Work Plan

Measurement of Soil and Groundwater COPC Concentrations in Eight Test Pit Locations at the CSMRI Flood Plain
Colorado School of Mines Research Institute Site
Golden, Colorado

Prepared by S.M. Stoller Corporation
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May 2010

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List of Acronyms and Abbreviations

Acronym or Abbreviation	Definition
ALARA	As low as reasonably achievable
bgs	Below ground surface
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	contaminant(s) of potential concern
CSMRI	Colorado School of Mines Research Institute
EPA	U.S. Environmental Protection Agency
GPS	Global positioning system
HASP	Health and Safety Plan
MLEP	Mass-limit equation procedure
NRC	U.S. Nuclear Regulatory Commission
PPE	Personal protective equipment
QA/QC	Quality Assurance/Quality Control
SAP	Sampling and Analysis Plan
SSL	Soil screening level
SWPE	Soil/water partition equation
TAT	Technical Assistance Team
XRF	X-ray fluorescence

1 Introduction

The S.M. Stoller Corporation (Stoller) prepared this work plan on behalf of Colorado School of Mines (School). This work plan is designed to guide activities associated with the excavation of eight exploratory test pits on the flood plain portion of the CSMRI Site (Site). This work will be completed under the Stoller radioactive materials license (RML No. 1094-01).

The primary purpose of this investigation will be to collect soil and impacted groundwater samples for laboratory analysis in order to derive a site-specific soil cleanup level for uranium that will be protective of groundwater; provide preliminary characterization data for the flood plain area; and evaluate different soil sampling methods to determine which methods will be most effective for sampling soils below the water table. Test pits will be geologically logged to provide a better understanding of the sediments underlying the flood plain and depth to bedrock. Additionally, groundwater samples from the test pits will be collected for laboratory analysis to evaluate the current status of the contaminant plume. Flood plain hydraulic conductivity values will be determined through the analysis of data recovered during pump tests, which will also be completed during this site work. Finally, a surface water sample will be collected from the recently relocated storm water outfall and upstream soil samples to determine background levels for uranium.

This work plan presents these tasks and summarizes the methodology and reasoning behind this effort.

1.1 Site Location and Description

The Site is located in Golden, Colorado, along Clear Creek between the Creek and the School's sports fields near the intersection of Birch and 12th Streets. More specifically, the Site is located on the south side of Clear Creek, east of U.S. Highway 6, in the northeast quarter of the northwest quarter of Section 33, Township 3 South, Range 70 West as shown in Figure 1-1. The main entrance to the Site is located at the west end of 11th Street. An 8-foot chain-link fence restricts access to the Site.

The Site includes an area that was the location of a former settling pond. The pond was remediated and closed by the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE) in 1992 as part of an emergency removal action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). That action was one of a series of environmental investigation, characterization, and response projects at the Site.

The Site boundaries have been reduced over the past years following investigations and response actions. Originally, the Site consisted of a fenced area – which once included Research Institute buildings that were eventually demolished – located north of the intersection of Birch and 12th Streets, along with an unfenced area known as the Clay Pits (Figure 1-1) and an unfenced area at a current location of the softball field where EPA had stockpiled contaminated soil from the former settling pond excavation project. The Clay Pits were deleted from the Site boundary following a site investigation in 2007 that determined no impacts existed in the Clay Pits area from CSMRI activities. The softball field area was also deleted from the Site boundary in the late 1990s after the EPA stockpile was disposed of offsite and further investigation work demonstrated the appropriateness of eliminating this area from the Site boundary. A large portion of the Research Institute, known as the upper terrace soils, is pending elimination from the Site boundary following a cleanup completed in 2007. Currently, a portion of this upper terrace area is beneath a newly constructed soccer field.

The remaining portion of the Site boundary for purposes of the assessment and characterization work described in this work plan is demarcated by an area shown on Figure 1-2 as the "Flood Plain Characterization Area." Neither the Clay Pits nor the upper terrace is part of the current investigation and characterization covered by this work plan, and they are no longer considered part of the Site in this document.

1.2 Site Geology

The bedrock underlying the Site consists of four steeply dipping formations overlain by four surficial geologic units. The bedrock formations are the Pierre Shale, the Fox Hills Sandstone, the Laramie Formation, and the Arapaho Formation. A geologic map of the bedrock formations is provided as Figure 1-3. These formations range from fine-grained shale and coal beds to coarse-grained sandstones and conglomerates. The coal bed within the Laramie Formation was historically mined. A plaque near the site commemorated the loss of life that took place in the mineshaft that underlies a portion of the site. Each of the four bedrock formations has a different chemical composition and can be expected to have different background concentrations of metals and radionuclides.

Four younger surficial deposits in the vicinity of the Site overlie the bedrock formations. These younger deposits are Louviers Alluvium, Post Piney Creek Alluvium, Colluvium, and artificial fill. These surficial deposits are the most impacted by research activities at the Site, with minor impacts to the underlying bedrock formations. Only the Louviers Alluvium and Post Piney Creek Alluvium are present in the area of the Site characterization work. Detailed lithologic descriptions of these units are contained in the report prepared by Stoller in 2007 (Stoller 2007). A geologic map showing the extent of these four deposits is presented as Figure 1-4. Each of these four deposits has different chemical composition and can be expected to have different background concentrations of metals and radionuclides. This fact complicates investigation activities.

1.3 Site Hydrology

Groundwater at the CSMRI Site can be divided into the upper terrace area and the flood plain area. Eleven monitoring wells installed on site have been sampled quarterly for the past three years and have allowed geochemical data and contaminant data to be collected. These wells have identified a uranium groundwater plume, the cleanup of which has triggered this characterization of the soils acting as source material.

Groundwater on the upper terrace occurs under unconfined conditions in the alluvium/colluvium deposits that overlie the bedrock formations of the Site. Depth to the water table ranges from about 14 to almost 27 feet below ground surface (bgs). Groundwater on the upper terrace area generally flows to the northeast and north toward the flood plain and Clear Creek. The surficial deposits are mainly recharged by infiltration of precipitation and to a limited extent by irrigation of the natural turf baseball field. Uranium has recently been detected in two groundwater monitor wells on the upper terrace at concentrations that fluctuate around the groundwater quality standard of 30 micrograms per liter (µg/L).

Groundwater in the flood plain also occurs under unconfined conditions. Groundwater flow in the flood plain area is heavily influenced by the seasonal fluctuations of Clear Creek. Hydrographs of flood plain monitor wells show a strong relationship between the stage height of Clear Creek and a recorded response in the chemistry and water elevation. Depth to the water table ranges from 3 to 5 feet bgs but will rise almost 2.5 feet during the June sampling event due to increase in flow of Clear Creek. Water chemistry is variable on the flood plain, fluctuating between a slightly reducing environment when the flood plain is losing groundwater and one rich in dissolved oxygen when receiving groundwater flow from the creek.

The results of the quarterly sampling events indicate persistent exceedances of uranium above the groundwater standard at monitor well CSMRI-8, located at the western end of the flood plain, since the well was initially installed in February 2007. Exceedances for uranium have recently also been detected in monitor well CSMRI-4. Since 2005, the concentration of uranium at this location had been below to slightly above the groundwater standard. However beginning with the groundwater standard exceedance in the December 2008 sampling event, the concentration of detected uranium has continued to increase. The suspected cause for this increase is site improvements on the upper terrace which originally channeled surface water directly onto the flood plain.

