratory control limits	1) Repeat 2) Correct problem	External review of analytical method accuracy. Historically, excellent performance. Reporting: Audit review
Control Charting and Proof of Competency	Annual, statistical review of method QC data for each analyst. or as needed	Data statistically within control limits.	1) Correct method problem 2) Adjust control limits	For statistical process control. Reporting: Audit review

%R or R% = Percent of expected concentration recovered. 100% is perfect recovery.
IC as applies to internal standard = Initial concentration of the internal standard in the calibration blank.
IDL = Instrument Detection Limit. This is the same as method detection limit but is determined for a specific instrument.
MDL = Method Detection Limit. The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is not zero.
MSD = Matrix Spike Duplicate.
PE Samples are synthetic samples prepared to measure the reliability of the laboratory analysis system. USEPA and State regulators use Water Supply (WS) and Water Pollution (WP) PE sample studies to measure a laboratory's ability to correctly analyze waters under the Safe Drinking Water Act and the Clean Water Act.
PQL or LLD = Practical Quantitation Limit. The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.
r = correlation coefficient. Values of *r* close to 1 indicate excellent linear reliability.
RPD = Relative Percent Difference. An RPD of 0 between duplicates is perfect duplication.

Table A-3

METHOD QA/QC Parameters Ammonia, Nitrate + Nitrite, Nitrate, and Nitrite EPA Method 350.1 (NH3) and 353.2 (Nitrate/Nitrite) Water Matrix Only				
QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
Instrument Calibration	5 point daily initial Calibration Range: (Nitrate is determined by calculation after determining Nitrite and Nitrate + Nitrite Batch size = no more than 20 samples.	Linear Regression Line r>0.995	1. Correct problem 2. Prepare new standards 3. Recalibrate	Calibration of instrument and check of response linearity.
Initial Calibration Verification (ICV)	Follows valid initial calibration. Also considered as a laboratory control sample. Daily analyses	%R = 90-110	1. Repeat once 2. Recalibrate 3. Prepare fresh standards	Evaluates accuracy/bias in calibration standards. Is a 2nd source standard.
Continuing Calibration Verification (CCV)	Mid-level standard analyzed every 10 samples and at the end of every analytical sequence.	%R = 90-110	1. Repeat once 2. Correct problem 3. Re-analyze all samples since last valid calibration check.	Verifies instrument calibration and stability throughout analyses. Also used as Laboratory fortified blank.
Continuing Calibration Blank (CCB)	Instrument blank analyzed every 10 samples and at the end of every analytical sequence.	< reporting limit blanks results are reported down to MDL.	1. Repeat once 2. Correct problem 3. Re-analyze all samples since last valid instrument blank.	Verifies instrument calibration and stability throughout analyses. Also used as Laboratory fortified blank.
Method Blank	1 every 20 samples. = CCB also	< reporting limit, blanks results are reported down to MDL.	1. Repeat once 2. Correct problem 3. Reanalyze all samples associated with method blank.	Measures and evaluates possible contamination in reagents and glassware used in method.
Laboratory Fortified Blank	1 every 20 samples. Also = CCB	%R 90-110	. Repeat once 2. Correct problem 3. Reanalyze all samples associated with failed LFB analyses.	Evaluates method performance on a clean sample matrix. Used to demonstrate that method is properly working.
Matrix Spike/Matrix Spike Duplicate	Minimum 1/10 samples or for each batch. MS/MSD analyzed in pairs.	%R 90-110	1. Repeat analyses 2. Dilute sample and re-spike 3. Correct problem	Analyte level in sample screened to determine spiking level. MS analyses my be substituted with lab fortified blank for samples with very high levels. MSD also used to measure precision.
Duplicate Sample	Minimum 1/10 samples	LLD to 10XLLD =3xLLD, >10XLLD = 10%RPD	1. Repeat analyses 2. Correct Problem 3. Re-prepare samples 4. Evaluate LFB and ICV performance. 5. Re-analyze set of samples.	Measures method precision. MSD analyses normally used.
Method Detection Limit (MDL) Studies	MDL – Every six months and initially for each new instrument setup or analyst.	MDL<0.5X of PQL	1) Repeat once 2) Correct problem	MDL studies are used to determine reporting and detection limit of method.
External PE Samples	Semi-annually, WS and/or WP study samples.	Within specified interlaboratory control limits	1) Repeat 2) Correct problem	External review of analytical method accuracy. Historically, excellent performance.
Control Charting and Proof of Competency	Annual, statistical review of method QC data for each analyst. or as needed	Data statistically within control limits.	1) Correct method problem 2) Adjust control limits 3) Replace analyst	For statistical process control.

%R or R% = Percent of expected concentration recovered. 100% is perfect recovery.
MDL = Method Detection Limit. The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is not zero.
MSD = Matrix Spike Duplicate.
PE Samples are synthetic samples prepared to measure the reliability of the laboratory analysis system. USEPA and State regulators use Water Supply (WS) and Water Pollution (WP) PE sample studies to measure a laboratory's ability to correctly analyze waters under the Safe Drinking Water Act and the Clean Water Act.
PQL or LLD = Practical Quantitation Limit. The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.
r = correlation coefficient. Values of *r* close to 1 indicate excellent linear reliability.
RPD = Relative Percent Difference. An RPD of 0 between duplicates is perfect duplication.

Table A-4

METHOD QA/QC Parameters ORTHO-PHOSPHATE AND TOTAL PHOSPHORUS EPA Method 365.1				
QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
Instrument Calibration	5 point daily initial Calibration Range: (Total Phosphorus determined as ortho-phosphate after digestion by sulfuric acid) Digestion batch size = no more than 20 samples.	Linear Regression Line r>0.995	1. Correct problem 2. Prepare new standards 3. Recalibrate	Calibration of instrument and check of response linearity.
Initial Calibration Verification (ICV)	Follows valid initial calibration. Considered a laboratory control sample for ortho-phosphate analyses.	%R = 90-110	1. Repeat once 2. Recalibrate 3. Prepare fresh standards	Evaluates accuracy/bias in calibration standards. Is a 2nd source standard
Continuing Calibration Verification (CCV)	Mid-level standard analyzed every 10 samples and at the end of every analytical sequence.	%R = 90-110	1. Repeat once 2. Correct problem 3. Re-analyze all samples since last valid calibration check.	Verifies instrument calibration and stability throughout analyses. Also used as Laboratory fortified blank.
Continuing Calibration Blank (CCB)	Instrument blank analyzed every 10 samples and at the end of every analytical sequence. Also considered as method blank for ortho-phosphate analyses.	< reporting limit, blanks results are reported down to MDL.	1. Repeat once 2. Correct problem 3. Re-analyze all samples since last valid instrument blank.	Verifies instrument calibration and stability throughout analyses. Also used as Laboratory fortified blank for ortho-phosphate.
Method Blank	Digestion blank, 1 every 20 samples.	< reporting limit, blanks results are reported down to MDL.	1. Repeat once 2. Correct problem 3. Reanalyze all samples associated with failed method blank.	Measures and evaluates possible contamination in reagents and glassware used in method.
Laboratory Fortified Blank	For total phosphorus a fortified sample going through each digestion batch. Batch = 20 samples or less.	%R 90-110	. Repeat once 2. Correct problem 3. Reanalyze all samples associated with failed LFB analyses.	Evaluates method performance on a clean sample matrix. Used to demonstrate that method is properly working
Matrix Spike/Matrix Spike Duplicate	Minimum 1/10 samples or for each batch.	%R 90-110	1. Repeat analyses 2. Dilute sample and re-spike 3. Correct problem	Analyte level in sample screened to determine spiking level. MS analyses my be substituted with lab fortified blank for samples with very high levels. MSD also used to measure precision.
Duplicate Sample	Minimum 1/10 samples	Either +/- 3X reporting limit or 10% RPD, whichever is greater	1. Repeat analyses 2. Correct Problem 3. Re-prepare samples 4. Analyze different sample 5. Re-analyze set of samples.	Measures method precision. MSD analyses preferred.
MDL Studies	MDL – Every six months for soils and water and initially for each new instrument setup or analyst.	MDL<0.5X of PQL	1) Repeat once 2) Correct problem	MDL studies are used to determine reporting and detection limit of method.
External PE Samples	Semi-annually, WS and/or WP study samples. Also internal audit samples	Within specified interlaboratory control limits	1) Repeat 2) Correct problem	External review of analytical method accuracy. Historically, excellent performance.
Control Charting and Proof of Competency	Annual, statistical review of method QC data for each analyst. or as needed	Data statistically within control limits.	1) Correct method problem 2) Adjust control limits 3) Replace analyst	For statistical process control.

%R or R% = Percent of expected concentration recovered. 100% is perfect recovery.
IDL = Instrument Detection Limit. This is the same as method detection limit but is determined for a specific instrument.
MDL = Method Detection Limit. The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is not zero.
MSD = Matrix Spike Duplicate.
PE Samples are synthetic samples prepared to measure the reliability of the laboratory analysis system. USEPA and State regulators use Water Supply (WS) and Water Pollution (WP) PE sample studies to measure a laboratory's ability to correctly analyze waters under the Safe Drinking Water Act and the Clean Water Act.
PQL or LLD = Practical Quantitation Limit. The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.
r = correlation coefficient. Values of *r* close to 1 indicate excellent linear reliability.
RPD = Relative Percent Difference. An RPD of 0 between duplicates is perfect duplication.

Attachment 1

Missoula Valley Water Quality District Standard Operating Procedures, Groundwater Sampling

STANDARD OPERATING PROCEDURES
GROUNDWATER SAMPLING

Missoula Valley Water Quality District

May 12, 1995

TABLE OF CONTENTS

MISSOULA CITY-COUNTY HEALTH DEPARTMENT
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1.0 INTRODUCTION

This document presents the procedures to be used by the Water Quality District staff when sampling groundwater monitoring wells. In order to obtain consistent, reliable, and accurate groundwater data, staff at the Water Quality District shall adhere to these procedures.

2.0 FIELD DOCUMENTATION

A field note book, documenting field activities conducted during sampling shall be maintained. Information concerning sample collection procedures, sample identification, test boring information, and any other pertinent information or observations when collecting a sample shall be recorded on the field note book. Copies of the field note book shall be kept as part of the monitoring well sampling file for future reference.

3.0 MONITORING WELL DEVELOPMENT

After a monitoring well is installed, the well shall be developed prior to sample collection. A well is developed to remove fine-grained material from the well screen, filter pack, and formation near the well, and to remove any water introduced during drilling and well construction. Development is accomplished by surging the well and pumping water from the well until clean water is extracted. If contaminated groundwater is suspected, procedures for storage of the water and proper disposal shall be made prior to beginning well development. In most cases, the water will be of sufficient quality to discharge it to the ground at the location of the well.

4.0 GROUNDWATER SAMPLING

The well shall be sampled only after it has been developed and allowed to recharge. A minimum of three well volumes must be purged from the well to ensure that the water sample collected from the well represents true groundwater conditions. The total volume to be purged shall be calculated using the total depth of the well, depth to groundwater, and diameter of the well and bore hole. The following equation shall be used to determine the well volume:

Well Volume = volume of water in well casing + volume of water in annulus

Well Volume = depth of water in well (feet) [1] *x volume of water (gallons/linear foot)* [2] *+ depth of water in annulus x porosity of filter pack* [3] *x volume (linear feet of annulus)* [4]

[1] *Equals Depth of well minus depth to water table*
[2] *Use 0.163 for 2" well, 0.65 for 4" well*
[3] *Use porosity of 0.25 for standard filter pack, native material use 0.20*
[4] *Use 0.34 (8" hole diameter), or 0.54 (10" hole diameter)*

To sample a well using the Rediflo pump system, follow these step by step instructions:

Step 1 - Thoroughly clean all equipment that may come in contact with the groundwater or well casing. Remove adhering soil particles from the equipment by scrubbing them with a hand brush in a solution of potable water and alconox, rinse the equipment with potable water, rinse the equipment with de-ionized water, and dry the equipment with clean paper towels. Store in a clean, dry place.

Step 2 - Remove the disposable bailer from the well casing. Clean the bailer as described in Section 5.4, and store in a clean, dry place.

Step 3 - Take a measurement of the static ground water level and depth of the well using a water level indicator capable of recording a measurement to the nearest 0.01 feet. Best measurements are obtained when the pressure in the well casing is equilibrated to the atmospheric pressure. If the well has been sealed, open the casing and allow the pressures to equilibrate for 15 minutes <u>before</u> taking a water level measurement.

Step 4 - Calculate the volume of water in the well casing and annulus space using the equation above. Multiply this number by 3 and record it in the field notebook. **(This is the minimum volume of water that must be pumped from the well prior to sample collection).**

Step 5 - Lower the Rediflo 2 Submersible pump into the well to a depth at least 10 feet below the static water level. **MAKE SURE THE DISCHARGE HOSE, ELECTRICAL SUPPLY LINE AND SUPPORT CABLE ARE ATTACHED TO THE PUMP BEFORE PLACING THE PUMP INTO THE WELL.**

Step 6 - Plug the converter box to the pump electrical supply line. Set the pump speed to maximum on the converter box.

Step 7 - Start the generator.

Step 8 - Plug the converter box power cable into the generator **(110 Volts)**.

Step 9 - Pump a minimum of 3 well volumes of water from the well, as calculated in step 4. Accurately measure the volume removed from the well using a 5-gallon bucket and test the pH, temperature, and conductivity of water being extracted at least three times per well volume.

Continue purging the well of water until three consecutive measurements show the pH and temperature within 0.1 units of each other and the specific conductance readings within 10% of each other. **Under no circumstances should less than 3 well volumes be extracted from the well prior to sampling.** Record the measurement time and result in the field notebook.

Step 10 - Turn off the generator. and remove all equipment from the well. Thoroughly clean all the equipment placed in the well, as described in Section 5.40, Decontamination Procedures for Equipment.

Step 11 - Collect a sample of groundwater using clean the disposable bailer that was removed from the well prior to purging. If no bailer was in the well, use a new clean disposable bailer. Place the bailer down the well and into the groundwater about 10-20 feet. Remove the bailer and pour the groundwater directly from the bailer into an appropriate sample container(s) provided by the analytical laboratory. Try not to agitate the water.

Step 12 - Label each sample container as described in Section 4.30, Sample Labelling. **Make sure all samples are shipped to the laboratory in a cooler with sufficient ice packs to maintain temperature below 4 degrees celsius. Always ship the samples with a chain-of-custody record.**

4.1 Sample Containers/Preservatives

The following containers and preservatives shall be used for sample collection:

Parameter	Container	Preservative
Metals	plastic bottle	cool < 4 C
Inorganic/Physical Factors	glass bottle	cool < 4 C
Volatile Organic Constituents	Two 40 ml glass vials	HCL< pH 2. fill to top, cool < 4 C
Pesticides/Herbicides/PCBs	glass bottle	cool < 4 C

4.2 Analytical Methods

Groundwater samples shall be collected from the monitoring wells on a quarterly basis. Each sample shall be tested for the parameters shown in Table 1.

TABLE 1
Well Sample Parameters

PARAMETER	EPA METHOD	SAMPLE FREQUENCY
Metals		quarterly
Aluminum	200.7	
Arsenic	206.3	
Barium	200.7	
Cadmium	200.7A.	
Chromium	200.7	
Copper	200.7	
Iron	200.7	
Lead	239.2	
Magnesium	200.7	
Manganese	200.7	
Mercury	245.1	
Nickel	200.7	
Selenium	270.3	
Silver	272.2	
Sodium	200.7	
Zinc	200.7	
Volatile Organics		quarterly
Bromoform	501.1	
Bromodichloromethane	501.1	
Chloroform	501.1	
Dibromochloromethane	501.1	
Total Trihalomethanes	501.1	
Benzene	502.2	
Vinyl chloride	502.2	
Carbon Tetrachloride	502.2	
1,2-Dichloroethane	502.2	
1,4-Dichlorobenzene	502.2	
1,1-Dichloroethylene	502.2	
1,1,1-Trichloroethane	502.2	
Trichlorethylene	502.2	
Bromobenzene	502.2	
Bromomethane	502.2	
Chlorobenzene	502.2	
Chloroethane	502.2	
Chloromethane	502.2	
o-chlorotoluene	502.2	
p-chlorotoluene	502.2	
Dibromochloropropane	504	
Dibromomethane	502.2	
1,2-Dichlorobenzene	502.2	
1,3-Dichlorobenzene	502.2	
trans-1,2-Dichloroethylene	502.2	
cis-1,2-Dichloroethylene	502.2	
Dichloromethane	502.2	
1,1-Dichloroethane	502.2	
1,1-Dichloropropene	502.2	
1,2-Dichloropropene	502.2	
trans-1,3-Dichloropropene	502.2	
cis-1,3-Dichloropropene	502.2	
2,2-Dichloropropene	502.2	
Ethylene Dibromide	504	

TABLE 1 (Continued)
Well Sample Parameters

PARAMETER	EPA METHOD	SAMPLE FREQUENCY
Ethylbenzene	502.2	quarterly
Styrene	502.2	
1,1,2-Trichloroethane	502.2	
1,1,1,2-Tetrachloroethane	502.2	
1,1,2,2-Tetrachlorethane	502.2	
Tetrachloroethylene	502.2	
1,2,3-Trichloropropane	502.2	
Toluene	502.2	
Xylene	502.2	
Chloroethylvinyl ether	502.2	
Dichlorodifluoromethane	502.2	
Trichlorofluoromethane	502.2	
Trichlorobenzenes	502.2	
Inorganic/Physical Factors		quarterly
Total Alkalinity	310.1	
Chloride	300.0	
Nitrate	300.0	
Nitrite	300.0	
Sulfate	300.0	
Hardness	215.2	
pH	150.1	
TDS	160.1	
Turbidity	180.1	

In addition to the above, at least once a year each well will be tested for the following pesticides and PCBs:

Alachlor
Aldrin
Atrazine
Chlordane
Dichloran
Dieldren
2,4-D
Endrin
Heptachlor
Heptachlor Epoxide
Hexachlorobenzene
Hexachloropentadiene
Lindane
Trifluralin
Methoxychlor
PCBs
Pentachloronitrobenzene
2,4,5-TP, Silvex
Simazine
Toxaphene

Additional parameters including picloram and pentachlorophenol may be analyzed at selected wells as the need arises.

4.30 Sample Labelling

A sample identification system will be used to identify each sample location and sample type. This system will provide a tracking system to allow for retrieval of information and to insure that each sample is uniquely numbered. Each sample container will be affixed with a label marked in permanent water-proof ink. Each label will include:

Sample location

Sample type
Date and time of collection
Name of collector
Analyses requested

4.4 Sample Shipment

All samples collected for analytical testing will be delivered to an approved analytical laboratory within their respective holding times. Under most circumstances the samples will be shipped to the analytical laboratory within 24 hours of collection. If the samples will not be shipped to the lab the same day they are collected, they should be placed in a refrigerator at the Health Department. During shipment from the sample site, samples will be kept on ice in a cooler.

4.5 Chain of Custody

A chain-of-custody record which documents possession of samples from time of collection to laboratory analysis will be maintained and accompany each sample.

5.00 QUALITY ASSURANCE/QUALITY CONTROL PLAN

The purpose of the QA/QC program is to maximize data accuracy and minimize interferences from sample handling which may reduce the quality of the data. QA/QC procedures will be practiced throughout sampling. The QA/QC program components performed in the field include decontamination of sampling equipment, calibration of all field measuring equipment, sample logging and chain-of-custody procedures, sample labelling, and ensuring that all samples are obtained, maintained, and shipped according to this plan.

