


FINAL

Summary Report

Terrestrial Investigation
Monte Cristo Mining Area

Prepared for
Washington State
Department of Ecology

August 31, 2015
17800-35

HARTCROWSER

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EXECUTIVE SUMMARY

Hart Crowser conducted two sampling trips in the Monte Cristo Mining Area (MCMA) between August 18, 2013, and September 3, 2013, to collect soil, plant, and soil invertebrate samples from each of six source areas and eight background locations in the MCMA. The objectives of these trips were to:

- Collect and analyze vascular plants, soil invertebrate tissue, and soil samples to determine site-specific uptake and bioaccumulation factors for metals;
- Develop a site-specific wildlife exposure model and compare measured bioaccumulation to published tissue concentration thresholds; and
- Update the existing MCMA geodatabase with information gathered during this phase of the remedial investigation.

During these sampling trips, we successfully sampled co-located soil, grasses, shrubs, and soil invertebrates at four background and two mine locations in Seventysix Gulch Watershed, and four background and four mine locations in Glacier Creek Watershed. This resulted in a total of 66 soil samples, 77 plant tissue samples, and 12 soil invertebrate samples.

Results of the Phase 2 site-specific Terrestrial Ecological Evaluation (TEE) indicated antimony, arsenic, cadmium, cobalt, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, thallium, and zinc were identified as ecological constituents of concern (COCs). However, there was considerable uncertainty associated with the Phase 2 TEE results. The purpose of the investigation was to assess site-specific plant uptake and bioaccumulation factors in the MCMA. The uptake and bioaccumulation factors were used to develop a site-specific wildlife exposure model and compare the model to published tissue concentration thresholds in the update to the site-specific TEE. Sample analytical results are presented in this report along with the updated TEE (in Appendix C) that was developed by DH Environmental Consulting in accordance with WAC 173-340-7493.

Field Work and Findings

Samples of plants, soil invertebrates, and co-located soil consisted of a five-point composite sample collected from an area of no more than approximately 2,000 square feet (e.g., a 25-foot radius circle). Occasionally there was only enough tissue material to collect a minimum of a three-point composite sample. We selected sample locations based on the following priorities: (1) near vegetation on the waste rock pile; (2) near vegetation immediately downslope of waste rock; or (3) near vegetation along the perimeter of waste rock.

Hart Crowser collected eight to ten soil, plant, and soil invertebrate samples from each of six source areas in the MCMA. This included samples from the O&B and Sheridan Mines located in the Seventysix Gulch Watershed, and the Pride of the Mountains, New Discovery, Mystery, and Justice Mines located in the Glacier Creek Watershed. In addition, four background samples from each of the two watersheds were collected for comparison to areas disturbed by historical mining activities.

In Seventysix Gulch Watershed, the four background soil samples all exceeded risk-based criteria for arsenic, manganese, mercury, and selenium. Of the ten soil samples collected at each mine (O&B and Sheridan), nearly all samples exceeded both risk-based criteria and the site-specific background for arsenic. Copper, iron, lead, and selenium also exceeded both criteria in more than half the samples at O&B Mine. No invertebrates were collected at O&B Mine, but the arsenic concentration for invertebrates found at Sheridan Mine was ten times higher than any of the background locations. In general, concentrations of arsenic, copper, and lead were higher at O&B Mine and Sheridan Mine than at the four background locations, but there does not appear to be a clear relationship or pattern in the raw data for the other constituents.

In Glacier Creek Watershed, the four background soil samples all exceeded risk-based criteria for arsenic, iron, manganese, and mercury. Of the ten soil samples collected at each mine (Pride of the Mountains, New Discovery, Justice, and Mystery), nearly all samples exceeded both the risk-based criteria and the site-specific background for antimony, arsenic, cadmium, copper, iron, lead, manganese, mercury, and zinc. Many of the samples from Justice Mine also exceeded both criteria for chromium, nickel, and selenium. For invertebrate samples, Mystery Mine, New Discovery Mine, Pride of the Mountains Mine, and one background location (BG-07-I) had much higher (4 to 200 times greater) arsenic concentrations than the other three background samples or Justice Mine. However, several other constituents (e.g., copper and zinc) had a similar range of concentrations in the background and mine samples.

For grasses and shrubs, arsenic concentrations in several samples from Justice Mine and a few from New Discovery Mine were much higher than the background samples. Compared to background samples, zinc concentrations appear to be elevated in several of the Justice Mine shrub samples, as well several grass and shrub samples from New Discovery and Pride of the Mountains Mines. Similar to the samples collected in Seventysix Gulch, however, there does not appear to be clear relationship or pattern in the raw data for the other constituents.

Statistical tests were used to compare each of the background and mine site source area soil samples. The results of those tests indicated at least two significantly different geochemical populations for the six mine sites (O&B, Sheridan, and Justice Mines in one group; Mystery, Pride of the Mountains, and New Discovery Mines in the second group). Additionally, these tests indicated the background samples were significantly different from all of the mine sites except Sheridan Mine.

The eight background soil samples collected were included in a recalculation of the site-specific background values for antimony, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, thallium, and zinc.

Using soil screening criteria, each of the six waste rock piles exceeded risk-based criteria as well as site-specific background values for a minimum of ten constituents. However, the results of the site-specific TEE (see Section 3.0 of Appendix C) indicate the following:

- There are no constituents of concern (COCs) for soil invertebrates based on the critical body residue evaluation;

- Only arsenic remains as a COC for individual plants living on a MCMA source area based on the critical body residue evaluation; and

- Arsenic and lead remain as COCs for wildlife (herbivorous and insectivorous) based on the wildlife exposure modeling. This applies to individual mammals or birds living on MCMA source areas.

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APPENDIX B
Chemical Data Quality Review and Laboratory Reports

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ACRONYMS

ARI	Analytical Resources Inc.
BAF	bioaccumulation factor
BRL	Brooks Rand Labs
CCB	continuing calibration blank
COC	constituents of concern
COPCs	constituents of potential concern
CRM	certified reference material
CCV	continuing calibration verification
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
GPS	global positioning system
ICB	instrument calibration blank
IS	internal standard
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
MCMA	Monte Cristo Mining Area
MDL	method detection limit
mg/kg	milligrams per kilogram
MS/MSD	matrix spike/matrix spike duplicate
PCA	principal components analysis
PS	post-digestion spike
QA/QC	quality assurance/quality control
RL	reporting limit
RPDs	laboratory duplicate relative percent differences
RSDs	laboratory replicate relative standard deviations
SAP	sampling and analysis plan
SFSR	South Fork Sauk River
SOW	statement of work
SRM	standard reference material
TEE	terrestrial ecological evaluation
TKN	total kjeldahl nitrogen
TOC	total organic carbon

Summary Report

Terrestrial Investigation

Monte Cristo Mining Area

1.0 INTRODUCTION

Hart Crowser staff conducted a reconnaissance and two site sampling trips in the Monte Cristo Mining Area (MCMA) near Granite Falls, Washington (Figure 1), in mid- to late-summer 2013. We performed this investigation for the Washington State Department of Ecology (Ecology) under Contract No. C1100144. Work was done in general accordance with the Ecology Statement of Work (SOW; Ecology 2012) and project Sampling and Analysis Plan (SAP) prepared by Hart Crowser (Hart Crowser 2013a).

The purpose of the terrestrial investigation was to collect soil and ecologically relevant plant and soil invertebrate (soil biota) samples to assess site-specific plant uptake and bioaccumulation factors in the Monte Cristo Mining Area (MCMA). The uptake and bioaccumulation factors were used to develop a site-specific wildlife exposure model and compare the model to published tissue concentration thresholds (see Appendix C prepared by DH Environmental Consulting). Several locations were previously identified for site-specific terrestrial exposure and background analysis. Ecology indicated that eight to ten soil, plant, and soil invertebrate samples should be collected from waste rock piles at the Sheridan and O&B Mines in the Seventysix Gulch Watershed, and Mystery, Justice, Pride of the Mountains, and New Discovery Mines in the Glacier Creek Watershed as impacted sites of interest. Near each mine, we also identified suitable background sample collection locations.

The objectives of this investigation were to:

- Collect and analyze vascular plants, soil invertebrate tissue, and soil samples to determine site-specific uptake and bioaccumulation factors for metals;
- Develop a site-specific wildlife exposure model and compare measured bioaccumulation to published tissue concentration thresholds; and
- Update the existing MCMA geodatabase with information gathered during this phase of the remedial investigation.

Between August 18, 2013, and September 3, 2013, Hart Crowser staff conducted two sampling trips to collect soil, plant, and soil invertebrate samples from each of six source areas and eight background locations in the MCMA. This report describes both sampling events including location summaries, sampling methods, selection criteria, and data analysis. Table 1 lists the soil, plants, and soil invertebrates sampled at each site in chronological order. Appendix A contains the field data sheets with site sketches, observations, and photographs taken at each location.

Table 1 – Sampling Summary

Location	Date	Samplers	Sample Type [1]	Plant(s)	Number of Plant and Soil Samples	Soil Invertebrate(s) [3]
O&B Mine	8/21 - 8/22	ASK/WDM	G	Sitka sedge	10	None
			S	Black huckleberry		
Background 01	8/22/2013	ASK/WDM	G	Sitka sedge	1	None
			S	Pacific bleeding heart		
Background 02	8/22/2013	ASK/WDM	G	Sitka sedge	1	Spiders, grasshoppers
			S	Edible thistle		
Sheridan Mine	8/24 - 8/25	ASK/WDM	G	Blue wild rye	10	Ants, spiders
			S	Black huckleberry		
Background 03	8/25/2013	ASK/WDM	G	None	1	Centipedes, spiders
			S	Black huckleberry		
Background 04	8/25/2013	ASK/WDM	G	None	1	Spiders
			S	Black huckleberry		
Mystery Mine	8/30 - 9/1	WDM/AJW	G	Black alpine sedge	10	Ants, spiders, grasshoppers, beetle
			S	Sitka mountain-ash		
Pride of the Mountains Mine	8/31/2013	ASK/NWG	G	Sitka sedge	10	Ants, spiders, grasshoppers, centipedes
			S	Huckleberry		
Background Glacier Basin 1	8/31/2013	ASK/NWG	G	Sitka sedge	1	Grasshoppers, ants
			S	Black huckleberry		
Background 08	9/1/2013	WDM/AJW	G	None	1	Ants, spiders, crickets, beetles
			S	Sitka mountain-ash		
Background 07	9/1/2013	WDM/AJW	G	None	1	Ants, crickets, beetles, spiders
			S	Huckleberry		
New Discovery Mine	9/1/2013	ASK/NWG	G	Composite grass/sedge [2]	8	Spiders, ants, centipedes, grasshoppers, beetle
			S	Huckleberry		
Justice Mine	9/2/2013	WDM/AJW	G	Spiny wood fern	10	Ants (red, carpenter), spider, beetle
			S	Common horsetail		
Background Glacier Basin 2	9/2/2013	ASK/NWG	G	Sitka sedge	1	Grasshoppers, spiders, ants
			S	Black huckleberry		

Notes:

1 G = grass/sedge, S = shrub.

2 Due to very limited grass/sedge sample material, field team had to sample multiple grass/sedge species. This material was composited into a sample.

3 Invertebrate samples at each mine/background location were composited into a single sample for that location.

Table 2 presents the project team members and their roles and responsibilities for this investigation.

Table 2 – Project Team Roles and Responsibilities

Project Role	Personnel Assignment	Roles/Responsibilities
Ecology Project Managers	Jason Shira (Ecology) (509) 454-7834 Mary Monahan (Ecology)	Client Project Managers
Program Manager	Mike Bailey Hart Crowser (206) 324-9530	Ensures that all work is carried out in accordance with contractual obligations and the Delivery Order statement of work. Assists the Project Manager as needed with technical decisions and in resolving issues. Final reviewer.
Project/Task Manager	Michelle Havey Hart Crowser (206) 324-9530	Overall responsibility for execution of the Work Plan. Coordinate with Client, Field Manager, and Program Manager as necessary to resolve issues.
Corporate Health and Safety Office (HSO)	Echo Summers Hart Crowser (206) 324-9530	Overall responsibility for review of the Health and Safety Plan and answering questions about health and safety.
Field Manager and Site Safety Coordinator (SSC)	Andrew Kaparos Hart Crowser (206) 324-9530	Ensures that explorations are conducted and samples are collected in accordance with project specifications. Coordinates field activities with Project and Program Managers.
Ecological Risk Assessment Specialist	Dr. Dana Houkal DH Environmental Consulting (206) 414-6401	Performs wildlife risk assessment. Coordinates with Project and Program Managers.
Project Chemist	Roger McGinnis Hart Crowser (206) 324-9530	Performs laboratory coordination and data quality review to assure analytical methods and data are consistent with project needs and data quality objectives.
Laboratory Services	Kelly Bottem Analytical Resources, Inc. (206) 695-6200	Analyzes soil samples.
Laboratory Services	Lydia Greaves Brooks Rand Labs (206) 632-6206	Analyzes plant and invertebrate tissue samples.

1.1 Background

The MCMA is located approximately 38 air miles east of Everett, Washington, on the steep mountainsides of the Cascade Range at the head of the South Fork Sauk River (SFSR). The abandoned or inactive mine workings include about 54 mine entries, prospects, and related facilities. The principal commodities produced were gold and silver, with an estimated 310,000 tons of ore produced between 1889 and 1907.

The MCMA was discovered by Joe Pearsall and Frank Peabody during the summer of 1889. A townsite was quickly established, consisting of stores, hotels, a school, and a newspaper. A railroad was completed in 1893 to transport ore to the smelter in Everett. Mineral production flourished for a few years until massive floods destroyed rail access in 1897. Mine production was reduced and intermittent, and was operated by a number of smaller companies until 1920 (Woodhouse 1997). Currently, the area is a popular hiking destination during the summer months with an extensive network of trails.

1.2 Glacier Creek Watershed

The Glacier Creek Watershed is characterized by rock, snow, and ice. The low elevation portions of the watershed contain forested areas with a shrub-dominated understory. High-elevation areas are dominated by rock, snow (seasonally), and ice, with small forested stands and low-growing shrubs, lichen, and moss. Talus slopes and rocky outcrops are common features in this watershed. Mining activity and processing in the Glacier Creek Watershed was prevalent and is described in the Monte Cristo Mining Area Remedial Investigation Phase 2 Summary Report (Hart Crowser 2012).

1.3 Seventysix Gulch Watershed

The Seventysix Gulch Watershed is characterized by a predominantly forested landscape interspersed with rock, snow, and ice. Dominant vegetation is similar to the Weden Creek and Glacier Creek watersheds, and consists of an overstory of Douglas fir (*Pseudotsuga menziesii*), true firs (*Abies* sp.), hemlock (*Tsuga* sp.), and cedar within an understory of shrubs. Evidence of historical timber harvest can be observed near established trails. High elevation areas contain a combination of forest stands, talus slopes, and rocky outcrops. Mining activity in the Seventysix Gulch Watershed was also quite prevalent and is described in the Monte Cristo Mining Area Remedial Investigation Phase 2 Summary Report (Hart Crowser 2012).

1.4 Weden Creek Watershed

Weden Creek is the third component of the SFSR headwaters, draining 31 miles of streams into the SFSR just upstream of Barlow Pass. The Weden Creek Watershed was not sampled as part of this investigation, but data previously collected in this area are included and discussed in the update to the Terrestrial Ecological Evaluation (Appendix C).

2.0 SAMPLING STRATEGY

As mentioned above, one of the objectives of this Phase 3 investigation was to collect and analyze plant and soil invertebrate tissue samples to determine site-specific plant uptake and bioaccumulation factors. It was determined that the field team should attempt to identify and sample both grasses and shrubs at each sample location. Ideally, the tissue samples would be co-located with soil samples. Overall, the goal was to collect 10 samples of each matrix (soil, shrubs, grasses, invertebrates) from 8 to 10 background areas and 10 samples of each matrix from each of the 6 mines sites.

2.1 Adaptive Sampling

After conducting a reconnaissance trip, it was apparent the field team would have difficulty finding co-located shrub and grass samples at 10 locations for each of the six mine sites. Both shrubs and grasses (i.e., grasses and sedges) were rarely found at a location (as indicated in the reconnaissance report, Hart Crowser 2013b). Therefore, we recommended the following adaptive sampling approach to Ecology:

- At each mine site, the field team would start by attempting to locate 10 shrub and 10 grass sample locations (note: the shrub and grass sample locations may not be co-located).
- If we were able to locate 10 shrub and 10 grass/sedge sample locations at a mine site, but they occupy more than 10 different sample locations, we would select the best shrub and best grass sample locations that yield a total of 10 sample locations at the mine site (note: these would provide the required 10 soil sample locations).
- If we were not able to find 10 co-located shrub and grass/sedge sample locations at a mine site, we would need to adjust the sampling to maximize the likelihood of collecting the overall target of 60 shrub and 60 grass samples. For example, if we sampled three mine sites and collected 20 shrub samples and 10 grass/sedge samples, we focused the sampling effort at the next mine site on collecting a greater proportion of grass/sedge samples.

At background sampling locations, we attempted to collect the same shrub and grass/sedge species that were collected from the mine sites wherever possible. Some of the background grass and/or shrub species were not common to other locations, but were the only available tissue sample at that particular location. Table 3 presents a summary of the samples collected.

3.0 TERRESTRIAL SAMPLING METHODS

Samples of plants, soil invertebrates, and co-located soil consisted of a five-point composite sample collected from an area of no more than approximately 2,000 square feet (e.g., a 25-foot radius circle). Occasionally there was only enough tissue material to collect a minimum of a three-point composite sample. The composite samples were used to generate tissue and soil datasets that are representative of waste rock pile and background conditions. These data sets were then used to estimate bioaccumulation of constituents in plants and soil invertebrates.

We selected sample locations based on the following priorities: (1) near vegetation on the waste rock pile, (2) near vegetation immediately downslope of waste rock, or (3) near vegetation along the perimeter of waste rock.

3.1 Plant Sampling

Sampling began by identifying suitable shrubs and grasses in the sample area. Next, shrubs and soil were sampled from a minimum of five subsample locations. The polygon formed by these five or more locations defined the sample area with a maximum area of approximately 2,000 square feet. The sample area polygon always contained sufficient grasses to meet sample requirements. However, the grass subsample locations were not necessarily located directly adjacent to the shrub/soil subsample locations, but were within 10 feet of the boundary of the sample area polygon.

Both grasses and broadleaf shrubs were sampled. We attempted to sample the same species of grass in all locations when possible, but this was not always possible. Therefore, at some locations it was necessary to sample different species of grasses in different sample areas or possibly several species within the same sample area. In the case of shrubs, the goal was also to sample the same species at each sample area.

Grasses were sampled by excising the whole plant with a knife at a point ranging approximately from 1 to 4 inches above the soil. The grass samples contained the stems, leaves, and flowers or seeds since all of this material may be consumed by herbivorous wildlife. Shrub sampling consisted of the current growing season's branch tips (i.e., the last 4 to 6 inches of the branch) as this is the material consumed by certain herbivorous wildlife. The shrub samples consisted of the branches, leaves, and buds. Knives were used to excise the shrub sample.

3.2 Invertebrate Sampling

Invertebrate sampling occurred anywhere within 10 feet of the sample area polygon. At the first several locations, pitfall traps were constructed and located close to clumps of vegetation (and on relatively flat ground, when possible). Invertebrate sampling also included the use of sweep nets and hand collection.

Collection of soil invertebrates was challenging due to the scarcity of organisms. Therefore, sampling at each sample area was conducted over a 1- to 3-day period using three sampling methods as follows:

- Sweep netting – used to collect more mobile invertebrates (e.g., grasshoppers) and sampled at least once daily;
- Hand collection – invertebrates observed on the soil surface or beneath surface debris (e.g., beetles) were collected with the aid of a pair of forceps at least once daily; and
- Pitfall traps – three traps per sample area and sampled at least once daily.

Sweep netting and hand collection of soil invertebrates occurred each time the sample area was visited to set up and check the pitfall traps. In addition to examining the ground surface within the sample area for invertebrates, rocks, logs, and other surface debris were overturned and invertebrates collected using forceps.

Three pitfall traps were set in each sample area (see Hart Crowser 2013a for a detailed description of the pitfall trap method). Pitfall traps were uniformly distributed across the sample area and located within or near patches of vegetation. The pitfall traps were used at O&B Mine, BG-01, BG-02, and Sheridan Mine, but were found to be minimally successful. Therefore, invertebrate sampling at the remaining locations was conducted by sweep netting and hand collection only.

Soil invertebrate sampling was the most challenging in terms of obtaining sufficient material to meet analytical requirements. Therefore, all soil invertebrates collected from a sample area by any of the three sampling methods during a 3-day sampling period were pooled to form a single composite sample. The approximate number of individuals comprising each major taxonomic group contained in the composite sample was generally recorded in the field and prior to shipment to the analytical laboratory (e.g., sample consists of 50 ants, 2 grasshoppers, 5 beetles, 1 spider).

3.3 Soil Sampling

Soil was sampled as close as possible to the base of each shrub from 0 to 12 inches below the duff layer with the aid of a hand trowel and shovel. Plant and soil invertebrate exposure to metals in soils at the MCMA site was expected to be concentrated in the upper one foot of the soil profile. Therefore, this soil stratum was most appropriate for use in estimating bioaccumulation.

Site information was recorded on field forms (Appendix A) and in field logbooks every time the sample area was visited.

4.0 SITE SAMPLING ACTIVITIES

Between August 19, 2013, and September 3, 2013, Hart Crowser collected eight to ten soil, plant, and soil invertebrate samples from each of six source areas in the MCMA. This included samples from the O&B (Figure 2) and Sheridan Mines (Figure 3) located in the Seventysix Gulch Watershed[1], and the Pride of the Mountains (Figure 4), New Discovery (Figure 4), Mystery (Figure 5), and Justice Mines (Figure 5) located in the Glacier Creek Watershed. In addition, four background samples from each of the two watersheds were collected for comparison to areas disturbed by historical mining activities.

Potential sampling locations were previously identified during a site reconnaissance. Once on site, the field team assessed the waste rock areas for potential sampling, identified ideal sampling points, and documented each location.

During each sampling event, global positioning system (GPS) points were collected at each sample location and are shown on Figures 2 through 5. Photographs were taken at each location to document vegetation, wildlife use, and other relevant site features, and site observations were noted on field forms (Appendix A). The vegetation and soil invertebrates sampled at the sites are presented in Table 3. We explored the surrounding areas for suitable background sampling locations and collected these samples where possible. Table 1 summarizes sampling activities completed during the sampling event in chronological order.

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[1] The O&B Mine location on the edge of the Seventysix Gulch Watershed shown on Figure 2 reflects limitations of available topographic mapping. Field observations indicate it is within the watershed.

4.1 Seventysix Gulch Watershed

4.1.1 O&B Mine

After being dropped off in the Monte Cristo Townsite (Townsite) on August 19, 2013, the field team unloaded gear at the Townsite and prepped gear for camping and for sampling O&B Mine over the next few days.

The next morning, the field team hiked up the Silver Lake Trail, over Poodle Dog Pass, to Silver Lake. We proceeded to set up our camp site near Silver Lake, and then hiked the ridge of Toad Mountain and navigated to O&B Mine.

Starting downgradient of the lower waste rock pile, we set pitfall traps (three per sample location) at ten locations (Figure 2). We selected sample locations based on the following priorities: (1) near vegetation on the waste rock pile, (2) near vegetation immediately downslope of waste rock, or (3) near vegetation along the perimeter of waste rock. Site sketches, field notes, and photographs (Photographs A-1 through A-4) were used to document the sampling area. The first day, we identified the best sampling locations and set pitfall traps. After setting the traps, we hiked back to the camp while searching for suitable background sampling locations.

Unfortunately, few invertebrates were observed near the O&B waste rock piles and our pitfall traps were unsuccessful in capturing any invertebrates. The field team attempted to use sweep nets in shrubs and bushes, and forceps along the ground and under rocks/logs; however, these methods too, were unsuccessful.

Vegetation and soil samples were collected. The grass sample consisted of Sitka sedge (*Carex sitchensis*) and the shrub sample was black huckleberry (*Gaylussacia baccata*; Table 3). No invertebrate sample was collected.

4.1.2 Background Locations (BG-01 and BG-02)

While hiking back to the camp from O&B Mine the first day, we identified two potential background sampling locations. Pitfall traps were set at each of these locations and GPS points were collected the following day during sampling activities.

The first background sample (BG-01) was located upslope of Cultus Lake, and downslope of a natural-looking talus sloped area (Figure 2; Photograph A-25). Sitka sedge and Pacific bleeding heart (*Dicentra formosa*) were collected for vegetation samples (Table 3). A couple of spiders were collected in the pitfall traps; there were no nearby crickets, ants, or any other invertebrates for collection. Therefore, we were not able to collect a suitable invertebrate sample at this location.

The second background sample (BG-02) location was west of the first background sample (Figure 2; Photograph A-26). This was located adjacent to a vegetated talus rock slope. Vegetation samples included Sitka sedge and edible thistle (*Cirsium edule*; Table 3). Spiders were found in the pitfall traps and several grasshoppers were caught using the sweep net and forceps near the sample location. Invertebrates collected for BG-02 included spiders and grasshoppers.

After background sampling was completed, the field team packed up the camp and hauled gear and samples down to the Townsite.

4.1.3 Sheridan Mine

Sheridan Mine was accessed by hiking from the Townsite cabin. We briefly followed the Silver Lake trail and then split off to follow a game trail, which led to the Sheridan Mine and background sampling locations.

Suitable sampling locations were much easier to find at this location compared to O&B Mine. The waste rock pile had some scattered vegetation growing on it, and visible invertebrates (primarily ants) on/within the waste rock pile. Abundant vegetation was growing immediately downslope of the waste rock pile as well.

Soil, vegetation, and invertebrate samples were collected from ten locations (Figure 3; Photographs A-5 through A-8). Pitfall traps were set, but they were once again unsuccessful in trapping many invertebrates. Most of the invertebrates sampled at this location were collected with forceps. The vegetation samples included black huckleberry and blue wildrye (*Elymus glaucus*; Table 3). Samples were collected from the top of the waste rock pile, midway down the waste rock pile, adjacent to the waste rock pile, and downgradient of the waste rock pile.

4.1.4 Background Locations (BG-03 and BG-04)

We attempted to locate suitable background sample locations upslope of the Sheridan Mine adit; however, this proved difficult due to the lack of soil and grass materials. The area upslope had abundant suitable vegetation, but was growing on top of boulders and large rocks, with minimal soil available for sampling. Additionally, this area was very steep and difficult to maneuver.

The field team decided to locate background sample locations while hiking back along the game trail toward the Silver Lake trail. We were able to find two suitable locations that were both upslope of the trail, and had no evidence of mining or other human impacts (Figure 3; Photograph A-27).

Black huckleberry was collected as the shrub vegetation for both of these background locations (BG-03 and BG-04; Table 3), but no grasses were available to sample. Soil samples were collected at both locations. Additionally, there was not much invertebrate activity in these areas. The field team was able to obtain sufficient invertebrate sample material for BG-04, but not for BG-03. Sampled invertebrates for BG-04 included ants, spiders, and centipedes.

After sampling O&B Mine, Sheridan Mine, and background locations, the field team was picked up by Hi-Line Helicopters and travelled back to Seattle. Once in Seattle, we processed the samples, delivered them to the labs, and reorganized supplies and equipment for the second portion of the sampling event. Due to the difficulty of collecting soil invertebrate samples, distance between remaining sample locations, and rugged terrain; a second sampling team was added for the remaining sampling efforts.

4.2 Glacier Creek Watershed

For the remainder of the terrestrial sampling, additional field team members were brought into the project. Nick Galvin and Andy Wade joined Andrew and Ward in the field to help complete sampling efforts.

- Team 1: Andrew Kaparos and Nick Galvin. Camped in Glacier Basin to sample Pride of the Mountains Mine, New Discovery Mine, and two background locations.

- Team 2: Ward McDonald and Andy Wade. Stayed at the US Forest Service Townsite cabin to sample Mystery Mine, Justice Mine, and two background locations.

As discussed with other team members (Hart Crowser program and project managers, Dr. Dana Houkal [ecological risk assessment subconsultant], and Ecology) during the rest days; for the remaining sampling locations, the field team would not spend time setting pitfall traps. Instead, we focused on actively looking for invertebrates, overturning rocks, logs, etc. Collection of invertebrates was done by hand using sweep nets and forceps.

4.2.1 Pride of the Mountains Mine

Team 1 hiked to Pride of the Mountains Mine in the upper portion of the watershed above the Glacier Creek Falls and explored the area. Two adits were found (only one was previously located during the reconnaissance). Potential background sample locations were identified during the hike up to the adit. Since collection of invertebrates was the biggest time requirement during the previous sampling trip, the field team decided to focus on collecting invertebrates the first day.

Soil and vegetation samples were collected at ten locations as we hiked up the waste rock pile (Figure 4; Photographs A-9 through A-12). Vegetation samples consisted of Sitka sedge (grass sample) and black huckleberry (shrub sample; Table 3). Invertebrates were collected as we hiked up/around the waste rock pile and compiled into a single sample (POM-I). Sampled invertebrates included ants, spiders, grasshoppers, and centipedes.

4.2.2 New Discovery Mine

Since New Discovery Mine was not investigated during the reconnaissance trip due to GPS errors, this was our first time visiting this location. Two adits were found above the waste rock pile (it appeared that a potential third adit was intentionally caved in and covered by a large wheel). There was an abundance of mine debris in this area.

The waste rock pile did not contain much vegetation and it was, therefore, not possible to collect samples from ten locations. We did, however, successfully sample eight locations. Our samples were collected from immediately downslope of the adit opening, in the middle of the waste rock pile, and adjacent to the waste rock pile (Figure 4; Photographs A-13 through A-17). Downslope of the waste rock pile was a large boulder field that ran down to the creek.

Due to the lack of vegetation on the waste rock pile, we made a field decision to collect a couple of different species of grasses and sedges for the “grass” vegetation sample; at each of the eight locations, a composite grass sample was collected. Black huckleberry was collected for the shrub vegetation sample. Co-located soil and invertebrate samples were also collected.

4.2.3 Background Locations (BG-GB1 and BG-GB2)

Background samples were collected from areas apparently not impacted by mining activities (Figure 4; Photographs A-28 and A-29). Both background vegetation samples in Glacier Basin (BG-GB1 and BG-GB2) consisted of Sitka sedge (grass) and black huckleberry (shrub; Table 3). Soil and invertebrate samples were also collected.

There were abundant grasshoppers in these background locations. Invertebrates sampled at both background locations included grasshoppers, ants, and spiders. The field team observed a large marmot eating huckleberries at the BG-GB2 location.

4.2.4 Mystery Mine

We hiked to Mystery Mine, locating ten sampling points along the way to the lower adit (Figure 5; Photographs A-18 through A-21). Sample locations were mainly within vegetated soil along the edges and center of the lower waste rock pile. One sample point was identified within the vegetation of the upper waste rock pile.

After identifying sample locations, we began collecting soil and vegetation samples and mapping mine features and drainages. We observed a “sulfur-like” odor and yellow discoloration of the water draining from the lower adit. This discoloration continued down past the lower waste rock pile, leaving the surrounding vegetation and stream bed stained. Deer and smaller animal tracks were observed in the softer sediment of the drainage.

The soil and vegetation samples were collected at each location as we moved downgradient from the mine adit. Vegetation samples consisted of black alpine sedge (*Carex nigricans*) and Sitka mountain-ash (*Sorbus sitchensis*; Table 3). These were the most common vegetation samples at each sample location.

Since each sample point had limited invertebrates, we collected a composite sample from the upper and lower waste rock piles. Most of the invertebrate specimens including crickets and ants were found near the toe of the lower waste rock pile.

4.2.5 Justice Mine

After completion of the Mystery Mine investigation, we hiked to Justice Mine. We mapped out nine sample locations along the drainage of the adit where most of the vegetation existed (Figure 5; Photographs A-22 through A-24). Vegetation samples along the mine tailings consisted of spiny wood fern (*Dryopteris expansa*) and common horsetail (*Equisetum arvense*; Table 3). Soil samples were collected along with the vegetation samples.

Invertebrates sampled at Justice Mine consisted of carpenter ants. Invertebrates were rarely observed at the individual sampling locations, so a composite sample was collected. Most of the sampled invertebrates were collected at the site of the old bunkhouse.

4.2.6 Background Locations (BG-07 and BG-08)

Background samples were collected west of the Justice Mine adit within the undisturbed vegetation. BG-07 (Figure 5; Photograph A-30) was located west of Justice Mine along the forested hillside while BG-08 (Figure 5; Photograph A-31) was located between BG-07 and Justice Mine. We collected vegetation, soil, and invertebrate samples at each location. BG-07 consisted of huckleberry (genera *Vaccinium* or *Gaylussacia*) and BG-08 consisted of Sitka mountain-ash (Table 3). Invertebrate samples for both BG-07 and BG-08 consisted of ants, spiders, crickets and beetles. Invertebrates were collected from decomposed trees and below forest duff.

5.0 SAMPLE ANALYSIS SELECTION CRITERIA

All together, the sampling effort described above yielded:

- 58 mine site and 8 background soil samples;
- 47 grass/sedge samples;
- 52 shrub samples; and
- 12 soil invertebrate tissue samples.

The soil samples were analyzed at the lab, but the tissue samples (shrubs, grasses, and invertebrates) were held by the lab until we received the analytical results for the soil samples. Based on the metals concentrations, we ran a series of statistical tests to determine if the mine sites were significantly different from each other or whether the areas had similar geochemistry and could be considered the same "population." If the mine site soils were significantly different from each other, we would analyze all tissue samples from the 58 sample locations. However, if the mine sites did not differ significantly, a subset of tissue samples of each matrix (shrub, grass, and invertebrate for analysis) would be selected from the mine sites for analysis.

5.1 Exclusion Criteria

On November 13, 2013, Hart Crowser met with Dr. Dana Houkal regarding requirements for generating a bioaccumulation factor (BAF) relationship between source area waste rock pile soil concentrations and plant and invertebrate tissue concentrations collected from the waste rock piles. This section describes our process for selecting individual tissue samples for analysis.

During our meeting with Dr. Houkal, he recommended submitting approximately 20 tissue samples for analysis. This number would allow for robust statistical analysis and an adequate distribution of sample concentrations. Due to the limited availability of background tissue samples, he recommended having the labs analyze all of the plant and tissue samples associated with the eight background samples (see Table 3 for the complete list of plant and soil invertebrate samples collected).

Initially, Hart Crowser established exclusion criteria for samples based upon abnormal soil metal loading ratios using a Principal Components Analysis (PCA) (Figure 6). To eliminate the possibility of irregular samples skewing the data, all samples collected during the terrestrial sampling activities were entered into the PCA. This established a “normal” ratio for metal loading across all samples. Samples that did not follow this ratio were considered to have an abnormal distribution of metals loading and were subsequently eliminated from analysis. The PCA was run excluding the earth metals iron and manganese because these elements are present at high concentrations in all samples and could potentially overwhelm the signature of the other mining-related metals.

Based on results from the PCA, the following samples were rejected based on abnormal distribution:

- MY-07-S (from Mystery Mine);
- OB-10-S (from O&B Mine); and
- SH-09-S and SH-10-S (from Sheridan Mine).

5.2 Sample Selection

The remaining samples were then ranked based on location and metal concentration in relation to the minimum, maximum, and mean sample values. Soil samples (from waste rock) were selected to represent a broad range of soil metal loading concentrations from all six source areas. The samples were selected in an effort to obtain robust data points for a regression analysis over the entire soil concentration range.

After considering the criteria mentioned above, 19 plant and tissue samples were recommended for lab analysis in addition to the background tissue samples (Table 3). This included 6 samples from the Seventysix Gulch Watershed and 13 samples from the Glacier Creek Watershed:

- OB-06-S, OB-07-S, and OB-09-S (from O&B Mine);
- SH-02-S, SH-03-S, and SH-05-S (from Sheridan Mine);
- JU-01-S, JU-02-S, JU-08-S, JU-09-S, and JU-10-S (from Justice Mine);
- MY-03-S and MY-09-S (from Mystery Mine);
- ND-04-S, ND-06-S, and ND-07-S (from New Discovery Mine); and
- POM-3-S, POM-6-S, and POM-8-S (from Pride of the Mountains Mine).

The selected samples provided a sound basis for generating the BAF and comparing impacted areas to background locations, by representing a broad distribution of locations, soil concentrations, and achieving high statistical power.

After additional statistical analysis, it appeared that the mine sites constitute two statistically significant groups, with background sites being significantly different from both mine groupings. Mine group 1 consisted of O&B, Sheridan, and Justice Mines; mine group 2 consisted of Pride of the Mountains New Discovery and Mystery Mines (Figure 7). These groupings may reflect different mineralization associated with the veins that were mined, which affect geochemistry of the waste rock. Based on these results and the desire for more statistical power for the tissue analysis, we compiled a list of 40 additional tissue samples for lab analysis. We factored in soil pH (samples selected to span the range of pH), mine group (samples selected to equally represent the two groups), and preferentially selected co-located grasses and shrubs. Plant samples were selected to permit analysis of grasses and shrubs from the same location where possible, rather than analysis of locations that had only grasses but not shrubs, or shrubs but not grasses.

After considering the criteria mentioned above, 40 plant samples were recommended for lab analysis in addition to samples previously submitted (Table 3). This included 12 samples from the Seventysix Gulch Watershed and 28 samples from the Glacier Creek Watershed:

- OB-01-S, OB-02-S, OB-04-S, and OB-10-S (from O&B Mine);
- SH-01-S and SH-08-S (from Sheridan Mine);
- JU-04-S, JU-05-S, JU-06-S, and JU-07-S (from Justice Mine);
- MY-02-S, MY-04-S, MY-05-S, and MY-08-S (from Mystery Mine);
- ND-01-S and ND-05-S (from New Discovery Mine); and
- POM-1-S, POM-2-S, and POM-5-S (from Pride of the Mountains Mine).

6.0 RESULTS

Site-specific background values were calculated as part of the Phase 2 Remedial Investigation (Table 19 in Hart Crowser 2012). Analytical results for the eight background samples collected in this phase of the investigation were added to the existing set of background samples and new site-specific background concentrations were calculated for the MCMA (Table 4). Based on the findings in Phase 2, some constituents were no longer considered constituents of potential concern (COPCs) and were not analyzed for the Phase 3 soil samples. Therefore, background values were only recalculated for the remaining COPCs: antimony, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, thallium, and zinc. The sample size for those COPCs is now 68 samples with the exception of selenium, which was not analyzed for one of the eight samples. The site-specific background values for the remaining constituents listed in Table 4 are still based on the 60 samples from the Phase 2 Remedial Investigation (Hart Crowser 2012).

The site-specific terrestrial ecological evaluation (TEE), updated with the biological sampling information from this phase 3 of the investigation, is presented in Appendix C. The TEE consists of six components including:

- Background comparisons for plant and soil biota (soil invertebrate) tissue samples;
- Site-specific bioaccumulation models for plants and soil biota;
- Critical body residue evaluation for plants and soil biota;
- Hazards to wildlife using site-specific bioaccumulation models;
- Hazards to populations of plants and animals; and
- Uncertainty analysis.

6.1 Seventysix Gulch Watershed

6.1.1 Soil Sampling

Concentrations of COPCs were compared to risk-based criteria and site-specific background values (Table 4) for samples from the four background locations and two mine sites described in Section 4.1.

6.1.1.1 Background Concentrations

BG-03 exceeded both the risk-based criteria and site-specific background for cadmium, cobalt, manganese, and selenium (Table 5). All four samples exceeded the risk-based criteria, but not site-specific background for arsenic, iron, and mercury.

6.1.1.2 Mine Features

Samples from O&B Mine exceeded both the risk-based criteria and site-specific background in all ten samples for arsenic, and exceeded both criteria for more than half of the samples for copper, iron, lead, and selenium (Table 5). Antimony, cadmium, and cobalt exceeded both criteria for three samples each. Mercury exceeded risk-based criteria, but not site-specific background in nine of the ten samples. Cobalt, iron, manganese, selenium, and zinc exceeded risk-based criteria but not site-specific background for at least three samples each.

For Sheridan Mine, samples exceeded both the risk-based criteria and site-specific background in more than half the samples for arsenic, iron, manganese, mercury, and selenium (Table 5). Cadmium, cobalt, lead, and zinc exceeded both criteria for at least two samples each. Copper exceeded risk-based criteria, but not site-specific background in nine of the ten samples. Iron, lead, manganese, mercury, and selenium exceeded risk-based criteria but not site-specific background for at least four samples.

6.1.2 Invertebrate Sampling

As mentioned above, invertebrate sampling was quite difficult due to the limited numbers present at the various sampling locations. In fact, no invertebrates were found at O&B Mine or BG-01 (near O&B Mine; Figure 2). In order to meet the minimum sample mass, the invertebrates collected at Sheridan Mine were composited to form one mine site sample and the invertebrates at the three background locations were composited at each site for a total of three background samples in the Seventysix Gulch Watershed.

Analytical results for the soil invertebrate samples can be found in Table 6. Comparing raw data, the arsenic concentration for invertebrates found at Sheridan Mine (119 milligrams per kilogram [mg/kg]) were ten-fold higher than any of the background locations (0.519 to 1.32 mg/kg). Additionally, chromium and mercury concentrations (0.263 and 0.0421 mg/kg, respectively) were nearly twice as high as the background values (maximum values of 0.094 and 0.0267 mg/kg, respectively). A detailed analysis of the invertebrate data and calculations to determine the soil invertebrate bioaccumulation factors can be found in Appendix C.

6.1.3 Plant Sampling

Grasses and shrubs were collected from a sample area (a nominal 2,000 square foot polygon) for each soil sample. As described in Section 5.2, a large portion of the plant tissue samples collected (77 of the 99) were selected to be analyzed by the lab. A total of 6 background samples from 4 locations, 12 samples representing 7 locations at O&B Mine, and 8 samples representing 7 locations at Sheridan Mine were analyzed.

Analytical results for the plant tissue samples can be found in Table 7. Arsenic concentrations in the grasses and shrubs sampled from O&B Mine (0.207 to 1.08 mg/kg) and Sheridan Mine (0.088 to 1.78 mg/kg) appear to be slightly higher than those sampled from the four background locations (0.032 to 0.077 mg/kg). There does not appear to be clear relationship or pattern in the raw data for the other constituents. A detailed analysis of the plant data and calculations to determine the plant uptake factors can be found in Appendix C.

6.2 Glacier Creek Watershed

6.2.1 Soil Sampling

Concentrations of COPCs were compared to risk-based criteria and site-specific background values (Table 4) for samples from the four background locations and four mine sites described in Section 4.2.

6.2.1.1 Background Concentrations

Antimony, arsenic, lead, manganese, and zinc exceeded risk-based criteria and site-specific background in at least two of the four samples (Table 5). BG-GB1 exceeded both the risk-based criteria and site-specific background for cadmium, cobalt, and iron, but was mistakenly not analyzed for selenium. All four samples exceeded the risk-based criteria, but not site-specific background for mercury.

6.2.1.2 Mine Features

Samples from Pride of the Mountains Mine exceeded both the risk-based criteria and site-specific background in all ten samples for antimony, arsenic, copper, lead, manganese, and zinc (Table 5). Samples exceeded both criteria in more than half the samples for cadmium, iron, and mercury. Cobalt and selenium exceeded both criteria in one sample each and exceeded risk-based criteria for five and eight additional samples, respectively. One sample (POM-4-S) was mistakenly not analyzed for selenium.

For New Discovery Mine, samples exceeded both the risk-based criteria and site-specific background in all eight samples for antimony, arsenic, cadmium, copper, iron, lead, manganese, mercury, and zinc (Table 5). Cobalt and thallium exceeded both criteria for at least four samples each. Selenium exceeded both criteria for one sample and exceeded risk-based criteria but not site-specific background for the other seven samples.

For Justice Mine, samples exceeded both the risk-based criteria and site-specific background in all ten samples for antimony, arsenic, cadmium, cobalt, copper, iron, lead, manganese, mercury, and zinc (Table 5). Chromium, nickel, and selenium exceeded both criteria for at least six samples each. Chromium and selenium exceeded risk-based criteria but not site-specific background in the remaining four and two samples, respectively.

For Mystery Mine, samples exceeded both the risk-based criteria and site-specific background in all ten samples for antimony, arsenic, cadmium, copper, iron, lead, mercury, thallium, and zinc (Table 5). Manganese and selenium exceeded both criteria in at least four samples each and exceeded risk-based criteria but not site-specific background in the remaining samples. Cobalt exceeded both criteria in one sample and exceeded risk-based criteria but not site-specific background in four samples.

6.2.2 Soil Invertebrate Sampling

While the invertebrate sampling was still difficult, a composite sample was successfully collected at each of the four background locations and the four mine sites in the Glacier Creek Watershed. Analytical results for the soil invertebrate samples can be found in Table 6. Comparing raw data, Mystery Mine, New Discovery Mine, Pride of the Mountains Mine, and one background location (BG-07-I) had much higher arsenic concentrations (13.1 to 63 mg/kg) than the other three background samples (0.236 to 3.95 mg/kg) or Justice Mine (1.87 mg/kg). The range of copper concentrations in background samples (5.67 to 18.3 mg/kg) was similar to those for the mine samples (4.49 to 23.6 mg/kg). Similarly, zinc concentrations appeared to be similar in background samples and mine samples. A detailed analysis of the invertebrate data and calculations to determine the soil invertebrate bioaccumulation factors can be found in Appendix C.

6.2.3 Plant Tissue Sampling

In the Glacier Creek Watershed, 6 background samples from 4 locations, 14 samples representing 9 locations at Justice Mine, 13 sample representing 8 locations at Mystery Mine, 8 samples representing 5 locations at New Discovery Mine, and 10 samples representing 6 locations at Pride of the Mountains Mine were analyzed.

Analytical results for the plant tissue samples can be found in Table 7. Arsenic concentrations in the background grasses and shrubs ranged from 0.047 to 0.221 mg/kg, while arsenic levels in several samples from Justice Mine were much higher, ranging from 1.24 to 149 mg/kg. In general, arsenic concentrations at the other mines were less than 8 mg/kg with a few exceptions from New Discovery Mine. Compared to background samples, zinc concentrations appear to be elevated in several of the Justice Mine shrub samples, as well several grass and shrub samples from New Discovery and Pride of the Mountains Mines. Similar to the samples collected in Seventysix Gulch, there does not appear to be clear relationship or pattern in the raw data for the other constituents. A detailed analysis of the plant data and calculations to determine the plant uptake factors can be found in Appendix C.

7.0 CONCLUSIONS

The site reconnaissance and two additional sampling trips were successful in identifying and sampling co-located soil, grasses, shrubs, and soil invertebrates at four background and two mine locations in Seventysix Gulch Watershed, and four background and four mine locations in Glacier Creek Watershed. This resulted in a total of 66 soil samples, 77 plant tissue samples, and 12 soil invertebrate samples. Outlined below are some of the findings from this investigation:

- Statistical tests were used on the background and mine site source area soil samples. The results of those tests indicated at least two significantly different geochemical populations for the six mine sites (O&B, Sheridan, and Justice Mines in one group; Mystery, Pride of the Mountains, and New Discovery Mines in the second group). Additionally, these tests indicated the background samples were significantly different from all of the mine sites except Sheridan Mine.

- The eight background soil samples collected were included in a recalculation of the site-specific background values for antimony, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, thallium, and zinc (updated values shown in Table 4).

- All of the waste rock piles sampled exceeded risk-based criteria as well as site-specific background values for several COPCs; the findings presented in Section 3.0 of Appendix C indicate the following:

  - There are no constituents of concern (COCs) for soil invertebrates based on the critical body residue evaluation;
  - Only arsenic remains as a COC for individual plants living on a MCMA source area based on the critical body residue evaluation; and
  - Arsenic and lead remain as a COC for wildlife (herbivorous and insectivorous) based on the wildlife exposure modeling. This applies to individual mammals or birds living on MCMA source areas.

8.0 USE OF THIS REPORT

Work for this project was performed, and this report prepared, in accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities at the time the work was performed. It is intended for the exclusive use of the Washington State Department of Ecology for specific application to the referenced site. This report is not meant to represent a legal opinion. No other warranty, express or implied, is made.

The information in this report is intended to be used to determine whether the site has released or has a potential to release hazardous substances to the environment at concentrations above Model Toxics Control Act human health or ecological screening levels.

9.0 REFERENCES

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TABLES

Table 3 - Soil Invertebrate, Shrub, and Grass Sample List

Group	Watershed	Location	Sample ID	Date	Time	pH	Matrix	Species
Background	Seventysix Gulch	Background 01	BG-01-VG	8/22/2013	1330		Veg - grass	Sitka sedge
			BG-01-VS	8/22/2013	1330		Veg - shrub	Pacific bleeding heart
		Background 02	BG-02-I	8/22/2013	1150		Inverts	Spiders, grasshoppers
			BG-02-VS	8/22/2013	1150		Veg - grass	Sitka sedge
			BG-02-VG	8/22/2013	1150		Veg - shrub	Edible thistle
		Background 03	BG-03-I	8/25/2013	1355		Inverts	Centipedes, spiders
			BG-03-VS	8/25/2013	1355		Veg - shrub	Black huckleberry
		Background 04	BG-04-I	8/25/2013	1520		Inverts	Spiders
			BG-04-VS	8/25/2013	1520		Veg - shrub	Black huckleberry
	Glacier Creek	Background Glacier Basin 1	BG-GB1-I	8/31/2013	1530		Inverts	Grasshoppers, ants
			BG-GB1-VG	8/31/2013	1530		Veg - grass	Sitka sedge
			BG-GB1-VS	8/31/2013	1530		Veg - shrub	Back huckleberry
		Background Glacier Basin 2	BG-GB2-I	9/2/2013	800		Inverts	Grasshoppers, spiders, ants
			BG-GB2-VG	9/2/2013	800		Veg - grass	Sitka sedge
			BG-GB2-VS	9/2/2013	800		Veg - shrub	Back huckleberry
		Background 07	BG-07-I	9/1/2013	915		Inverts	Ants, crickets, beetles, spiders
			BG-07-VS	9/1/2013	1255		Veg - shrub	Huckleberry
		Background 08	BG-08-I	9/3/2013	1516		Inverts	Ants, spiders, crickets, beetles
			BG-08-VS	9/3/2013	900		Veg - shrub	Sitka mountain-ash
Mine Group 1	Seventysix Gulch	O&B Mine	OB-01-VG	8/21/2013	1030	4.61	Veg - grass	Sitka sedge
			OB-01-VS	8/21/2013	1030	4.61	Veg - shrub	Black huckleberry
			OB-02-VG	8/21/2013	1140	3.81	Veg - grass	Sitka sedge
			OB-02-VS	8/21/2013	1140	3.81	Veg - shrub	Black huckleberry
			OB-03-VS	8/21/2013	1245	4.56	Veg - shrub	Black huckleberry
			OB-04-VG	8/21/2013	1310	4.63	Veg - grass	Sitka sedge
			OB-04-VS	8/21/2013	1310	4.63	Veg - shrub	Black huckleberry
			OB-05-VG	8/21/2013	1430	4.52	Veg - grass	Sitka sedge
			OB-06-VG	8/21/2013	1330	4.65	Veg - grass	Sitka sedge
			OB-06-VS	8/21/2013	1330	4.65	Veg - shrub	Black huckleberry
			OB-07-VG	8/22/2013	935	4.55	Veg - grass	Sitka sedge
			OB-07-VS	8/22/2013	935	4.55	Veg - shrub	Black huckleberry
			OB-08-VG	8/22/2013	1010	3.95	Veg - grass	Sitka sedge
			OB-09-VG	8/22/2013	1050	3.84	Veg - grass	Sitka sedge
			OB-10-VG	8/21/2013	1410	4.85	Veg - grass	Sitka sedge
			OB-10-VS	8/21/2013	1410	4.85	Veg - shrub	Black huckleberry
		Sheridan Mine	SH-I	8/24/2013	1300		Inverts	Ants, spiders
			SH-01-VG	8/24/2013	1405	5.34	Veg - grass	Blue wildrye
			SH-01-VS	8/24/2013	1405	5.34	Veg - shrub	Black huckleberry
			SH-02-VG	8/24/2013	1500	5.14	Veg - grass	Blue wildrye
			SH-03-VS	8/24/2013	1515	3.63	Veg - shrub	Black huckleberry
			SH-04-VG	8/24/2013	1530	3.48	Veg - grass	Blue wildrye
			SH-05-VS	8/25/2013	1105	3.87	Veg - shrub	Black huckleberry
			SH-06-VS	8/25/2013	1135	3.65	Veg - shrub	Black huckleberry
			SH-07-VS	8/25/2013	1150	4.23	Veg - shrub	Black huckleberry
			SH-08-VG	8/25/2013	1205	4.71	Veg - grass	Blue wildrye
			SH-08-VS	8/25/2013	1205	4.71	Veg - shrub	Black huckleberry
			SH-09-VS	8/25/2013	1220	4.05	Veg - shrub	Black huckleberry
			SH-10-VS	8/25/2013	1230	4.31	Veg - shrub	Black huckleberry
	Glacier Creek	Justice Mine	JU-I	9/2/2013	915		Inverts	Ants (red, carpenter), spider, beetle
			JU-01-VS	9/2/2013	1300	5.77	Veg - shrub	Common horsetail
			JU-02-VS	9/2/2013	1320	4.78	Veg - shrub	Common horsetail
			JU-03-VS	9/2/2013	1340	5.31	Veg - shrub	Common horsetail
			JU-04-VG	9/2/2013	1440	5.75	Veg - grass	Spiny wood fern
			JU-04-VS	9/2/2013	1440	5.75	Veg - shrub	Common horsetail
			JU-05-VG	9/2/2013	1450	4.45	Veg - grass	Spiny wood fern
			JU-05-VS	9/2/2013	1450	4.45	Veg - shrub	Common horsetail
			JU-06-VG	9/2/2013	1500	5.85	Veg - grass	Spiny wood fern
			JU-06-VS	9/2/2013	1500	5.85	Veg - shrub	Common horsetail
			JU-07-VG	9/2/2013	1515	6.02	Veg - grass	Spiny wood fern
			JU-07-VS	9/2/2013	1515	6.02	Veg - shrub	Common horsetail
			JU-08-VG	9/2/2013	1525	5.99	Veg - grass	Spiny wood fern
			JU-08-VS	9/2/2013	1525	5.99	Veg - shrub	Common horsetail
			JU-09-VS	9/2/2013	1540	6.75	Veg - shrub	Common horsetail
			JU-10-VS	9/2/2013	1550	5.41	Veg - shrub	Common horsetail

Table 3 - Soil Invertebrate, Shrub, and Grass Sample List

Group	Watershed	Location	Sample ID	Date	Time	pH	Matrix	Species
Mine Group 2	Glacier Creek	Mystery Mine	MM-I	8/31/2013	1000		Inverts	Ants, spiders, grasshoppers, beetle
			MY-01-VG	8/31/2013	1400	4.31	Veg - grass	Black alpine sedge
			MY-02-VG	8/30/2013	1508	3.65	Veg - grass	Black alpine sedge
			MY-02-VS	8/30/2013	1508	3.65	Veg - shrub	Sitka mountain-ash
			MY-03-VG	8/31/2013	1030	3.83	Veg - grass	Black alpine sedge
			MY-03-VS	8/31/2013	1030	3.83	Veg - shrub	Sitka mountain-ash
			MY-04-VG	9/1/2013	1120	3.72	Veg - grass	Black alpine sedge
			MY-04-VS	8/31/2013	1120	3.72	Veg - shrub	Sitka mountain-ash
			MY-05-VG	8/31/2013	1150	4.15	Veg - grass	Black alpine sedge
			MY-05-VS	8/31/2013	1150	4.15	Veg - shrub	Sitka mountain-ash
			MY-06-VS	8/31/2013	1330	3.7	Veg - shrub	Sitka mountain-ash
			MY-07-VS	8/31/2013	1420	3.8	Veg - shrub	Sitka mountain-ash
			MY-08-VG	8/31/2013	1500	3.66	Veg - grass	Black alpine sedge
			MY-08-VS	8/31/2013	1500	3.66	Veg - shrub	Sitka mountain-ash
			MY-09-VS	9/1/2013	930	4.19	Veg - shrub	Sitka mountain-ash
			MY-10-VG	9/1/2013	1035	4.25	Veg - grass	Black alpine sedge
			MY-10-VS	9/1/2013	1035	4.25	Veg - shrub	Sitka mountain-ash
		Pride of the Mountains Mine	POM-I	8/30/2013	1300		Inverts	Ants, spiders, grasshoppers, centipedes
			POM-1-VG	8/31/2013	830	4.73	Veg - grass	Sitka sedge
			POM-1-VS	8/31/2013	830	4.73	Veg - shrub	Huckleberry
			POM-2-VG	8/31/2013	910	4.81	Veg - grass	Sitka sedge
			POM-2-VS	8/31/2013	910	4.81	Veg - shrub	Huckleberry
			POM-3-VG	8/31/2013	940	4.6	Veg - grass	Sitka sedge
			POM-4-VG	8/31/2013	1020	4.14	Veg - grass	Sitka sedge
			POM-5-VG	8/31/2013	1050	4.45	Veg - grass	Sitka sedge
			POM-5-VS	8/31/2013	1050	4.45	Veg - shrub	Huckleberry
			POM-6-VG	8/31/2013	1120	4	Veg - grass	Sitka sedge
			POM-6-VS	8/31/2013	1120	4	Veg - shrub	Huckleberry
			POM-7-VG	8/31/2013	1145	4.23	Veg - grass	Sitka sedge
			POM-7-VS	8/31/2013	1145	4.23	Veg - shrub	Huckleberry
			POM-8-VG	8/31/2013	1215	4.99	Veg - grass	Sitka sedge
			POM-9-VG	8/31/2013	1310	3.84	Veg - grass	Sitka sedge
			POM-9-VS	8/31/2013	1310	3.84	Veg - shrub	Huckleberry
			POM-10-VG	8/31/2013	1330	3.86	Veg - grass	Sitka sedge
		New Discovery Mine	ND-I	9/1/2013	900		Inverts	Spiders, ants, centipedes, grasshoppers, beetle
			ND-01-VG	9/1/2013	1010	4.56	Veg - grass	Composite grass/sedge[1]
			ND-01-VS	9/1/2013	1010	4.56	Veg - shrub	Huckleberry
			ND-02-VG	9/1/2013	1030	0	Veg - grass	Composite grass/sedge[1]
			ND-02-VS	9/1/2013	1030	0	Veg - shrub	Huckleberry
			ND-03-VG	9/1/2013	1100	5.78	Veg - grass	Composite grass/sedge[1]
			ND-04-VG	9/1/2013	1120	5.23	Veg - grass	Composite grass/sedge[1]
			ND-04-VS	9/1/2013	1120	5.23	Veg - shrub	Huckleberry
			ND-05-VG	9/1/2013	1145	4.87	Veg - grass	Composite grass/sedge[1]
			ND-05-VS	9/1/2013	1145	4.87	Veg - shrub	Huckleberry
			ND-06-VG	9/1/2013	1205	4.65	Veg - grass	Composite grass/sedge[1]
			ND-07-VG	9/1/2013	1430	4.61	Veg - grass	Composite grass/sedge[1]
			ND-08-VG	9/1/2013	1450	3.96	Veg - grass	Composite grass/sedge[1]

Notes:

1 Due to very limited grass/sedge sample material, field team had to sample multiple grass/sedge species. This material was composited into a sample.

(gray) Co-located soil samples were analyzed and the plant and invertebrate samples analyzed in the first round of selection are highlighted gray.

(yellow) Additional plant and invertebrate samples selected for the second round of analysis (based on the co-located soil sample results) are highlighted yellow.

Table 4 – Potential Chemical-Specific RBCs, Site-Specific Background, and Proposed Screening Criteria for Waste Rock, Soil, and Tailings

Constituents of Potential Concern (mg/kg)	Risk-Based Criteria (a)	Site-Specific Background	State of Washington									Federal	
					MTCA Method B Soil Cleanup Levels			Ecological Indicator Screening Criteria				EPA Eco-SSLs (g)	
			Ecology-Reported Natural Background (b)	MTCA Method A Soil Cleanup Levels (c)	Soil Ingestion (d)	Soil Ingestion and Dermal Contact (d)	Groundwater Protection (e)	Protection of Plants (f)	Protection of Soil (f)	Protection of Wildlife (f)	Unrestricted Land Use (g) MTCA 173-340-900 (Table 749-2).	Protection of Plants	Protection of Soil Invertebrates
Aluminum (Al)	50	37,300 (j)	37,200	--	80,000	72,000	--	50	--	--	--	pH-dependent	pH-dependent
Antimony (Sb)	5	5.4 (k)	--	--	32	28.8	5.42	5	--	--	--	--	78
Arsenic (As)	0.62	216 (k)	7	20	0.67	0.62	5.84	-- / 10 (h)	-- / 60 (h)	7 / 132 (h)	20 / -- (h)	18	--
Barium (Ba)	102	83 (j)	--	--	16,000	14,400	1,650	500	--	102	1,250	--	330
Beryllium (Be)	1.40	0.54 (j)	1.4	--	160	140	63	10	--	--	25	--	40
Cadmium (Cd)	0.69	0.76 (k)	1	2	80	74	0.69	4	20	14	25	32	140
Calcium (Ca) (l)	--	1,940 (j)	--	--	--	--	--	--	--	--	--	--	--
Chromium III (Cr III)	2,000	64 (k)	42 (i)	2,000	120,000	44,600	2,000	42 (i)	42 (i)	67 (i)	42 (i)	--	--
Chromium VI (Cr VI)	19			19	240 / 2	128 / 1.1	38.4 / 18						
Cobalt (Co)	13	21 (k)	--	--	--	--	--	20	--	--	--	13	--
Copper (Cu)	36	106 (k)	36	--	2,960	2,700	577	100	50	217	100	70	80
Iron (Fe)	91	41,400 (k)	43,100	--	24,000	21,600	91.2	--	--	--	--	pH- & Eh-dependent	pH- & Eh-dependent
Lead (Pb)	17	78 (k)	17	250	--	--	3,000	50	500	118	220	120	1,700
Magnesium (Mg) (l)	--	9,740 (j)											
Manganese (Mn)	52	1,060 (k)	1,100	--	11,200	10,100	52	1,100	--	1,500	--	220	450
Mercury (Hg, inorganic)	0.07	0.37 (k)	0.07	2	--	--	2.09	0.3	0.1	5.5	9	--	--
Nickel (Ni)	30	39 (k)	38	--	1,600	1,400	130	30	200	980	100	38	280
Potassium (K)(l)	--	1,470 (j)	--	--	--	--	--	--	--	--	--	--	--
Selenium (Se)	0.30	2.1 (k)	--	--	400	360	5.2	1	70	0.3	0.8	0.52	4.1
Silver (Ag)	2	1.2 (j)	--	--	400	360	13.7	2	--	--	--	560	--
Sodium (Na) (l)	--	360 (j)	--	--	--	--	--	--	--	--	--	--	--
Thallium (Th)	1	0.6 (k)	--	--	--	--	2.85	1	--	--	--	--	--
Vanadium (Va)	2	92 (j)	--	--	560	505	2,240	2	--	--	26	--	--
Zinc (Zn)	86	157 (k)	86	--	24,000	22,000	5,970	86	200	360	270	160	120

Notes:

(a) Risk-based criteria from shaded source.