In late 2008 and through 2009, artificial turf athletic fields with storm water drainage beds were constructed on the upper terrace. Storm water passes through the drainage beds and is conveyed via a 24-inch pipe to an outlet at the edge of the upper terrace approximately 30 feet northeast of monitor well CSMRI-9. The discharged water then runs down the upper terrace slope onto the flood plain. Only after the discharge pipe was in place did the concentration of uranium at monitor well CSMRI-4 exceed the groundwater standard. The recent relocation of this pipe and subsequent reduction in the volume of surface water flowing onto the flood plain is anticipated to return the concentration in CSMRI-4 to pre-2008 levels.

1.4 Current Site Conditions

The Site is currently overgrown with grasses, willows, and other low vegetation. Three groundwater monitoring wells are located on the flood plain, and an additional eight groundwater monitoring wells are located on the upper terrace. Two surface water locations along with all the monitoring wells have been sampled on a quarterly basis since February 2005. This monitoring program will remain in place during the characterization described in this work plan. The Site is currently in a stable configuration.

The School has constructed a synthetic surface soccer field south of the currently work site, and a planned parking lot will be located between the soccer field and the flood plain. The parking lot, access road, and a proposed bike path are currently in the design phase.

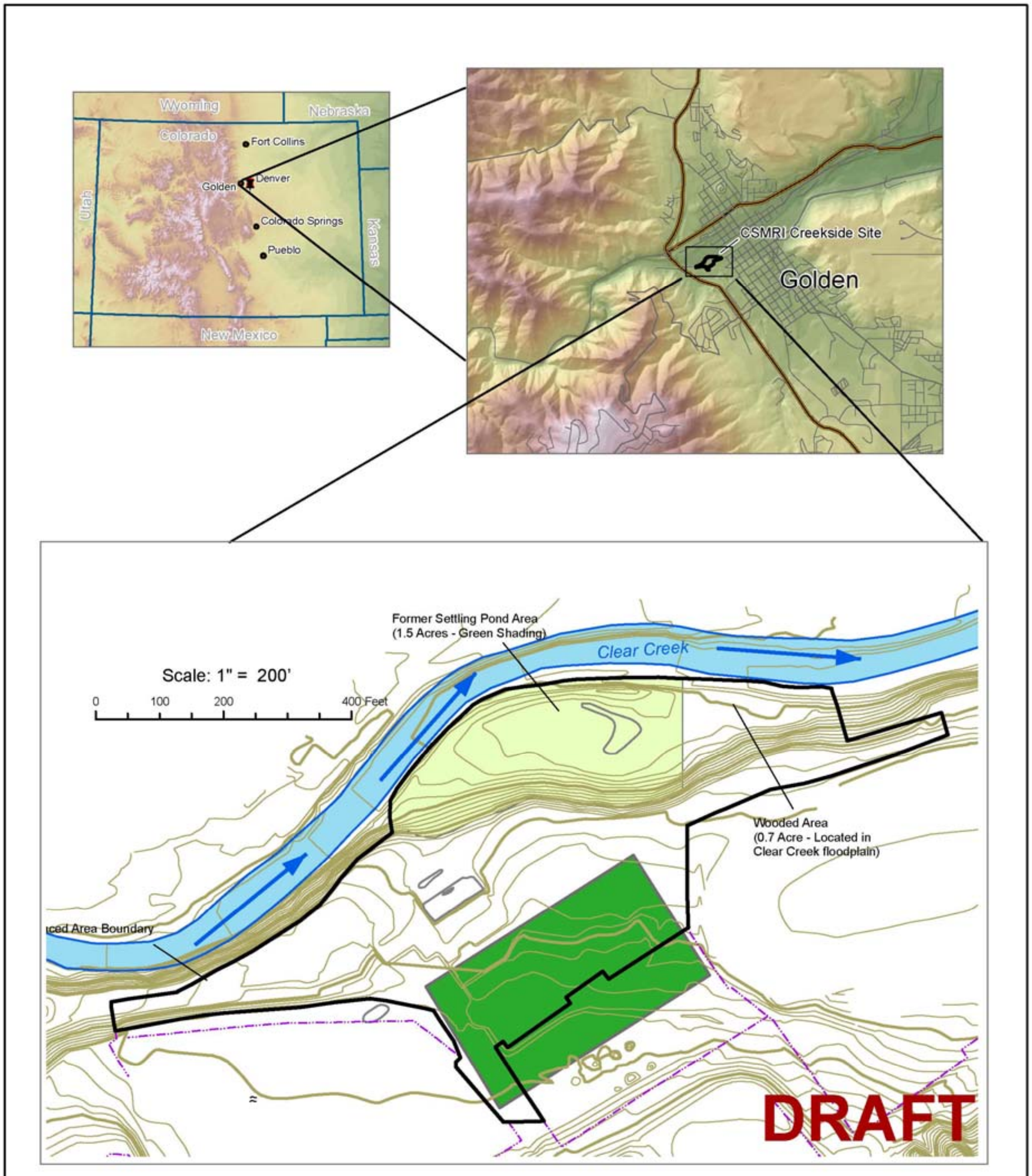


Figure 1-1

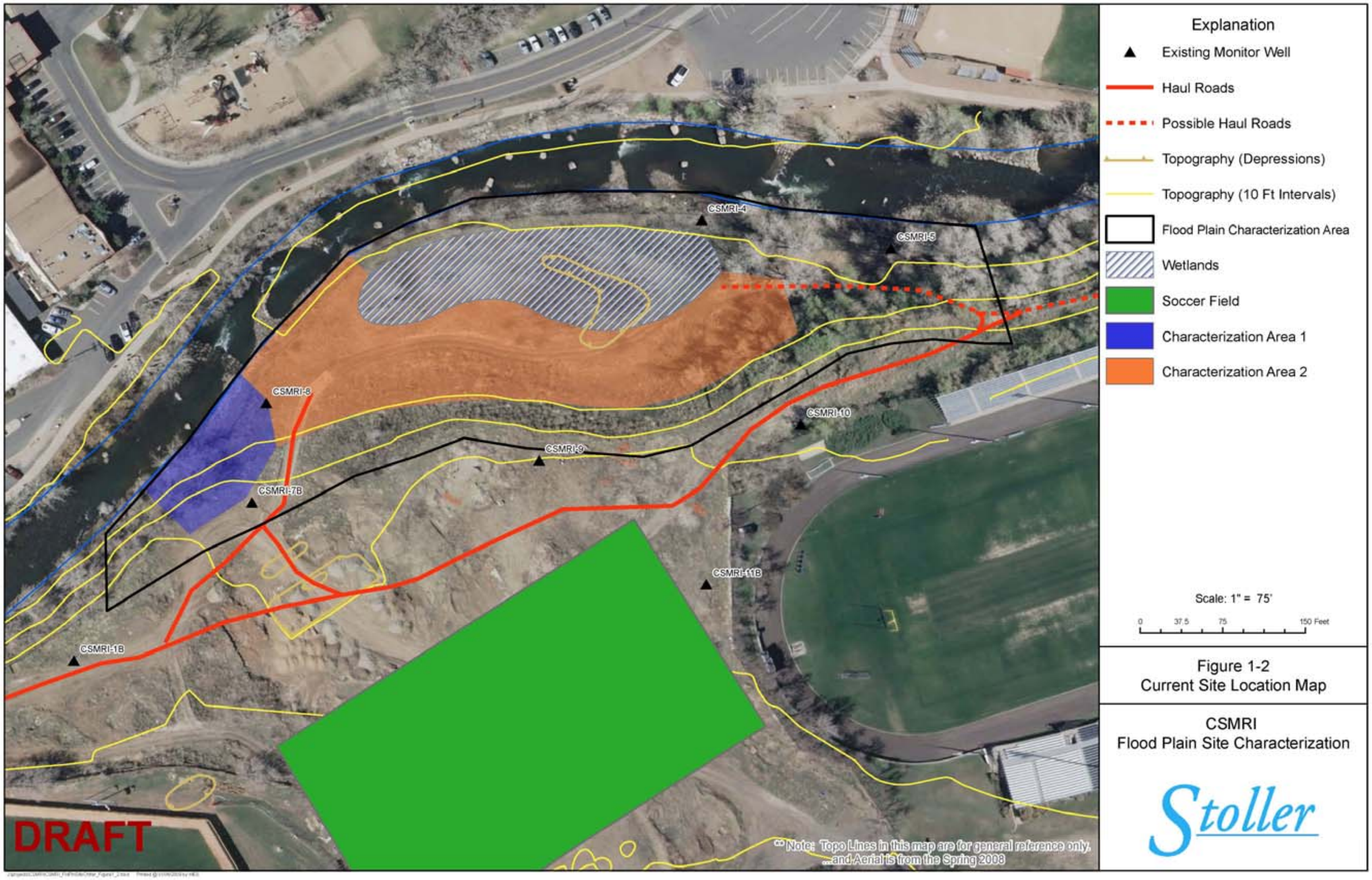
CSMRI
Original 2006
Site Location Map

Explanation

- 2006 CSMRI Creekside Site Boundary
- Fences
- Topography (1 ft Intervals)
- Topography (5 ft Intervals)
- Former Settling Pond Area
- Aproximate Location of Soccer Field

CSMRI
Flood Plain
Site Characterization

Stoller


Explanation
Existing Monitor Well
Haul Roads
Possible Haul Roads
Topography (Depressions)
Topography (10 Ft Intervals)
Flood Plain Characterization Area
Wetlands
Soccer Field
Characterization Area 1
Characterization Area 2
Scale: 1" = 75'
0
37.5
75
150 Feet
Figure 1-2
Current Site Location Map
CSMRI
Flood Plain Site Characterization
Stoller
CSMRI-4
CSMRI-5
CSMRI-6
CSMRI-10
CSMRI-9
CSMRI-7B
CSMRI-11B
CSMRI-1B
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** Note: Topo Lines in this map are for general reference only,
...and Aerial is from the Spring 2008

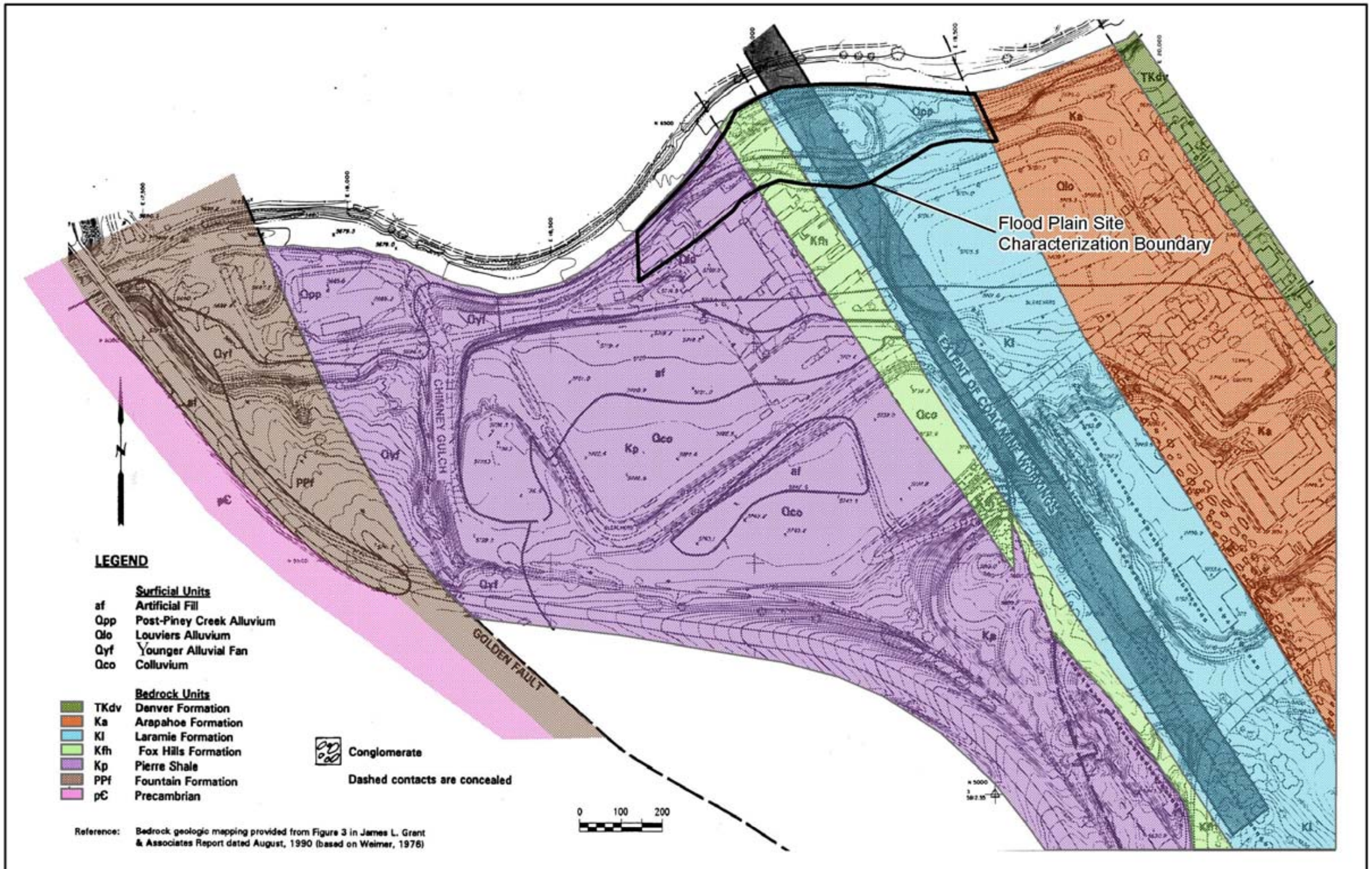

Figure 1-3

CSMRI
Bedrock Geologic Map

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CSMRI
Flood Plain
Site Characterization