5.1 Field Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures will be practiced throughout the program. Equipment blanks (bailer blanks) used to detect contamination during sample collection from equipment will be collected at a frequency of one per 20 samples. Equipment blanks shall be tested for the full range of parameters for a given sampling event. The equipment blank sample will be taken from a bailer used to collect a sample.

Trip blanks will also be used to determine whether samples are contaminated during shipping of samples from the lab to the field and from the field back to the lab. Trip blanks will be used at a frequency of one per 20 samples. The trip blank shall originate at the laboratory by filling two 40 ml vials with deionized water and placing it in the sample cooler. The trip blank shall be left in the cooler during sampling and shipment back to the lab. Trip blanks will be tested for volatile organic constituents only.

Duplicate and split samples will be collected at a frequency of one per 20 samples. They will be used to reflect the precision of sampling techniques, field procedures, and laboratory analyses. Duplicate samples will be sent blind to the same lab analyzing all the samples for a particular sampling event. Split samples will be sent to a different lab. Duplicate and spilt sample shall be tested for the full range of parameters for a given sampling event.

Each sampling event will have at least one equipment blank, trip blank, duplicate sample, and split sample.

5.2 Data Interpretation

The results of the split and duplicate samples will be compared to the original sample to evaluate the relative percent difference between the analyses. The relative percent difference (RPD) indicates the relative precision of the field sampling techniques and analytical testing methods. The RPD is calculated using the following equation:

$$RPD = \frac{\text{(sample result - duplicate sample result)}}{\text{(average result of both samples)}} \times 100$$

For groundwater samples an RPD of 20 or less will be deemed acceptable. Any RPDs that are outside of this range will be noted and the validity of the sample results will be evaluated.

5.3 Equipment Calibration

Equipment used to obtain field measurements (pH meter, specific conductance meter, temperature meter) will be calibrated following the schedule outlined by the operating manuals for each instrument. All water level measurements will be taken with the same water level indicator to minimize varibility in measurements due to the equipment. Water levels will be recorded to the nearest 0.01 foot and will be referenced to a surveyed data point on the wellhead.

5.4 Decontamination Procedures

The procedures for cleaning sampling equipment are described below:

The outside of the submersible pump, discharge hose, electric cable, and support wire shall be cleaned after each sample is collected from a well. Cleaning will include:

a. Removing adhering soil particles by scrubbing with a hand brush in a solution of potable water and alconox.
b. Rinsing with potable water.
c. Rinsing with de-ionized water.
d. Air drying

The water level sensor shall also be cleaned in the same manner after each use.

Well-dedicated disposable bailers will be used to collect actual water samples.

5.5 Laboratory Quality Assurance/Quality Control

Samples will be delivered to the analytical laboratory within the appropriate holding times. The laboratory will provide QA/QC information with sample analytical results, including; detection limits, and results from laboratory and preparation blanks. Further laboratory QA/QC information such as calibration schedules and surrogate spike recoveries will be maintained on file at the lab for reference if needed.

APPENDIX B

River Sampling Regime/BMP Decision Methodology Spreadsheets

Table B-1

River Sampling Regime/Construction BMP Decision Methodology Spreadsheet #1 - Turbidity

Milltown Reservoir Sediments Operable Unit

Data Input

Date Sampled: 8/21/2002

Constituent	CFR at Turah or CFR near Duck Bridge[1] Measured Concentration	BFR near Bonner or BFR near I-90[2] Measured Concentration	CFR above Missoula or CFR near Milltown Dam[3] Measured Concentration	Warning Limit	Field Standard Deviation
Turbidity (NTU)	Unsampled	Unsampled	20	12	NA
Total Suspended Solids (mg/L)	6	3	93	440	2.20

Flow Measurement Location	Measured Flow (cfs)	Percent Error	Standard Deviation (cfs)
CFR at Turah	513	5%	59
BFR near Bonner	700	5%	80
CFR above Missoula	1,210	5%	146

Notes:

Shaded cells are for measured inputs.

Flow error of 5% is typical for stable channels (6-2-05 email from John Lambing, USGS). Standard deviation is the product of the percent error and the mean flow, where mean flow is based on the current USGS flow record through Water Year 2004.

(1) A temporary monitoring station on the CFR near Duck Bridge may be established and monitored when restoration construction and/or other activities/impacts are ongoing on the CFR upstream of the RA project area. If available, TSS concentration results from this station may be obtained from the sampling entity and used to represent upstream concentrations. If both restoration construction and RA-related reservoir drawdown impacts upstream of the RA project area are occurring simultaneously then results from both upstream stations may be considered.

(2) A temporary monitoring station on the BFR near the I-90 may be established and monitored when restoration construction and/or other activities/impacts are ongoing on the BFR upstream of the RA project area. If available, TSS concentration results from this station may be obtained from the sampling entity and used to represent upstream concentrations. If both non-RA construction and RA-related reservoir drawdown impacts upstream of the RA project area are occurring simultaneously then results from both upstream stations may be considered.

(3) A temporary monitoring station on the CFR near Milltown Dam may be established and monitored when restoration construction and/or other activities/impacts are ongoing on the CFR downstream of the RA project area. If available, TSS concentration results from this station may be obtained from the sampling entity and used to represent downstream concentrations.

Propagation of Error Calculations

Constituent	Upstream Flow-Weighted Concentration	Total Standard Deviation
Total Suspended Solids (mg/L)	4.3	1.7

Results

Action
Add Regime 2 Sampling plus Evaluate BMPs

Notes:

Sample inputs are based on 8-21-02 USGS measurements of 2002 drawdown.

Propagation of error equations are from Kavanagh and Bird, 1992. "Surveying - Principles and Applications" 3rd. Ed. and www.rit.edu/~uphysics/uncertainties/Uncertaintiespart2.html.

Action determination: If CFR above Missoula turbidity below warning limit, then Regime 1 Sampling. If CFR above Missoula turbidity above warning limit, but the TSS concentration is below the sum of the upstream flow-weighted TSS concentration and the total standard deviation, then add Regime 2 Sampling. If CFR above Missoula turbidity above warning limit, and TSS concentration above the sum of the upstream flow-weighted TSS concentration and the total standard deviation, then add Regime 2 Sampling plus evaluate BMPs. (Note: as described in the " Contingency Plan for Exceedance of Downstream Surface Water Quality Standards/Warning Limits", prior to proceeding with evaluation of BMPs an additional check may be done to confirm that the cause of the exceedance is RA construction activities rather than background net loading from the RA project area unrelated to RA activities that has historically been observed during high-flow and ice scour events.)

Upstream Flow-weighted Concentration

$$C_{upstr} = \frac{C_{Turah} * Q_{Turah} + C_{BFR} * Q_{BFR}}{Q_{abvMiss}}$$

Propagation of Error Equations

Sum of A and B to Produce C

$$\sigma_C = \sqrt{\sigma_A^2 + \sigma_B^2}$$

Multiplication of A and B to Produce C

$$\sigma_C = \sqrt{A^2\sigma_B^2 + B^2\sigma_A^2}$$

Division of A by B to Produce C

$$\sigma_C = C * \sqrt{\left(\frac{\sigma_A}{A}\right)^2 + \left(\frac{\sigma_B}{B}\right)^2}$$

Table B-2
River Sampling Regime/Construction BMP Decision Methodology Spreadsheet #2 -
TSS, Dissolved Arsenic, Dissolved Metals Evaluation
Milltown Reservoir Sediments Operable Unit

Data Input

Date Sampled: 8/21/2002

Constituent	CFR at Turah or CFR near Duck Bridge (1) Measured Concentration	BFR near Bonner or BFR near I-90(2) Measured Concentration	CFR above Missoula or CFR near Milltown Dam(3) Measured Concentration	Warning Limit	Field Standard Deviation	Lab Standard Deviation	Combined Standard Deviation
Arsenic, Dissolved (μg/L)	4.8	1.2	3.4	8	0.15	0.16	0.22
Cadmium, Dissolved (μg/L)	0.02	0.04	0.04	1.6	0.01	0.00	0.01
Copper, Dissolved (μg/L)	1.7	0.4	1.1	20	0.13	0.08	0.15
Iron, Dissolved (μg/L)	10	10	15	800	1.3	1.6	2.1
Lead, Dissolved (μg/L)	0.08	0.08	0.12	52	0.02	0.02	0.03
Zinc, Dissolved (μg/L)	1	1	2	94	0.38	0.24	0.45
Total Suspended Solids (mg/L)	6	3	93	440	2.2	NA	2.20

Flow Measurement Location	Measured Flow (cfs)	Percent Error	Standard Deviation (cfs)
CFR at Turah	513	5%	59
BFR near Bonner	700	5%	80
CFR above Missoula	1,210	5%	146

Notes:

Shaded cells are for measured inputs.

Flow error of 5% is typical for stable channels (6-2-05 email from John Lambing, USGS). Standard deviation is the product of the percent error and the mean flow, where mean flow is based on the current USGS flow record through Water Year 2004.

(1) A temporary monitoring station on the CFR near Duck Bridge may be established and monitored when restoration construction and/or other activities/impacts are ongoing on the CFR upstream of the RA project area. If available, TSS, arsenic and metals concentration results from this station may be obtained from the sampling entity and used to represent upstream concentrations. If both restoration construction and RA-related reservoir drawdown impacts upstream of the RA project area are occurring simultaneously then results from both upstream stations may be considered.

(2) A temporary monitoring station on the BFR near the I-90 may be established and monitored when restoration construction and/or other activities/impacts are ongoing on the BFR upstream of the RA project area. If available, TSS, arsenic and metals concentration results from this station may be obtained from the sampling entity and used to represent upstream concentrations. If both non-RA construction and RA-related reservoir drawdown impacts upstream of the RA project area are occurring simultaneously then results from both upstream stations may be considered.

(3) A temporary monitoring station on the CFR near Milltown Dam may be established and monitored when restoration construction and/or other activities/impacts are ongoing on the CFR downstream of the RA project area. If available, TSS, arsenic and metals concentration results from this station may be obtained from the sampling entity and used to represent downstream concentrations.

Propagation of Error Calculations

Constituent	Upstream Flow-Weighted Concentration	Total Standard Deviation
Arsenic, Dissolved (μg/L)	2.7	0.4
Cadmium, Dissolved (μg/L)	0.03	0.01
Copper, Dissolved (μg/L)	1.0	0.2
Iron, Dissolved (μg/L)	10.0	2.1
Lead, Dissolved (μg/L)	0.08	0.02
Zinc, Dissolved (μg/L)	1.0	0.4
Total Suspended Solids (mg/L)	4.3	1.7

Upstream Flow-weighted Concentration

$$C_{upstr} = \frac{C_{Turah} * Q_{Turah} + C_{BFR} * Q_{BFR}}{Q_{abvMiss}}$$

Propagation of Error Equations

Sum of A and B to Produce C

$$\sigma_C = \sqrt{\sigma_A^2 + \sigma_B^2}$$

Multiplication of A and B to Produce C

$$\sigma_C = \sqrt{A^2 \sigma_B^2 + B^2 \sigma_A^2}$$

Division of A by B to Produce C

$$\sigma_C = C * \sqrt{\left(\frac{\sigma_A}{A}\right)^2 + \left(\frac{\sigma_B}{B}\right)^2}$$

Results

Constituent	Action
Arsenic, Dissolved (μg/L)	Regime 1 Sampling
Cadmium, Dissolved (μg/L)	Regime 1 Sampling
Copper, Dissolved (μg/L)	Regime 1 Sampling
Iron, Dissolved (μg/L)	Regime 1 Sampling
Lead, Dissolved (μg/L)	Regime 1 Sampling
Zinc, Dissolved (μg/L)	Regime 1 Sampling
Total Suspended Solids (mg/L)	Regime 1 Sampling

Notes:

Sample inputs are based on 8-21-02 USGS measurements of 2002 drawdown.

Propagation of error equations are from Kavanagh and Bird, 1992. "Surveying - Principles and Applications" 3rd. Ed. and www.rit.edu/~uphysics/uncertainties/Uncertaintiespart2.html.

Action determination: If CFR above Missoula TSS, dissolved arsenic and dissolved metal concentrations are all below their warning limits, then Regime 1 Sampling. If CFR above Missoula TSS, dissolved arsenic or dissolved metal concentration(s) are above their warning limits, but below the sum of the upstream flow-weighted concentration and the total standard deviation, then add Regime 2 Sampling. If CFR above Missoula TSS, dissolved arsenic or dissolved metal concentration(s) are above their warning limit, and above the sum of the upstream flow-weighted concentration and the total standard deviation, then add Regime 2 Sampling plus evaluate BMPs. (Note: as described in the " Contingency Plan for Exceedance of Downstream Surface Water Quality Standards/Warning Limits", prior to proceeding with evaluation of BMPs an additional check may be done to confirm that the cause of the exceedance is RA construction activities rather than background net loading from the RA project area unrelated to RA activities that has historically been observed during high-flow and ice scour events.)

APPENDIX C

Early Warning Wells Dissolved Arsenic Trigger Levels Statistical Analysis

Purpose

In response to comments on the Draft Remedial Action Monitoring Plan, a statistical analysis was conducted to determine BMP dissolved arsenic trigger levels for proposed early warning wells. Early warning wells are proposed to be monitored under the Remedial Action Monitoring Plan (RAMP, Envirocon, 2006) for departures from historic dissolved arsenic concentrations that may trigger additional sampling and/or BMPs. The purpose of this calculation brief is to calculate a trigger dissolved arsenic concentration for each early warning well using an analysis of the historic data of each well. This methodology is consistent with those used in evaluating groundwater monitoring data from RCRA facilities.

Methods

Nineteen proposed early warning wells with 21 sampling points (Well 923 is nested) are shown on Figure 7 of the RAMP. A statistical analysis was conducted on 20 of these sampling points to establish trigger concentration values (One of the proposed early warning wells, NRW, has not yet been installed and therefore has no available data. A trigger value for NRW will be established during the RA as sample results become available). All available data was used in the analysis. For MW-5 data, there were undefined detection limits for the non-detects and the non-detects could not be used in the analysis of those wells.

A one-sided tolerance interval with 95% coverage and a 95% tolerance coefficient was constructed from the dissolved arsenic background data. This upper one-sided tolerance interval is the proposed trigger value.

For wells with non-detects in their data sets, the recommended procedure for handling non-detects in the "Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance" (Interim Final Guidance Addendum, EPA, 1992) was followed. The data were segregated into the percentage non-detects for a data set. If the percentage of non-detects was less than 15% of all samples taken at the well, then each non-detect was replaced by half its instrument detection limit (IDL). If the percent of non-detects was between 15% and 50%, Cohen's adjustment to the sample mean and variance was used. No data sets had non-detects greater than 50%. Cohen's adjustment only allows for one IDL to be used in the calculations. In the early warning wells that had non-detects, the IDLs varied throughout the data sets due to different instruments used in the lab. A sensitivity analysis was performed to resolve which IDL to use for the Cohen method using the highest reported IDL and the lowest reported IDL. Using the lowest IDL generally produced the lowest trigger concentration; therefore, the lowest IDL was used throughout the Cohen method calculations.

Aitchison's adjustment to the mean and standard deviation was also used to evaluate non-detects. Aitchison's assumes the non-detects are zero concentrations and is recommended when there is a higher percentage of non-detects (greater than 50%). Aitchinson's method was computed for comparison to Cohen's method. The comparison indicated less than a 10% difference in trigger concentrations for all data sets evaluated. Cohen's method was selected for all data sets with non-detects.

Construction of the tolerance intervals included testing for normality. Four normality tests (Probability Plots, Coefficient of Skewness, Shapiro-Wilk, and Correlation Coefficient) were conducted on the data and the natural logarithm of the data.

For data sets where at least one test indicated the data was distributed normally, the following procedure was used. The one-sided tolerance interval was calculated using the following equation:

$$TI = \bar{x} + KS$$

Where:
$\bar{x}$ = Mean
K = Tolerance factor
S = Standard deviation

The one-sided tolerance factor was calculated using the following equation:

$$K = t_{n-1,1-\alpha}\sqrt{1+\frac{1}{n}}$$

Where:
t = Critical value of Student's t Distribution (One-tailed)
n = Number of observations
α = Significance level used to compute the confidence level

Where both the data and the logarithm of the data met the model of normality, the most normal tolerance interval (i.e. the one which satisfied the greatest number of the normality tests) was chosen as the trigger value.

For data sets which did not meet the model of normality, a non-parametric tolerance interval was constructed. For the upper tolerance limit of the non-parametric data sets, the maximum value of the sample data was chosen.

Results
A summary of the calculated trigger concentrations for each well are presented in Table C-1. Detailed calculations are presented in Attachment C-1.

Discussion

A statistical analysis was performed using EPA recommended procedures for 19 proposed early warning wells. Wells 916A and G had less than 15% non-detects for which half the IDL was used. Wells 920, C8, C21, DB-007, and DB-035 had 15% to 50% non-detects for which the Cohen method was used. Wells 923B and DB-039 did not meet the model of normality; therefore, the non-parametric analysis was applied. All other wells satisfied at least one normal distribution test and parametric analyses were performed.

References

Envirocon, 2006. "Final Remedial Action Monitoring Plan, Milltown Reservoir Sediments Operable Unit," May.

EPA, 1992. "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities," prepared by the Office of Solid Waste Permits and State Programs Division, July.

Eisenhart, Churchill, Millard W. Hastay, and W. Allen Wallis, 1947. "Selected Techniques of Statistical Analysis for Scientific and Industrial Research and Production and Management Engineering." New York.