(b) Data from Natural Background Soil Metals Concentrations in Washington State (Ecology 1994).

(c) WAC 173-340-740(2), WAC 173-340-900 (Table 740-1). Model Toxics Control Act (MTCA) Method A soil cleanup levels.

(d) WAC 173-340-740(3). MTCA Method B unrestricted land use soil cleanup standards. For carcinogenic constituents, the value is presented as the "non-carcinogenic level / carcinogenic level" calculated using Equations 740-1 and 740-2 for ingestion and dermal contact. Information from CLARC 3.1 was used unless otherwise noted.

(e) WAC 173-340-740(3)(b)(iii)(A); MTCA Method B unrestricted land use soil cleanup standards, groundwater protection. Values calculated using the MTCA three-phase partitioning model WAC 173-340-747(4). Where applicable, the drinking water maximum contaminant level (MCL) is used.

(f) MTCA 173-340-900 (Table 749-3).

(g) EPA Ecological Soil Screening Levels (ECO-SSL) are found at http://www.epa.gov/ecotox/ecossl/.

(h) Based on Arsenic III / Arsenic V.

(i) Based on total Chromium.

(j) Denotes values that were calculated from 60 total samples across three watersheds using proUCL 5.0 (10 samples collected in 2005 by Cascade Earth Sciences and 50 samples in 2011 by Hart Crowser).

(k) Site-specific background values calculated by pooling 68 background soil samples, except selenium was calculated with only 67 samples.

(l) Constituent is an essential element, is considered non-toxic under a wide range of environmental concentrations, and is excluded from further evaluation.

Cleanup criteria is the maximum of the lowest ARAR and site-specific background values.

-- Not established or not applicable.

Table 5 - Analytical Results for Soil Samples

Area	Sample ID	Sampling Date	Antimony	Arsenic	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Methylmercury	Nickel	Selenium	Thallium	Zinc	pH	Total Organic Carbon	Total Solids
			Concentration in mg/kg																	
	Risk-based critera		5	0.62	0.69	19	13	36	91.2	17	52	0.07		30	0.3	1	86			
	Site-specific background		5.4	216	0.76	64	21	106	41400	78	1060	0.37		39	2.1	0.6	157			
Seventysix Gulch Background	BG-01-S	8/22/2013	0.44 UJ	31	0.3	11.4	5.1	28.5	22500	11	482	0.09	0.044 T	10	2.45	0.096 T	38	4.48	7.29	65.26
	BG-02-S	8/22/2013	0.37 UJ	6.1	0.3	6.5	2.3	12.9	10800	12	128	0.11	0.254 J	5	0.74 T	0.128 T	19	4.63	15.2	85.52
	BG-03-S	8/25/2013	0.42 UJ	65	0.8	11.2	29.1	34.6	31000	53	1540	0.2	0.339 J	8	2.8	0.164 T	73	4.76	7.84	75.13
	BG-04-S	8/25/2013	0.5 UJ	25	0.4	4.8	2.9	8.9	11300	19	62	0.12	0.155 J	4	0.87 T	0.044 T	19	4.98	8.18	68.94
O&B Mine	OB-01-S	8/21/2013	1.52 JT	2600	0.154 U	6.9	8.9	243	23700	134	470	0.18	0.243 J	5	2.84	0.098 T	34	4.61	7.37	69.65
	OB-02-S	8/21/2013	3.9 JT	10100	0.79 T	7	20	219	57300	280	828	0.22	0.029 JT	16	2.63 J	0.137 T	91	3.81	5.4	90.98
	OB-03-S	8/21/2013	5.5 JT	11900	0.87 T	6	27	688	68400	290	1050	0.3	0.078 J	14	2.88	0.136 T	112	4.56	16	86.62
	OB-04-S	8/21/2013	8.8 JT	14200	0.8 U	5	15	1140	81700	400	666	0.32	0.033 JT	8	3.25 J	0.1 T	53	4.63	18.5	69.15
	OB-05-S	8/21/2013	2.2 JT	6300	0.324 U	6	37.8	1280	41900	298	1430	0.24	0.088 J	16	2.18	0.089 T	106	4.52	22.7	75.59
	OB-06-S	8/21/2013	0.43 JT	302	0.4	4.3	2.6	70	14100	39	125	0.1	0.128 J	3	1.6	0.064 T	24	4.65	12.4	77.66
	OB-07-S	8/22/2013	2 JT	3720	0.466 T	62	17	225	48900	158	900	0.19	0.117 J	96	2.52	0.149 T	125	4.55	7.84	66.93
	OB-08-S	8/22/2013	7.9 JT	10900	0.6 U	52	15	423	99300	520	902	0.31	0.034 J	83	2	0.14 T	110	3.95	6.15	88.41
	OB-09-S	8/22/2013	1.53 JT	2150	0.137 U	2.7	3.7	110	14300	83	48	0.07	0.073 J	2	0.57 T	0.024 T	16	3.84	8.67	78.6
	OB-10-S	8/21/2013	1.1 JT	1880	0.5	8	31.9	1040	34900	60	1340	0.17	0.145 J	25	1.94	0.088 T	173	4.85	6.9	89.95
Sheridan Mine	SH-01-S	8/24/2013	2.3 JT	1710	1.6	16	23.1	101	46100	63	2550	0.39	0.016 JT	29	2.33	0.2	449	5.34	1.53	95.57
	SH-02-S	8/24/2013	4.8 JT	7610	5	14	32	97	66600	70	12600	0.63	0.087 J	51	2.81	0.168 T	857	5.14	13.9	94.55
	SH-03-S	8/24/2013	1.9 JT	3160	2	21	13	70	67700	150	1700	0.86	0.211 J	24	1.19	0.135 T	338	3.63	2.98	97.03
	SH-04-S	8/24/2013	3.6 JT	8030	0.54 U	18	26	100	71600	90	4660	0.65	0.57 J	34	2.32	0.125 T	278	3.48	4.78	95.81
	SH-05-S	8/25/2013	4.3 JT	5750	0.53 U	16	20	79	73700	50	2680	1.06	0.312 J	24	1.69	0.158 T	142	3.87	4.19	97.01
	SH-06-S	8/25/2013	2.6 JT	1490	0.55 U	6	3	64	73500	50	432	0.32	0.028 T	2.83 T	1.91	0.168 T	44	3.65	7.34	96.79
	SH-07-S	8/25/2013	0.8 UJ	650	0.28 U	7	7.7	57.3	39300	30	858	0.36	0.535 J	7	2.3	0.109 T	62	4.23	12.7	95.09
	SH-08-S	8/25/2013	0.76 JT	291	0.4	6.4	9.1	81.4	23100	40	652	0.13	0.179 J	4	1.91	0.075 T	71	4.71	12.8	80.39
	SH-09-S	8/25/2013	0.37 JT	45	0.4	4	2.4	24.3	12100	14	80.2	0.07	0.166 J	3	0.76 T	0.031 T	48	4.05	8.39	91.99
	SH-10-S	8/25/2013	1.08 JT	148	0.6	8.3	14.5	80.8	27700	63	954	0.24	0.353 J	5	4.96	0.062 T	54	4.31	20.9	77.61
Glacier Creek Background	BG-07-S	9/1/2013	20 UJ	70	0.7 U	19	3	23.2	24000	14	106	0.16	0.064 JG	8	1.82	0.3 T	45	5.31	3.78	75.61
	BG-08-S	9/1/2013	1.88 JT	292	0.139 U	17.8	3.7	31.5	20200	45	635	0.11	0.26 JG	7	1.17 T	0.073 T	27	4.33	8.74	78.04
	BG-GB1-S	8/31/2013	30 J	590	0.9	14	29.8	93.2	47100	194	4680	0.21	0.236 JG	9		0.6	268	4.74	6.66	85.79
	BG-GB2-S	9/2/2013	20 J	450	0.7	16	18.8	88.7	37500	116	2260	0.2	0.033 UJ	12	1.82	0.5	242	4.96	4.11	93.41
Pride of the Mountains Mine	POM-1-S	8/31/2013	20 J	600	1.1	6	15.9	123	34300	360	3190	0.18	0.287 JG	4	1.28 T	0.3	307	4.73	2.61	81.92
	POM-2-S	8/31/2013	20 J	1160	3	3	10.5	230	30500	506	1200	0.96	0.705 JG	3	1.1 T	0.2	523	4.81	6.82	89.44
	POM-3-S	8/31/2013	30 J	2330	11.1	3	17.1	411	55200	1120	3660	0.95	0.034 UJ	5	1.41	0.5	1530	4.6	3.19	91.91
	POM-4-S	8/31/2013	50 J	8310	0.55 U	2.45 T	18	555	68700	3210	3500	0.68	0.035 JTG	2.05 T		0.4	1030	4.14	1.81	95.06
	POM-5-S	8/31/2013	40 J	2980	0.292 U	3	23	270	62200	1150	3340	0.8	0.914 JG	3	1.81	0.4	568	4.45	2.86	88.28
	POM-6-S	8/31/2013	20 J	3480	0.296 U	4	10.4	238	39500	1140	3500	0.43	0.045 JG	1.95 T	1.14 T	0.3	291	4	4.98	93.2
	POM-7-S	8/31/2013	61.8 JT	10600	2.89 U	7.1 U	14	442	47300	2620	3580	0.54	0.033 UJ	7.9 U	0.79 T	0.3	600	4.23	3.67	90.57
	POM-8-S	8/31/2013	30 J	3230	9.2	4	12.5	247	58700	681	4300	0.22	0.031 R	2.47 T	1.22	0.5	1660	4.99	0.643	96.93
	POM-9-S	8/31/2013	130 J	9390	1.12 U	5	15	169	64800	2250	3400	1	0.214 JG	3.1 T	1.56	1	830	3.84	2.02	94.94
	POM-10-S	8/31/2013	40 J	970	0.8 T	5	13	133	59700	320	4670	0.38	0.03 R	3.53 T	2.76	1.6	555	3.86	1.85	94

Table 5 - Analytical Results for Soil Samples

Area	Sample ID	Sampling Date	Antimony	Arsenic	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Methylmercury	Nickel	Selenium	Thallium	Zinc	pH	Total Organic Carbon	Total Solids
			Concentration in mg/kg																	
	Risk-based critera		5	0.62	0.69	19	13	36	91.2	17	52	0.07		30	0.3	1	86			
	Site-specific background		5.4	216	0.76	64	21	106	41400	78	1060	0.37		39	2.1	0.6	157			
New Discovery Mine	ND-01-S	9/1/2013	***80*** J	***3850*** J	***22***	7	***25***	***490***	***94800***	***1550***	***3910***	***1.04***	0.286 JG	5	*0.61* T	0.2 J	***3330*** J	4.56	5.35	85.27
	ND-02-S	9/1/2013	***100*** J	***7310***	***2***	6	*16*	***150***	***53700***	***1590***	***2720***	***1.58***	0.033 JG	10	*0.47* T	0.5	***840***	4.15	1.18	98.22
	ND-03-S	9/1/2013	***70*** J	***7480***	***6***	18	***32***	***309***	***85900***	***810***	***5660***	***1.17***	0.049 JG	15	*1.09* T	***1.1***	***2040***	5.78	4.33	92.79
	ND-04-S	9/1/2013	***150*** J	***7380***	***14***	3	***38***	***597***	***92700***	***2010***	***12100***	***2.52***	0.033 R	9	***2.46***	***6.9***	***2370***	5.23	2.63	93.16
	ND-05-S	9/1/2013	***70*** J	***6010***	***2***	8	***23***	***135***	***62100***	***1230***	***3580***	***0.94***	0.028 R	10	*0.46* T	0.5	***780***	4.87	0.951	98.21
	ND-06-S	9/1/2013	***50*** J	***3400***	***1***	14	***26***	***404***	***78900***	***990***	***3510***	***1.76***	0.28 JG	5	*1.69*	0.3	***447***	4.65	5.68	90.76
	ND-07-S	9/1/2013	***70*** J	***3320***	***3***	*20*	***34***	***319***	***102000***	***460***	***5580***	***1.74***	0.03 R	8	*1.44*	***3.7***	***954***	4.61	2.31	96.8
	ND-08-S	9/1/2013	***130*** J	***6790***	***5***	10	*17*	***374***	***104000***	***2620***	***2430***	***1.16***	0.039 JG	20	*1.12*	***3.6***	***670***	3.96	2.09	97.69
Justice Mine	JU-01-S	9/2/2013	***260*** J	***13600***	***46***	*20*	***31***	***1250***	***76700***	***4070***	***3980***	***2.3***	0.66 JG	22	***2.17***	0.233 T	***3360***	5.77	3.98	80.94
	JU-02-S	9/2/2013	***140*** J	***27400***	***11***	*20*	***24***	***631***	***85900***	***2980***	***2150***	***0.93***	0.032 UJ	10	***4.5***	0.3	***1040***	4.78	1.4	87.42
	JU-03-S	9/2/2013	***26.1*** JT	***7980***	***16***	***98***	***65***	***1550***	***75400***	***580***	***3190***	***0.53***	0.185 JG	***97***	*1.44*	0.237 T	***1850***	5.31	7.57	77.87
	JU-04-S	9/2/2013	***14.5*** JT	***6490***	***22.4***	***94***	***59***	***1240***	***63500***	***454***	***2450***	***0.72***	0.552 JG	***96***	***2.68***	0.237 T	***3980***	5.75	1.79	61.12
	JU-05-S	9/2/2013	***140*** J	***15100***	***9***	*28*	***29***	***634***	***69800***	***2000***	***1810***	***1.04***	0.048 JG	15	***3.73***	0.182 T	***752***	4.45	9.26	86.41
	JU-06-S	9/2/2013	***20*** J	***6390***	***22.7***	***85***	***39***	***974***	***60000***	***627***	***2040***	***0.63***	0.293 JG	***74***	***3.96***	0.224 T	***3440***	5.85	9.22	58.66
	JU-07-S	9/2/2013	***40*** J	***7350***	***21***	***67***	***38***	***774***	***71000***	***750***	***3200***	***1.25***	0.132 JG	***80***	***3.12***	0.195 T	***3520***	6.02	3.37	61.4
	JU-08-S	9/2/2013	***40*** J	***7670***	***17***	***85***	***31***	***812***	***59300***	***740***	***2250***	***0.79***	0.457 JG	***60***	*2.08*	0.173 T	***2420***	5.99	6.13	64.02
	JU-09-S	9/2/2013	***50*** J	***11200***	***43***	*52*	***55***	***2560***	***65000***	***1250***	***5320***	***0.83***	0.147 JG	***55***	***4.69***	0.15 T	***4580***	6.75	2.93	76.04
	JU-10-S	9/2/2013	***90*** J	***9810***	***26***	***71***	***58***	***1010***	***76500***	***1790***	***3250***	***1.1***	0.029 UJ	***87***	***2.47***	0.3	***2800***	5.41	1.24	94.22
Mystery Mine	My-01-S	8/30/2013	***170*** J	***13200***	***1*** U	6	*21*	***388***	***91900***	***1370***	***1890***	***1.64***	0.033 R	6 T	*1.52*	***3***	***1020***	4.31	3.14	81.94
	My-02-S	8/30/2013	***560*** J	***15500***	***2*** U	7	***25***	***363***	***80700***	***2440***	***4180***	***2.23***	0.029 R	10 T	*1.24*	***1.9***	***1040***	3.65	0.356	91.3
	My-03-S	8/31/2013	***440*** J	***17000***	***5*** U	10 T	8 T	***296***	***129000***	***1840***	*889*	***1.1***	0.02 JTG	30 U	***2.83***	***4.2***	***320***	3.83	4.22	87.06
	My-04-S	8/31/2013	***280*** J	***13000***	***5*** U	10 T	8 T	***199***	***93900***	***1660***	*406*	***0.84***	0.046 JG	30 U	***2.46***	***3.7***	***330***	3.72	2.94	91.37
	My-05-S	8/31/2013	***70*** J	***3970***	***1*** U	5	*18*	***168***	***77400***	***530***	***2440***	***0.58***	0.032 R	5 T	*1.2* T	***8.4***	***695***	4.15	2.03	89.16
	My-06-S	8/31/2013	***190*** J	***8930***	***1*** U	4	6	***177***	***72200***	***1110***	*772*	***1.29***	0.267 JG	5 T	***2.28***	***4.9***	***277***	3.7	8.22	90.49
	My-07-S	8/31/2013	***560*** J	***10200***	***2*** U	5 U	3 T	***207***	***74300***	***1640***	*149*	***1.49***	0.037 JG	10 U	*1.79*	***3.8***	***220***	3.8	2.2	92.98
	My-08-S	8/31/2013	***290*** J	***10200***	***2*** U	9	*16*	***295***	***113000***	***1800***	***4580***	***1.21***	0.031 R	10 T	*0.98* T	***2.5***	***950***	3.66	2.34	92.46
	My-09-S	9/1/2013	***560*** J	***20600***	***6*** U	10 U	8 T	***186***	***130000***	***1920***	*329*	***5.2***	0.18 JG	30 U	***3.06***	***9.7***	***200***	4.19	2.94	83.04
	My-10-S	9/1/2013	***60*** J	***2760***	***1***	5	*16*	***174***	***77000***	***490***	***2970***	***0.47***	0.031 R	5 T	*0.94* T	***5.6***	***918***	4.25	0.817	90.98

(boxed)	Exceeds the site-specific background listed in Table 4.
Italic	Exceeds the lowest risk-based criteria (RBC) listed in Table 4.
Bold italic	Exceeds both the lowest RBC and site-specific background values listed in Table 4 - COPC.

COPC - constituent of potential concern

Table 6 - Analytical Results for Invertebrate Tissue Samples

Area	Sample ID	Sampling Date	Aluminum	Antimony	Arsenic	Barium	Berylium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Methylmercury	Nickel	Potassium
			Concentration in mg/kg																	
Seventysix Gulch Background	BG-02-I	8/22/2013	33.1	0.007 U	0.519	1.87	0.029 U	0.307	465	0.017 U	0.037 T	14.1	28.8	0.068	400	29.5	0.00677	0.00457	0.35	3100
	BG-03-I	8/25/2013	45.2	0.02 T	1.32	2.68	0.03 U	1.03	12600	0.094 T	0.048 T	11.1	48.2	0.826	527	80.7	0.0117	0.00619	0.05 U	481
	BG-04-I	8/25/2013	18	0.006 U	0.892	0.76	0.027 U	0.626	302	0.021 T	0.032 T	5.83	34.9	0.179	241	146	0.0267	0.00643	0.07 T	1920
Sheridan Mine	SH-I	8/24/2013	218	0.249	119	1.82	0.03 U	0.928	334	0.263	0.699	9.55	1110	1.23	380	172	0.0421	0.0143	0.73	1920
Glacier Creek Background	BG-07-I	9/1/2013	14.6	0.114	13.1	0.82	0.031 U	0.476	1130	0.019 U	0.021 U	10.6	93.9	0.461	367	57.6	0.0435	0.0268	0.05 U	1330
	BG-08-I	9/3/2013	10.1	0.006 U	0.383	1.75	0.027 U	0.301	218	0.016 U	0.018 U	5.67	27.4	0.035 T	278	89	0.0116	0.00402	0.09 T	2230
	BG-GB1-I	8/31/2013	117	0.421	3.95	3.53	0.027 U	0.136	506	0.102 T	0.299	18.3	271	1.67	315	69.9	0.00395	0.00098 U	0.53	2190
	BG-GB2-I	9/2/2013	26.2	0.026 J	0.236	3.04	0.027 U	0.064	369	0.016 U	0.159	16.5	23.7	0.177	311	48.6	0.0018	0.00093 U	1.11	2560
Justice Mine	JU-I	9/2/2013	18.9	0.016 T	1.87	1.09	0.027 U	0.355	165	0.135	0.035 T	4.49	38.4	0.37	231	38.9	0.0149	0.00485	0.07 T	2030
Mystery Mine	MM-I	8/31/2013	43.6	3.64	63	0.87	0.026 U	0.46	243	0.077 T	0.114 T	19.2	424	10.2	290	41.4	0.0283	0.00645	0.17 T	2180
New Discovery Mine	ND-I	9/1/2013	196	1.25	29	1.37	0.03 U	0.72	325	0.144	0.344	23.6	618	11.5	311	115	0.029	0.0111	0.29	1530
Pride of the Mountains Mine	POM-I	8/30/2013	272	0.929	14.5	3.99	0.027 U	0.974	195	0.104 T	0.133 T	9.49	349	21.6	191	58.3	0.0197	0.00919	0.16 T	1110

Area	Sample ID	Sampling Date	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	Total Solids in %
			Concentration in mg/kg						
Seventysix Gulch Background	BG-02-I	8/22/2013	0.06 U	0.081 T	143	0.004 T	0.06 U	47.4	30.14
	BG-03-I	8/25/2013	0.06 U	0.299	84	0.006 T	0.06 U	46	20.42
	BG-04-I	8/25/2013	0.07 T	0.055 T	262	0.005 T	0.05 U	61.3	31.66
Sheridan Mine	SH-I	8/24/2013	0.11 T	0.179	486	0.004 T	0.42	65.9	37.03
Glacier Creek Background	BG-07-I	9/1/2013	0.12 T	0.22	333	0.011	0.06 U	71.2	32.7
	BG-08-I	9/3/2013	0.05 U	0.029 T	332	0.003 T	0.05 U	45.3	35.72
	BG-GB1-I	8/31/2013	0.05 U	0.023 T	74.1	0.007 T	0.43	41.8	30.41
	BG-GB2-I	9/2/2013	0.05 U	0.018 U	60.4	0.006 T	0.05 U	40.2	29.05
Justice Mine	JU-I	9/2/2013	0.05 U	0.018 U	262	0.002 U	0.05 U	49.1	35.29
Mystery Mine	MM-I	8/31/2013	0.07 T	0.717	136	0.056	0.17	50.4	28.19
New Discovery Mine	ND-I	9/1/2013	0.1 T	0.527	283	0.019	0.76	57.1	34.41
Pride of the Mountains Mine	POM-I	8/30/2013	0.1 T	0.177	216	0.006 T	0.33	50.2	26.24

U = Not detected at the reporting limit indicated.
J = Estimated value.
T = Value is between the MDL and MRL.

Table 7 - Analytical Results for Plant Tissue Samples

Area	Sample ID	Sampling Date	Concentration in mg/kg																	
			Aluminum	Antimony	Arsenic	Barium	Berylium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Methylmercury	Nickel	Potassium
Seventysix Gulch Background	BG-01-VG	8/22/2013	1.48	0.007 U	0.037 T	1.34	0.029 U	0.016 T	402	0.018 T	0.019 U	1.52	8.22	0.02 T	267	170	0.00106	0.00091 U	0.4	4320
	BG-01-VS	8/22/2013	26.7	0.007 U	0.035 T	6.87	0.03 U	0.007 U	514	0.021 T	0.02 U	1.69	10.7	0.038 T	388	69.7	0.00536	0.00094 U	0.37	1360
	BG-02-VG	8/22/2013	2.09	0.007 U	0.077	2.85	0.029 U	0.021	741	0.04 T	0.019 U	1.49	12.8	0.034 T	373	131	0.00121	0.00099 U	0.75	3730
	BG-02-VS	8/22/2013	4.24	0.007 U	0.039 T	5.99	0.031 U	0.134	2750	0.018 U	0.02 U	3.04	9.64	0.052	390	9.18	0.00043	0.00094 U	0.05 U	1630
	BG-03-VS	8/25/2013	43.8	0.007 U	0.032 T	11.8	0.031 U	0.042	1680	0.027 T	0.021 U	1.53	9.76	0.011 T	523	217	0.00284	0.00101 U	0.49	1710
	BG-04-VS	8/25/2013	48.1	0.006 U	0.038	14.5	0.027 U	0.008 T	1430	0.016 U	0.024 T	1.78	8.29	0.034 T	485	259	0.00216 C	0.00095 U	0.5	1750
O&B Mine	OB-02-VG	8/21/2013	2.16	0.008 T	0.483	2.49	0.032 U	0.028	337	0.78 J	0.033 T	3.4	20.5	0.183	183	122	0.00105	0.00111 U	0.61	4200
	OB-02-VS	8/21/2013	43.1	0.007 U	1.08	12.7	0.031 U	0.01 T	1460	0.02 T	0.065 T	4.01	20.3	0.145	361	226	0.00173	0.00111 U	0.28	2210
	OB-04-VG	8/21/2013	1.94	0.007 U	0.271	3.13	0.028 U	0.008 T	476	0.03 T	0.019 U	2.89	10.5	0.064	152	79.3	0.00092	0.00108 U	0.28	2210
	OB-04-VS	8/21/2013	29.3	0.007 U	0.487	8.52	0.031 U	0.007 U	939	0.06 T	0.023 T	12.6	57.1	0.048	249	27.7	0.00155	0.00111 U	0.31	1730
	OB-06-VG	8/21/2013	1.48	0.006 U	0.306	1.72	0.027 U	0.008 T	174	0.025 T	0.018 U	0.62	5.67	0.091	206	45.1	0.00075	0.00099 U	0.16 T	2480
	OB-06-VS	8/21/2013	35.5	0.007 U	0.321	8.79	0.029 U	0.013 T	1110	0.018 U	0.019 U	2.08	9.15	0.042	348	186	0.00129	0.001 U	0.22	1260
	OB-07-VG	8/22/2013	2.74	0.007 U	0.942	0.48	0.032 U	0.012 T	191	0.058 T	0.024 T	3.71	18.4	0.274	166	116	0.00134	0.00091 U	0.39	4320
	OB-07-VS	8/22/2013	57.7	0.007 U	0.713	11	0.03 U	0.01 T	1400	0.018 U	0.023 T	3.1	15.9	0.102	355	202	0.00174	0.00094 U	0.34	2170
	OB-08-VG	8/22/2013	1.48	0.007 U	0.412	0.66	0.029 U	0.013 T	229	0.137	0.024 T	2.13	12.3	0.157	138	110	0.00096	0.00105 U	0.36	3710
	OB-09-VG	8/22/2013	1.35	0.009 T	0.335	1.09	0.03 U	0.01 T	210	0.03 T	0.02 U	0.92	8.44	0.112	204	84.1	0.00066	0.00096 U	0.11 T	3190
	OB-10-VG	8/21/2013	2.02	0.007 U	0.229	1.92	0.028 U	0.007 U	260	0.479	0.042 T	103	727	0.071	209	93.3	0.00103	0.00108 U	0.49	2770
	OB-10-VS	8/21/2013	39	0.007 U	0.207	15.1	0.029 U	0.02	1120	0.23	0.047 T	51.7	337	0.057	406	364	0.00168	0.00109 U	0.64	1580
Sheridan Mine	SH-02-VG	8/24/2013	1.57	0.007 U	1.78	1.43	0.029 U	0.007 U	905	0.063 T	0.019 U	0.67	8.98	0.013 T	164	34.7	0.0015	0.00096 U	0.05 U	3160
	SH-03-VS	8/24/2013	28.1	0.007 U	0.191	20.3	0.03 U	0.027	2290	0.018 U	0.023 T	2.19	10.2	0.013 T	688	469	0.00359	0.00094 U	0.55	1690
	SH-04-VG	8/24/2013	1.51	0.01 T	0.6	0.61	0.027 U	0.017 T	739	0.268	0.018 U	1.16	10.7	0.021 T	122	17.9	0.00141	0.00105 U	0.13 T	2860
	SH-05-VS	8/25/2013	19.9	0.009 T	0.477	7.87	0.026 U	0.018	2330	0.016 U	0.02 T	1.54	9.03	0.017 T	559	313	0.00427	0.00112 T	0.28	1670
	SH-06-VS	8/25/2013	15.1	0.007 U	0.165	10.5	0.03 U	0.007 U	1350	0.052 T	0.02 U	1.27	9.94	0.016 T	409	352	0.00172	0.00109 U	0.19 T	727
	SH-08-VG	8/25/2013	1.58	0.007 U	0.138	3.17	0.029 U	0.026	357	0.098 T	0.02 U	1.19	9.39	0.018 T	126	83.3	0.00113	0.00099 U	0.23	2090
	SH-08-VS	8/25/2013	22.8	0.007 U	0.088	14.4	0.032 U	0.008 T	1450	0.037 T	0.021 U	1.88	15	0.012 T	450	484	0.00248	0.00111 U	0.15 T	689
	SH-09-VS	8/25/2013	33.2	0.007 U	0.149	21.2	0.029 U	0.022	2270	0.029 T	0.019 U	3.26	16.1	0.019 T	848	337	0.00343	0.00106 U	0.35	1980
Glacier Creek Background	BG-07-VS	9/1/2013	56.4	0.007 U	0.084	20.7	0.03 U	0.01 T	1440	0.018 U	0.02 U	1.2	10.7	0.026 T	561	188	0.00391	0.00095 U	0.15 T	1010
	BG-08-VS	9/3/2013	2.4	0.007 U	0.138	14.5	0.029 U	0.007 U	2440	0.017 U	0.019 U	1.45	10.9	0.029 T	728	167	0.00546	0.00096 U	0.58	1360
	BG-GB1-VG	8/31/2013	4.81	0.007 U	0.221	8.82	0.029 U	0.037	932	0.036 T	0.019 U	1.49	14.7	0.176	411	161	0.002	0.00094 U	0.4	4270
	BG-GB1-VS	8/31/2013	48.2	0.007 U	0.084	24.3	0.03 U	0.022	1460	0.018 U	0.02 U	1.69	11.1	0.052	492	293	0.0028	0.00097 U	0.22	1860
	BG-GB2-VG	9/2/2013	9.45	0.014 T	0.158	16.8	0.03 U	0.055	1010	0.031 T	0.02 U	1.24	18.2	0.258	341	143	0.00273	0.00101 U	0.39	4920
	BG-GB2-VS	9/2/2013	51.1	0.006 U	0.047	35.9	0.026 U	0.032	1720	0.016 U	0.017 U	1.66	10.6	0.049	536	369	0.00276	0.00094 U	0.19	1990
Justice Mine	Ju-01-VS	9/2/2013	5.88	0.038 J	2.43	3.12	0.03 U	0.027	8590	0.088 T	0.16	1.28	14	0.248	992	5.72	0.00231	0.00098 U	0.58	4190
	Ju-02-VS	9/2/2013	131	0.783	59.2	2.47	0.028 U	0.163	7440	1.61	0.418	5.55	659	13.4	561	31.2	0.00506	0.00093 U	0.84	3380
	Ju-04-VG	9/2/2013	13	0.016 T	1.35	9.69	0.03 U	0.021	1230	0.021 T	0.02 U	0.64	12.9	0.407	277	16.5	0.00319	0.00102 U	0.55	1860
	Ju-04-VS	9/2/2013	10.6	0.026	7.49	2.56	0.028 U	0.041	6710	0.112 T	0.054 T	1.44	25.7	0.297	492	2.96	0.00176	0.00104 U	1.61	2820
	Ju-05-VG	9/2/2013	43.4	0.643	38.1	16.5	0.03 U	0.128	2440	0.12	0.101 T	3.19	143	6.2	371	20.8	0.00567	0.00104 U	0.61	3800
	Ju-05-VS	9/2/2013	83.4	1.76	149	2.64	0.029 U	0.221	6480	0.334	0.471	15.3	528	22.3	428	21.1	0.00695	0.00101 U	0.4	2300
	Ju-06-VG	9/2/2013	6.71	0.01 T	0.643	3.58	0.031 U	0.015 T	1930	0.035 T	0.021 U	0.98	11.7	0.102	192	1.54	0.00459	0.00102 U	0.95	3930
	Ju-06-VS	9/2/2013	51.6	0.144	15	2.7	0.029 U	0.114	7430	0.151	0.089 T	3.96	99.7	2.22	440	5.34	0.00293	0.00106 U	0.6	2140
	Ju-07-VG	9/2/2013	40.4	0.142	5.75	9.07	0.03 U	0.025	1820	0.04 T	0.049 T	2.61	34.6	3.61	333	30.3	0.00329	0.00104 U	0.76	3340
	Ju-07-VS	9/2/2013	38.3	0.372	39.6	2.44	0.03 U	0.078	7020	0.252	0.168	4.37	281	3.36	462	78.6	0.00281	0.00099 U	0.52	3360
	Ju-08-VG	9/2/2013	16.2	0.028	1.24	17.6	0.029 U	0.025	1600	0.018 U	0.02 U	1	18.9	0.212	382	11.4	0.00455	0.00098 U	0.55	3140
	Ju-08-VS	9/2/2013	4.28	0.02 T	1.35	1.67	0.031 U	0.018 T	7190	0.065 T	0.022 T	0.85	15.1	0.149	434	1.39	0.00212	0.001 U	0.05 U	2770
	Ju-09-VS	9/2/2013	82.4	0.226	37.2	1.2	0.028 U	0.136	7150	0.429	0.146 T	6.32	146	1.72	773	17.1	0.00276	0.00095 U	0.14 T	4080
	Ju-10-VS	9/2/2013	7.2	0.029	19.6	1.12	0.028 U	0.025	7620	0.091 T	0.147 T	1.25	20.4	0.218	933	5.98	0.00137	0.00098 U	0.12 T	3640

Table 7 - Analytical Results for Plant Tissue Samples

Area	Sample ID	Sampling Date	Concentration in mg/kg						Total Solids in %
			Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	
Seventysix Gulch Background	BG-01-VG	8/22/2013	0.06 U	0.019 U	6.8 U	0.002 U	0.06 U	8.27	19.36
	BG-01-VS	8/22/2013	0.06 U	0.02 U	7.1 U	0.002 U	0.06 U	7.43	23.51
	BG-02-VG	8/22/2013	0.06 U	0.019 U	7.8 T	0.002 U	0.06 U	13.1	24.91
	BG-02-VS	8/22/2013	0.06 U	0.02 U	7.2 U	0.002 U	0.06 U	15.4	14.03
	BG-03-VS	8/25/2013	0.06 U	0.021 U	48.2	0.002 U	0.06 U	6.65	20.44
	BG-04-VS	8/25/2013	0.05 U	0.018 U	94.8	0.002 U	0.05 U	5.24	17.36
O&B Mine	OB-02-VG	8/21/2013	0.06 U	0.049 T	7.4 U	0.002 U	0.06 U	8.12	21.8
	OB-02-VS	8/21/2013	0.06 U	0.02 U	7.1 U	0.004 T	0.06 U	13.1	23.47
	OB-04-VG	8/21/2013	0.06 U	0.108	6.5 U	0.002 U	0.06 U	8.05	14.93
	OB-04-VS	8/21/2013	0.06 U	0.021 U	7.3 U	0.002 U	0.06 U	6.84	20.86
	OB-06-VG	8/21/2013	0.05 U	0.018 U	7.4 T	0.002 U	0.05 U	4.42	17.28
	OB-06-VS	8/21/2013	0.06 U	0.019 U	6.8 U	0.002 U	0.06 U	10.7	19.44
	OB-07-VG	8/22/2013	0.06 U	0.127	9.4 T	0.002 U	0.06 U	14	18.14
	OB-07-VS	8/22/2013	0.06 U	0.02 U	7 U	0.002 U	0.06 U	14.4	18.87
	OB-08-VG	8/22/2013	0.06 U	0.096 T	16.2 T	0.002 U	0.06 U	7.82	13.95
	OB-09-VG	8/22/2013	0.06 U	0.02 U	10.9 T	0.002 U	0.06 U	3.96	14.41
	OB-10-VG	8/21/2013	0.06 U	0.019 U	6.5 U	0.002 U	0.11 T	7.91	16.25
	OB-10-VS	8/21/2013	0.06 U	0.019 U	6.8 U	0.002 U	0.07 T	12.8	21.8
Sheridan Mine	SH-02-VG	8/24/2013	0.06 U	0.019 U	6.8 U	0.002 U	0.06 U	2.54	16.14
	SH-03-VS	8/24/2013	0.06 U	0.02 U	7 U	0.002 U	0.06 U	16	23.97
	SH-04-VG	8/24/2013	0.05 U	0.018 U	8.3 T	0.002 U	0.05 U	10.9	19.59
	SH-05-VS	8/25/2013	0.05 U	0.017 U	12.1 T	0.002 U	0.05 U	10.9	22.77
	SH-06-VS	8/25/2013	0.06 U	0.02 U	6.9 U	0.002 U	0.06 U	5.48	19.95
	SH-08-VG	8/25/2013	0.06 U	0.02 U	6.8 U	0.002 U	0.06 U	9.1	17.72
	SH-08-VS	8/25/2013	0.06 U	0.021 U	7.4 U	0.002 U	0.06 U	4.55	20.92
	SH-09-VS	8/25/2013	0.06 U	0.019 U	6.9 T	0.002 U	0.06 U	9.39	31.03
Glacier Creek Background	BG-07-VS	9/1/2013	0.06 U	0.02 U	354	0.002 U	0.06 U	6.23	17.76
	BG-08-VS	9/3/2013	0.06 U	0.019 U	13.5 T	0.002 U	0.06 U	6.99	22.58
	BG-GB1-VG	8/31/2013	0.06 U	0.019 U	15.4 T	0.002 U	0.06 U	20.9	27.03
	BG-GB1-VS	8/31/2013	0.06 U	0.02 U	7.1 U	0.003 T	0.06 U	11.7	26.37
	BG-GB2-VG	9/2/2013	0.06 U	0.02 U	7 U	0.004 T	0.06 U	11.9	28.29
	BG-GB2-VS	9/2/2013	0.05 U	0.017 U	6.1 U	0.003 T	0.05 U	11.9	26.24
Justice Mine	Ju-01-VS	9/2/2013	0.06 U	0.026 T	20.5	0.004 T	0.06 U	154	20.58
	Ju-02-VS	9/2/2013	0.06 U	0.079 T	21.8	0.012	0.62	80.6	22.81
	Ju-04-VG	9/2/2013	0.06 U	0.025 T	6.9 U	0.002 U	0.06 U	14.2	13.23
	Ju-04-VS	9/2/2013	0.06 U	0.019 U	23	0.003 T	0.06 U	243	17.91
	Ju-05-VG	9/2/2013	0.06 U	0.094 T	43.3	0.002 U	0.11 T	32.5	17.44
	Ju-05-VS	9/2/2013	0.06 U	0.192	44.5	0.003 T	0.31	115	16.9
	Ju-06-VG	9/2/2013	0.06 U	0.03 T	7.2 U	0.002 U	0.06 U	45.7	15.4
	Ju-06-VS	9/2/2013	0.06 U	0.035 T	24.5	0.002 U	0.12 T	180	18.88
	Ju-07-VG	9/2/2013	0.06 U	0.06 T	9.9 T	0.002 U	0.06 U	10.3	15.35
	Ju-07-VS	9/2/2013	0.06 U	0.045 T	20.7	0.002 U	0.11 T	126	20.04
	Ju-08-VG	9/2/2013	0.06 U	0.025 T	6.9 U	0.002 U	0.06 U	31.1	15.29
	Ju-08-VS	9/2/2013	0.06 U	0.021 U	7.3 U	0.002 U	0.06 U	70.1	18.22
	Ju-09-VS	9/2/2013	0.06 U	0.04 T	47.3	0.002 U	0.17 T	54.3	18.69
	Ju-10-VS	9/2/2013	0.06 U	0.024 T	13.6 T	0.002 U	0.06 U	67.5	20.25

Table 7 - Analytical Results for Plant Tissue Samples

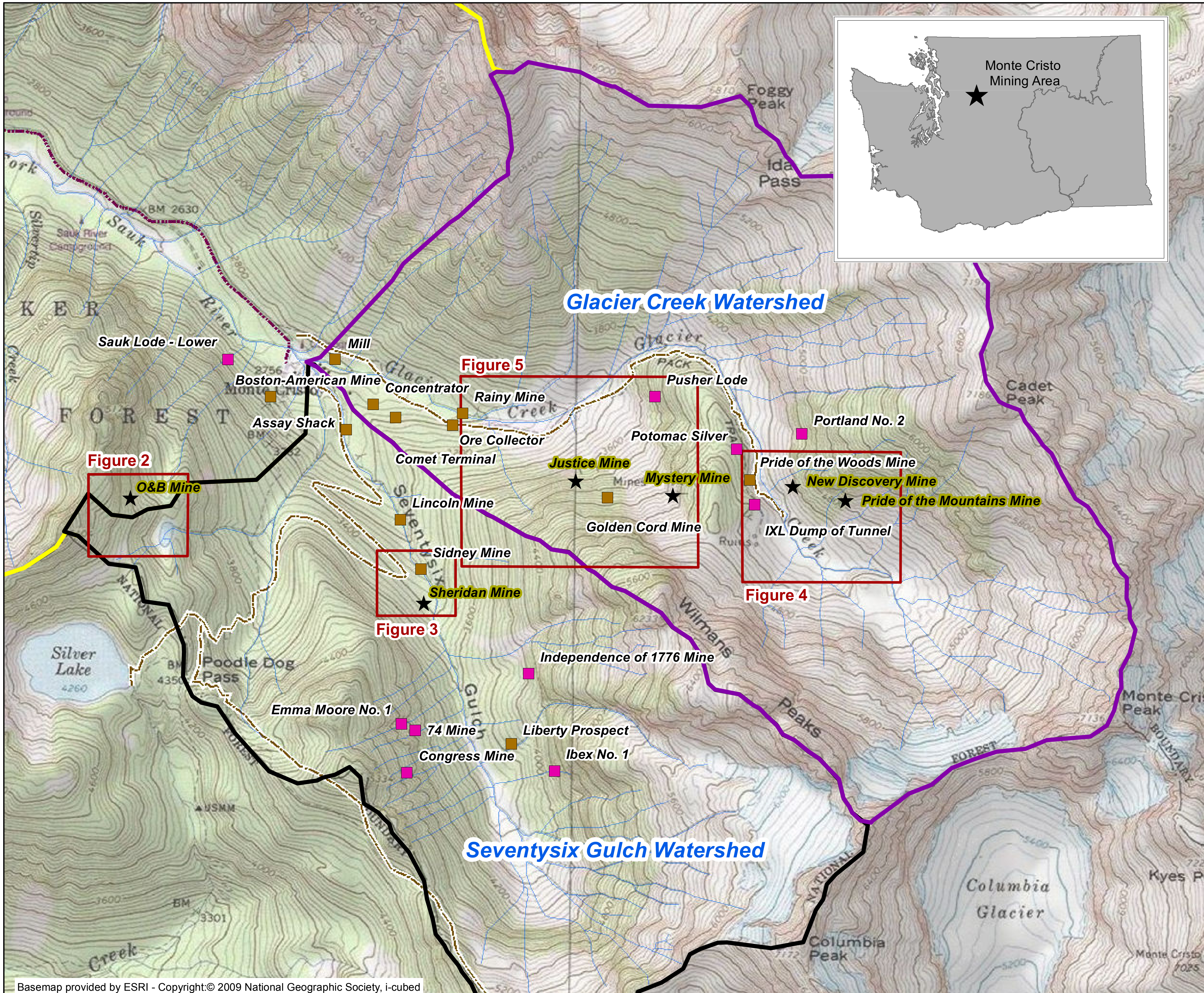
Area	Sample ID	Sampling Date	Concentration in mg/kg																	
			Aluminum	Antimony	Arsenic	Barium	Berylium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Methylmercury	Nickel	Potassium
Mystery Mine	My-02-VG	8/30/2013	4.22	0.296	5.53	0.3	0.028 U	0.102	354	0.034 T	0.023 T	1.67	57.5	1.05	319	207	0.00431	0.00101 U	0.08 T	2300
	My-02-VS	8/30/2013	1.6	0.021	0.348	2.65	0.029 U	0.011 T	1570	0.018 U	0.02 U	1.69	14.9	0.103	387	202	0.00408	0.00109 U	0.07 T	2690
	My-03-VG	8/31/2013	5.94	0.195 J	3.19	2.72	0.03 U	0.05	697	0.051 T	0.02 U	1.68	57.7	3.31	337	243	0.00248	0.00102 U	0.07 T	4010
	My-03-VS	8/31/2013	4.87	0.109 J	2.06	7.28	0.03 U	0.009 T	2990	0.018 U	0.038 T	2.95	42.8	0.876	457	434	0.00687	0.00095 U	0.11 T	4770
	My-04-VG	8/31/2013	5.42	0.033	0.828	1	0.032 U	0.025	320	0.048 T	0.021 U	2.91	15.5	0.384	291	68.5	0.00233	0.00104 U	0.1 T	1970
	My-04-VS	8/31/2013	2.27	0.012 T	0.212	2.43	0.028 U	0.01 T	1480	0.017 U	0.035 T	2.65	18.3	0.408	473	287	0.00442	0.00108 U	0.2	3980
	My-06-VS	8/31/2013	2.5	0.017 T	0.325	1.43	0.031 U	0.007 U	1100	0.019 U	0.031 T	2.41	14.1	0.097	373	172	0.00508	0.00108 U	0.1 T	5210
	My-07-VS	8/31/2013	1.46	0.007 U	0.082	0.61	0.029 U	0.007 U	734	0.017 U	0.019 U	1.67	8.3	0.032 T	157	92.5	0.00177	0.00109 U	0.05 U	2290
	My-08-VG	8/31/2013	6.59	0.423	7.54	0.33	0.032 U	0.066	340	0.035 T	0.045 T	2.71	68.4	1.99	256	240	0.0053	0.00108 U	0.19 T	4110
	My-08-VS	8/31/2013	2.49	0.079	1.31	0.38	0.031 U	0.013 T	1020	0.018 U	0.02 U	1.33	16.3	0.348	286	179	0.00338	0.00103 U	0.11 T	2130
	My-09-VS	9/1/2013	1.87	0.007 U	0.132	6.23	0.028 U	0.017 T	2020	0.017 U	0.021 T	2.6	12.9	0.054	352	173	0.00369	0.00097 U	0.05 U	3900
	My-10-VG	9/1/2013	12.5	0.185	3.94	1.33	0.03 U	0.206	448	0.038 T	0.026 T	1.22	82.9	1.36	256	210	0.00288	0.00106 U	0.06 T	2830
	My-10-VS	9/1/2013	1.88	0.007 U	0.16	0.69	0.029 U	0.026	1760	0.018 U	0.029 T	2.69	10.8	0.027 T	636	230	0.00305	0.00098 U	0.05 U	3630
New Discovery Mine	ND-01-VG	9/1/2013	8.43	0.025	0.804	2.67	0.03 U	0.095	656	0.043 T	0.129 T	2.57	46.5	0.843	276	73.5	0.00142	0.00101 U	0.24	2860
	ND-01-VS	9/1/2013	12.4	0.007 U	0.75	13.9	0.029 U	1.27	1740	0.028 T	0.019 U	2.19	34.8	0.342	553	134	0.00371	0.00109 U	0.16 T	2040
	ND-04-VG	9/1/2013	11	0.184 J	3.73	2.15	0.028 U	0.398	983	0.042 T	0.039 T	3.04	103	2.47	431	64.6	0.00304	0.00104 U	0.18 T	3330
	ND-04-VS	9/1/2013	9.34	0.185 J	3.08	1.03	0.032 U	8.65	1860	0.019 U	0.061 T	3.9	59.7	0.709	1050	604	0.0067	0.00094 U	0.11 T	2890
	ND-05-VG	9/1/2013	27.1	0.328	11.1	2.5	0.034 U	0.131	845	0.089 T	0.071 T	1.88	131	4.8	230	150	0.00364	0.00101 U	0.22 T	2720
	ND-05-VS	9/1/2013	111	0.327	14.4	4.47	0.029 U	0.053	1920	0.141	0.134 T	1.81	307	5.68	319	77.2	0.00777	0.00104 U	0.19 T	1820
	ND-06-VG	9/1/2013	22.7	0.195 J	7.88	9.76	0.03 U	0.327	670	0.049 T	0.035 T	3.24	64.2	15.3	336	106	0.00416	0.00093 U	0.21	4570
	ND-07-VG	9/1/2013	14.3	0.24 J	5.45	1.36	0.03 U	0.246	852	0.035 T	0.08 T	3.42	115	1.12	478	132	0.0035	0.00104 U	0.43	3360
Pride of the Mountains Mine	POM-1-VG	8/31/2013	2.63	0.007 U	0.182	3.72	0.031 U	0.036	643	0.056 T	0.021 U	1.48	13	0.352	243	107	0.00125	0.00103 U	0.24	4490
	POM-1-VS	8/31/2013	34.7	0.007 T	0.266	18.1	0.027 U	0.015 T	1020	0.041 T	0.018 U	1.5	9.04	0.13	271	237	0.00209	0.00094 U	0.15 T	1380
	POM-2-VG	8/31/2013	2.65	0.006 U	0.431	2.73	0.028 U	0.106	541	0.042 T	0.018 U	2.36	11.3	2.85	251	106	0.00153	0.00105 U	0.15 T	4370
	POM-2-VS	8/31/2013	41.2	0.014 T	0.23	14.9	0.029 U	0.052	1840	0.018 U	0.02 U	1.56	11.7	0.278	306	236	0.00451	0.00176 T	0.05 U	1790
	POM-3-VG	8/31/2013	4.01	0.013 T	0.788	2.55	0.034 U	0.087	730	0.142	0.023 U	5.35	18	4.82	318	176	0.00226	0.00094 U	0.14 T	5860
	POM-6-VG	8/31/2013	4.74	0.026	1.66	3.1	0.03 U	0.051	910	0.063 T	0.02 U	3.01	23.3	2.73	313	309	0.00295	0.00093 U	0.13 T	5720
	POM-6-VS	8/31/2013	140	0.038	1.62	8.89	0.028 U	0.066	2140	0.017 U	0.019 U	2.19	25.4	1.49	507	454	0.00281	0.00096 U	0.13 T	1440
	POM-8-VG	8/31/2013	3.61	0.023	1.33	3.76	0.031 U	0.184	2280	0.034 T	0.021 U	2.71	17.1	0.517	543	12.1	0.00205	0.00092 U	0.05 U	4430
	POM-9-VG	8/31/2013	6.86	0.071	1.12	5.86	0.027 U	0.026	525	0.098 T	0.018 U	1.76	26.6	7.41	179	156	0.00249	0.00111 U	0.1 T	3720
	POM-9-VS	8/31/2013	53.2	0.182	3.27	14.4	0.029 U	0.042	1390	0.039 T	0.019 U	1.69	42.4	5.51	297	333	0.00444	0.001 U	0.06 T	1700

Table 7 - Analytical Results for Plant Tissue Samples

Area	Sample ID	Sampling Date	Selenium		Silver		Sodium		Thallium		Vanadium		Zinc	Total Solids in %
			Concentration in mg/kg											
Mystery Mine	My-02-VG	8/30/2013	0.06	U	0.07	T	6.4	U	0.033		0.06	U	14.6	23.4
	My-02-VS	8/30/2013	0.06	U	0.02	U	6.8	U	0.004	T	0.06	U	9.21	22.31
	My-03-VG	8/31/2013	0.06	U	0.093	T	7	U	0.516		0.06	U	24.4	24.53
	My-03-VS	8/31/2013	0.06	U	0.02	U	7	U	0.139		0.06	U	16.1	32.12
	My-04-VG	8/31/2013	0.06	U	0.021	U	7.5	U	0.085		0.06	U	18.8	14.91
	My-04-VS	8/31/2013	0.06	U	0.019	U	6.6	U	0.012		0.06	U	12.5	28.82
	My-06-VS	8/31/2013	0.06	U	0.021	U	7.2	U	0.008	T	0.06	U	9.2	30.11
	My-07-VS	8/31/2013	0.06	U	0.019	U	11	T	0.034		0.06	U	4.52	20.47
	My-08-VG	8/31/2013	0.06	U	0.174		7.4	U	0.04		0.06	U	20.4	25.15
	My-08-VS	8/31/2013	0.06	U	0.02	U	7.1	U	0.002	U	0.06	U	6.79	22.08
	My-09-VS	9/1/2013	0.06	U	0.019	U	6.6	U	0.022		0.06	U	11.3	30.55
	My-10-VG	9/1/2013	0.06	U	0.096	T	7	U	0.45		0.06	U	25	15.15
	My-10-VS	9/1/2013	0.06	U	0.02	U	6.9	U	0.079		0.06	U	15.9	28.12
New Discovery Mine	ND-01-VG	9/1/2013	0.06	U	0.02	U	7.1	U	0.005	T	0.06	U	15.3	15.34
	ND-01-VS	9/1/2013	0.06	U	0.019	U	7.4	T	0.039		0.06	U	66.5	23.71
	ND-04-VG	9/1/2013	0.06	U	0.037	T	10.1	T	0.041		0.08	T	66	21.33
	ND-04-VS	9/1/2013	0.06	U	0.026	T	7.4	U	1.75		0.06	U	315	33.44
	ND-05-VG	9/1/2013	0.07	U	0.074	T	11.4	T	0.008	T	0.09	T	44.5	20.57
	ND-05-VS	9/1/2013	0.06	U	0.049	T	6.8	U	0.006	T	0.24		12.6	19.17
	ND-06-VG	9/1/2013	0.06	U	0.072	T	7.1	T	0.009		0.08	T	53.2	24.79
	ND-07-VG	9/1/2013	0.06	U	0.112		8.8	T	0.032		0.1	T	61	22.26
Pride of the Mountains Mine	POM-1-VG	8/31/2013	0.06	U	0.021	U	10.6	T	0.003	T	0.06	U	20.8	18.55
	POM-1-VS	8/31/2013	0.05	U	0.018	U	6.4	U	0.002	U	0.05	U	7.75	20.76
	POM-2-VG	8/31/2013	0.06	U	0.08	T	9.3	T	0.005	T	0.06	U	42.2	22.65
	POM-2-VS	8/31/2013	0.06	U	0.02	U	6.9	U	0.005	T	0.06	U	18	21.94
	POM-3-VG	8/31/2013	0.07	U	0.087	T	7.9	U	0.009	T	0.07	U	51.1	28.36
	POM-6-VG	8/31/2013	0.06	U	0.065	T	7	U	0.005	T	0.06	U	26	26.79
	POM-6-VS	8/31/2013	0.06	U	0.019	U	6.6	U	0.002	U	0.06	U	18	24.57
	POM-8-VG	8/31/2013	0.06	U	0.036	T	7.3	U	0.002	U	0.06	U	105	27.15
	POM-9-VG	8/31/2013	0.05	U	0.077	T	7.2	T	0.008		0.05	U	21.9	19.88
	POM-9-VS	8/31/2013	0.06	U	0.043	T	6.7	U	0.011		0.06	U	18.3	21.81

U = Not detected at the reporting limit indicated.
J = Estimated value.
T = Value is between the MDL and MRL.

FIGURES



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Mine Features

- Mine features sampled in 2011
- Mine features sampled before 2011
- Mine features sampled in 2013

Features

- Roads
- Trails
- Streams

Watersheds

- South Fork Sauk River Watershed
- Seventysix Gulch Watershed
- Glacier Creek Watershed

N

1 inch = 1,500 feet

0 0.125 0.25 0.5 Miles

NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet

Monte Cristo Mining Area Terrestrial Sampling
Monte Cristo, Washington

Terrestrial Sampling Locations

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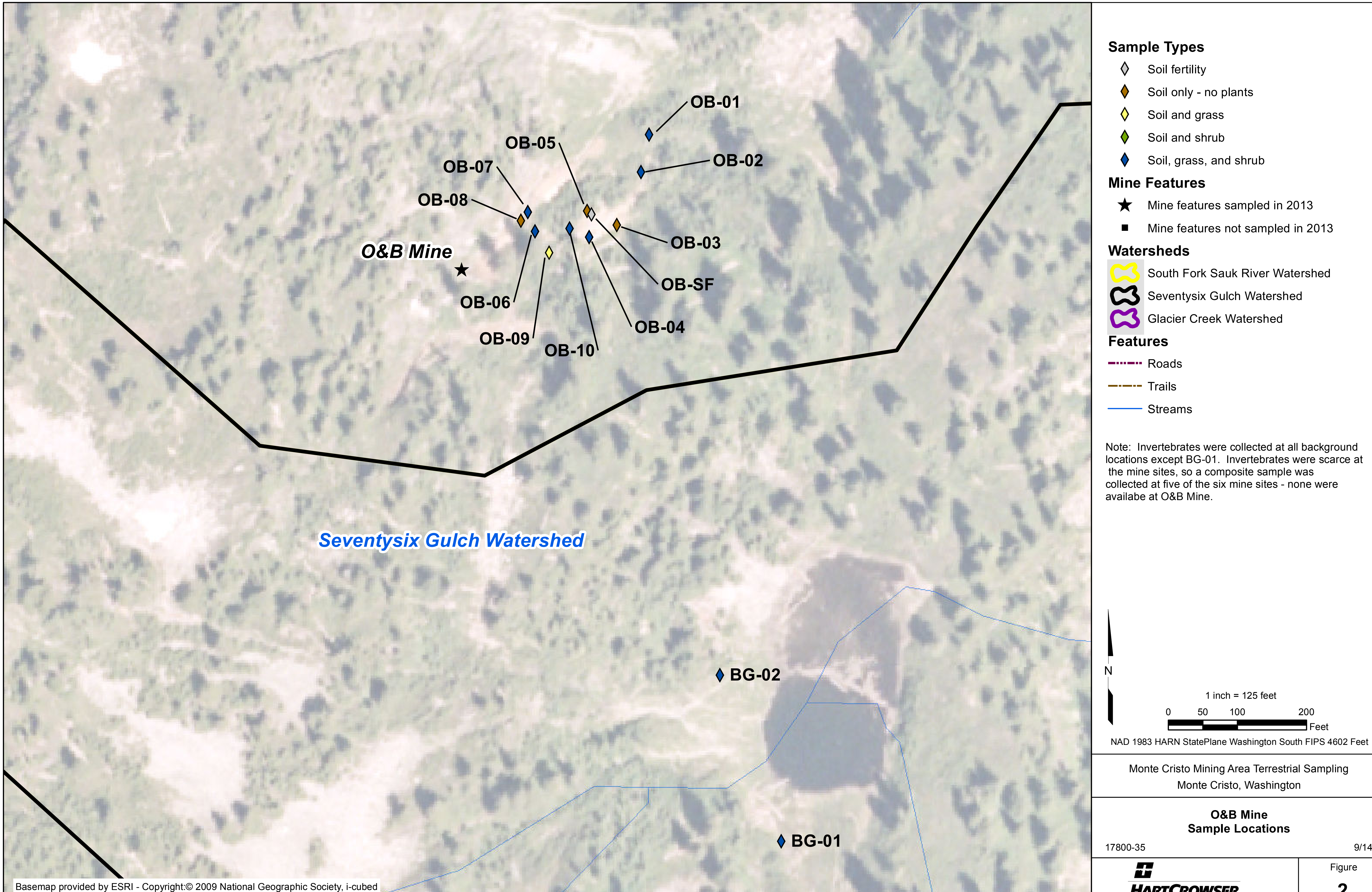
Figure
1



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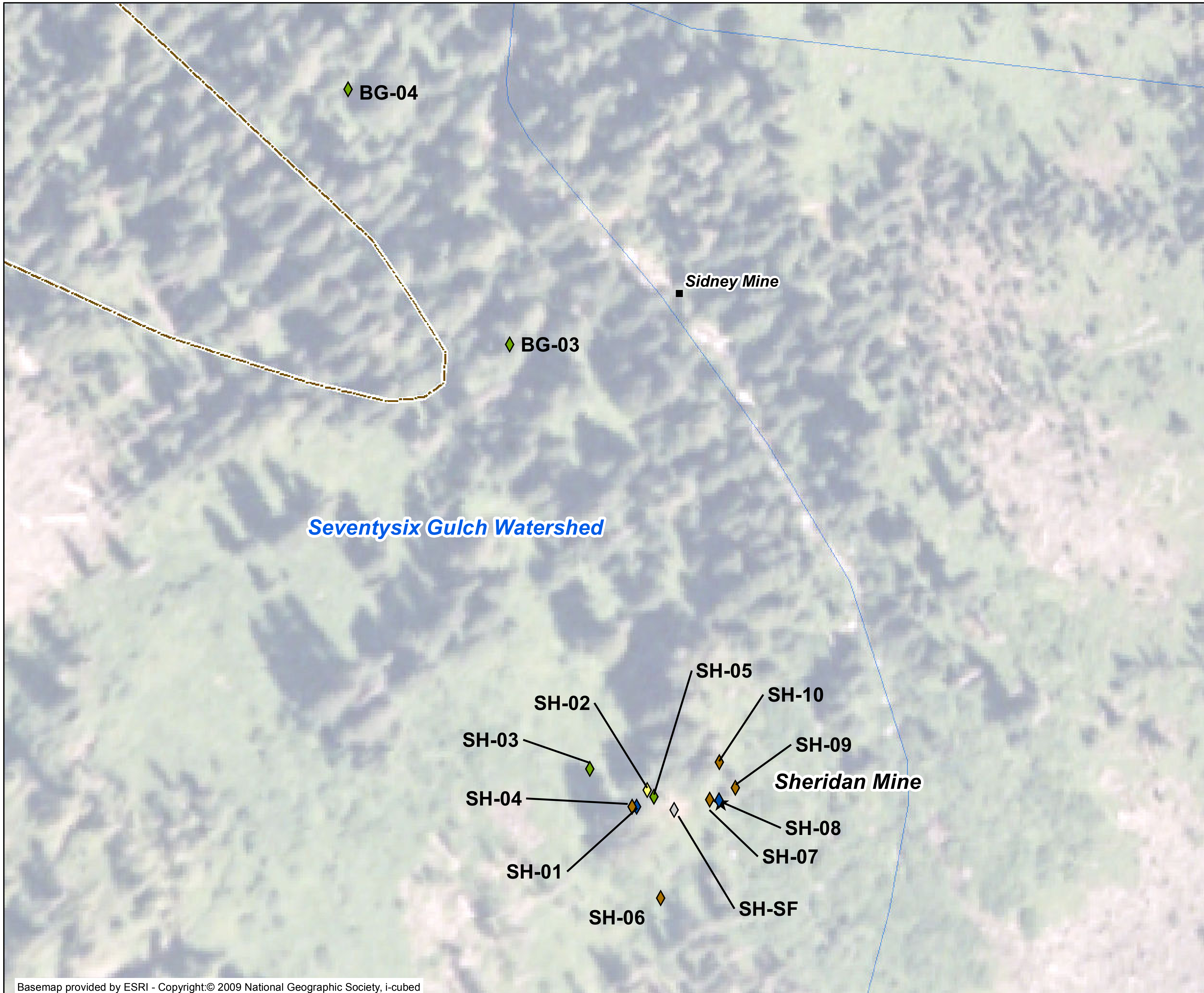

R:\GIS\PROJECTS\17800\06_MCMA\mxds\SummaryReportFigure 1.mxd Author: HC-MAH

Sample Types
- Soil fertility
- Soil only - no plants
- Soil and grass
- Soil and shrub
- Soil, grass, and shrub

Mine Features
- Mine features sampled in 2013
- Mine features not sampled in 2013

Watersheds
- South Fork Sauk River Watershed
- Seventysix Gulch Watershed
- Glacier Creek Watershed

Features
- Roads
- Trails
- Streams

Note: Invertebrates were collected at all background locations except BG-01. Invertebrates were scarce at the mine sites, so a composite sample was collected at five of the six mine sites - none were availabe at O&B Mine.