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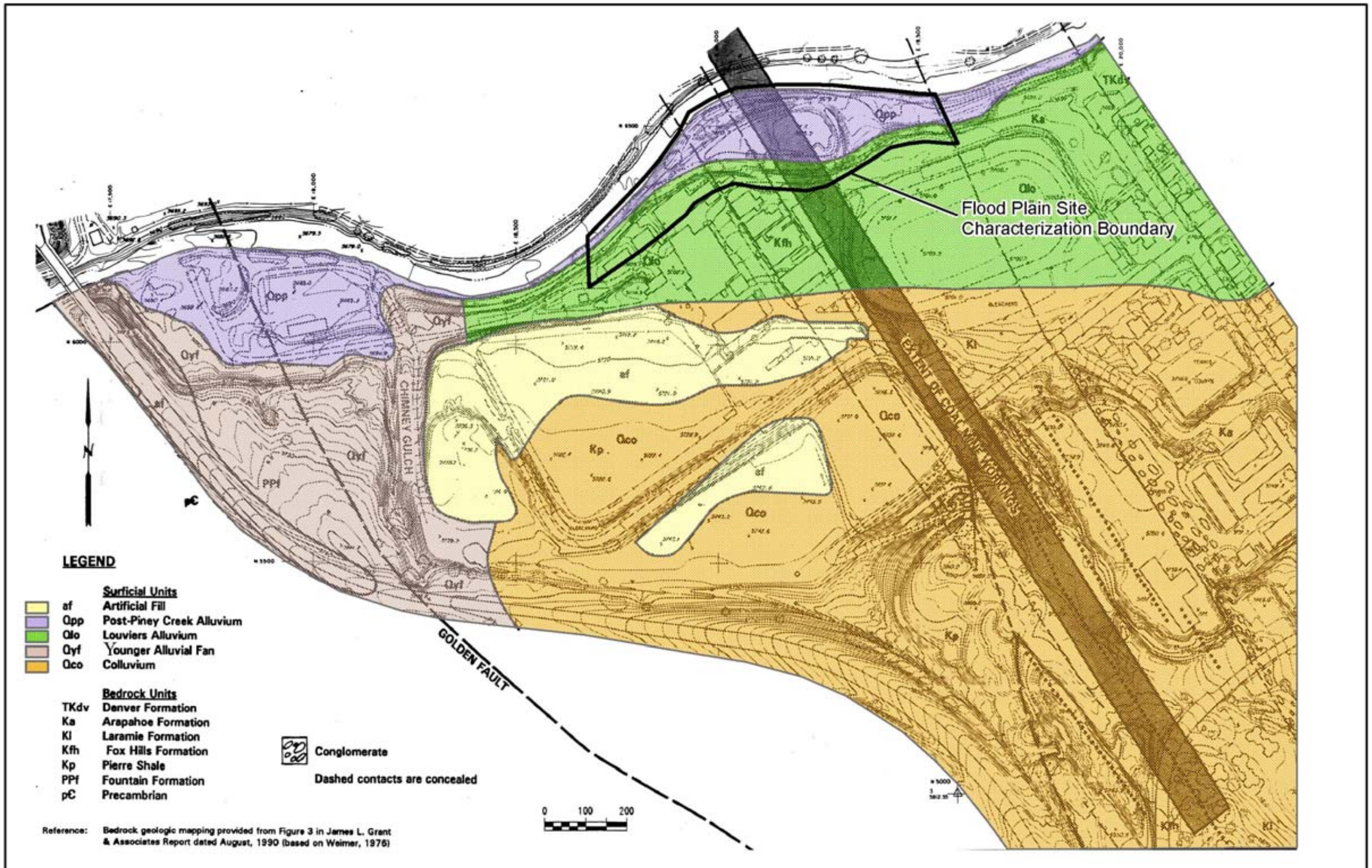

Figure 1-4

CSMRI
Surface Geologic Map

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CSMRI
Flood Plain
Site Characterization

Stoller

2 Site Assessment and Flood Plain Characterization Objectives

The objectives of the flood plain site characterization are to gather additional data to better understand subsurface site conditions and aid in the development and planning of the upcoming site-wide characterization work. Site activities are designed with this objective in mind and will include the following:

- Gather lithologic data of surface and subsurface soils to aid in the development of the site characterization work plan and to help determine the volume of material that may ultimately require removal.
- Determine the depth to bedrock under the flood plain and identify the bedrock geologic formation.
- Confirm or refute the presence of the abandoned channel suspected to be at the toe of the terrace slope.
- Conduct pump/slug tests (rising head and falling head) on monitor wells CSMRI-4, CSMRI-5, and CSMRI-8 to develop the range of hydraulic conductivity of saturated sediments within the flood plain.
- Test various soil sampling methods to determine the field sampling methods that are most effective for screening soils below the water table.
- Collect soil samples from alluvium upstream of the Site to evaluate background levels of uranium.
- Collect eight bulk soil samples from the flood plain area to perform batch adsorption tests to develop site-specific soil partitioning coefficient (Kd) and to provide soil for bulk density and sieve analyses.
- Collect approximately 10+ gallons of groundwater sample from monitor well CSMRI-8, which will be used in batch adsorption testing of the above soil samples.
- Use the analytical results from samples described in the two previous bullets to derive a site-specific soil cleanup goal for uranium (including sub-groundwater soil) that is protective of groundwater.
- Collect select soil samples from test pits for analysis of site contaminants of potential concern (COPCs) including uranium, molybdenum, arsenic, lead, mercury, vanadium, and screening level Ra-226.
- Collect grab groundwater samples from each test pit, filter, and submit for analytical testing for the presence of uranium.
- Sample the relocated storm water outfall and analyze for major anions and cations to better understand the chemical impact the surface water had on the uranium groundwater plume.
- Prepare and submit Flood Plain Characterization Report, which will present the results of the field efforts and the geochemical modeling that will identify a site-specific soil screening level for uranium and COPC at the CSMRI site.

3 Existing Site Assessment Data

CSMRI was established in approximately 1912 as a mined minerals research and development institute. Geologic samples from around the world were submitted to CSMRI for laboratory bench-scale studies in mineral beneficiation and extraction methods. Some of the earliest data indicate that research on radium extraction was performed on the site. Later processes involved organic additives with the subsequent generation of possible mixed wastes. Tailing and waste material containing metals and radioactive materials from some of the processes were disposed of onsite (Ecology & Environment 1993) around building foundations and into a constructed tailings pond located immediately north of the CSMRI site and on remnant sand bar adjacent to Clear Creek (i.e., flood plain area).

The flood plain site has not previously been investigated completely for nature and extent of contamination. In January 1992, a water main break under Building 109 of the CSMRI site filled the tailing pond, which eventually overflowed releasing radioactive and heavy metals to Clear Creek. Damage to the tailings dam was temporarily repaired by an EPA Emergency Response Cleanup Service contractor with technical supervision by the U.S. Bureau of Mines.

In May 1992, Ecology & Environment, Inc., as an EPA Technical Assistance Team (TAT) was tasked to conduct the initial cleanup of the CSMRI site, including the tailings pond area of the flood plain. In July 1992, the TAT began excavation of the tailings pond. The tailings pond were dewatered and the water was contained in four frac tanks and areas of soil contaminated with radionuclides were excavated to a cleanup level of 70 microREM per hour (μR/hr). An x-ray fluorescence meter (XRF) was then used to determine whether further excavation was needed to remove heavy metals contamination. Approximately 15,000 cubic yards (yd^3) of contaminated soil were removed from the tailings pond and around the CSMRI buildings.

Confirmatory sampling by the TAT contractor was conducted on a 10 meter by 10 meter grid in the tailings pond area. All samples had measured activity of less that 15 picoCuries per gram (pCi/g), the limit prescribed by the Nuclear Regulatory Commission (NRC) for soils below 6 inches of cover. Approximately 6,000 yd^3 of fill and topsoil were then placed in the excavated areas. A 10-meter grid was then placed over the area and composite soil samples were collected for screening. All samples passed the 5 pCi/gm limit for surface soils as prescribed by NRC.

Since the EPA removal action, characterization work on the flood plain site remediated by EPA has been limited to the installation and quarterly sampling of groundwater monitoring wells. (Stoller remediated some flood plain areas east of the EPA removal action area.) Data from these wells have indicated the presence of a dissolved uranium plume underlying a portion of the flood plain site. The highest detected concentration of uranium in groundwater is located in the area of well CSMRI-8, which is located at the upgradient (west) end of the flood plain. The uranium plume has also been detected in wells CSMRI-4 and CSMRI-5, but at a much lower concentration. This plume geometry is indicative of a cause area located around and to the west of well CSMRI-8.