Table C-1

Early Warning Wells
Arsenic Statistics Results Summary

Well ID	Trigger Concentration (mg/L)
916A	0.0050
919A	0.0040
920	0.0031
923A	0.0078
923B	0.0082
923C	0.0113
C8	0.0043
C21	0.0040
DB-001	0.0040
DB-007	0.0049
DB-035	0.0033
DB-039	0.0050
DH1	0.0040
DH2	0.0021
NRW	NA
G	0.0191
HGD	0.0022
HGS	0.0023
MM2	0.0031
MW-5	0.0020
MW-7	0.0067

Note:

NRW - new replacement well proposed to be installed in Milltown by EPA

NA - no data available, proposed well

Attachment C-1

Supporting Calculations

Well 916A Statistics - Preliminary

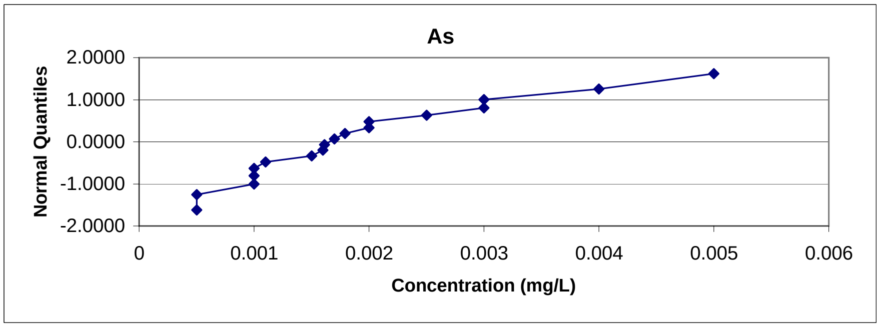
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	916A	06/11/98	0.0005	-7.6009	0.05	-1.6199
2	916A	12/17/02	0.0005	-7.6009	0.11	-1.2521
3	916A	06/30/97	0.001	-6.9078	0.16	-1.0031
4	916A	11/30/01	0.001	-6.9078	0.21	-0.8046
5	916A	07/18/03	0.001	-6.9078	0.26	-0.6336
6	916A	01/02/04	0.0011	-6.8124	0.32	-0.4795
7	916A	06/21/04	0.0015	-6.5023	0.37	-0.3360
8	916A	06/27/00	0.0016	-6.4378	0.42	-0.1992
9	916A	11/30/05	0.0016139	-6.4291	0.47	-0.0660
10	916A	12/02/04	0.0017	-6.3771	0.53	0.0660
11	916A	06/07/05	0.0018	-6.3257	0.58	0.1992
12	916A	06/29/99	0.002	-6.2146	0.63	0.3360
13	916A	06/12/02	0.002	-6.2146	0.68	0.4795
14	916A	12/02/99	0.0025	-5.9915	0.74	0.6336
15	916A	12/05/97	0.003	-5.8091	0.79	0.8046
16	916A	11/29/00	0.003	-5.8091	0.84	1.0031
17	916A	06/12/01	0.004	-5.5215	0.89	1.2521
18	916A	12/06/98	0.005	-5.2983	0.95	1.6199

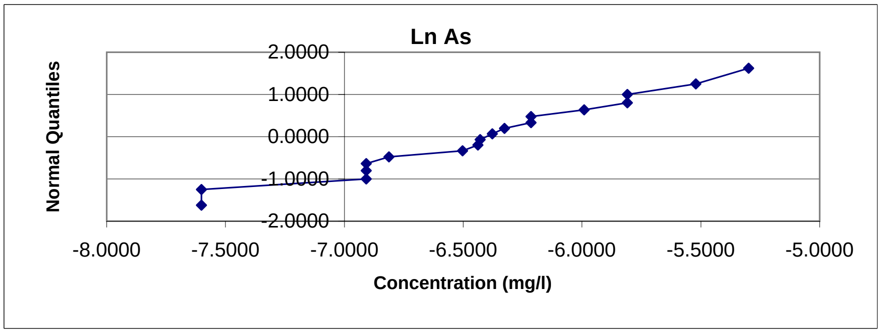
Maximum	0.005	
Mean	0.0019	-6.4260
Stdev	0.0012	0.6303
Standard Error	0.0003	0.1486
Student t-test Value	1.740	
Tolerance Factor	1.7877	
Upper Limit 95%-95% Tolerance Interval	**0.0041**	**0.0050**

Normality Tests

Skew	1.2172	-0.2356
	Skewed	Normal
Shapiro-Wilk (W)	0.8951	0.9644
Shapiro-Wilk (Wc)	0.897	
	Non-normal	Normal
Correlation Coeff	0.9426	0.9834
Critical Correlation Coeff	0.945	
	Non-normal	Normal

Selected Trigger Concentration (UCL) (mg/L) **0.0050**





Well 919A Statistics - Preliminary

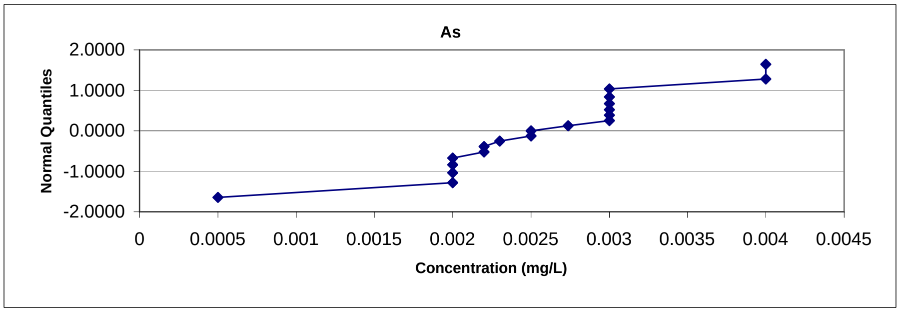
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	919A	01/17/97	0.0005	-7.6009	0.05	-1.6449
2	919A	06/19/97	0.002	-6.2146	0.10	-1.2816
3	919A	06/11/98	0.002	-6.2146	0.15	-1.0364
4	919A	06/27/00	0.002	-6.2146	0.20	-0.8416
5	919A	12/18/02	0.002	-6.2146	0.25	-0.6745
6	919A	06/22/04	0.0022	-6.1193	0.30	-0.5244
7	919A	11/30/05	0.0022	-6.1193	0.35	-0.3853
8	919A	12/03/99	0.0023	-6.0748	0.40	-0.2533
9	919A	06/30/99	0.0025	-5.9915	0.45	-0.1257
10	919A	12/03/04	0.0025	-5.9915	0.50	0.0000
11	919A	06/08/05	0.0027	-5.9008	0.55	0.1257
12	919A	12/15/97	0.003	-5.8091	0.60	0.2533
13	919A	11/30/00	0.003	-5.8091	0.65	0.3853
14	919A	06/12/01	0.003	-5.8091	0.70	0.5244
15	919A	12/04/01	0.003	-5.8091	0.75	0.6745
16	919A	07/18/03	0.003	-5.8091	0.80	0.8416
17	919A	01/08/04	0.003	-5.8091	0.85	1.0364
18	919A	12/07/98	0.004	-5.5215	0.90	1.2816
19	919A	06/13/02	0.004	-5.5215	0.95	1.6449

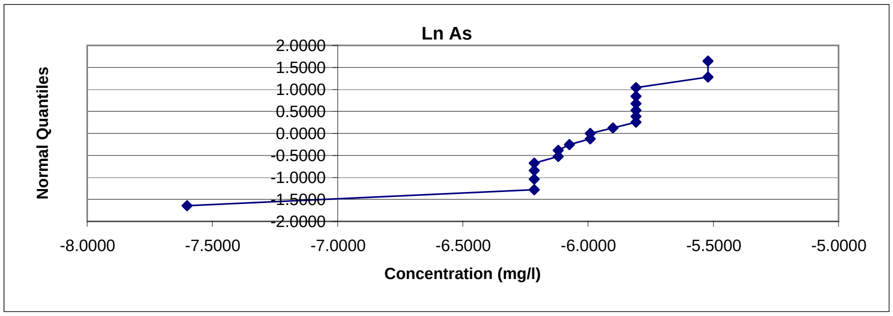
Maximum	0.004	
Mean	0.0026	-6.0292
Stdev	0.0008	0.4379
Standard Error	0.0002	0.1005
Student t-test Value	1.734	
Tolerance Factor	1.7790	
Upper Limit 95%-95% Tolerance Interval	**0.0040**	**0.0052**

Normality Tests

Skew	-0.4563	-2.6487
	Normal	Skewed
Shapiro-Wilk (W)	0.9064	0.7096
Shapiro-Wilk (Wc)	0.901	
	Normal	Non-normal
Correlation Coeff	0.9384	0.8155
Critical Correlation Coeff	0.947	
	Non-normal	Non-normal

Selected Trigger Concentration (UCL) (mg/L) **0.0040**





Well 920 Statistics - Preliminary Cohen Non-Detects Method

n	m	Well	Date	As (mg/L)	Ln As
1	1	920	06/26/00	0.0015	-6.5023
2	2	920	11/29/00	0.002	-6.2146
3	3	920	12/17/02	0.001	-6.9078
4	4	920	07/16/03	0.001	-6.9078
5	5	920	01/02/04	0.00072	-7.2363
6	1	920	12/13/95	0.0005	-7.6009
7	2	920	06/11/96	0.0005	-7.6009
8	3	920	12/10/96	0.0005	-7.6009
9	4	920	06/17/97	0.0005	-7.6009
10	5	920	12/04/97	0.002	-6.2146
11	6	920	06/09/98	0.0005	-7.6009
12	7	920	12/06/98	0.004	-5.5215
13	8	920	06/28/99	0.002	-6.2146
14	9	920	12/01/99	0.0017	-6.3771
15	10	920	06/11/01	0.002	-6.2146
16	11	920	11/29/01	0.0020	-6.2146
17	12	920	06/12/02	0.002	-6.2146
18	13	920	06/18/04	0.00077	-7.1691
19	14	920	12/01/04	0.00067	-7.3082
20	15	920	11/28/05	0.000743	-7.2051
21	16	920	06/07/05	0.00092	-6.9911

Mean of Detects	0.0013	-6.8531
Stdev of Detects	0.0010	0.6969
Variance of Detects	0.000001	0.4856
h	0.238095	
γ	2.535	3.308
λ	0.5341	0.6717
Adjusted Mean	0.0010	-7.1105
Adjusted Stdev	0.0011	0.7643

IDL varies, Cohen's only set up for 1 IDL - used 0.00072

Note, Non-Detects highlighted

Well 920 Statistics - Preliminary

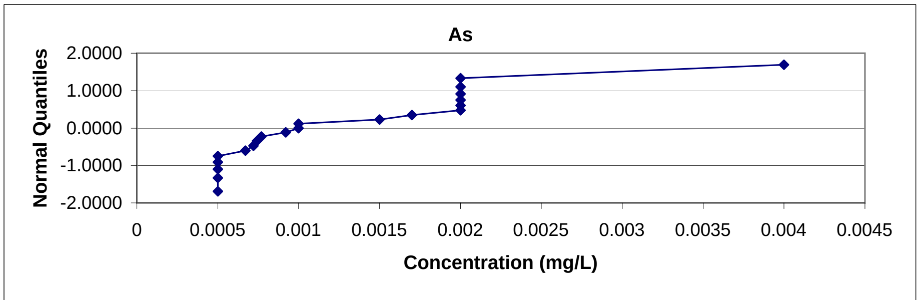
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	920	12/13/95	0.0005	-7.6009	0.05	-1.6906
2	920	06/11/96	0.0005	-7.6009	0.09	-1.3352
3	920	12/10/96	0.0005	-7.6009	0.14	-1.0968
4	920	06/17/97	0.0005	-7.6009	0.18	-0.9085
5	920	06/09/98	0.0005	-7.6009	0.23	-0.7479
6	920	12/01/04	0.00067	-7.3082	0.27	-0.6046
7	920	01/02/04	0.00072	-7.2363	0.32	-0.4728
8	920	11/28/05	0.0007428	-7.2051	0.36	-0.3488
9	920	06/18/04	0.00077	-7.1691	0.41	-0.2299
10	920	06/07/05	0.00092	-6.9911	0.45	-0.1142
11	920	12/17/02	0.001	-6.9078	0.50	0.0000
12	920	07/16/03	0.001	-6.9078	0.55	0.1142
13	920	06/26/00	0.0015	-6.5023	0.59	0.2299
14	920	12/01/99	0.0017	-6.3771	0.64	0.3488
15	920	12/04/97	0.002	-6.2146	0.68	0.4728
16	920	06/28/99	0.002	-6.2146	0.73	0.6046
17	920	11/29/00	0.002	-6.2146	0.77	0.7479
18	920	06/11/01	0.002	-6.2146	0.82	0.9085
19	920	11/29/01	0.0020	-6.2146	0.86	1.0968
20	920	06/12/02	0.002	-6.2146	0.91	1.3352
21	920	12/06/98	0.004	-5.5215	0.95	1.6906

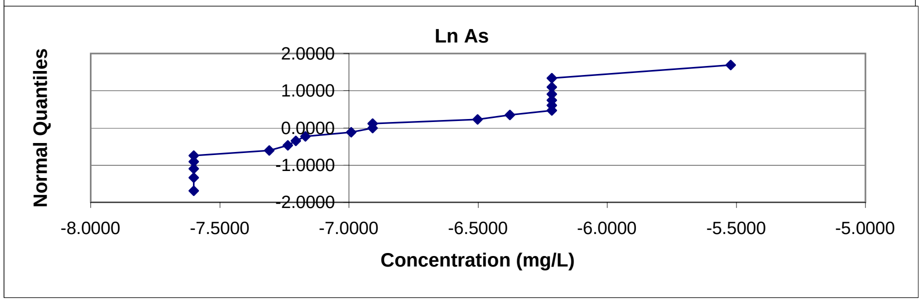
Maximum	0.004	
Mean	0.0010	-7.1105
Stdev	0.0011	0.7643
Standard Error	0.0002	0.1668
Student t-test Value	1.725	
Tolerance Factor	1.7656	
Upper Limit 95%-95% Tolerance Interval	**0.0029**	**0.0031**

Normality Tests

Skew	1.4810	0.2621
	Skewed	Normal
Shapiro-Wilk (W)	0.5373	0.6090
Shapiro-Wilk (Wc)	0.908	
	Non-normal	Non-normal
Correlation Coeff	0.8933	0.9551
Critical Correlation Coeff	0.952	
	Non-normal	Normal

Selected Trigger Concentration (UCL) (mg/L)	**0.0031**





Well 923A Statistics - Preliminary

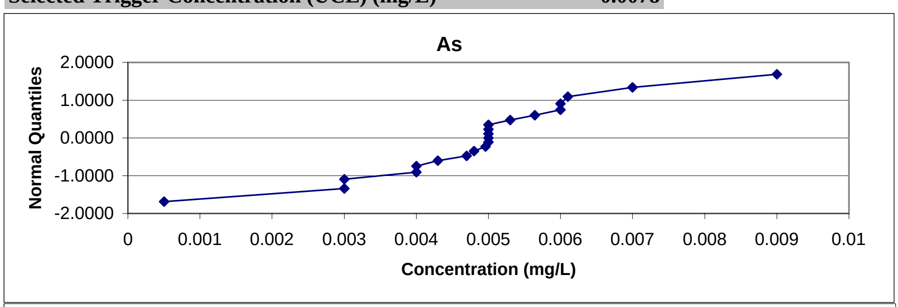
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	923A	12/13/95	0.0005	-7.6009	0.05	-1.6906
2	923A	06/11/96	0.003	-5.8091	0.09	-1.3352
3	923A	12/16/96	0.003	-5.8091	0.14	-1.0968
4	923A	06/25/97	0.004	-5.5215	0.18	-0.9085
5	923A	06/15/01	0.004	-5.5215	0.23	-0.7479
6	923A	06/28/04	0.0043	-5.4491	0.27	-0.6046
7	923A	07/07/00	0.0047	-5.3602	0.32	-0.4728
8	923A	12/14/04	0.0048	-5.3391	0.36	-0.3488
9	923A	06/14/05	0.0050	-5.3064	0.41	-0.2299
10	923A	06/16/98	0.005	-5.2983	0.45	-0.1142
11	923A	07/01/99	0.005	-5.2983	0.50	0.0000
12	923A	12/03/01	0.005	-5.2983	0.55	0.1142
13	923A	12/20/02	0.0050	-5.2983	0.59	0.2299
14	923A	07/18/03	0.005	-5.2983	0.64	0.3488
15	923A	01/15/04	0.0053	-5.2400	0.68	0.4728
16	923A	12/01/05	0.0056459	-5.1768	0.73	0.6046
17	923A	12/05/00	0.006	-5.1160	0.77	0.7479
18	923A	06/18/02	0.006	-5.1160	0.82	0.9085
19	923A	12/07/99	0.0061	-5.0995	0.86	1.0968
20	923A	12/16/97	0.007	-4.9618	0.91	1.3352
21	923A	12/11/98	0.009	-4.7105	0.95	1.6906

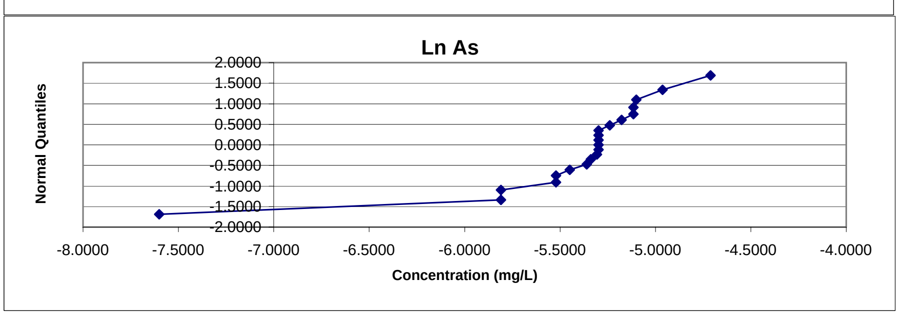
Maximum	0.009	
Mean	0.0049	-5.4109
Stdev	0.0017	0.5598
Standard Error	0.0004	0.1222
Student t-test Value	1.725	
Tolerance Factor	1.7656	
Upper Limit 95%-95% Tolerance Interval	**0.0078**	**0.0120**

Normality Tests

Skew	-0.2545	-3.1780
	Normal	Skewed
Shapiro-Wilk (W)	0.9161	0.6420
Shapiro-Wilk (Wc)	0.908	
	Normal	Non-normal
Correlation Coeff	0.9348	0.7692
Critical Correlation Coeff	0.952	
	Non-normal	Non-normal

Selected Trigger Concentration (UCL) (mg/L)	**0.0078**





Well 923B Statistics - Preliminary

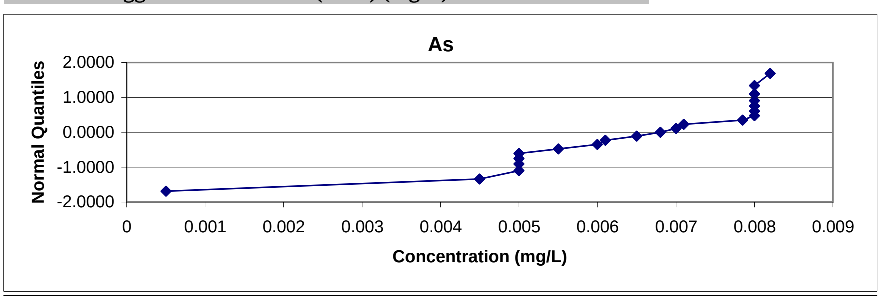
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	923B	12/13/95	0.0005	-7.6009	0.05	-1.6906
2	923B	12/20/02	0.0045	-5.4037	0.09	-1.3352
3	923B	12/16/96	0.005	-5.2983	0.14	-1.0968
4	923B	12/16/97	0.005	-5.2983	0.18	-0.9085
5	923B	06/15/01	0.005	-5.2983	0.23	-0.7479
6	923B	12/03/01	0.005	-5.2983	0.27	-0.6046
7	923B	01/15/04	0.0055	-5.2030	0.32	-0.4728
8	923B	12/05/00	0.006	-5.1160	0.36	-0.3488
9	923B	07/07/00	0.0061	-5.0995	0.41	-0.2299
10	923B	12/14/04	0.0065	-5.0360	0.45	-0.1142
11	923B	06/28/04	0.0068	-4.9908	0.50	0.0000
12	923B	06/18/02	0.007	-4.9618	0.55	0.1142
13	923B	12/07/99	0.0071	-4.9477	0.59	0.2299
14	923B	12/01/05	0.0078505	-4.8472	0.64	0.3488
15	923B	06/11/96	0.008	-4.8283	0.68	0.4728
16	923B	06/25/97	0.008	-4.8283	0.73	0.6046
17	923B	06/16/98	0.008	-4.8283	0.77	0.7479
18	923B	12/11/98	0.008	-4.8283	0.82	0.9085
19	923B	07/01/99	0.008	-4.8283	0.86	1.0968
20	923B	07/18/03	0.008	-4.8283	0.91	1.3352
21	923B	06/15/05	0.0082	-4.8035	0.95	1.6906