N

1 inch = 100 feet

0 40 80 160 Feet

NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet

Monte Cristo Mining Area Terrestrial Sampling
Monte Cristo, Washington

Sheridan Mine
Sample Locations

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Figure
3

Sample Types
- Soil fertility
- Soil only - no plants
- Soil and grass
- Soil and shrub
- Soil, grass, and shrub

Mine Features
- Mine features sampled in 2013
- Mine features not sampled in 2013

Watersheds
- South Fork Sauk River Watershed
- Seventysix Gulch Watershed
- Glacier Creek Watershed

Features
- Roads
- Trails
- Streams

Note: Invertebrates were collected at all background locations except BG-01. Invertebrates were scarce at the mine sites, so a composite sample was collected at five of the six mine sites - none were availabe at O&B Mine.

N

1 inch = 200 feet

0 80 160 320 Feet

NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet

Monte Cristo Mining Area Terrestrial Sampling
Monte Cristo, Washington

New Discovery and Pride of the Mountains Mine Sample Locations

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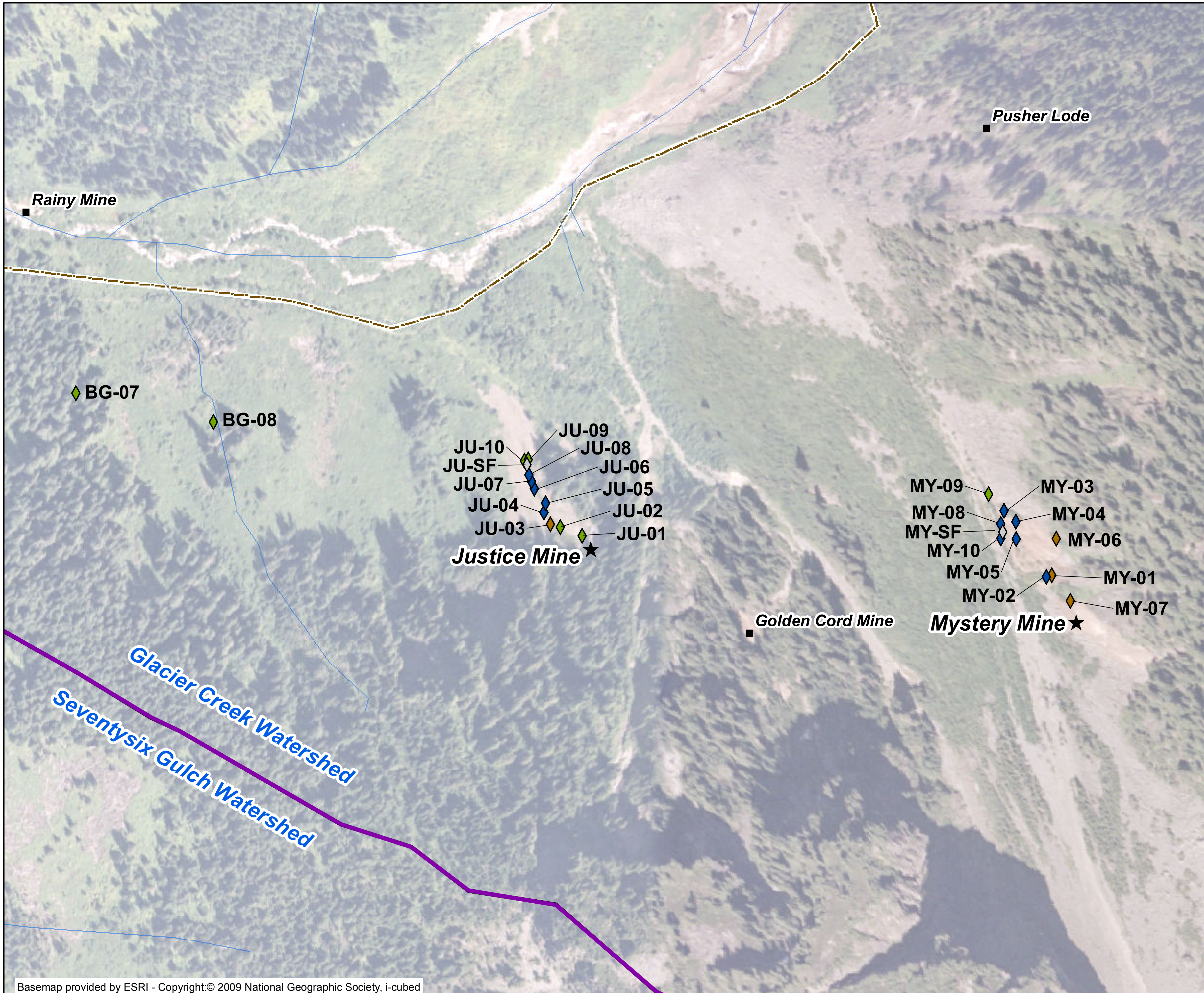
Figure **4**

R:\GIS\PROJECTS\17800\06_MCMA\mxds\SummaryReport\Figure 1.mxd Author: HC-MAH



Sample Types

- Soil fertility
- Soil only - no plants
- Soil and grass
- Soil and shrub
- Soil, grass, and shrub

Mine Features

- ★ Mine features sampled in 2013
- ■ Mine features not sampled in 2013

Watersheds

- South Fork Sauk River Watershed
- Seventysix Gulch Watershed
- Glacier Creek Watershed

Features

- Roads
- Trails
- Streams

Note: Invertebrates were collected at all background locations except BG-01. Invertebrates were scarce at the mine sites, so a composite sample was collected at five of the six mine sites - none were availabe at O&B Mine.

N

1 inch = 300 feet

0 125 250 500 Feet

NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet

Monte Cristo Mining Area Terrestrial Sampling
Monte Cristo, Washington

Mystery Mine and Justice Mine Sample Locations

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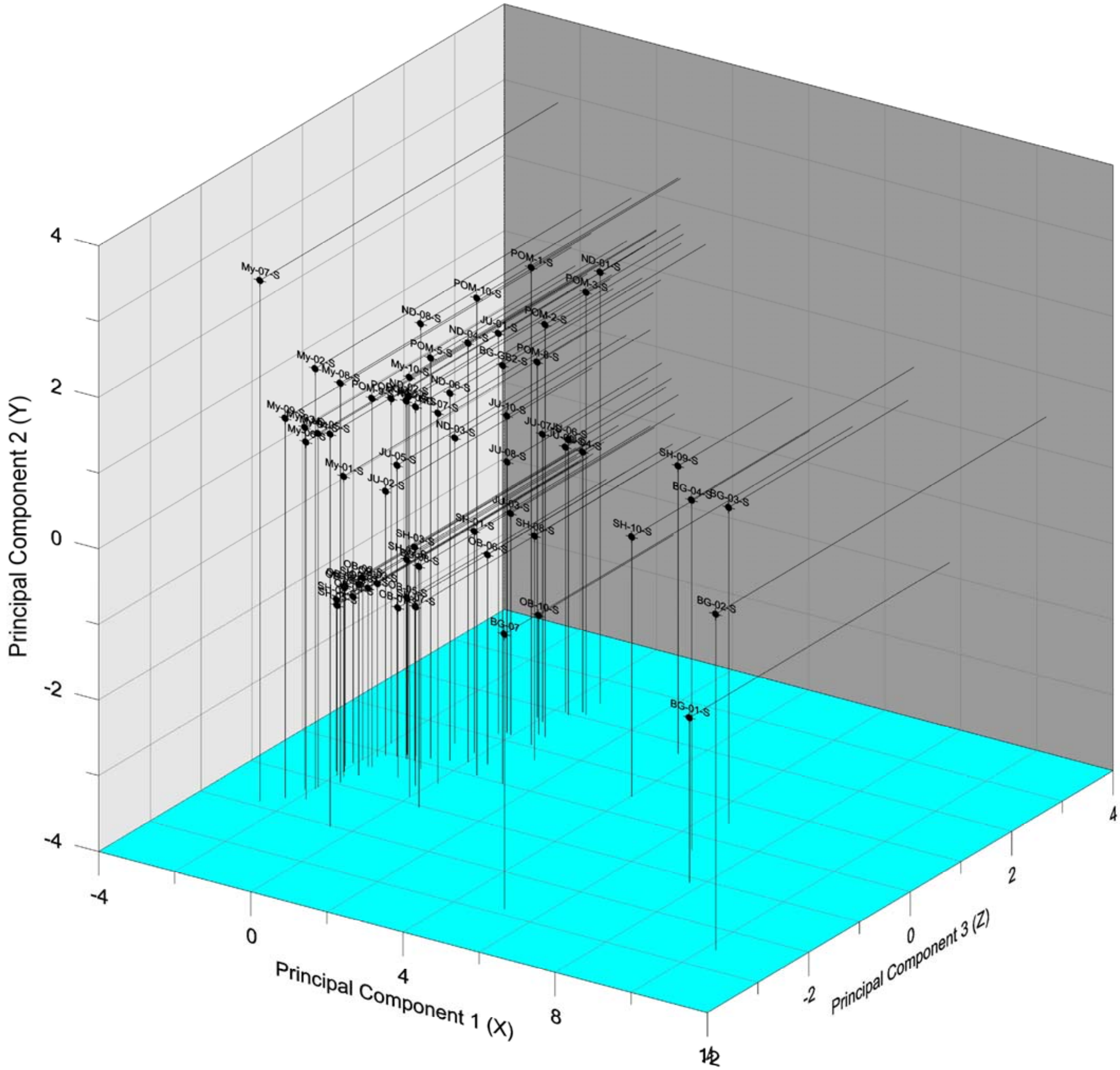
HARTCROWSER

Figure 5

R:\GIS\PROJECTS\17800\06_MCMA\mxds\SummaryReport\Figure 1.mxd Author: HC-MAH



Monte Cristo Mining Area Terrestrial Sampling
Monte Cristo, Washington

PCA Sample Scores Relative Ratios (excluding Fe and Mn)

17800-35 9/14

HARTCROWSER

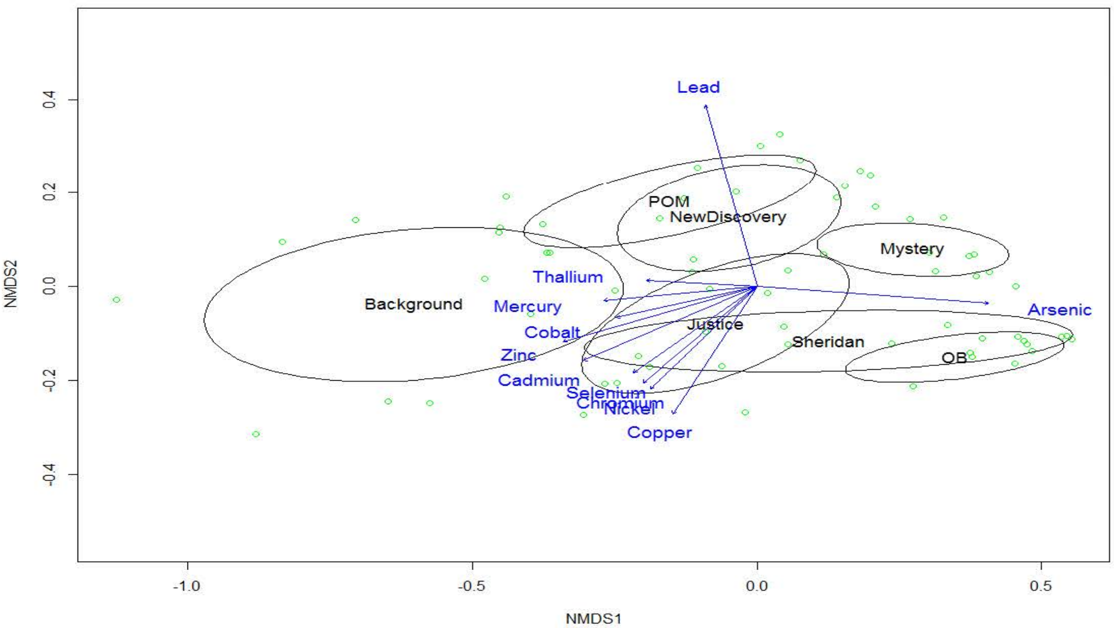
Figure 6

L:\Project Notebook\1780035 Monte Cristo Phase 3\Terrestrial

	Background	Justice	Mystery	New Discovery	OB	Pride of the Mountains
Background						
Justice	**0.0004998**					
Mystery	**0.0004998**	0.002999				
New Discovery	**0.001999**	0.09595	**0.001999**			
OB	**0.0004998**	**0.001499**	**0.0005**	**0.0004998**		
Pride of the Mountains	**0.001999**	0.02049	**0.0005**	0.2894	**0.0005**	
Sheridan	0.003498	0.2659	0.1124	0.09345	0.1339	0.01599
p<	0.00238 for significance					
assuming alpha of 0.05						

Data are relative ratios (not including iron or manganese)

Red and bold numbers indicate a signficant difference betweeen the row and column "populations".



Monte Cristo Mining Area Terrestrial Sampling
Monte Cristo, Washington

Nonparametric Multidimensional Scaling Results

17800-35 9/14

HARTCROWSER

Figure

7

L:\Project Notebook\1780035 Monte Cristo Phase

APPENDIX A
Field Forms and Site Photographs

O & B MINE

Photograph A-1 – August 21, 2013. The O&B Mine lower waste rock piles; pitfall traps (red arrow) and vegetation collection adjacent to pile.

Photograph A-2 – August 20, 2013. Setting invertebrate pitfall traps near vegetation downgradient of the O&B Mine waste rock piles.

Photograph A-3 – August 21, 2013. Collecting soil and vegetation samples downslope of waste rock pile. Nearby vegetation includes saxifrage, Sitka sedge, and black huckleberry.

Photograph A-4 – August 21, 2013. Typical vegetation shrub sample (sample # OB-01-VS, black huckleberry).

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 8/21/13 1030

Samplers: ASK / WDM

Sample Location: O+B Mine, downslope of ~~OB-01~~ lower WRP

Sample No.: OB-01

Subsample location sketch:

Topography:

Latitude: 966855.36' N

Longitude: 1419130.56' E

Vegetation Description: saxifrage, sitka sedge, black huckleberry, lady fern

Soil Description: Moist, brown, sl. silty sandy gravel, w/abundant organics
moist, lt. brown, fine to medium sand

Vegetation Sample: OB-01-VG (grass), OB-01-VS (shrub)
Grass sample = sitka sedge
Shrub sample = black huckleberry

Soil Sample: OB-01-S, OB-01-SMM (methyl mercury)

Soil Invertebrate Sample: No inverts in pitfall traps - day 1

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5912 – 5917 = setting first pitfall trap(s) near OB-01.

DSCN 5918 = view down lower WR pile - shows erosion (may be able to compare to photos from 2011 and see any changes),

DSCN 5931 - 38 = OB-01 sampling area, soil sampling, veg samples, etc.

DSCN 5957-58 = invert collection w/ sweep net

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

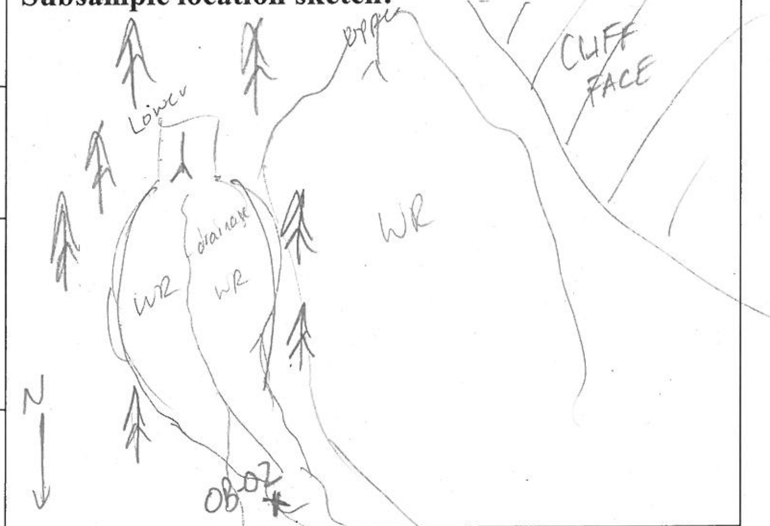
Date/Time: 8/21/13 1140

Samplers: ASK / WDM

Sample Location: O+B Mine
OB-02

Sample No.: OB-02

Subsample location sketch:



Topography: 4446.00 ft (MSL)

Latitude: 966800.22' N

Longitude: 1419117.51' E

Vegetation Description: saxifrage, sitka sedge, black huckleberry

Soil Description: moist, lt. brown to brown, fine to coarse sandy gravel to gravelly sand, w/ trace silt and scattered organics

Vegetation Sample:
OB-02-VG = sitka sedge
OB-02-VS = black huckleberry

Soil Sample: OB-02-S
OB-02-SMM
Refusal at 6" bgs, roots @ 3" bgs

Soil Invertebrate Sample: No inverts on day 1

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN5939-40 = OB-02 sampling area.

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

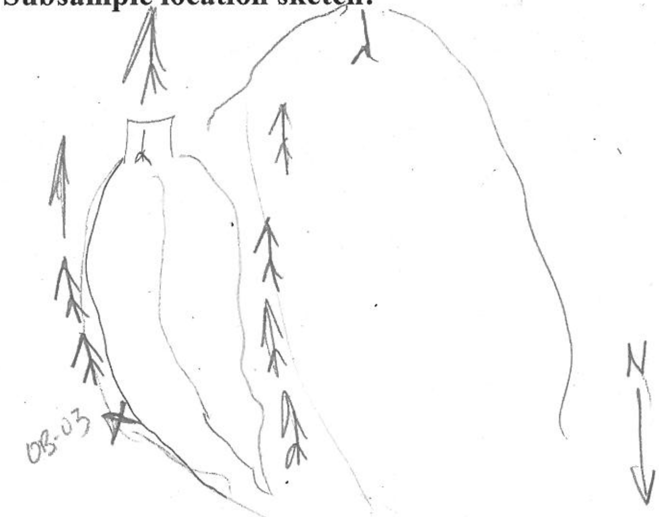
Date/Time: 8/21/13 1245

Samplers: ASK/WOM

Sample Location: O+B Mine, lower WRP

Sample No.: OB-03

Subsample location sketch:



Topography: 4413.35'

Latitude: 966724.81' N

Longitude: 1419083.37' E

Vegetation Description: Saxifrage, sitkasedge, NO HUCKLEBERRY

Soil Description: Moist, lt. brown to brown, fine to coarse sandy gravel to gravelly sand w/ trace silt and scattered organics

Vegetation Sample: OB-03-VG = sitka sedge

Soil Sample: OB-03-S
OB-03-SMM
Refusal at 4" bgs, roots @ 2-3" bgs

Soil Invertebrate Sample: NONE

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

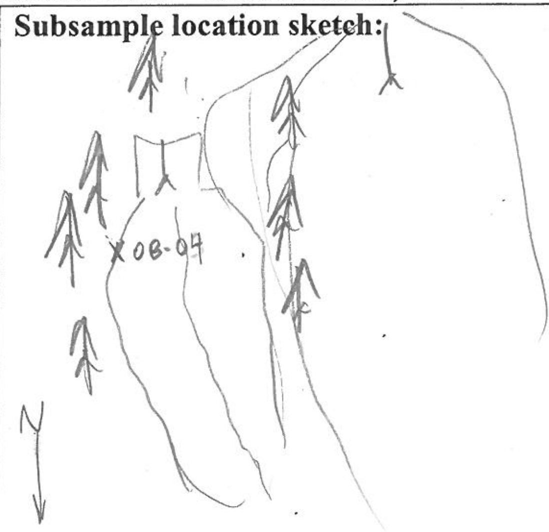
Photo Log:

DSCN 5945 = looking upslope at OB-03 sample area (pitfall trap) and LWRP erosion.

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 8/21/13 1310	**Subsample location sketch:** 
Samplers: ASK / WDM	
Sample Location: O+B ~~B~~ MINE - lower WRP	
Sample No.: OB-04	

Topography: 4408.01 ft	**Latitude:** 966705.84' N	**Longitude:** 1419042.37' E

Vegetation Description: Black huckleberry, sitka sedge, saxifrage

Soil Description: moist, brown, silty fine ~~sand~~ gravelly sand w/ abundant organics

Vegetation Sample: OB-04-VG = sitke sedge
OB-04-VS = black huckleberry

Soil Sample: OB-04-S
OB-04-SMM
Refusal between 3-5" BGS

Soil Invertebrate Sample: NONE

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5947^{48} = OB-04 sample area (pitfall trap)

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

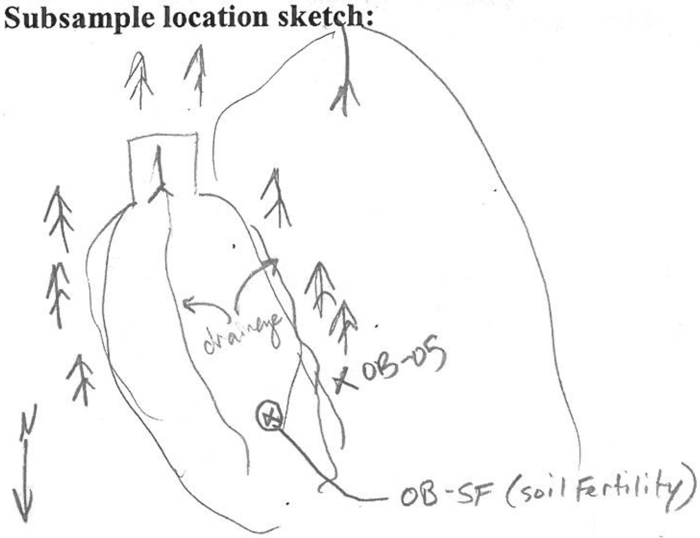
Date/Time: 8/21/13 1430

Samplers: ASK/WDM

Sample Location: O+B Mine, lower WRP

Sample No.: OB-05

Subsample location sketch:



Topography: 4403.94'

Latitude: 966743.44' N

Longitude: 1419039.53

Vegetation Description: saxifrage, sitka sedge

Soil Description: moist brown + dark brown, silty sandy gravel w/ abundant organics
Refusal @ 2" bgs - lots of rocks

Vegetation Sample: OB-05-VG = sitka sedge
NO SHRUB SAMPLE

Soil Sample:
OB-05-S
OB-05-SMM
OB SF = SOIL FERTILITY FOR O+B MINE

Soil Invertebrate Sample:
NONE

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN5950 - 5952 = OB-05 sample area /pitfall traps.

DSCN5953 = OB-SF soil fertility sample.

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

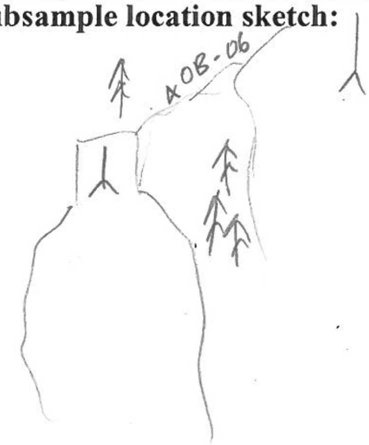
Date/Time: 8/21/13 1330

Samplers: ASK/WDM

Sample Location: O+B Mine, located upslope (SW) of lower adit opening

Sample No.: OB-06

Subsample location sketch:



Topography: 4428.70'

Latitude: 966714.29' N

Longitude: 1418963.98' E

Vegetation Description: saxifrage, sitka sedge, black huckleberry

Soil Description: 1/2" duff followed by → moist, grey brown sl. silty to silty, sl. gravelly fine to medium sand w/ scattered organics.

Vegetation Sample:
OB-06-VS = black huckleberry
OB-06-VG = sitka sedge

Soil Sample:
OB-06-S
OB-06-SMM
Refusal @ 6" bgs, 1/2" duff layer

Soil Invertebrate Sample: NONE

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5949 = pitfall traps/sample area.

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

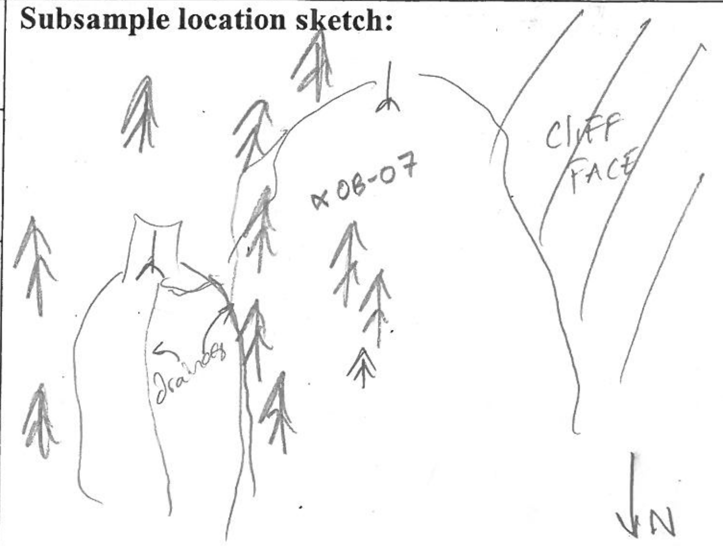
Date/Time: 8/22/13 0935

Samplers: ASK/WDM

Sample Location: O+B MINE, upslope (SW) of lower adit

Sample No.: OB-07

Subsample location sketch:



Topography: 4452,00' MSL
50° slope, loose rock, cobbles to boulders

Latitude: 966792.04' N

Longitude: 1418953,96' E

Vegetation Description: sitka sedge, black huckleberry, saxifrage

Soil Description: moist, brown, silty fine sand w/ scattered organics
6" to refusal, 3" duff layer

Vegetation Sample:
OB-07-V5 = black huckleberry
OB-07-V6 = sitka sedge

Soil Sample:
OB-07-S
OB-07-SMM

Soil Invertebrate Sample: None collected. Pitfall traps (3) empty except for 1 fly and 1 very small red spider. Sample not collected.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5961, 62 = OB-07 sample area

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

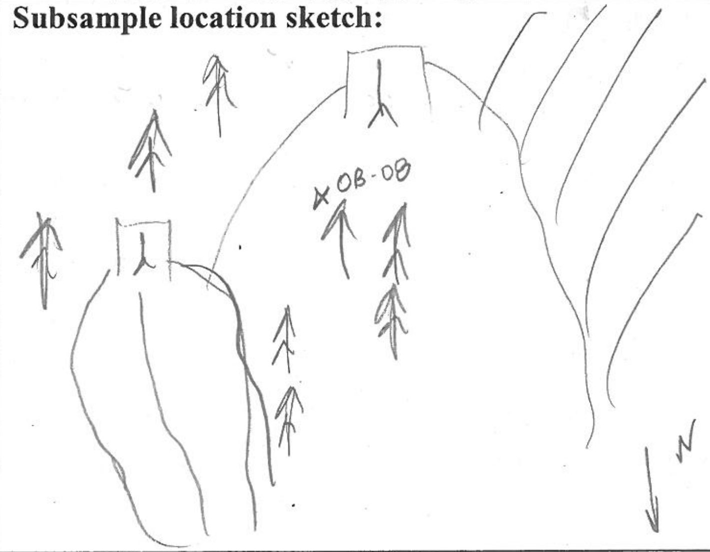
Date/Time: 8/22/13 1010

Samplers: ASK/WDM

Sample Location: O+B Mine, upper WRP

Sample No.: OB-08

Subsample location sketch:



Topography: 4446.75'
~50° slope, slope rocks, in trees

Latitude: 966 732.76' N

Longitude: 1418946.08' E

Vegetation Description: saxifrage, sitka sedge

Soil Description: 2" duff layer ~~followed~~ followed by moist brown, sl. sandy gravel w/ trace silt and occasional organics
5" to refusal.

Vegetation Sample: No black huckleberry
OB-08-VG = sitka sedge

Soil Sample:
OB-08-S
OB-OD-SMM

Soil Invertebrate Sample: 2 pitfall traps had small amount of inverts (spiders, ant(s), tick(?)). Although this is not enough tissue material to run analysis on, it's the best we've seen so far so we bagged them.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5963 -64 = OB-08 sample area

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

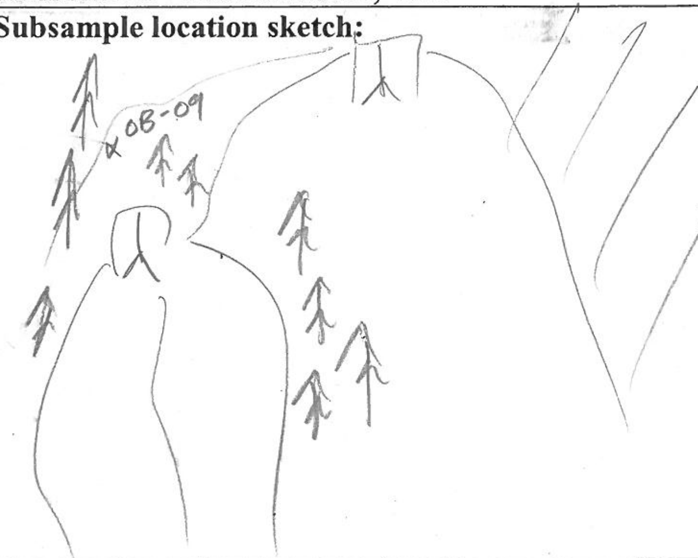
Date/Time: 8/22/13 1050

Samplers: ASK/WDM

Sample Location: O+B Mine, upslope of lower adit, downslope of WR from upper adit(s).

Sample No.: OB-09

Subsample location sketch:



Topography: 4487.46'
73° slope - very steep w/some trees

Latitude: 966683.15' N

Longitude: 1418984.86' E

Vegetation Description: saxifrage, some scattered sitka sedge

Soil Description: 6" duff layer followed by → moist, brown to grey sl. silty fine to medium sand w/occasional organics

Vegetation Sample:
OB-09-VG = sitka sedge
no shrub sample

Soil Sample:
OB-09-S
OB-09-SMM

Soil Invertebrate Sample: A couple of small red spiders in 1 pitfall trap. Not worth collecting

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 8/21/13 1410

Samplers: ASK/WDM

Sample Location: O+B Mine

Sample No.: OB-10

Subsample location sketch:

Topography: 4421.50' MSL

Latitude: 966718.25' N

Longitude: 1419014.33' E

Vegetation Description: saxifrage, black huckleberry, sitka sedge

Soil Description: moist, brown, fine to coarse sandy gravel w/ trace silt.
LOTS OF ROCKS, DIFFICULT TO COLLECT SAMPLE

Vegetation Sample:
OB-10-VG = sitka sedge
OB-10-VS = black huckleberry

Soil Sample:
OB-10-S
OB-10-SMM

Soil Invertebrate Sample: NONE

Authorization:

FIELD FORM

TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

PHOTOS DSCN5972-82 show field crew pushing game carts w/equipment/samples/supplies down Silver Lakes trail to MC townsite.

Comments:

Authorization:

SHERIDAN MINE

Photograph A-5 – August 25, 2013. View of the top of the Sheridan Mine waste rock pile.

Photograph A-6 – August 27, 2013. Collecting samples and marking with GPS.

Photograph A-7 – August 24, 2013. Soil fertility sample (SH-SF) collected on Sheridan Mine waste rock pile.

Photograph A-8 – August 5, 2013. Pitfall traps set on, adjacent to, and downgradient of the Sheridan waste rock pile.

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

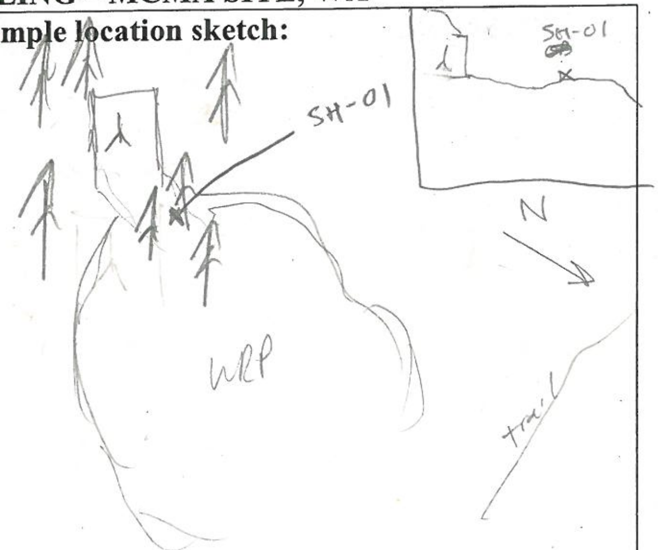
Date/Time: 8/24/13 1405

Samplers: ASK | WDM

Sample Location: Sheridan mine

Sample No.: SH-01

Subsample location sketch:



Topography: SH-01 near flat portion of WRP just outside adit
ELEV. = 3407.82'

Latitude: 965016.09' N

Longitude: 1423346.11' E

Vegetation Description: salmonberry, black huckleberry, blue wildrye (grass), edible thistle, moss

Soil Description: Damp, lt. brown fine to coarse sandy gravel w/ trace silt to damp dark brown sl. silty sandy gravel w/ abundant organics

Vegetation Sample:
SH-01-VS = black huckleberry
SH-01-VG = blue wildrye

Soil Sample:
SH-01-S
SH-01-SMY

Soil Invertebrate Sample: Some ants and spiders caught by forceps.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN5984 - view from ~~SH-04~~ sample area, looking at adit opening. sample area is bottom right corner of photo.

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

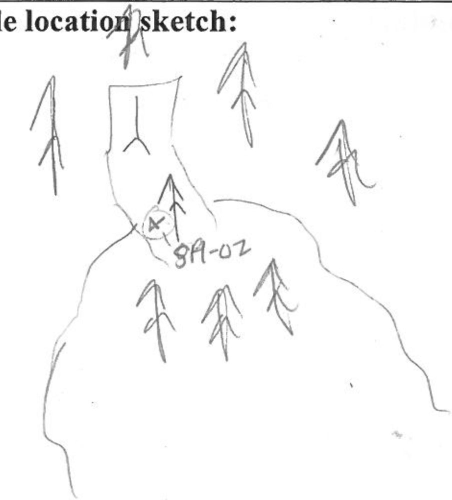
Date/Time: 8/24/13 1500

Samplers: ASK/WDM

Sample Location: Sheridan Mine

Sample No.: SH-02

Subsample location sketch:



Topography: ELEV. = 3355.05'

Latitude: 965033.85' N

Longitude: -1423356.92' E

Vegetation Description: Blue wildrye, lilly, Edible thistle,

Soil Description: Damp, dark brown sl. silty sandy gravel w/ scattered organics

Refusal @ 4" bgs

Vegetation Sample: No black huckleberry for this location

SH-02-VG = blue wildrye

Soil Sample: SH-02-S

SH-02-SMM

Soil Invertebrate Sample: Ants collected over entire WRP - will be composited into single sample (SH-I)

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5985 = SH-02 sample area, right half of photo

~~[illegible]~~

DSCN 5987 = looking back towards sample area

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

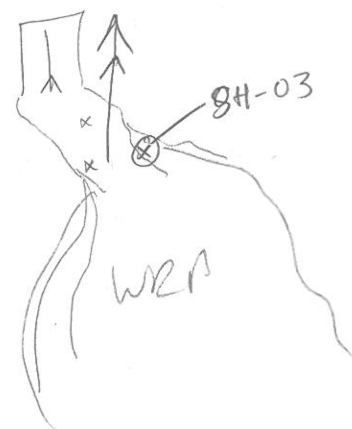
Date/Time: 8/24/13 1515

Samplers: ASK / WDM

Sample Location: SHERIDAN MINE

Sample No.: SH-03

Subsample location sketch:



Topography: 3517.28', mostly flat

Latitude: 965057.13' N

Longitude: 1423280.13' E

Vegetation Description: black huckleberry, no blue wildrye

Soil Description: Damp, lt. brown fine to coarse sl. sandy gravel W/ trace silt to damp dk brown sl. silty sandy gravel w/ trace organics

Vegetation Sample: SH-03-VS = black huckleberry

Soil Sample:
SH-03-S
SH-03-SMM
4" bgs to refusal

Soil Invertebrate Sample:
SH-I

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

left side of photo DSCN 5985

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

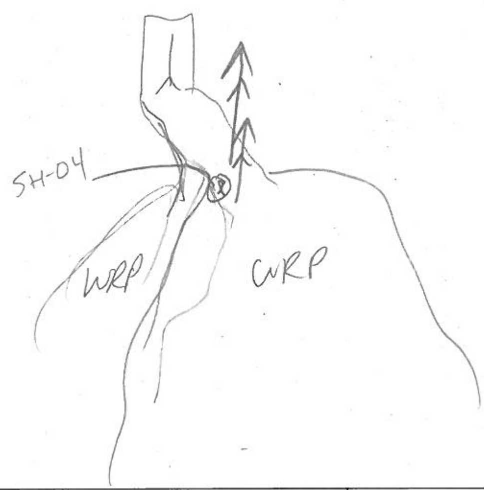
Date/Time: 8/24/13 1530

Samplers: ASK/WDM

Sample Location: SHERIDAN MINE

Sample No.: SH-04

Subsample location sketch:



Topography:

Latitude:

Longitude:

Vegetation Description: Blue wildrye, moss, lilly. No blackhuckleberry to sample

Soil Description: Damp, dark brown, sl. silty sandy gravel w/ scattered organics

Vegetation Sample: SH-04-VG = blue wildrye

Soil Sample:
SH-04-S
SH-04-SMM

Soil Invertebrate Sample: SH-I

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5986

DSCN 5988 – looking downslope to WRP

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

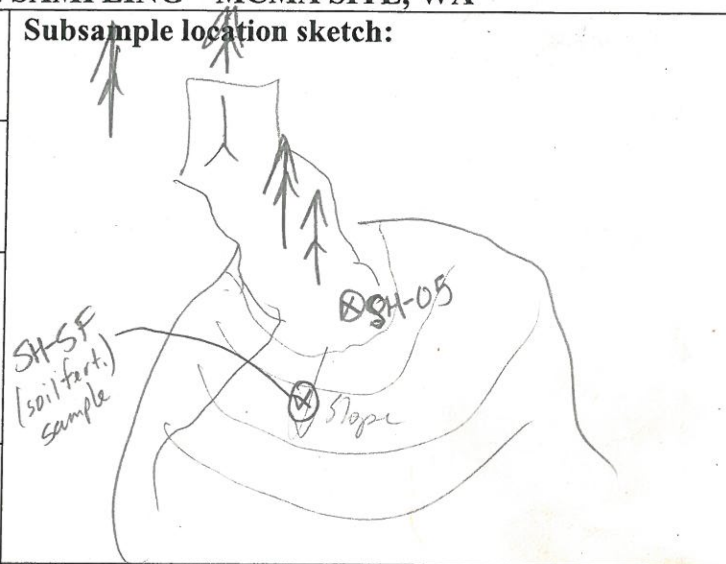
Date/Time:
8/25/13 1105

Samplers:
ASK/WDM

Sample Location:
SHERIDAN MINE

Sample No.:
SH-05

Subsample location sketch:



Topography:
25° slope

Latitude:

Longitude:

Vegetation Description: Small amount of black huckleberry, moss, no grass/sedge

Soil Description: Damp, brown sl. silty fine to coarse sandy gravel (talus)
6" refusal, <1" duff

Vegetation Sample:
SH-05-VS = black huckleberry

Soil Sample:
SH-05-SS
SH-05-SMM

Soil Invertebrate Sample: No insects in pitfall traps for SH-05,
SH-I = composite invert sample for SH WRP.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5989 = SH-SF sample
5990 ↗
5991 ↗

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

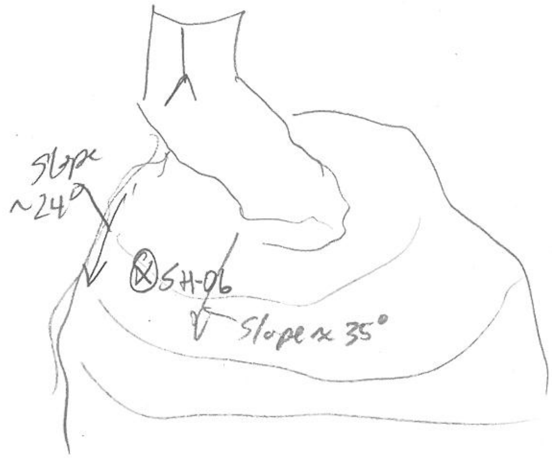
Date/Time: 8/25/13 1135

Samplers: ASK/WDM

Sample Location: SHERIDAN MINE

Sample No.: SH-06

Subsample location sketch:



Topography:

Latitude:

Longitude:

Vegetation Description: Black huckleberry, ferns, thimbleberry, devils club
No grass/sedge sample

Soil Description: Same as previous

Vegetation Sample: SH-06-VS = black huckleberry

Soil Sample:
SH-06-S
SH-06-SMM

Soil Invertebrate Sample: 2 ants + 2 spiders in pitfall traps - added to composite invert sample for WRP (SH-I)

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5992 -93

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

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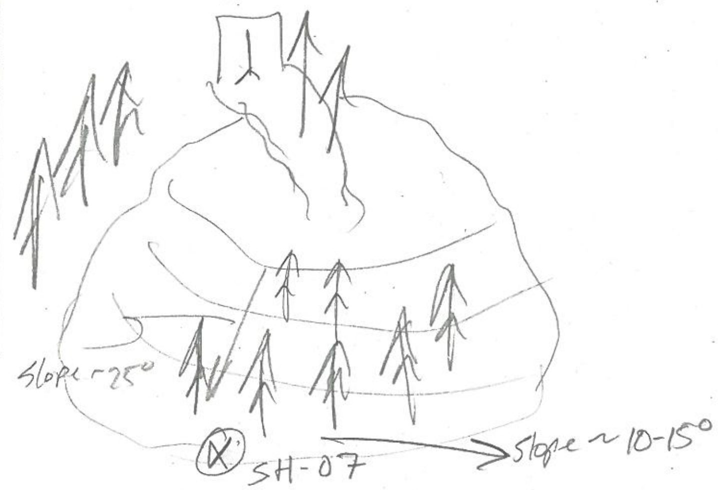
8/25/13. 1150</td><td rowspan="4">Subsample location sketch:

</td></tr>
<tr><td>Samplers:
ASK / WDM</td></tr>
<tr><td>Sample Location:
SHERIDAN MINE</td></tr>
<tr><td>Sample No.:
SH-07</td></tr>
</table>

Topography:	Latitude:	Longitude:
~25° slope		

Vegetation Description: Black huckleberry, ferns, devils club, salmon berry, lots of downed/dead trees
NO grass/sedge sample

Soil Description: same as prev.

Vegetation Sample: SH-07-VS = black huckleberry

Soil Sample:
SH-07-S
SH-07-SMM

Soil Invertebrate Sample: No inverts in pitfall traps. Catipillar caught on log.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5994

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

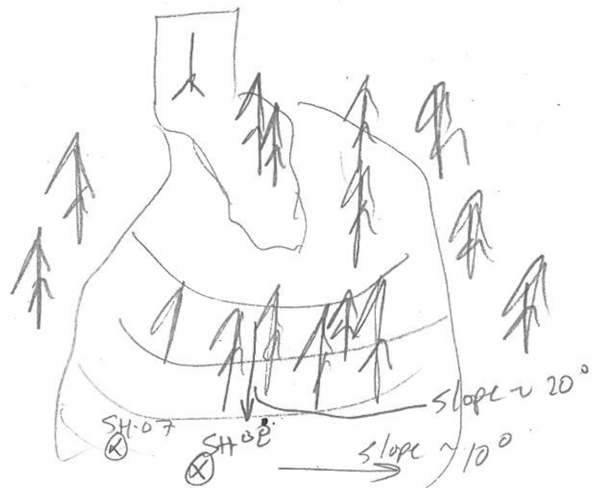
Date/Time: 8/25/13 1205

Samplers: ASK/WDM

Sample Location: SHERIDAN MINE

Sample No.: SH-08

Subsample location sketch:



Topography:

Latitude:

Longitude:

Vegetation Description: Black huckleberry, thimbleberry, ferns, devils club, blue wildrye

Soil Description:

Vegetation Sample:
SH-08-VG = blue wildrye
SH-08-VS = black huckleberry

Soil Sample:
SH-08-S
SH-08-SMM

Soil Invertebrate Sample: one spider in pitfall trap. Sample added to SH-I.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

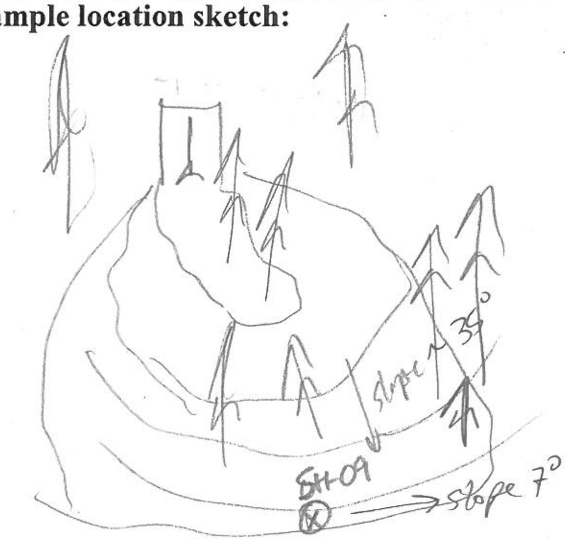
Photo Log:

DSCN 5995

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 8/25/10 1220	**Subsample location sketch:** 
Samplers: ASK/WDM	
Sample Location: SHERIDAN MINE	
Sample No.: SH-09	

Topography:	**Latitude:**	**Longitude:**

Vegetation Description: Black huckleberry, ferns, lillys, devil's club, moss, salmonberry
No grass/sedge to sample

Soil Description:

Vegetation Sample:
SH-09-VS = black huckleberry

Soil Sample:
SH-09-S
SH-09-SMM

Soil Invertebrate Sample: 2 small spiders – added to SH-I.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

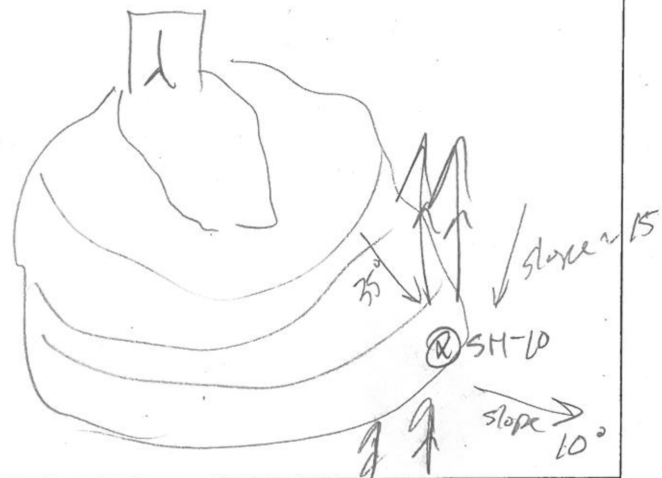
Photo Log:

DSCN 5997

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 8/25/13 1230	**Subsample location sketch:** 
Samplers: ASK/WDM	
Sample Location: SHERIDAN MINE	
Sample No.: SH-10	

Topography:	**Latitude:**	**Longitude:**

Vegetation Description: Black huckleberry, devils club, lilly's, ferns, salmonberry
No grass/sedges

Soil Description:

Vegetation Sample:
SH-10-VS = black huckleberry

Soil Sample:
SH-10-S
SH-10-SMM

Soil Invertebrate Sample: No insects in pitfall traps.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

~~Sept 5, 1998~~

Comments:

Authorization:

PRIDE OF THE MOUNTAINS MINE

Photograph A-9 – August 31, 2013. Sample of black huckleberry (shrub sample collection for Pride of the Mountains Mine).

Photograph A-10 – August 31, 2013. Sampling on the Pride of the Mountains waste rock.

Photograph A-11 – August 31, 2013. View of the lower portion of waste rock and associated vegetation for the Pride of the Mountains Mine.

Photograph A-12 – August 31, 2013. Vegetation sampling (Sitka sedge) adjacent to waste rock pile.

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

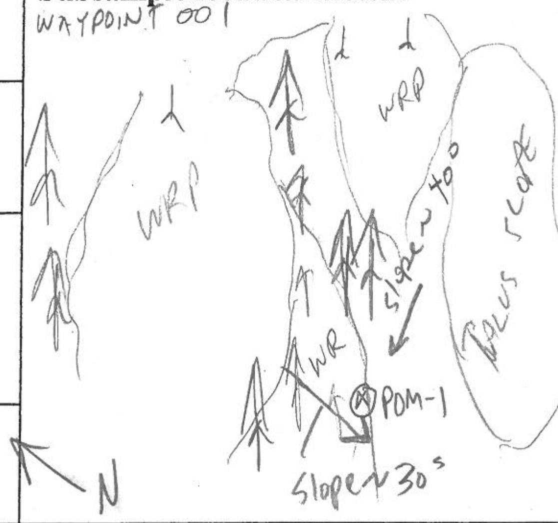
Date/Time: 8/31/13 0830

Samplers: ASK/NWG

Sample Location: ~~PO~~ Pride of the Mountains Mine

Sample No.: POM-1 = WAYPOINT 001 in GARMIN

Subsample location sketch:



Topography: ELEV NOT PROVIDED ON GARMIN
steep, rocky slopes w/abundant veg + mine debris

Latitude: N 47.70363°

Longitude: W 122.34037

Vegetation Description: cedars, black huckleberry, sitka sedge, ferns, bleeding columbine, saxifrage, hemlocks

Soil Description: Damp to moist, brown, gravelly SILT w/ abundant organics
Refusal @ 8-10" bgs

Vegetation Sample: POM-1-VS = black huckleberry
POM-1-VG = sitka sedge

Soil Sample: POM-1-S composite samples from ~~4~~ 5 locations
POM-1-SMM

Soil Invertebrate Sample: POM-I collected ants, spiders, grasshoppers, centipedes
↳ composite sample for entire WRP

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

CIMG 0487 – sample area, view N

0488 – " ", view upslope (NE)

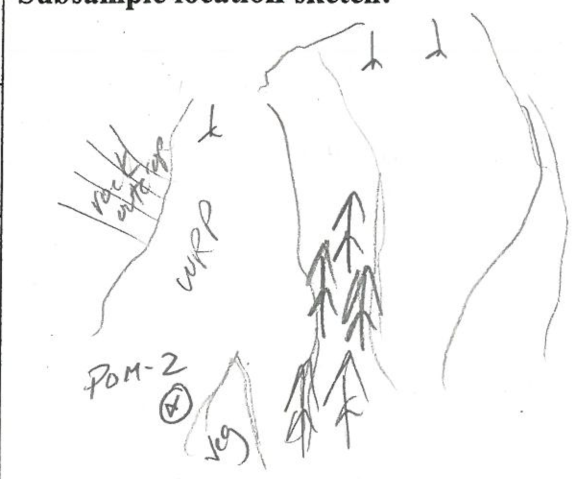
Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 08/31/13 0910

Subsample location sketch:



Samplers: ASK/NWG

Sample Location: Pride of the Mountains

Sample No.: POM-2
GARMIN WAYPOINT 002

Topography: Steep, vegetation and loose WR, mine debris, slope ~ 40°

Latitude: N 47.97963°

Longitude: W 121.35965°

Vegetation Description: Black huckleberry, sitka sedge, hemlocks, alders, saxifrage, lillys, other shrubs

Soil Description: Damp to moist, brown to reddish brown, sl. sandy SILT, w/ abundant gravels and organics
Refusal @ 10-11" bgs

Vegetation Sample:
POM-2-VG = sitka sedge
POM-2-VS = black huckleberry

Soil Sample:
POM-2-S
POM-2-SMM
Composite sample from 4 locations. Other areas too rocky to dig.

Soil Invertebrate Sample:
POM-I

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

CIMG 0489 - sample area, view SE
0490 - " " , view downslope (NW)

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

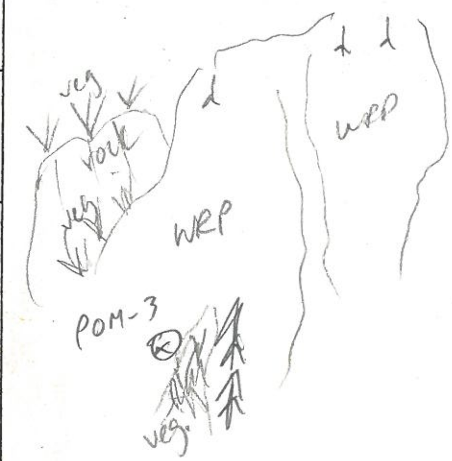
Date/Time: 8/31/13 0940

Samplers: ASK/NWG

Sample Location: Pride at the Mountains
50' upslope of POM-2

Sample No.: POM-3 GARMIN WAYPOINT 003

Subsample location sketch:



Topography: ELEV. ~~[illegible]~~ 4546'

Latitude: N 47.97982°

Longitude: W 121.36002°

Vegetation Description: sitka sedge, ferns, lillys, unidentifed shrub
NO HUCKLEBERRY FOR SAMPLE

Soil Description: Damp, brown, sl. sandy silty GRAVEL, w/ abundant organics
Refusal btwn 8-12" bgs

Vegetation Sample: POM-3-VG = sitka sedge
No VS sample

Soil Sample: POM-3-S
POM-3-SMM

Soil Invertebrate Sample: POM-I

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

CIMG 0491 - sample area, view SE

0492 · " " , view S

Comments:

Authorization:

POM-4
8/31/13 1020

WAYPOINT 004

TOPOGRAPHY: LAT LONG
ELEV. = 4529' N 47.97987° W121. ~~33~~ 35980°
steep slope

VEG. DESCRIPTION
~~[illegible]~~ unidentified shrub, NO HUCKLEBERRY
sitka sedge, ferns, lillys, bleeding columbine,
saxifrage

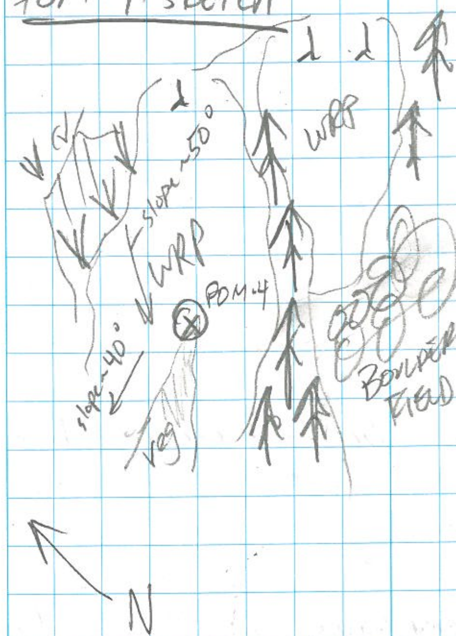
SOIL DESCR
Damp, brown, Sl. ~~sandy~~ ~~silty~~ silty sandy gravel w/ abundant organics. Refusal @ ~6-8" bgs

VEG. SAMPLE
POM-4-VG = sitka sedge

SOIL SAMPLE
POM-4-S
POM-4-SMM

INVERTS
POM-I

POM-4 SKETCH



4 PHOTOS TAKEN AT SAMPLING AREA
CIMG 0493-0494 = sample area, view SE
0495 = view downslope, 0496 = view upslope

SOIL ~~FERTILITY~~ SAMPLE = POM-SF
= GARMIN WAYPOINT 005
2 PHOTOS TAKEN
0-12" bgs
CIMG 0497-0498 = soil fertility sample area

POM-5

8/31/13 1050

WAYPOINT 006

TOPO	LAT	LONG
4617'	N 47.97983°	W 121.35969°

VEG

same un-ID'd shrub, black huckleberry, sitka sedge hemlocks, furs, lillys, moss,

SOIL

Damp, brown, sl. silty sandy gravel w/abundant org,
+ Damp, brown, sl. sandy silty gravel w/abrn. org

VEG. SAMPLE

POM-5-VS = black huckleberry
POM-5-VG = sitka sedge

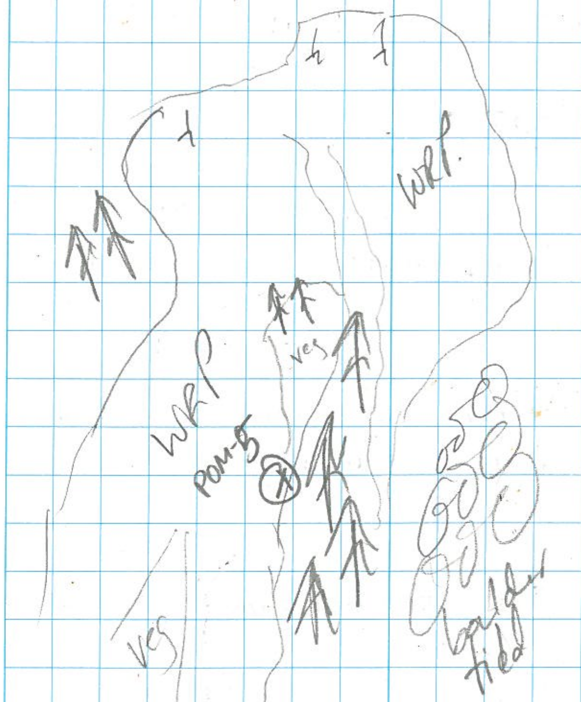
SOIL SAMPLE

POM-5-S
POM-5-SMM

INVERT

POM-I

POM-5 SKETCH



2 photos taken of sampling area

CIMG0 4999 - 0500 = sampling area
view ~~E~~ E, view S

POM-6

8/31/13 1120

WAYPOINT 007

TOPO	LAT	LONG
NO ELEV.	N 47.97982°	W 121.35963°

VEG

sitka sedge, some un-ID'd shrub, huckleberry, cedars, hemlock, other shrubs, bleeding columbine

SOIL

Damp Brown Sl. silty sandy gravel w/ abund. org.

VEG SAMPLE

POM-6-VG = sitka sedge
POM-6-VS = huckleberry

SOIL SAMPLE

POM-6-S
POM-6-SMM

INVBRT

POM I

SKETCH

2 photos taken
CIMG 0501 – sample area, view N
0502 – " ", view S

POM-7

8/31/13 1145

WAYPOINT 008

TOPO.	LAT	LONG.
NO ELEV.	N 47.98001°	W 121.35962°

Steep slope ~ 50°

VEG.

Huckleberry, sitka sedge, cedars, lillys, other shrubs, bleeding columbine

SOIL

Damp, brown, sl. silty sandy gravel w/ trace organics

VEG SAMPLE

POM-7-VS = huckleberry
POM-7-VG = sitka sedge

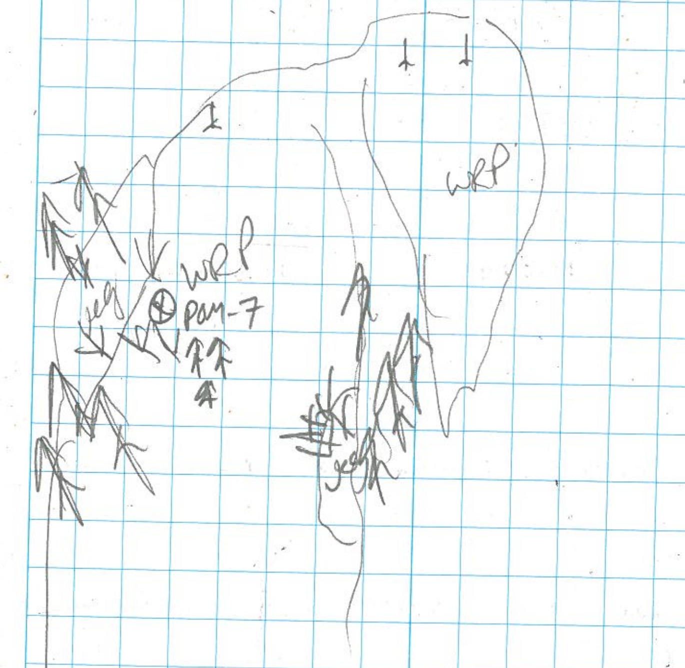
SOIL SAMPLE

POM-7-S
POM-7-SMM

INVERTS

POM-I

SKETCH



2 photos taken

CIMG 0503 - sample area, view S
0504 - " " , view W

POM-8

8/31/13 1215

WAYPOINT 009

TOPO. LAT LONG

no elev. N 47.98008° W 121.35960°

steep slope w/
loose rock N 60°

VEG.

