REFERENCE FRI DATA QUALITY OBJECTIVES

The Data Quality Objective (DQO) process is a 7-step systematic planning process recommended by the U.S. EPA when environmental data are used to select between potential alternatives or estimate extent of contamination (EPA 2006). DQOs were developed in the DQO report submitted to the U.S. EPA in October 2008 (Atlantic Richfield, 2008) and approved with comments by the EPA on April 23, 2009 (U.S. EPA, 2009). The intent of the PWP submitted to the EPA in July 2009 was to meet the requirements of the Administrative Order, elaborate on the data gap activities identified in the DQO Report and present a prioritization and general scope and schedule for upcoming RI/FS investigation activities. The PWP also provided a Sampling and Analysis Plan (SAP) with a Quality Assurance Project Plan (QAPP) and a Field Sampling Plan (FSP). The QAPP included identification of the primary analytical methods compared to typical human health and ecological risk assessment decision criteria, which are incorporated into the more detailed DQOs provided here.

This FRI work plan is being prepared to expand upon the DQO Report and the PWP and provide specific details such as refined DQOs; the investigation locations; the number of soil borings and/or monitoring wells to be installed; the number of samples of soil, surface water, groundwater, biota and other applicable medium to be collected; the analytical program; and a schedule for implementation of the Reference Site FRI.

STEP 1 - STATE THE PROBLEM

Give a concise description of the problem that necessitates the study and develop a conceptual model of the environmental hazard to be investigated.

To estimate the reference concentrations of identified COPCs in surface soils, groundwater, surface water, sediments and biota analytical data from other similarly mineralized areas need to be collected to allow identification and quantification of potential COPCs, to help in making risk management decisions, and support establishment of realistic and site-specific action levels.

In addition to the conceptual models that underlie the human health and ecological risk assessments (see CSM figures), the Reference Site FRI is framed around the conceptual model that natural weathering of pyritic materials in mineralized areas could result in elevated levels of COPCs in soils, surface waters and sediments, groundwater, and biota in areas that are un-impacted by historic mining activities at the Site.

STEP 2 - IDENTIFY THE GOALS OF THE STUDY (PRINCIPAL STUDY QUESTIONS)

Identify principal study questions, consider alternative outcomes, develop decision statements, organize multiple decisions.

The principal study question is: **"Are the concentrations of COPCs in soils, groundwater, surface water, sediments, and biota attributable to site-related sources, or are the observed concentrations in these media associated with reference or ambient conditions?"**

Alternative outcomes include:

- Identification and quantification of COPCs;
- Release from corrective action (RCA) for specific COPCs and pathways; and
- Establishment of realistic site-specific action levels.

The decision statements underlying development of the FRI include:

- If the Upper Confidence Limit (UCL) for COPCs calculated from the reference surface water and sediment locations is above or equivalent to the concentration measured in surface water and sediment in areas being evaluated as potentially impacted by the site then those COPCs will be considered associated with natural mineral weathering and mass loading and a RCA will be requested.
- If the UCL for COPCs calculated from the reference soil dataset is above US Environmental Protection Agency (EPA) industrial Regional Screening Levels (RSLs) and ecological risk-based soil screening levels (SSLs), alternative site-specific action levels will be established.
- If the UCL for COPCs calculated from the reference groundwater is above and/or equivalent to the concentration measured in groundwater in areas being evaluated as potentially impacted by the site then those COPCs will be considered associated with natural mineral weathering and a RCA will be requested.
- If the concentration for COPCs measured in biota from reference areas and habitat types is above or equivalent to the concentration measured in biota and habitat being evaluated as potentially impacted by the site then those COPCs will be considered to not pose a risk above that associated with reference site conditions.

STEP 3 - IDENTIFY INFORMATION INPUTS

Identify types and sources of information needed to answer study questions, identify the basis of information, and select appropriate sampling and analysis methods for generating the information.

Several types and sources of information are needed to answer the study question. Field observations and analytical results from multiple media and habitats are required.

Inputs to the decision include:

- Determination of soil types on site and in defined habitat types in reference areas;
- Soil COPC analytical data from on-site and reference locations;
- Groundwater COPC analytical data from existing reference monitoring wells (if available) and/or newly installed reference monitoring wells located in analgous mineralized materials for comparison to site and downgradient data;
- Surface water COPC analytical data from identified reference locations within defined habitat types and analogous mineralized area for comparison to site and downstream locations;
- Sediment COPC analytical data from locations corresponding to surface water sampling locations;
- Confirmation of selected receptor species habitat; and
- Selected biota (fish and plant tissue) COPC analytical data from defined habitat types in reference locations.