The field activities covered by this work plan are scheduled for June 1 and 2, 2010. It is anticipated that the only one piece of equipment (a track excavator capable of digging to a depth of about 15 feet bgs) will be used to complete the work.

3.1 Site Preparation

Only limited site preparation will be required for the work to be performed under this work plan. Equipment will use existing roads and be tracked from the terrace slope to the flood plain. No soil will be stockpiled, and the test pits will be backfilled with the material that was excavated from them after data and samples have been collected.

Prior to excavation, test pits will be marked with survey flags and surveyed using a hand-held global positioning system (GPS) and utilities will be located. Some site grading may be necessary directly adjacent to the pits to control runoff and achieve positive drainage back into the excavations.

3.2 Site Security

Stoller will be responsible for Site security throughout the project. The access gates will be locked when the Site is unattended. They will be unlocked during working hours; however, all visitors will be required to check in with Stoller personnel. Site work will be confined to the flood plain itself and all visitors shall be escorted while onsite. Stoller and subcontractor personnel will produce proper identification upon request.

3.3 Material and Equipment

The following materials and equipment will be mobilized to the Site:

- Temporary Facilities
  - None
- Heavy Equipment
  - Track excavator capable of digging to 15 feet bgs
- Field Instruments
  - Handheld GPS
- Sampling Equipment and Supplies
  - Nitrile gloves
  - Decontamination solution
  - 4-gallon plastic buckets
  - Oven to dry soil samples
  - Tool box
  - Disposable soil scoops
  - Stainless steel mixing bowl
  - Bowl liners
  - Field logbooks
  - Laptop computer
  - Sample containers
  - Sample labels
  - Chain-of-custody forms and tape
  - Plastic bags
  - Coolers for shipping samples
- Radiological Control Instrumentation and Supplies
  - Dual alpha/beta scintillation counter
  - Alpha/beta scintillation probe with appropriate survey meter

  - Radiation dose rate survey meter (i.e., MicroR meter)
- Miscellaneous
  - Fire extinguishers
  - Hand tools
  - Emergency eyewash station
  - Absorbent pads/spill kit (fueling)
  - First aid kit
  - Mobile telephones
  - Personal protective equipment (PPE)
  - Designated vehicle with emergency supplies - designated Stoller vehicle supplied with first aid equipment, to be used only in the event of an emergency
  - Trash bags, trash dumpster, and recycling containers
  - Poly sheeting

3.4 Positional Surveying Equipment

A Garmin eTrex Vista hand-held GPS unit will be used to collect the GPS coordinates for the horizontal position of each test pit within an accuracy of ± 10 feet. This GPS data will be used to record the locations test pits so they can be plotted accurately on a site map.

4 Site Characterization Activities

The test pits are designed to target both impacted and non-impacted soil and groundwater in the flood plain both acting to better understand the lithology underlying the Site and the nature of contamination. Information gathered during this study will be used and aid in the design of a site characterization work plan. The sections below detail the scope of each task that will be performed in the execution of this plan.

4.1 Task 1 – Collect Bulk Soil and Groundwater Samples

Stoller will subcontract with an experienced operator to use either a track-mounted backhoe or excavator to dig the eight test pits. The bulk soil samples collected from each test pit will consist of 11 pounds of soil (5 kilograms). The rationale for each test pit location is described below. The approximate locations of the proposed test pits are shown on Figure 4-1.

- CSMRI-CLT-001: Upgradient of CSMRI-8. CSMRI-8 is the most highly impacted groundwater monitoring well on the Site, there is a suspect source upgradient and no data have been collected from this area. This area contains two outfalls from the former CSMRI facility that have not yet been removed from the site.
- CSMRI-CLT-002: Upgradient of CSMRI-8. This test pit will be placed is in an area identified in the Ecology & Environmental report as having elevated background levels of radionuclides in subsurface soil.
- CSMRI-CLT-003: Downgradient of CSMRI-8. This test pit will be placed is in an area identified in the Ecology & Environmental report as having elevated background levels of radionuclides in subsurface soil.
- CSMRI-CLT-004 and CSMRI-CLT-005 will collect soil data from the toe of the slope to determine the lithology in the saturated zone underlying the flood plain and if fill is present where historic photographs show a former stream channel. These areas were identified in the Ecology & Environmental report as having low-moderately elevated background levels of radionuclides in subsurface soil.
- CSMRI-CLT-006: Between CSMRI-8 and the former location of EPA settling pond cleanup. This area is identified in the Ecology & Environmental report as having low background levels of radionuclides in subsurface soil.
- CSMRI-CLT-007 and CSMRI-CLT-008 will collect soil data from the wetlands to determine if the geochemical properties of underlying soil have diminished the mobility of uranium metal. These areas were identified in the Ecology & Environmental report as having low-moderately elevated background levels of radionuclides in subsurface soil.

Each of the test pits will extend to bedrock. By extending the pits to bedrock, the thicknesses of the unsaturated soil, saturated soil, and depth/elevation of bedrock can be determined. Thickness values generated during the test pit phase can be used to better quantify soil volumes should contaminated soil removal in the flood plain area be required. During the excavation of each test pit, all test pits will be closely inspected. Lithologic logs will be prepared to document the sediment and bedrock sequences encountered at each location. Soils will be described according to Unified Soil Classification System (USCS) guidelines using visual and manual procedures. Soil and rock descriptions will include estimated percentages of soil components and color determinations using Munsell Soil Color Charts. The depth and location of geologic material collected for laboratory analysis will also be documented on the lithology logs. Special care will be taken to note color changes in the flood plain sediments to determine the depths at which the EPA stopped their remediation efforts of the flood plain in the summer of 1992. At least two test pits will be located at the base of the slope to the bench terrace to better identify the nature and depth of sediments that may be associated with Clear Creek meandering stream channels.

Grab samples of the groundwater in each test pit will be collected, filtered, and submitted for analytical testing of dissolved uranium. Sampling of the groundwater at multiple locations will aid in the identification of unknown hotspots within the flood plain area and will delineate the shape of the uranium plume. The location of all test pits will be recorded with a hand-held GPS unit.

Samples to be collected for screening and/or laboratory analysis are summarized below:

Table 4-1
Summary of Samples to be Collected

Bulk soil samples from 8 test pits	Batch adsorption testing for soil partitioning coefficient
Bulk groundwater sample from CSMRI-8	Leachate for batch adsorption testing as described above
Characterization soil samples from 8 test pits	Analysis for U, V, Mo, Pb, As, Hg, and screening level Ra-226
Soil sampling test from below the water table (2 samples per test pit)	Analysis for U, V, Mo, Pb, As, Hg, and screening level Ra-226
Background uranium sample and analysis	Collect 8 samples from upstream and analyze for U
Storm water sample collection	Field parameters and major anions/cations
Grab 8 test pit groundwater samples	Determine concentration of dissolved uranium in flood plain; plume definition and orientation
Geotechnical soil samples	Bulk density, sieve analyses, clay fraction

4.2 Task 2 – Collect Characterization Soil Samples and Perform Soil Sampling Study

Soil samples will be collected to provide preliminary site characterization data for the area of the eight test pits. Each of the three samples collected from each test pit will be analyzed for COPCs including metals U, V, Mo, Pb, As, Hg and screening level Ra-226. This data will be used to refine our understanding of the nature and extent of contamination in the flood plain area. One sample will be collected from the soil below the EPA fill just above the water table, one sample will be collected from two feet below the water table, and the final sample will be collected from the bedrock surface underlying the alluvium.