Grasses, sitka sedge, misc. shrubs, NO HUCKLEBERRY
edible thistle,

SOIL

Damp, brown sl. silty sandy gravel w/ abundant organics

VEG SAMPLE

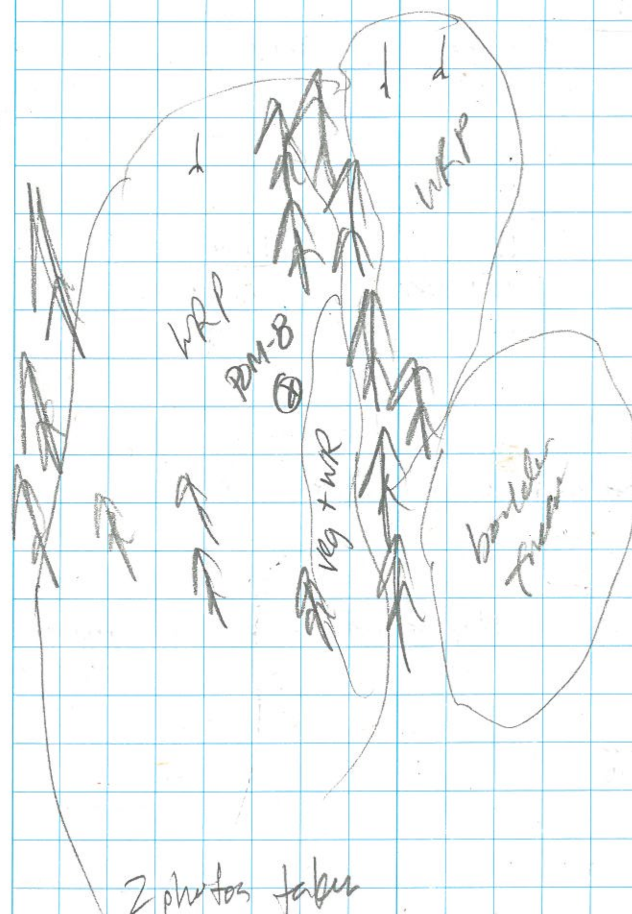
POM-8-VG = sitka sedge

SOIL SAMPLE

POM-8-S
POM-8-SMM

INVERTS

POM-I



2 photos taken

CIMG0505 - sample area, view N
0506 - " ", view downslope (NE)

POM-9

8/31/13 1310

WAYPOINT 010

TOPO	LAT	LONG
4758'	47.48033°	W121.35801°

steep slope ~40°

VEG.

cedars, un-ID'd shrub, black huckleberry (young) grass (sitka sedge), saxifrage
↳ found some

SOIL

Damp, brown, silty sandy gravel w/ abundant organics

VEG SAMPLE

POM-9-VS = black huckleberry
POM-9-VG = sitka sedge

SOIL SAM

POM-9-S
POM-9-SMM

INVERTS

POM-II

2 photos taken

CIMG 0507 - sample area, view S
0508 - view upslope (E)

POM-10

8/31/13 1330

WAYPOINT 011

TOPO	LAT	LONG
4758'	N 47.98044°	W 121.35768°

VEG.

saxifrage, sitka sedge, NO SHRUBS

SOIL

Damp, brown, sl. silty to silty - sandy gravel w/ abund. organics

VEG. SAMPLE

POM-10-VG = sitka sedge

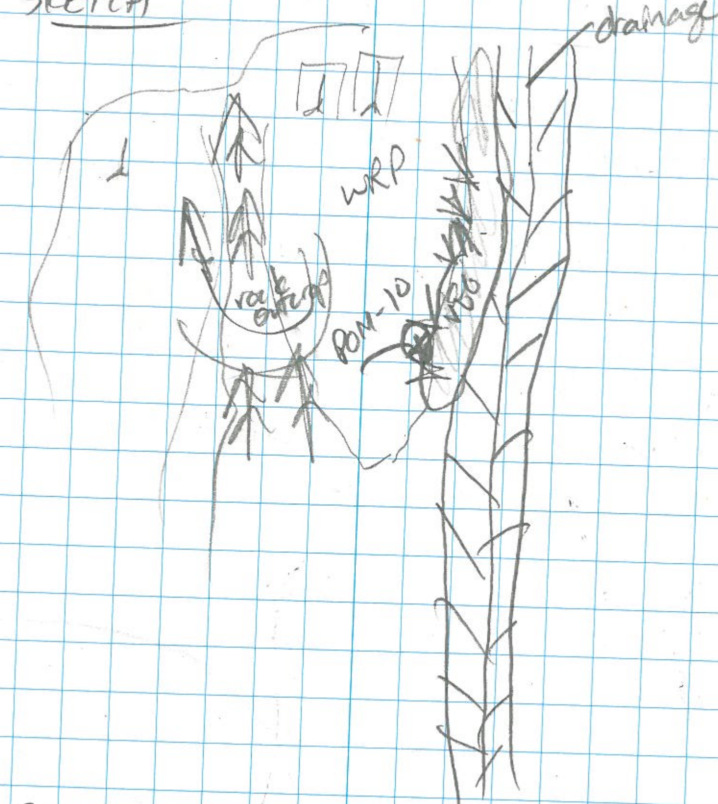
SOIL SAMPLE

POM-10-S
POM-10-SMM

INVERTS

POM-I

SKETCH



2 PHOTOS TAKEN

CIMG 0509 - sample area, view S
0510 - " ", downslope

NEW DISCOVERY MINE

Photograph A-13 – September 1, 2013. New Discovery Mine waste rock piles. Adit location shown by arrows. View from trail across the valley.

Photograph A-14 – September 1, 2013. Hiking across boulder field to New Discovery Mine.

Photograph A-15 – September 1, 2013. Soil and vegetation sampling (grass & sedge composite sample and black huckleberry shrub sample). View downslope toward Glacier Creek.

Photograph A-16 – September 1, 2013. New Discovery Mine; waste rock pile and limited vegetation.

Photograph A-17 – September 1, 2013. Invertebrate collection; checking sample weight. Five gummy bears is approximately 10 grams of invertebrates.

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

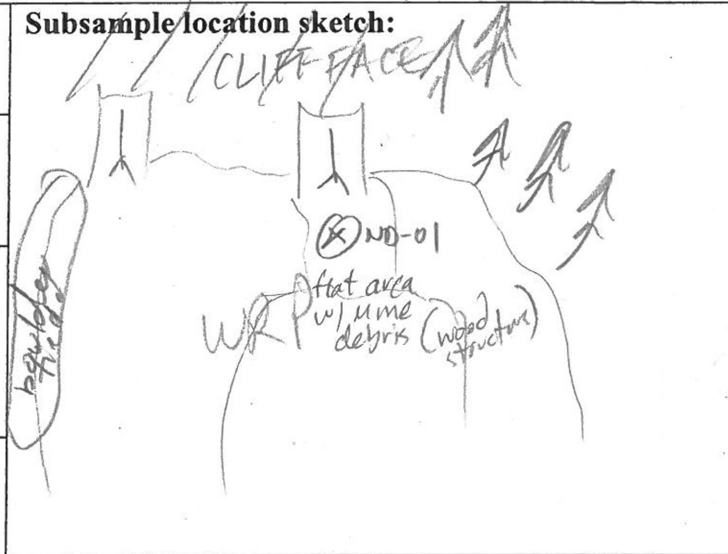
Date/Time: 9/1/13 1010

Samplers: ASK/NWG

Sample Location: New Discovery Mine

Sample No.: ND-01
WAYPOINT 013

Subsample location sketch:



Topography: 4589'

Latitude: N 47.98088°

Longitude: W 121.36217°

Vegetation Description: Ferns, wildflowers, pacific bleeding heart (? pink flower), grasses hemlocks, cedars, lillys, some huckleberry

Soil Description: Damp, brown, sl. sandy silty gravel, w/abundant wood waste
to red brown

Vegetation Sample:
ND-01-VG = grass/sedge * due to insufficient grass tissue available, several (3) types collected for composite sample
ND-01-VS = huckleberry

Soil Sample:
ND-01-S
ND-01-SMM

Soil Invertebrate Sample: spiders, ants, centipedes, grasshopper
ND-I

Authorization:

Photo Log:

1 photo

CIMG 0517 – sample area, downslope of adit, view E

GENERAL ND PHOTOS

Pictures 0513-0516 show New Discovery Mine area

0513 – hiking to WR

0514 – downslope of first adit

0515 – top of WRP – view from downslope of adit facing N

0516 – view downslope

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time:
9/1/13 1030

Samplers:
ASK/NML

Sample Location:
New Discovery

Sample No.:
ND-02
WAYPOINT 014

Subsample location sketch:

Topography: 4605'
flat to steep slope,

Latitude: N 47.98084°

Longitude: W 121.36237°

Vegetation Description: Cedars, hemlocks, wildflowers, saxifrage, moss, some grasses, huckleberry (young, small amount)

Soil Description: Damp, sl. sandy silty gravel (br to red brown
Damp, grey brown, sl. silty sandy gravel
} both w/ abundant organics

Vegetation Sample:
ND-02-VG = grass/sedge → again had to combine species of grass/sedges
ND-02-VS = huckleberry

Soil Sample:
ND-02-S
ND-02-SMM

Soil Invertebrate Sample:
ND-I

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

2 photos taken

CIMG 0518 -0519

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

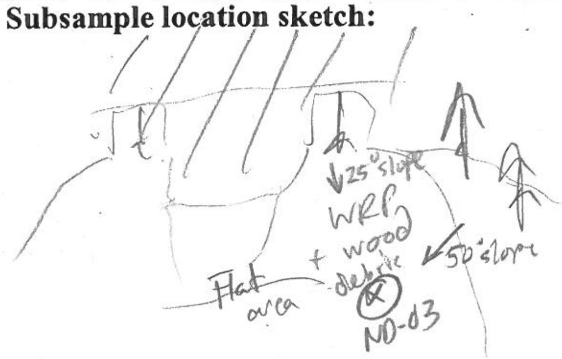
Date/Time:
9/1/13 1100

Samplers:
ASK/NWG

Sample Location:
New Discovery

Sample No.:
ND-03
WAYPOINT 015

Subsample location sketch:



Topography: 4537'
Sloping down from adit (25°), flat, wood debris area

Latitude: N 47.98077°

Longitude: W 121.36230°

Vegetation Description: small patches of grass, saxifrage, spruce, fern, moss
NO SHRUB FOR SAMPLE

Soil Description: Damp, brown and grey, sl. sandy silty gravel, w/abundant organics and wood waste.

Vegetation Sample:
ND-03-VG = grass/sedge sample
NO SHRUBS

Soil Sample:
ND-03-S
ND-03-SMM

Soil Invertebrate Sample:
ND-I

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

2 photos

CIMG 0520 – 0521

Comments:

Not much plant tissue available to sample

Had to combine different species of grass/sedge for VG sample.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time:
9/1/13 1120

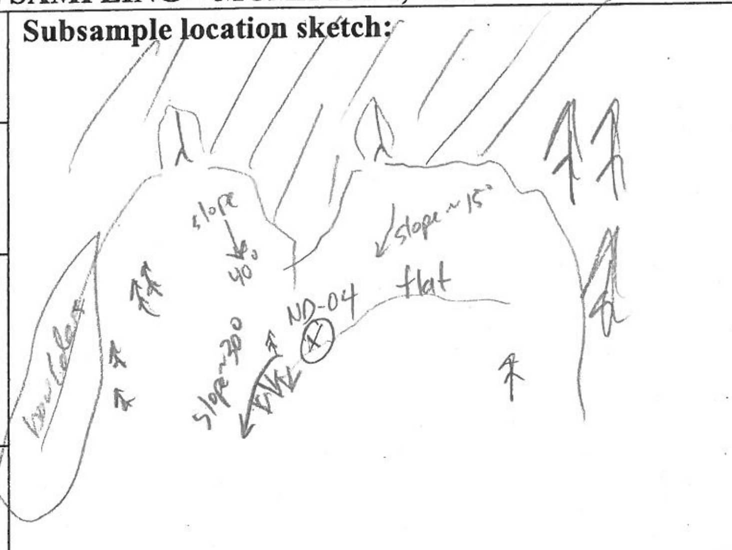
Samplers:
ASK/NWO

Sample Location:
New Discovery

Sample No.:
ND-04
WAYPOINT 016

Topography: 4548'
downslope of both adits, see sketch.

Subsample location sketch:



Latitude:
N 47.98092°

Longitude:
W 121.36238°

Vegetation Description: saxifrage, fur, wildflowers, pacific bleedingheart (? pink flower), small patch of huckleberry (young), small (few) patches of grass/sedge

Soil Description: Damp, brown, sl. sandy silty gravel w/ abundant wood material

Vegetation Sample:
ND-04-VS = huckleberry
ND-04-VG = grass/sedge

Soil Sample:
ND-04-S
ND-04-SMM

Soil Invertebrate Sample:
ND-I

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

3 photos taken

CIMG 0522 - 0524

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time:
9/1/13 1145

Samplers:
ASK/NWZ

Sample Location:
New Discovery

Sample No.: No ELEV
ND-05
WAYPOINT 017

Subsample location sketch:

Topography:
Steep slopes ~50°

Latitude:
N 47.98102°

Longitude:
W 121.36227°

Vegetation Description: firs, cedars, black huckleberry, saxifrage, some grass/sedge other shrub (one previously un-ID'd @ POM)

Soil Description: Damp, brown to grey, sl. silty sandy gravel w/abundant org.

Vegetation Sample:
ND-05-VS = black huckleberry
ND-05-VG = sedge/grass

Soil Sample:
ND-05-S
ND-05-SMM

Soil Invertebrate Sample:
ND-I

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

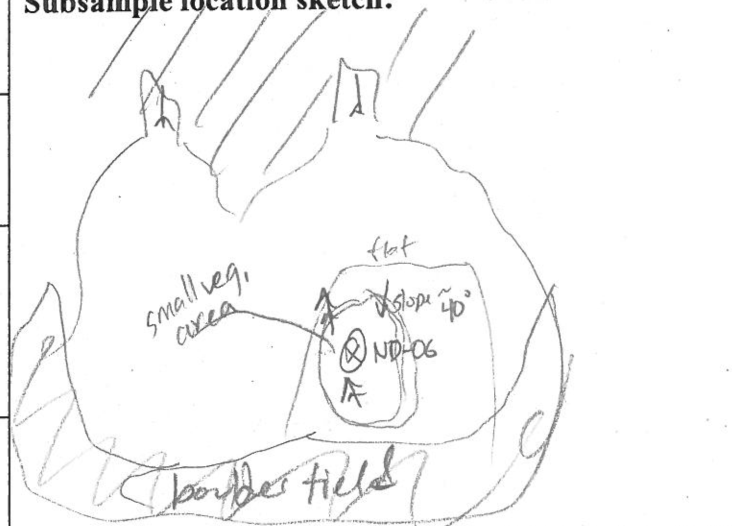
CIMG 0525 – 0526

2 photos taken
· downslope & up

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 9/1/13 1205	**Subsample location sketch:** 
Samplers: ASK/NWG	
Sample Location: New Discovery Mine	
Sample No.: ND-06 WAYPOINT 018	
Topography: 4449' Steep slopes, veg. area beneath flat wood remains	**Latitude:** N 47.98088° / **Longitude:** W 121.36234°
Vegetation Description: cedars, saxifrage, grass/sedge, pacific bleedingheart, NO SHRUBS	
Soil Description: Damp, brown, sl. sandy silty gravel w/ abundant organics	
Vegetation Sample: ND-06-VG = grass/sedge NO SHRUB TO SAMPLE	
Soil Sample: ND-06-S ND-06-SMM	
Soil Invertebrate Sample: Beetle, ants ND-I	

Authorization:

Photo Log:

CIMG 0527 (blurry)
0528

2 photos taken up/down

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time:
9/1/13 1430

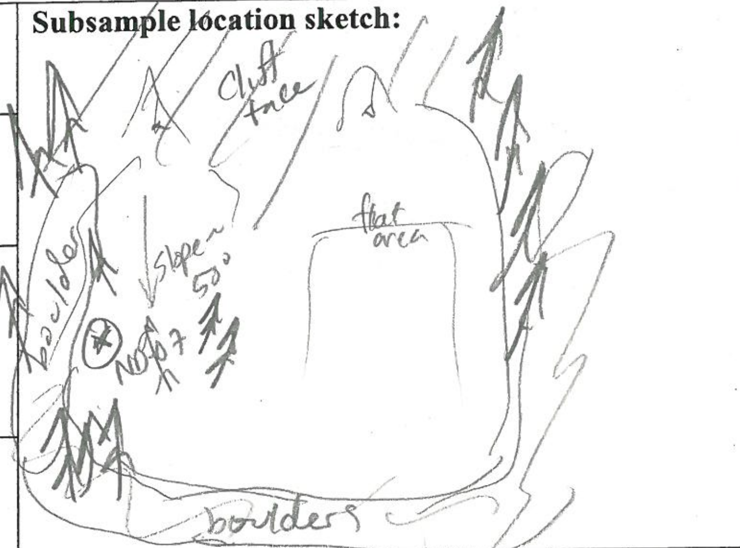
Samplers:
ASK/NWG

Sample Location:
New Disc

Sample No.:
ND-07
WAYPOINT 019

Topography: 4448'
steep slope, loose WR

Subsample location sketch:



Latitude:
N. 47.98103°

Longitude:
W 121.36259°

Vegetation Description: firs, cedars, grass/sedge patches, saxifrage, NO SHRUBS

Soil Description: Damp, brown, silty sandy gravel w/ some organics

Vegetation Sample:
ND-07-VG = grass/sedge

Soil Sample:
ND-07-S
ND-07-SMM

Soil Invertebrate Sample:
ND-I → PHOTO CIMG 0529 = checking weight of invert sample.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

~~CIMG [illegible]~~

CIMG 0530 – 0531

2 plates

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 9/1/13 1450 (ND-08) / 1500 (SF)

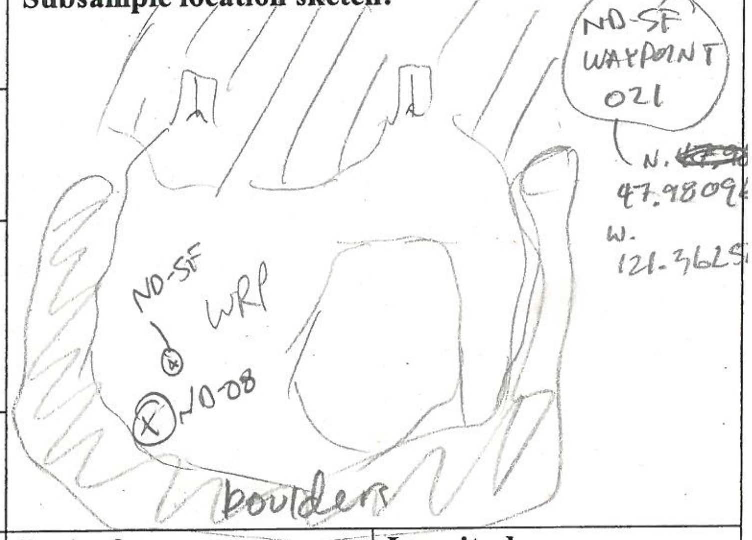
Samplers: ASK/NWG

Sample Location: New Discovery Mine

Sample No.: ND-08
WAYPOINT 020

Topography: 4419'
steep slope, bottom of WRP, just upslope of boulder

Subsample location sketch:



Latitude: N 47.98091°

Longitude: W 121.36258°

Vegetation Description: fir, grass/sedge, pacific bleeding heart, NO SHRUBS
(small patches)

Soil Description: Damp, brown sl. silty sandy gravel w/ organics

SF SAMPLE: Damp, brown, silty gravel w/ abundant organics and black wood fragments

Vegetation Sample: ND-08-VG = sedge/grass

Soil Sample:
ND-08-S
ND-08-SMM

Soil Invertebrate Sample:
ND-I

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

CIMG 0532-0533

PHOTO - CIMG0534 - view from bottom of bolder field looking up @ ND mine WRP.

Comments:

Authorization:

MYSTERY MINE

Photograph A-18 – August 31, 2013. Vegetation identification (Sitka mountain-ash) and sampling on Mystery Mine.

Photograph A-19 – August 31, 2013. Soil sample collection near vegetation on waste rock pile.

Photograph A-20 – August 30, 2013. Vegetation sample (black alpine sedge) from Mystery Mine waste rock.

Photograph A-21 – August 30, 2013. Mystery Mine soil sample profile.

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

VIEW E/SE LOOKING AT

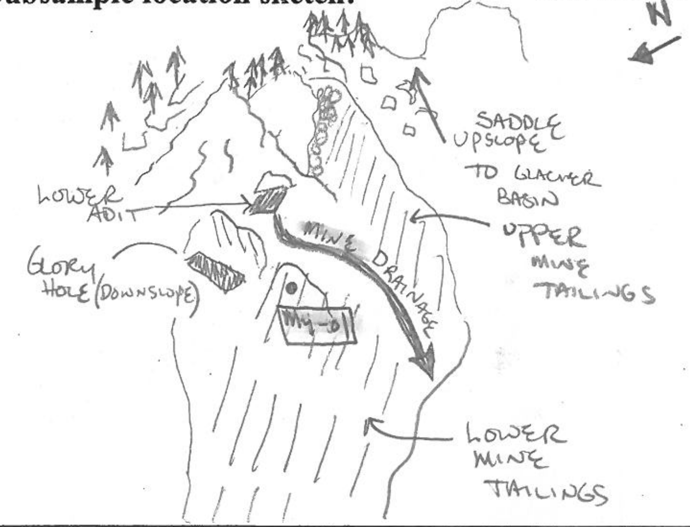
Date/Time: 8/30/13 1340 HRS

Samplers: WDM AJW

Sample Location: MYSTERY (MY-01)

Sample No.: MY-01-S (METALS)
MY-01-SMM (MERCURY)

Subsample location sketch:



Topography: 36° SLOPE

Latitude:

Longitude:

Vegetation Description: SMALL BRUSHY CEDAR, ALDER + FIR,

Soil Description: MOIST, YELLOW BROWN SILTY V. SANDY GRAVEL (WITH COBBLE)
(ON LOWER TALUS SLOPE)

Vegetation Sample: GRASS (SEDGE + + (SHRUB)
↳ BLACK ALPINE SEDGE
MY-01-VG (BLACK ALPINE SEDGE)
1340 HRS

Soil Sample: MY-01-S (METALS)
MY-01-SMM (MERCURY)
~12" REFUSAL

Soil Invertebrate Sample: NO INVERTS

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log: 269-1442 (AJW CAMERA) PIC# 004 ON DRIVE

- VIEW SAMPLE LOCATION W/ ADIT UPSLOPE AND UPPER MINE TAILINGS IN BACKGROUND
- VIEW E/SE

(AJW) PIC# 005 : SOIL SAMPLE FOR BLACK ALPINE SEDGE

Comments:
- SAMPLE LOCATION DUE NORTH OF MINE DRAINAGE CEDAR + SHRUB + GRASS SAMPLES
- NO INVERTS ALONG SAMPLE SITE

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

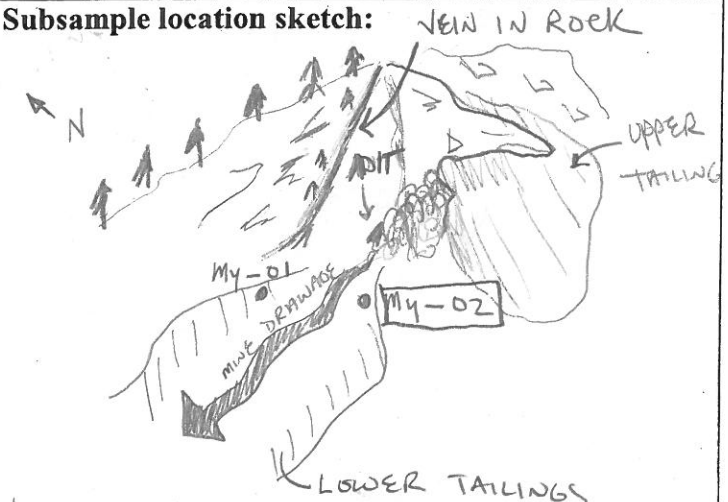
Date/Time: 8/30/13 1508 HRS

Samplers: WDM/AJW

Sample Location: MYSTERY (MY_02)

Sample No.: My – 02 – S (METALS)
My – 02 – SMM (MERCURY)

Subsample location sketch:



VIEW NE AT LOWER ADIT

Topography: 30° SLOPE

Latitude:

Longitude:

Vegetation Description: BLACK ALPINE SEDGE

Soil Description: MOIST, YELLOW BROWN SILTY V. SANDY GRAVEL (TAILINGS)
SULFUR ODOR + COLORATION

Vegetation Sample: GRASS: BLACK ALPINE SEDGE
My – 02 – V6 (BLACK ALPINE SEDGE)
~~My – 02 – VS (W. MT. ASH)~~ NO W. MT. ASH

Soil Sample: My – 02 – S (METALS)
My – 02 – SMM (MERCURY)

Soil Invertebrate Sample: ANTS NEAR SAMPLING LOCATION

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log: PIC # 1444 – VIEW NE AT TOP OF LOWER TAILINGS / LOWER MINE ADIT

(PIC # 006 ON DRIVE)

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time:

8/31/13 1030 HRS

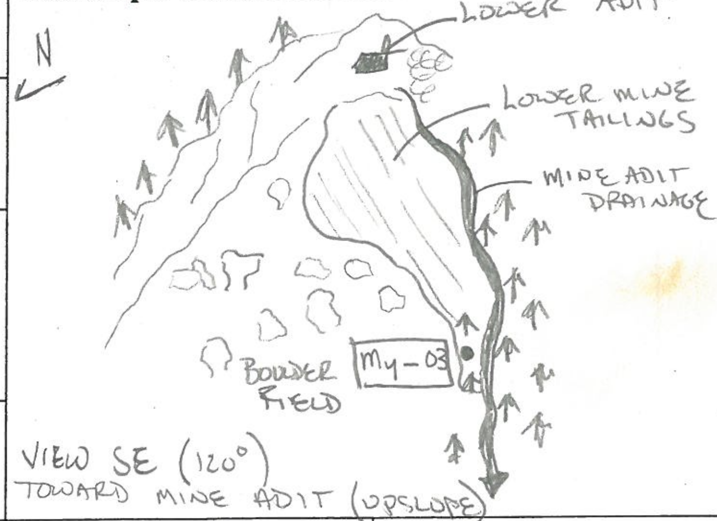
Samplers:

WDM / AJW

Sample Location: MYSTERY (MY – 03) LOCATED AT TOE OF LOWER WASTE ROCK PILE / ON TOP OF TAILINGS

Sample No.: My – 03

Subsample location sketch:



Topography: 26°
LOOKING UPSLOPE
Rock CLIFFS TO LEFT, BOULDER FIELD,

Latitude:

Longitude:

Vegetation Description: PURPLE MT. HEATHER, BLACK ALPINE SEDGE, W. MT. ASH SCATTERED ON TAILINGS PILE

Soil Description: (LOOSE TO MED. DENSE) MOIST, BROWN, SILTY, V. GRAVELLY, F-C SAND (TAILINGS)

Vegetation Sample:
My – 03 – VS (SHRUB – W. MT. ASH)
My – 03 – VG (BLACK ALPINE SEDGE)

Soil Sample:
My – 03 – SMM (MERCURY)
My – 03 – S (METALS)

Soil Invertebrate Sample: COMPOSITE
SCATTERED SPIDERS

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log: PIC#

6012 (WDM) – VIEW E. TOWARD BOULDER FIELD AT SAMPLING LOC.

6013 (WDM) – BLACK ALPINE SEDGE AFTER SAMPLING

6014 (WDM) W. MT. ASH

Comments:

- OLD RAIL CAR TRACK APPEARS TO FOLLOW TAILINGS + DRAINAGE DOWNSLOPE FROM MINE ADIT
- DRAINAGE STILL CONTAINS DISCOLORATION OF YELLOW + BROWN ON ROCKS

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 8/31/13 1120 HRS	**Subsample location sketch:** 
Samplers: WDM/AJW	
Sample Location: MYSTERY (My-04) LOCATED AT TOE OF SLOPE (UPSLOPE OF My-03) ON SIDE OF WRP	
Sample No.: My-04	
Topography: 25° SLOPE	**Latitude:**
	Longitude:

Vegetation Description: SCATT. W. MT. ASH + SEDGE ABUNDANT ALDERS, LILLIES AND UNKNOWN SHRUB

Soil Description: (LOOSE - MED DENSE) MOIST, BROWN, SILTY, V. GRAVELLY F.C SAND (TAILINGS

Vegetation Sample:
My-04_VG (SEDGE)
My-04_VS (W. MT. ASH)
~~My-04_VG2 ( )~~

Soil Sample:
My-04_S (METALS)
My-04-Smm (MERCURY)

Soil Invertebrate Sample: NO ABUNDANT INVERTS

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log: PIC# 6016 – VIEW E UPSLOPE AT TAILINGS PILE

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

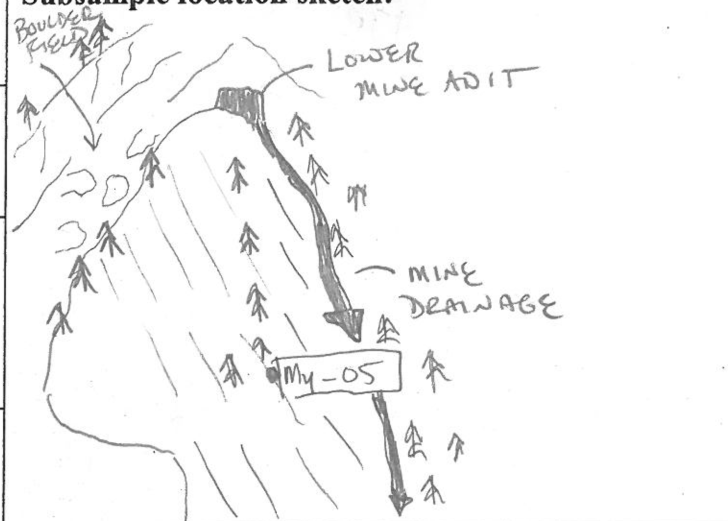
Date/Time: 8/31/13 1150 HRS

Samplers: WDM / AJW

Sample Location: MYSTERY (MY_05)
- CENTRAL / CLIMBERS RIGHT OF LOWER TAILINGS PILE
- WITHIN WRP

Sample No.: My – 05

Subsample location sketch:



Topography: 35°

Latitude:

Longitude:

Vegetation Description: ALDERS, BLACK ALPINE SEDGE, + SMALL W. MT. ASH

Soil Description: (LOOSE - MED. DENSE) MOIST, BROWN, SILTY GRAVELLY F-C SAND

Vegetation Sample:
My– 05– VG (W. MT. ASH)
~~My– 05– VG2 ( )~~
My – 05_VG E (BLACK ALPINE SEDGE)

Soil Sample:
My– 05_ Smm (MERCURY)
My – 05_ S (METALS)

Soil Invertebrate Sample: NO APPARENT INVERTS

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:
(WDM) PIC # 6018-6019
- VIEW E. FROM MY-05/UPSLOPE

Comments:

Authorization:

FIELD FORM

TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 8/31/13 1330

Samplers: WDM/AJW

Sample Location: MYSTERY MY-06 LOCATED ON E. SIDE OF MINE TAILINGS

Sample No.: MY-06

Subsample location sketch:

Topography: 36°E SLOPE

Latitude:

Longitude:

Vegetation Description: DEVIL'S CLUB, LADY FERN, W. MT. ASH, UNIDENT SEDGE

Soil Description: (LOOSE) DRY, BROWN, SILTY, GRAVELLY FM SAND, ABUNDANT GR + COBBLES + BOULDERS

Vegetation Sample: MY-06-VS (W. MT. ASH)

~~MY-06-VS2 ( )~~

NO BLACK ALPINE SEDGE

Soil Sample: MY-06-S (METALS)

MY-06-SMM (MERCURY)

Soil Invertebrate Sample: CARPENTER ANTS, + GRASSHOPPERS

Authorization:

FIELD FORM

TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

(WPM) PIC# 6020 – VIEW NW
& DOWNSLOPE FROM MY-06

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 8/31/13 1420

Samplers: WDM / AJW

Sample Location: MYSTERY (My_07)
LOCATED ON E. SIDE OF UPPER TAILINGS / UPSLOPE OF UPPER ADIT.

Sample No.: My_07

Subsample location sketch:

Topography: 30° SLOPE

Latitude:

Longitude:

Vegetation Description: NO SEDGE, W. MOUNTAIN ASH

Soil Description: LOOSE TO DENSE, DAMP, RED BROWN, SL. SILTY F-C SAND W/ BOULDERS

Vegetation Sample: My_07_VS W. MOUNTAIN ASH

Soil Sample:
My_07_S (METALS)
My_07_Smm (MERCURY)

Soil Invertebrate Sample: ANTS + BEETLE

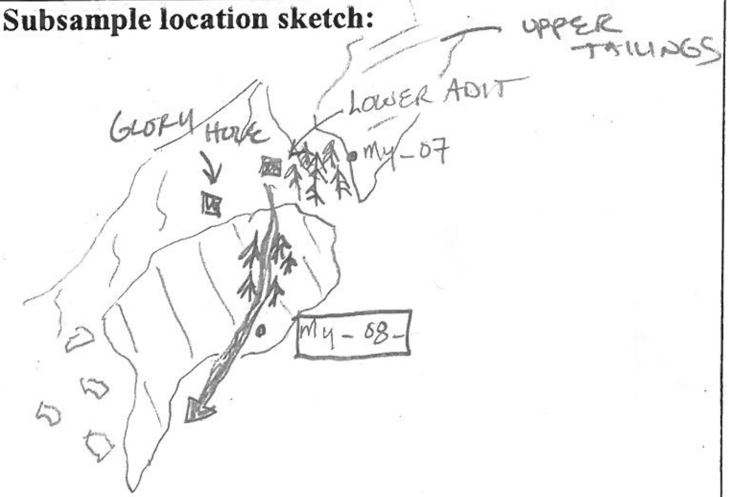
Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log: (WDM) PIC # 6021 – VIEW E. AT TAILINGS (UPPER) FROM MY-07 w/ W. MT. ASH
Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 8/31/13 1500	**Subsample location sketch:** 
Samplers: WDM/ AJW	
Sample Location: MYSTERY (My-08) S. OF DRAINAGE BELOW LOWER ADIT/ (ON TAILINGS PILE)	
Sample No.: My-08	
Topography: 37° SLOPE	**Latitude:** / **Longitude:**

Vegetation Description: SCATT. W. MT. ASH + BLACK ALPINE SEDGE w/ CEDAR + ALDER

Soil Description: (DENSE) MOIST, BROWN, SL. SILTY, F-C GRAVELLY SAND w/ BOULDERS

Vegetation Sample:
My-08-VS (W. MT. ASH)
My-08-VG (BLACK ALPINE SEDGE)

Soil Sample:
My-08-S (METALS)
My-08-SMM (MERCURY)

Soil Invertebrate Sample:
NA

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

(WDM) PIC# 6022 – VIEW UPSLOPE
AT MY-08

Comments:

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 9/1/13 0930	**Subsample location sketch:** 
Samplers: WDM AJW	
Sample Location: MYSTERY (MY-09)	
Sample No.: MY-09	
Topography:	**Latitude:** / **Longitude:**
Vegetation Description: CEDAR, W. MT. ASH, HUCKLEBERRY, (GRASS #2)	
Soil Description: MED. DENSE, DAMP, RED BROWN, SL. SILTY, ~~F-M~~ SANDY GRAVEL W/ BOULDERS	
Vegetation Sample: MY-09-VS (W. MT. ASH) ~~MY-09-VS2 ( )~~	
Soil Sample: MY_09_S (METALS) MY-09-SMM (MERCURY)	
Soil Invertebrate Sample: ANT	

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

(WDM) PIC # 6023 ~~6024~~

VIEW SE + UPSLOPE AT MY-09

Comments: LOCATED AT TOE OF TALUS / DRAINAGE OF ADIT IN VEGETATION ON (R) SIDE OF PICTURE

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 9/1/13 1035

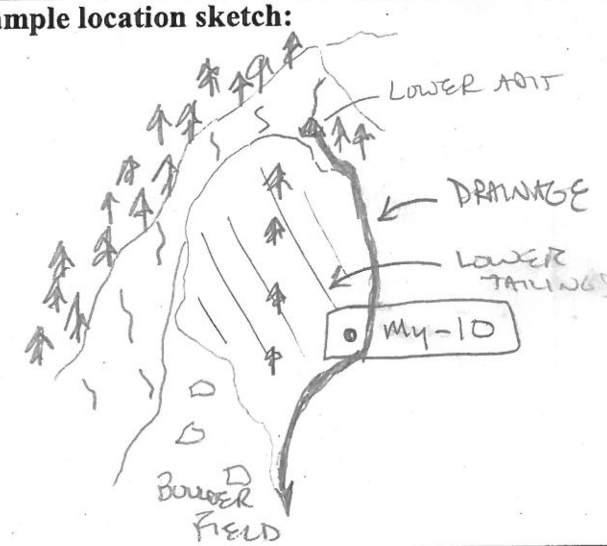
Samplers: WDM/ AJW

Sample Location: MYSTERY (MY-10)
(R) SIDE OF LOWER TAILINGS

Sample No.: MY-10

Topography: 35° SLOPE

Subsample location sketch:



Latitude:

Longitude:

Vegetation Description: FIR, W. MT. ASH, BLACK ALPINE SEDGE
VEGETATION SCATTERED AROUND SAMPLE POINT

Soil Description: (V. DENSE), DAMP, RED BROWN, SL. SANDY GRAVEL W/ BOULDERS + ORGANICS + HUMUS
TO (MED. DENSE) MOIST, RED BROWN, SL. SILTY, V. SANDY GRAVEL W/ BOULDERS

Vegetation Sample: MY-10-VG (BLACK ALPINE SEDGE)
MY-10_VS (W. MT. ASH)

Soil Sample: MY-10-S (METALS)
MY-10_SMM (MERCURY)

Soil Invertebrate Sample: OCC. ANT

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

Comments:

Authorization:

JUSTICE MINE

Photograph A-22 – September 2, 2013. View from Justice Mine adit downslope. Drainage from adit and surrounding vegetation (common horsetail).

Photograph A-23 – September 2, 2013. View upslope toward adit. Common horsetail sampling near drainage on waste rock.

Photograph A-24 – September 2, 2013. Some of the invertebrates collected from Justice Mine.

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

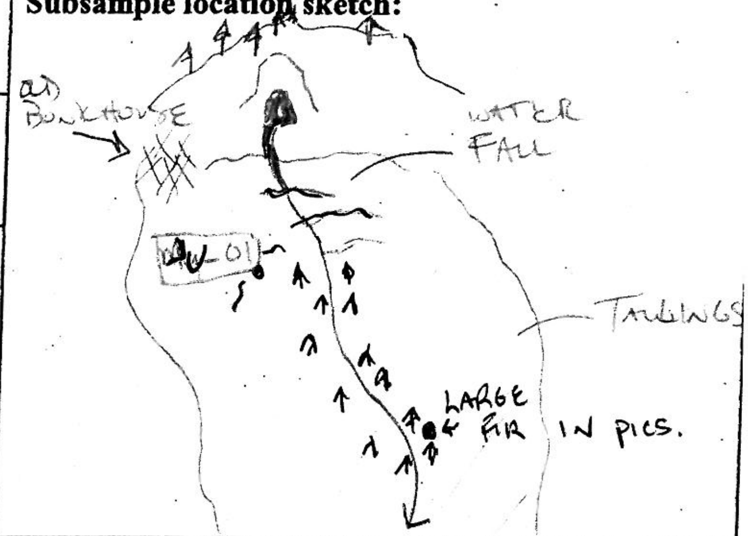
Date/Time:
9/2/13 1300 HRS

Samplers:
WDM / AJW

Sample Location:
JUSTICE MINE
(JMV-01)
CLIMBERS LEFT JUST BELOW ADIT ON WRP

Sample No.: JMV-01

Subsample location sketch:



Topography: 35°

Latitude:

Longitude:

Vegetation Description: HORSE TAIL (COMMON)
FERN, SITKA SEDGE

Soil Description: (LOOSE) MOIST, RED BROWN TO BLACK,
GRAVELLY, SL. SANDY ORGANIC SILT
2" REFUSAL OVER BEDROCK

Vegetation Sample: JMV-01_VS (COMMON HORSE TAIL)
JMV-01_VG

Soil Sample: JMV-01_S (METALS)
JMV-01_SMM (MERCURY)

Soil Invertebrate Sample: CARPENTER ANTS

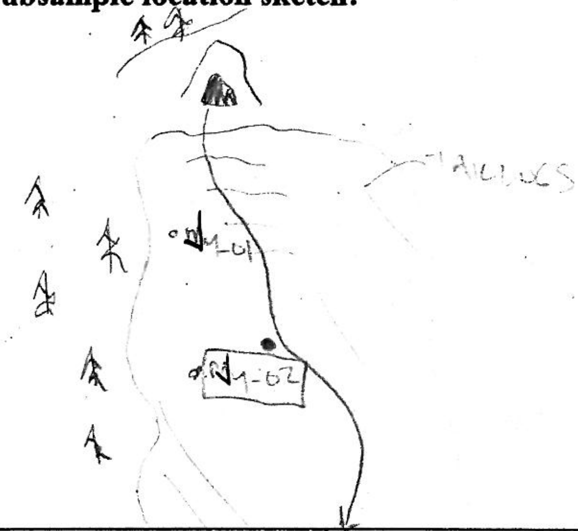
Authorization: WDM! PIC # 6036

NO SECONDARY VEG. SAMPLE DUE TO FERN AND GRASS SPECIES

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time:
9/2/13 1320 HRS

Subsample location sketch:



Samplers:
WDM / AJW

Sample Location:
JUSTICE MINE
(JV-02)
CLIMBERS LEFT DOWNSTREAM
OF MY-01

Sample No.: JV-02

Topography:
50° SLOPE ALONG
DRAINAGE

Latitude:

Longitude:

Vegetation Description:
HORSE TAIL + FERN

Soil Description: (MED. DENSE TO DENSE) MOIST, BROWN
SILTY, V. F. (GRAVELLY SAND
W/ COBBLE + BOULDER (TAILINGS)

Vegetation Sample: JV-02-VS (COMMON HORSETAIL)

Soil Sample: JV-02-S (METALS)
JV-02-S (MERCURY)

Soil Invertebrate Sample:
RED ANTS + SPIDER

JV-II

Authorization: PIC # 6037

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

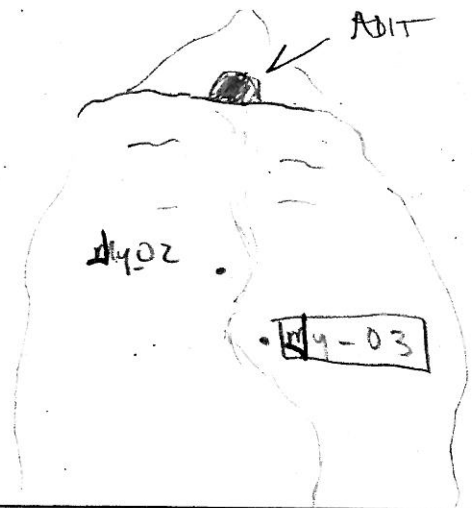
Date/Time: 9/2/13 1340

Samplers: WDM / AJW

Sample Location: JUSTICE (JU-03) CLIMBERS RIGHT, BELOW MY-02

Sample No.: JU-03

Subsample location sketch:



Topography: 45°

Latitude:

Longitude:

Vegetation Description: HORSE TAIL (COMMON)

Soil Description: (LOOSE) MOIST, BROWN, F-C SANDY GRAVEL W/ SILT

Vegetation Sample: JU ~~MY~~ – 03.VS (COMMON HORSE TAIL)

Soil Sample: JU_03-S (METALS)
JU-03-SMM (MERCURY)

Soil Invertebrate Sample: JU-I /NA

Authorization: (WDM) PC# 6038

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

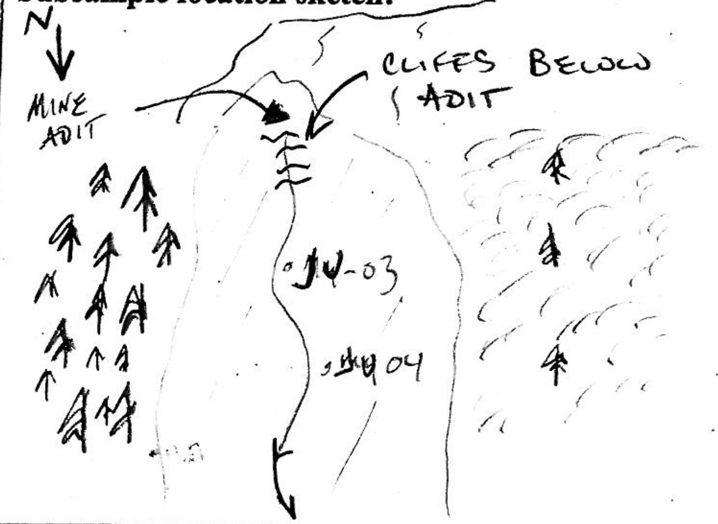
Date/Time: 9/2/13 1440

Samplers: WDM / AJW

Sample Location: JUSTICE (JU-04) ON BEND OF DRAINAGE CLIMBERS RIGHT

Sample No.: JU-04

Subsample location sketch:



Topography: 45°

Latitude:

Longitude:

Vegetation Description: COMMON HORSETAIL
FERN

Soil Description: (LOOSE) DAMP TO MOIST, DRK. BROWN
SL. SILTY F-C GRAVELLY SAND

Vegetation Sample: JU-04-VS (COMMON HORSE TAIL)
JU-04-V6 (FERN) SPINY WOOD FERN

Soil Sample: JU-04-S (METALS)
JU-04-SMM (MERCURY

Soil Invertebrate Sample: BEETLE

Authorization: (WDM) PIC # 6039

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

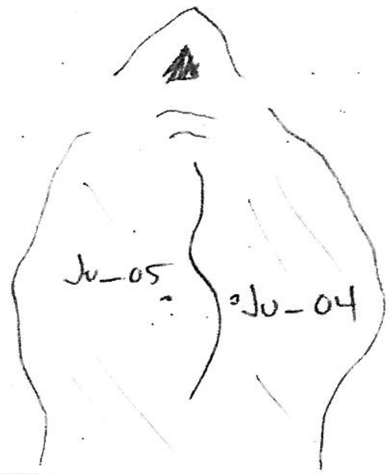
Date/Time: 9/2/13 1450

Samplers: WDM / AJW

Sample Location: JUSTICE (JU-05) OTHERSIDE OF DRAINAGE FROM JU-04

Sample No.: JU-05

Subsample location sketch:



Topography: 45°

Latitude:

Longitude:

Vegetation Description: COMMON HORSE TAIL & FERN

Soil Description: (LOOSE), DAMP TO MOIST, DARK BROWN SL. SILTY F-C SANDY GRAVEL

Vegetation Sample:
JU-05-V5 (COMMON HORSE TAIL)
JU-05-V6 (FERN) SPINY WOOD FERN

Soil Sample:
JU-05-S (METALS)
JU-05-SMM (MERCURY)

Soil Invertebrate Sample:

Authorization: (WDM) PIC# 6040

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time:
8/2/13 1500

Samplers:
WDM / AJW

Sample Location:
JUSTICE
(JU-06)
DOWNSTREAM OF JU-05

Sample No.:
JU-06

Subsample location sketch:

Topography: 45°

Latitude:

Longitude:

Vegetation Description: COMMON HORSETAIL
+
SPINY WOOD FERN

Soil Description: MOIST, DARK BROWN, Sl. SILTY F-C
GRAVELLY SAND

Vegetation Sample: COMMON HORSETAIL + SPINY WOOD FERN
JU-06-V6 (SPINY WOOD FERN)
JU-06-V5 (COMMON HORSE TAIL

Soil Sample: JU-06-S (METALS)
JU-06-SMM (MERCURY

Soil Invertebrate Sample:

Authorization:
(WDM) PIC # 6041

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 9/2/13 1515

Samplers: WDM/AIW

Sample Location: JUSTICE (JU-07) BELOW JU-06

Sample No.: JU-07

Subsample location sketch:

Topography: 40°

Latitude:

Longitude:

Vegetation Description: COMMON HORSE TAIL
FERN
MT. HEMLOCK

Soil Description: (LOOSE), MOIST, GREY BROWN,
F. SANDY SILT W/ F-C SAND
+ BOULDERS

Vegetation Sample: JU-07-V5 (COMMON HORSE TAIL)
JU-07-V6 (FERN)

Soil Sample: JU-07-S (METALS)
JU-07-SMM (MERCURY)

Soil Invertebrate Sample:

Authorization:

PIC # 6013 VIEW UPSLOPE AT JU-07

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

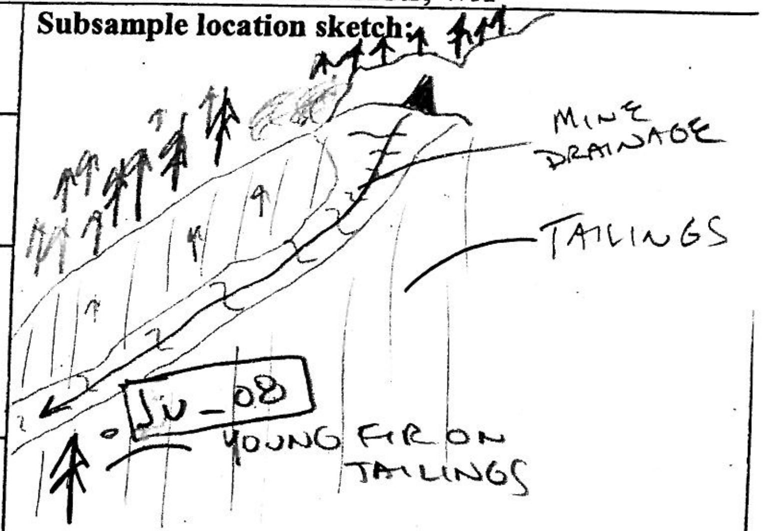
Date/Time: 9/2/13 1525

Samplers: WDM / AJW

Sample Location: (JU-08) JUSTICE DOWNSLOPE JU-07

Sample No.: JU-08

Subsample location sketch:



Topography: 40°

Latitude:

Longitude:

Vegetation Description: FERN, HEMLOCK, COMMON HORSE TAIL (LOOSE), MOIST, GREY BROWN SANDY SILT

Soil Description:

Vegetation Sample: JU-08_V5 (COMMON HORSE TAIL)
JU_08_V6 (FERN) SPINY WOOD

Soil Sample: JU-08-S (METALS)
JU-08-SMM (MERCURY

Soil Invertebrate Sample:

Authorization: PIC # 6044

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time:

9/2/13 1540

Samplers:

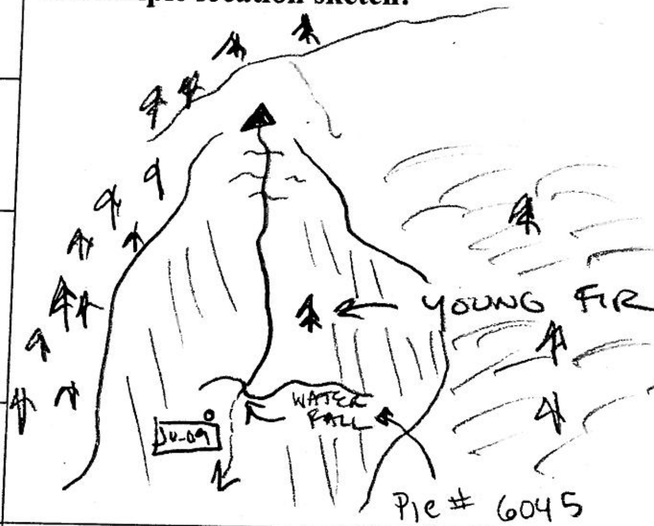
WDM + AJW

Sample Location: JUSTICE MINE (JU-09)

LOCATED AT BOTTOM OF DRAINAGE AT END OF COMMON HORSETAIL

Sample No.: JU-09

Subsample location sketch:



Topography: 40°

Latitude:

Longitude:

Vegetation Description: COMMON HORSETAIL

Soil Description: (SOFT) WET, RED BROWN F. SANDY SILT

Vegetation Sample: JU_09_VS (COMMON HORSETAIL)

Soil Sample: JU-09_S (METALS)

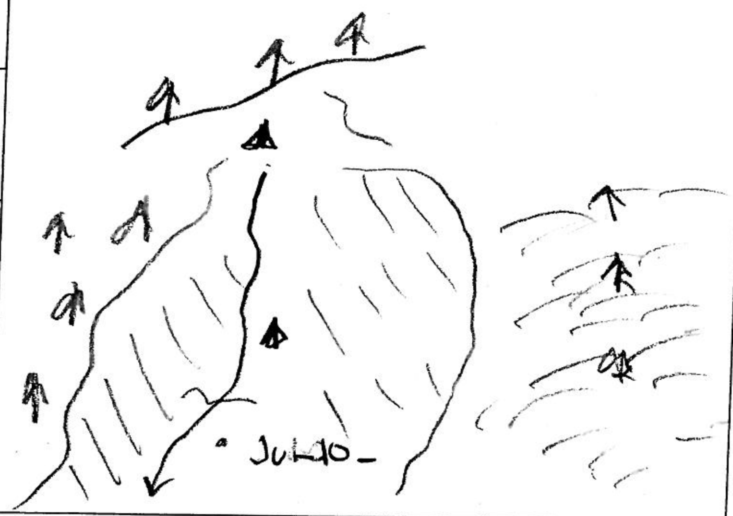
JU-09-SMM (MERCURY)

Soil Invertebrate Sample:

Authorization: PIC # 6045

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 9/2/13 1550	**Subsample location sketch:**
Samplers: WDM + AJW	
Sample Location: JUSTICE MINE (JU-10) ACCROSS DRAINAGE FROM JU-09	
Sample No.: JU-10	



Topography: 40°	**Latitude:**	**Longitude:**

Vegetation Description: COMMON HORSE TAIL

Soil Description: (MED. DENSE), MOIST BROWN F-C SANDY SILTY GRAVEL

Vegetation Sample: JU-10_VS (COMMON HORSETAIL)

Soil Sample: JU-10-S (METALS)
JU-10-SMM (MERCURY)

Soil Invertebrate Sample:

Authorization: (WDM) PIC # 6046

BACKGROUND LOCATIONS

Photograph A-25 – August 20, 2013. Red arrow pointing to background sample location (BG-01).

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time:
8/22/13 1330

Samplers:
ASK/WDM

Sample Location:
Background 01

Sample No.:
BG-01

Subsample location sketch:

Topography: 4296.84' slope ≈ 35°, vegetated hillside	**Latitude:** 965831.36' N	**Longitude:** 1419320.36' E

Vegetation Description: sitka sedge, ferns, pacific bleeding heart
purple mountain heather

Soil Description: moist to wet, brown to lt. brown, very silty gravelly sand
w/ abundant organics

Vegetation Sample:
BG-01-VS = pacific bleedingheart
BG-01-VG = sitka sedge

Soil Sample:
BG-01-S
BG-01-SMM

Soil Invertebrate Sample: three spiders in pitfall traps, no nearby crickets/ants/etc.

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5922 = shows cultus lake in vicinity of BG 01 + 02 locations

~~DSCN 592~~

Comments:

Authorization:

Photograph A-26 – August 20, 2013. Background sample location (BG-02).

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

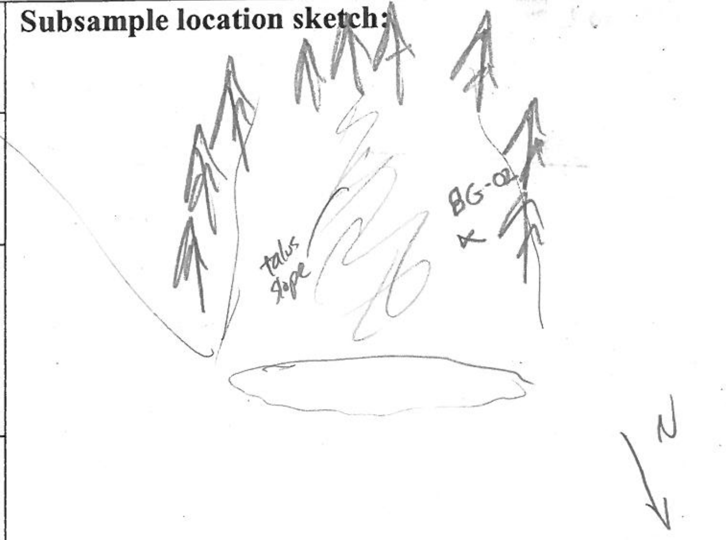
Date/Time: 8/22/13 1150

Samplers: ASR / WDM

Sample Location: Background 02

Sample No.: BG-02

Subsample location sketch:



Topography: 4298.86'
48° slope, vegetated talus rock area

Latitude: 966072.15' N

Longitude: 1419231.95' E

Vegetation Description: sitka sedge, edible thistle, ferns

Soil Description: 3" duff followed by Damp, brown gray, ~~st~~ silty fine sand
5" refusal

Vegetation Sample: ~~[illegible]~~ BG-02-VS = edible thistle
BG-02-VG = sitka sedge

Soil Sample:
BG-02-S
BG-02-SMM

Soil Invertebrate Sample: spiders in pitfall traps, several grasshopers caught by sweep net within the vicinity of sampling area.

BG-02-I

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5922 = shows cultus lake in vicinity of background 01 + 02 locations,
~~DSCN 5932~~

DSCN 5969 = B6-02 sample area, looking upslope
5970 = B6-02 area near cultus lake

Comments:

Authorization:

Photograph A-27 – August 25, 2013. Background sample location (BG-03).

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

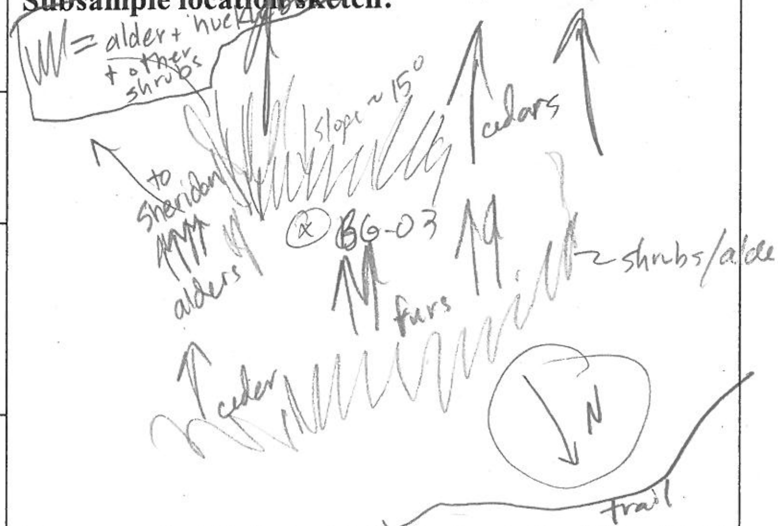
Date/Time:
8/25/13 1355

Samplers:
ASK/WDM

Sample Location:
BACKGROUND 03

Sample No.:
BG-03

Subsample location sketch:



Topography:
Slope ~ 15° downhill

Latitude:

Longitude:

Vegetation Description: Alders, ferns, pacific bleeding heart, furs, black huckelberry, lillys, moss, large cedars
NO GRASSES / SEDGES IN THIS AREA(s) [we tried several different locations for BG samples]

Soil Description: 6" duff followed by moist, lt. redish brown silty fine sand w/scattered organics

Vegetation Sample:
BG-03-VS

Soil Sample:
BG-03-S
BG-03-S MM

Soil Invertebrate Sample: NONE IN PITFALL TRAPS.
Some centipedes, spiders, potatoe (?) bugs caught with forceps in vicinity.
Not much invert activity in area

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

DSCN 5998

Comments:

Authorization:

*Missing photograph. Background sample location BG-04 missing photo. Landscape and vegetation very similar to BG-03.

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

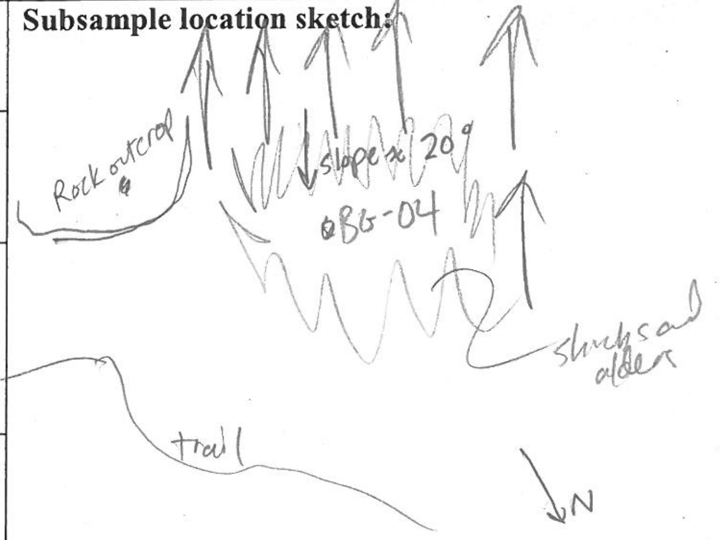
Date/Time: 8/25/13 1520

Samplers: ASK/WDM

Sample Location: BACKGROUND 04

Sample No.: BG-04

Subsample location sketch:



Topography: slope ~ 20°

Latitude:

Longitude:

Vegetation Description: large cedars and firs, alders, black huckleberry, ferns, devils club
salmonberry
NO GRASS/SEDGE TO SAMPLE.