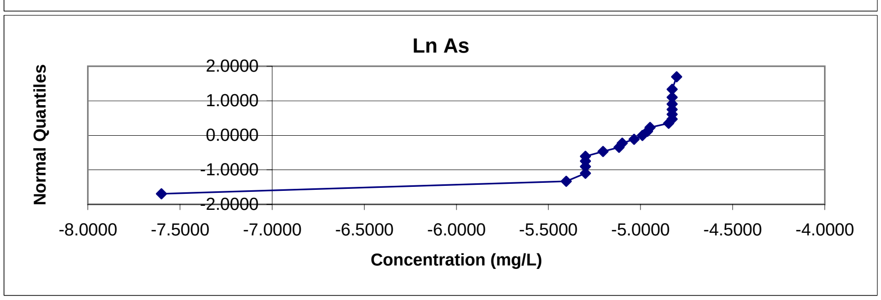
	As	Ln As
Maximum	0.0082	
Mean	0.0064	-5.1511
Stdev	0.0019	0.5964
Standard Error	0.0004	0.1301
Student t-test Value	1.725	
Tolerance Factor	1.7656	
Upper Limit 95%-95% Tolerance Interval	**0.0097**	**0.0166**

Normality Tests

	As	Ln As
Skew	-1.6069	-3.7620
	Skewed	Skewed
Shapiro-Wilk (W)	0.8208	0.5197
Shapiro-Wilk (Wc)	0.908	
	Non-normal	Non-normal
Correlation Coeff	0.8987	0.6925
Critical Correlation Coeff	0.952	
	Non-normal	Non-normal

Selected Trigger Concentration (UCL) (mg/L) **0.0082** **Non-Parametric**





Well 923C Statistics - Preliminary

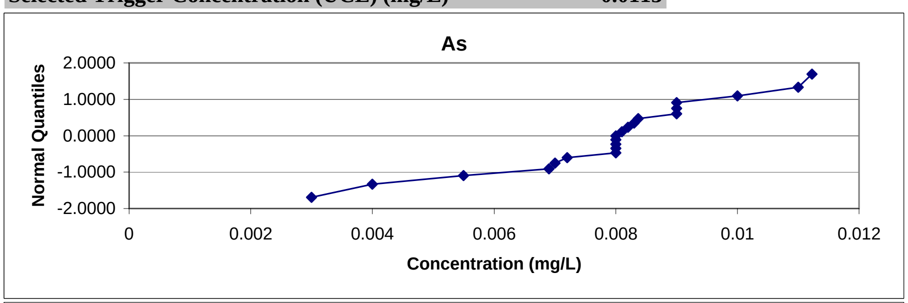
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	923C	06/15/01	0.003	-5.8091	0.05	-1.6906
2	923C	12/19/95	0.004	-5.5215	0.09	-1.3352
3	923C	12/16/96	0.0055	-5.2030	0.14	-1.0968
4	923C	01/15/04	0.0069	-4.9762	0.18	-0.9085
5	923C	12/03/01	0.007	-4.9618	0.23	-0.7479
6	923C	07/07/00	0.0072	-4.9337	0.27	-0.6046
7	923C	12/20/02	0.008	-4.8283	0.32	-0.4728
8	923C	06/16/98	0.008	-4.8283	0.36	-0.3488
9	923C	12/16/97	0.008	-4.8283	0.41	-0.2299
10	923C	06/25/97	0.008	-4.8283	0.45	-0.1142
11	923C	06/11/96	0.008	-4.8283	0.50	0.0000
12	923C	12/07/99	0.0081	-4.8159	0.55	0.1142
13	923C	12/16/04	0.0082	-4.8036	0.59	0.2299
14	923C	06/28/04	0.0083	-4.7915	0.64	0.3488
15	923C	06/15/05	0.0084	-4.7834	0.68	0.4728
16	923C	06/18/02	0.009	-4.7105	0.73	0.6046
17	923C	12/05/00	0.009	-4.7105	0.77	0.7479
18	923C	07/01/99	0.009	-4.7105	0.82	0.9085
19	923C	07/18/03	0.01	-4.6052	0.86	1.0968
20	923C	12/14/98	0.011	-4.5099	0.91	1.3352
21	923C	12/01/05	0.0112263	-4.4895	0.95	1.6906

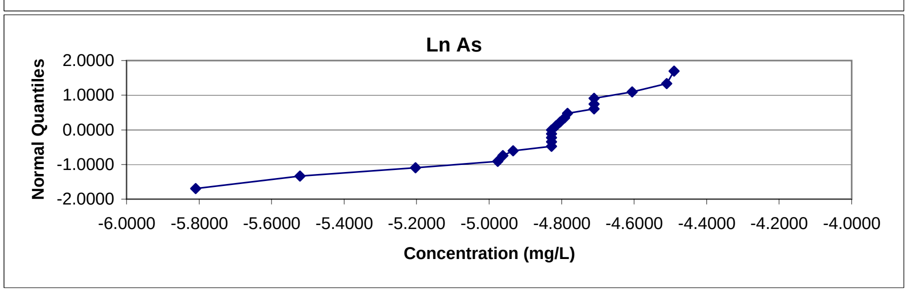
Maximum	0.0112263	
Mean	0.0079	-4.8799
Stdev	0.0020	0.3074
Standard Error	0.0004	0.0671
Student t-test Value	1.725	
Tolerance Factor	1.7656	
Upper Limit 95%-95% Tolerance Interval	**0.0113**	**0.0131**

Normality Tests

Skew	-0.8239	-1.8143
	Normal	Skewed
Shapiro-Wilk (W)	0.9065	0.8002
Shapiro-Wilk (Wc)	0.908	
	Non-normal	Non-normal
Correlation Coeff	0.9431	0.8805
Critical Correlation Coeff	0.952	
	Non-normal	Non-normal

Selected Trigger Concentration (UCL) (mg/L) **0.0113**





Well C8 Statistics - Preliminary Cohen Non-Detects Method

n	m	Well	Date	As (mg/L)	Ln As
1	1	C8	06/22/01	0.002	-6.2146081
2	2	C8	06/28/02	0.001	-6.90775528
3	3	C8	01/03/03	0.001	-6.90775528
4	1	C8	12/12/01	0.003	-5.80914299
5	2	C8	07/29/03	0.001	-6.90775528
6	3	C8	01/20/04	0.0030	-5.80914299
7	4	C8	07/07/04	0.0017	-6.37712703
8	5	C8	12/14/04	0.0018	-6.31996861
9	6	C8	06/16/05	0.0018078	-6.31564464
10	7	C8	12/06/05	0.0017436	-6.35180334

Mean of Detects	0.0020	-6.2701
Stdev of Detects	0.0007	0.3773
Variance of Detects	0.0000005	0.1424
h	0.3	
γ	0.531	0.350
λ	0.4949	0.4676
Adjusted Mean	0.0015	-6.5683
Adjusted Stdev	0.0010	0.5766

IDL varies, Cohen's only set up for 1 IDL - used 0.001

Note, Non-Detects highlighted

Well C8 Statistics - Preliminary

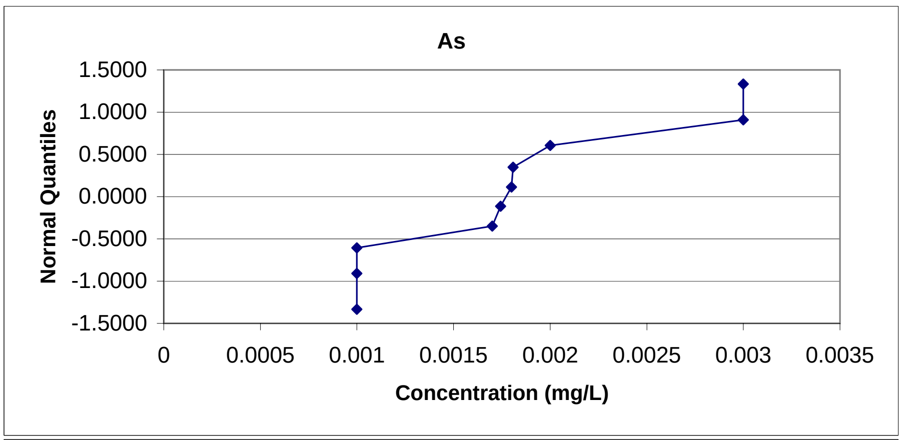
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	C8	06/28/02	0.001	-6.9078	0.09	-1.3352
2	C8	01/03/03	0.001	-6.9078	0.18	-0.9085
3	C8	07/29/03	0.001	-6.9078	0.27	-0.6046
4	C8	07/07/04	0.0017	-6.3771	0.36	-0.3488
5	C8	12/06/05	0.0017436	-6.3518	0.45	-0.1142
6	C8	12/14/04	0.0018	-6.3200	0.55	0.1142
7	C8	06/16/05	0.0018078	-6.3156	0.64	0.3488
8	C8	06/22/01	0.002	-6.2146	0.73	0.6046
9	C8	12/12/01	0.003	-5.8091	0.82	0.9085
10	C8	01/20/04	0.0030	-5.8091	0.91	1.3352

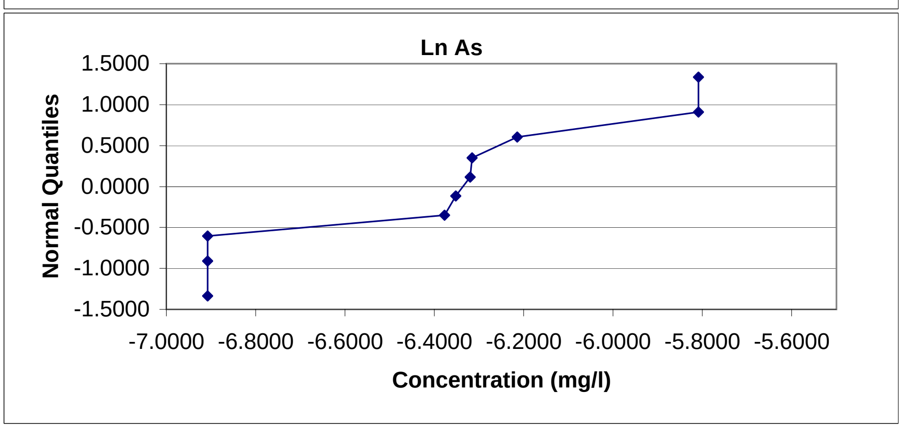
Maximum	0.003	
Mean	0.0015	-6.5683
Stdev	0.0010	0.5766
Standard Error	0.0003	0.1823
Student t-test Value	1.833	
Tolerance Factor	1.9225	
Upper Limit 95%-95% Tolerance Interval	**0.0035**	**0.0043**

Normality Tests

Skew	0.6496	-0.0175
	Normal	Normal
Shapiro-Wilk (W)	0.1353	0.4413
Shapiro-Wilk (Wc)	0.842	
	Non-normal	Non-normal
Correlation Coeff	0.9351	0.9458
Critical Correlation Coeff	0.917	
	Normal	Normal

Selected Trigger Concentration (UCL) (mg/L) **0.0043**





Well C21 Statistics - Preliminary Cohen Non-Detects Method

n	m	Well	Date	As (mg/L)	Ln As
1	1	C21	07/29/03	0.00052	-7.56168175
2	2	C21	06/28/02	0.001	-6.90775528
3	3	C21	01/03/03	0.001	-6.90775528
4	4	C21	06/22/01	0.002	-6.2146081
5	1	C21	12/12/01	0.001	-6.90775528
6	2	C21	12/06/05	0.0013539	-6.60476596
7	3	C21	06/16/05	0.0014588	-6.5301411
8	4	C21	07/07/04	0.0015	-6.50229017
9	5	C21	12/14/04	0.0016	-6.43775165
10	6	C21	01/20/04	0.0022	-6.11929792

Mean of Detects	0.0015	-6.5170
Stdev of Detects	0.0004	0.2550
Variance of Detects	0.0000002	0.0650
h	0.4	
γ	0.155	0.060
λ	0.6373	0.6128
Adjusted Mean	0.0009	-7.1572
Adjusted Stdev	0.0009	0.8566

IDL varies, Cohen's only set up for 1 IDL - used 0.00052

Note, Non-Detects highlighted

Well C21 Statistics - Preliminary

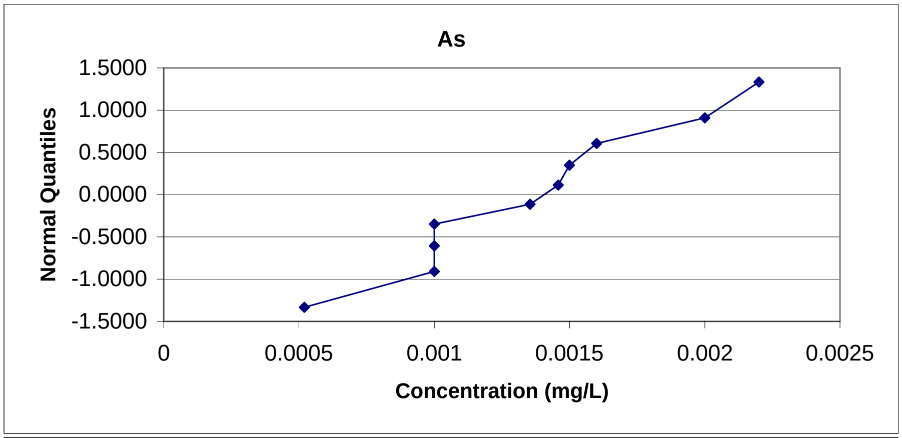
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	C21	07/29/03	0.00052	-7.5617	0.09	-1.3352
2	C21	12/12/01	0.001	-6.9078	0.18	-0.9085
3	C21	06/28/02	0.001	-6.9078	0.27	-0.6046
4	C21	01/03/03	0.001	-6.9078	0.36	-0.3488
5	C21	12/06/05	0.0013539	-6.6048	0.45	-0.1142
6	C21	06/16/05	0.0014588	-6.5301	0.55	0.1142
7	C21	07/07/04	0.0015	-6.5023	0.64	0.3488
8	C21	12/14/04	0.0016	-6.4378	0.73	0.6046
9	C21	06/22/01	0.002	-6.2146	0.82	0.9085
10	C21	01/20/04	0.0022	-6.1193	0.91	1.3352

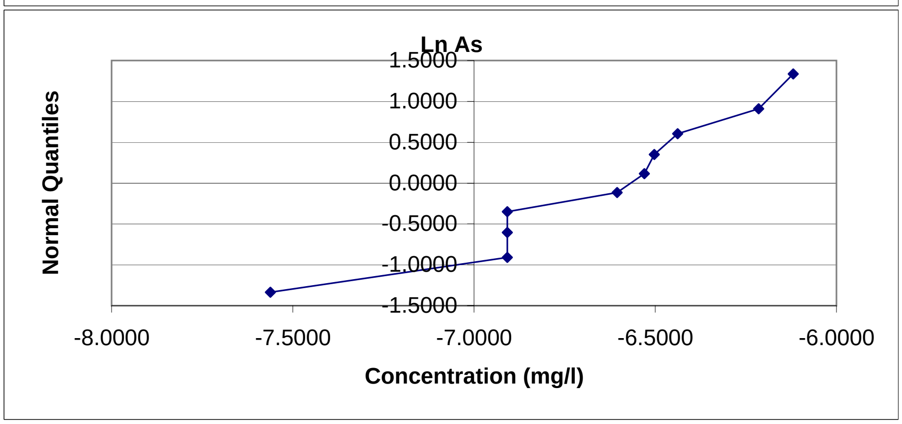
Maximum	0.0022	
Mean	0.0009	-7.1572
Stdev	0.0009	0.8566
Standard Error	0.0003	0.2709
Student t-test Value	1.833	
Tolerance Factor	1.9225	
Upper Limit 95%-95% Tolerance Interval	**0.0026**	**0.0040**

Normality Tests

Skew	0.1263	-0.8874
	Normal	Normal
Shapiro-Wilk (W)	0.3111	0.2214
Shapiro-Wilk (Wc)	0.842	
	Non-normal	Non-normal
Correlation Coeff	0.9794	0.9536
Critical Correlation Coeff	0.917	
	Normal	Normal

Selected Trigger Concentration (UCL) (mg/L) **0.0040**





Well DB-001 Statistics - Preliminary

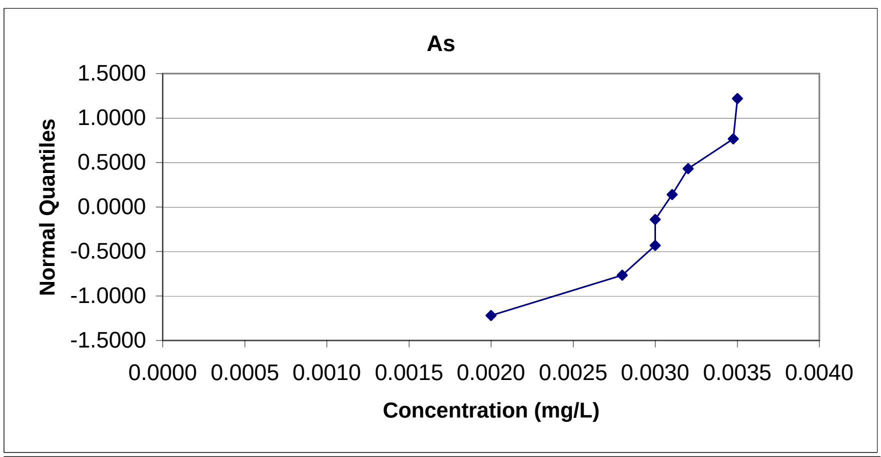
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	DB-001	07/30/03	0.0020	-6.2146	0.11	-1.2206
2	DB-001	01/20/04	0.0028	-5.8781	0.22	-0.7647
3	DB-001	06/20/01	0.003	-5.8091	0.33	-0.4307
4	DB-001	01/02/03	0.0030	-5.8091	0.44	-0.1397
5	DB-001	06/16/05	0.0031026	-5.7755	0.56	0.1397
6	DB-001	12/16/04	0.0032	-5.7446	0.67	0.4307
7	DB-001	12/06/05	0.003475	-5.6622	0.78	0.7647
8	DB-001	07/07/04	0.0035	-5.6550	0.89	1.2206

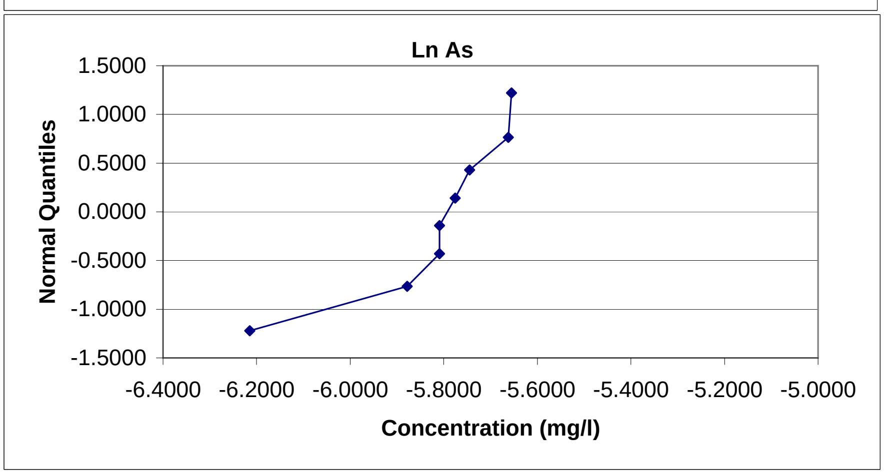
	As (mg/L)	Ln As
Maximum	0.0035	
Mean	0.0030	-5.8185
Stdev	0.0005	0.1769
Standard Error	0.0002	0.0626
Student t-test Value	1.895	
Tolerance Factor	2.0100	
Upper Limit 95%-95% Tolerance Interval	**0.0040**	**0.0042**