Two additional samples will be collected from each test pit to investigate suitable techniques for determining nature and extent of the contaminants from beneath the water table during the characterization by removal currently proposed for Fall 2010. One of these samples will be from settled fines from a water/mud sample collected from the resulting test pit, and the other will be a grab sample from the excavated material that is either mechanically screened or filtered through a mesh to separate the solids from groundwater.

4.3 Task 3 – Complete Slug/Pump Tests on Flood Plain Monitor Wells

To derive site-specific alluvial aquifer hydraulic conductivity and transmissivity values, Stoller anticipates conducting a limited pump test on monitor well CSMRI-8 and a slug test (falling head and rising head) on monitor wells CSMRI-4 and CSMRI-5. As discussed above, the pump test, with recovery, at CSMRI-8 will be conducted while the 10+ gallons of aquifer groundwater are collected. Should the pump test not succeed due to the pumping of the 10+ gallons in a very short time interval, then a slug test will be conducted at CSMRI-8 to collect the necessary data.

A pressure transducer with a data logger will be onsite and will be used to record changes in the potentiometric surface of the water table while the pump test and the two slug tests are being conducted. The raw data generated from the pump/slug tests will be entered into AQTESOLVE Pro v. 4 for data analyses and curve matching. The hydraulic conductivity values and hydraulic gradients will be used to determine the rate of groundwater flow, which in turn will be used in the geochemical modeling.

4.4 Task 4 – Perform Geochemical Modeling

Stoller has retained an experienced geochemical modeling firm that will oversee the geochemical laboratory testing and will integrate the site-specific field and laboratory data into the geochemical modeling. The EPA guidance document presents two methods for determining soil screening levels (SSLs) for radionuclides. The first method uses a generalized soil/water partition equation (SWPE). The second method uses the mass-limit equation procedure (MLEP). The SWPE method tends to overestimate leaching to groundwater because it assumes an infinite contaminant source.

In addition to the calculation of soil partition coefficients and SSLs for uranium, the geochemical modeling firm will perform geochemical modeling of the leachate using PHREEQCi to speciate the solution and evaluate potential precipitation and sorption mechanisms that may attenuate uranium concentrations along the groundwater flow path. The proposal from Whetstone Associates, Inc. to conduct the geochemical testing and modeling is presented as Appendix A.

4.5 Task 5 – Perform Storm Water Sampling and Uranium Background Sampling and Analysis

A single water sample will be collected from the storm water outfall and analyzed for major anions and cations. Additionally, pending School and landowner approval eight soil samples will be collected from a similar depositional environment as the flood plain area, upstream from the flood plain area and analyzed for uranium. This data set will be used to determine a background uranium concentration.

4.6 Health and Safety Control

The site-specific HASP (HASP) is provided in Appendix B. The administrative controls, engineering controls, personnel protection, and monitoring practices to ensure worker safety during the characterization activities are summarized in the following subsections, with details provided in the HASP.

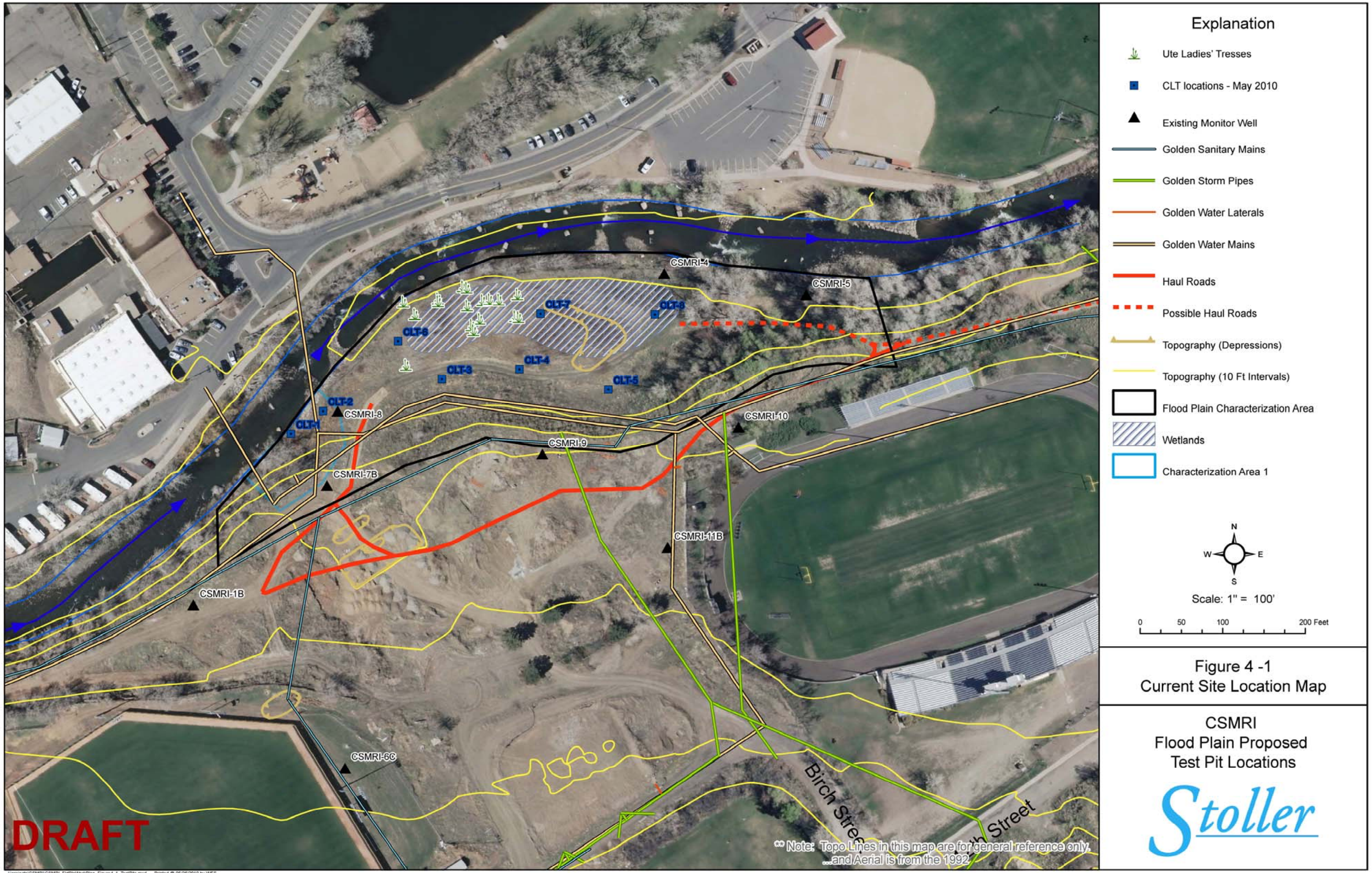

Figure 4 -1
Current Site Location Map

CSMRI
Flood Plain Proposed
Test Pit Locations

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5 Sampling and Analysis Plan

The sampling and analysis activities associated with this characterization project will be a combination of field measurements and samples submitted to offsite laboratories for analytical and soil partitioning coefficient testing. This Sampling and Analysis Plan (SAP) describes:

- Field instrumentation requirements,
- Techniques for identifying sampling locations,
- Sample collection methodologies, including types and frequencies of field QC samples,
- Sample labeling, control, packaging, and shipping requirements, and
- Sample analysis requirements for measurements performed in the offsite laboratory.