Soil Description:

Vegetation Sample: BG-04-VS = black huckleberry

Soil Sample:

Soil Invertebrate Sample: NONE IN PITFALL TRAPS,
spider caught w/ forceps
BG-04-I

Authorization:

Photo Log:

Comments:

Authorization:

Photograph A-28 – September 2, 2013. Background sample location (BG-GB-01).

BG-GB1 BACKGROUND SAMPLE 1

8/31/13 1530

WAYPOINT 012

TOPO	LAT	LONG
—	N 47.98043°	W 121.35767°

boulder field w/ veg. Slope ~30°

VEG

sitka sedge, black huckleberry, saxifrage, hemlock, ciders, other shrubs

SOIL

VEG SAMPLE

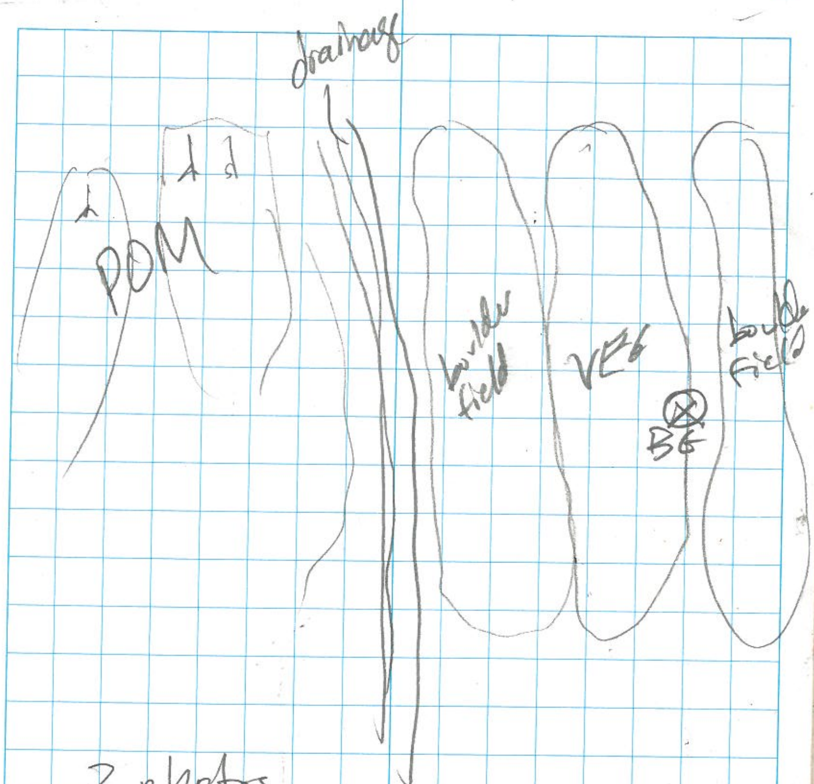
BG-GB1-VS = black huck
BG-GB1-VG = sitka sedge

SOIL SAM

BG-GB1-S
BG-GB1-SMM

INVERTS

Grasshoppers, ants (BG-GB1-I)



2 photos
CIMG 0511-0512

AFTER COLLECTING INVERTS AT BG1, WE HIKED BACK TO CAMP @ 1630

Photograph A-29 – September 2, 2013. Background sample location (BG-GB-02).

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

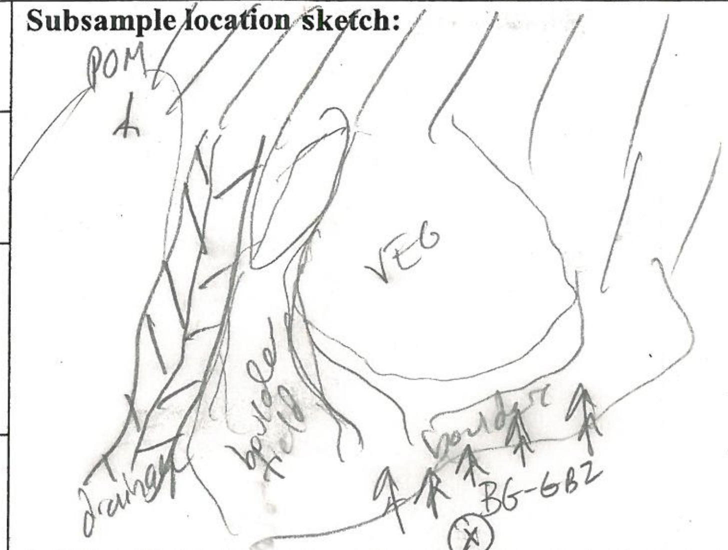
Date/Time:
9/2/13 0800

Samplers:
ASK / NWG

Sample Location:
BACKGROUND 02
- GLACIER BASIN

Sample No.:
BG-GB2-
WAYPOINT 022

Subsample location sketch:



Topography: 4492'
Rocky/talus area w/ lots of veg. Slope ~20°

Latitude:
N 47.97793°

Longitude:
W 121.35809°

Vegetation Description: cedars, firs, black huckleberry, sitka sedge, saxifrage,
SAW MARMOT EATING BLACK HUCKLEBERRYS

Soil Description: Damp, brown sl. silty sandy gravel w/ abundant organics

Vegetation Sample:
BG-GB2-VS = black huckleberry
BG-GB2-VG = sitka sedge

Soil Sample:
BG-GB2-S
BG-GB2-SMA

Soil Invertebrate Sample: ~~SAW MARMOT~~
Lots of grasshoppers, some spiders and ants
Collected over 10 grams btwn 0800 - 1010.
BG-GB2-I 0800

Authorization:

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Photo Log:

CIMG 0535 - background sample area

0536 - view downslope

0537 - view upslope

3 pages

Comments:

Authorization:

Photograph A-30 – September 1, 2013. Background sample location (BG-07).

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

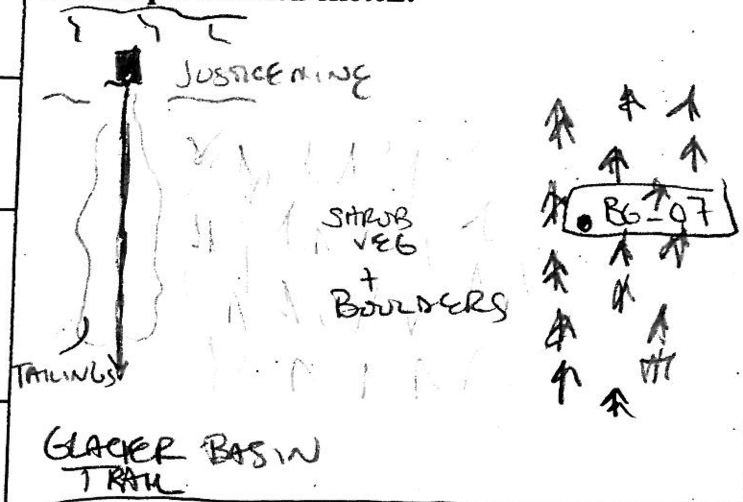
Date/Time: 9/1/3 1255

Samplers: WDM/AJW

Sample Location: BACKGROUND 07 (BG-07)

Sample No.: BG-07

Subsample location sketch:



Topography: 35°

Latitude:

Longitude:

Vegetation Description: SCATTERED HUCKLEBERRY PLANTS + FERN

Soil Description: (V. LOOSE) DRY YELLOW BROWN V. SILTY F. SAND w/ COBBLES

Vegetation Sample: BG-07-VS (HUCKLEBERRY)

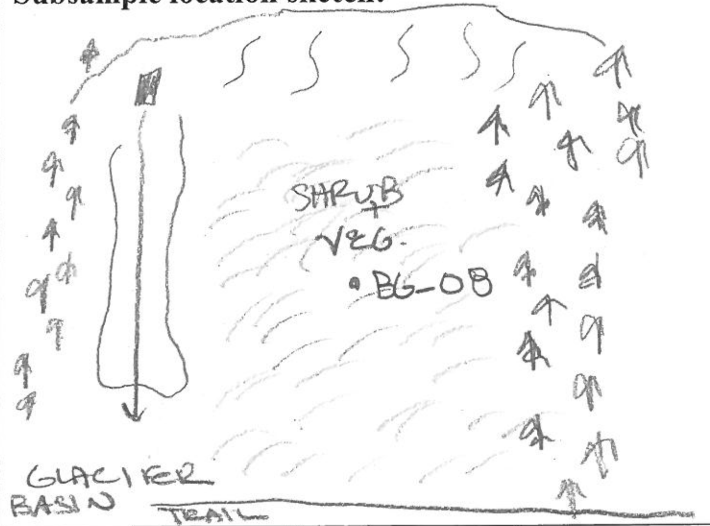
Soil Sample: BG-07-S (METALS)
BG-07-SMM (MERCURY)

Soil Invertebrate Sample: BG-07-I
CRICKETS, ANTS, BEETLES, + SPIDERS

Authorization: (WDM) PIC # 6027

Photograph A-31 – September 1, 2013. Background sample location (BG-08).

FIELD FORM
TERRESTRIAL ECOLOGICAL SAMPLING – MCMA SITE, WA

Date/Time: 9/1/13 1510	**Subsample location sketch:** 
Samplers: WDM + AJW	
Sample Location: BACKGROUND 8 (BG-08)	
Sample No.: BG - 08	
Topography: 35°	**Latitude:** / **Longitude:**
Vegetation Description: W. MT. ASH, UNIDENTIFIED SHRUB, CEDARS, FIRS	
Soil Description: (V. LOOSE) DRY BROWN, SILTY F. SAND.	
Vegetation Sample: BG - 08 - VS (W. MT. ASH)	
Soil Sample: BG-08-S (METALS) BG-08-SMM (MERCURY)	
Soil Invertebrate Sample: ANTS, SPIDERS, CRICKETS, & BEETLES	

Authorization:

APPENDIX B
Chemical Data Quality Review and Laboratory Reports

(Laboratory Reports Provided on CD)

APPENDIX B
CHEMICAL DATA QUALITY REVIEW
AND LABORATORY REPORTS

CHEMICAL DATA QUALITY REVIEW

Eighty-six soil samples, twelve invertebrate samples, and ninety-nine plant samples were collected from July through September 2013. The samples were submitted for chemical analysis to Analytical Resources Inc. (ARI), of Tukwila, Washington and Brooks Rand Labs (BRL), of Seattle, Washington. A summary of the sample names, matrices, associated laboratory reports, and analytical tests are provided in Tables B-1 and B-2.

Quality assurance/quality control (QA/QC) reviews of laboratory procedures were performed on an ongoing basis by the laboratories. Hart Crowser reviewed the data, using laboratory quality control results summary sheets and raw data, as required, to ensure they met data quality objectives for the project. Data review followed the Monte Cristo Mining Area, Remediation Investigation Phase 3, Sampling and Analysis Plan/Quality Assurance Project Plan, dated May 31, 2013, and the format outlined in the National Functional Guidelines for Inorganic Data Review (EPA 2010) modified to include specific criteria of the individual analytical methods. The following elements were reviewed:

- Sampling documentation;
- Holding times and receiving temperatures;
- Reporting limits;
- Laboratory method blanks (metals only);
- Laboratory control sample/laboratory control sample duplicate (LCS/LCSD) recoveries (metals only);
- Matrix spike/matrix spike duplicate (MS/MSD) recoveries (metals only);
- Post-digestion spike (PS) recoveries (metals only);
- Certified reference material (CRM) recoveries and standard reference material (SRM) recoveries;
- Laboratory replicate relative standard deviations (RSDs); and
- Laboratory duplicate relative percent differences (RPDs).

The data were acceptable for use with qualification as described in the sections below. Full laboratory results are presented at the end of this appendix.

Sample Naming Conventions

Samples collected from a sampling location had the same date and time, and were generally distinguished by the sample name. Soil samples submitted to ARI were identified with a –S in the sample name (e.g. BG-01-S). The same soil samples were submitted to BRL with a –SMM in the sample name (e.g. BG-01-SMM). Plant samples submitted to BRL had a –VG or –VS in the sample name (e.g. BG-01-VG and BG-01-VS). Invertebrate samples had a –I in the sample name (e.g. BG-02-I).

Sample Receiving Discrepancies

BRL 1335038: The biota samples were included on the Chain of Custody form and marked for analysis. The laboratory was contacted and the biota samples were placed on hold. The Chain of Custody requested analysis for "metals." The laboratory was contacted and informed that methyl mercury and total recoverable selenium only were to be analyzed. The laboratory was contacted at a later date and the biota samples were prepared and analyzed between December 31, 2013 and January 17, 2014.

BRL 1335038: The soil samples were shipped in resealable plastic bags. Samples OB-02-SMM and OB-04-SMM had water seepage into the bags during transport. Results for methylmercury and selenium for those samples were qualified as estimated (J) due to the potential for cross-contamination.

BRL 1336035: The invertebrate samples were included on the Chain of Custody and marked for analysis. The laboratory was contacted and the invertebrate samples were placed on hold. The laboratory was contacted at a later date and the invertebrate samples were prepared and analyzed between December 31, 2013 and January 17, 2014.

BRL 1336036: The sample containers were listed individually on the Chain of Custody with different sampling times for each container. The containers were entered into the laboratory LIMS as separate samples. The Chain of Custody incorrectly marked the samples for arsenic and selenium speciation. Those analyses were not performed.

BRL 1336037: The invertebrate samples were marked for analysis on the Chain of Custody. The laboratory was contacted and the invertebrate samples were placed on hold. The laboratory was contacted at a later date and the invertebrate samples were prepared and analyzed between December 31, 2013 and January 17, 2014.

ARI XC92 and XC93: The Chain of Custody was submitted without total organic carbon (TOC) or pH analyses marked. The laboratory added TOC and pH to the Chain of Custody.

ARI XE13: Sample BG-07-S was misidentified on the Chain of Custody as BG-07. The sample identification was hand-corrected on the laboratory reports.

Holding Times, Preservation, and Receiving Temperatures

The sample coolers and samples were received intact at the laboratory and were within the required 0 to 6 degrees Celsius.

Sample holding times were evaluated by comparing the sample collection dates to the sample extraction dates and analysis dates, with the following exceptions:

- ARI XC93: Samples OB-SF and SH-SF were received at the laboratory eight days after sample collection. Holding times for ammonia, nitrate, and nitrite were exceeded. Results for those analytes were qualified as estimated (J) due to the holding time exceedances.

- ARI XE13: Sample My-SF was received at the laboratory fewer than 48 hours before the holding time expired for ammonia, nitrate, and nitrite. Sample My-SF was analyzed past the holding time for ammonia, nitrate, and nitrite, and results for those analytes were qualified as estimated (J) due to the holding time exceedances.

Sample preservation met method requirements.

Reporting Limits

Reporting limits were elevated in some samples because of sample dilution. Such increases in the reporting limits are an unavoidable but acceptable consequence of sample dilution that enables quantification of target analytes within the calibration range of the instrument, or that reduces the interferences, thereby enabling quantification of target analytes.

Analyte detections between the method detection limit (MDL) and method reporting limit (RL) were qualified by the laboratory with J (ARI) or B (BRL). The J or B qualifier was changed to T to be consistent with the Washington State Department of Ecology Environmental Information Management (EIM) database reporting requirements.

Soil Samples

EPA Method 1630 for Methylmercury

Laboratory Blanks

Method blanks were analyzed at the required frequency. Sample results were method-blank corrected.

- B131524-BLK2: This method blank had a detection for methylmercury above the RL, which was determined to be a Grubb's Outlier. The MB was not reported or used in any blank-correction calculations.

- B131543-BLK2: This method blank had a detection for methylmercury above the RL, which was determined to be a Grubb's Outlier. The MB was not reported or used in any blank-correction calculations.

- 1333703-CCB1: The continuing calibration blank (CCB) contained methylmercury above the MRL. No sample results were reported which were bracketed by this CCB.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The MS and MSD recoveries and RPDs were within control limits with the following exceptions:

- SH-01-SMM MS/MSD: The MS recovery failed low, while the MSD recovery was within control limits. The RPD exceeded the control limits. The laboratory qualified the source sample with N. The N qualifier was changed to J (estimated).

- POM-10-SMM MS/MSD: The MS and MSD recoveries failed low (below 30 percent). The source sample, sample duplicate, and MS/MSD results for methylmercury were below the MDL. The samples were reanalyzed with similar results. A post-spike was within control, indicating a matrix interference. The laboratory rejected the results (R) for POM-10-SMM. The sample preparation technician noted that the sample had an orange filtrate. This same orange filtrate was observed in samples POM-8-SMM, ND-03-SMM, ND-04-SMM, ND-05-SMM, ND-06-SMM, and ND-07-SMM. The laboratory reported those samples as estimates (J). All detected results in this batch were qualified as estimated with a low bias (JG) [BG-GB1-SMM, ND-01-SMM, ND-02-SMM, ND-03-SMM, ND-06-SMM, ND-08-SMM, POM-1-SMM, POM-2-SMM, POM-4-SMM, POM-5-SMM, POM-6-SMM, and POM-9-SMM]. All non-detect results that exhibited an orange tint were rejected (R) [ND-04-SMM, ND-05-SMM, ND-07-SMM, POM-8-SMM, and POM-10-SMM]. All non-detect results that did not exhibit an orange tint were qualified as estimated at the detection limit (UJ) [BG-GB2-SMM, POM-3-SMM and POM-7-SMM].

- My-01-SMM MS/MSD: The MS and MSD recoveries failed low (below 30 percent). The source sample, sample duplicate, and MS/MSD results for methylmercury were below the MDL. The sample preparation technician verbally stated that all samples from the batch (B131543) had an "orange-ish tinge." Two out of the three MS/MSD sets from this batch were within control, so the laboratory only qualified sample My-01-SMM as R (rejected), but noted that the other samples in the batch may also be affected by the matrix suppression. All detected results in this batch were qualified as estimated with a low bias (JG) [My-03-SMM, My-04-SMM, My-06-SMM, My-07-SMM, My-09-SMM, Ju-01-SMM, Ju-03-SMM, Ju-04-SMM, Ju-05-SMM, Ju-06-SMM, Ju-07-SMM, Ju-08-SMM, Ju-09-SMM, BG-07-SMM, and BG-08-SMM]. All non-detect results associated with the Mystery Mine samples were rejected [My-01-SMM, My-02-SMM, My-05-SMM, My-08-SMM, and My-10-SMM]. All non-detect results that were not associated with the Mystery Mine samples were qualified as estimated at the detection limit (UJ) [Ju-02-SMM and Ju-10-SMM].

Certified Reference Material

All CRM recoveries were within control limits.

Laboratory Duplicate

Laboratory duplicate RPDs were within QAPP and laboratory control limits with the following exceptions:

- OB-07-SMM Dup: The RPD was 55 percent, and the result for methylmercury in the sample was qualified by the laboratory with M. The M qualifier was changed to J (estimated).

- SH-01-SMM Dup: The RPD was 128 percent. The sample and duplicate results were less than five times the RL, and not qualified.

- POM-2-SMM Dup: The RPD was 39 percent, and the result for methylmercury in the sample was qualified by the laboratory with M. The M qualifier was changed to J (estimated).

- BG-08-SMM Dup: The RPD was 44 percent, and the result for methylmercury in the sample was qualified by the laboratory with M. The M qualifier was changed to J (estimated).

EPA Draft Method 1638 for Total Selenium

Laboratory Blanks

Method blanks were analyzed at the required frequency. Sample results were method-blank corrected.

- 1300702-ICB2, 1300702-ICB3, and 1300702-IBL1: Selenium results in these instrument control blanks (ICBs) were greater than the MRL. The blanks did not bracket any reported data, and no results were qualified.

- 1300712-ICB2, 1300712-ICB3, 1300712-IBL1, 1300712-IBL4, and 1300712-CCB1: Selenium results in these instrument blanks were greater than the low calibration standard. The blanks did not bracket any reported data, and no results were qualified.

Laboratory Control Sample (LCS)

All LCS recoveries were within control limits.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The MS and MSD recoveries and RPDs were within control limits with the following exceptions:

- BG-07-SMM MS/MSD: During the sample digestion procedure, the MSD demonstrated a mass loss above the laboratory acceptance criteria. However, as the MSD recoveries and RPD were within control, there appeared to be no selenium loss during the digestion. No sample results were qualified.

Laboratory Duplicate

Laboratory duplicate RPDs were within control limits.

Sample Batch Notes

- B131827: There were apparent interferences with the preferred isotope (Se78) for these samples. Therefore, the laboratory reported from the Se77 isotope.

EPA Method 6010C for Total Antimony, Arsenic, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Nickel, and Zinc

Laboratory Blanks

No blank contamination was detected.

Laboratory Control Sample (LCS)

All LCS and LCSD recoveries were within control limits. RPDs between the LCS and LCSD were also within control limits.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The MS and MSD recoveries and RPDs were within control limits with the following exceptions:

- OB-01-S MS/MSD: The recoveries for arsenic, iron, and manganese fell outside the control limits. The recovery for antimony failed low. The amounts of arsenic, iron, and manganese in the source sample were greater than the amount spiked, and sample results were not qualified. The post-spike results for antimony were within control, indicating a matrix effect. Antimony results in all associated samples were qualified as estimated (J) [OB-01-S, OB-02-S, OB-03-S, OB-04-S, OB-06-S, OB-10-S, OB-05-S, OB-07-S, OB-08-S, OB-09-S, BG-02-S, and BG-01-S].

- SH-01-S MS/MSD: The recoveries for arsenic, iron, manganese, and zinc fell outside the control limits. The recovery for antimony failed low. The amounts of arsenic, iron, manganese, and zinc in the source sample were greater than the amount spiked, and sample results were not qualified. The post-spike results for antimony were within control, indicating a matrix effect. Antimony results in all associated samples were qualified as estimated (J) [SH-01-S, SH-02-S, SH-03-S, SH-04-S, SH-06-S, SH-10-S, SH-05-S, SH-07-S, SH-08-S, SH-09-S, BG-03-S, and BG-04-S].

- My-01-S MS/MSD: The recoveries for arsenic, copper, iron, manganese, and lead fell outside the control limits. The recovery for antimony failed low. The recoveries for zinc were within control limits, but the results were not applicable due to the high amount of zinc in the source sample. The amounts of arsenic, copper, iron, manganese, and lead in the source sample were greater than the amount spiked, and sample results were not qualified. The post-spike results for antimony were within control, indicating a matrix effect. Antimony results in all associated samples were qualified as estimated (J) [My-01-S, My-02-S, My-03-S, My-04-S, My-05-S, My-06-S, My-07-S, My-08-S, My-09-S, My-10-S, and BG-07-S].

- BG-08-S MS/MSD: The recoveries for iron fell outside the control limits. The recoveries for antimony failed low. The recoveries for manganese were within control limits, but the results were not applicable due to the high levels of manganese in the source sample. The amount of iron in the source sample was greater than the amount spiked, and sample results were not qualified. The post-spike results for antimony were within control, indicating a matrix effect. Antimony results in all associated samples were qualified as estimated (J) [BG-08-S, BG-GB1-S, BG-GB2-S, JU-01-S, JU-02-S, JU-03-S, JU-04-S, JU-05-S, JU-06-S, JU-09-S, JU-07-S, and JU-08-S].

- JU-10-S MS/MSD: The recoveries for arsenic, copper, iron, manganese, lead, and zinc fell outside the control limits. The recovery for antimony failed low. The amounts of arsenic, copper, iron, manganese, lead, and zinc in the source sample were greater than the amount spiked, and sample results were not qualified. The post-spike results for antimony were within control, indicating a matrix effect. Antimony results in all associated samples were qualified as estimated (J) [JU-10-S,

POM-1-S, POM-2-S, POM-3-S, POM-4-S, POM-5-S, POM-6-S, POM-7-S, POM-8-S, POM-9-S, and POM-10-S].

- ND-01-S MS: The recoveries for arsenic, cadmium, copper, iron, manganese, lead, and zinc fell outside the control limits. The recovery for antimony failed low. The amounts of arsenic, copper, iron, manganese, lead, and zinc in the source sample were greater than the amount spiked, and sample results were not qualified. The post-spike results for antimony and cadmium were within control, indicating a matrix effect. Antimony results in all associated samples were qualified as estimated (J) [ND-01-S, ND-02-S, ND-03-S, ND-04-S, NH-05-S, ND-06-S, ND-07-S, and ND-08-S.] The recovery for cadmium failed high, and cadmium results in the source sample, ND-01-S were qualified as estimated (J).

Laboratory Duplicate

Laboratory duplicate RPDs were within control limits or not applicable with the following exceptions:

- OB-01-S Dup: The RPD for arsenic exceeded the method control limits, but fell within the QAPP control limits. Sample results were not qualified.

- My-01-S Dup: The RPD for manganese exceeded the method control limits, but fell within the QAPP control limits. Sample results were not qualified.

- ND-01-S Dup: The RPDs for cadmium and zinc exceeded the method and QAPP control limits. The results for cadmium and zinc were qualified as estimated (J) in ND-01-S.

EPA Method 7471A for Total Mercury

Laboratory Blanks

No blank contamination was detected.

Laboratory Control Sample (LCS)

All LCS and LCSD recoveries were within control limits. RPDs between the LCS and LCSD were also within control limits.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The MS and MSD recoveries and RPDs were within control limits with the following exceptions:

- My-01-S MS: The MS recovery for mercury failed high. The amount of mercury in the source sample was greater than the amount spiked, and sample results were not qualified.

- ND-01-S MS: The MS recovery for mercury failed high. The amount of mercury in the source sample was greater than the amount spiked, and sample results were not qualified.

Laboratory Duplicate

Laboratory duplicate RPDs were within control limits or not applicable when sample and duplicate results were less than five times the RL.

EPA Method 200.8 for Total Arsenic and Thallium

Laboratory Blanks

No blank contamination was detected.

Laboratory Control Sample (LCS)

All LCS and LCSD recoveries were within control limits. RPDs between the LCS and LCSD were also within control limits.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The MS and MSD recoveries and RPDs were within control limits with the following exception:

- ND-01-S MS: The recovery for thallium failed low. The post-spike was within control, indicating a matrix effect. The result for thallium in ND-01-S was qualified as estimated (J).

Laboratory Duplicate

Laboratory duplicate RPDs were within control limits or not applicable when sample and duplicate results were less than five times the RL.

Conventional Analyses

Analytical Methods

Total solids were prepared and analyzed following Standard Method 2540G for samples analyzed at BRL. Total solids were prepared and analyzed following SM 2540B for samples analyzed at ARI. pH was analyzed following EPA Method 9045. TOC was prepared and analyzed following Plumb, 1981. Cation Exchange Capacity was analyzed by EPA Method 9080. Ammonia was analyzed following EPA Method 350.1 modified. Nitrate and nitrite were analyzed following EPA Method 353.2. Orthophosphorus was analyzed following EPA Method 365.2. Total Kjeldahl Nitrogen (TKN) was analyzed following EPA Method 351.2.

Laboratory Blanks

No blank contamination was detected for TOC, ammonia, nitrate, nitrite, cation exchange capacity, orthophosphorus, TKN, or total solids by SM 2540B with the following exception:

- MB-090913: The MB had a detection for ammonia at the reporting limit. The result for ammonia in the associated sample, My-SF, was greater than five times the amount in the MB, and not qualified. The result for ammonia in the associated sample, JU-SF, was less than five times the amount in the MB and qualified as non-detect (U).

Laboratory Control Sample (LCS)

All LCS and LCSD recoveries were within control limits for pH, orthophosphorus, TKN, and TOC.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The MS and MSD recoveries and RPDs were within control limits for ammonia, nitrate, nitrite, TKN, and TOC.

Laboratory Duplicate

Laboratory duplicate RPDs were within control limits or not applicable for pH, cation exchange capacity, TKN, and total solids by SM 2540G with the following exception:

- OB-SF Dup: The RPD for TKN exceeded the control limits. The sample results were less than five times the MRL and not qualified.

Standard Reference Material

All SRM recoveries were within control limits for TOC, nitrate, nitrite, TKN, orthophosphorus, and ammonia.

Laboratory Replicate

Laboratory replicate Relative Standard Deviations (RSDs) were within control limits for TOC and total solids by SM 2540B.

- My-SF: The RSD for ammonia exceeded the control limits. The results for ammonia in My-SF were qualified as estimated (J).

- My-SF: The RSD for nitrate and nitrite exceeded the control limits. The sample results for nitrate and nitrite were less than five times the MRL and not qualified.

Tissue Samples

EPA Method 1631 for Total Mercury

Laboratory Blanks

Method blanks were analyzed at the required frequency. Sample results were method-blank corrected.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

All MS and MSD recoveries were within control limits. RPDs between the MS and MSD were also within control limits.

Laboratory Duplicate

Laboratory duplicate RPDs were within control limits with the following exceptions:

- BG-04-VS Dup: The RPD was 53 percent and the result for mercury in the sample was qualified by the laboratory with M. The M qualifier was changed to J (estimated).

Certified Reference Material

All CRM recoveries were within control limits.

EPA Method 1638 for Total Silver, Aluminum, Arsenic, Barium, Beryllium, Calcium, Cadmium, Cobalt, Chromium, Copper, Iron, Potassium, Magnesium, Manganese, Sodium, Nickel, Lead, Antimony, Selenium, Thallium, Vanadium, and Zinc

Laboratory Blanks

Method blanks were analyzed at the required frequency. Sample results were method-blank corrected.

- 1400007-ICB2 and 1400007-ICB3: The ICBs analyzed on January 3, 2014 had results for arsenic above the low calibration standard. No samples were associated with those blanks, and no results were qualified.

- 1400020-ICB2: The ICB analyzed on January 8, 2014 had results for aluminum and manganese above the low calibration standard. No samples were associated with that ICB, and no results were qualified.

- 1400020-CCBI and 1400020-CCBM: The CCBs analyzed on January 8, 2014 had concentrations for manganese above the low calibration standard. All samples bracketed by these CCBs were greater than ten times the concentration in the CCBs, and no data was qualified.

- 1400020-CCBO, 1400020-CCBP, and 140020-CCBQ: The CCBs analyzed on January 8, 2014 had concentrations for Vanadium above the low calibration standard. These CCBs were not associated with the samples, and no results were qualified.

- B132238-BLK1: This method blank had a detection for zinc above the RL, which was determined to be a Grubb's Outlier. The MB was not used in any blank-corrected calculations.

- 1400027-ICB2: The ICB analyzed on January 10, 2014 had results for chromium and iron above the low calibration standard. No samples were associated with that ICB, and no results were qualified.

- 1400041-ICB3: The ICB analyzed on January 17, 2014 had a concentration for selenium above the low calibration standard. No samples were associated with that ICB, and no results were qualified.

- 1400043-ICB2: The ICB analyzed on January 21, 2014 had a concentration for antimony above the low calibration standard. No samples were associated with that ICB, and no results were qualified.

- 1400043-CCBE through 1400043-CCBM: The CCBs analyzed on January 21, 2014 had concentrations for antimony above the low calibration standard. This was the third analysis of these samples. Associated samples with concentrations greater than the MRL but less than ten times the amount in the bracketing CCBs were qualified by the laboratory with J. The results for antimony were qualified as estimated with a potential high bias (JL) [BG-GB2-I, Ju-01-VS, My-03-VG, My-03-VS, ND-04-VG, ND-04-VS, ND-06-VG, and ND-07-VG].

Laboratory Control Sample (LCS)

All LCS and LCSD recoveries were within control limits. RPDs between the LCS and LCSD were also within control limits.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

All MS and MSD recoveries and RPDs were within control limits with the following exceptions:

- SH-I MS/MSD: The recovery for zinc in the MS fell below the control limits, while the MSD was within control. The recoveries for aluminum, arsenic, iron, potassium, and manganese were not reported in the MS or MSD. The amounts of zinc, aluminum, arsenic, iron, potassium, and manganese in the source sample were greater than the amount spiked, and no results were qualified.

- BG-02-VG MS/MSD: The recoveries for potassium and manganese were not reported in the MS or MSD. The amounts of potassium and manganese in the source sample were greater than the amount spiked, and no results were qualified.

- POM-6-VS MS/MSD: The recoveries for aluminum, calcium, potassium, and manganese were not reported in the MS or MSD. The amounts of aluminum, calcium, potassium, and manganese in the source sample were greater than the amount spiked, and no results were qualified.

- My-09-VS MS/MSD: The recoveries for calcium, potassium, and manganese were not reported in the MS or MSD. The amounts of calcium, potassium, and manganese in the source sample were greater than the amount spiked, and no results were qualified.

- BG-GB1-I MS/MSD: The recovery for antimony in the MS fell below the control limits, while the MSD was within control. The recoveries for aluminum, potassium, manganese, and lead were not reported in the MS or MSD. The recovery for copper was not reported in the MSD, though copper recoveries were in control in the MS. The amounts of aluminum, antimony, copper, potassium, manganese, and lead in the source sample were greater than the amount spiked, and no results were qualified.

Laboratory Duplicate

Laboratory duplicate RPDs were within control limits with the following exceptions:

- SH-I Dup: The RPD for silver exceeded the control limit. The sample and duplicate results were less than five times the MRL and no results were qualified.

- My-09-VS Dup: The RPDs for cadmium and thallium exceeded the control limits. The sample and duplicate results were less than five times the MRL and no results were qualified.

Certified Reference Material

All CRM recoveries were within control limits of 75 to 125 percent with the following exceptions:

- NIST 1547: For the analysis on January 8, 2014, the recoveries for aluminum and vanadium failed low. Nickel did not recover. The certified values for nickel and vanadium are less than five times the MRLs. The historical laboratory recoveries for aluminum and nickel were comparable to these results. The LCS and MS recoveries for aluminum, nickel, and vanadium were within control, and additional SRM recoveries for nickel and vanadium were within control. No sample results were qualified.

- NIST 1547: For the analysis on January 10, 2014, the recovery for chromium failed low. The result was comparable to historical laboratory recoveries. A second SRM (TORT-3) also failed low for chromium. The LCS and MS recoveries were within control, and no sample results were qualified.

Internal Standards

- Sequence 1400043: Several Indium internal standard (IS) recoveries exceeded the acceptance criteria. Associated samples, blanks, QC samples, and continuing calibration verifications (CCVs) also had elevated IS recoveries. As all CCVs and QC sample results met acceptance criteria, no sample qualifications were made.

EPA Method 1630 for Methylmercury

Laboratory Blanks

Method blanks were analyzed at the required frequency. Sample results were method-blank corrected.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The MS and MSD recoveries and RPDs were within control limits.

Certified Reference Material

All CRM recoveries were within control limits.

Laboratory Duplicate

Samples and duplicates were non-detect, therefore the RPDs were not applicable.

Total Solids by SM2540G

Laboratory Duplicate

Laboratory duplicate RPDs were within control limits.

Table B-1 - Monte Cristo Soil Sample Analysis Summary

Sample ID	Sample Date	Sample Time	Matrix	Analysis: Total Metals	Methyl Hg by EPA 1630 modified	Selenium by EPA draft Method 1638, modifie	Total Organic Carbon	pH	Total solids by SM 2540G	Soil Fertility	Lab Report	DV	Notes
BG-01-S	8/22/2013	1330	SOIL	X			X	X			XC92	X	
BG-01-SMM	8/22/2013	1330	SOIL		X				X		1335038	X	
BG-02-S	8/22/2013	1150	SOIL	X			X	X			XC92	X	
BG-02-SMM	8/22/2013	1150	SOIL		X				X		1335038	X	
BG-03-S	8/25/2013	1355	SOIL	X			X	X			XC93	X	
BG-03-SMM	8/25/2013	1355	SOIL		X				X		1335038	X	
BG-04-S	8/25/2013	1520	SOIL	X			X	X			XC93	X	
BG-04-SMM	8/25/2013	1520	SOIL		X				X		1335038	X	
BG-07-S	9/1/2013	1255	SOIL	X			X	X			XE13	X	COC had incorrect sample name (BG-07). Hand corrected and scanned revised pages.
BG-07-SMM	9/1/2013	1255	SOIL		X	X					1336036	X	
BG-08-S	9/1/2013	1510	SOIL	X			X	X			XE14	X	
BG-08-SMM	9/1/2013	1510	SOIL		X	X					1336036	X	
BG-GB1-S	8/31/2013	1530	SOIL	X			X	X			XE14	X	
BG-GB1-SMM	8/31/2013	1530	SOIL		X	X					1336035	X	
BG-GB2-S	9/2/2013	0800	SOIL	X			X	X			XE14	X	
BG-GB2-SMM	9/2/2013	0800	SOIL		X	X					1336035	X	
JU-01-S	9/2/2013	1300	SOIL	X			X	X			XE14	X	
JU-01-SMM	9/2/2013	1300	SOIL		X	X					1336036	X	
JU-02-S	9/2/2013	1320	SOIL	X			X	X			XE14	X	
JU-02-SMM	9/2/2013	1320	SOIL		X	X					1336036	X	
JU-03-S	9/2/2013	1340	SOIL	X			X	X			XE14	X	
JU-03-SMM	9/2/2013	1340	SOIL		X	X					1336036	X	
JU-04-S	9/2/2013	1440	SOIL	X			X	X			XE14	X	
JU-04-SMM	9/2/2013	1440	SOIL		X	X					1336036	X	
JU-05-S	9/2/2013	1450	SOIL	X			X	X			XE14	X	
JU-05-SMM	9/2/2013	1450	SOIL		X	X					1336036	X	
JU-06-S	9/2/2013	1500	SOIL	X			X	X			XE14	X	
JU-06-SMM	9/2/2013	1500	SOIL		X	X					1336036	X	
JU-07-S	9/2/2013	1515	SOIL	X			X	X			XE14	X	
JU-07-SMM	9/2/2013	1515	SOIL		X	X					1336036	X	
JU-08-S	9/2/2013	1525	SOIL	X			X	X			XE14	X	
JU-08-SMM	9/2/2013	1525	SOIL		X	X					1336036	X	
JU-09-S	9/2/2013	1540	SOIL	X			X	X			XE14	X	
JU-09-SMM	9/2/2013	1540	SOIL		X	X					1336036	X	
JU-10-S	9/2/2013	1550	SOIL	X			X	X			XE15	x	
JU-10-SMM	9/2/2013	1550	SOIL		X	X					1336036	X	
JU-SF	9/2/2013	1600	SOIL	X			X	X		X	XE15	x	
My-01-S	8/30/2013	1340	SOIL	X			X	X			XE13	X	
My-01-SMM	8/30/2013	1340	SOIL		X	X					1336036	X	
My-02-S	8/30/2013	1508	SOIL	X			X	X			XE13	X	
My-02-SMM	8/30/2013	1508	SOIL		X	X					1336036	X	
My-03-S	8/31/2013	1030	SOIL	X			X	X			XE13	X	
My-03-SMM	8/31/2013	1030	SOIL		X	X					1336036	X	
My-04-S	8/31/2013	1120	SOIL	X			X	X			XE13	X	
My-04-SMM	8/31/2013	1120	SOIL		X	X					1336036	X	
My-05-S	8/31/2013	1150	SOIL	X			X	X			XE13	X	
My-05-SMM	8/31/2013	1150	SOIL		X	X					1336036	X	
My-06-S	8/31/2013	1330	SOIL	X			X	X			XE13	X	
My-06-SMM	8/31/2013	1330	SOIL		X	X					1336036	X	
My-07-S	8/31/2013	1420	SOIL	X			X	X			XE13	X	
My-07-SMM	8/31/2013	1420	SOIL		X	X					1336036	X	
My-08-S	8/31/2013	1500	SOIL	X			X	X			XE13	X	
My-08-SMM	8/31/2013	1500	SOIL		X	X					1336036	X	
My-09-S	9/1/2013	0930	SOIL	X			X	X			XE13	X	
My-09-SMM	9/1/2013	0930	SOIL		X	X					1336036	X	
My-10-S	9/1/2013	1035	SOIL	X			X	X			XE13	X	
My-10-SMM	9/1/2013	1035	SOIL		X	X					1336036	X	
My-SF	9/1/2013	1055	SOIL							X	XE13	X	
ND-01-S	9/1/2013	1010	SOIL	X			X	X			XE15	x	
ND-01-SMM	9/1/2013	1010	SOIL		X	X					1336035	X	
ND-02-S	9/1/2013	1030	SOIL	X			X	X			XE16	x	
ND-02-SMM	9/1/2013	1030	SOIL		X	X					1336035	X	
ND-03-S	9/1/2013	1100	SOIL	X			X	X			XE16	x	
ND-03-SMM	9/1/2013	1100	SOIL		X	X					1336035	X	
ND-04-S	9/1/2013	1120	SOIL	X			X	X			XE16	x	
ND-04-SMM	9/1/2013	1120	SOIL		X	X					1336035	X	
ND-05-S	9/1/2013	1145	SOIL	X			X	X			XE16	x	
ND-05-SMM	9/1/2013	1145	SOIL		X	X					1336035	X	
ND-06-S	9/1/2013	1205	SOIL	X			X	X			XE16	x	
ND-06-SMM	9/1/2013	1205	SOIL		X	X					1336035	X	
ND-07-S	9/1/2013	1430	SOIL	X			X	X			XE16	x	
ND-07-SMM	9/1/2013	1430	SOIL		X	X					1336035	X	
ND-08-S	9/1/2013	1450	SOIL	X			X	X			XE16	x	
ND-08-SMM	9/1/2013	1450	SOIL		X	X					1336035	X	
ND-SF	9/1/2013	1500	SOIL					x			XE16	x	Additional fertility tests were not completed due to holding time issues.
OB-01-S	8/21/2013	1030	SOIL	X			X	X			XC92	X	
OB-01-SMM	8/21/2013	1030	SOIL		X				X		1335038	X	
OB-02-S	8/21/2013	1040	SOIL	X			X	X			XC92	X	
OB-02-SMM	8/21/2013	1040	SOIL		X				X		1335038	X	Water in resealable plastic bag
OB-03-S	8/21/2013	1245	SOIL	X			X	X			XC92	X	
OB-03-SMM	8/21/2013	1245	SOIL		X				X		1335038	X	
OB-04-S	8/21/2013	1310	SOIL	X			X	X			XC92	X	
OB-04-SMM	8/21/2013	1310	SOIL		X				X		1335038	X	Water in resealable plastic bag
OB-05-S	8/21/2013	1430	SOIL	X			X	X			XC92	X	
OB-05-SMM	8/21/2013	1430	SOIL		X				X		1335038	X	
OB-06-S	8/21/2013	1330	SOIL	X			X	X			XC92	X	
OB-06-SMM	8/21/2013	1330	SOIL		X				X		1335038	X	
OB-07-S	8/22/2013	0935	SOIL	X			X	X			XC92	X	
OB-07-SMM	8/22/2013	0935	SOIL		X				X		1335038	X	
OB-08-S	8/22/2013	1010	SOIL	X			X	X			XC92	X	
OB-08-SMM	8/22/2013	1010	SOIL		X				X		1335038	X	
OB-09-S	8/22/2013	1050	SOIL	X			X	X			XC92	X	
OB-09-SMM	8/22/2013	1050	SOIL		X				X		1335038	X	

Table B-1 - Monte Cristo Soil Sample Analysis Summary

Sample ID	Sample Date	Sample Time	Matrix	Analysis: Total Metals	Analysis: Methyl Hg by EPA 1630 modified	Analysis: Selenium by EPA draft Method 1638, modifie	Analysis: Total Organic Carbon	Analysis: pH	Analysis: Total solids by SM 2540G	Analysis: Soil Fertility	Lab Report	DV	Notes
OB-10-S	8/21/2013	1410	SOIL	X			X	X			XC92	X	
OB-10-SMM	8/21/2013	1410	SOIL		X				X		1335038	X	
OB-SF	8/21/2013	1445	SOIL	X			X	X		X	XC93	X	
POM-1-S	8/31/2013	0830	SOIL	X			X	X			XE15	x	
POM-1-SMM	8/31/2013	0830	SOIL		X	X					1336035	X	
POM-2-S	8/31/2013	0910	SOIL	X			X	X			XE15	x	
POM-2-SMM	8/31/2013	0910	SOIL		X	X					1336035	X	
POM-3-S	8/31/2013	0940	SOIL	X			X	X			XE15	x	
POM-3-SMM	8/31/2013	0940	SOIL		X	X					1336035	X	
POM-4-S	8/31/2013	1020	SOIL	X			X	X			XE15	x	
POM-4-SMM	8/31/2013	1020	SOIL		X	X					1336035	X	
POM-5-S	8/31/2013	1050	SOIL	X			X	X			XE15	x	
POM-5-SMM	8/31/2013	1050	SOIL		X	X					1336035	X	
POM-6-S	8/31/2013	1120	SOIL	X			X	X			XE15	x	
POM-6-SMM	8/31/2013	1120	SOIL		X	X					1336035	X	
POM-7-S	8/31/2013	1145	SOIL	X			X	X			XE15	x	
POM-7-SMM	8/31/2013	1145	SOIL		X	X					1336035	X	
POM-8-S	8/31/2013	1215	SOIL	X			X	X			XE15	x	
POM-8-SMM	8/31/2013	1215	SOIL		X	X					1336035	X	
POM-9-S	8/31/2013	1310	SOIL	X			X	X			XE15	x	
POM-9-SMM	8/31/2013	1310	SOIL		X	X					1336035	X	
POM-10-S	8/31/2013	1330	SOIL	X			X	X			XE15	x	
POM-10-SMM	8/31/2013	1330	SOIL		X	X					1336035	X	
POM-SF	8/31/2013	1020	SOIL					x			XE16	x	Additional fertility tests were not completed due to holding time issues.
SH-01-S	8/24/2013	1405	SOIL	X			X	X			XC93	X	
SH-01-SMM	8/24/2013	1405	SOIL		X				X		1335038	X	
SH-02-S	8/24/2013	1500	SOIL	X			X	X			XC93	X	
SH-02-SMM	8/24/2013	1500	SOIL		X				X		1335038	X	
SH-03-S	8/24/2013	1515	SOIL	X			X	X			XC93	X	
SH-03-SMM	8/24/2013	1515	SOIL		X				X		1335038	X	
SH-04-S	8/24/2013	1530	SOIL	X			X	X			XC93	X	
SH-04-SMM	8/24/2013	1530	SOIL		X				X		1335038	X	
SH-05-S	8/25/2013	1105	SOIL	X			X	X			XC93	X	
SH-05-SMM	8/25/2013	1105	SOIL		X				X		1335038	X	
SH-06-S	8/25/2013	1135	SOIL	X			X	X			XC93	X	
SH-06-SMM	8/25/2013	1135	SOIL		X				X		1335038	X	
SH-07-S	8/25/2013	1150	SOIL	X			X	X			XC93	X	
SH-07-SMM	8/25/2013	1150	SOIL		X				X		1335038	X	
SH-08-S	8/25/2013	1205	SOIL	X			X	X			XC93	X	
SH-08-SMM	8/25/2013	1205	SOIL		X				X		1335038	X	
SH-09-S	8/25/2013	1220	SOIL	X			X	X			XC93	X	
SH-09-SMM	8/25/2013	1220	SOIL		X				X		1335038	X	
SH-10-S	8/25/2013	1230	SOIL	X			X	X			XC93	X	
SH-10-SMM	8/25/2013	1230	SOIL		X				X		1335038	X	
SH-SF	8/21/2013	1130	SOIL	X			X	X		X	XC93	X	
				69	**66**	**42**	**69**	**71**	**24**	**4**			

Table B-2 - Monte Cristo Plant or Invertebrate Sample Analysis Summary

Sample ID	Sample Date	Sample Time	Matrix	Analyses: Total Metals	Analyses: HOLD	Lab Report	DV	Notes
BG-01-VG	8/22/2013	1330	VEG	X		1335038	X	
BG-01-VS	8/22/2013	1330	VEG	X		1335038	X	
BG-02-I	8/22/2013	1150	INVERT	X		1335038	X	
BG-02-VG	8/22/2013	1150	VEG	X		1335038	X	
BG-02-VS	8/22/2013	1150	VEG	X		1335038	X	
BG-03-I	8/25/2013	1355	INVERT	X		1335038	X	
BG-03-VS	8/25/2013	1355	VEG	X		1335038	X	
BG-04-I	8/25/2013	1520	INVERT	X		1335038	X	Labeled BG-03-I on COC - should be BG-04-I
BG-04-VS	8/25/2013	1520	VEG	X		1335038	X	
BG-07-I	9/1/2013	1255	INVERT	X		1336035	X	
BG-07-VS	9/1/2013	1255	VEG	X		1336037	X	SHRUB
BG-08-I	9/3/2013	1516	INVERT	X		1336035	X	
BG-08-VS	9/3/2013	0900	VEG	X		1336037	X	
BG-GB1-I	8/31/2013	1530	INVERT	X		1336035	X	
BG-GB1-VG	8/31/2013	1530	VEG	X		1336035	X	
BG-GB1-VS	8/31/2013	1530	VEG	X		1336035	X	
BG-GB2-I	9/2/2013	0800	INVERT	X		1336035	X	
BG-GB2-VG	9/2/2013	0800	VEG	X		1336035	X	
BG-GB2-VS	9/2/2013	0800	VEG	X		1336035	X	
JU-01-VS	9/2/2013	1300	VEG	X		1336037	X	
JU-02-VS	9/2/2013	1320	VEG	X		1336037	X	
JU-03-VS	9/2/2013	1340	VEG	X		1336037	X	
JU-04-VG	9/2/2013	1440	VEG	X		1336037	X	
JU-04-VS	9/2/2013	1440	VEG	X		1336037	X	
JU-05-VG	9/2/2013	1450	VEG	X		1336037	X	
JU-05-VS	9/2/2013	1450	VEG	X		1336037	X	
JU-06-VG	9/2/2013	1500	VEG	X		1336037	X	
JU-06-VS	9/2/2013	1500	VEG	X		1336037	X	
JU-07-VG	9/2/2013	1515	VEG	X		1336037	X	
JU-07-VS	9/2/2013	1515	VEG	X		1336037	X	
JU-08-VG	9/2/2013	1525	VEG	X		1336037	X	
JU-08-VS	9/2/2013	1525	VEG	X		1336037	X	
JU-09-VS	9/2/2013	1540	VEG	X		1336037	X	
JU-10-VS	9/2/2013	1550	VEG	X		1336037	X	
JU-I	9/2/2013	0915	INVERT	X		1336035	X	
MM-I	8/31/2013	1000	INVERT	X		1336035	X	
My-01-VG	8/31/2013	1400	VEG	X		1336037	X	GRASS
My-02-VG	8/30/2013	1508	VEG	X		1336037	X	GRASS
My-02-VS	8/30/2013	1508	VEG	X		1336037	X	SHRUB
My-03-VG	8/31/2013	1030	VEG	X		1336037	X	GRASS
My-03-VS	8/31/2013	1030	VEG	X		1336037	X	SHRUB
My-04-VG	8/31/2013	1120	VEG	X		1336037	X	GRASS
My-04-VS	8/31/2013	1120	VEG	X		1336037	X	SHRUB
My-05-VG	8/31/2013	1150	VEG	X		1336037	X	GRASS
My-05-VS	8/31/2013	1150	VEG	X		1336037	X	SHRUB
My-06-VS	8/31/2013	1330	VEG	X		1336037	X	SHRUB
My-07-VS	8/31/2013	1420	VEG	X		1336037	X	SHRUB
My-08-VG	8/31/2013	1500	VEG	X		1336037	X	GRASS
My-08-VS	8/31/2013	1500	VEG	X		1336037	X	SHRUB
My-09-VS	9/1/2013	0930	VEG	X		1336037	X	SHRUB
My-10-VG	9/1/2013	1035	VEG	X		1336037	X	GRASS
My-10-VS	9/1/2013	1035	VEG	X		1336037	X	SHRUB
ND-01-VG	9/1/2013	1010	VEG	X		1336035	X	
ND-01-VS	9/1/2013	1010	VEG	X		1336035	X	
ND-02-VG	9/1/2013	1030	VEG	X		1336035	X	
ND-02-VS	9/1/2013	1030	VEG	X		1336035	X	
ND-03-VG	9/1/2013	1100	VEG	X		1336035	X	
ND-04-VG	9/1/2013	1120	VEG	X		1336035	X	
ND-04-VS	9/1/2013	1120	VEG	X		1336035	X	
ND-05-VG	9/1/2013	1145	VEG	X		1336035	X	
ND-05-VS	9/1/2013	1145	VEG	X		1336035	X	
ND-06-VG	9/1/2013	1205	VEG	X		1336035	X	
ND-07-VG	9/1/2013	1430	VEG	X		1336035	X	
ND-08-VG	9/1/2013	1450	VEG	X		1336035	X	
ND-I	9/1/2013	0900	INVERT	X		1336035	X	
OB-01-VG	8/21/2013	1030	VEG	X		1335038	X	
OB-01-VS	8/21/2013	1030	VEG	X		1335038	X	
OB-02-VG	8/21/2013	1140	VEG	X		1335038	X	
OB-02-VS	8/21/2013	1140	VEG	X		1335038	X	
OB-03-VG	8/21/2013	1245	VEG	X		1335038	X	
OB-04-VG	8/21/2013	1310	VEG	X		1335038	X	
OB-04-VS	8/21/2013	1310	VEG	X		1335038	X	
OB-05-VG	8/21/2013	1430	VEG	X		1335038	X	
OB-06-VG	8/21/2013	1330	VEG	X		1335038	X	
OB-06-VS	8/21/2013	1330	VEG	X		1335038	X	
OB-07-VG	8/22/2013	0935	VEG	X		1335038	X	
OB-07-VS	8/22/2013	0935	VEG	X		1335038	X	
OB-08-VG	8/22/2013	1010	VEG	X		1335038	X	
OB-09-VG	8/22/2013	1050	VEG	X		1335038	X	
OB-10-VG	8/21/2013	1410	VEG	X		1335038	X	
OB-10-VS	8/21/2013	1410	VEG	X		1335038	X	
POM-10-VG	8/31/2013	1330	VEG	X		1336035	X	

Table B-2 - Monte Cristo Plant or Invertebrate Sample Analysis Summary

Sample ID	Sample Date	Sample Time	Matrix	Analyses: Total Metals	Analyses: HOLD	Lab Report	DV	Notes
POM-1-VG	8/31/2013	0830	VEG	X		1336035	X	
POM-1-VS	8/31/2013	0830	VEG	X		1336035	X	
POM-2-VG	8/31/2013	0910	VEG	X		1336035	X	
POM-2-VS	8/31/2013	0910	VEG	X		1336035	X	
POM-3-VG	8/31/2013	0940	VEG	X		1336035	X	
POM-4-VG	8/31/2013	1020	VEG	X		1336035	X	
POM-5-VG	8/31/2013	1050	VEG	X		1336035	X	
POM-5-VS	8/31/2013	1050	VEG	X		1336035	X	
POM-6-VG	8/31/2013	1120	VEG	X		1336035	X	
POM-6-VS	8/31/2013	1120	VEG	X		1336035	X	
POM-7-VG	8/31/2013	1145	VEG	X		1336035	X	
POM-7-VS	8/31/2013	1145	VEG	X		1336035	X	
POM-8-VG	8/31/2013	1215	VEG	X		1336035	X	
POM-9-VG	8/31/2013	1310	VEG	X		1336035	X	
POM-9-VS	8/31/2013	1310	VEG	X		1336035	X	
POM-I	8/30/2013	1300	INVERT	X		1336035	X	
SH-01-VG	8/24/2013	1405	VEG	X		1335038	X	
SH-01-VS	8/24/2013	1405	VEG	X		1335038	X	
SH-02-VG	8/24/2013	1500	VEG	X		1335038	X	
SH-03-VS	8/24/2013	1515	VEG	X		1335038	X	
SH-04-VG	8/24/2013	1530	VEG	X		1335038	X	
SH-05-VS	8/25/2013	1105	VEG	X		1335038	X	
SH-06-VS	8/25/2013	1135	VEG	X		1335038	X	
SH-07-VS	8/25/2013	1150	VEG	X		1335038	X	
SH-08-VG	8/25/2013	1205	VEG	X		1335038	X	
SH-08-VS	8/25/2013	1205	VEG	X		1335038	X	
SH-09-VS	8/25/2013	1220	VEG	X		1335038	X	
SH-10-VS	8/25/2013	1230	VEG	X		1335038	X	
SH-I	8/24/2013	1300	INVERT	X		1335038	X	
				111				

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Phase 3 Terrestrial Ecological Evaluation

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LIST OF ACRONYMS

BAF	bioaccumulation factor
C_p	concentration of constituent in prey (mg/kg DW)
C_s	concentration of constituent in soil (mg/kg DW)
CBR	critical body residue (mg/kg DW)
COC	constituent of concern
COPC	constituent of potential concern
DW	dry weight
EC_{20}	effects concentration at which there is 20 percent impairment of the trait (mg/kg)
EcoSSL	ecological soil screening level
EEA	ecological exposure area
EISC	ecological indicator soil concentration (mg/kg DW)
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration (mg/kg DW)
FIR	food ingestion rate (kg/kg/day)
HQ	hazard quotient
LOAEL	lowest observed adverse effect level (mg/kg/day)
MCMA	Monte Cristo Mining Area
MTCA	Model Toxics Control Act
MVP	minimum viable population
P	proportion of contaminated food in diet
P	p-value or significance level
r^2	coefficient of determination
RI	remedial investigation
SIR	soil ingestion rate (mg/kg/day)
TEE	terrestrial ecological evaluation
TRV	toxicity reference value (mg/kg/day)
WAC	Washington Administrative Code
WMW	Wilcoxon-Mann-Whitney

APPENDIX C
PHASE 3 TERRESTRIAL ECOLOGICAL EVALUATION

EXECUTIVE SUMMARY

A terrestrial ecological evaluation (TEE) was conducted at the Monte Cristo Mining Area (MCMA) as part of the Phase 3 remedial investigation. The Phase 3 TEE used plant tissue, soil biota tissue, and soil data collected from the MCMA in 2013 to help assess hazards to plants, soil biota, and wildlife.

Elements of the Phase 3 TEE include:

1. Constituents of potential concern (COPCs) were identified by comparing plant and soil biota tissue concentrations from the MCMA source areas (i.e., waste rock piles) to natural background concentrations.
2. Tissue and soil data collected in 2013 were used to derive bioaccumulation models for COPCs in plants and soil biota.
3. Critical body residue (CBR) values for COPCs in plants and soil biota were derived from the scientific literature. The CBRs were compared to measured and modeled tissue concentrations from the MCMA to assess hazards to individual plants and soil biota living on MCMA source areas.
4. Hazards to wildlife were assessed using exposure models for the vole, shrew, and robin. Both measured and modeled tissue concentrations were evaluated to assess hazards to individual animals living on source areas.

Conclusions of the Phase 3 TEE are summarized as follows:

1. Individual soil biota living on the MCMA source areas will not be adversely affected by exposure to mining-related constituents.
2. Individual plants will be adversely affected by exposure to arsenic on source areas located in Ecological Exposure Areas 1, 2, and 4 on the MCMA. This conclusion is based on a CBR for reduced plant growth.
3. Individual wildlife living on source areas will be adversely affected by exposure to arsenic and lead in Ecological Exposure Areas 1, 2, 3, and 4 of the MCMA.

There are uncertainties associated with many steps of this Phase 3 TEE. However, these uncertainties are not expected to result in an underestimation of hazards.

1.0 INTRODUCTION

A terrestrial ecological evaluation (TEE) of the Monte Cristo Mining Area (MCMA) was conducted as part of the Phase 2 Remedial Investigation (RI) (Hart Crowser 2012). The Phase 2 TEE used soil data collected from the MCMA and natural background areas to help characterize ecological hazards. Results of the Phase 2 TEE showed that many metal constituents pose ecological hazards based on comparison to MTCA screening criteria (e.g., WAC 173-340-900, Table 749-3).

Following a review of the Phase 2 TEE results, it was decided that additional sample collection and use of additional evaluation methods would help refine hazard estimates. A Phase 3 RI work plan (Hart Crowser 2013) was drafted in 2013 and field sampling was conducted in August-September 2013. This Phase 3 TEE incorporates sample data collected in 2013 and uses additional evaluation methods to improve the estimates of ecological hazards at the MCMA.

Summaries of the Phase 2 TEE and Phase 3 terrestrial sampling are provided in Sections 1.1 and 1.2, respectively, to provide a context for the Phase 3 TEE. Integration of the Phase 2 and 3 TEEs is discussed in Section 1.3 along with a framework for the Phase 3 TEE.

1.1 Summary of Phase 2 TEE

The Phase 2 TEE is presented in Appendix C of the Phase 2 RI Report (Hart Crowser 2012). The Phase 2 TEE consisted of three major sections:

- Problem formulation;
- Derivation of alternative ecological soil indicator concentrations; and
- Hazard characterization.

Problem formulation defined the scope of the TEE. It included an ecological conceptual site model that identified complete exposure pathways and ecological receptors of concern. Receptors of concern included plants, soil biota, and wildlife (specifically the vole, shrew, and robin). The MCMA was divided into five ecological exposure areas (EEAs; Figure C-1) that were largely defined by watershed boundaries. Ecological constituents of potential concern (COPCs) were identified by comparing the MCMA source soil metals concentrations to natural background soil metals concentrations and the Model Toxics Control Act (MTCA) ecological indicator soil concentrations (EISCs), [Chapter 173-340 Washington Administrative Code (WAC) Table 749-3].

Alternative EISCs were also evaluated for COPCs from the United States Environmental Protection Agency's (EPA's) ecological soil screening level (EcoSSL) documents.[1] The EcoSSLs differ from the MTCA EISCs because they were derived using more comprehensive and recent toxicity data. The EcoSSLs for plants and soil biota were selected as alternative EISCs. For wildlife, the MTCA wildlife models were used (WAC 173-340 Table 749-4), but were modified using exposure parameter values provided in the EcoSSLs. In addition, bioaccumulation factors (BAFs) and toxicity reference values (TRVs) provided in the EcoSSLs were used to derive alternative wildlife EISCs. The alternative plant, soil biota, and wildlife EISCs were then compared to the MCMA soil reasonable maximum exposure point concentrations (EPCs). EPCs were calculated for each of the five EEAs.