Multiple sampling and analysis methods will be required as appropriate for each of the media to be characterized. The sampling and analysis methodology is discussed in the SAP, QAPP and FSP included in the PWP and in Sections 5.1 through 5.7, and in the associated SOPs (Appendix X) and SAPs (Appendix Y) appended to this FRI Work Plan.

STEP 4 - DEFINE THE BOUNDARIES OF THE STUDY

Specify the target population, determine spatial and temporal limits, identify practical constraints, and define the scale of inference.

The appropriate data of interest are surface waters and stream sediments, shallow groundwater, surface soils, and biota collected from major habitat types.

The RSA will include areas to the south/southeast of the on-property area where similar mineralized and altered material exist. In addition, it is anticipated that historic reference surface water sampling locations and adjacent floodplain along Leviathan Creek (STA 1), Aspen Creek (STA 22), and Mountaineer Creek (STA 24), and a location(s) along Poison Creeks will be included in the RSA. Supplemental reference sampling areas/locations may be added if other off-site locations with similar habitats and mineralization are located and as required to support a determination of reference conditions.

The study duration will extend from spring 2010 through spring 2011 and may extend to later time periods if additional information is determined to be necessary based on evaluation of initial samples. Groundwater, surface water, and stream sediment samples from reference monitoring wells/locations will be monitored on a seasonal basis for at least the spring, summer and fall

seasons to assess potential temporal changes in groundwater and surface water quality (access dependant). COPC concentrations in soils are expected to be relatively static, and decisions based on sampling results form a single sampling event will remain applicable for many years barring additional contamination.

STEP 5 - DEVELOP THE ANALYTIC APPROACH

Specify appropriate population parameters for making estimates and specify the statistical function and the estimation procedure.

- If the concentration of the representative COPC data set from surface water, sediment, soils, groundwater, and/or biota from potentially impacted areas are not substantially greater than COPC concentrations in surface water, sediment, soils, groundwater, and/or biota from reference locations (with greater than 90% confidence), then risks associated with the potentially impacted areas are similar to reference areas, or are within the acceptable risk range, and no action may be acceptable.
- If the concentration of the representative COPC data set in surface water, sediment, soils, groundwater, and/or biota from potentially impacted areas are substantially greater than COPC concentrations in surface water, sediment, soils, groundwater, and/or biota from reference areas, then risks associated with the potentially impacted areas are higher than reference location risks, and risks should be assessed and corrective measured evaluated.

Estimation procedure: for all COPCs, the UCL will be derived for each analyte if one or more of its individual data points exceed relevant screening levels. Individual data points for each COPC will be compared to industrial RSLs and ecological screening levels. The appropriate UCLs will be calculated following EPA 2002 guidance and EPA software ProUCL (Version # 4.00.04) (http://www.epa.gov/esd/tsc/software.htm).

STEP 6 - SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA

Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.

The decision rules defined in Step 5 will be evaluated with the following statistical hypotheses consistent with Background Test Form 2 from EPA, 2002. The choice of hypotheses in Background Test Form is designed to be protective of human health and the environment (EPA, 2002).

The null hypothesis (H_0): The mean COPC concentrations in surface water, sediment, soils, groundwater, and/or biota from potentially impacted areas exceed the COPC concentrations in these media in reference areas by a statistically significant amount (S).

The alternative hypothesis (H_A): The mean COPC concentrations in surface water, sediment, soils, groundwater, and/or biota from potentially impacted areas do not exceed the COPC concentrations in these media in reference areas by a statistically significant amount (S).

There are two possible decision errors:

Type I Error (a false positive) – rejection of the null hypothesis and determining that the concentration of COPC in impacted areas does not exceed the reference concentration when it actually does. The probability of making this type of error is denoted as α.

Type II Error (a false negative) – the null hypothesis is not rejected and the concentration of COPCs associated with impacted areas is determined to exceed the reference concentration by a substantial amount when it actually does not. The probability of making this type of error is denoted as β.

The choice of hypothesis used in Background Test Form 2 is designed to be protective of human health and the environment and making a Type II error is preferable to committing a Type I error (EPA, 2002). For this FRI a confidence level or 90% (α = 0.10) and a power of 80% (β = 0.20) are used.