The purpose of this SAP is to provide guidance for collection and analysis of exploratory test pit samples. Support activities for radiological control of the Site and worker protection are also covered in this SAP. Table 5-1 summarizes analytes, testing methods, reporting limits, and laboratory methods.

5.1 Field Radiation Detection Instrumentation

A variety of radiation detection instruments will be used on this project. Radiation detectors will be purchased or leased from certified vendors and will have current calibrations. Documentation of the calibration will be maintained onsite. Performance checks will be performed on all detectors prior to use in accordance with the applicable operating procedure(s).

- Sodium-iodide (NaI) gamma scintillation detector – Used during excavation activities as a screening tool to identify areas of elevated gamma radiation activity that may contribute to an exposure potential. Instruments such as the Ludlum Model 44-10, coupled with a Ludlum Model 2350-1 scaler/ratemeter, will be used for these surveys. Applicable Procedure: SOP-RAD-001, Portable Radiation Survey Instrument Operation
- Hand-held alpha/beta scintillator probe – Used for frisking and general surveys. Instruments such as a Ludlum Model 43-89 in conjunction with a Ludlum Model 2360 alpha/beta scaler/ratemeter will be used. Applicable Procedure: SOP-RAD-001, Portable Radiation Survey Instrument Operation
- Dual alpha/beta scintillation counter – Used on site to count swipes. Instruments such as a Ludlum Model 2929 with a Model 43-10-1 detector will be used. Applicable Procedure: SOP-RAD-031, Counting Systems Operation
- Ludlum Model 19 MicroR meter (or equivalent) – Used for dose rate surveys. Applicable Procedure: SOP-RAD-001, Portable Radiation Survey Instrument Operation

5.2 Contamination Control and Radiological Protection Instrumentation

Radiological surveys will be performed during project characterization and sampling activities to ensure that fugitive radiologically impacted material is not dispersed beyond the Site, as well as to provide worker protection and monitoring.

Table 5-1
Sample Summary

Analyses	Container	Preservative	Method	Reporting Limit	Holding Time
Soil					
Metals (As, Mo, Pb, U, V) (Hg)	1 x 4 oz wide mouth	Keep cool in field by placing on ice	EPA 3050/6010B and 7471A (ICP/CVAA)	1,000; 1,000; 300; 20,000; 1,000 ug/kg respectively. (33.33 ug/kg)	6 months
Ra226 scan	1 x 4 oz	None	E903.0	1 pCi/g	6 months
Aqueous					
Metals (U) from test pits	500 ml poly container	None	EPA 6020	0.01 ug/l	6 months
Batch Adsorption Tests (Aqueous)					
Temperature/pH/Conductivity/DO/ORP	Field Derived	N/A	Horriba U22	Various	N/A
Alkalinity (Bicarbonate); Alkalinity (Carbonate); Alkalinity (Total); Hardness as CaCO3; Ca; Mg; Na; K; Cl; Fl (undistilled); Sulfate as SO4; Nitrate + Nitrite as N; TDS; Cation/Anion balance; Al (total/dissolved); Fe (total/dissolved); Mn (total/dissolved); Mo (total/dissolved); U (total/dissolved)	5-gallon poly containers – 10 gallons minimum required for batch adsorption tests	Keep cool in field by placing on ice	Various	Various	Various – samples will be couriered daily and preserved immediately at Chemac Labs, Centennial, Colorado
Batch Adsorption Test (soil) Composite of saturated soil column	5-gallon open top bucket w/lid 11 lbs. Minimum	N/A	EPA/530-SW-87-006-F	N/A	6 months
Soil Geotechnical Parameters					
Wet and Dry Bulk Density with percent Moisture	Shelby tube liner	N/A	ASTM-D2937 ASTM-D2216	N/A	N/A
Sieve Analyses (mechanical analyses) (Sand, Silt, Clay fraction)	1-gallon ziplock container	N/A	ASTM-D6913	N/A	N/A

5.2.1 Swipe Sampling and Counting

Swipe samples will be taken to monitor for removable alpha and beta contamination prior to release of samples, equipment, and vehicles that were in areas of potential radiological contamination. Swipe samples will be collected in accordance with procedure SOP-RAD-002, Swipe Sample Collection. These swipes will be counted on a Ludlum Model 2929 alpha/beta scaler with a Model 43-10-1 sample counter (or equivalent) in accordance with procedure SOP-RAD-031, Counting Systems Operation.

5.2.2 Personnel and Equipment Survey Requirements

All personnel and equipment leaving the contaminated area of the work site will be surveyed for contamination via a Ludlum Model 2360 alpha/beta data logger with a Model 43-89 alpha/beta scintillation probe (or equivalent). Personnel found with detectable contamination on their skin or clothing will be promptly decontaminated.

Surveys for the release of equipment will be documented on a Radiological Survey Form, ST-RAD-GEN-005, or similar form that identifies, at a minimum, the released equipment, survey instrument used, survey results, background at the time of the survey, and name of the surveyor. If radon potentially causes elevated removable alpha readings, the equipment will not be released until the swipes have been allowed to decay and a recount meets the unrestricted release limit.

5.2.3 Personnel Dose Monitoring

Occupational exposure monitoring for external radiation is required if a worker is likely to exceed 500 mrem per year from sources external to the body, per 6 CCR 1007-1, Part 4. Stoller has established an ALARA guideline of 100 mrem per year in accordance with the company Radiation Protection Program. These limits are not anticipated to be exceeded on this project. Area dose rate surveys will be performed using a Ludlum Model 19 MicroR meter, or equivalent instrument, in accordance with procedure SOP-RAD-033, External Dose Rate Tracking. If an area dose greater than 50 microrem/hr above background is observed, the planned work activities will be evaluated and every effort will be made to limit personnel time in the area. If this evaluation indicates that the external dose to any worker could exceed 100 mrem per calendar year, dosimeters will be issued.

5.3 Sample Acquisition – General Guidelines

Samples will be collected from the exploratory test pits to better understand the sediments underlying the flood plain, determine depth to bedrock, evaluate the effectiveness of different soil sampling methods that may be used during the site characterization, and derive a site-specific soil cleanup level for uranium that will be protective of groundwater. General guidelines for sample collection of all sample types are provided in this section. Specific information on each sample type is provided in the following sections. All samples must be collected, handled, documented, analyzed, and reported in a defensible manner.

5.3.1 Use Disposable Equipment and Take Representative Samples

Samples will be collected and prepared using disposable soil scoops or, if necessary, gloved hands. The samplers shall ensure that a representative proportion of each type of soil present in the sampling location is included in the sample and that different types of soils are not over- or under-represented. Rocks and cobbles larger than 3 cm and other extraneous material such as vegetation and roots will be excluded and/or manually removed from samples. Samples may be grab samples or composite samples, as specified in the sample acquisition guidelines for the specific type of sample being collected.

5.3.2 Log all Sampling Events

All sampling events will be documented on the Sample Collection Log. Samples that will be submitted to the offsite laboratory will be recorded on a Chain-of-Custody form.

5.3.3 Use Clean Containers

Certified clean sample containers shall be used for all samples submitted to the offsite laboratory. These containers will be supplied by the laboratory.