Results of the Phase 2 TEE indicated the following metals are constituents of concern (COCs):

[1] Available online at http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

- Plants – Sb, As, Cd, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se, Tl and Zn[2]
- Soil Biota – Sb, As, Cd, Cu, Pb, Mn, Hg, Se, and Zn
- Herbivorous Wildlife (i.e., vole) – As, Cd, Pb, and Se
- Insectivorous Wildlife (i.e., shrew and robin) – Sb, As, Cd, Cr, Cu, Pb, Se, and Zn

However, there was considerable uncertainty associated with the Phase 2 TEE hazard results.

1.2 Summary of Phase 3 Sampling

Phase 3 RI field sampling occurred in August and September, 2013, and included the collection of co-located soil, plant, and soil biota samples. Due to a paucity of soil biota present at MCMA source and background sample areas, a single composite sample was collected from each of five mine areas (Justice, Mystery, New Discovery, Pride of the Mountains, and Sheridan Mines) and seven natural background areas. The natural background areas are not impacted by known mining activities. Each composite soil biota sample was comprised of one to five different groups of soil invertebrates including ants (family Formicidae), spiders (order Araneae), beetles (order Coleoptera), grasshoppers (suborder Caelifera), crickets (family Gryllidae), and centipedes (class Chilopoda). Soil biota samples were collected from a broad area at each mine site and background area that encompassed locations where the plant samples were collected.

Plant samples were collected from six mine areas (O&B, Justice, Mystery, New Discovery, Pride of the Mountains, and Sheridan Mines). Sixty-five plant samples from mine areas were analyzed and included in the Phase 3 TEE. Twelve plant samples were also collected from natural background areas. Plant samples were placed into two broad groupings: grasses and shrubs, and included the following species:

- Grasses – Sitka sedge (*Carex aquatilis var. dives*), blue wild rye (*Elymus glaucus*), spiny wood fern (*Dropteris expansa*), black alpine sedge (*Carex nigricans*), and a composite of grass and sedge.

- Shrubs – Pacific bleeding heart (*Dicentra formosa*), edible thistle (*Cirsium edule*), black huckleberry (*Gaylussacia baccata*), huckleberry (genera *Vaccinium* or *Gaylussacia*), Sitka mountain-ash (*Sorbus sitchensis*), and common horsetail (*Equisetum arvense*).

Sedge and huckleberry were widespread and sampled at many areas. However, other species were only sampled at a single area. For example, sedge and huckleberry were not present at the Justice Mine, so instead spiny wood fern and common horsetail were sampled. Spiny wood fern and common horsetail were not sampled in any other areas.

[2] Al – aluminum, Sb – antimony, As – arsenic, Ba – barium, Be- beryllium, Cd – cadmium, Ca – calcium, Cr – chromium, Co – cobalt, Cu – copper, Fe – iron, Pb – lead, Mg – magnesium, Mn – manganese, Hg – mercury, MeHg – methylmercury, Ni – nickel, K – potassium, Se – selenium, Ag – silver, Na – sodium, Tl – thallium, V – vanadium, and Zn – zinc

Plant samples were composite samples consisting of three to five subsamples of individual plants distributed over a sample area of approximately 2,000 square feet. Co-located composite soil samples (i.e., three to five subsamples collected from the upper 30 cm) were also collected from each 2,000-square-foot area wherever a plant sample was collected. Efforts were made to collect grass and shrub samples from the same 2,000-square-foot sample areas. However, this was not possible in all cases. The goal of plant sampling was to collect all the plant samples from the mine waste rock piles. However, because of the paucity of plants on the waste rock piles, some plant samples were collected from areas adjacent to the sides of the waste rock piles or at the toe of the waste rock piles.

Plant and soil biota tissue samples were analyzed for 24 constituents: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, MeHg, Ni, K, Se, Ag, Na, Tl, V, and Zn. Soil samples were analyzed for the 14 ecological COCs identified in the Phase 2 TEE (plus MeHg) and include: Sb, As, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, MeHg, Ni, Se, Tl and Zn.

A more detailed description of the Phase 3 sampling is provided in Section 4 of the main body of the Phase 3 RI report.

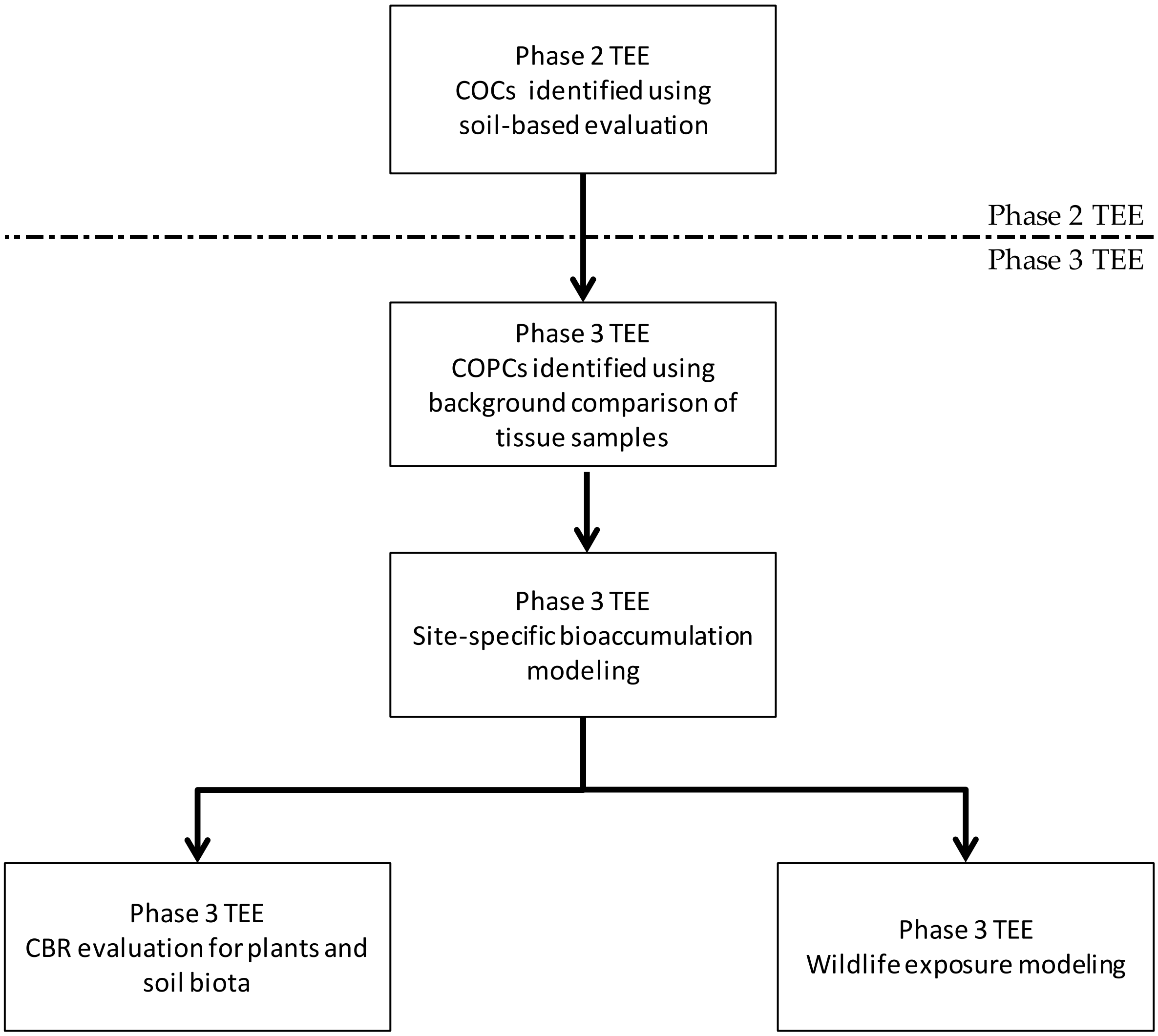
1.3 Integration and Framework for the Phase 3 TEE

This Phase 3 TEE builds upon information presented in the Phase 2 TEE (Hart Crowser 2012). Pertinent information contained in the Phase 2 TEE is included in the Phase 3 TEE by reference. The ecological conceptual site model presented in the Phase 2 TEE remains essentially unchanged. The COCs identified in the Phase 2 TEE are carried into the Phase 3 TEE for further evaluation. However, the hazard conclusions of the Phase 2 TEE are superseded by the more definitive Phase 3 hazard conclusions. For example, if Zn was identified as posing a hazard to plants in the Phase 2 TEE, but results of the Phase 3 TEE show Zn does not pose a hazard to plants, the final conclusion is that Zn does not pose a hazard to plants.

Figure C-2 shows the major elements of the Phase 3 TEE. The elements of the Phase 3 TEE are presented in Section 2.0 and include:

- Section 2.1 – Background Comparisons of Plant and Soil Biota Tissue Samples
- Section 2.2 – Site-Specific Bioaccumulation Models for Plants and Soil Biota
- Section 2.3 – Critical Body Residue Evaluation for Plants and Soil Biota
- Section 2.4 – Hazards to Wildlife Using Site-Specific Bioaccumulation Models
- Section 2.5 – Uncertainty Analysis

Section 3.0 provides a summary of results reported in Section 2.0 and presents the major conclusions of the Phase 3 TEE. Attachment C-1 presents a population-based risk assessment that was completed as part of the uncertainty analysis.



Notes:

TEE - terrestrial ecological evaluation

COC - constituent of concern

COPC - constituent of potential concern

CBR - critical body residue

Figure C-2 – Phase 3 TEE Analytical Framework

2.0 ELEMENTS OF THE PHASE 3 TEE

The analytical data used in the Phase 3 TEE are provided in Tables 5 through 7 of the Phase 3 RI Report. A data validation report confirming the usability of the analytical data for hazard assessment purposes is provided in Appendix B of the Phase 3 RI Report.

2.1 Background Comparisons of Plant and Soil Biota Tissue Samples

Per WAC 173-340-7491 (1)(d), concentrations of constituents on a site that do not exceed natural background concentrations do not require remedial action. Background comparisons of constituent concentrations in soil were conducted in the Phase 2 TEE to help identify COPCs. Background comparisons of constituent concentrations in plant and soil biota tissues are conducted herein to refine the list of COPCs.[3] The refined list of COPCs will be the subject of additional Phase 3 TEE evaluations.

2.1.1 Methods

The statistical methods used for comparing natural background concentrations of COCs to site concentrations for plants and soil biota tissue samples for Phase 3 are identical to those used to compare natural background to site soil concentrations in the Phase 2 TEE (Hart Crowser 2012). Background comparisons were made using EPA's ProUCL software.[4] The hypothesis testing option was used with the null hypothesis being the mean/median concentrations of constituents in tissue samples whenever those from the MCMA were less than or equal to the mean/median concentrations in samples from natural background areas. Following EPA's ProUCL recommendations, the nonparametric Wilcoxon-Mann-Whitney (WMW) test was used when less than 40 percent of the samples from either the MCMA or background data sets contained non-detect values. However, the WMW test was not used on data sets with multiple detection limits. A two-sample WMW test in the "Full" mode was run on data sets with all detections, while a two-sample WMW test in the "with NDs" mode was run on data sets with non-detections > 0 percent and < 40 percent. A two-sample Gehan test was used when 40 percent or more of the samples from either the MCMA or background areas were non-detect values ("with NDs" mode). The Gehan test was also used when multiple detection limits were present in either the MCMA or background data sets.

All MCMA and natural background tissue samples were included in background comparisons, including non-detected values and potential data outliers.

2.1.2 Plants

Background comparisons were made on the fourteen Phase 2 TEE COCs for plants and herbivorous wildlife (i.e., Sb, As, Cd, Co, Cu, Fe, Mn, Pb, Ni, Hg, MeHg, Se, Tl, and Zn) (see Section 1.1). Note that methylmercury (MeHg) was not analyzed in Phase 2 RI soil samples, but MeHg was analyzed in Phase 3 soil and tissue samples and is included in this analysis for completeness. For purposes of this background comparison, all plant samples from the MCMA were compared to all plant samples from the natural background areas.[5] Descriptive statistics for plant samples collected from background and

[3] This approach is consistent with the alternatives allowed under MTCA including site-specific field studies and other methods approved by the department [WAC 173-340-7493(3)].
[4] Available online at http://www.epa.gov/osp/hstl/tsc/software.htm
[5] This approach is supported by information presented in Section 2.2.1.2 through 2.2.1.5.

MCMA areas were generated using ProUCL and provided in Attachment C-2. Background statistical test selection is summarized in Table C-1. Results of background comparisons are summarized in Table C-2 and ProUCL background comparison output files are provided in Attachment C-3.

Table C-1 – Plant Tissue Background Comparison Statistical Test Selection

Phase 2 COC	Background Dataset		Site Dataset		Background Test
	≥ 40% ND?	> 1 DL?	≥ 40% ND?	> 1 DL?	
Antimony	Yes	Yes	No	Yes	Gehan
Arsenic	No	No	No	No	WMW
Cadmium	No	No	No	No	WMW
Cobalt	Yes	Yes	Yes	Yes	Gehan
Copper	No	No	No	No	WMW
Iron	No	No	No	No	WMW
Lead	No	No	No	No	WMW
Manganese	No	No	No	No	WMW
Mercury	No	No	No	No	WMW
Methylmercury[a]	ND	--	Yes	Yes	--
Nickle	No	No	No	No	WMW
Selenium	ND	--	ND	--	--
Thallium	Yes	No	Yes	No	Gehan
Zinc	No	No	No	No	WMW

Notes:
COC - constituent of concern
ND - nondetect
DL - detection limit
WMW - Wilcoxon-Mann-Whitney
[a] Methylmercury was not analyzed in Phase 2 RI soil samples, so was not identified as a Phase 2 TEE COC. However, methylmercury was included in Phase 3 soil and tissue sample analysis and is included in all tables for completeness. Methylmercury was not detected in any background plant samples, but was detected in 2 of 65 MCMA plant samples. A background statistical comparison was not performed due to the lack of detected data.

Eight constituents in plants (Sb, As, Co, Cu, Fe, Pb, Tl, and Zn) have tissue concentrations in the MCMA exceeding background (Table C-2). These eight constituents are identified as COPCs and will be evaluated further in this Phase 3 TEE. While all eight constituents are plant COPCs, only arsenic and lead are herbivorous wildlife COPCs because the other plant COPCs were not identified as herbivorous wildlife COCs in the Phase 2 TEE.

Table C-2 – Summary of Plant Tissue Background Comparisons

Phase 2 COC[5]	Is site > background?[1]	Phase 2 TEE Plant COCs in Ecological Exposure Area?[2]					Plant COPC for Phase 3 TEE?[3]
		1	2	3	4	5	
Antimony	Yes	Yes	Yes	Yes	Yes	No	Yes
Arsenic	Yes	Yes	Yes	Yes	Yes	No	Yes
Cadmium	No	No	No	No	Yes	No	No
Cobalt	Yes	No	Yes	No	No	No	Yes
Copper	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Iron	Yes	Yes	Yes	Yes	No	No	Yes
Lead	Yes	Yes	Yes	Yes	Yes	No	Yes
Manganese	No	No	No	No	Yes	No	No
Mercury	No	Yes	Yes	Yes	Yes	No	No
Methylmercury[4]	--	--	--	--	--	--	No
Nickel	No	No	No	No	No	Yes	No
Selenium	No[6]	No	Yes	No	No	No	No
Thallium	Yes	Yes	No	Yes	No	No	Yes
Zinc	Yes	Yes	Yes	Yes	Yes	No	Yes

Notes:

COC - constituent of concern

COPC - constituent of potential concern

TEE - terrestrial ecological evaluation

SC - ecological indicator soil concentration

EPA - US Environmental Protection Agency

EcoSSL - ecological soil screening level

[1] ProUCL background comparison output files are provided in Attachment C-3.

[2] Phase 2 plant COCs were identified in five ecological exposure areas in the TEE conducted as part of the MCMA Phase 2 Remedial Investigation (Hart Crowser 2012).

[3] Constituents with MCMA plant tissue concentrations greater than background which were identified as a plant COC in at least one ecological exposure area in the Phase 2 Remedial Investigation (Hart Crowser 2012), were identified as COPCs for the Phase 3 TEE.

[4] Methylmercury detections were at trace levels (0.0012 mg/kg in huckleberry at sample location SH-05 and 0.0176 mg/kg in huckleberry at sample location POM-02). Detection limits ranged from 0.0091 to 0.0011 mg/kg. Considering the low frequency of detection in MCMA samples (3 percent) and the trace levels detected, methylmercury was not identified as a COPC in plants.

[5] As described in Section 1.1, Phase 2 TEE plant COCs include As, Cd, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se, Tl, and Zn, while Phase 2 TEE herbivorous wildlife COCs include As, Cd, Pb, and Se.

[6] Selenium were not detected in any plant samples from background or MCMA areas. Therefore, it was concluded that plant concentrations of selenium at the MCMA do not exceed background.

Constituents retained as soil biota COPCs following background comparisons are highlighted and evaluated further in the Phase 3 TEE.

2.1.3 Soil Biota

Background comparisons were made on the ten Phase 2 TEE COCs for soil biota and insectivorous wildlife (i.e., Sb, As, Cd, Cr, Cu, Pb, Mn, Hg, MeHg, Se, and Zn) (see Section 1.1). Descriptive statistics for soil biota samples collected from background and MCMA areas were generated using ProUCL and provided in Attachment C-4. Background statistical test selection is summarized in Table C-3. Results of background comparisons are summarized in Table C-4 and ProUCL background comparison output files are provided in Attachment C-5.

Table C-3 - Soil Biota Tissue Background Comparison Statistical Test Selection

Phase 2 COC	Background Dataset		Site Dataset		Background Test
	≥ 40% ND?	> 1 DL?	≥ 40% ND?	> 1 DL?	
Antimony	Yes	Yes	No	No	Gehan
Arsenic	No	No	No	No	WMW
Cadmium	No	No	No	No	WMW
Ca	No	No	No	No	WMW
Chromium	Yes	Yes	No	No	Gehan
Copper	No	No	No	No	WMW
Lead	No	No	No	No	WMW
Manganese	No	No	No	No	WMW
Mercury	No	No	No	No	WMW
Methylmercury	No	Yes	No	No	Gehan
Selenium	Yes	Yes	No	No	Gehan
Zinc	No	No	No	No	WMW

Notes:
COC - constituent of concern
ND – non-detect
DL - detection limit
WMW - Wilcoxon-Mann-Whitney

Five constituents in soil biota (Sb, As, Cr, Pb, and MeHg) have concentrations in the MCMA exceeding background (Table C-4). These five constituents are identified as COPCs and will be evaluated further in this Phase 3 TEE. The specific COPCs for soil biota are Sb, As, Pb, and MeHg, while the insectivorous wildlife COPCs are Sb, As, Cr, Pb, and MeHg.

Table C-4 -Summary of Soil Biota Tissue Background Comparisons

Phase 2 COC[5]	Is site > background?[1]	Phase 2 TEE Soil Biota COCs in Ecological Exposure Area?[2]					Soil Biota COPC for Phase 3 TEE?[3]
		1	2	3	4	5	
Antimony	Yes	Yes	No	Yes	Yes	No	Yes
Arsenic	Yes	Yes	Yes	Yes	Yes	No	Yes
Cadmium	No	Yes	No	Yes	Yes	No	No
Chromium	Yes	No	No	No	No	Yes	Yes
Copper	No	Yes	Yes	Yes	Yes	No	No
Lead	Yes	Yes	Yes	Yes	Yes	No	Yes
Manganese	No	No	No	No	Yes	No	No
Mercury	No	Yes[4]	Yes[4]	Yes[4]	Yes[4]	No	No
Methylmercury	Yes	--	--	--	--	--	Yes
Selenium	No	No	Yes	No	No	No	No
Zinc	No	Yes	Yes	Yes	Yes	No	No

Notes:
COC - constituent of concern
EISC - ecological indicator soil concentration
COPC - constituent of potential concern
EPA - US Environmental Protection Agency
TEE - terrestrial ecological evaluation
EcoSSL - ecological soil screening level

[1] ProUCL background comparison output files are provided in Attachment C-5.
[2] Soil biota COCs were identified in five ecological exposure areas in the TEE conducted as part of the MCMA Phase 2 Remedial Investigation (Hart Crowser 2012).
[3] Constituents with site soil biota tissue concentrations greater than background which were identified as a soil biota COC in at least one ecological exposure area in the Phase 2 Remedial Investigation (Hart Crowser 2012), were retained as COPCs for the Phase 3 TEE.
[4] This constituent was identified as a COPC during Phase 2 TEE screening using the lowest MTCA EISC (Hart Crowser 2012). In the Phase 2 site-specific TEE (Hart Crowser 2012), COPCs were compared to EPA's EcoSSLs. An EcoSSL was not available for soil invertebrates for this constituent, so the constituent was retained as a COC in the Phase 2 TEE.
[5] As described in Section 1.1, Phase 2 TEE soil biota COCs include Sb, As, Cd, Cu, Pb, Mn, Hg, Se, and Zn, while Phase 2 TEE insectivorous wildlife COCs include Sb, As, Cd, Cr, Cu, Pb, Se, and Zn.
Constituents retained as soil biota COPCs following background comparisons are highlighted and evaluated further in the Phase 3 TEE.

2.2 Site-specific Bioaccumulation Models for Plants and Soil Biota

Bioaccumulation models were used in the Phase 2 TEE to estimate exposure of wildlife to soil-borne COPCs. These bioaccumulation models were obtained from the literature and may not be representative of bioaccumulation at the MCMA. Therefore, site-specific bioaccumulation models were developed using co-located soil and plant/soil biota tissue data collected from the MCMA.

The site-specific bioaccumulation models will be used for two purposes:

- To estimate the plant and soil biota tissue concentrations for COPCs in each of five EEAs identified in the Phase 2 TEE.
- To estimate the exposure of wildlife to COPCs through the ingestion of food in each EEA identified in the Phase 2 TEE.

2.2.1 Methods

Exploratory analysis of the plant and soil biota datasets was conducted to determine how best to organize the data for purposes of bioaccumulation modeling. Exploratory analysis included:

- Evaluate the option of combining the MCMA and background datasets for soil biota and plants (Section 2.2.1.1).
- Evaluate the effect of the MCMA mine site soil groupings (Group 1 and Group 2 sites) on soil biota and plant tissue data groupings (Section 2.2.1.2).
- For plants, evaluate if the grass and shrub tissue datasets from the MCMA should be combined (Section 2.2.1.3).
- For plants, evaluate the influence of different species on bioaccumulation within the MCMA (Section 2.2.1.4).
- For plants, evaluate the influence of sample location (i.e., on the waste rock pile versus adjacent to the waste rock pile) on bioaccumulation within the MCMA (Section 2.2.1.5).

All Phase 3 tissue and soil data were used in these analyses. In most cases, statistical analysis was performed using EPA's ProUCL software, which uses statistically valid methods to address non-detected (censored) data. In cases where individual sample bioaccumulation factors (BAFs) were calculated, one-half the detection limit was substituted for non-detected values.

2.2.1.1 Use of MCMA and Background Tissue Data for Bioaccumulation

Only five soil biota tissue samples were available from the MCMA. Such a small dataset has significant limitations when performing regression analysis for deriving bioaccumulation models. Therefore, the option of combining soil biota data from the MCMA and background areas was evaluated to improve the predictability of the regression equations. A two-step process was used to evaluate the background and MCMA soil biota tissue data:

- Bioaccumulation factors (BAFs) were calculated for co-located tissue and soil samples for each COPC.[6] BAF is the concentration in tissue (mg/kg dry weight [DW]) divided by the concentration in soil (mg/kg [DW]). If the COPC was not detected in the soil and/or tissue sample, one-half the detected limit was used as the value.

- The MCMA and background BAFs were compared using EPA's ProUCL hypothesis test for two samples using the WMW non-parametric test. A two-sided WMW test was conducted with the null hypothesis being the MCMA BAFs are equal to the background BAFs.

If results of the WMW test showed no significant differences between the BAFs for the MCMA and background areas, the datasets were pooled for purposes of bioaccumulation modeling. If the MCMA and background BAF datasets were significantly different, only the MCMA dataset was used for bioaccumulation modeling.

Results of BAF testing show that the soil biota BAFs for the MCMA and background areas are not significantly different for Sb, As, Pb, and MeHg, but are significantly different for chromium (Attachment C-6). Therefore, the MCMA and background soil biota data for Sb, As, Pb, and MeHg were combined for bioaccumulation modeling, but only the MCMA soil biota data were used for bioaccumulation modeling of chromium.

A much larger dataset of plant tissue samples is available from the MCMA (i.e., 65 samples), so it was deemed unnecessary to consider including the background plant tissue samples (i.e., 12 samples) in the bioaccumulation modeling. Therefore, bioaccumulation modeling for plants only used plant tissue data from the MCMA.

2.2.1.2 Effect of Mine Soil Groupings on Bioaccumulation

Previous analysis of soil data from the MCMA showed mine sites could be organized into two major groups based on the relative proportion of metals. Group 1 sites include the Justice, O&B, and Sheridan mines and Group 2 sites included the Mystery, New Discovery, and Pride of the Mountains Mines. This pattern was investigated in soil biota and plant tissue samples by comparing BAFs from Group 1 and 2 sites using the methodology described in Section 2.2.1.1.

Although few soil biota tissues samples were available from the MCMA, a comparison of soil from Group 1 and 2 sites was conducted for the five COPCs identified in Section 2.1.3. Results show there is no significant difference among the Group 1 and 2 mine sites in the BAFs for soil biota COPCs (Sb, As, Cr, Pb, and MeHg) (Attachment C-7). Therefore, soil biota tissue data from the Group 1 and 2 mine sites was combined for bioaccumulation modeling.

[6] For the purpose of calculating soil biota BAFs, a median soil concentration was derived for each mine area using the 2013 soils data. The soil biota tissue concentration was divided by the median soil concentration to yield a BAF.

The plant BAF dataset was more complex than the soil biota dataset because it comprised two major plant groups (grasses and shrubs) with a number of different species within each plant group. This was further compounded by the fact that some species were sampled from one mine site, while others were sampled from other mine sites. For example, spiny wood fern (grouped as a grass) and common horsetail (grouped as a shrub) were only sampled at the Justice Mine (Group 1). After performing a number of preliminary analyses, the most appropriate plant BAF data to use for these comparisons were identified as sedges (a grass) and huckleberry (a shrub).[7] Sedges and huckleberry were sampled at most of the five mine sites[8] and use of these data eliminated the confounding effects of sampling different species at the different mine sites.

Results of comparing BAFs for sedge and huckleberry for plant COPCs (i.e., Sb, As, Co, Cu, Fe, Pb, Tl, and Zn) at Group 1 and 2 sites show that 13 of 16 comparisons are not significantly different for Group 1 and 2 sites (Attachment C-8). The exceptions are iron for huckleberry and zinc for huckleberry and sedge. Since the majority of comparisons do not show significant differences, separating the plants tissue data into different soil groups for purposes of bioaccumulation modeling does not appear to be warranted. Therefore, plant tissue data from the Group 1 and 2 mine sites was combined for bioaccumulation modeling.

2.2.1.3 Effect of Grass and Shrub Grouping on Bioaccumulation

The possibility of combining grass and shrubs tissue datasets for bioaccumulation modeling was investigated by comparing BAFs from the MCMA. The statistical methodology for comparing grass and shrub BAFs is described in Section 2.2.1.1.

Results for the eight plant COPCs (Sb, As, Co, Cu, Fe, Pb, Tl, and Zn) show that the BAFs for grass and shrub samples from the MCMA are not significantly different for six of eight COPCs (Attachment C-9). The exceptions are cobalt (median BAFs are 0.00125 for grasses and 0.00205 for shrubs) and lead (median BAFs are 0.00118 for grasses and 0.000357 for shrubs). These results do not indicate frequent or consistent differences in BAFs between grasses or shrubs. Therefore, the grass and shrub tissue data will be combined for purposes of bioaccumulation modeling.

2.2.1.4 Effect of Plant Species on Bioaccumulation

Eleven different plant species were sampled in 2013 (five grasses – Sitka sedge, blue wild rye, spiny wood fern, black alpine sedge, and a composite of grass and sedge; six shrubs – Pacific bleeding heart, edible thistle, black huckleberry, huckleberry, Sitka mountain-ash, and common horsetail). A qualitative examination of the effect of plant species was conducted by examining bar graphs of median BAFs of the eight plant COPCs (Sb, As, Co, Cu, Fe, Pb, Tl, and Zn) for each species and mine site

[7] The sedge group included species identified as Sitka sedge and black alpine sedge. The huckleberry group included species identified as black huckleberry and huckleberry.
[8] Sedge was sampled at the O&B Mine (group 1), Mystery Mine (Group 2), and Pride of the Mountains Mine (Group 2), while huckleberry was sampled at the O&B Mine (Group 1), Sheridan Mine (Group 1), New Discovery Mine (Group 2), and Pride of the Mountains Mine (Group 2).

(Note: figures are not presented). In general, no clear patterns of species differences in median BAFs were discernible. Some relevant observations are:

- Common horsetail at the Justice Mine had the highest median BAFs for arsenic and iron.
- Spiny wood fern at the Justice Mine had the lowest median BAFs for copper and zinc.
- Sitka mountain-ash at the Mystery Mine had the lowest median BAFs for arsenic, lead, and thallium, but had the highest median BAF for cobalt.

Although median BAFs varied considerably depending on plant species and mine site, no strong patterns were observed. In general, BAFs for metals are expected to vary depending upon soil concentrations and soil characteristics. Bioaccumulation factors of metals generally decline as soil concentrations increase. This is because many plants have the ability to control the uptake of metals so that they do not become toxic to the plant. One important soil characteristic that controls the bioavailability of some metals is the soil pH. In general, the bioavailability of cations (e.g., copper, lead, iron, and zinc) tends to increase as the soil pH decreases, while the bioavailability of anions (e.g., arsenic) tends to increase as soil pH increases. The lowest median soil pH occurred at the Mystery Mine (3.8), the highest soil pH occurred at the Justice Mine (5.8.), and the median pH at the New Discovery, O&B, Pride of the Mountains, and Sheridan Mines varied between 4.2 and 4.6. However, no obvious patterns of BAFs relative to mine site soil pH were discernible.

Results of this qualitative analysis found no compelling reasons to separate plant species for purposes of bioaccumulation modeling. Therefore, plant species were grouped together for bioaccumulation modeling.

2.2.1.5 Effect of Plant Sample Location on Bioaccumulation

Although most of the plant tissue samples were collected from locations directly on the mine waste rock piles, plant cover was sparse and some plant samples had to be collected adjacent to the sides of the waste rock piles or at the toe of the waste rock piles. The influence of sample location was investigated to determine if there were consistent and significant differences in bioaccumulation. Each plant sample was classified as either “On” (45 samples) or “Off” (20 samples) the waste rock piles. The BAFs for the eight plant COPCs (Sb, As, Co, Cu, Fe, Pb, Tl, and Zn) were analyzed using the statistical methodology described in Section 2.2.1.1.

Results of the comparison of plant samples collected “On” and “Off” the mine waste rock piles show that six of eight COPCs have BAFs that are not significantly different (Attachment C-10). The exceptions are copper (median BAFs for “On” is 0.0088 and “Off” is 0.0134) and thallium (median BAFs for “On” is 0.0071 and “Off” is 0.0133). These results indicate that grouping plant samples based on location (“On” and “Off” the waste rock piles) is unwarranted. Therefore, for purposes of bioaccumulation modeling, plant samples located “On” and “Off” the waste rock piles will be grouped together.

2.2.2 Bioaccumulation Modeling

The following methodology was used to derive bioaccumulation models:

- Following EPA (1997), a regression equation was preferentially used as the site-specific bioaccumulation model. The regression equation had to comply with the following acceptance criteria: the regression had to be statistically significant ($p \leq 0.05$), the coefficient of determination (r^2) had to be equal to or greater than 0.2, and the slope of the regression line had to be positive.

- Two regression models were run on each tissue type and constituent, a linear and a log-log linear model. The log-log linear regression model was used by EPA (1997) to derive bioaccumulation models for use in the EcoSSLs. If both models met the acceptability criteria, the regression model with the highest r^2 was selected as the site-specific bioaccumulation model. If neither regression met the acceptability criteria, the median BAF was calculated and used as the site-specific bioaccumulation model.

2.2.2.1 Results of Bioaccumulation Modeling for Plants

Results of bioaccumulation modeling for plants are summarized in Table C-5. Regression equations meeting acceptance criteria are available for six of eight plant COPCs (antimony, arsenic, cobalt, lead, thallium, and zinc) and will be used as site-specific bioaccumulation models. Neither the linear regression model nor log-log linear regression model met acceptance criteria for copper and iron, so the median BAF is used as the bioaccumulation model.

Table C-5 - Summary of Bioaccumulation Modeling for Plants

Constituent[1]	Model
Antimony	ln(y) = 0.5556 ln(x) - 5.5624 (r2 = 0.385, p < 0.001, n = 65)
Arsenic	ln(y) = 0.6834 ln(x) - 5.5414 (r2 = 0.233, p < 0.001, n = 65)
Cobalt	ln(y) = 0.6939 ln(x) - 5.6351 (r2 = 0.268, p < 0.001, n = 65)
Copper	y = 0.00966 x (n =655)
Iron	y = 0.000384 x (n =655)
Lead	ln(y) = 1.0013 ln(x) - 7.3314 (r2 = 0.466, p < 0.001, n = 65)
Thallium	ln(y) = 0.9815 ln(x) - 4.5694 (r2 = 0.647, p < 0.001, n = 65)
Zinc	ln(y) = 0.5067 ln(x) - 0.1012 (r2 = 0.483, p < 0.001, n = 65)

Notes:
1 Bioaccumulation models were developed for the plant COPCs identified in Section 2.1.2.
r2 = coefficient of determination
p = significance of the regression
n = number of samples
y = constituent concentration in soil invertebrate tissue (mg/kg dry weight)
x = constituent concentration in soil (mg/kg dry weight)

2.2.2.2 Results of Bioaccumulation Modeling for Soil Biota

Results of bioaccumulation modeling for soil biota are summarized in Table C-6. Regression equations meeting acceptance criteria are available for antimony, arsenic, and lead and will be used as site-specific bioaccumulation models. Neither the linear regression model nor log-log linear regression model met acceptance criteria for chromium or methylmercury, so the median BAF is used as the bioaccumulation model.

Table C-6 - Summary of Bioaccumulation Modeling for Soil Biota

Constituent[1]	Are BAFs in MCMA and background samples significantly different?[2]	Model
Antimony	No	$y = 0.0128x + 0.0434$ ($r^2 = 0.94$, $p = 0.0000002$, n = 12)
Arsenic	No	$\ln(y) = 0.4964 \ln(x) - 1.6847$ ($r^2 = 0.34$, $p = 0.046$, n = 12)
Chromium	Yes	$y = 0.011x$ (n = 5)
Lead	No	$\ln(y) = 0.8337 \ln(x) - 4.3042$ ($r^2 = 0.57$, $p = 0.005$, n = 12)
Methylmercury	No	$y = 0.035x$ (n = 12)

Notes:
[1] Bioaccumulation models were developed for the soil biota COPCs identified in Section 2.1.3.
[2] See Section 2.2.1.1 for details.
r^2 = coefficient of determination
p = significance of the regression
n = number of samples
y = constituent concentration in soil invertebrate tissue (mg/kg dry weight)
x = constituent concentration in soil (mg/kg dry weight)
BAF = bioaccumulation factor

2.3 Critical Body Residue Evaluation for Plants and Soil Biota

Critical body residues (CBRs) are concentrations of constituents measured in the tissues of organisms below which adverse effects to the organisms are not expected to occur. CBRs were derived for COPCs in plants (Section 2.3.1) and soil biota (Section 2.3.2) from the published toxicological literature. The CBRs were then compared to measured and modeled tissue concentrations from the MCMA. A reasonable maximum exposure point concentration (EPC) was derived for each COPC using the measured tissue concentration of plants and soil biota from the MCMA. Tissue EPCs were derived using EPA's ProUCL and included non-detected values. Modeled tissue concentrations were derived by substituting the soil EPCs for each of the five EEAs into the site-specific bioaccumulation models developed in Sections 2.2.2.1 for plants and Section 2.2.2.2 for soil biota. The resulting modeled tissue EPCs were then compared to the CBRs. If a measured or modeled tissue EPC was greater than the CBR and resulted in a hazard quotient (HQ) greater than one[9], this indicated the constituent poses a hazard to the organism.

[9] The HQ is calculated by dividing the tissue EPC (mg/kg dry weight) by the CBR (mg/kg dry weight).

2.3.1 Plants

2.3.1.1 Critical Body Residue Methodology

Eight metals (Sb, As, Co, Cu, Fe, Pb, Tl, and Zn) were identified as plant COPCs (Section 2.1.2), so CBRs were developed for each of these COPCs.

Considerable toxicological data is available for deriving plant CBRs for several metals. Much of these data were developed to support the determination of nutritional requirements for agronomic crops. Beckett and Davis (1977) helped to develop the biological basis for plant CBRs. For essential elements, the dose response curve for accumulation of metals in tissues begins with reduced yields at tissue concentrations below nutritional requirements (Figure C-3). As the tissue concentration increases, it reaches the lower critical level at which point the yield curve plateaus and optimal nutritional requirements are met. As the tissue concentration increases further, it reaches an upper critical level at which point the yield begins to decline. An essential component of this relationship is that for a particular species the relative yield at the plateau of the curve may shift up or down due to other environmental factors (e.g., temperature, nutrition, water relations), while the upper critical level remains relatively constant. For non-essential elements, the dose-response curve consists of a plateau at which point the yield is constant over a range of tissue concentrations and an upper critical level at which point the yield begins to decline as the tissue concentration become toxic.

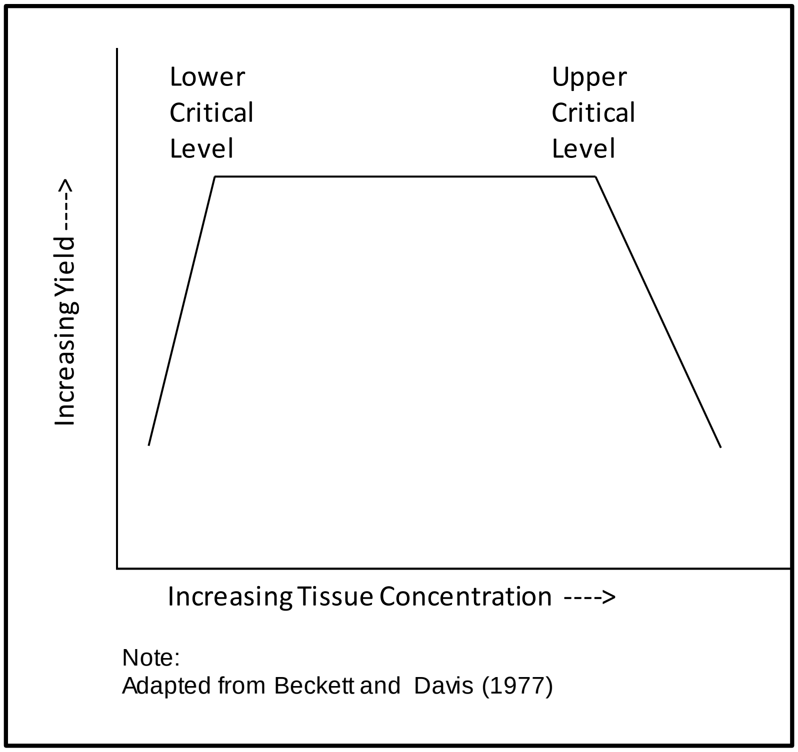


Figure C-3 – Plant Dose-response Curve for Essential Elements

A number of published comprehensive studies of plant CBRs were compiled and reviewed with the results presented in Table C-7. Kabata-Pendias (2001) conducted a review of tissue metal studies and identified sufficient or normal levels and excessive or toxic levels reported for a variety of crop plants. Five other studies reported either the upper critical levels or the tissue concentration at which there is a 10 percent reduction in growth/yield (Table C-7). Typically the lowest reported value was selected as the CBR except in a few cases of unusually low toxicity values (i.e., outliers) which were not considered to be representative of potential toxicity. In most cases, the selected CBR was well above the sufficient or normal level identified by Kabata-Pendias (2001). Macinol and Beckett (1985) and Adriano (1980) compiled the published CBR reports and presented the data in tabular form. Their phytotoxicity data include a broad variety of agronomic crops. Studies by Beckett and Davis (1977), Davis and Beckett (1978), and Davis et al. (1978) reported original study results for a number of crop species and a number of metals.

The use of upper critical levels or the 10th percentile values to represent the CBR is a conservative approach as these levels occur at the point at which yield begins to decrease or decreases have just begun. The ecological relevance of a small decrease in plant yield to the overall health of the plant is questionable. However, for most metals there is a wide margin between the sufficient or normal tissue concentration identified by Kabata-Pendias (2001) and the selected CBR. This suggests that these CBRs are useful for assessing phytotoxicity.

Table C-7 shows that the selected CBR for arsenic, copper, and zinc fall well within the sufficient or normal tissue concentration ranges identified by Kabata-Pendias (2001). Clearly, CBRs that fall within the normal or sufficient range of tissue concentrations are of limited value for evaluating potential phytotoxicity. Copper and zinc are essential nutrients for plants and their internal tissue levels are actively regulated, while arsenic is not an essential plant nutrient (EPA 2007). A more in-depth evaluation was conducted to identify more appropriate CBRs for arsenic, copper, and zinc.

Chang et al. (1992) developed an approach for deriving phytotoxicity criteria for determining metal soil loading rates for the land application of municipal sludge. They identified the 50 percent phytotoxicity threshold (PT_{50} – tissue concentration at which there is a 50 percent reduction in growth) tissue concentration in young test plants as the most appropriate endpoint for extrapolating to a significant reduction of growth/yield at maturity. Almost all published metals toxicity data are based on assessing effects on growth at early life stages of agronomic crops because of constraints associated with testing to maturity (e.g., time, experimental setup, cost). The PT_{50} was selected as the endpoint for developing CBRs for arsenic, copper, and zinc at the MCMA.

A literature review was conducted to identify data sources for deriving additional CBR data for arsenic, copper, and zinc. Selected literature either had to provide a PT_{50} value or provide data sufficient to calculate a PT_{50} value. In cases where dose-response data were provided, a linear regression model was developed with tissue metal concentration as the independent variable and growth/yield as the dependent variable. The PT_{50} was derived from the regression model using the reported control growth/yield as the standard growth/yield. The 10th percentile of the PT_{50} values was selected as the final CBR.

Results of the additional CBR evaluations are presented in Table C-8 for arsenic, Table C-9 for copper, and Table C-10 for zinc. The selected CBR for arsenic is 3 mg/kg DW and is above the sufficient or normal level, but below the excessive or toxic level (Table C-7). The selected CBR for copper is 25 mg/kg DW and is at the upper end of the sufficient or normal range and at the lower end of the excessive or toxic range (Table C-7). The selected CBR for zinc is 324 mg/kg DW and is above the sufficient or normal range and at the upper end of the excessive or toxic range (Table C-7).

Table C-8 – Plant Tissue PT50 Values for Arsenic (mg/kg DW)

Species	Source	PT_{50}
Lima bean	Woolson (1973)	1.7
Corn	Gluz (2002)	3
Cabbage	Woolson (1973)	3.4
Green bean	Woolson (1973)	3.7
Tomato	Woolson (1973)	4.5
Soybean	Deuel and Swaboda (1972)	4.5
Cotton	Deuel and Swaboda (1972)	8
Pistacio	Moreno-Jimenez et. al. (2009)	10
Alfalfa	Anderson et. al. (2008)	10
Spinach	Woolson (1973)	10
Ryegrass	Anderson et. al. (2008)	11
Black gram	Srivastava and Shumar (2013)	11.3
Ryegrass	Gluz (2002)	15.8
Blueberry	Anastasia and Kender (1973)	16.2
Millet	Anderson et. al. (2008)	18
Rice	Quazi et. al (2011)	22
Basin wildrye	Knudson et. al. (2003)	35.5
Sunflower	Gluz (2002)	41.5
Radish	Woolson (1973)	43
Tamarix	Moreno-Jimenez et. al. (2009)	110
Barley	Davis, Beckett, and Wollan (1978)	117
	10th Percentile =	**3**

Notes:
PT_{50} - phytotoxic threshold at which there is a 50 percent reduction in growth
DW - dry weight

Table C-9 – Plant Tissue PT50 Values for Copper (mg/kg DW)

Species	Source	PT_{50}
Corn	MacLean and Dekker (1978)	8.3
Lettuce	MacLean and Dekker (1978)	20.6
Bush bean	Wallace et. al. (1977)	29.5
Corn	McBride (2001)	37
Cassava	Howeler et. al. (1982) as cited in Paschke and Redente (2002)	40
Bush Bean	Chang et. al. (1992)	60
Pakchoi	Yang et. al. (2002)	62
Barley	Davis et. al. (1978)	64
Chinese cabbage	Yang et. al. (2002)	75
Celery	Yang et. al. (2002)	140
Corn	Chang et. al. (1992)	375
Slender wheatgrass	Paschke and Redente (2002)	737
Wheat	Paschke and Redente (2002)	2,761
Tufted hairgrass	Paschke and Redente (2002)	2,978
Basin wildrye	Paschke and Redente (2002)	4,050
Redtop	Paschke and Redente (2002)	10,792
	10th Percentile =	**25**

Notes:
PT50 - phytotoxic threshold at which there is a 50 percent reduction in growth
DW - dry weight

Table C-10 – Plant Tissue PT50 Values for Zinc (mg/kg DW)

Species	Source	PT_{50}
Bush bean	Ruano et. al. (1988)	283
Bush bean	Giordano et. al. (1975)	321
Bermudagrass	Best et al (2003)	324
Meadow foxtail	Best et. al. (2004)	327
Wheat	Chang et al (1992)	350
Bush bean	Chang et al (1992)	375
Lettuce	MacLean and Dekker (1978)	395
Lettuce	Chang et al (1992)	475
Corn	Takkar and Mann (1978)	600
Red fescue	Best et. al. (2004)	615
Jack bean	Andrade et. al. (2009)	770
Bush bean	Wallace et. al. (1977)	903
Corn	Giordano et al (1975)	930
Rape	Montilla et. al. (2003)	1,072
Corn	Chang et al (1992)	2,200
Great basin wildrye	Paschke et. al. (2000)	2,449
Big bluegrass	Paschke et. al. (2000)	2,562
Corn	Mortvedt and Giordano (1975)	3,658
Tufted hairgrass	Paschke et. al. (2000)	4,380
Slender wheatgrass	Paschke et al (2000)	5,026
	10^{th} Percentile =	**324**

Notes:
PT_{50} - phytotoxic threshold at which there is a 50 percent reduction in growth
DW - dry weight

2.3.1.2 Hazard Characterization

The plant CBRs for the eight COPCs (Section 2.1.2) and the MCMA measured plant tissues EPCs (Attachment C-11) are shown in Table C-11. Results show that the measured plant tissue EPCs are less than the CBR for seven of eight COPCs (Sb, Co, Cu, Fe, Pb, Tl, and Zn). The exception is arsenic, which has a measured plant tissue EPC (10.69 mg/kg DW) above the CBR (3 mg/kg DW) that would result in an HQ of 4.

Plant bioaccumulation models derived in Section 2.2.2.1 and soil EPCs for each EEA developed during the Phase 2 TEE (Hart Crowser 2012) were used to derive the modeled plant tissue EPCs shown in Table C-11. Results show the modeled plant tissue EPCs for all EEAs are less than the CBRs for seven of eight COPCs (Sb, Co, Cu, Fe, Pb, Tl, and Zn). The exception is arsenic, which has modeled plant tissue EPCs above the arsenic CBR at EEAs 1, 2, and 4. However, only EEAs 1 and 4 have HQs above one (in both areas the HQ is 2).

Table C-11 – Comparison of Measured and Modeled Plant Tissue EPCs to Plant CBRs

Plant COPC	Plant CBR (mg/kg DW)	Measured Plant EPC (mg/kg)	Ecological Exposure Area Soil EPCs (mg/kg)[1]					Ecological Exposure Area Modeled Plant Tissue EPCs (mg/kg DW)[2]				
			1	2	3	4	5	1	2	3	4	5
Antimony	150	0.257	4,301	72	3,827	675	4	0.401	0.041	0.376	0.143	0.009
Arsenic	3	10.69	32,028	27,439	12,730	38,158	327	4.7	4.2	2.5	5.3	0.2
Cobalt	6	0.0709	7	48	21	26	31	0.014	0.052	0.030	0.034	0.039
Copper	25	12.56	943	742	524	261	114	9.1	7.2	5.1	2.5	1.1
Iron	500	151.5	67,590	105,833	94,482	76,199	43,809	26.0	40.6	36.3	29.3	16.8
Lead	30	3.989	10,092	594	16,364	4,238	72	6.7	0.4	10.8	2.8	0.0
Thallium	20	0.179	3.67	0.33	3.05	0.46	0.21	0.037	0.003	0.031	0.005	0.002
Zinc	324	70.1	2,822	306	1,090	2,138	135	50.6	16.4	31.3	44.0	10.9

Notes:
COPC - constituents of potential concern identified in Section 2.1.2.
CBR - Critical body residue for plants developed in Section 2.3.1.
EPC - exposure point concentration
DW - dry weight
[1] Soil EPCs were obtained from the Phase 2 TEE (Hart Crowser 2012).
[2] Modeled plant tissue EPCs were calculated by substituting the soil EPCs into the bioaccumulation models derived in Section 2.2.2.
Highlighted concentrations are greater than the CBR.

Plant bioaccumulation models derived in Section 2.2.2.1 and soil EPCs for each EEA developed during the Phase 2 TEE (Hart Crowser 2012) were used to derive the modeled plant tissue EPCs shown in Table C-11. Results show the modeled plant tissue EPCs for all EEAs are less than the CBRs for seven of eight COPCs (Sb, Co, Cu, Fe, Pb, Tl, and Zn). The exception is arsenic, which has modeled plant tissue EPCs above the arsenic CBR at EEAs 1, 2, and 4. However, only ecological exposure areas 1 and 4 have HQs above one (in both areas the HQ is 2).

Based on these results, arsenic is identified as a COC for plants and poses a hazard (expressed as a reduction in plant growth) to individual plants living on the MCMA source areas (i.e., waste rock piles).

2.3.2 Soil Biota

2.3.2.1 Critical Body Residue Methodology

Five metals (Sb, As, Cr, Pb, and MeHg) were identified as soil biota COPCs at the MCMA (Section 2.1.3). CBRs were developed for each of these COPCs.

There is considerably less tissue toxicity data available from which soil biota CBRs can be derived. In addition, much of the soil biota data comes from toxicity tests using earthworms. Although earthworms are generally considered to be sensitive toxicity test species, the relationship between the CBRs for earthworms and the CBRs for soil biota present at the MCMA (i.e., ants) is unknown.

Due to the lack of soil biota tissue toxicity data for COPCs, the approach used to derive soil biota CBRs was different than that used for plant CBRs. A literature review was conducted to identify appropriate studies from which to derive CBRs. For all COPCs, only a single study was found that had suitable tissue and effects data. The lowest observed adverse effect level (LOAEL) was selected as the CBR. For some COPCs, the study reported results for multiple endpoints (e.g., reproduction, growth). In these cases, the lowest LOAEL was selected as the CBR. Use of LOAEL toxicity data is consistent with the MTCA TEE procedures (WAC 173-340-7493(4)(a)).

For purposes of deriving soil biota CBRs for the MCMA, the LOAEL is defined as the tissue concentration at which there is a 20 percent depression in the characteristics (termed the effect concentration 20 or EC_{20}). The EC_{20} is a standard endpoint used in environmental toxicity testing which is deemed as biologically significant. The EC_{20} was typically derived using linear regression models of the body residues and toxicity data. Acceptance criteria for the regression model included an r^2 of 0.2 or greater and a significant level of $p = 0.05$ or less.

Antimony

No literature was found from which a soil biota CBR could be derived for antimony.

Arsenic

A study by Wong (2003) was used to develop the soil biota CBR for arsenic. Earthworms (*Eisenia andrei*) were exposed to six concentrations of arsenic and a control in both an artificial and field soil. Tests included four replicates with ten worms per replicate and earthworms were fed periodically. After 28 days, earthworms were removed from the test containers and their survival and growth recorded. The earthworms were depurated for 24 hours prior to chemical analysis. Test soil was incubated for an additional 28 days after which the total number of cocoons, number of hatched cocoons, and number of juveniles were assessed.

Significant effects of arsenic exposure were observed on the survival, growth and reproduction of earthworms (Wong 2003). Wong (2003) developed a series of regression equations modeling the effect of earthworm arsenic concentrations on the survival, growth and reproduction (Table C-12). These models were used to derive EC_{20} values for each endpoint (Table C-12). The arsenic EC_{20} values ranged from 68 mg/kg DW for the number of juveniles in field soil to 717 mg/kg DW for weight change in the artificial soil. The lowest EC_{20} (68 mg/kg DW) was selected as the soil biota CBR for arsenic.

Table C-12 – Bioaccumulation and Toxicity of Arsenic in Earthworms

Soil type	Trait	Regression Model[a]	r^2	EC_{20}[b]
Artificial Soil	adult survival (%)	$y = -0.0002x^2 - 0.02x + 101.77$	0.82	280
	weight change (%)	$y = -0.0002x^2 + 0.14x + 13.95$	0.9	717
	total number of cocoons	$y = -0.0007x^2 + 0.14x + 66.44$	0.98	257
	number of hatched cocoons	$y = -0.0007x^2 + 0.12x + 61.24$	0.99	233
	number of juveniles	$y = -0.0013x^2 + 0.18x + 143.61$	0.98	212
Field Soil	survival (%)	$y = -0.0003x^2 + 0.06x + 98.97$	0.47	370
	weight change (%)	$y = -0.0003x^2 + 0.07x + 22.31$	0.64	336
	total number of cocoons	$y = 0.0001x^2 - 0.22x + 70.46$	0.97	73
	number of hatched cocoons	$y = 0.00005x^2 - 0.13x + 47.43$	0.96	97
	number of juveniles	$y = 0.005x^2 -0.69x + 203.3$	0.97	68

Source: Wong (2003)
Notes:
[a] In these models, y = trait and x = arsenic tissue concentration (mg/kg dry weight)
[b] The EC_{20} are effect concentrations (mg/kg dry weight) at which there is a 20 percent decrease in the value of the trait. The EC_{20} values were calculated using the regression models and control treatment values reported by Wong (2003).
r^2 - coefficient of determination

Chromium

A study by van Gestel et al. (1993) was used to derive the soil biota CBR for chromium. Adult earthworms (*Eisenia andrei*) were exposed to chromium added to an artificial soil for a three-week period. Chromium was added at five treatment concentrations plus a control and food was added to the soil. Treatments were replicated four times. Earthworm weight was measured at the beginning and end of the 3-week test period and growth expressed as the percent weight change. At the end of the 3-week test period, the cocoon production was assessed and the cocoons transferred to untreated soil for an additional five weeks after which the number of juveniles was assessed. In addition, at the end of the 3-week test period, adult earthworms were depurated for 24 hours prior to chemical analysis.

Results of the van Gestel et al. (1993) study are provided in Table C-13 and show that the concentrations of chromium in earthworms increased with increasing soil concentration. Growth and the number of juveniles decreased with increasing earthworm chromium concentration. Linear regression models were derived from this data where x = chromium concentration in earthworm (mg/kg DW) as follows:

- Growth (%) = -0.4079x + 28.875 ($r^2 = 0.338$, $p = 0.19$)
- Juveniles per worm (no.) = -0.0552x + 1.1065 ($r^2 = 0.646$, $p = 0.05$)

The regression model for the number of juveniles met acceptance criteria and was used to develop the CBR. The CBR for chromium of 2.65 mg/kg DW was generated by substituting tissue concentrations into the model to yield an EC_{20}.

Table C-13 - Bioaccumulation and Toxicity of Chromium in Earthworms

Soil Treatment (mg/kg DW)	Earthworm Concentration (mg/kg DW)	Earthworm Growth (%)[1]	Juveniles per Earthworm (no.)
0 (control)	0.3	34	1.2
10	0.8	30	1.25
32	1.2	24	1.3
100	3.9	27	0.55
320	4.6	24	0.5
1000	18	22.5	0.25

Source: Van Gestel et al. (1993)
Notes:
DW - dry weight
[1] Growth measured as the percent weight change from the beginning to the end of the test.

Lead

A study by Inouye et al. (2006) was used to derive the soil biota CBR for lead. Adult earthworms (*Eisenia fetida)* were exposed to five treatment concentrations of lead (plus a control) applied to a field soil. Earthworms (five replicates of five earthworms each) were exposed to treated soil for 28 days and periodically fed. After 28 days, survival and growth were measured and the earthworms were depurated overnight prior to chemical analysis. Soil treatment containers were incubated for an additional 28 days after which the number of cocoons and number of juvenile earthworms were assessed.

Inouye et al. (2006) reported 100 percent survival in all lead treatments and no significant effects of lead on growth. However, lead had significant effects on the number of cocoons and number of juveniles. These data are provided in Table C-14. Linear regression models were derived from this data (where x = lead concentration in earthworm (mg/kg DW)). Since the earthworm lead concentrations for the control was not provided, values from the lowest lead treatment were used as the experimental control. The linear regression models are:

- Number of cocoons = -0.0108x + 10.353 ($r^2 = 0.92$, $p = 0.002$)
- Number of juveniles = -0.0076x + 6.1768 ($r^2 = 0.53$, $p = 0.01$)

Both regression models met acceptance criteria. Substituting tissue concentrations into the models yielded lead EC_{20} of 262 mg/kg DW for the number of cocoons and 180 mg/kg DW for the number of juveniles. The lower EC_{20} of 180 mg/kg DW was selected as the soil biota CBR for lead.

Table C-14 – Bioaccumulation and Toxicity of Lead in Earthworms

Soil Concentration (mg/kg DW)	Earthworm Concentration (mg/kg FW)	Earthworm Concentration (mg/kg DW)[a]	Number of Cocoons at 56 Days	Number of Juveniles at 56 Days
5 (control)	NA	NA	17.8	45.2
328	5.8	36.25	9.4	6
461	14.1	88.125	9.4	5.8
943	41.9	261.875	8	2.4
1577	73.5	459.375	6.4	5.4
2351	97.9	611.875	2.8	0.2

Source: Inouye et al. (2006)
Notes:
[a] calculated assuming 84 percent moisture content in earthworms (EPA 1993)
DW - dry weight
FW - fresh weight
NA - not available

Methylmercury

A single study (Burton et al. 2006) was found from which a methylmercury CBR could be derived. The bioaccumulation kinetics of methylmercury and mercury were studied using uptake and depuration test phases. Earthworms (*Eisenia fetida*) were initially exposed to three natural soils contaminated with methylmercury and mercury and an uncontaminated control soil for a period of 28 days (uptake phase). All earthworms were then transferred to the uncontaminated control soil for an additional 14 days (depuration phase). The survival and growth of the earthworms were recorded on days 1, 2, 4, 7, 14, 21, 28, 35, and 42. In addition, the concentration of methylmercury and mercury accumulating in earthworms was measured on the same days. Earthworms were depurated for 24 hours prior to chemical analysis. Methylmercury concentrations in the soils at the beginning of the test were 0.00735 mg/kg (high contamination), 0.00250 mg/kg (moderate contamination), 0.00148 mg/kg (low contamination), and 0.00112 mg/kg (uncontaminated control). The test design included 36 replicates with 10 worms per replicate for each soil type. Earthworms were fed weekly.

Results showed that survival was high for all soils tested ranging from 95.5 to 100 percent survival (Burton et al. 2006). Growth rate averaged 5.1 mg per week and statistical analysis by the authors showed no differences in growth among soil types over the 42-day test period. The authors concluded that the survival and growth of earthworms were not affected by exposure to methylmercury or mercury in any of the soils. The maximum methylmercury concentrations in earthworms at the end of the 28-day test varied between 0.105mg/kg DW for the control soil to 0.775 mg/kg DW for the highly contaminated soil.

Although the data provided by Burton et al. (2006) were insufficient to derive a soil biota methylmercury EC_{20}, the results can be used as a no effects tissue concentration. The no effects tissue concentration is more protective then the EC_{20}. Therefore, a methylmercury soil biota CBR is 0.775 mg/kg DW.

2.3.2.2 Hazard Characterization

The soil biota CBRs for the five soil biota COPCs (Section 2.1.3) and the MCMA measured soil biota EPCs (Attachment C-12) are shown in Table C-15. Results show that the measured soil biota EPCs are less than the CBR for chromium, lead, and methylmercury. The measured soil biota EPC for arsenic is above the CBR, but the resulting HQ does not exceed 1. Therefore, arsenic is not identified as a COC based on measured tissue data. Antimony could not be evaluated due to the lack of a CBR.

Table C-15 – Comparison of Measured and Modeled Soil Biota Tissue EPCs to Soil Biota CBRs

Soil Biota COPC	Soil Biota CBR (mg/kg DW)	Measured Soil Biota EPC (mg/kg DW)	Ecological Exposure Area Soil EPC (mg/kg)[1]					Ecological Exposure Area Modeled Soil Biota Tissue EPC (mg/kg)[2]				
			1	2	3	4	5	1	2	3	4	5
Antimony	NA	2.593	4,301	72	3,827	675	4	1.16	1.10	1.16	1.14	1.06
Arsenic	68	90.31	32,028	27,439	12,730	38,158	327	31.98	29.62	20.23	34.89	3.29
Chromium	2.65	0.213	54	73	12	18	104	0.59	0.80	0.13	0.20	1.14
Lead	180	17.25	10,092	594	16,364	4,238	72	29.43	2.77	44.04	14.28	0.48
Methyl-mercury[3]	0.775	0.0127	0.34					0.012				

Notes:
NA - not available
COPC - constituents of potential concern identified in Section 2.1.2.
CBR - Critical body residue for soil biota developed in Section 2.3.1.
EPC - exposure point concentration
DW - dry weight
[1] Soil EPCs were obtained from the Phase 2 TEE (Hart Crowser 2012).
[2] Modeled plant tissue EPCs were calculated by substituting the soil EPCs into the bioaccumulation models derived in Section 2.2.2.
[3] Methylmercury was not measured in Phase 2 soil samples. A single soil EPC was calculated for the MCMA using the Phase 3 soils data.
Highlighted concentrations are greater than the CBR.