Normality Tests

Skew	-1.4631	-1.8455
	Skewed	Skewed
Shapiro-Wilk (W)	0.8625	0.8056
Shapiro-Wilk (Wc)	0.818	
	Normal	Non-normal
Correlation Coeff	0.9162	0.8811
Critical Correlation Coeff	0.905	
	Normal	Non-normal

Selected Trigger Concentration (UCL) (mg/L) **0.0040**





Well DB-007 Statistics - Preliminary Cohen Non-Detects Method

n	m	Well	Date	As (mg/L)	Ln As
1	1	DB-007	07/30/03	0.00052	-7.56168175
2	2	DB-007	01/20/04	0.00072	-7.23625935
3	3	DB-007	12/12/01	0.001	-6.90775528
4	4	DB-007	07/02/02	0.001	-6.90775528
5	5	DB-007	06/21/01	0.002	-6.2146081
6	1	DB-007	12/16/04	0.001	-6.72543372
7	2	DB-007	06/16/05	0.001	-6.6765642
8	3	DB-007	07/07/04	0.0013	-6.64539101
9	4	DB-007	12/06/05	0.0014	-6.56381103
10	5	DB-007	01/02/03	0.002	-6.2146081
11	6	DB-007	01/05/01	0.003	-5.80914299

Mean of Detects	0.0017	-6.4392
Stdev of Detects	0.0007	0.3588
Variance of Detects	0.0000005	0.1287
h	0.45	
γ	0.357	0.102
λ	0.8077	0.7406
Adjusted Mean	0.0007	-7.2705
Adjusted Stdev	0.0013	1.0305

IDL varies, Cohen's only set up for 1 IDL - used 0.00052

Note, Non-Detects highlighted

Well DB-007 Statistics - Preliminary

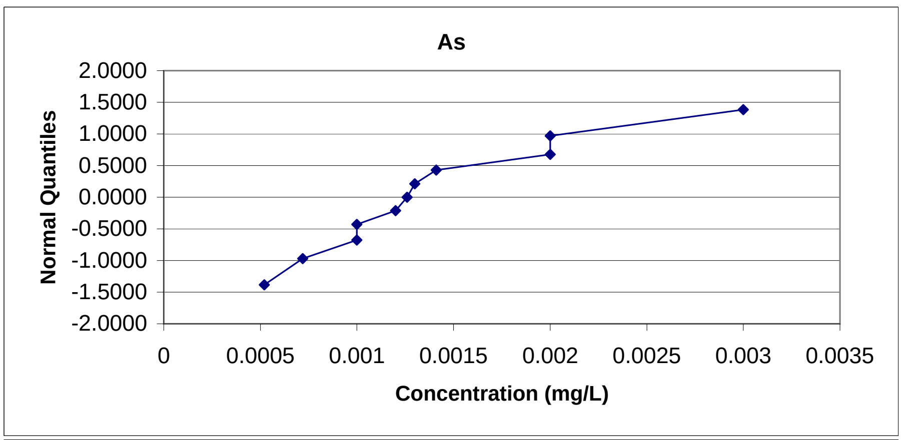
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	DB-007	07/30/03	0.00052	-7.5617	0.08	-1.3830
2	DB-007	01/20/04	0.00072	-7.2363	0.17	-0.9674
3	DB-007	12/12/01	0.001	-6.9078	0.25	-0.6745
4	DB-007	07/02/02	0.001	-6.9078	0.33	-0.4307
5	DB-007	12/16/04	0.001	-6.7254	0.42	-0.2104
6	DB-007	06/16/05	0.001	-6.6766	0.50	0.0000
7	DB-007	07/07/04	0.0013	-6.6454	0.58	0.2104
8	DB-007	12/06/05	0.0014	-6.5638	0.67	0.4307
9	DB-007	06/21/01	0.002	-6.2146	0.75	0.6745
10	DB-007	01/02/03	0.002	-6.2146	0.83	0.9674
11	DB-007	01/05/01	0.003	-5.8091	0.92	1.3830

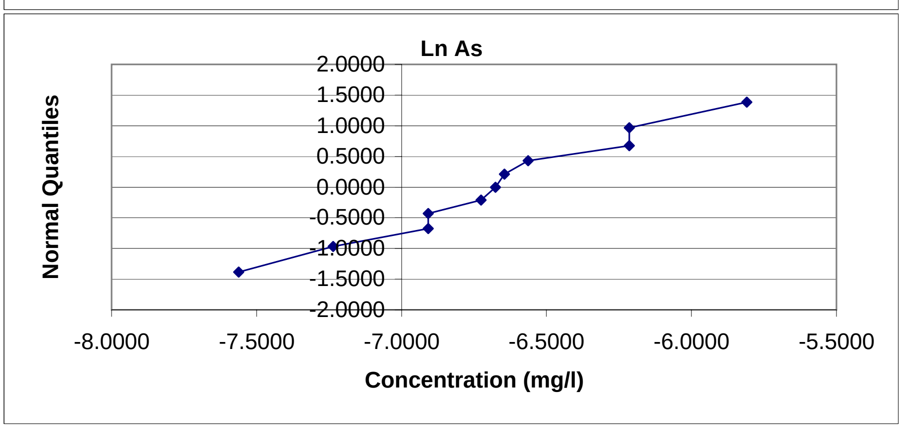
Maximum	0.003	
Mean	0.0007	-7.2705
Stdev	0.0013	1.0305
Standard Error	0.0004	0.3107
Student t-test Value	1.812	
Tolerance Factor	1.8926	
Upper Limit 95%-95% Tolerance Interval	**0.0031**	**0.0049**

Normality Tests

Skew	1.2014	-0.0298
	Skewed	Normal
Shapiro-Wilk (W)	0.2754	0.2209
Shapiro-Wilk (Wc)	0.850	
	Non-normal	Non-normal
Correlation Coeff	0.9409	0.9824
Critical Correlation Coeff	0.922	
	Normal	Normal

Selected Trigger Concentration (UCL) (mg/L)	**0.0049**





Well DB-035 Statistics - Preliminary Cohen Non-Detects Method

n	m	Well	Date	As (mg/L)	Ln As
1	1	DB-035	1/2/03	0.001	-6.90775528
2	2	DB-035	7/31/03	0.00052	-7.56168175
3	1	DB-035	1/6/01	0.003	-5.80914299
4	2	DB-035	12/12/01	0.002	-6.2146081
5	3	DB-035	1/20/04	0.0021	-6.16581793
6	4	DB-035	7/7/04	0.0015	-6.50229017
7	5	DB-035	12/14/04	0.0015	-6.50229017
8	6	DB-035	12/06/05	0.001495	-6.50562907
9	7	DB-035	6/16/05	0.0016	-6.46191628

Mean of Detects	0.0019	-6.3088
Stdev of Detects	0.0006	0.2633
Variance of Detects	0.0000003	0.0693
h	0.22	
γ	0.167	0.044
λ	0.2986	0.2804
Adjusted Mean	0.0015	-6.6601
Adjusted Stdev	0.0009	0.7138

IDL varies, Cohen's only set up for 1 IDL - used 0.00052

Note, Non-Detects highlighted

Well DB-035 Statistics - Preliminary

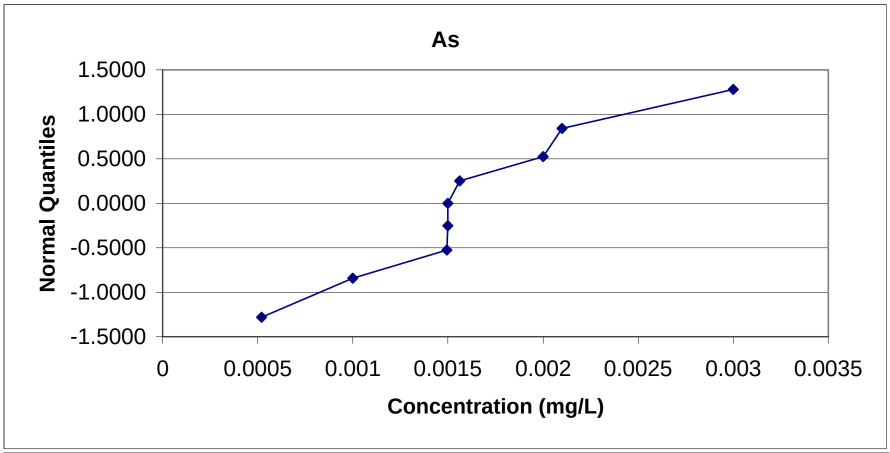
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	DB-035	07/31/03	0.00052	-7.5617	0.10	-1.2816
2	DB-035	01/02/03	0.0010	-6.9078	0.20	-0.8416
3	DB-035	12/06/05	0.001495	-6.5056	0.30	-0.5244
4	DB-035	07/07/04	0.0015	-6.5023	0.40	-0.2533
5	DB-035	12/14/04	0.0015	-6.5023	0.50	0.0000
6	DB-035	06/16/05	0.0016	-6.4619	0.60	0.2533
7	DB-035	12/12/01	0.0020	-6.2146	0.70	0.5244
8	DB-035	01/20/04	0.0021	-6.1658	0.80	0.8416
9	DB-035	01/06/01	0.003	-5.8091	0.90	1.2816

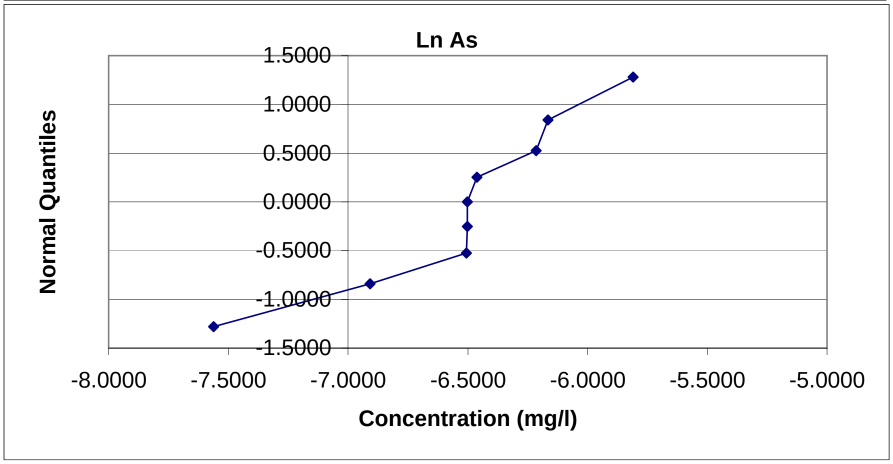
Maximum	0.003	
Mean	0.0015	-6.6601
Stdev	0.0009	0.7138
Standard Error	0.0003	0.2379
Student t-test Value	1.860	
Tolerance Factor	1.9606	
Upper Limit 95%-95% Tolerance Interval	**0.0033**	**0.0052**

Normality Tests

Skew	0.5116	-1.0420
	Normal	Skewed
Shapiro-Wilk (W)	0.5366	0.4366
Shapiro-Wilk (Wc)	0.829	
	Non-normal	Non-normal
Correlation Coeff	0.9547	0.9333
Critical Correlation Coeff	0.912	
	Normal	Normal

Selected Trigger Concentration (UCL) (mg/L) **0.0033**





Well DB-039 Statistics - Preliminary

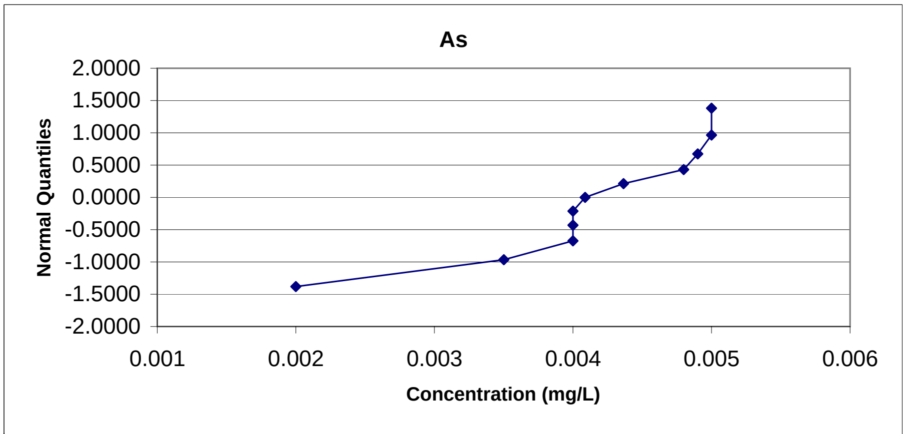
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	DB-039	06/28/02	0.002	-6.2146	0.08	-1.3830
2	DB-039	07/07/04	0.0035	-5.6550	0.17	-0.9674
3	DB-039	06/22/01	0.004	-5.5215	0.25	-0.6745
4	DB-039	01/02/03	0.004	-5.5215	0.33	-0.4307
5	DB-039	07/31/03	0.004	-5.5215	0.42	-0.2104
6	DB-039	12/06/05	0.0040888	-5.4995	0.50	0.0000
7	DB-039	06/16/05	0.0044	-5.4341	0.58	0.2104
8	DB-039	12/14/04	0.0048	-5.3391	0.67	0.4307
9	DB-039	01/21/04	0.0049	-5.3185	0.75	0.6745
10	DB-039	01/03/01	0.005	-5.2983	0.83	0.9674
11	DB-039	12/14/01	0.005	-5.2983	0.92	1.3830

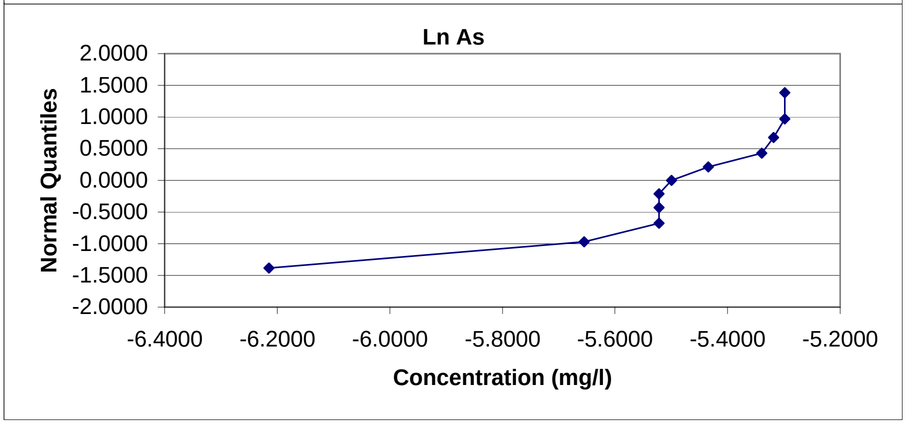
Maximum	0.005	
Mean	0.0042	-5.5111
Stdev	0.0009	0.2606
Standard Error	0.0003	0.0786
Student t-test Value	1.812	
Tolerance Factor	1.8926	
Upper Limit 95%-95% Tolerance Interval	**0.0058**	**0.0066**

Normality Tests

Skew	-1.5328	-2.2043
	Skewed	Skewed
Shapiro-Wilk (W)	0.8368	0.7410
Shapiro-Wilk (Wc)	0.850	
	Non-normal	Non-normal
Correlation Coeff	0.9049	0.8426
Critical Correlation Coeff	0.922	
	Non-normal	Non-normal

Selected Trigger Concentration (UCL) (mg/L) **0.0050** **Non-Parametric**





Well DH1 Statistics - Preliminary

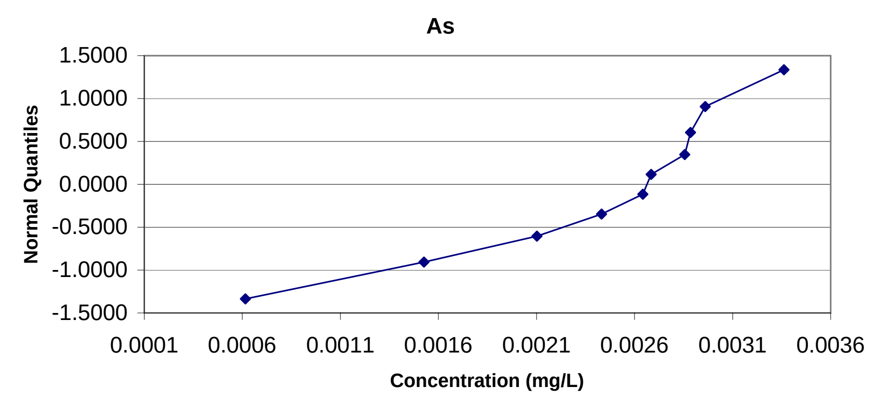
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	DH1	06/16/05	0.00061523	-7.3935	0.09	-1.3352
2	DH1	05/05/05	0.0015263	-6.4849	0.18	-0.9085
3	DH1	05/25/05	0.00210205	-6.1648	0.27	-0.6046
4	DH1	02/18/05	0.00243175	-6.0191	0.36	-0.3488
5	DH1	02/04/05	0.0026416	-5.9364	0.45	-0.1142
6	DH1	01/19/05	0.00268425	-5.9204	0.55	0.1142
7	DH1	12/13/04	0.00285625	-5.8582	0.64	0.3488
8	DH1	04/14/05	0.0029	-5.8481	0.73	0.6046
9	DH1	03/29/05	0.0029608	-5.8223	0.82	0.9085
10	DH1	10/17/04	0.003361	-5.6955	0.91	1.3352

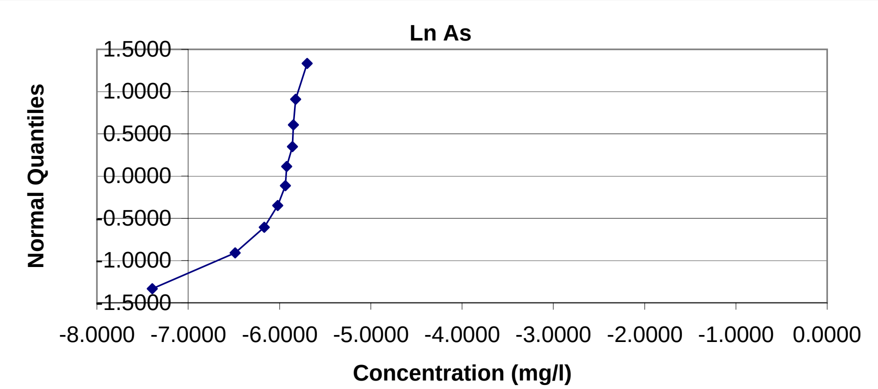
Maximum	0.003361	
Mean	0.0024	-6.1143
Stdev	0.0008	0.5002
Standard Error	0.0003	0.1582
Student t-test Value	1.833	
Tolerance Factor	1.9225	
Upper Limit 95%-95% Tolerance Interval	**0.0040**	**0.0058**