Sampling of surface water, sediment, soils, groundwater, and/or biota will be performed opportunistically and professional judgment will be used to assess the suitability of initial sampling results. Both statistical and judgmental sampling designs will be employed as warranted by the media of interest. As additional data are available, statistical analysis will be applied to assess concentration data such that a confidence level of at least 90% is achieved.

Appropriate quality assurance/quality control (QA/QC) measures will be in place (e.g. collection of field duplicates, laboratory splits, trip blanks calibration data) as specified in the QAPP to reduce the risk of sampling and analytical error. Implementation of these measures will result in a reliable analytical data set suitable for use in risk assessment and calculation of upper concentration limits (UCLs).

STEP 7 - OPTIMIZE THE DESIGN FOR OBTAINING DATA

Select resource-effective sampling and analysis plan(s) that meets the performance or acceptance criteria.

This FRI for reference area characterization has a high degree of complexity as it will involve the sampling and analysis of multiple media types for a broad range of contaminants. As such, no single sampling plan can adequately address the varied media that will be sampled and

analyzed. The sampling plans for each of the media types being evaluated under this FRI are discussed below.

Surface Water

Sampling of surface water and sediment will occur during specific time ranges determined by the seasonal hydrological flow patterns of the watersheds. Five replicate samples will be collected at discrete stations:

- Leviathan Creek Station 1 (Reference for on-property Leviathan Creek Stations);
- Aspen Creek Station 22 (Reference for on-property Aspen Creek Stations);
- Mountaineer Creek Station 24 (Reference for upper Bryant to Barney Riley Creek Stations);
- Poison Creek Station TBD (Reference for upper Bryant to Barney Riley Creek Stations).

These sampling locations will be verified through field reconnaissance. Additional sites may be included and additional sampling will be performed as needed to support requirements for risk assessment and the development of reference conditions.

Sediment

Stream sediments will be collected from the reach that includes the surface water sampling stations. The use multi-incremental sampling (MIS) methodology (see description) is anticipated to allow representative soil/sediment samples to be collected and reduce the analytical costs, as described in detail in Section X.X.X. Thirty sediment samples will be collected along a systematic grid pattern and composited using MIS processing procedures to form a single sample for analysis. To allow statistical comparisons, 5 composite samples be collected from each reach.

Groundwater

Sampling of groundwater will occur during specific time ranges determined by the seasonal hydrological flow patterns of the watersheds. Previous wells/piezometers used for estimation of reference conditions included PZ-31 and PZ-32 (Figure 6). These will be sampled and included in the reference well set if available. Historic well location and rehabilitation activities will be conducted under a separate FRI (AMEC, 2009x) to determine if these historic locations are currently viable monitoring locations. Additional reference groundwater monitoring wells will be installed in the area south/southeast of the open pit and will be completed in geological material representative of the historic mineralized zone. It is anticipated that between 2 to 5 additional wells will be installed to provide a sufficient data set for statistical analysis.

Soils

Soil samples will be collected in each of the habitat types identified within the reference areas and analyzed for COPCs. The soil sampling locations for the Reference Site FRI will include areas to the south/southeast of the impacted on-site areas reference mineralized areas (Figure 4) and along reference floodplain areas (Figure 5).

A MI sampling approach will be used for sample collection. MI sampling protocols allow representative soil/sediment samples to be collected and reduce the analytical costs because fewer samples are required to characterize chemical concentrations within the decision unit being sampled (described in Section X.XX). Five (5) polygons will be identified for each habitat type in the floodplains and uplands of the reference areas (not all habitats will be found in all of the reference areas). MIS protocols will be used to collect a single composite sample from 5 different polygons for statistical comparisons.

Biota

Vegetation

There are two components to the vegetation sampling. First the identification of plant species along floodplain transects provides documentation that the species that are analyzed, for the risk assessments, represent the most abundant species likely to be consumed by ecological and human receptors. Once this information has been gathered, the species and tissue types selected for analysis will be collected randomly from within each habitat polygon.

Fish

Fish population estimates will be accomplished using the three pass electrofishing method (Li and Li, 1996) described in greater detail in Section X.X. Chemical analysis of selected fish species would be completed by creating three composite samples following protocols in EPA (2000).

The Herbst index will be used to assess the health of benthic invertebrates and EPA soil screening levels will be used to assess impacts to soil invertebrates. The risk for other receptors will be estimated by calculating the dose from soil/sediment, plant and fish receptors.