Soil biota bioaccumulation models developed in Section 2.2.2.2 and soil EPCs for each EEA developed during the Phase 2 TEE (Hart Crowser 2012) were used to develop the modeled soil biota tissue EPCs shown in Table C-15. Results indicate the modeled soil biota tissue EPCs for all EEAs are less than the CBRs for arsenic, chromium, lead, and methylmercury. Antimony could not be evaluated due to a lack of a CBR.

The soil biota hazards from antimony could not be assessed in the Phase 3 TEE because literature could not be found from which a soil biota tissue CBR could be derived. The Phase 2 TEE (Hart Crowser 2012) compared the EPA EcoSSL for soil biota (78 mg/kg soil) to soil EPCs to conclude that antimony poses a hazard to soil biota at EEAs 1, 3, and 4. EPA (2012) more recently reviewed the scientific literature on the toxicity of antimony. For soil biota, EPA determined the soil-based LC_{50} and EC_{50} for reproduction to be 10,119 mg/kg in soil. EPA also determined the soil biota reproductive lowest observed effect concentration (LOEC) to be 2,950 mg/kg in soil. The highest MCMA EEA soil EPC for antimony is 4,301 mg/kg. Since the resulting HQ is not greater than one

(4,301 mg/kg/2,950 mg/kg = 1[10]), it is concluded that antimony at the MCMA does not pose a hazard to soil biota.

These results show that no mining related constituents pose a hazard to individual soil biota living on the MCMA source areas (i.e., waste rock piles).

2.4 Hazards to Wildlife Using Site-Specific Bioaccumulation Models

2.4.1 Introduction

In the Phase 2 TEE (Hart Crowser 2012), hazards to wildlife were assessed using ecological indicator soil concentrations (EISCs) derived using MTCA exposure models for the vole, shrew, and robin. These models were modified with exposure factors, bioaccumulation models, and toxicity reference values obtained from EPA's EcoSSLs. A similar analysis is conducted in this Phase 3 TEE.

Based on the results of background tissue comparisons (Section 2.1.2 for plants and Section 2.1.3 for soil biota), the following COPCs will be evaluated in this Phase 3 wildlife TEE:

- Herbivorous wildlife (i.e., vole) for arsenic and lead.
- Insectivorous wildlife (i.e., shrew and robin) for antimony, arsenic, chromium, and lead.

Note that methylmercury is not identified as a COPC for insectivorous wildlife. Methylmercury was not included in the analysis of Phase 2 soil samples, but was included in the soils and tissue analysis during Phase 3 and was identified as a soil biota COPC. However, the Phase 3 soil EPC for methylmercury (0.34 mg/kg) is below the MTCA wildlife ISC for organic mercury (0.4 mg/mg). Therefore, methylmercury is not identified as a COPC for insectivorous wildlife.

2.4.2 Methods

The wildlife exposure models used to evaluate hazards in the Phase 2 TEE (Hart Crowser 2012) are also used in this Phase 3 TEE. However, the models are modified from producing an EISC to producing a hazard quotient (HQ) by calculating a total dose (i.e., dose from the ingestion of food and dose from incidental ingestion of soil) and dividing the total dose by a toxicity reference value (TRV). The general wildlife exposure model is shown in Equation 1.

[10] HQs were reported to one significant figure as suggested by EPA (2004).

Equation 1: $$HQ = \frac{(FIR \times P \times C_p) + (SIR \times P \times C_s)}{TRV}$$

Where:

HQ = hazard quotient (unitless)
FIR = food ingestion rate (mg/kg/d)
P = proportion of contaminated food in diet (percent)
C_p = concentration of constituent in prey (mg/kg DW)
SIR = soil ingestions rate (mg/kg/d)
C_s = concentrations of constituent in soil (mg/kg DW)
TRV = toxicity reference value (mg/kg/d)

The HQs first were calculated using the tissue EPCs derived from the site-specific plant and soil biota tissue data (i.e., measured data). Tissue EPCs were calculated using ProUCL and results are provided in Attachment C-11 for plants and Attachment C-12 for soil biota. Then, HQs were calculated using the site-specific bioaccumulation models developed in Section 2.2.2.1 (plants) and Section 2.2.2.2 (soil biota) (i.e., modeled data). Modeled plant and soil biota tissue EPCs were derived by substituting the soil EPCs for each of five EEAs developed in the Phase 2 TEE (Hart Crowser 2012) into the site-specific bioaccumulation models.

An HQ greater than one indicates the constituent poses a hazard to the wildlife receptor.

2.4.3 Results

Results of wildlife exposure modeling are shown in Tables C-16 to C-20. Important observations are:

- Resulting HQs using the measured and modeled tissue data are similar.
- Soil ingestion typically contributes the majority of the total dose.
- The only HQ above 1 where the dose from food ingestion is greater than the dose from soil ingestion is arsenic in soil biota for the shrew in EEA 5. This is the result of applying the measured tissue EPCs equally across all EEAs regardless of soil concentrations. In fact, no soil biota tissue samples were collected from EEA 5. Therefore, for EEA 5, the modeled tissue concentrations provide a better estimate of the dose and these results show no HQs above one.
- The only instances where food ingestion alone would result in an HQ above one are:
    - The measured arsenic concentration in soil biota for the shrew in EEAs 1, 2, 3, 4, and 5. This is driven by the very high measured soil biota EPCs for arsenic of 90.31 mg/kg DW.
- Arsenic and lead have HQs greater than one (Table C-21) indicating they pose a hazard to wildlife in two or more EEAs.

Table C-16 – Wildlife Hazard Quotients for Ecological Exposure Area 1

Receptor	COPC	Measured Food Dose (mg/kg/d)	Soil Dose (mg/ kg/d)	Total Dose (mg kg/d)	TRV (mg/ kg/d)	HQ	Modeled Food Dose (mg/ kg/d)	Soil Dose (mg/ kg/d)	Total Dose (mg/ kg/d)	TRV (mg/ kg/d)	HQ
Vole	Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Arsenic	0.94	89.68	90.61	3.00	30	0.41	89.68	90.09	3.00	30
	Chromium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lead	0.35	28.26	28.61	8.81	3	0.59	28.26	28.84	8.81	3
Shrew	Antimony	0.27	13.48	13.75	17.20	0.80	5.76	13.48	19.24	17.20	1.12
	Arsenic	9.44	100.41	109.85	3.00	37	3.34	100.41	103.75	3.00	35
	Chromium	0.02	0.17	0.19	30.40	0.01	0.06	0.17	0.23	30.40	0.01
	Lead	1.80	31.64	33.44	8.81	4	3.08	31.64	34.71	8.81	4
Robin	Antimony	0.28	48.09	48.36	NA	NA	5.93	48.09	54.02	NA	NA
	Arsenic	9.72	358.07	367.79	NA	NA	3.44	358.07	361.52	NA	NA
	Chromium	0.02	0.61	0.63	2.80	0.23	0.06	0.61	0.67	2.80	0.24
	Lead	1.86	112.83	114.69	3.80	30	3.17	112.83	116.00	3.80	31

Notes:
COPC - constituent of potential concern
TRV - toxicity reference value
HQ - hazard quotient
NA - not applicable or not available
HQ > 1 are highlighted

Table C-17 – Wildlife Hazard Quotients for Ecological Exposure Area 2

Receptor	COPC	Measured Food Dose (mg/kg/d)	Soil Dose (mg/kg/ d)	Total Dose (mg/kg/ d)	TRV (mg/ kg/d)	HQ	Modeled Food Dose (mg/kg/d)	Soil Dose (mg/kg/ d)	Total Dose (mg/kg/ d)	TRV (mg/kg/ d)	HQ
Vole	Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Arsenic	0.94	76.83	77.76	3.00	26	0.37	76.83	77.20	3.00	26
	Chromium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lead	0.35	1.66	2.01	8.81	0.23	0.03	1.66	1.70	8.81	0.19
Shrew	Antimony	0.27	0.23	0.50	17.20	0.03	0.10	0.23	0.33	17.20	0.02
	Arsenic	9.44	86.02	95.46	3.00	32	3.10	86.02	89.12	3.00	30
	Chromium	0.02	0.23	0.25	30.40	0.01	0.08	0.23	0.31	30.40	0.01
	Lead	1.80	1.86	3.66	8.81	0.42	0.29	1.86	2.15	8.81	0.24
Robin	Antimony	0.28	0.80	1.08	NA	NA	0.10	0.80	0.91	NA	NA
	Arsenic	9.72	306.77	316.49	NA	NA	3.19	306.77	309.96	NA	NA
	Chromium	0.02	0.81	0.83	2.80	0.30	0.09	0.81	0.90	2.80	0.32
	Lead	1.86	6.64	8.49	3.80	2	0.30	6.64	6.93	3.80	2

Notes:
COPC - constituent of potential concern
TRV - toxicity reference value
HQ - hazard quotient
NA - not applicable or not available
HQ > 1 are highlighted

Table C-18 – Wildlife Hazard Quotients for Ecological Exposure Area 3

Receptor	COPC	Measured Food Dose (mg/kg/d)	Soil Dose (mg/kg/d)	Total Dose (mg/kg/d)	TRV (mg/kg/d)	HQ	Modeled Food Dose (mg/kg/d)	Soil Dose (mg/kg/d)	Total Dose (mg/kg/d)	TRV (mg/kg/d)	HQ
Vole	Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Arsenic	0.94	35.64	36.58	3.00	12	0.22	35.64	35.86	3.00	12
	Chromium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lead	0.35	45.82	46.17	8.81	5	0.95	45.82	46.77	8.81	5
Shrew	Antimony	0.27	12.00	12.27	17.20	0.71	5.12	12.00	17.12	17.20	1
	Arsenic	9.44	39.91	49.35	3.00	16	2.11	39.91	42.02	3.00	14
	Chromium	0.02	0.04	0.06	30.40	0.002	0.01	0.04	0.05	30.40	0.002
	Lead	1.80	51.30	53.10	8.81	6	4.60	51.30	55.90	8.81	6
Robin	Antimony	0.28	42.79	43.06	NA	NA	5.28	42.79	48.06	NA	NA
	Arsenic	9.72	142.32	152.04	NA	NA	2.18	142.32	144.50	NA	NA
	Chromium	0.02	0.13	0.15	2.80	0.05	0.01	0.13	0.14	2.80	0.05
	Lead	1.86	182.95	184.81	3.80	49	4.74	182.95	187.69	3.80	49

Notes:
COPC - constituent of potential concern
TRV - toxicity reference value
HQ - hazard quotient
NA - not applicable or not available
HQ > 1 are highlighted

Table C-19 - Wildlife Hazard Quotients for Ecological Exposure Area 4

Receptor	COPC	Measured Food Dose (mg/kg/d)	Soil Dose (mg/kg/d)	Total Dose (mg/kg/d)	TRV (mg/kg/d)	HQ	Modeled Food Dose (mg/kg/d)	Soil Dose (mg/kg/d)	Total Dose (mg/kg/d)	TRV (mg/kg/d)	HQ
Vole	Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Arsenic	0.94	106.84	107.78	3.00	36	0.46	106.84	107.31	3.00	36
	Chromium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lead	0.35	11.87	12.22	8.81	1	0.25	11.87	12.11	8.81	1
Shrew	Antimony	0.27	2.12	2.39	17.20	0.14	0.91	2.12	3.03	17.20	0.18
	Arsenic	9.44	119.63	129.06	3.00	43	3.65	119.63	123.27	3.00	41
	Chromium	0.02	0.06	0.08	30.40	0.003	0.02	0.06	0.08	30.40	0.002
	Lead	1.80	13.29	15.09	8.81	2	1.49	13.29	14.78	8.81	2
Robin	Antimony	0.28	7.55	7.83	NA	NA	0.94	7.55	8.49	NA	NA
	Arsenic	9.72	426.61	436.33	NA	NA	3.76	426.61	430.36	NA	NA
	Chromium	0.02	0.20	0.22	2.80	0.08	0.02	0.20	0.22	2.80	0.08
	Lead	1.86	47.38	49.24	3.80	13	1.54	47.38	48.92	3.80	13

Notes:
COPC - constituent of potential concern
TRV - toxicity reference value
HQ - hazard quotient
NA - not applicable or not available
HQ > 1 are highlighted

Table C-20 – Wildlife Hazard Quotients for Ecological Exposure Area 5

Receptor	COPC	Measured Food Dose (mg/kg/d)	Soil Dose (mg/kg/d)	Total Dose (mg/kg/d)	TRV (mg/kg/d)	HQ	Modeled Food Dose (mg/kg/d)	Soil Dose (mg/kg/d)	Total Dose (mg/kg/d)	TRV (mg/kg/d)	HQ
Vole	Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Arsenic	0.94	0.92	1.85	3.00	0.62	0.02	0.92	0.93	3.00	0.31
	Chromium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lead	0.35	0.20	0.55	8.81	0.06	0.004	0.20	0.21	8.81	0.02
Shrew	Antimony	0.27	0.01	0.28	17.20	0.02	0.01	0.01	0.02	17.20	0.001
	Arsenic	9.44	1.02	10.46	3.00	3	0.34	1.02	1.37	3.00	0.46
	Chromium	0.02	0.33	0.35	30.40	0.01	0.12	0.33	0.45	30.40	0.01
	Lead	1.80	0.23	2.03	8.81	0.23	0.05	0.23	0.28	8.81	0.03
Robin	Antimony	0.28	0.05	0.33	NA	NA	0.01	0.05	0.06	NA	NA
	Arsenic	9.72	3.65	13.37	NA	NA	0.35	3.65	4.01	NA	NA
	Chromium	0.02	1.16	1.18	2.80	0.42	0.12	1.16	1.28	2.80	0.46
	Lead	1.86	0.81	2.66	3.80	0.70	0.05	0.81	0.86	3.80	0.23

Notes:
COPC - constituent of potential concern
TRV - toxicity reference value
HQ - hazard quotient
NA - not applicable or not available
HQ > 1 are highlighted

Table C-21 – Summary of Wildlife Hazard Quotients Greater Than One

Receptor	Constituent	Tissue Data Source	Ecological Exposure Area with HQ > 1
Vole	Arsenic	Measured	1, 2, 3, and 4
		Modeled	1, 2, 3, and 4
	Lead	Measured	1 and 3
		Modeled	1 and 3
Shrew	Arsenic	Measured	1, 2, 3, 4, and 5
		Modeled	1, 2, 3, and 4
	Lead	Measured	1, 3, and 4
		Modeled	1, 3, and 4
Robin	Lead	Measured	1, 2, 3, and 4
		Modeled	1, 2, 3, and 4

Note:
HQ - hazard quotient

2.5 Uncertainty Analysis

A qualitative summary of major uncertainties associated with the Phase 3 TEE is provided in the following sections.

2.5.1 Data

Co-located tissue and soil samples were collected from six mines and from background areas as part of the Phase 3 RI. Analysis of Phase 2 soil data indicated that the mines could be segregated into two groups (Group 1 and Group 2) based upon their relative percentage of the metals. Three of the mines sampled during Phase 3 fall into Group 1 (Justice, O&B, and Sheridan Mines), while the other three mines sampled during Phase 3 fall into Group 2 (Mystery, New Discovery, and Pride of the Mountains Mines). Therefore, the six mines sampled during the Phase 3 RI are considered to be representative of all other MCMA mines.

Soil samples were collected from the upper foot of the soil profile, which is assumed to be the zone in which plant roots and soil invertebrates live. It is possible that roots of shrubs may extend deeper than one foot. However, soil biota are unlikely to be exposed to soil below one foot. It is likely that metals concentrations measured in the upper foot of soil are comparable to concentrations found at greater depth at the same location. Therefore, the level of uncertainty associated with soil sampling depth is considered low.

Grass and shrub tissue samples were collected from 65 locations on the six MCMA mine sites and 12 background locations. Each plant tissue sample was a composite of three to five different plants located within a relatively small area (< 2,000 square feet). A co-located three- to five-point composite soil sample was collected from each plant tissue sample location. Although the goal of plant sampling was to collect one species of shrub (i.e., huckleberry) and one species of grass (i.e., sedge) from all six mine sites and all twelve background sites, this was not always possible because these species were not present at all sites. However, information presented in Section 2.2.1.4 suggests that the differing plant species had little effect on assessing bioaccumulation. Therefore, this sampling design should generate a robust and reliable dataset for characterizing the bioaccumulation of metal constituents in plants.

Soil biota tissue samples were collected in 2013 from five mine sites and seven background locations. Each soil biota sample was a composite of animals collected over a wide area. This sampling design was driven by the low abundance and low mass of invertebrates present. In addition, the soil biota composite samples were mixtures of different invertebrate groups including ants, spiders, centipedes, grasshoppers, crickets, and beetles. For purposes of evaluating bioaccumulation, the composite soil invertebrate tissue samples were compared to the median concentrations for the mine site. There was considerable variability in constituent concentrations in soil samples within each of the five mine areas. It is difficult to determine the direction of uncertainty in bioaccumulation models derived using this approach, but the magnitude of uncertainty is expected to be high.

2.5.2 Tissue Background Comparisons

The plant tissue dataset for making background comparisons is considered to be robust (65 MCMA samples and 12 background samples) with little uncertainty associated with the results. The soil biota dataset is relatively small (5 MCMA samples and 7 background samples), leading to a moderate degree of uncertainty in results of the background comparisons.

Background tissue comparisons were made using ProUCL's nonparametric WMW and Gehan tests. These tests are robust in that they are independent of the actual underlying data distributions and are not biased by data outliers. Therefore, there is little uncertainty associated with the statistical methods used for making background comparisons.

2.5.3 Site-Specific Bioaccumulation Models

Empirical site-specific bioaccumulation models are better predictors of bioaccumulation than generic models obtained from the literature. This is because these models incorporate site-specific factors into the prediction of bioaccumulation. These factors can vary greatly from those at other sites.

Although EPA methodology was followed in deriving the site-specific bioaccumulation regression models, several models had low coefficients of determination (r^2). For example, an r^2 of 0.3 signifies that variation in the soil concentrations accounts for 30 percent of the variation in the tissue concentration. The other 70 percent of variation in the tissue concentration is attributable to causes other than variation in soil concentration. Therefore, there is a moderate to high degree of uncertainty in the ability of some of the regression models to predict bioaccumulation.

2.5.4 Critical Body Residue Evaluations

A fairly comprehensive toxicity dataset was available for deriving CBRs for plants. Therefore, there is low uncertainty associated with the plant CBRs. For soil biota, usually a single toxicity study was found for each COC that was suitable for deriving a soil biota CBR. The paucity of soil biota toxicity data leads to a high level of uncertainty with the use of soil biota CBRs.

2.5.5 Wildlife Risks Using Site-Specific Bioaccumulation Models

Standard wildlife exposure models developed in the Phase 2 TEE (Hart Crowser 2012) were combined with the site-specific bioaccumulation models developed in the Phase 3 TEE to assess hazards to individual wildlife receptors. There is little uncertainty associated with the exposure factors, TRVs, or bioaccumulation models used in these models.

There was insufficient toxicological data for EPA to derive bird TRVs for antimony and arsenic for use in the EcoSSLs. Therefore, hazards to birds from antimony and arsenic could not be evaluated. Because there is considerable uncertainty in the evaluation of hazards to birds from antimony and arsenic, the direction and magnitude of this uncertainty is unknown.

The selection of wildlife COPCs using background comparisons for plant and soil biota tissue constituent concentrations neglects the exposure and hazards due to soil ingestion alone. At most hazardous waste sites, food ingestion is the most significant exposure pathway. However, at the MCMA, bioaccumulation of constituents in plants and soil biota is relatively low while soil concentrations can be very high. In these cases, soil ingestion may be a more significant exposure pathway than food ingestion. The hazards associated with soil ingestion for Phase 2 wildlife COCs not evaluated in the Phase 3 wildlife TEE (Section 2.4) are shown in Table C-22. In 49 of 50 cases, the HQs due to soil ingestion are below one. The only exception is exposure of the robin to cadmium in soil at EEA 4 which yielded a HQ of 2. The cadmium soil EPC for EEA 4 (323.9 mg/kg) is significantly greater than the EPCs for the other four EEAs (range 0.65 to 28.22 mg/kg). The cadmium EPC for EEA 4 is the result of one or two extremely high data points that do not appear representative of the area. These results indicate that there is little uncertainty with the Phase 3 wildlife evaluation (Section 2.4) due to COPC selection in Section 2.1.

2.5.6 Risks to Local Populations of Plants and Animals

A qualitative population-level risk assessment was conducted for plants and animals living in the Glacier Creek, Seventysix Gulch, and Weden Creek watersheds (see Attachment C-1). Although this analysis lacked some ecological rigor (e.g., detailed habitat and population surveys of the MCMA were not conducted), results indicate that local populations of plants and animals living in each watershed are not at risk of extinction from exposure to constituents associated with source areas. There is low uncertainty associated with the conclusions of the population-level risk assessment.

3.0 SUMMARY AND CONCLUSIONS

Results of the Phase 3 TEE are summarized in Figure C-4 with the following significant conclusions:

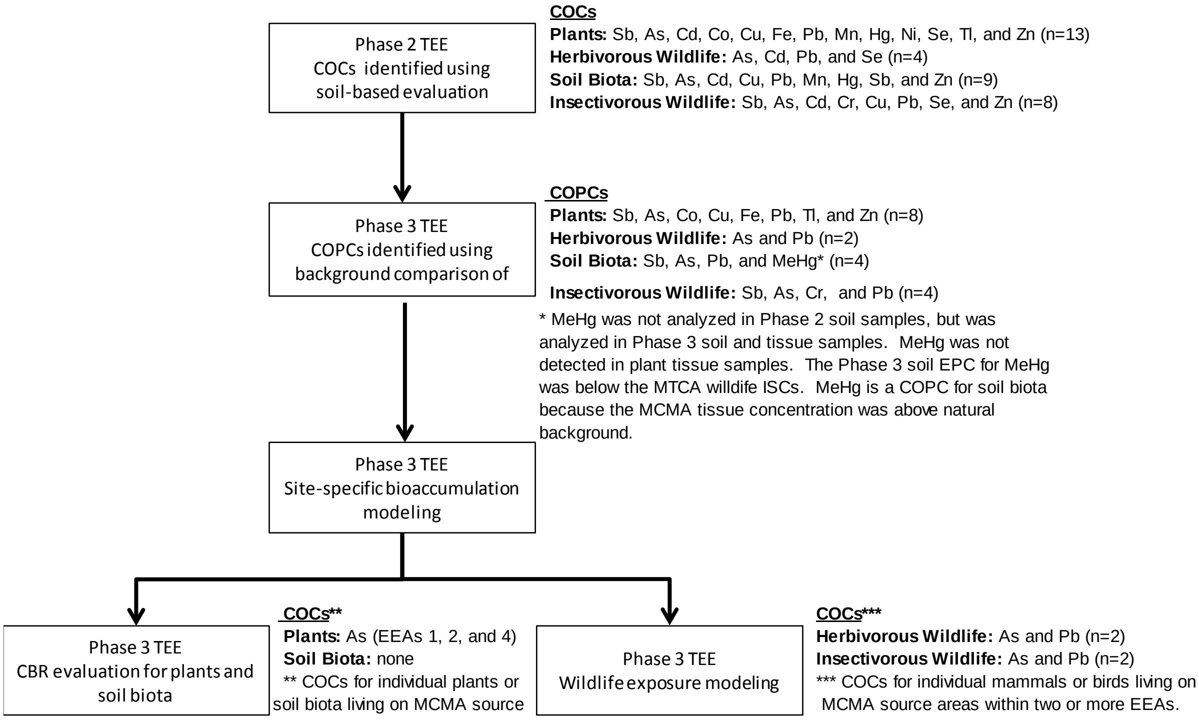
- Individual soil biota living on the MCMA source areas (i.e., waste rock piles) will not be adversely affected by exposure to mining-related constituents.

- Individual plants living on the MCMA source areas within EEAs 1, 2, and 4 will be adversely affected by exposure to arsenic. This conclusion is based on a CBR for reduced plant growth.

- Individual herbivorous and insectivorous wildlife living on the MCMA source areas will be adversely affected by exposure to arsenic and lead in soil. Hazards are greatest in EEAs 1, 2, 3, and 4. In EEA 5, the only hazard is from arsenic to the shrew.

- The population-based risk assessment completed as part of the uncertainty analysis (see Attachment C-1) indicates that local populations of plants and wildlife living within the Glacier Creek, Seventysix Gulch, and Weden Creek watersheds will likely remain viable following exposure to mining-related constituents on the MCMA source areas.

There are uncertainties associated with many steps of the Phase 3 TEE. However, these uncertainties are not expected to result in an underestimation of hazards.



Notes:
TEE - terrestrial ecological evaluation
COC - constituent of concern
COPC - constituent of potential concern
CBR - critical body residue
EEA - ecological exposure area
n - number of COPCs or COCs

Figure C-4 – Summary of Phase 3 TEE

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TABLES

Table C-7 – Summary of Plant Tissue Toxicity Data (mg/kg DW) for Plant COPCs

COPC	Mature Leaf Sufficient or Normal [1]	Mature Leaf Excessive or Toxic Level [1]	Phytotoxic [7]	Young Barley [6]	Species Specific [2]	Young Spring Barley [3]	Species Specific [4]	Species Specific [5]	Critical Body Residue
Antimony	7-50	150	NA	NA	NA	NA (note: growth depressed at high exposure conc., but not detected in tissue at DL=2 mg/kg)	NA	NA	150
Arsenic	1 - 1.7	5-20	3-10	NA	NA	20	1-4 (bean) 2-18 (tomato) 2-16 (sudangrass) >10-20 (barley) 4 (cotton) 1 (soybean) 1-4 (cabbage)	NA	1
Cobalt	0.02 - 1.0	15-50	25-100	NA	NA	6	6 (barley) 20-25 (barley) 10 (cabbage) 4 -40 (bush bean)	NA	6
Copper	5 - 30	20-100	25-40	19	20 (barley)* 19 (lettuce)* 18 (rape)* 21 (ryegrass) 18 (wheat)	20	**10 (overall level)** 30-35 (ryegrass) 35 (bentgrass) 20 (bluegrass) 18-20 (barley) 18 (wheat) 11 (wheat) 14-17 (wheat) 16 (rape) 14 (maize) 5 (maize) 10-15 (maize) 20-30 (snapbeans) 30 (bushbeans) 15 (bushbeans) 17-21 (lettuce) 8 (lettuce) 5-10 (lettuce) 14 (lettuce) 10 (lettue) 20-23 (lettuce) 25 (cabbage) 17 (sugar beet) >14 (carrot) 16 (cauliflower) >64 (spinach) 25-35 (spinach) 15 (cassava)	50-60 (alfalfa) 12 (barely) 50-70 (corn) 10 (cucmber) 12 (grasses) 50 (soybean) 15 (tomato) 10 (winter wheat)	10
Iron	30 - 150 [6]	> 500	NA	NA	NA	NA	considered unlikely to be phytotoxic in soil	NA	500
Lead	5 - 10	30-300	NA	NA	NA	35	considered unlikely to be phytotoxic in soil	NA	30
Thallium	NA	20	NA	NA	NA	20	NA	NA	20
Zinc	27 - 150	100-400	500-1,500	186	366 (barley)* 221 (ryegrass)	290	**100 (overall value)** 210 (ryegrass) 370-560 (ryegrass) 290 (barley) 220 (barley) 200 (lucerne) 108-224 (wheat) 400-500 (wheat) <200 (maize) 100 (maize) 450 (soybean) 130 (bush bean) 150 (bush bean) 200 (bushbean) 250 (bushbean) 60 (bushbean) 250 (field bean) 380-530 (lettuce) 150-250 (lettuce) <200 (lettuce) 320-430 (lettuce) 150-200 (lettuce) 250-300 (clover) 100 (cabbage) 700-900 (potato) 330-460 (spinach) 600 (spinach) 350 (tomato) 380-550 (sotghum) 300 (sweetcorn) 380-500 (pea) 100-150 (sugar beet) 330 (cabbage) 120 (cassava)	702 (alfalfa) 95 - 242 (bush 792 (corn) 200 (cotton) 523 (lettuce) 220 (peanut) 1,700 (oat) 64 - 195 526 (tomato) 485 (tung)	100

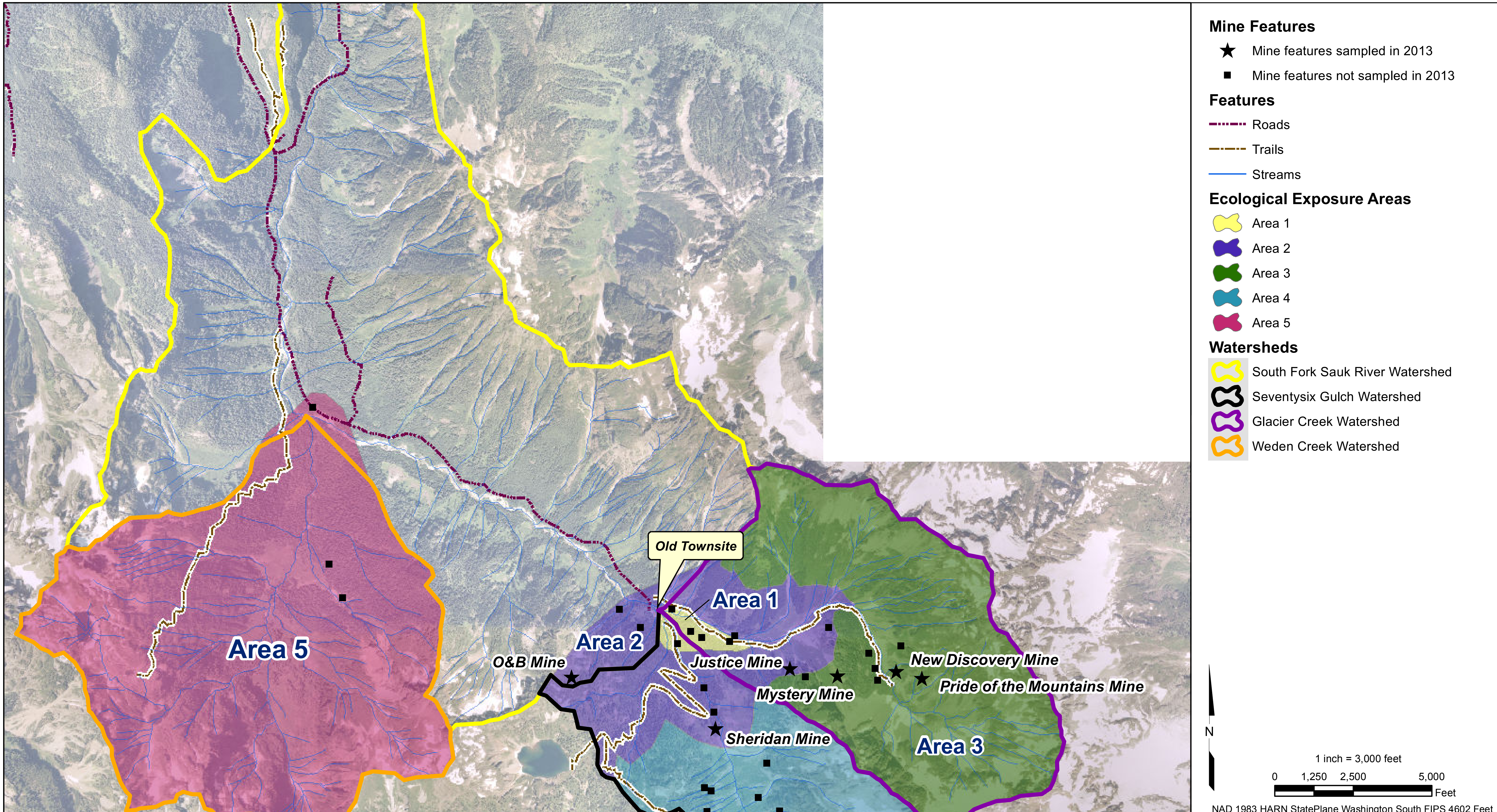
Notes:
NA - not available
DW - dry weight
[1] Kabata-Pendias (2001)
[2] Davis and Beckett (1978); values are the upper critical levels and * indicates value is the mean of multiple test results
[3] Davis, Beckett, and Wollan (1978): values are the upper critical level in spring barley
[4] Macnicol and Beckett (1985): most individual values are the 10th percentile growth/yield reduction, but some are the upper critical level; the authors evaluated the datasets for Cd, Cu, Ni, and Zn and identified an overall upper critical level below which growth/yield reductions are not expected to occur (bolded values)
[5] Adriano (1980) as cited in Jones (1991): values are the tissue concentrations at which a ten percent reduction in growth/yield occurs
[6] Beckett and Davis (1977): values are the upper critical levals and the values shown are the means of multiple test results
[7] Langmuir et al. (2004): values are phytotoxic in plant foliage

Table C-22 – Supplemental Analysis of Wildlife Hazards from Incidental Soil Ingestion

Receptor	Constituent	Ecological Exposure Area 1			Ecological Exposure Area 2			Ecological Exposure Area 3			Ecological Exposure Area 4			Ecological Exposure Area 5		
		Soil Dose (mg/kg/d)	TRV (mg/kg/d)	HQ	Soil Dose (mg/kg/d)	TRV (mg/kg/d)	HQ	Soil Dose (mg/kg/d)	TRV (mg/kg/d)	HQ	Soil Dose (mg/kg/d)	TRV (mg/kg/d)	HQ	Soil Dose (mg/kg/d)	TRV (mg/kg/d)	HQ
Vole	Cadmium	0.079	1.3	0.06	0.004	1.3	0.003	0.041	1.3	0.03	0.905	1.3	0.7	0.002	1.3	0.001
	Selenium	0.006	0.3	0.02	0.034	0.3	0.1	0.008	0.3	0.03	0.004	0.3	0.01	0.003	0.3	0.01
Shrew	Cadmium	0.089	1.3	0.07	0.004	1.3	0.003	0.047	1.3	0.04	1.018	1.3	0.8	0.002	1.3	0.002
	Copper	2.972	19.6	0.2	2.337	19.6	0.1	1.652	19.6	0.08	0.822	19.6	0.04	0.360	19.6	0.02
	Selenium	0.006	0.3	0.02	0.038	0.3	0.1	0.009	0.3	0.03	0.005	0.3	0.02	0.003	0.3	0.01
	Zinc	8.889	84.2	0.1	0.965	84.2	0.01	3.434	84.2	0.04	6.735	84.2	0.08	0.425	84.2	0.01
Robin	Cadmium	0.315	2.4	0.1	0.014	2.4	0.01	0.165	2.4	0.07	3.614	2.4	2	0.007	2.4	0.003
	Copper	10.547	24.1	0.4	8.294	24.1	0.3	5.862	24.1	0.2	2.917	24.1	0.1	1.278	24.1	0.05
	Selenium	0.023	0.4	0.06	0.135	0.4	0.3	0.031	0.4	0.08	0.016	0.4	0.04	0.012	0.4	0.03
	Zinc	31.550	86.8	0.4	3.426	86.8	0.04	12.186	86.8	0.1	23.903	86.8	0.3	1.508	86.8	0.02

Notes:
TRV - toxicity reference value
HQ - hazard quotient
HQ > 1 are highlighted

FIGURES



Monte Cristo Mining Area Terrestrial Sampling
Monte Cristo, Washington

Ecological Exposure Areas

17800-35 9/14

HARTCROWSER

Figure
C-1

R:\GIS\PROJECTS\17800\55_MCMA\mxds\TerrReport\Figure C-1.mxd

ATTACHMENTS

Attachment C-1

This attachment describes a population-based risk assessment that was completed to provide additional perspective to the uncertainty analysis as summarized in Section 2.5. MTCA allows for use of an uncertainty analysis in a site-specific terrestrial ecological evaluation to describe the range of potential ecological risks from hazardous substances present at the site, based on the toxicological characteristics of the hazardous substances present, and to evaluate the uncertainty regarding these risks [WAC 173-340-7493(5)].

RISKS TO POPULATIONS OF PLANTS AND WILDLIFE

Introduction

The Phase 2 TEE identified a number of threatened or endangered species which may occur in the project area (Hart Crowser 2012). However, it is considered highly unlikely that any of these species would be exposed to constituents associated with the MCMA source areas. For example, the northern spotted owl typically nests in old growth forest and forages in forests, consuming small mammals such as flying squirrels, mice, and woodrats (Thomas et al. 1990). Since suitable habitat, and to some extent prey, are not present on the MCMA waste rock piles, use of these areas by the northern spotted owl can be assumed not to occur. Based on the assumption that endangered and threatened species will not be exposed to constituents on MCMA waste rock piles, the goal of the Phase 3 TEE is the protection of populations of plants and animals from significant adverse effects on reproduction, growth or survival.

A metapopulation of plants or animals typically consist of a group of spatially separated populations of the same species that occur in areas of suitable habitat. Although some species are generalists and can live in a wide variety of habitats, others have very narrow habitat requirements and occur in more isolated patches of suitable habitat. Migration of individuals between these isolated populations and into uninhabited areas of suitable habitat is controlled by a number of factors including distance, intervening habitat conditions, and mobility of the organism. Although an isolated population may become extinct because of a catastrophic event (e.g., fire, disease), the metapopulation remains stable.

The goal of this qualitative population-level assessment is to evaluate the likelihood that local populations of plants and animals will remain viable indefinitely following potential exposure to mining-related constituents. If these local populations are not at risk of extinction, it will be concluded that the MCMA does not pose a risk to the long-term viability of populations of plants and animals.

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Methods

For this assessment, local populations are delimited by the boundaries of each of three MCMA watersheds (Glacier Creek, Seventysix Gulch and Weden Creek) identified in the Phase 2 RI (Hart Crowser 2012). A detailed and quantitative study of populations of plants and animals inhabiting these three watersheds is outside the scope of this TEE. Indeed, a quantitative study is unwarranted and a qualitative evaluation serves to demonstrate the impact of source areas on the viability of local populations.

For demonstrative purposes, a surrogate wildlife species was identified for use in this population evaluation. The selected species is the Townsend's vole. The Townsend's vole is a small herbivorous mammal that likely inhabits the MCMA and is the prey base for many carnivorous birds and mammals. The portion of the vole population affected by exposure to source areas includes animals living on the source area as well as animals migrating from adjacent areas onto the source areas. The conceptual framework for and results of the qualitative population-level assessment of potential impacts on the Townsend's vole can be readily extrapolated to other species of mammals and birds. Impacts to local populations of plants from exposure to source areas are not evaluated directly because it is assumed the results of the evaluation for the vole can be extrapolated to plants. Plants typically have a much higher reproductive potential than mammals, which should increase plants' ability to preserve population abundance. Therefore, a local population of plants should be less likely to be affected by exposure to source areas then a local population of voles.

Simplifying assumptions used in this qualitative evaluation include:

- The habitat present over each watershed is uniformly suitable habitat for the Townsend's vole.
- All individuals of the local population of Townsend's vole that live on the MCMA source areas suffer mortality.
- In addition, all migrants moving onto source areas will also suffer mortality. It is assumed that a non-source area equal to the source area will be affected by migration (i.e., mortality occurs over an area equal to two times the source area).
- This evaluation examines the local population response at a particular point in time and does not model the response of the population over time.
- The local population of Townsend's vole that lives within each watershed, exclusive of the MCMA source areas, functions as a normal population and is not affected by catastrophic events (e.g., fire, large landslide, disease) that could cause the extinction of the local population.

Important ecological information about the Townsend's vole (Cornely and Vern 1988) include:

- Population density varies greatly during the year and between years.

- The breeding season varies from as early as February to as late as October and females can have several litters per year.
- Home range averaged 900 per square meter (m^2) for males and 500 m^2 for females.
- Mean annual fluctuations in population density ranges from 94 to 239 voles per hectare (/ha) (38 to 97 voles/acre).
- Peak population densities average 697 voles/ha.

The total area (acres) and source area (acres) for the Glacier Creek, Seventysix Gulch and Weden Creek watersheds were originally reported in the Phase 2 RI (see Table 15, Hart Crowser 2012) and updated for use in the Phase 3 TEE.

The effect of source area size on the local population size of voles was modeled using Equation 2.

Equation 2:

$$P_r = (A_w \times D) - (A_{sa} \times 2 \times D)$$

Where:

P_r = residual population (# voles) [the residual population is the number of voles that remains following the mortality of two times the number of voles inhabiting the source area]
A_w = area of watershed (acres)
D = density of voles (voles/acre)
A_{sa} = area of source area (acre)

The population model was run using a range of source area sizes (including the actual source area size) to generate a range of residual population sizes for each watershed. In addition, the models were run using a range of vole density values (38 and 97 voles/acre).

In order to assess the viability of the local population, a threshold population is required below which the local population may no longer be viable. Traill et al. (2010) reviewed the extant literature on population studies to determine their status as an endangered or threatened species. They evaluated studies conducted on a wide variety of plant and animal species. It was determined that a minimum viable population (MVP) of 5,000 adult individuals was required to ensure the long-term persistence and evolutionary potential of a population (Traill et al. 2010). Therefore, an MVP of 5,000 adult individuals was selected as the viability threshold for the MCMA population-level evaluation.

Results

Results of the population modeling are shown in Figures C-1-1, C-1-2, and C-1-3 for the Glacier Creek, Seventysix Gulch, and Weden Creek watersheds, respectively. The figures show the effect of the size of the source area on the residual population size. The figures also indicate the actual source area size, the residual population associated with the actual source area size, and the predicted source area size required to reach the MVP of 5,000 voles.

Figures C-1-1 to C-1-3 show an inverse linear relationship between the size of the source area and size of the residual population. Model output is affected by vole density in that the source area size at which the MVP threshold is reached becomes smaller as the density become smaller.

In all cases, the residual population size calculated using the actual source area size is significantly greater than the threshold MVP of 5,000 individuals (Figures C-1-1, C-1-2, and C-1-3). In addition, the reduction of local vole populations due to exposure to the actual source area is 2.7 percent, 2.2 percent, and 0.1 percent for Glacier Creek, Seventysix Gulch, and Weden Creek watersheds, respectively. Since the natural variation in the population size of voles is 250 percent (maximum mean density of 97 voles per acre/minimum mean density of 38 voles per acre), it can be safely concluded that the loss of 2.7 percent or less of the local population due to exposure to source areas will not affect population viability.

These results indicated that local populations of the Townsend's vole will remain viable following exposure to MCMA source areas within the Glacier Creek, Seventysix Gulch, and Weden Creek watersheds. These results can be extrapolated to populations of plants and other animals.

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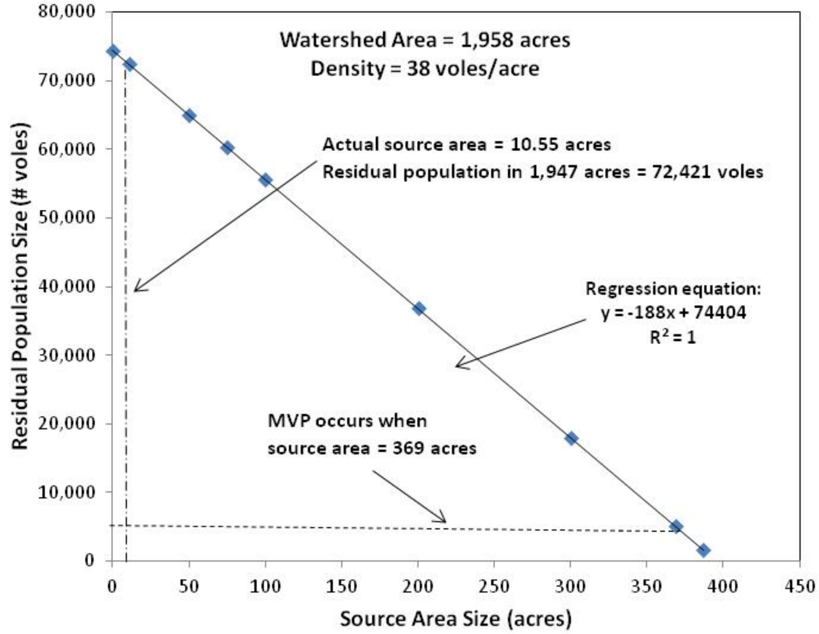
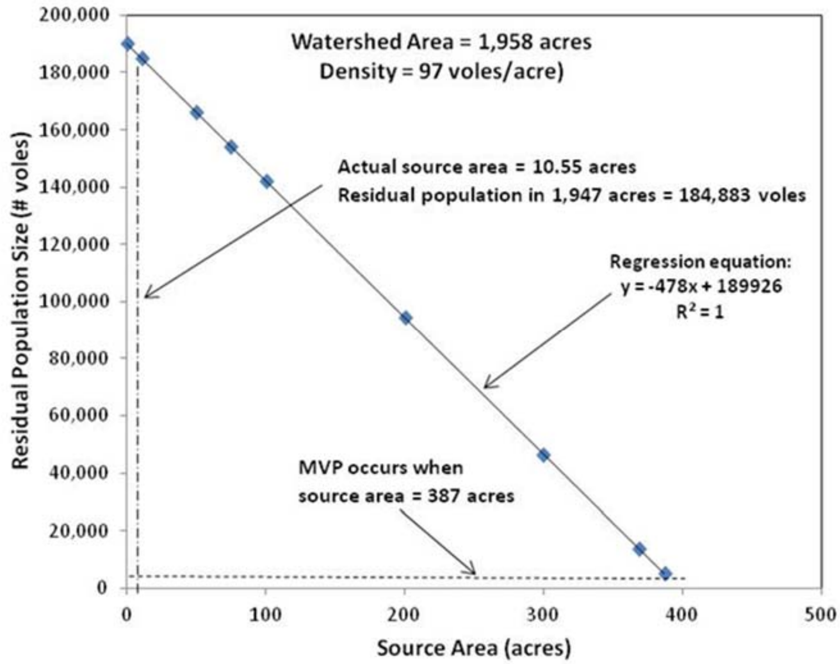
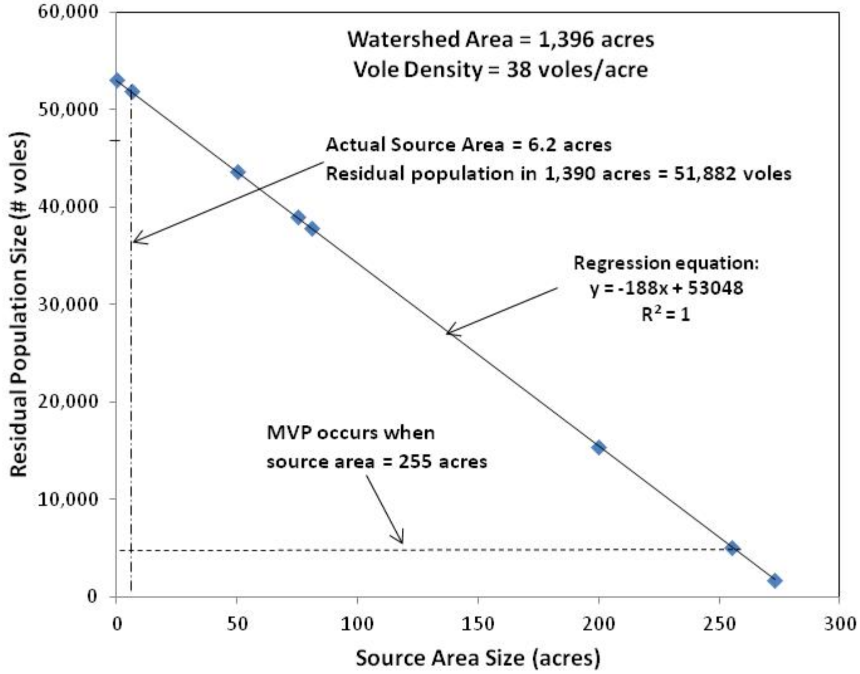
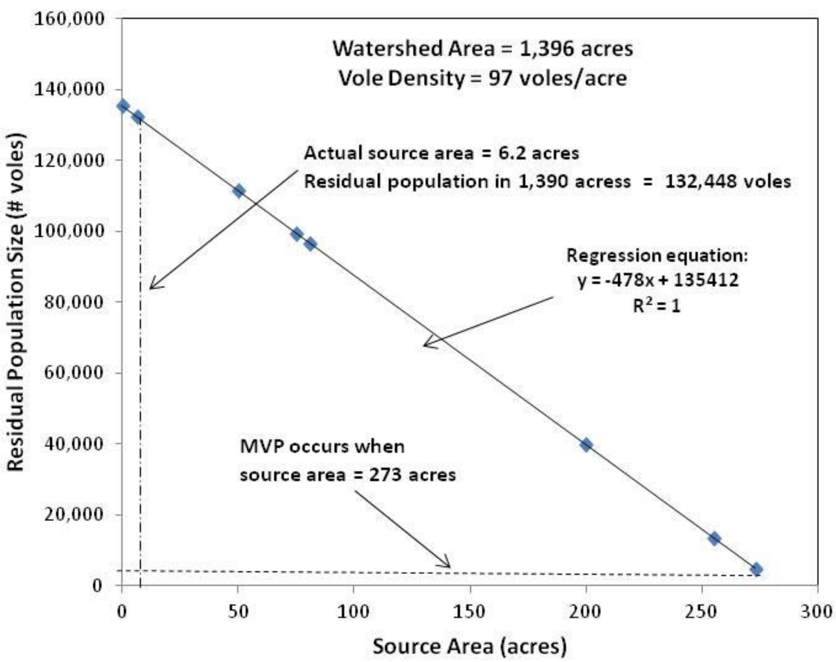




Notes:
R^2 - coefficient of determination
MVP – minimum viable population (i.e., 5,000 adult individual)
x – source area (acres)
y – residual population (# voles)

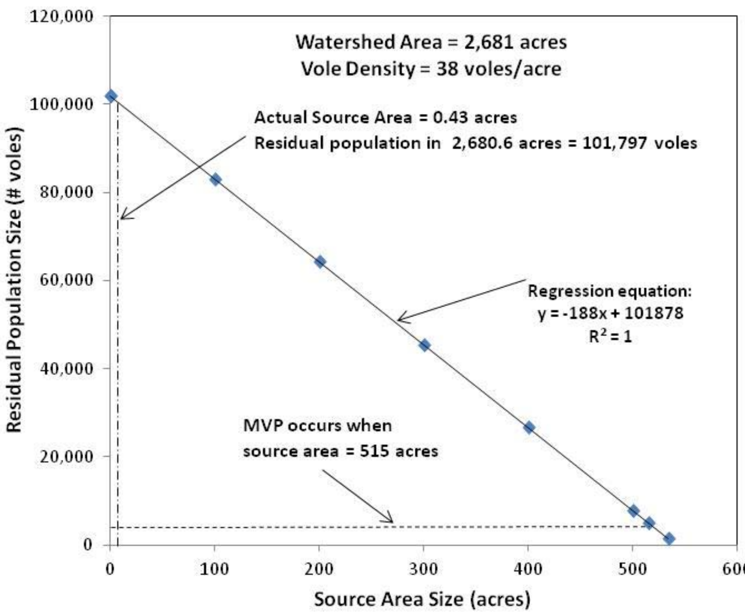
Figure C-1-1 – Vole Population Model, Glacier Creek Watershed

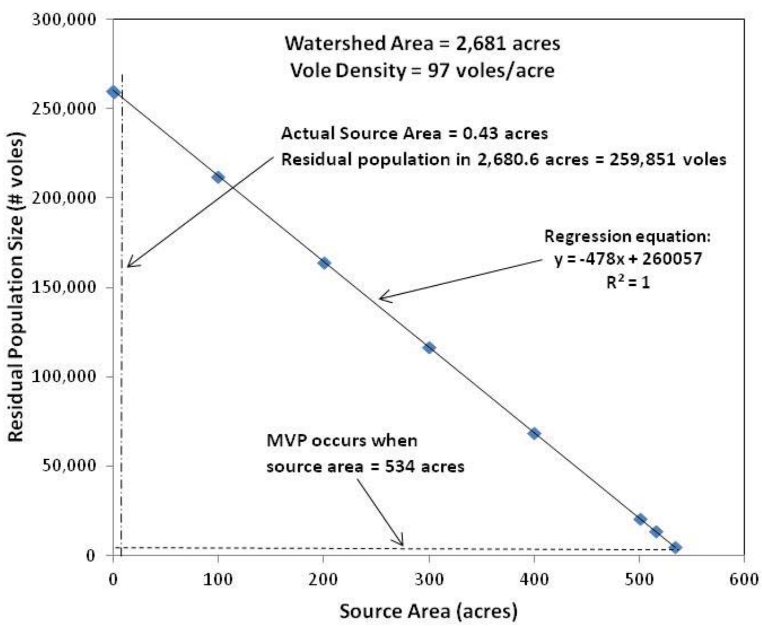




Notes:
R^2 - coefficient of determination
MVP – minimum viable population (i.e., 5,000 adult individual)
x – source area (acres)
y – residual population (# voles)

Figure C-1-2 – Vole Population Model, Seventysix Gulch Watershed





Notes:
R^2 - coefficient of determination
MVP – minimum viable population (i.e., 5,000 adult individual)
x – source area (acres)
y – residual population (# voles)

Figure C-1-3 – Vole Population Model, Weden Creek Watershed

Attachment C-2
ProUCL Output Files – Plant Tissue Sample Summary Statistics

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	**Num Ds**	**NumNDs**	**% NDs**	**Minimum**	**Maximum**	**Mean**	**Median**	**SD**	**MAD/0.675**	**Skewness**	**CV**
Background											
Antimony	1	11	91.67%	0.014	0.014	0.014	0.014	N/A	0	N/A	N/A
Arsenic	12	0	0.00%	0.032	0.221	0.0825	0.062	0.0603	0.0363	1.349	0.731
Cadmium	10	2	16.67%	0.008	0.134	0.0377	0.027	0.0369	0.0193	2.295	0.979
Cobalt	1	11	91.67%	0.024	0.024	0.024	0.024	N/A	0	N/A	N/A
Copper	12	0	0.00%	1.2	3.04	1.648	1.525	0.471	0.222	2.623	0.286
Iron	12	0	0.00%	8.22	18.2	11.3	10.7	2.804	1.483	1.511	0.248
Lead	12	0	0.00%	0.011	0.258	0.0649	0.036	0.0742	0.0215	2.17	1.143
Manganese	12	0	0.00%	9.18	369	181.4	168.5	96.24	63.75	0.221	0.531
Mercury	12	0	0.00%	0.00043	0.00546	0.00273	0.00275	0.00157	0.00142	0.554	0.575
Methyl Mercury[a]	0	12	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nickle	11	1	8.33%	0.15	0.75	0.404	0.4	0.177	0.148	0.359	0.438
Selenium	0	12	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	3	9	75.00%	0.003	0.004	0.00333	0.003	0.00057735	0	1.732	0.173
Zinc	12	0	0.00%	5.24	20.9	10.48	9.985	4.59	4.529	1.038	0.438
MCMA											
Antimony	43	22	33.85%	0.007	1.76	0.174	0.038	0.302	0.046	3.865	1.731
Arsenic	65	0	0.00%	0.082	149	7.247	0.942	20.92	1.09	5.405	2.886
Cadmium	59	6	9.23%	0.008	8.65	0.231	0.027	1.129	0.0252	7.413	4.876
Cobalt	36	29	44.62%	0.02	0.471	0.0818	0.0435	0.0999	0.0304	2.908	1.221
Copper	65	0	0.00%	0.62	103	5.014	2.19	13.96	1.26	6.181	2.784
Iron	65	0	0.00%	5.67	727	74.17	18.4	143.1	12.54	3.319	1.929
Lead	65	0	0.00%	0.012	22.3	1.897	0.297	3.869	0.409	3.51	2.04
Manganese	65	0	0.00%	1.39	604	156.9	116	140.1	134.9	1.097	0.892
Mercury	65	0	0.00%	0.00066	0.00777	0.00298	0.00281	0.00165	0.00187	0.886	0.556
Methyl Mercury[a]	2	63	96.92%	0.00112	0.00176	0.00144	0.00144	0.00045255	0.00047443	N/A	0.314
Nickle	58	7	10.77%	0.06	1.61	0.314	0.215	0.276	0.156	2.294	0.877
Selenium	0	65	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	32	33	50.77%	0.003	1.75	0.106	0.01	0.322	0.00964	4.67	3.046
Zinc	65	0	0.00%	2.54	315	39.34	16	56.89	12.23	3	1.446

Notes:

Num Ds = number of detects

NumNDs = number of nondetects

% NDs = percent nondetects

SD = standard deviation

MAD = median absolute deviation

CV = coefficient of variation

TEE - terrestrial ecological evaluation

COC - constituent of concern

Concentrations are expressed in milligrams per kilogram (mg/kg).

[a] Methyl mercury was not analyzed in Phase 2 RI soil samples (Hart Crowser 2012), so was not identified as a Phase 2 TEE COC. However, methyl mercury was included in Phase 3 soil and tissue sample analysis and is included here for completeness.