Normality Tests

Skew	-1.3702	-2.2156
	Skewed	Skewed
Shapiro-Wilk (W)	0.8789	0.7284
Shapiro-Wilk (Wc)	0.842	
	Normal	Non-normal
Correlation Coeff	0.9272	0.8335
Critical Correlation Coeff	0.917	
	Normal	Non-normal

Selected Trigger Concentration (UCL) (mg/L) **0.0040**





Well DH2 Statistics - Preliminary

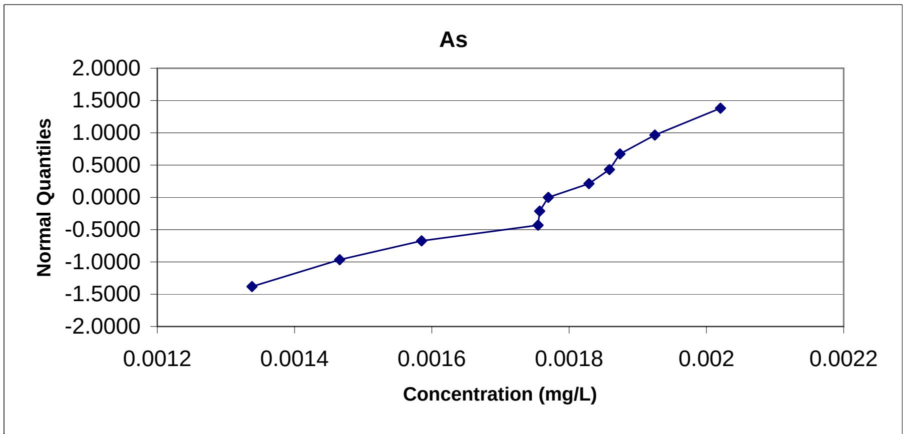
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	DH2	06/16/05	0.00133809	-6.6165	0.08	-1.3830
2	DH2	02/04/05	0.00146585	-6.5253	0.17	-0.9674
3	DH2	02/18/05	0.00158525	-6.4470	0.25	-0.6745
4	DH2	04/14/05	0.00175465	-6.3455	0.33	-0.4307
5	DH2	12/13/04	0.0017571	-6.3441	0.42	-0.2104
6	DH2	05/05/05	0.0017699	-6.3368	0.50	0.0000
7	DH2	11/14/04	0.001829	-6.3040	0.58	0.2104
8	DH2	05/25/05	0.00185855	-6.2880	0.67	0.4307
9	DH2	01/19/05	0.00187415	-6.2796	0.75	0.6745
10	DH2	10/17/04	0.001925	-6.2528	0.83	0.9674
11	DH2	03/29/05	0.0020	-6.2045	0.92	1.3830

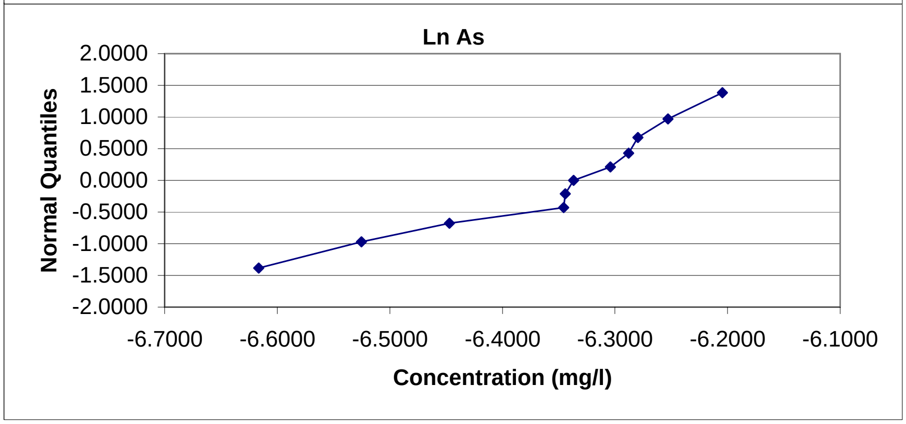
Maximum	0.0020204	
Mean	0.0017	-6.3586
Stdev	0.0002	0.1233
Standard Error	0.0001	0.0372
Student t-test Value	1.812	
Tolerance Factor	1.8926	
Upper Limit 95%-95% Tolerance Interval	**0.0021**	**0.0022**

Normality Tests

Skew	-0.8730	-1.0832
	Normal	Skewed
Shapiro-Wilk (W)	0.9254	0.8996
Shapiro-Wilk (Wc)	0.850	
	Normal	Normal
Correlation Coeff	0.9595	0.9447
Critical Correlation Coeff	0.922	
	Normal	Normal

Selected Trigger Concentration (UCL) (mg/L) **0.0021**





Well G Statistics - Preliminary

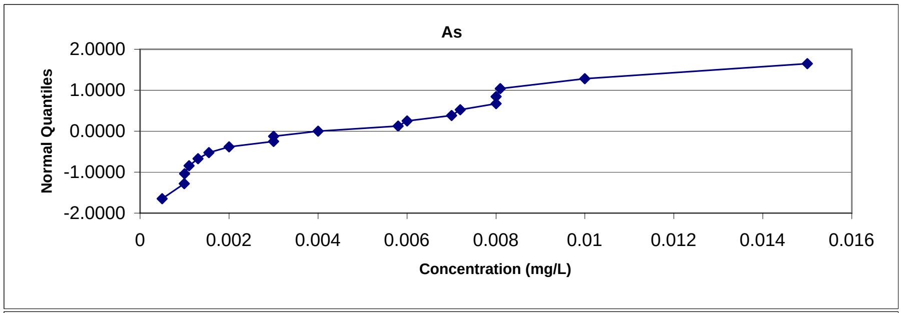
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	G	12/11/96	0.0005	-7.6009	0.05	-1.6449
2	G	11/28/05	0.0009919	-6.9159	0.10	-1.2816
3	G	12/06/00	0.001	-6.9078	0.15	-1.0364
4	G	12/16/04	0.0011	-6.8124	0.20	-0.8416
5	G	06/28/04	0.0013	-6.6454	0.25	-0.6745
6	G	06/15/05	0.0015	-6.4720	0.30	-0.5244
7	G	12/19/02	0.002	-6.2146	0.35	-0.3853
8	G	07/08/99	0.003	-5.8091	0.40	-0.2533
9	G	07/21/03	0.003	-5.8091	0.45	-0.1257
10	G	12/04/01	0.004	-5.5215	0.50	0.0000
11	G	12/03/99	0.0058	-5.1499	0.55	0.1257
12	G	06/18/97	0.006	-5.1160	0.60	0.2533
13	G	06/13/01	0.007	-4.9618	0.65	0.3853
14	G	01/12/04	0.0072	-4.9337	0.70	0.5244
15	G	06/16/98	0.008	-4.8283	0.75	0.6745
16	G	06/14/02	0.0080	-4.8283	0.80	0.8416
17	G	06/29/00	0.0081	-4.8159	0.85	1.0364
18	G	12/22/97	0.01	-4.6052	0.90	1.2816
19	G	12/10/98	0.015	-4.1997	0.95	1.6449

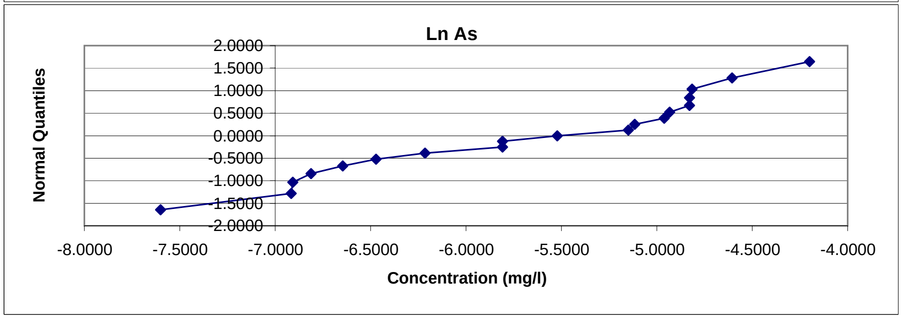
	As (mg/L)	Ln As
Maximum	0.015	
Mean	0.0049	-5.6920
Stdev	0.0039	0.9754
Standard Error	0.0009	0.2238
Student t-test Value	1.734	
Tolerance Factor	1.7790	
Upper Limit 95%-95% Tolerance Interval	**0.0119**	**0.0191**

Normality Tests

	As (mg/L)	Ln As
Skew	0.9168	-0.3836
	Normal	Normal
Shapiro-Wilk (W)	0.8963	0.9340
Shapiro-Wilk (Wc)	0.901	
	Non-normal	Normal
Correlation Coeff	0.9477	0.9734
Critical Correlation Coeff	0.947	
	Normal	Normal

Selected Trigger Concentration (UCL) (mg/L) **0.0191**





Well HGD Statistics - Preliminary

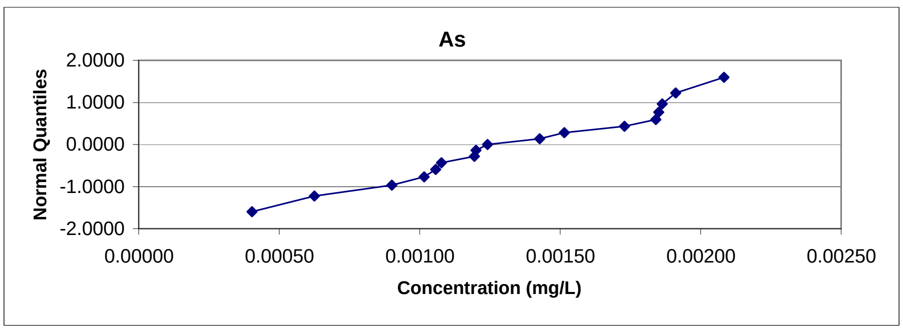
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	HGD	03/04/05	0.00040	-7.8168	0.06	-1.5932
2	HGD	06/16/05	0.00063	-7.3776	0.11	-1.2206
3	HGD	06/07/05	0.00090	-7.0127	0.17	-0.9674
4	HGD	05/17/05	0.00102	-6.8920	0.22	-0.7647
5	HGD	04/06/05	0.00106	-6.8521	0.28	-0.5895
6	HGD	04/26/05	0.00108	-6.8329	0.33	-0.4307
7	HGD	12/13/04	0.00119	-6.7302	0.39	-0.2822
8	HGD	05/08/04	0.00120	-6.7254	0.44	-0.1397
9	HGD	11/14/04	0.00124	-6.6917	0.50	0.0000
10	HGD	06/02/04	0.00143	-6.5519	0.56	0.1397
11	HGD	06/30/04	0.00151	-6.4926	0.61	0.2822
12	HGD	05/19/04	0.00173	-6.3600	0.67	0.4307
13	HGD	08/13/04	0.00184	-6.2974	0.72	0.5895
14	HGD	09/16/04	0.00185	-6.2924	0.78	0.7647
15	HGD	07/19/04	0.00186	-6.2856	0.83	0.9674
16	HGD	10/17/04	0.00191	-6.2599	0.89	1.2206
17	HGD	06/16/04	0.00208	-6.1740	0.94	1.5932

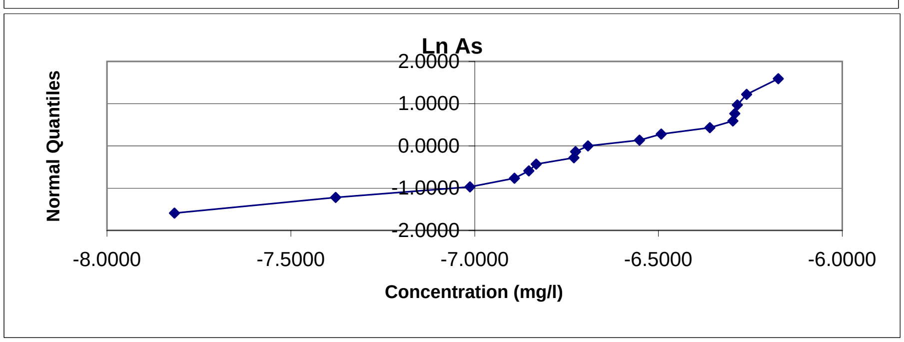
	As (mg/L)	Ln As
Maximum	0.00208297	
Mean	0.0013	-6.6850
Stdev	0.0005	0.4352
Standard Error	0.0001	0.1056
Student t-test Value	1.746	
Tolerance Factor	1.7966	
Upper Limit 95%-95% Tolerance Interval	**0.0022**	**0.0027**

Normality Tests

Skew	-0.2467	-1.2008
	Normal	Skewed
Shapiro-Wilk (W)	0.9546	0.8943
Shapiro-Wilk (Wc)	0.892	
	Normal	Normal
Correlation Coeff	0.9827	0.9420
Critical Correlation Coeff	0.942	
	Normal	Non-normal

Selected Trigger Concentration (UCL) (mg/L) **0.0022**





Well HGS Statistics - Preliminary

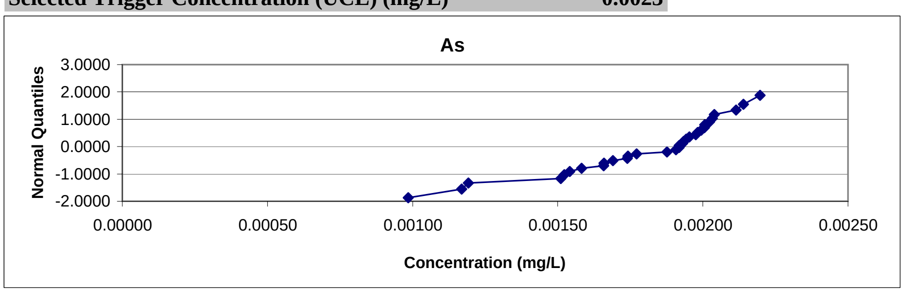
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	HGS	05/05/05	0.00099	-6.9226	0.03	-1.8764
2	HGS	03/04/05	0.00117	-6.7513	0.06	-1.5497
3	HGS	03/16/05	0.00119	-6.7316	0.09	-1.3352
4	HGS	02/18/05	0.00151	-6.4955	0.12	-1.1689
5	HGS	06/16/05	0.00152	-6.4874	0.15	-1.0300
6	HGS	07/09/04	0.00154	-6.4750	0.18	-0.9085
7	HGS	02/04/05	0.00158	-6.4493	0.21	-0.7991
8	HGS	06/30/04	0.00166	-6.4018	0.24	-0.6985
9	HGS	04/06/05	0.00166	-6.4014	0.27	-0.6046
10	HGS	03/29/05	0.00169	-6.3829	0.30	-0.5157
11	HGS	12/13/04	0.00174	-6.3537	0.33	-0.4307
12	HGS	07/19/04	0.00174	-6.3527	0.36	-0.3488
13	HGS	11/14/04	0.00177	-6.3358	0.39	-0.2691
14	HGS	01/19/05	0.00188	-6.2785	0.42	-0.1911
15	HGS	05/17/05	0.00191	-6.2623	0.45	-0.1142
16	HGS	09/16/04	0.00192	-6.2566	0.48	-0.0380
17	HGS	04/14/05	0.00192	-6.2564	0.52	0.0380
18	HGS	05/14/04	0.00193	-6.2502	0.55	0.1142
19	HGS	08/13/04	0.00193	-6.2484	0.58	0.1911
20	HGS	08/30/04	0.00194	-6.2440	0.61	0.2691
21	HGS	06/22/04	0.00195	-6.2383	0.64	0.3488
22	HGS	05/19/04	0.00198	-6.2271	0.67	0.4307
23	HGS	05/25/04	0.00198	-6.2236	0.70	0.5157
24	HGS	05/25/05	0.00199	-6.2177	0.73	0.6046
25	HGS	06/07/05	0.00200	-6.2122	0.76	0.6985
26	HGS	10/17/04	0.00201	-6.2115	0.79	0.7991
27	HGS	06/02/04	0.00202	-6.2030	0.82	0.9085
28	HGS	07/30/04	0.00203	-6.1981	0.85	1.0300
29	HGS	06/09/04	0.00204	-6.1951	0.88	1.1689
30	HGS	04/26/05	0.00211	-6.1589	0.91	1.3352
31	HGS	05/05/04	0.00214	-6.1469	0.94	1.5497
32	HGS	06/16/04	0.00220	-6.1208	0.97	1.8764

Maximum	0.00219661	
Mean	0.0018	-6.3341
Stdev	0.0003	0.1848
Standard Error	0.0001	0.0327
Student t-test Value	1.696	
Tolerance Factor	1.7223	
Upper Limit 95%-95% Tolerance Interval	**0.0023**	**0.0024**

Normality Tests

Skew	-1.2503	-1.6956
	Skewed	Skewed
Shapiro-Wilk (W)	0.9631	0.8219
Shapiro-Wilk (Wc)	0.930	
	Normal	Non-normal
Correlation Coeff	0.9369	0.8992
Critical Correlation Coeff	0.966	
	Non-normal	Non-normal

Selected Trigger Concentration (UCL) (mg/L) **0.0023**



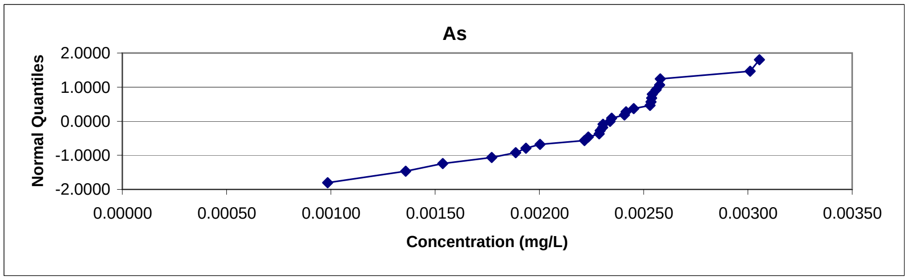
Well MM2 Statistics - Preliminary

n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	MM2	09/16/04	0.00098	-6.9231	0.04	-1.8027
2	MM2	03/04/05	0.00136	-6.6015	0.07	-1.4652
3	MM2	03/16/05	0.00154	-6.4780	0.11	-1.2419
4	MM2	11/14/04	0.00177	-6.3358	0.14	-1.0676
5	MM2	06/16/05	0.00189	-6.2730	0.18	-0.9208
6	MM2	03/29/05	0.00193	-6.2477	0.21	-0.7916
7	MM2	04/06/05	0.00200	-6.2133	0.25	-0.6745
8	MM2	04/26/05	0.00222	-6.1117	0.29	-0.5659
9	MM2	10/17/04	0.00223	-6.1038	0.32	-0.4637
10	MM2	06/07/05	0.00229	-6.0805	0.36	-0.3661
11	MM2	04/14/05	0.00229	-6.0787	0.39	-0.2719
12	MM2	07/09/04	0.00230	-6.0732	0.43	-0.1800
13	MM2	05/17/05	0.00230	-6.0729	0.46	-0.0896
14	MM2	05/25/05	0.00234	-6.0583	0.50	0.0000
15	MM2	07/19/04	0.00235	-6.0545	0.54	0.0896
16	MM2	05/05/05	0.00241	-6.0290	0.57	0.1800
17	MM2	06/30/04	0.00242	-6.0255	0.61	0.2719
18	MM2	05/25/04	0.00245	-6.0107	0.64	0.3661
19	MM2	08/13/04	0.00253	-5.9793	0.68	0.4637
20	MM2	07/30/04	0.00254	-5.9774	0.71	0.5659
21	MM2	06/02/04	0.00254	-5.9760	0.75	0.6745
22	MM2	08/30/04	0.00254	-5.9751	0.79	0.7916
23	MM2	05/14/04	0.00256	-5.9677	0.82	0.9208
24	MM2	06/22/04	0.00258	-5.9613	0.86	1.0676
25	MM2	06/09/04	0.00258	-5.9603	0.89	1.2419
26	MM2	06/16/04	0.00301	-5.8053	0.93	1.4652
27	MM2	05/19/04	0.00306	-5.7907	0.96	1.8027