Attachment C-3
ProUCL Output Files – Plant Tissue Background Comparisons

Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Dana new work_042514\Hart Crowser\MCMA_051114\Phase 3 report\plant eval\plant bkgd, plant-plantsoil-BAF plots_042214\background comparisons_050814\plant data-all.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Antimony

Area of Concern Data: Sb-s

Background Data: Sb-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	22	11
Number of Detect Data	43	1
Minimum Non-Detect	0.006	0.006
Maximum Non-Detect	0.007	0.007
Percent Non detects	33.85%	91.67%
Minimum Detected	0.007	0.014
Maximum Detected	1.76	0.014
Mean of Detected Data	0.174	0.014
Median of Detected Data	0.038	0.014
SD of Detected Data	0.302	N/A

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test Value	3.482
Critical z (0.95)	1.645
P-Value	0.00024859

Conclusion with Alpha = 0.05

Reject H0, Conclude Site > Background

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Arsenic

Area of Concern Data: As-s

Background Data: As-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	0	0
Number of Detect Data	65	12
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	0.082	0.032
Maximum Detected	149	0.221
Mean of Detected Data	7.247	0.0825
Median of Detected Data	0.942	0.062
SD of Detected Data	20.92	0.0603

Wilcoxon-Mann-Whitney Site vs Background Test

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	2904
WMW Test U-Stat	5.168
WMW Critical Value (0.050)	1.645
P-Value	1.1815E-07

Conclusion with Alpha = 0.05

Reject H0, Conclude Site > Background

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Cadmium

Area of Concern Data: Cd-s

Background Data: Cd-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	6	2
Number of Detect Data	59	10
Minimum Non-Detect	0.007	0.007
Maximum Non-Detect	0.007	0.007
Percent Non detects	9.23%	16.67%
Minimum Detected	0.008	0.008
Maximum Detected	8.65	0.134
Mean of Detected Data	0.231	0.0377
Median of Detected Data	0.027	0.027
SD of Detected Data	1.129	0.0369

Wilcoxon-Mann-Whitney Site vs Background Test

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	2607
WMW Test U-Stat	1.004
WMW Critical Value (0.050)	1.645
P-Value	0.158

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site <= Background

P-Value >= alpha (0.05)

Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Dana new work_042514\Hart Crowser\MCMA_050814\Phase 3 report\plant eval\plant bkgd, plant-plantsoil-BAF plots_042214\plant data-all.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Cobalt

Area of Concern Data: Co-s

Background Data: Co-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	29	11
Number of Detect Data	36	1
Minimum Non-Detect	0.018	0.017
Maximum Non-Detect	0.023	0.021
Percent Non detects	44.62%	91.67%
Minimum Detected	0.02	0.024
Maximum Detected	0.471	0.024
Mean of Detected Data	0.0818	0.024
Median of Detected Data	0.0435	0.024
SD of Detected Data	0.0999	N/A

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test Value	2.916
Critical z (0.95)	1.645
P-Value	0.00178

Conclusion with Alpha = 0.05

Reject H0, Conclude Site > Background

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Copper

Area of Concern Data: Cu-s

Background Data: Cu-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	0	0
Number of Detect Data	65	12
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	0.62	1.2
Maximum Detected	103	3.04
Mean of Detected Data	5.014	1.648
Median of Detected Data	2.19	1.525
SD of Detected Data	13.96	0.471

Wilcoxon-Mann-Whitney Site vs Background Test

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	2689
WMW Test U-Stat	2.149
WMW Critical Value (0.050)	1.645
P-Value	0.0158

Conclusion with Alpha = 0.05

Reject H0, Conclude Site > Background

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Iron
Area of Concern Data: Fe-s
Background Data: Fe-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	0	0
Number of Detect Data	65	12
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	5.67	8.22
Maximum Detected	727	18.2
Mean of Detected Data	74.17	11.3
Median of Detected Data	18.4	10.7
SD of Detected Data	143.1	2.804

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	2777
WMW Test U-Stat	3.392
WMW Critical Value (0.050)	1.645
P-Value	0.00034734

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Lead

Area of Concern Data: Pb-s

Background Data: Pb-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	0	0
Number of Detect Data	65	12
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	0.012	0.011
Maximum Detected	22.3	0.258
Mean of Detected Data	1.897	0.0649
Median of Detected Data	0.297	0.036
SD of Detected Data	3.869	0.0742

Wilcoxon-Mann-Whitney Site vs Background Test

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	2779
WMW Test U-Stat	3.42
WMW Critical Value (0.050)	1.645
P-Value	0.00031339

Conclusion with Alpha = 0.05

Reject H0, Conclude Site > Background

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Manganese

Area of Concern Data: Mn-s

Background Data: Mn-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	0	0
Number of Detect Data	65	12
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	1.39	9.18
Maximum Detected	604	369
Mean of Detected Data	156.9	181.4
Median of Detected Data	116	168.5
SD of Detected Data	140.1	96.24

Wilcoxon-Mann-Whitney Site vs Background Test

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	2458
WMW Test U-Stat	-1.088
WMW Critical Value (0.050)	1.645
P-Value	0.862

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site <= Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Mercury

Area of Concern Data: Hg-s

Background Data: Hg-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	0	0
Number of Detect Data	65	12
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	0.00066	0.00043
Maximum Detected	0.00777	0.00546
Mean of Detected Data	0.00298	0.00273
Median of Detected Data	0.00281	0.00275
SD of Detected Data	0.00165	0.00157

Wilcoxon-Mann-Whitney Site vs Background Test

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	2569
WMW Test U-Stat	0.463
WMW Critical Value (0.050)	1.645
P-Value	0.322

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site <= Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Niclel

Area of Concern Data: Ni-s

Background Data: Ni-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	7	1
Number of Detect Data	58	11
Minimum Non-Detect	0.05	0.05
Maximum Non-Detect	0.05	0.05
Percent Non detects	10.77%	8.33%
Minimum Detected	0.06	0.15
Maximum Detected	1.61	0.75
Mean of Detected Data	0.314	0.404
Median of Detected Data	0.215	0.4
SD of Detected Data	0.276	0.177

Wilcoxon-Mann-Whitney Site vs Background Test

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	2409
WMW Test U-Stat	-1.777
WMW Critical Value (0.050)	1.645
P-Value	0.962

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site <= Background

P-Value >= alpha (0.05)

Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Dana new work_042514\Hart Crowser\MCMA_050814\Phase 3 report\plant eval\plant bkgd, plant-plantsoil-BAF plots_042214\plant data-all.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Thallium

Area of Concern Data: Tl-s

Background Data: Tl-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	33	9
Number of Detect Data	32	3
Minimum Non-Detect	0.002	0.002
Maximum Non-Detect	0.002	0.002
Percent Non detects	50.77%	75.00%
Minimum Detected	0.003	0.003
Maximum Detected	1.75	0.004
Mean of Detected Data	0.106	0.00333
Median of Detected Data	0.01	0.003
SD of Detected Data	0.322	0.00057735

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test Value	2.002
Critical z (0.95)	1.645
P-Value	0.0226

Conclusion with Alpha = 0.05

Reject H0, Conclude Site > Background

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Zinc

Area of Concern Data: Zn-s

Background Data: Zn-b

Raw Statistics

	Site	Background
Number of Valid Data	65	12
Number of Non-Detect Data	0	0
Number of Detect Data	65	12
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	2.54	5.24
Maximum Detected	315	20.9
Mean of Detected Data	39.34	10.48
Median of Detected Data	16	9.985
SD of Detected Data	56.89	4.59

Wilcoxon-Mann-Whitney Site vs Background Test

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	2717
WMW Test U-Stat	2.542
WMW Critical Value (0.050)	1.645
P-Value	0.00551

Conclusion with Alpha = 0.05

Reject H0, Conclude Site > Background

P-Value < alpha (0.05)

Attachment C-4
ProUCL Output Files – Soil Biota Tissue Sample Summary Statistics

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

Phase 2 TEE COC	Raw Statistics using Detected Observations										
	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Background											
Antimony	4	3	42.86%	0.02	0.421	0.145	0.07	0.189	0.0697	1.712	1.3
Arsenic	7	0	0.00%	0.236	13.1	2.914	0.892	4.669	0.755	2.285	1.602
Cadmium	7	0	0.00%	0.064	1.03	0.42	0.307	0.33	0.254	1.073	0.785
Chromium	3	4	57.14%	0.021	0.102	0.0723	0.094	0.0446	0.0119	-1.67	0.617
Copper	7	0	0.00%	5.67	18.3	11.73	11.1	4.912	7.813	-0.0464	0.419
Lead	7	0	0.00%	0.035	1.67	0.488	0.179	0.59	0.213	1.666	1.208
Manganese	7	0	0.00%	29.5	146	74.47	69.9	37.34	28.32	1.148	0.501
Mercury	7	0	0.00%	0.0018	0.0435	0.0151	0.0116	0.0149	0.0113	1.397	0.985
Methylmercury[a]	5	2	28.57%	0.00402	0.0268	0.0096	0.00619	0.00967	0.0024	2.173	1.007
Selenium	2	5	71.43%	0.07	0.12	0.095	0.095	0.0354	0.0371	N/A	0.372
Zinc	7	0	0.00%	40.2	71.2	50.46	46	11.43	6.227	1.284	0.227
MCMA											
Antimony	5	0	0.00%	0.016	3.64	1.217	0.929	1.443	1.008	1.602	1.186
Arsenic	5	0	0.00%	1.87	119	45.47	29	47.02	40.22	1.145	1.034
Cadmium	5	0	0.00%	0.355	0.974	0.687	0.72	0.275	0.377	-0.219	0.401
Chromium	5	0	0.00%	0.077	0.263	0.145	0.135	0.0713	0.046	1.476	0.493
Copper	5	0	0.00%	4.49	23.6	13.27	9.55	7.86	7.502	0.456	0.592
Lead	5	0	0.00%	0.37	21.6	8.98	10.2	8.679	13.3	0.589	0.966
Manganese	5	0	0.00%	38.9	172	85.12	58.3	57.46	28.76	1.056	0.675
Mercury	5	0	0.00%	0.0149	0.0421	0.0268	0.0283	0.0104	0.0128	0.574	0.388
Methylmercury[a]	5	0	0.00%	0.00485	0.0143	0.00918	0.00919	0.00375	0.00406	0.318	0.408
Selenium	4	1	20.00%	0.07	0.11	0.095	0.1	0.0173	0.00741	-1.54	0.182
Zinc	5	0	0.00%	49.1	65.9	54.54	50.4	7.092	1.927	1.366	0.13

Notes:

Num Ds = number of detects

NumNDs = number of nondetects

% NDs = percent nondetects

SD = standard deviation

MAD = median absolute deviation

CV = coefficient of variation

TEE - terrestrial ecological evaluation

COC - constituent of concern

Concentrations are expressed in milligrams per kilogram (mg/kg).

[a] Methylmercury was not analyzed in Phase 2 RI soil samples (Hart Crowser 2012), so was not identified as a Phase 2 TEE COC. However, methylmercury was included in Phase 3 soil and tissue sample analysis and is included here for completeness.

Attachment C-5
ProUCL Output Files – Soil Biota Tissue Background Comparisons

Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Dana new work_031914\Hart Crowser\MCMA_win & work\Phase 3 report\invert eval\invert bkgd,UCL,summ stats,\invert data\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater than Background Mean/Median

Antimony
Area of Concern Data: Sbs
Background Data: Sb

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	0	3
Number of Detect Data	5	4
Minimum Non-Detect	N/A	0.006
Maximum Non-Detect	N/A	0.007
Percent Non -Detects	0.00%	42.86%
Minimum Detected	0.016	0.02
Maximum Detected	3.64	0.421
Mean of Detected Data	1.217	0.145
Median of Detected Data	0.929	0.07
SD of Detected Data	1.443	0.189

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test Value	2.044
Critical z (0.95)	1.645
P-Value	0.0205

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Arsenic
Area of Concern Data: Ass
Background Data: As

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	0	0
Number of Detect Data	5	7
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	1.87	0.236
Maximum Detected	119	13.1
Mean of Detected Data	45.47	2.914
Median of Detected Data	29	0.892
SD of Detected Data	47.02	4.669

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	48
WMW Test U-Stat	33
WMW Critical Value (0.050)	28
Approximate P-Value	0.00743

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Cadmium
Area of Concern Data: Cds
Background Data: Cd

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	0	0
Number of Detect Data	5	7
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non -Detects	0.00%	0.00%
Minimum Detected	0.355	0.064
Maximum Detected	0.974	1.03
Mean of Detected Data	0.687	0.42
Median of Detected Data	0.72	0.307
SD of Detected Data	0.275	0.33

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	41
WMW Test U-Stat	26
WMW Critical Value (0.050)	28
Approximate P-Value	0.0969

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background

Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Dana new work_031914\Hart Crowser\MCMA_win & work\Phase 3 report\invert eval\invert bkgd,UCL,summ stats,\invert data\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Chromium
Area of Concern Data: Crs
Background Data: Cr

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	0	4
Number of Detect Data	5	3
Minimum Non-Detect	N/A	0.016
Maximum Non-Detect	N/A	0.019
Percent Non -Detects	0.00%	57.14%
Minimum Detected	0.077	0.021
Maximum Detected	0.263	0.102
Mean of Detected Data	0.145	0.0723
Median of Detected Data	0.135	0.094
SD of Detected Data	0.0713	0.0446

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test Value	2.562
Critical z (0.95)	1.645
P-Value	0.0052

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Copper
Area of Concern Data: Cus
Background Data: Cu

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	0	0
Number of Detect Data	5	7
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non -Detects	0.00%	0.00%
Minimum Detected	4.49	5.67
Maximum Detected	23.6	18.3
Mean of Detected Data	13.27	11.73
Median of Detected Data	9.55	11.1
SD of Detected Data	7.86	4.912

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	33
WMW Test U-Stat	18
WMW Critical Value (0.050)	28
Approximate P-Value	0.5

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Lead
Area of Concern Data: Pbs
Background Data: Pb

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	0	0
Number of Detect Data	5	7
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non -Detects	0.00%	0.00%
Minimum Detected	0.37	0.035
Maximum Detected	21.6	1.67
Mean of Detected Data	8.98	0.488
Median of Detected Data	10.2	0.179
SD of Detected Data	8.679	0.59

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	46
WMW Test U-Stat	31
WMW Critical Value (0.050)	28
Approximate P-Value	0.0174

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Manganese
Area of Concern Data: Mns
Background Data: Mn

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	0	0
Number of Detect Data	5	7
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non -Detects	0.00%	0.00%
Minimum Detected	38.9	29.5
Maximum Detected	172	146
Mean of Detected Data	85.12	74.47
Median of Detected Data	58.3	69.9
SD of Detected Data	57.46	37.34

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	33
WMW Test U-Stat	18
WMW Critical Value (0.050)	28
Approximate P-Value	0.5

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Mercury
Area of Concern Data: Hgs
Background Data: Hg

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	0	0
Number of Detect Data	5	7
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non -Detects	0.00%	0.00%
Minimum Detected	0.0149	0.0018
Maximum Detected	0.0421	0.0435
Mean of Detected Data	0.0268	0.0151
Median of Detected Data	0.0283	0.0116
SD of Detected Data	0.0104	0.0149

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	43
WMW Test U-Stat	28
WMW Critical Value (0.050)	28
Approximate P-Value	0.0522

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background

Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Dana new work_031914\Hart Crowser\MCMA_win & work\Phase 3 report\invert eval\invert bkgd,UCL,summ stats,\invert data\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Methylmercury
Area of Concern Data: MeHgs
Background Data: MeHg

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	0	2
Number of Detect Data	5	5
Minimum Non-Detect	N/A	0.00093
Maximum Non-Detect	N/A	0.00098
Percent Non detects	0.00%	28.57%
Minimum Detected	0.00485	0.00402
Maximum Detected	0.0143	0.0268
Mean of Detected Data	0.00918	0.0096
Median of Detected Data	0.00919	0.00619
SD of Detected Data	0.00375	0.00967

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test Value	1.708
Critical z (0.95)	1.645
P-Value	0.0438

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Dana new work_031914\Hart Crowser\MCMA_win & work\Phase 3 report\invert eval\invert bkgd,UCL,summ stats,\invert data\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Selenium
Area of Concern Data: Ses
Background Data: Se

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	1	5
Number of Detect Data	4	2
Minimum Non-Detect	0.05	0.05
Maximum Non-Detect	0.05	0.06
Percent Non -Detects	20.00%	71.43%
Minimum Detected	0.07	0.07
Maximum Detected	0.11	0.12
Mean of Detected Data	0.095	0.095
Median of Detected Data	0.1	0.095
SD of Detected Data	0.0173	0.0354

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test Value	1.387
Critical z (0.95)	1.645
P-Value	0.0827

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\invert data.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Zinc
Area of Concern Data: Zns
Background Data: Zn

Raw Statistics

	Site	Background
Number of Valid Data	5	7
Number of Non-Detect Data	0	0
Number of Detect Data	5	7
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non -Detects	0.00%	0.00%
Minimum Detected	49.1	40.2
Maximum Detected	65.9	71.2
Mean of Detected Data	54.54	50.46
Median of Detected Data	50.4	46
SD of Detected Data	7.092	11.43

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	41
WMW Test U-Stat	26
WMW Critical Value (0.050)	28
Approximate P-Value	0.0969

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background

Attachment C-6
ProUCL Output Files – Soil Biota BAF Comparisons of MCMA and Background Areas

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	C:\Users\admin\Desktop\invert BAF w ND 0.5DL_050914.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Antimony
Area of Concern Data: Sb-s
Background Data: Sb-b

Raw Statistics

	Site	Background
Number of Valid Observations	5	7
Number of Distinct Observations	5	7
Minimum	0.00036	0.0013
Maximum	0.119	0.0952
Mean	0.035	0.0221
Median	0.0167	0.012
SD	0.0477	0.0329
SE of Mean	0.0213	0.0124

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	37
WMW Test U-Stat	22
Lower Critical Value (0.025)	6
Upper Critical Value (0.975)	29
Approximate P-Value	0.516

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	C:\Users\admin\Desktop\invert BAF w ND 0.5DL_050914.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Arsenic
Area of Concern Data: As-s
Background Data: As-b

Raw Statistics

	Site	Background
Number of Valid Observations	5	7
Number of Distinct Observations	5	7
Minimum	0.00021	0.00052
Maximum	0.0744	0.187
Mean	0.0178	0.0481
Median	0.00467	0.0203
SD	0.0317	0.0681
SE of Mean	0.0142	0.0257

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	26
WMW Test U-Stat	11
Lower Critical Value (0.025)	6
Upper Critical Value (0.975)	29
Approximate P-Value	0.256

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	C:\Users\admin\Desktop\invert BAF w ND 0.5DL_050914.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Chromium
Area of Concern Data: Cr-s
Background Data: Cr-b

Raw Statistics

	Site	Background
Number of Valid Observations	5	7
Number of Distinct Observations	5	6
Minimum	0.00196	0.00045
Maximum	0.0276	0.00839
Mean	0.0166	0.00326
Median	0.016	0.00131
SD	0.00988	0.00343
SE of Mean	0.00442	0.0013

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	47
WMW Test U-Stat	32
Lower Critical Value (0.025)	6
Upper Critical Value (0.975)	29
Approximate P-Value	0.023

Conclusion with Alpha = 0.05
Reject H0, Conclude Site <> Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	C:\Users\admin\Desktop\invert BAF w ND 0.5DL_050914.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Lead
Area of Concern Data: Pb-s
Background Data: Pb-b

Raw Statistics

	Site	Background
Number of Valid Observations	5	7
Number of Distinct Observations	5	7
Minimum	0.00037	0.00078
Maximum	0.0218	0.0329
Mean	0.0111	0.0106
Median	0.00827	0.00861
SD	0.00902	0.011
SE of Mean	0.00403	0.00417

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	33
WMW Test U-Stat	18
Lower Critical Value (0.025)	6
Upper Critical Value (0.975)	29
Approximate P-Value	1

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	C:\Users\admin\Desktop\invert BAF w ND 0.5DL_050914.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Methyl Mercury
Area of Concern Data: MeHg-s
Background Data: MeHg-b

Raw Statistics

	Site	Background
Number of Valid Observations	5	7
Number of Distinct Observations	5	7
Minimum	0.0299	0.00208
Maximum	0.308	0.419
Mean	0.168	0.0775
Median	0.198	0.0183
SD	0.115	0.151
SE of Mean	0.0512	0.0571

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	44
WMW Test U-Stat	29
Lower Critical Value (0.025)	6
Upper Critical Value (0.975)	29
Approximate P-Value	0.074

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Attachment C-7
ProUCL Output Files – Soil Biota BAF Comparisons for Group 1 and 2 Sites

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Antimony
Area of Concern Data: Sb-2
Background Data: Sb-1

Raw Statistics

	Site	Background
Number of Valid Observations	3	2
Number of Distinct Observations	3	2
Minimum	0.0128	0.00036
Maximum	0.0265	0.119
Mean	0.0187	0.0595
Median	0.0167	0.0595
SD	0.0071	0.0836
SE of Mean	0.0041	0.0591

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	9
WMW Test U-Stat	3
Lower Critical Value (0.025)	0
Upper Critical Value (0.975)	6
Approximate P-Value	0.773

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Arsenic
Area of Concern Data: As-2
Background Data: As-1

Raw Statistics

	Site	Background
Number of Valid Observations	3	2
Number of Distinct Observations	3	2
Minimum	0.00453	0.00021
Maximum	0.00543	0.0744
Mean	0.00488	0.0373
Median	0.00467	0.0373
SD	0.00048429	0.0524
SE of Mean	0.0002796	0.0371

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	9
WMW Test U-Stat	3
Lower Critical Value (0.025)	0
Upper Critical Value (0.975)	6
Approximate P-Value	0.773

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Chromium
Area of Concern Data: Cr-2
Background Data: Cr-1

Raw Statistics

	Site	Background
Number of Valid Observations	3	2
Number of Distinct Observations	3	2
Minimum	0.014	0.00196
Maximum	0.0276	0.0236
Mean	0.0192	0.0128
Median	0.016	0.0128
SD	0.00731	0.0153
SE of Mean	0.00422	0.0108

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	10
WMW Test U-Stat	4
Lower Critical Value (0.025)	0
Upper Critical Value (0.975)	6
Approximate P-Value	0.773

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Lead
Area of Concern Data: Pb-2
Background Data: Pb-1

Raw Statistics

	Site	Background
Number of Valid Observations	3	2
Number of Distinct Observations	3	2
Minimum	0.00618	0.00037
Maximum	0.0191	0.0218
Mean	0.0112	0.0111
Median	0.00827	0.0111
SD	0.00695	0.0151
SE of Mean	0.00401	0.0107

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	9
WMW Test U-Stat	3
Lower Critical Value (0.025)	0
Upper Critical Value (0.975)	6
Approximate P-Value	0.773

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Methyl Mercury
Area of Concern Data: MeHg-2
Background Data: MeHg-1

Raw Statistics

	Site	Background
Number of Valid Observations	3	2
Number of Distinct Observations	3	2
Minimum	0.198	0.0292
Maximum	0.308	0.0733
Mean	0.246	0.0513
Median	0.23	0.0513
SD	0.0566	0.0312
SE of Mean	0.0327	0.0221

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	12
WMW Test U-Stat	6
Lower Critical Value (0.025)	0
Upper Critical Value (0.975)	6
Approximate P-Value	0.149

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Attachment C-8
ProUCL Output Files – Plant BAF Comparisons for Group 1 and 2 Sites

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Antimony - Huckleberry
Area of Concern Data: Sb-huc-2
Background Data: Sb-huc-1

Raw Statistics

	Site	Background
Number of Valid Observations	7	9
Number of Distinct Observations	7	9
Minimum	0.00004375	0.00039773
Maximum	0.00467	0.00946
Mean	0.00147	0.00365
Median	0.00123	0.00209
SD	0.00155	0.00317
SE of Mean	0.00058506	0.00106

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	43
WMW Test U-Stat	15
Lower Critical Value (0.025)	13
Upper Critical Value (0.975)	50
Approximate P-Value	0.0719

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Arsenic - Huckleberry
Area of Concern Data: As-2-s
Background Data: As-1-s

Raw Statistics

	Site	Background
Number of Valid Observations	7	9
Number of Distinct Observations	7	9
Minimum	0.00019481	0.000034296
Maximum	0.0024	0.00331
Mean	0.00063765	0.00058518
Median	0.00041734	0.00011074
SD	0.00078323	0.00107
SE of Mean	0.00029603	0.00035699

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	76
WMW Test U-Stat	48
Lower Critical Value (0.025)	13
Upper Critical Value (0.975)	50
Approximate P-Value	0.0903

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Cobalt - Huckleberry
Area of Concern Data: Co-2-s
Background Data: Co-1-s

Raw Statistics

	Site	Background
Number of Valid Observations	7	9
Number of Distinct Observations	7	9
Minimum	0.00213	0.00014516
Maximum	0.0176	0.0288
Mean	0.00636	0.00729
Median	0.004	0.00578
SD	0.00539	0.00907
SE of Mean	0.00204	0.00302

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	63
WMW Test U-Stat	35
Lower Critical Value (0.025)	13
Upper Critical Value (0.975)	50
Approximate P-Value	0.751

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Copper - Huckleberry
Area of Concern Data: Cu-2-s
Background Data: Cu-1-s

Raw Statistics

	Site	Background
Number of Valid Observations	7	9
Number of Distinct Observations	7	9
Minimum	0.00038	0.001
Maximum	0.00583	0.00396
Mean	0.00155	0.00214
Median	0.00091346	0.00153
SD	0.00192	0.00117
SE of Mean	0.00072748	0.00038844

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	42
WMW Test U-Stat	14
Lower Critical Value (0.025)	13
Upper Critical Value (0.975)	50
Approximate P-Value	0.0567

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Iron - huckleberry
Area of Concern Data: Fe-2-s
Background Data: Fe-1-s

Raw Statistics

	Site	Background
Number of Valid Observations	7	9
Number of Distinct Observations	7	9
Minimum	0.00447	0.0111
Maximum	0.0134	0.134
Mean	0.00894	0.0369
Median	0.0092	0.0231
SD	0.00322	0.0382
SE of Mean	0.00122	0.0127

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	30
WMW Test U-Stat	2
Lower Critical Value (0.025)	13
Upper Critical Value (0.975)	50
Approximate P-Value	0.0015

Conclusion with Alpha = 0.05
Reject H0, Conclude Site <> Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Lead - Huckleberry
Area of Concern Data: Pb-2-s
Background Data: Pb-1-s

Raw Statistics

	Site	Background
Number of Valid Observations	7	9
Number of Distinct Observations	7	9
Minimum	0.00026356	0.00012252
Maximum	0.00494	0.00966
Mean	0.00113	0.00152
Median	0.00064304	0.00064894
SD	0.00169	0.00307
SE of Mean	0.0006387	0.00102

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	61
WMW Test U-Stat	33
Lower Critical Value (0.025)	13
Upper Critical Value (0.975)	50
Approximate P-Value	0.916

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Thallium - Huckleberry
Area of Concern Data: Tl-2-s
Background Data: Tl-1-s

Raw Statistics

	Site	Background
Number of Valid Observations	7	9
Number of Distinct Observations	6	9
Minimum	0.00333	0.00595
Maximum	0.254	0.0323
Mean	0.0719	0.0121
Median	0.012	0.01
SD	0.106	0.00827
SE of Mean	0.04	0.00276

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	65
WMW Test U-Stat	37
Lower Critical Value (0.025)	13
Upper Critical Value (0.975)	50
Approximate P-Value	0.597

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Zinc - Huckleberry
Area of Concern Data: Zn-2-s
Background Data: Zn-1-s

Raw Statistics

	Site	Background
Number of Valid Observations	7	9
Number of Distinct Observations	7	9
Minimum	0.0162	0.0473
Maximum	0.133	0.446
Mean	0.0447	0.141
Median	0.0252	0.115
SD	0.0418	0.123
SE of Mean	0.0158	0.0409

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	36
WMW Test U-Stat	8
Lower Critical Value (0.025)	13
Upper Critical Value (0.975)	50
Approximate P-Value	0.0111

Conclusion with Alpha = 0.05
Reject H0, Conclude Site <> Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Antimony - Sedge
Area of Concern Data: Sb-sdg-2
Background Data: Sb-sdg-1

Raw Statistics

	Site	Background
Number of Valid Observations	11	7
Number of Distinct Observations	11	7
Minimum	0.00011786	0.00039773
Maximum	0.00308	0.00698
Mean	0.00081843	0.00295
Median	0.00052857	0.00205
SD	0.00087023	0.00258
SE of Mean	0.00026239	0.00097485

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	83
WMW Test U-Stat	17
Lower Critical Value (0.025)	17
Upper Critical Value (0.975)	60
Approximate P-Value	0.0463

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Arsenic - Sedge
Area of Concern Data: As-2-g
Background Data: As-1-g

Raw Statistics

	Site	Background
Number of Valid Observations	11	7
Number of Distinct Observations	11	7
Minimum	0.000063692	0.000019085
Maximum	0.00143	0.00101
Mean	0.000436	0.00023554
Median	0.00035677	0.00012181
SD	0.00037624	0.00035252
SE of Mean	0.00011344	0.00013324

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	126
WMW Test U-Stat	60
Lower Critical Value (0.025)	17
Upper Critical Value (0.975)	60
Approximate P-Value	0.0572

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Cobalt - Sedge
Area of Concern Data: Co-2-g
Background Data: Co-1-g

Raw Statistics

	Site	Background
Number of Valid Observations	11	7
Number of Distinct Observations	11	7
Minimum	0.0006	0.00063333
Maximum	0.00281	0.00346
Mean	0.00114	0.00183
Median	0.00092	0.0016
SD	0.00063755	0.00094685
SE of Mean	0.00019223	0.00035788

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	84
WMW Test U-Stat	18
Lower Critical Value (0.025)	17
Upper Critical Value (0.975)	60
Approximate P-Value	0.0572

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Copper - Sedge
Area of Concern Data: Cu-2-g
Background Data: Cu-1-g

Raw Statistics

	Site	Background
Number of Valid Observations	11	7
Number of Distinct Observations	11	7
Minimum	0.0046	0.00254
Maximum	0.0146	0.099
Mean	0.01	0.0223
Median	0.0104	0.00886
SD	0.00317	0.0342
SE of Mean	0.00095454	0.0129

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	103
WMW Test U-Stat	37
Lower Critical Value (0.025)	17
Upper Critical Value (0.975)	60
Approximate P-Value	0.856

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Lead - Sedge
Area of Concern Data: Fe-2-g
Background Data: Fe-1-g

Raw Statistics

	Site	Background
Number of Valid Observations	11	7
Number of Distinct Observations	11	7
Minimum	0.00016507	0.00012387
Maximum	0.00108	0.0208
Mean	0.00048855	0.00326
Median	0.00041049	0.00037628
SD	0.00024971	0.00775
SE of Mean	0.000075291	0.00293

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	112
WMW Test U-Stat	46
Lower Critical Value (0.025)	17
Upper Critical Value (0.975)	60
Approximate P-Value	0.526

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Lead - Sedge
Area of Concern Data: Pb-2-g
Background Data: Pb-1-g

Raw Statistics

	Site	Background
Number of Valid Observations	11	7
Number of Distinct Observations	11	7
Minimum	0.00023133	0.00016
Maximum	0.00563	0.00233
Mean	0.00215	0.0011
Median	0.0018	0.00118
SD	0.00172	0.00078658
SE of Mean	0.00051948	0.0002973

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	119
WMW Test U-Stat	53
Lower Critical Value (0.025)	17
Upper Critical Value (0.975)	60
Approximate P-Value	0.205

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Thallium - Sedge
Area of Concern Data: Tl-2-g
Background Data: Tl-1-g

Raw Statistics

	Site	Background
Number of Valid Observations	11	7
Number of Distinct Observations	11	7
Minimum	0.002	0.00671
Maximum	0.123	0.0417
Mean	0.0308	0.0143
Median	0.0174	0.01
SD	0.0368	0.0125
SE of Mean	0.0111	0.00472

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	122.5
WMW Test U-Stat	56.5
Lower Critical Value (0.025)	17
Upper Critical Value (0.975)	60
Approximate P-Value	0.113

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Zinc - Sedge
Area of Concern Data: Zn-2-g
Background Data: Zn-1-g

Raw Statistics

	Site	Background
Number of Valid Observations	11	7
Number of Distinct Observations	11	7
Minimum	0.014	0.0457
Maximum	0.0893	0.248
Mean	0.0506	0.129
Median	0.057	0.112
SD	0.0268	0.0704
SE of Mean	0.00808	0.0266

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	76
WMW Test U-Stat	10
Lower Critical Value (0.025)	17
Upper Critical Value (0.975)	60
Approximate P-Value	0.00863

Conclusion with Alpha = 0.05
Reject H0, Conclude Site <> Background

Attachment C-9
ProUCL Ouput Files – Grass and Shrub BAF Comparisons

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Antimony
Area of Concern Data: Sb-shrb
Background Data: Sb-grs

Raw Statistics

	Site	Background
Number of Valid Observations	34	31
Number of Distinct Observations	33	31
Minimum	0.00000625	0.00011786
Maximum	0.0126	0.00698
Mean	0.00255	0.00199
Median	0.00129	0.00123
SD	0.00331	0.0019
SE of Mean	0.00056711	0.00034142

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	1082
WMW Test U-Stat	0.519
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.595

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Arsenic
Area of Concern Data: As-s
Background Data: As-g

Raw Statistics

	Site	Background
Number of Valid Observations	34	31
Number of Distinct Observations	34	31
Minimum	6.4078E-06	0.000019085
Maximum	0.00987	0.00252
Mean	0.00108	0.00056528
Median	0.00019324	0.00030333
SD	0.002	0.00067956
SE of Mean	0.00034292	0.00012205

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	1081
WMW Test U-Stat	0.532
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.586

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Cobalt
Area of Concern Data: Co-s
Background Data: Co-g

Raw Statistics

	Site	Background
Number of Valid Observations	34	31
Number of Distinct Observations	34	31
Minimum	0.00038	0.00016949
Maximum	0.0174	0.00516
Mean	0.00319	0.00147
Median	0.00205	0.00125
SD	0.0038	0.00116
SE of Mean	0.00065213	0.00020759

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	1314
WMW Test U-Stat	2.509
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.0121

Conclusion with Alpha = 0.05
Reject H0, Conclude Site <> Background

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Copper
Area of Concern Data: Cu-s
Background Data: Cu-g

Raw Statistics

	Site	Background
Number of Valid Observations	34	31
Number of Distinct Observations	34	31
Minimum	0.00102	0.00051613
Maximum	0.134	0.099
Mean	0.0161	0.0114
Median	0.0105	0.00886
SD	0.0233	0.0169
SE of Mean	0.00399	0.00303

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	1209
WMW Test U-Stat	1.136
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.256

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Iron
Area of Concern Data: Fe-s
Background Data: Fe-g

Raw Statistics

	Site	Background
Number of Valid Observations	34	31
Number of Distinct Observations	34	31
Minimum	0.000099231	0.00012387
Maximum	0.00966	0.0208
Mean	0.0014	0.00122
Median	0.00036068	0.00040649
SD	0.00244	0.00367
SE of Mean	0.00041822	0.00065961

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	1093
WMW Test U-Stat	0.374
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.698

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Lead
Area of Concern Data: Pb-s
Background Data: Pb-g

Raw Statistics

	Site	Background
Number of Valid Observations	34	31
Number of Distinct Observations	34	31
Minimum	0.000019512	0.00016
Maximum	0.0112	0.0155
Mean	0.00126	0.0021
Median	0.00035692	0.00118
SD	0.00221	0.0029
SE of Mean	0.00037827	0.00052055

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	935
WMW Test U-Stat	2.449
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.0138

Conclusion with Alpha = 0.05
Reject H0, Conclude Site <> Background

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Thallium
Area of Concern Data: Tl-s
Background Data: Tl-g

Raw Statistics

	Site	Background
Number of Valid Observations	34	31
Number of Distinct Observations	32	27
Minimum	0.0004	0.002
Maximum	0.254	0.123
Mean	0.0241	0.0186
Median	0.00947	0.01
SD	0.0523	0.0245
SE of Mean	0.00896	0.00439

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	1047
WMW Test U-Stat	0.978
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.321

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Zinc
Area of Concern Data: Zn-s
Background Data: Zn-g

Raw Statistics

	Site	Background
Number of Valid Observations	34	31
Number of Distinct Observations	34	31
Minimum	0.00715	0.00293
Maximum	0.446	0.248
Mean	0.0721	0.0638
Median	0.0488	0.057
SD	0.0814	0.0571
SE of Mean	0.014	0.0102

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	1137
WMW Test U-Stat	0.19
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.849

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Attachment C-10
ProUCL Output Files – BAF Comparisons for Plants Located "On" and "Off" the Waste Rock Piles

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	C:\Dana new work_042514\Hart Crowser\MCMA_051114\Phase 3 report\plant eval\plant eval on-off MCMA WRP_042514\plant BAF comparion On&Off WRP_-51014\plant BAFs data on&off WRP
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Antimony
Area of Concern Data: Sb-0
Background Data: Sb-1

Raw Statistics

	Site	Background
Number of Valid Observations	20	45
Number of Distinct Observations	17	41
Minimum	0.00004375	0.00000625
Maximum	0.00946	0.0126
Mean	0.00272	0.00209
Median	0.00195	0.00123
SD	0.00284	0.00268
SE of Mean	0.00063535	0.00039914

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	716
WMW Test U-Stat	0.789
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.43

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Arsenic
Area of Concern Data: As-0
Background Data: As-1

Raw Statistics

	Site	Background
Number of Valid Observations	20	45
Number of Distinct Observations	20	45
Minimum	0.000019085	6.4078E-06
Maximum	0.00331	0.00987
Mean	0.00059259	0.0009444
Median	0.00022137	0.00025323
SD	0.00086744	0.00175
SE of Mean	0.00019396	0.00026028

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	621
WMW Test U-Stat	0.547
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.575

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Cobalt
Area of Concern Data: Co-0
Background Data: Co-1

Raw Statistics

	Site	Background
Number of Valid Observations	20	45
Number of Distinct Observations	20	45
Minimum	0.00029688	0.00016949
Maximum	0.00516	0.0174
Mean	0.00184	0.00261
Median	0.0015	0.00135
SD	0.00134	0.00345
SE of Mean	0.00030024	0.00051399

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	655.5
WMW Test U-Stat	0.0569
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.943

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Copper
Area of Concern Data: Cu-0
Background Data: Cu-1

Raw Statistics

	Site	Background
Number of Valid Observations	20	45
Number of Distinct Observations	20	45
Minimum	0.00254	0.00051613
Maximum	0.134	0.0241
Mean	0.0255	0.00868
Median	0.0134	0.0088
SD	0.0336	0.00565
SE of Mean	0.00751	0.00084173

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	855
WMW Test U-Stat	2.765
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.0057

Conclusion with Alpha = 0.05
Reject H0, Conclude Site <> Background

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Iron
Area of Concern Data: Fe-0
Background Data: Fe-1

Raw Statistics

	Site	Background
Number of Valid Observations	20	45
Number of Distinct Observations	20	45
Minimum	0.00012852	0.000099231
Maximum	0.0208	0.00767
Mean	0.00196	0.00102
Median	0.00040431	0.00037628
SD	0.0049	0.00174
SE of Mean	0.0011	0.00025915

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	705
WMW Test U-Stat	0.632
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.527

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Lead
Area of Concern Data: Pb-0
Background Data: Pb-1

Raw Statistics

	Site	Background
Number of Valid Observations	20	45
Number of Distinct Observations	20	45
Minimum	0.000055102	0.000019512
Maximum	0.0155	0.0112
Mean	0.00149	0.00174
Median	0.00053086	0.00075918
SD	0.00337	0.00217
SE of Mean	0.00075308	0.00032386

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	586
WMW Test U-Stat	1.045
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.29

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Thallium
Area of Concern Data: Tl-0
Background Data: Tl-1

Raw Statistics

	Site	Background
Number of Valid Observations	20	45
Number of Distinct Observations	15	37
Minimum	0.00333	0.0004
Maximum	0.195	0.254
Mean	0.027	0.019
Median	0.0133	0.00714
SD	0.0429	0.0406
SE of Mean	0.0096	0.00606

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	813.5
WMW Test U-Stat	2.175
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.0297

Conclusion with Alpha = 0.05
Reject H0, Conclude Site <> Background

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Equal to Background Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean/Median Not Equal to Background Mean/Median

Zinc
Area of Concern Data: Zn-0
Background Data: Zn-1

Raw Statistics

	Site	Background
Number of Valid Observations	20	45
Number of Distinct Observations	20	45
Minimum	0.00296	0.00293
Maximum	0.446	0.248
Mean	0.0992	0.0543
Median	0.0709	0.0432
SD	0.101	0.0466
SE of Mean	0.0226	0.00695

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC = Mean/Median of Background

Site Rank Sum W-Stat	787
WMW Test U-Stat	1.798
Lower Critical Value (0.025)	-1.96
Upper Critical Value (0.975)	1.96
P-Value	0.0722

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site = Background

P-Value >= alpha (0.05)

Attachment C-11
ProUCL Output Files – Plant Tissue Upper Confidence Limit Values (mg/kg dry weight)

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony
Sb

General Statistics

Number of Valid Data	65	Number of Detected Data	43
Number of Distinct Detected Data	37	Number of Non-Detect Data	22
		Percent Non-Detects	33.85%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.007	Minimum Detected	-4.962
Maximum Detected	1.76	Maximum Detected	0.565
Mean of Detected	0.174	Mean of Detected	-2.766
SD of Detected	0.302	SD of Detected	1.483
Minimum Non-Detect	0.006	Minimum Non-Detect	-5.116
Maximum Non-Detect	0.007	Maximum Non-Detect	-4.962

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	22
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	43
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	33.85%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.571	Shapiro Wilk Test Statistic	0.932
5% Shapiro Wilk Critical Value	0.943	5% Shapiro Wilk Critical Value	0.943
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.117	Mean	-3.748
SD	0.258	SD	1.833
95% DL/2 (t) UCL	0.17	95% H-Stat (DL/2) UCL	0.241
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0296	Mean in Log Scale	-3.979
SD	0.337	SD in Log Scale	2.171
95% MLE (t) UCL	0.0993	Mean in Original Scale	0.116
95% MLE (Tiku) UCL	0.104	SD in Original Scale	0.258
		95% t UCL	0.17
		95% Percentile Bootstrap UCL	0.175
		95% BCA Bootstrap UCL	0.198
		95% H UCL	0.464

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.578	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.302		
nu star	49.75		
A-D Test Statistic	1.495	**Nonparametric Statistics**	
5% A-D Critical Value	0.803	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.803	Mean	0.118
5% K-S Critical Value	0.142	SD	0.255
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.032
		95% KM (t) UCL	0.171
Assuming Gamma Distribution		95% KM (z) UCL	0.17
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.171
Minimum	0.000001	95% KM (bootstrap t) UCL	0.213
Maximum	1.76	95% KM (BCA) UCL	0.174
Mean	0.115	95% KM (Percentile Bootstrap) UCL	0.174
Median	0.017	95% KM (Chebyshev) UCL	0.257
SD	0.258	97.5% KM (Chebyshev) UCL	0.318
k star	0.175	99% KM (Chebyshev) UCL	0.437
Theta star	0.658		
Nu star	22.8	**Potential UCLs to Use**	
AppChi2	12.94	95% KM (Chebyshev) UCL	0.257
95% Gamma Approximate UCL (Use when n >= 40)	0.203		
95% Adjusted Gamma UCL (Use when n < 40)	0.206		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Arsenic

As

General Statistics

Number of Valid Observations	65	Number of Distinct Observations	64

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.082	Minimum of Log Data	-2.501
Maximum	149	Maximum of Log Data	5.004
Mean	7.247	Mean of log Data	0.225
Geometric Mean	1.252	SD of log Data	1.757
Median	0.942		
SD	20.92		
Std. Error of Mean	2.594		
Coefficient of Variation	2.886		
Skewness	5.405		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.366	Lilliefors Test Statistic	0.0982
Lilliefors Critical Value	0.11	Lilliefors Critical Value	0.11
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	11.58	95% H-UCL	10.69
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13.11
95% Adjusted-CLT UCL (Chen-1995)	13.37	97.5% Chebyshev (MVUE) UCL	16.38
95% Modified-t UCL (Johnson-1978)	11.87	99% Chebyshev (MVUE) UCL	22.81
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.371	**Data appear Lognormal at 5% Significance Level**	
Theta Star	19.54		
MLE of Mean	7.247		
MLE of Standard Deviation	11.9		
nu star	48.22		
Approximate Chi Square Value (.05)	33.28	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0463	95% CLT UCL	11.51
Adjusted Chi Square Value	33	95% Jackknife UCL	11.58
		95% Standard Bootstrap UCL	11.47
Anderson-Darling Test Statistic	4.735	95% Bootstrap-t UCL	17.14
Anderson-Darling 5% Critical Value	0.846	95% Hall's Bootstrap UCL	27.12
Kolmogorov-Smirnov Test Statistic	0.215	95% Percentile Bootstrap UCL	12.09
Kolmogorov-Smirnov 5% Critical Value	0.119	95% BCA Bootstrap UCL	13.78
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	18.56
		97.5% Chebyshev(Mean, Sd) UCL	23.45
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	33.06
95% Approximate Gamma UCL (Use when n >= 40)	10.5		
95% Adjusted Gamma UCL (Use when n < 40)	10.59		
Potential UCL to Use		Use 95% H-UCL	10.69

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cobalt
Co

General Statistics

Number of Valid Data	65	Number of Detected Data	36
Number of Distinct Detected Data	31	Number of Non-Detect Data	29
		Percent Non-Detects	44.62%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.02	Minimum Detected	-3.912
Maximum Detected	0.471	Maximum Detected	-0.753
Mean of Detected	0.0818	Mean of Detected	-2.924
SD of Detected	0.0999	SD of Detected	0.844
Minimum Non-Detect	0.018	Minimum Non-Detect	-4.017
Maximum Non-Detect	0.023	Maximum Non-Detect	-3.772

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	32
Number treated as Detected	33
Single DL Non-Detect Percentage	49.23%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.611	Shapiro Wilk Test Statistic	0.896
5% Shapiro Wilk Critical Value	0.935	5% Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0497	Mean	-3.682
SD	0.0822	SD	1.057
95% DL/2 (t) UCL	0.0667	95% H-Stat (DL/2) UCL	0.0593
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0027	Mean in Log Scale	-3.894
SD	0.125	SD in Log Scale	1.32
95% MLE (t) UCL	0.0286	Mean in Original Scale	0.0485
95% MLE (Tiku) UCL	0.0347	SD in Original Scale	0.0828
		95% t UCL	0.0657
		95% Percentile Bootstrap UCL	0.0666
		95% BCA Bootstrap UCL	0.071
		95% H UCL	0.0702

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.238	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.0661		
nu star	89.17		
A-D Test Statistic	1.944	**Nonparametric Statistics**	
5% A-D Critical Value	0.77	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.77	Mean	0.0542
5% K-S Critical Value	0.15	SD	0.0795
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.01
		95% KM (t) UCL	0.0709
Assuming Gamma Distribution		95% KM (z) UCL	0.0707
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0704
Minimum	0.000001	95% KM (bootstrap t) UCL	0.0839
Maximum	0.471	95% KM (BCA) UCL	0.0737
Mean	0.0453	95% KM (Percentile Bootstrap) UCL	0.0726
Median	0.023	95% KM (Chebyshev) UCL	0.0978
SD	0.0845	97.5% KM (Chebyshev) UCL	0.117
k star	0.165	99% KM (Chebyshev) UCL	0.154
Theta star	0.275		
Nu star	21.43	**Potential UCLs to Use**	
AppChi2	11.91	95% KM (t) UCL	0.0709
95% Gamma Approximate UCL (Use when n >= 40)	0.0815	95% KM (% Bootstrap) UCL	0.0726
95% Adjusted Gamma UCL (Use when n < 40)	0.0827		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Copper
Cu

General Statistics

Number of Valid Observations	65	Number of Distinct Observations	59
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.62	Minimum of Log Data	-0.478
Maximum	103	Maximum of Log Data	4.635
Mean	5.014	Mean of log Data	0.891
Geometric Mean	2.437	SD of log Data	0.867
Median	2.19		
SD	13.96		
Std. Error of Mean	1.731		
Coefficient of Variation	2.784		
Skewness	6.181		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.411	Lilliefors Test Statistic	0.163
Lilliefors Critical Value	0.11	Lilliefors Critical Value	0.11
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	7.903	95% H-UCL	4.481
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5.41
95% Adjusted-CLT UCL (Chen-1995)	9.279	97.5% Chebyshev (MVUE) UCL	6.228
95% Modified-t UCL (Johnson-1978)	8.124	99% Chebyshev (MVUE) UCL	7.834
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.792	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	6.329		
MLE of Mean	5.014		
MLE of Standard Deviation	5.633		
nu star	103		
Approximate Chi Square Value (.05)	80.58	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0463	95% CLT UCL	7.861
Adjusted Chi Square Value	80.13	95% Jackknife UCL	7.903
		95% Standard Bootstrap UCL	7.875
Anderson-Darling Test Statistic	8.46	95% Bootstrap-t UCL	20.59
Anderson-Darling 5% Critical Value	0.789	95% Hall's Bootstrap UCL	18.9
Kolmogorov-Smirnov Test Statistic	0.304	95% Percentile Bootstrap UCL	8.174
Kolmogorov-Smirnov 5% Critical Value	0.115	95% BCA Bootstrap UCL	10.57
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	12.56
		97.5% Chebyshev(Mean, Sd) UCL	15.82
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	22.24
95% Approximate Gamma UCL (Use when n >= 40)	6.409		
95% Adjusted Gamma UCL (Use when n < 40)	6.445		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	12.56

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iron
Fe

General Statistics

Number of Valid Observations	65	Number of Distinct Observations	63

Raw Statistics		**Log-transformed Statistics**	
Minimum	5.67	Minimum of Log Data	1.735
Maximum	727	Maximum of Log Data	6.589
Mean	74.17	Mean of log Data	3.385
Geometric Mean	29.52	SD of log Data	1.192
Median	18.4		
SD	143.1		
Std. Error of Mean	17.75		
Coefficient of Variation	1.929		
Skewness	3.319		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.316	Lilliefors Test Statistic	0.189
Lilliefors Critical Value	0.11	Lilliefors Critical Value	0.11
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	103.8	95% H-UCL	83.78
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	106.6
95% Adjusted-CLT UCL (Chen-1995)	111.2	97.5% Chebyshev (MVUE) UCL	127.1
95% Modified-t UCL (Johnson-1978)	105	99% Chebyshev (MVUE) UCL	167.5
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.641	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	115.7		
MLE of Mean	74.17		
MLE of Standard Deviation	92.63		
nu star	83.34		
Approximate Chi Square Value (.05)	63.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0463	95% CLT UCL	103.4
Adjusted Chi Square Value	62.91	95% Jackknife UCL	103.8
		95% Standard Bootstrap UCL	103.9
Anderson-Darling Test Statistic	5.785	95% Bootstrap-t UCL	117.2
Anderson-Darling 5% Critical Value	0.801	95% Hall's Bootstrap UCL	111.8
Kolmogorov-Smirnov Test Statistic	0.24	95% Percentile Bootstrap UCL	105.6
Kolmogorov-Smirnov 5% Critical Value	0.116	95% BCA Bootstrap UCL	112.8
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	151.5
		97.5% Chebyshev(Mean, Sd) UCL	185
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	250.8
95% Approximate Gamma UCL (Use when n >= 40)	97.65		
95% Adjusted Gamma UCL (Use when n < 40)	98.26		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	151.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Lead
Pb

General Statistics

Number of Valid Observations	65	Number of Distinct Observations	63

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.012	Minimum of Log Data	-4.423
Maximum	22.3	Maximum of Log Data	3.105
Mean	1.897	Mean of log Data	-1.044
Geometric Mean	0.352	SD of log Data	2.019
Median	0.297		
SD	3.869		
Std. Error of Mean	0.48		
Coefficient of Variation	2.04		
Skewness	3.51		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.313	Lilliefors Test Statistic	0.0708
Lilliefors Critical Value	0.11	Lilliefors Critical Value	0.11
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2.698	95% H-UCL	5.823
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6.56
95% Adjusted-CLT UCL (Chen-1995)	2.91	97.5% Chebyshev (MVUE) UCL	8.329
95% Modified-t UCL (Johnson-1978)	2.733	99% Chebyshev (MVUE) UCL	11.8
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.384	**Data appear Lognormal at 5% Significance Level**	
Theta Star	4.94		
MLE of Mean	1.897		
MLE of Standard Deviation	3.061		
nu star	49.93		
Approximate Chi Square Value (.05)	34.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0463	95% CLT UCL	2.686
Adjusted Chi Square Value	34.42	95% Jackknife UCL	2.698
		95% Standard Bootstrap UCL	2.682
Anderson-Darling Test Statistic	2.061	95% Bootstrap-t UCL	3.113
Anderson-Darling 5% Critical Value	0.842	95% Hall's Bootstrap UCL	3.196
Kolmogorov-Smirnov Test Statistic	0.183	95% Percentile Bootstrap UCL	2.721
Kolmogorov-Smirnov 5% Critical Value	0.119	95% BCA Bootstrap UCL	3.022
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3.989
		97.5% Chebyshev(Mean, Sd) UCL	4.894
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6.672
95% Approximate Gamma UCL (Use when n >= 40)	2.729		
95% Adjusted Gamma UCL (Use when n < 40)	2.752		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	3.989

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Thallium
Tl

General Statistics

Number of Valid Data	65	Number of Detected Data	32
Number of Distinct Detected Data	21	Number of Non-Detect Data	33
		Percent Non-Detects	50.77%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.003	Minimum Detected	-5.809
Maximum Detected	1.75	Maximum Detected	0.56
Mean of Detected	0.106	Mean of Detected	-4.036
SD of Detected	0.322	SD of Detected	1.627
Minimum Non-Detect	0.002	Minimum Non-Detect	-6.215
Maximum Non-Detect	0.002	Maximum Non-Detect	-6.215

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.354	Shapiro Wilk Test Statistic	0.876
5% Shapiro Wilk Critical Value	0.93	5% Shapiro Wilk Critical Value	0.93
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0526	Mean	-5.494
SD	0.23	SD	1.837
95% DL/2 (t) UCL	0.1	95% H-Stat (DL/2) UCL	0.0426
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-6.329
		SD in Log Scale	2.79
		Mean in Original Scale	0.0523
		SD in Original Scale	0.23
		95% t UCL	0.1
		95% Percentile Bootstrap UCL	0.103
		95% BCA Bootstrap UCL	0.131
		95% H-UCL	0.302
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.358	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.295		
nu star	22.92		
A-D Test Statistic	3.715	**Nonparametric Statistics**	
5% A-D Critical Value	0.839	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.839	Mean	0.0536
5% K-S Critical Value	0.167	SD	0.228
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0288
		95% KM (t) UCL	0.102
Assuming Gamma Distribution		95% KM (z) UCL	0.101
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.101
Minimum	0.000001	95% KM (bootstrap t) UCL	0.314
Maximum	1.75	95% KM (BCA) UCL	0.108
Mean	0.0521	95% KM (Percentile Bootstrap) UCL	0.106
Median	0.000001	95% KM (Chebyshev) UCL	0.179
SD	0.23	97.5% KM (Chebyshev) UCL	0.233
k star	0.134	99% KM (Chebyshev) UCL	0.34
Theta star	0.388		
Nu star	17.43	**Potential UCLs to Use**	
AppChi2	8.977	95% KM (Chebyshev) UCL	0.179
95% Gamma Approximate UCL (Use when n >= 40)	0.101		
95% Adjusted Gamma UCL (Use when n < 40)	0.103		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Zinc
Zn

General Statistics

Number of Valid Observations	65	Number of Distinct Observations	63
Raw Statistics		**Log-transformed Statistics**	
Minimum	2.54	Minimum of Log Data	0.932
Maximum	315	Maximum of Log Data	5.753
Mean	39.34	Mean of log Data	3.031
Geometric Mean	20.73	SD of log Data	1.075
Median	16		
SD	56.89		
Std. Error of Mean	7.056		
Coefficient of Variation	1.446		
Skewness	3		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.27	Lilliefors Test Statistic	0.121
Lilliefors Critical Value	0.11	Lilliefors Critical Value	0.11
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	51.12	95% H-UCL	50.12
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	62.11
95% Adjusted-CLT UCL (Chen-1995)	53.75	97.5% Chebyshev (MVUE) UCL	73.21
95% Modified-t UCL (Johnson-1978)	51.56	99% Chebyshev (MVUE) UCL	95.02
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.879	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	44.75		
MLE of Mean	39.34		
MLE of Standard Deviation	41.96		
nu star	114.3		
Approximate Chi Square Value (.05)	90.6	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0463	95% CLT UCL	50.95
Adjusted Chi Square Value	90.12	95% Jackknife UCL	51.12
		95% Standard Bootstrap UCL	50.72
Anderson-Darling Test Statistic	2.869	95% Bootstrap-t UCL	57.45
Anderson-Darling 5% Critical Value	0.784	95% Hall's Bootstrap UCL	55.64
Kolmogorov-Smirnov Test Statistic	0.188	95% Percentile Bootstrap UCL	51.52
Kolmogorov-Smirnov 5% Critical Value	0.114	95% BCA Bootstrap UCL	55.08
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	70.1
		97.5% Chebyshev(Mean, Sd) UCL	83.41
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	109.5
95% Approximate Gamma UCL (Use when n >= 40)	49.62		
95% Adjusted Gamma UCL (Use when n < 40)	49.89		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	70.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Attachment C-12
ProUCL Output Files – Soil Biota Tissue Upper Confidence Limit Values (mg/kg dry weight)

General UCL Statistics for Full Data Sets

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

Sb

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.016	Minimum of Log Data	-4.135
Maximum	3.64	Maximum of Log Data	1.292
Mean	1.217	Mean of log Data	-0.817
Geometric Mean	0.442	SD of log Data	2.087
Median	0.929		
SD	1.443		
Std. Error of Mean	0.646		
Coefficient of Variation	1.186		
Skewness	1.602		

Warning: A sample size of 'n' = 5 may not adequate enough to compute meaningful and reliable test statistics and estimates!

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If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 5 Values in this data
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Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.843	Shapiro Wilk Test Statistic	0.917
Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2.593	95% H-UCL	105787
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	7.8
95% Adjusted-CLT UCL (Chen-1995)	2.773	97.5% Chebyshev (MVUE) UCL	10.39
95% Modified-t UCL (Johnson-1978)	2.67	99% Chebyshev (MVUE) UCL	15.48

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.377	Data appear Normal at 5% Significance Level	
Theta Star	3.229		
MLE of Mean	1.217		
MLE of Standard Deviation	1.982		
nu star	3.768		
Approximate Chi Square Value (.05)	0.632	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0086	95% CLT UCL	2.279
Adjusted Chi Square Value	0.253	95% Jackknife UCL	2.593
		95% Standard Bootstrap UCL	2.17
Anderson-Darling Test Statistic	0.202	95% Bootstrap-t UCL	3.663
Anderson-Darling 5% Critical Value	0.705	95% Hall's Bootstrap UCL	6.869
Kolmogorov-Smirnov Test Statistic	0.194	95% Percentile Bootstrap UCL	2.206
Kolmogorov-Smirnov 5% Critical Value	0.369	95% BCA Bootstrap UCL	2.484
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4.031
		97.5% Chebyshev(Mean, Sd) UCL	5.248
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	7.64
95% Approximate Gamma UCL (Use when n >= 40)	7.252		
95% Adjusted Gamma UCL (Use when n < 40)	18.13		
Potential UCL to Use		Use 95% Student's-t UCL	2.593

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Arsenic

As

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5

Raw Statistics		**Log-transformed Statistics**	
Minimum	1.87	Minimum of Log Data	0.626
Maximum	119	Maximum of Log Data	4.779
Mean	45.47	Mean of log Data	3.118
Geometric Mean	22.6	SD of log Data	1.603
Median	29		
SD	47.02		
Std. Error of Mean	21.03		
Coefficient of Variation	1.034		
Skewness	1.145		

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Warning: There are only 5 Values in this data
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Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.907	Shapiro Wilk Test Statistic	0.944
Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	90.31	95% H-UCL	35683
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	208.4
95% Adjusted-CLT UCL (Chen-1995)	91.57	97.5% Chebyshev (MVUE) UCL	274.7
95% Modified-t UCL (Johnson-1978)	92.1	99% Chebyshev (MVUE) UCL	404.8
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.471	**Data appear Normal at 5% Significance Level**	
Theta Star	96.64		
MLE of Mean	45.47		
MLE of Standard Deviation	66.29		
nu star	4.705		
Approximate Chi Square Value (.05)	1.019	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0086	95% CLT UCL	80.07
Adjusted Chi Square Value	0.458	95% Jackknife UCL	90.31
		95% Standard Bootstrap UCL	75.58

Anderson-Darling Test Statistic	0.169	95% Bootstrap-t UCL	150.2
Anderson-Darling 5% Critical Value	0.696	95% Hall's Bootstrap UCL	287.9
Kolmogorov-Smirnov Test Statistic	0.15	95% Percentile Bootstrap UCL	78.6
Kolmogorov-Smirnov 5% Critical Value	0.366	95% BCA Bootstrap UCL	78.6
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	137.1
		97.5% Chebyshev(Mean, Sd) UCL	176.8
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	254.7
95% Approximate Gamma UCL (Use when n >= 40)	210.1		
95% Adjusted Gamma UCL (Use when n < 40)	467.6		
Potential UCL to Use		Use 95% Student's-t UCL	90.31

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium

Cr

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.077	Minimum of Log Data	-2.564
Maximum	0.263	Maximum of Log Data	-1.336
Mean	0.145	Mean of log Data	-2.021
Geometric Mean	0.133	SD of log Data	0.456
Median	0.135		
SD	0.0713		
Std. Error of Mean	0.0319		
Coefficient of Variation	0.493		
Skewness	1.476		

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Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.874	Shapiro Wilk Test Statistic	0.964
Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.213	95% H-UCL	0.279
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.271
95% Adjusted-CLT UCL (Chen-1995)	0.22	97.5% Chebyshev (MVUE) UCL	0.326
95% Modified-t UCL (Johnson-1978)	0.216	99% Chebyshev (MVUE) UCL	0.433
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.5	**Data appear Normal at 5% Significance Level**	
Theta Star	0.0578		
MLE of Mean	0.145		
MLE of Standard Deviation	0.0915		
nu star	25		
Approximate Chi Square Value (.05)	14.61	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0086	95% CLT UCL	0.197
Adjusted Chi Square Value	11.29	95% Jackknife UCL	0.213
		95% Standard Bootstrap UCL	0.191
Anderson-Darling Test Statistic	0.295	95% Bootstrap-t UCL	0.257
Anderson-Darling 5% Critical Value	0.68	95% Hall's Bootstrap UCL	0.447

Kolmogorov-Smirnov Test Statistic	0.249
Kolmogorov-Smirnov 5% Critical Value	0.358
Data appear Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	0.247
95% Adjusted Gamma UCL (Use when n < 40)	0.32

95% Percentile Bootstrap UCL	0.194
95% BCA Bootstrap UCL	0.206
95% Chebyshev(Mean, Sd) UCL	0.284
97.5% Chebyshev(Mean, Sd) UCL	0.344
99% Chebyshev(Mean, Sd) UCL	0.462

Potential UCL to Use	Use 95% Student's-t UCL 0.213

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Lead

Pb

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.37	Minimum of Log Data	-0.994
Maximum	21.6	Maximum of Log Data	3.073
Mean	8.98	Mean of log Data	1.41
Geometric Mean	4.096	SD of log Data	1.724
Median	10.2		
SD	8.679		
Std. Error of Mean	3.881		
Coefficient of Variation	0.966		
Skewness	0.589		

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Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.913	Shapiro Wilk Test Statistic	0.884
Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	17.25	95% H-UCL	20071
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	44.38
95% Adjusted-CLT UCL (Chen-1995)	16.46	97.5% Chebyshev (MVUE) UCL	58.68
95% Modified-t UCL (Johnson-1978)	17.42	99% Chebyshev (MVUE) UCL	86.77
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.438	**Data appear Normal at 5% Significance Level**	
Theta Star	20.51		
MLE of Mean	8.98		
MLE of Standard Deviation	13.57		
nu star	4.378		
Approximate Chi Square Value (.05)	0.876	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0086	95% CLT UCL	15.36
Adjusted Chi Square Value	0.379	95% Jackknife UCL	17.25
		95% Standard Bootstrap UCL	14.67
Anderson-Darling Test Statistic	0.374	95% Bootstrap-t UCL	19.89
Anderson-Darling 5% Critical Value	0.698	95% Hall's Bootstrap UCL	15.47
Kolmogorov-Smirnov Test Statistic	0.29	95% Percentile Bootstrap UCL	15.07

Kolmogorov-Smirnov 5% Critical Value	0.367	95% BCA Bootstrap UCL	15.28
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	25.9
		97.5% Chebyshev(Mean, Sd) UCL	33.22
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	47.6
95% Approximate Gamma UCL (Use when n >= 40)	44.86		
95% Adjusted Gamma UCL (Use when n < 40)	103.8		
Potential UCL to Use		Use 95% Student's-t UCL	17.25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Methylmercury

MeHg

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.00485	Minimum of Log Data	-5.329
Maximum	0.0143	Maximum of Log Data	-4.247
Mean	0.00918	Mean of log Data	-4.762
Geometric Mean	0.00855	SD of log Data	0.43
Median	0.00919		
SD	0.00375		
Std. Error of Mean	0.00167		
Coefficient of Variation	0.408		
Skewness	0.318		

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Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.977	Shapiro Wilk Test Statistic	0.977
Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0127	95% H-UCL	0.0169
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0168
95% Adjusted-CLT UCL (Chen-1995)	0.0122	97.5% Chebyshev (MVUE) UCL	0.0202
95% Modified-t UCL (Johnson-1978)	0.0128	99% Chebyshev (MVUE) UCL	0.0267
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.01	**Data appear Normal at 5% Significance Level**	
Theta Star	0.00305		
MLE of Mean	0.00918		
MLE of Standard Deviation	0.00529		
nu star	30.1		
Approximate Chi Square Value (.05)	18.57	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0086	95% CLT UCL	0.0119
Adjusted Chi Square Value	14.76	95% Jackknife UCL	0.0127
		95% Standard Bootstrap UCL	0.0116
Anderson-Darling Test Statistic	0.193	95% Bootstrap-t UCL	0.0131
Anderson-Darling 5% Critical Value	0.68	95% Hall's Bootstrap UCL	0.0127
Kolmogorov-Smirnov Test Statistic	0.178	95% Percentile Bootstrap UCL	0.0116

Kolmogorov-Smirnov 5% Critical Value	0.358	95% BCA Bootstrap UCL	0.0118
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0165
		97.5% Chebyshev(Mean, Sd) UCL	0.0196
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0258
95% Approximate Gamma UCL (Use when n >= 40)	0.0149		
95% Adjusted Gamma UCL (Use when n < 40)	0.0187		
Potential UCL to Use		Use 95% Student's-t UCL	0.0127

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.