Maximum	0.00305583	
Mean	0.0023	-6.1172
Stdev	0.0005	0.2409
Standard Error	0.0001	0.0464
Student t-test Value	1.706	
Tolerance Factor	1.7373	
Upper Limit 95%-95% Tolerance Interval	**0.0031**	**0.0034**

Normality Tests		
Skew	-0.9953	-1.8161
	Normal	Skewed
Shapiro-Wilk (W)	0.9560	0.8226
Shapiro-Wilk (Wc)	0.923	
	Normal	Non-normal
Correlation Coeff	0.9442	0.8923
Critical Correlation Coeff	0.96	
	Non-normal	Non-normal

Selected Trigger Concentration (UCL) (mg/L)	**0.0031**



Well MW-5 Statistics - Preliminary

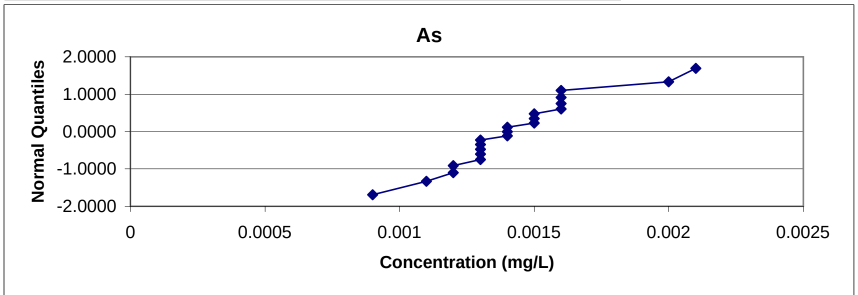
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	MW-5	06/03/02	0.0009	-7.0131	0.05	-1.6906
2	MW-5	05/15/97	0.0011	-6.8124	0.09	-1.3352
3	MW-5	03/07/01	0.0012	-6.7254	0.14	-1.0968
4	MW-5	06/13/01	0.0012	-6.7254	0.18	-0.9085
5	MW-5	02/29/00	0.0013	-6.6454	0.23	-0.7479
6	MW-5	03/12/02	0.0013	-6.6454	0.27	-0.6046
7	MW-5	04/07/03	0.0013	-6.6454	0.32	-0.4728
8	MW-5	07/08/03	0.0013	-6.6454	0.36	-0.3488
9	MW-5	05/11/05	0.0013	-6.6454	0.41	-0.2299
10	MW-5	11/13/97	0.0014	-6.5713	0.45	-0.1142
11	MW-5	06/29/99	0.0014	-6.5713	0.50	0.0000
12	MW-5	06/22/00	0.0014	-6.5713	0.55	0.1142
13	MW-5	03/10/98	0.0015	-6.5023	0.59	0.2299
14	MW-5	02/24/99	0.0015	-6.5023	0.64	0.3488
15	MW-5	07/21/04	0.0015	-6.5023	0.68	0.4728
16	MW-5	02/25/97	0.0016	-6.4378	0.73	0.6046
17	MW-5	08/19/97	0.0016	-6.4378	0.77	0.7479
18	MW-5	05/27/98	0.0016	-6.4378	0.82	0.9085
19	MW-5	03/25/04	0.0016	-6.4378	0.86	1.0968
20	MW-5	11/27/96	0.002	-6.2146	0.91	1.3352
21	MW-5	11/07/95	0.0021	-6.1658	0.95	1.6906

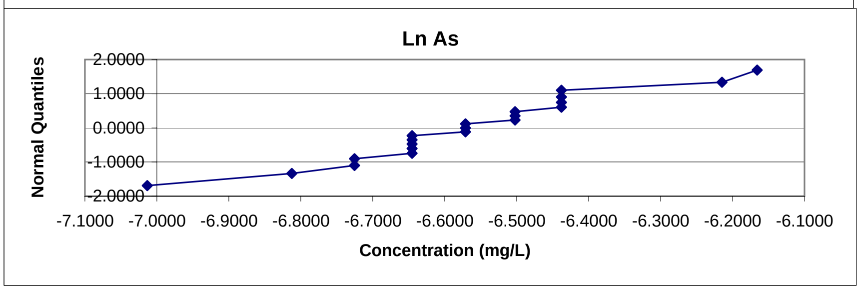
Maximum	0.0021	
Mean	0.0014	-6.5645
Stdev	0.0003	0.1877
Standard Error	0.0001	0.0410
Student t-test Value	1.725	
Tolerance Factor	1.7656	
Upper Limit 95%-95% Tolerance Interval	**0.0019**	**0.0020**

Normality Tests

Skew	0.7405	-0.0112
	Normal	Normal
Shapiro-Wilk (W)	0.9275	0.9513
Shapiro-Wilk (Wc)	0.908	
	Normal	Normal
Correlation Coeff	0.9528	0.9643
Critical Correlation Coeff	0.952	
	Normal	Normal

Selected Trigger Concentration (UCL) (mg/L) **0.0020**





Well MW-7 Statistics - Preliminary

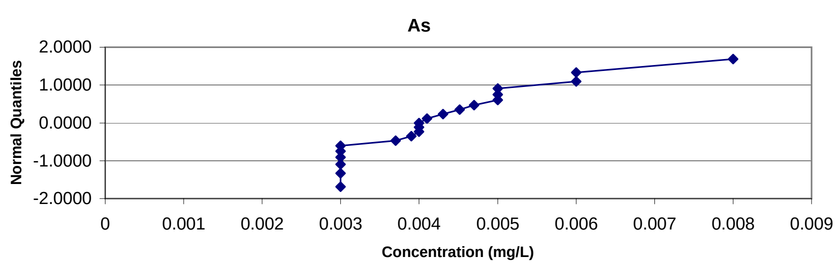
n	Well	Date	As (mg/L)	Ln As	qi	Normal Quantile
1	MW-7	12/11/95	0.003	-5.8091	0.05	-1.6906
2	MW-7	06/11/96	0.003	-5.8091	0.09	-1.3352
3	MW-7	12/13/96	0.003	-5.8091	0.14	-1.0968
4	MW-7	06/19/97	0.003	-5.8091	0.18	-0.9085
5	MW-7	06/15/98	0.003	-5.8091	0.23	-0.7479
6	MW-7	07/21/03	0.003	-5.8091	0.27	-0.6046
7	MW-7	12/06/99	0.0037	-5.5994	0.32	-0.4728
8	MW-7	06/23/04	0.0039	-5.5468	0.36	-0.3488
9	MW-7	07/01/99	0.004	-5.5215	0.41	-0.2299
10	MW-7	12/04/01	0.004	-5.5215	0.45	-0.1142
11	MW-7	12/18/02	0.0040	-5.5215	0.50	0.0000
12	MW-7	06/29/00	0.0041	-5.4968	0.55	0.1142
13	MW-7	06/15/05	0.0043	-5.4484	0.59	0.2299
14	MW-7	11/30/05	0.0045175	-5.3998	0.64	0.3488
15	MW-7	12/14/04	0.0047	-5.3602	0.68	0.4728
16	MW-7	12/04/00	0.005	-5.2983	0.73	0.6046
17	MW-7	06/15/01	0.005	-5.2983	0.77	0.7479
18	MW-7	06/14/02	0.005	-5.2983	0.82	0.9085
19	MW-7	12/16/97	0.006	-5.1160	0.86	1.0968
20	MW-7	01/07/04	0.006	-5.1160	0.91	1.3352
21	MW-7	12/08/98	0.008	-4.8283	0.95	1.6906

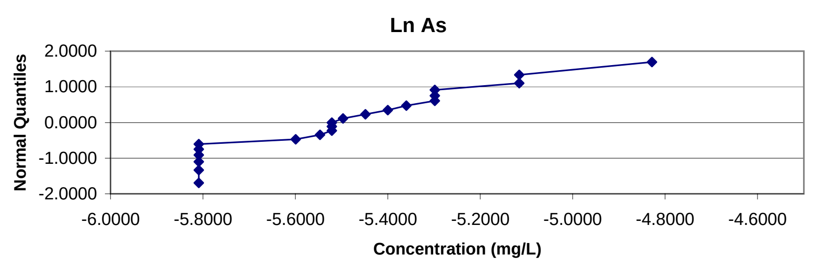
	As (mg/L)	Ln As
Maximum	0.008	
Mean	0.0043	-5.4869
Stdev	0.0013	0.2724
Standard Error	0.0003	0.0594
Student t-test Value	1.725	
Tolerance Factor	1.7656	
Upper Limit 95%-95% Tolerance Interval	**0.0065**	**0.0067**

Normality Tests

Skew	1.3142	0.5696
	Skewed	Normal
Shapiro-Wilk (W)	0.8676	0.9159
Shapiro-Wilk (Wc)	0.908	
	Non-normal	Normal
Correlation Coeff	0.9279	0.9608
Critical Correlation Coeff	0.952	
	Non-normal	Normal

Selected Trigger Concentration (UCL) (mg/L) **0.0067**

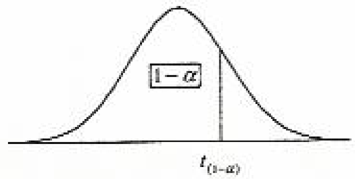




APPENDIX G

STATISTICAL TABLES

Table G-1. Critical Values of Student's t Distribution (One-Tailed)



Degrees of Freedom (see note)	*t* values for $(1-\alpha)$ or $(1-\beta)$								
	0.70	**0.75**	**0.80**	**0.85**	**0.90**	**0.95**	**0.975**	**0.99**	**0.995**
1	0.727	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657
2	0.617	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925
3	0.584	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841
4	0.569	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604
5	0.559	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032
6	0.553	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707
7	0.549	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499
8	0.546	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355
9	0.543	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250
10	0.542	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169
11	0.540	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106
12	0.539	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055
13	0.538	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012
14	0.537	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977
15	0.536	0.691	0.866	1.074	1.340	1.753	2.131	2.602	2.947
16	0.535	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921
17	0.534	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898
18	0.534	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878
19	0.533	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861
20	0.533	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845
21	0.532	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831
22	0.532	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819
23	0.532	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807
24	0.531	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797
25	0.531	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787
26	0.531	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779
27	0.531	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771
28	0.530	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763
29	0.530	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756
30	0.530	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750
40	0.529	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704
60	0.527	0.679	0.848	1.046	1.296	1.671	2.000	2.390	2.660
120	0.526	0.677	0.845	1.041	1.289	1.658	1.980	2.358	2.617
∞	0.524	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576

Note: For simple random or systematic sampling, degrees of freedom (df) are equal to the number of samples (n) collected from a solid waste and analyzed, less one (in other words, $df = n-1$). If stratified random sampling is used, calculate df using Equation 12 or 14 in Section 5.4.2.2.

The last row of the table (∞ degrees of freedom) gives the critical values for a standard normal distribution (z). For example, the z value for $1-\alpha$ where $\alpha = 0.10$ is found in the last row as 1.282.

TABLE A-1.

COEFFICIENTS $\{A_{N-I+1}\}$ FOR W TEST OF NORMALITY, FOR N=2(1)50

i/n	2	3	4	5	6	7	8	9	10
1	0.7071	0.7071	0.6872	0.6646	0.6431	0.6233	0.6052	0.5888	0.5739
2	----	.0000	.1677	.2413	.2806	.3031	.3164	.3244	.3291
3	----	----	----	.0000	.0875	.1401	.1743	.1976	.2141
4	----	----	----	----	----	.0000	.0561	.0947	.1224
5	----	----	----	----	----	----	----	.0000	.0399

i/n	11	12	13	14	15	16	17	18	19	20
1	0.5601	0.5475	0.5359	0.5251	0.5150	0.5056	0.4968	0.4886	0.4808	0.4734
2	.3315	.3325	.3325	.3318	.3306	.3290	.3273	.3253	.3232	.3211
3	.2260	.2347	.2412	.2460	.2495	.2521	.2540	.2553	.2561	.2565
4	.1429	.1586	.1707	.1802	.1878	.1939	.1988	.2027	.2059	.2085
5	.0695	.0922	.1099	.1240	.1353	.1447	.1524	.1587	.1641	.1686
6	0.0000	0.0303	0.0539	0.0727	0.0880	0.1005	0.1109	0.1197	0.1271	0.1334
7	----	----	.0000	.0240	.0433	.0593	.0725	.0837	.0932	.1013
8	----	----	----	----	.0000	.0196	.0359	.0496	.0612	.0711
9	----	----	----	----	----	----	.0000	.0163	.0303	.0422
10	----	----	----	----	----	----	----	----	.0000	.0140

i/n	21	22	23	24	25	26	27	28	29	30
1	0.4643	0.4590	0.4542	0.4493	0.4450	0.4407	0.4366	0.4328	0.4291	0.4254
2	.3185	.3156	.3126	.3098	.3069	.3043	.3018	.2992	.2968	.2944
3	.2578	.2571	.2563	.2554	.2543	.2533	.2522	.2510	.2499	.2487
4	.2119	.2131	.2139	.2145	.2148	.2151	.2152	.2151	.2150	.2148
5	.1736	.1764	.1787	.1807	.1822	.1836	.1848	.1857	.1864	.1870
6	0.1399	0.1443	0.1480	0.1512	0.1539	0.1563	0.1584	0.1601	0.1616	0.1630
7	.1092	.1150	.1201	.1245	.1283	.1316	.1346	.1372	.1395	.1415
8	.0804	.0878	.0941	.0997	.1046	.1089	.1128	.1162	.1192	.1219
9	.0530	.0618	.0696	.0764	.0823	.0876	.0923	.0965	.1002	.1036
10	.0263	.0368	.0459	.0539	.0610	.0672	.0728	.0778	.0822	.0862
11	0.0000	0.0122	0.0228	0.0321	0.0403	0.0476	0.0540	0.0598	0.0650	0.0697
12	----	----	.0000	.0107	.0200	.0284	.0358	.0424	.0483	.0537
13	----	----	----	----	.0000	.0094	.0178	.0253	.0320	.0381
14	----	----	----	----	----	----	.0000	.0084	.0159	.0227
15	----	----	----	----	----	----	----	----	.0000	.0076

i/n	31	32	33	34	35	36	37	38	39	40
1	0.4220	0.4188	0.4156	0.4127	0.4096	0.4068	0.4040	0.4015	0.3989	0.3964
2	.2921	.2898	.2876	.2854	.2834	.2813	.2794	.2774	.2755	.2737
3	.2475	.2463	.2451	.2439	.2427	.2415	.2403	.2391	.2380	.2368
4	.2145	.2141	.2137	.2132	.2127	.2121	.2116	.2110	.2104	.2098
5	.1874	.1878	.1880	.1882	.1883	.1883	.1883	.1881	.1880	.1878
6	0.1641	0.1651	0.1660	0.1667	0.1673	0.1678	0.1683	0.1686	0.1689	0.1691
7	.1433	.1449	.1463	.1475	.1487	.1496	.1503	.1513	.1520	.1526
8	.1243	.1265	.1284	.1301	.1317	.1331	.1344	.1356	.1366	.1376
9	.1066	.1093	.1118	.1140	.1160	.1179	.1196	.1211	.1225	.1237
10	.0899	.0931	.0961	.0988	.1013	.1036	.1056	.1075	.1092	.1108

TABLE A-1. (CONTINUED)

COEFFICIENTS $\{A_{N-I+1}\}$ FOR W TEST OF NORMALITY, FOR N=2(1)50

i/n	31	32	33	34	35	36	37	38	39	40
11	0.0739	0.0777	0.0812	0.0844	0.0873	0.0900	0.0924	0.0947	0.0967	0.0986
12	.0585	.0629	.0669	.0706	.0739	.0770	.0798	.0824	.0848	.0870
13	.0435	.0485	.0530	.0572	.0610	.0645	.0677	.0706	.0733	.0759
14	.0289	.0344	.0395	.0441	.0484	.0523	.0559	.0592	.0622	.0651
15	.0144	.0206	.0262	.0314	.0361	.0404	.0444	.0481	.0515	.0546
16	0.0000	0.0068	0.0131	0.0187	0.0239	0.0287	0.0331	0.0372	0.0409	0.0444
17	----	----	.0000	.0062	.0119	.0172	.0220	.0264	.0305	.0343
18	----	----	----	----	.0000	.0057	.0110	.0158	.0203	.0244
19	----	----	----	----	----	----	.0000	.0053	.0101	.0146
20	----	----	----	----	----	----	----	----	.0000	.0049

i/n	41	42	43	44	45	46	47	48	49	50
1	0.3940	0.3917	0.3894	0.3872	0.3850	0.3830	0.3808	0.3789	0.3770	0.3751
2	.2719	.2701	.2684	.2667	.2651	.2635	.2620	.2604	.2589	.2574
3	.2357	.2345	.2334	.2323	.2313	.2302	.2291	.2281	.2271	.2260
4	.2091	.2085	.2078	.2072	.2065	.2058	.2052	.2045	.2038	.2032
5	.1876	.1874	.1871	.1868	.1865	.1862	.1859	.1855	.1851	.1847
6	0.1693	0.1694	0.1695	0.1695	0.1695	0.1695	0.1695	0.1693	0.1692	0.1691
7	.1531	.1535	.1539	.1542	.1545	.1548	.1550	.1551	.1553	.1554
8	.1384	.1392	.1398	.1405	.1410	.1415	.1420	.1423	.1427	.1430
9	.1249	.1259	.1269	.1278	.1286	.1293	.1300	.1306	.1312	.1317
10	.1123	.1136	.1149	.1160	.1170	.1180	.1189	.1197	.1205	.1212
11	0.1004	0.1020	0.1035	0.1049	0.1062	0.1073	0.1085	0.1095	0.1105	0.1113
12	.0891	.0909	.0927	.0943	.0959	.0972	.0986	.0998	.1010	.1020
13	.0782	.0804	.0824	.0842	.0860	.0876	.0892	.0906	.0919	.0932
14	.0677	.0701	.0724	.0745	.0775	.0785	.0801	.0817	.0832	.0846
15	.0575	.0602	.0628	.0651	.0673	.0694	.0713	.0731	.0748	.0764
16	0.0476	0.0506	0.0534	0.0560	0.0584	0.0607	0.0628	0.0648	0.0667	0.0685
17	.0379	.0411	.0442	.0471	.0497	.0522	.0546	.0568	.0588	.0608
18	.0283	.0318	.0352	.0383	.0412	.0439	.0465	.0489	.0511	.0532
19	.0188	.0227	.0263	.0296	.0328	.0357	.0385	.0411	.0436	.0459
20	.0094	.0136	.0175	.0211	.0245	.0277	.0307	.0335	.0361	.0386
21	0.0000	0.0045	0.0087	0.0126	0.0163	0.0197	0.0229	0.0259	0.0288	0.0314
22	----	----	.0000	.0042	.0081	.0118	.0153	.0185	.0215	.0244
23	----	----	----	----	.0000	.0039	.0076	.0111	.0143	.0174
24	----	----	----	----	----	----	.0000	.0037	.0071	.0104
25	----	----	----	----	----	----	----	----	.0000	.0035

TABLE A-2.

PERCENTAGE POINTS OF THE W TEST FOR N=3(1)50

n	0.01	0.05
3	0.753	0.767
4	.687	.748
5	.686	.762
6	0.713	0.788
7	.730	.803
8	.749	.818
9	.764	.829
10	.781	.842
11	0.792	0.850
12	.805	.859
13	.814	.866
14	.825	.874
15	.835	.881
16	0.844	0.887
17	.851	.892
18	.858	.897
19	.863	.901
20	.868	.905
21	0.873	0.908
22	.878	.911
23	.881	.914
24	.884	.916
25	.888	.918
26	0.891	0.920
27	.894	.923
28	.896	.924
29	.898	.926
30	.900	.927
31	0.902	0.929
32	.904	.930
33	.906	.931
34	.908	.933
35	.910	.934

TABLE A-2. (CONTINUED)

PERCENTAGE POINTS OF THE W TEST FOR N=3(1)50

n	0.01	0.05
36	0.912	0.935
37	.914	.936
38	.916	.938
39	.917	.939
40	.919	.940
41	0.920	0.941
42	.922	.942
43	.923	.943
44	.924	.944
45	.926	.945
46	0.927	0.945
47	.928	.946
48	.929	.947
49	.929	.947
50	.930	.947

TABLE A-3.

PERCENTAGE POINTS OF THE W′ TEST FOR N≥35

n	.01	.05
35	0.919	0.943
50	.935	.953
51	0.935	0.954
53	.938	.957
55	.940	.958
57	.944	.961
59	.945	.962
61	0.947	0.963
63	.947	.964
65	.948	.965
67	.950	.966
69	.951	.966
71	0.953	0.967
73	.956	.968
75	.956	.969
77	.957	.969
79	.957	.970
81	0.958	0.970
83	.960	.971
85	.961	.972
87	.961	.972
89	.961	.972
91	0.962	0.973
93	.963	.973
95	.965	.974
97	.965	.975
99	.967	.976

TABLE A-4.

PERCENT POINTS OF THE NORMAL PROBABILITY PLOT CORRELETION COEFFICIENT FOR N=3(1)50(5)100

n	.01	.025	.05
3	.869	.872	.879
4	.822	.845	.868
5	.822	.855	.879
6	.835	.868	.890
7	.847	.876	.899
8	.859	.886	.905
9	.868	.893	.912
10	.876	.900	.917
11	.883	.906	.922
12	.889	.912	.926
13	.895	.917	.931
14	.901	.921	.934
15	.907	.925	.937
16	.912	.928	.940
17	.912	.931	.942
18	.919	.934	.945
19	.923	.937	.947
20	.925	.939	.950
21	.928	.942	.952
22	.930	.944	.954
23	.933	.947	.955
24	.936	.949	.957
25	.937	.950	.958
26	.939	.952	.959
27	.941	.953	.960
28	.943	.955	.962
29	.945	.956	.962
30	.947	.957	.964
31	.948	.958	.965
32	.949	.959	.966
33	.950	.960	.967
34	.951	.960	.967
35	.952	.961	.968
36	.953	.962	.968
37	.955	.962	.969
38	.956	.964	.970
39	.957	.965	.971
40	.958	.966	.972

PERCENT POINTS OF THE NORMAL PROBABILITY PLOT CORRELETION COEFFICIENT FOR N=3(1)50(5)100

n	.01	.025	.05
41	.958	.967	.973
42	.959	.967	.973
43	.959	.967	.973
44	.960	.968	.974
45	.961	.969	.974
46	.962	.969	.974
47	.963	.970	.975
48	.963	.970	.975
49	.964	.971	.977
50	.965	.972	.978
55	.967	.974	.980
60	.970	.976	.981
65	.972	.977	.982
70	.974	.978	.983
75	.975	.979	.984
80	.976	.980	.985
85	.977	.981	.985
90	.978	.982	.985
95	.979	.983	.986
100	.981	.984	.987

TABLE A-5.

VALUES OF LAMBDA FOR COHEN'S METHOD

	Percentage of Non-detects										
γ	.01	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50
.01	.0102	.0530	.1111	.1747	.2443	.3205	.4043	.4967	.5989	.7128	.8403
.05	.0105	.0547	.1143	.1793	.2503	.3279	.4130	.5066	.6101	.7252	.8540
.10	.0110	.0566	.1180	.1848	.2574	.3366	.4233	.5184	.6234	.7400	.8703
.15	.0113	.0584	.1215	.1898	.2640	.3448	.4330	.5296	.6361	.7542	.8860
.20	.0116	.0600	.1247	.1946	.2703	.3525	.4422	.5403	.6483	.7678	.9012
.25	.0120	.0615	.1277	.1991	.2763	.3599	.4510	.5506	.6600	.7810	.9158
.30	.0122	.0630	.1306	.2034	.2819	.3670	.4595	.5604	.6713	.7937	.9300
.35	.0125	.0643	.1333	.2075	.2874	.3738	.4676	.5699	.6821	.8060	.9437
.40	.0128	.0657	.1360	.2114	.2926	.3803	.4755	.5791	.6927	.8179	.9570
.45	.0130	.0669	.1385	.2152	.2976	.3866	.4831	.5880	.7029	.8295	.9700
.50	.0133	.0681	.1409	.2188	.3025	.3928	.4904	.5967	.7129	.8408	.9826
.55	.0135	.0693	.1432	.2224	.3073	.3987	.4976	.6051	.7225	.8517	.9950
.60	.0137	.0704	.1455	.2258	.3118	.4045	.5046	.6133	.7320	.8625	1.0070
.65	.0140	.0715	.1477	.2291	.3163	.4101	.5114	.6213	.7412	.8729	1.0188
.70	.0142	.0726	.1499	.2323	.3206	.4156	.5180	.6291	.7502	.8832	1.0303
.75	.0144	.0736	.1520	.2355	.3249	.4209	.5245	.6367	.7590	.8932	1.0416
.80	.0146	.0747	.1540	.2386	.3290	.4261	.5308	.6441	.7676	.9031	1.0527
.85	.0148	.0756	.1560	.2416	.3331	.4312	.5370	.6515	.7761	.9127	1.0636
.90	.0150	.0766	.1579	.2445	.3370	.4362	.5430	.6586	.7844	.9222	1.0743
.95	.0152	.0775	.1598	.2474	.3409	.4411	.5490	.6656	.7925	.9314	1.0847
1.00	.0153	.0785	.1617	.2502	.3447	.4459	.5548	.6725	.8005	.9406	1.0951
1.05	.0155	.0794	.1635	.2530	.3484	.4506	.5605	.6793	.8084	.9496	1.1052
1.10	.0157	.0803	.1653	.2557	.3521	.4553	.5662	.6860	.8161	.9584	1.1152
1.15	.0159	.0811	.1671	.2584	.3557	.4598	.5717	.6925	.8237	.9671	1.1250
1.20	.0160	.0820	.1688	.2610	.3592	.4643	.5771	.6990	.8312	.9756	1.1347
1.25	.0162	.0828	.1705	.2636	.3627	.4687	.5825	.7053	.8385	.9841	1.1443
1.30	.0164	.0836	.1722	.2661	.3661	.4730	.5878	.7115	.8458	.9924	1.1537
1.35	.0165	.0845	.1738	.2686	.3695	.4773	.5930	.7177	.8529	1.0006	1.1629
1.40	.0167	.0853	.1754	.2710	.3728	.4815	.5981	.7238	.8600	1.0087	1.1721
1.45	.0168	.0860	.1770	.2735	.3761	.4856	.6031	.7298	.8670	1.0166	1.1812
1.50	.0170	.0868	.1786	.2758	.3793	.4897	.6081	.7357	.8738	1.0245	1.1901
1.55	.0171	.0876	.1801	.2782	.3825	.4938	.6130	.7415	.8806	1.0323	1.1989
1.60	.0173	.0883	.1817	.2805	.3856	.4977	.6179	.7472	.8873	1.0400	1.2076
1.65	.0174	.0891	.1832	.2828	.3887	.5017	.6227	.7529	.8939	1.0476	1.2162
1.70	.0176	.0898	.1846	.2851	.3918	.5055	.6274	.7585	.9005	1.0551	1.2248
1.75	.0177	.0905	.1861	.2873	.3948	.5094	.6321	.7641	.9069	1.0625	1.2332
1.80	.0179	.0913	.1876	.2895	.3978	.5132	.6367	.7696	.9133	1.0698	1.2415
1.85	.0180	.0920	.1890	.2917	.4007	.5169	.6413	.7750	.9196	1.0771	1.2497
1.90	.0181	.0927	.1904	.2938	.4036	.5206	.6458	.7804	.9259	1.0842	1.2579
1.95	.0183	.0933	.1918	.2960	.4065	.5243	.6502	.7857	.9321	1.0913	1.2660

TABLE A-5. (CONTINUED)

VALUES OF LAMBDA FOR COHEN'S METHOD

	Percentage of Non-detects										
γ	.01	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50
2.00	.0184	.0940	.1932	.2981	.4093	.5279	.6547	.7909	.9382	1.0984	1.2739
2.05	.0186	.0947	.1945	.3001	.4122	.5315	.6590	.7961	.9442	1.1053	1.2819
2.10	.0187	.0954	.1959	.3022	.4149	.5350	.6634	.8013	.9502	1.1122	1.2897
2.15	.0188	.0960	.1972	.3042	.4177	.5385	.6676	.8063	.9562	1.1190	1.2974
2.20	.0189	.0967	.1986	.3062	.4204	.5420	.6719	.8114	.9620	1.1258	1.3051
2.25	.0191	.0973	.1999	.3082	.4231	.5454	.6761	.8164	.9679	1.1325	1.3127
2.30	.0192	.0980	.2012	.3102	.4258	.5488	.6802	.8213	.9736	1.1391	1.3203
2.35	.0193	.0986	.2025	.3122	.4285	.5522	.6844	.8262	.9794	1.1457	1.3278
2.40	.0194	.0992	.2037	.3141	.4311	.5555	.6884	.8311	.9850	1.1522	1.3352
2.45	.0196	.0998	.2050	.3160	.4337	.5588	.6925	.8359	.9906	1.1587	1.3425
2.50	.0197	.1005	.2062	.3179	.4363	.5621	.6965	.8407	.9962	1.1651	1.3498
2.55	.0198	.1011	.2075	.3198	.4388	.5654	.7005	.8454	1.0017	1.1714	1.3571
2.60	.0199	.1017	.2087	.3217	.4414	.5686	.7044	.8501	1.0072	1.1777	1.3642
2.65	.0201	.1023	.2099	.3236	.4439	.5718	.7083	.8548	1.0126	1.1840	1.3714
2.70	.0202	.1029	.2111	.3254	.4464	.5750	.7122	.8594	1.0180	1.1902	1.3784
2.75	.0203	.1035	.2123	.3272	.4489	.5781	.7161	.8639	1.0234	1.1963	1.3854
2.80	.0204	.1040	.2135	.3290	.4513	.5812	.7199	.8685	1.0287	1.2024	1.3924
2.85	.0205	.1046	.2147	.3308	.4537	.5843	.7237	.8730	1.0339	1.2085	1.3993
2.90	.0206	.1052	.2158	.3326	.4562	.5874	.7274	.8775	1.0392	1.2145	1.4061
2.95	.0207	.1058	.2170	.3344	.4585	.5905	.7311	.8819	1.0443	1.2205	1.4129
3.00	.0209	.1063	.2182	.3361	.4609	.5935	.7348	.8863	1.0495	1.2264	1.4197
3.05	.0210	.1069	.2193	.3378	.4633	.5965	.7385	.8907	1.0546	1.2323	1.4264
3.10	.0211	.1074	.2204	.3396	.4656	.5995	.7422	.8950	1.0597	1.2381	1.4330
3.15	.0212	.1080	.2216	.3413	.4679	.6024	.7458	.8993	1.0647	1.2439	1.4396
3.20	.0213	.1085	.2227	.3430	.4703	.6054	.7494	.9036	1.0697	1.2497	1.4462
3.25	.0214	.1091	.2238	.3447	.4725	.6083	.7529	.9079	1.0747	1.2554	1.4527
3.30	.0215	.1096	.2249	.3464	.4748	.6112	.7565	.9121	1.0796	1.2611	1.4592
3.35	.0216	.1102	.2260	.3480	.4771	.6141	.76	.9163	1.0845	1.2668	1.4657
3.40	.0217	.1107	.2270	.3497	.4793	.6169	.7635	.9205	1.0894	1.2724	1.4720
3.45	.0218	.1112	.2281	.3513	.4816	.6197	.7670	.9246	1.0942	1.2779	1.4784
3.50	.0219	.1118	.2292	.3529	.4838	.6226	.7704	.9287	1.0990	1.2835	1.4847
3.55	.0220	.1123	.2303	.3546	.4860	.6254	.7739	.9328	1.1038	1.2890	1.4910
3.60	.0221	.1128	.2313	.3562	.4882	.6282	.7773	.9369	1.1086	1.2945	1.4972
3.65	.0222	.1133	.2324	.3578	.4903	.6309	.7807	.9409	1.1133	1.2999	1.5034
3.70	.0223	.1138	.2334	.3594	.4925	.6337	.7840	.9449	1.1180	1.3053	1.5096
3.75	.0224	.1143	.2344	.3609	.4946	.6364	.7874	.9489	1.1226	1.3107	1.5157
3.80	.0225	.1148	.2355	.3625	.4968	.6391	.7907	.9529	1.1273	1.3160	1.5218
3.85	.0226	.1153	.2365	.3641	.4989	.6418	.7940	.9568	1.1319	1.3213	1.5279
3.90	.0227	.1158	.2375	.3656	.5010	.6445	.7973	.9607	1.1364	1.3266	1.5339
3.95	.0228	.1163	.2385	.3672	.5031	.6472	.8006	.9646	1.1410	1.3318	1.5399

TABLE A-5. (CONTINUED)

VALUES OF LAMBDA FOR COHEN'S METHOD

	Percentage of Non-detects										
γ	.01	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50
4.00	.0229	.1168	.2395	.3687	.5052	.6498	.8038	.9685	1.1455	1.3371	1.5458
4.05	.0230	.1173	.2405	.3702	.5072	.6525	.8070	.9723	1.1500	1.3423	1.5518
4.10	.0231	.1178	.2415	.3717	.5093	.6551	.8102	.9762	1.1545	1.3474	1.5577
4.15	.0232	.1183	.2425	.3732	.5113	.6577	.8134	.9800	1.1590	1.3526	1.5635
4.20	.0233	.1188	.2435	.3747	.5134	.6603	.8166	.9837	1.1634	1.3577	1.5693
4.25	.0234	.1193	.2444	.3762	.5154	.6629	.8198	.9875	1.1678	1.3627	1.5751
4.30	.0235	.1197	.2454	.3777	.5174	.6654	.8229	.9913	1.1722	1.3678	1.5809
4.35	.0236	.1202	.2464	.3792	.5194	.6680	.8260	.9950	1.1765	1.3728	1.5866
4.40	.0237	.1207	.2473	.3806	.5214	.6705	.8291	.9987	1.1809	1.3778	1.5924
4.45	.0238	.1212	.2483	.3821	.5234	.6730	.8322	1.0024	1.1852	1.3828	1.5980
4.50	.0239	.1216	.2492	.3836	.5253	.6755	.8353	1.0060	1.1895	1.3878	1.6037
4.55	.0240	.1221	.2502	.3850	.5273	.6780	.8384	1.0097	1.1937	1.3927	1.6093
4.60	.0241	.1225	.2511	.3864	.5292	.6805	.8414	1.0133	1.1980	1.3976	1.6149
4.65	.0241	.1230	.2521	.3879	.5312	.6830	.8445	1.0169	1.2022	1.4024	1.6205
4.70	.0242	.1235	.2530	.3893	.5331	.6855	.8475	1.0205	1.2064	1.4073	1.6260
4.75	.0243	.1239	.2539	.3907	.5350	.6879	.8505	1.0241	1.2106	1.4121	1.6315
4.80	.0244	.1244	.2548	.3921	.5370	.6903	.8535	1.0277	1.2148	1.4169	1.6370
4.85	.0245	.1248	.2558	.3935	.5389	.6928	.8564	1.0312	1.2189	1.4217	1.6425
4.90	.0246	.1253	.2567	.3949	.5407	.6952	.8594	1.0348	1.2230	1.4265	1.6479
4.95	.0247	.1257	.2576	.3963	.5426	.6976	.8623	1.0383	1.2272	1.4312	1.6533
5.00	.0248	.1262	.2585	.3977	.5445	.7000	.8653	1.0418	1.2312	1.4359	1.6587
5.05	.0249	.1266	.2594	.3990	.5464	.7024	.8682	1.0452	1.2353	1.4406	1.6641
5.10	.0249	.1270	.2603	.4004	.5482	.7047	.8711	1.0487	1.2394	1.4453	1.6694
5.15	.0250	.1275	.2612	.4018	.5501	.7071	.8740	1.0521	1.2434	1.4500	1.6747
5.20	.0251	.1279	.2621	.4031	.5519	.7094	.8768	1.0556	1.2474	1.4546	1.6800
5.25	.0252	.1284	.2629	.4045	.5537	.7118	.8797	1.0590	1.2514	1.4592	1.6853
5.30	.0253	.1288	.2638	.4058	.5556	.7141	.8825	1.0624	1.2554	1.4638	1.6905
5.35	.0254	.1292	.2647	.4071	.5574	.7164	.8854	1.0658	1.2594	1.4684	1.6958
5.40	.0255	.1296	.2656	.4085	.5592	.7187	.8882	1.0691	1.2633	1.4729	1.7010
5.45	.0255	.1301	.2664	.4098	.5610	.7210	.8910	1.0725	1.2672	1.4775	1.7061
5.50	.0256	.1305	.2673	.4111	.5628	.7233	.8938	1.0758	1.2711	1.4820	1.7113
5.55	.0257	.1309	.2682	.4124	.5646	.7256	.8966	1.0792	1.2750	1.4865	1.7164
5.60	.0258	.1313	.2690	.4137	.5663	.7278	.8994	1.0825	1.2789	1.4910	1.7215
5.65	.0259	.1318	.2699	.4150	.5681	.7301	.9022	1.0858	1.2828	1.4954	1.7266
5.70	.0260	.1322	.2707	.4163	.5699	.7323	.9049	1.0891	1.2866	1.4999	1.7317
5.75	.0260	.1326	.2716	.4176	.5716	.7346	.9077	1.0924	1.2905	1.5043	1.7368
5.80	.0261	.1330	.2724	.4189	.5734	.7368	.9104	1.0956	1.2943	1.5087	1.7418
5.85	.0262	.1334	.2732	.4202	.5751	.7390	.9131	1.0989	1.2981	1.5131	1.7468
5.90	.0263	.1338	.2741	.4215	.5769	.7412	.9158	1.1021	1.3019	1.5175	1.7518
5.95	.0264	.1342	.2749	.4227	.5786	.7434	.9185	1.1053	1.3057	1.5218	1.7568
6.00	.0264	.1346	.2757	.4240	.5803	.7456	.9212	1.1085	1.3094	1.5262	1.7617