5.3.4 Take Field QC and Split Samples

Field QC samples will be used to assess sample variability and evaluate potential sources of contamination. Field duplicates are the only type of QC sample that will be collected for this project. Field duplicate samples are collected at the same time and from the same source and placed in separate sample containers. Duplicate frequencies are specified in the following sections for each type of sampling. These samples will be submitted to the offsite laboratory for the same analysis(es) as those requested for the original sample. Duplicate data will be used to measure the precision of the entire sampling and analysis procedure. Samples will be assigned unique numbers and will not be identified as duplicates to the laboratory. Equipment rinsates will not be required, as all sampling equipment will be disposable.

5.4 Sample Identification and Labeling Requirements

Samples shall be identified using a unique 5-digit number. Sample type, date, and depth of lift will be tracked as separate fields in a sampling and analysis database.

Sample labels will be pre-printed whenever possible to reduce the possibility of misidentification of samples. Labels will include, at a minimum, the following information:

- Sample number
- Name of the sample collector
- Date and time of sample collection
- Client (Stoller)
- Location (CSMRI)
- Analysis(es) to be performed at the laboratory
- Preservative, if applicable

5.5 Sampling Handling and Custody Requirements

Components of the chain of custody include sample labels, sample seals, chain-of-custody form, field logbook, and sample collection logs. Samples will be stored in a secure place with restricted access until they are delivered to the offsite laboratory. A chain-of-custody record will be signed by each person who has custody of the samples and will accompany the samples at all times. At a minimum, the chain-of-custody form will include the following information:

- Site name

- Signature and initials of sample collector
- Date and time of sample collection
- Sample ID
- Sample matrix
- Sampling type (e.g., composite or grab)
- Sampling location
- Number of sample containers shipped
- Requested analysis(es)
- Sample preservation information
- Method of shipment/name of carrier
- Signatures of persons in the chain of custody
- Date and time of each change in sample custody
- Name of laboratory

Chain of custody will begin once the samples are collected. To ensure proper traceability, all samples will be properly labeled at the time of acquisition. Samples to be stored onsite will be placed in a locked storage area with the corresponding chain of custody. Samples requiring laboratory analysis may be allowed to accumulate onsite prior to delivery to the laboratory.

Samples will be delivered to the laboratory in coolers sealed with custody seals if handled by more than one individual. The original chain-of-custody form will be transported with the samples. Upon receipt of the samples by the laboratory, the laboratory sample custodian will inventory the samples by comparing sample labels to those on the chain-of-custody forms. The laboratory shall maintain documented chain of custody through the laboratory analytical process.

5.6 Sample Packaging and Shipment

Prior to packaging for shipment, sample containers shall be swipe sampled to verify absence of external removable radiological contamination in accordance with procedure SOP-RAD-002, Swipe Sample Collection. The DOT release criteria for removable contamination are in the table below. Containers with contamination above this level will be decontaminated using wet wipes until they are below this level.

Table 5-2
DOT Removable External Contamination Limits

Contaminant	Maximum Limit* (dpm/cm2)	Maximum Limit (dpm/100 cm2)
Alpha-emitting radionuclides	2.2	220
Beta and gamma emitters	22	2,200

*From 6 CCR 1007-1 Part 17, Section 17.15.18.1 Table 3. Equivalent to DOT limits in 49 CFR Part 173.443 when the 0.10 swiping efficiency is included.

Sample bottles will also be surveyed using a dose rate meter such as a Ludlum Model 19 MicroR meter. Limited quantity radioactive materials must have a surface dose rate that does not exceed 0.5 mrem/hr at any point on the external surface of the package.

Individual sample containers will be placed into a sealed plastic bag. Samples will then be packed in a cooler lined with a large plastic bag. The chain-of-custody form will be placed into a zip-locked bag and taped on the inside lid of the cooler. Each cooler will be sealed with a chain-of-custody seal.

Verification samples are expected to have levels of radionuclides exempt from DOT classification as radioactive material based on the Site cleanup goals; therefore, these samples will be shipped as general freight with no special shipping provisions.

Coolers will be transported to the analytical laboratory. The coolers will be clearly labeled with sufficient information on the waybill to ensure positive identification.

5.7 Sample Acquisition – Test Pit Analytical Soil Samples

The following section describes how test pit soil samples will be collected and used to characterize each test pit location.

5.7.1 Sampling Locations

Soil samples will be collected from eight exploratory test pits in the flood plain portion of the CSMRI Site. The approximate locations of these test pits are shown in Figure 4-1.

Five samples will be collected from each test pit. One sample will be collected from the soil below the EPA fill just above the water table, one sample will be collected from two feet below the water table, and the final sample will be collected from the bedrock surface underlying the alluvium. In addition, two samples will be collected to investigate suitable techniques for determining nature and extent of the contaminants from beneath the water table during the characterization by removal currently proposed for Fall 2010. One of these samples will be from settled fines from a water/mud sample collected from the resulting test pit.

Depth below ground surface (bgs) will be measured and included along with a sketch of each sampling location in the sampler's field notes.

5.7.2 Sample Collection

Soil samples collected from each location shown in Figure 4-1 will be taken in a way that they are representative of the region being sampled. Rocks and cobbles will be removed from the sample as directed by the laboratory. The remaining soil and fine material will be mixed until a homogeneous mixture has been achieved.

The homogeneous mixture shall be used to fill the applicable sample container(s), as listed in the table below. Each sample container will be labeled as previously described above and custody sealed. Excess material shall be discarded back into the excavated stockpile. Sample collection will be documented on a Sample Collection Log and chain-of-custody forms.

Table 5-3
Exploratory Test Pit Soil Samples

EPA Method	Laboratory Method	Sample Container	Preservation	Holding Time
ASTM D3972-90M	Total Uranium	Poly container, 16-ounce wide mouth	None	180 days
EPA 3050/6010B and 7471A (Hg)	ICP metals (As, Hg, Pb, Mo, V) (ICP/CVAA)	Poly container, 4-ounce wide mouth	4°C	28 days
EPA 901.0M	Radium 226 scan	Poly container, 4-ounce wide mouth	None	180 days

5.7.3 Field QC

Duplicate samples will be collected for a minimum of 10 percent of all the test pit samples

5.8 Sample Acquisition – Test Pit Groundwater Samples

The following section describes how groundwater samples will be collected and used to characterize each test pit location.

5.8.1 Sampling Locations

Groundwater samples will be collected from eight exploratory test pits in the flood plain portion of the CSMRI Site. The approximate locations of these test pits are shown in Figure 4-1.

One groundwater sample will be collected from each test pit. The sample will be collected from the groundwater that collects once the test pit has been excavated to the bedrock.

5.8.2 Sample Collection

A single groundwater sample will be collected from each location shown in Figure 4-1. The samples will be field filtered through a 0.45 µm sieve. The filtered sample will be used to fill the applicable sample container(s), as listed in the table below. Each sample container will be labeled as previously described and custody sealed. Excess material shall be discarded back into the test pit. Sample collection will be documented on a Sample Collection Log and chain-of-custody forms.

Table 5-4
Exploratory Test Pit Groundwater Samples

EPA Method	Laboratory Method	Sample Container	Preservation	Holding Time
EPA 6020	Total Uranium	Poly container, 16-ounce wide mouth	None	180 days

5.8.3 Field QC

Duplicate samples will be collected for a minimum of 10 percent of the groundwater samples. For this exploratory test pit sampling, 1 duplicate groundwater sample will be collected.

5.9 Sample Acquisition – Test Pit Soil Partitioning Samples

The following section describes how test pit soil samples will be collected and used to perform batch adsorption tests to develop a site-specific soil partitioning coefficient (Kd) and to provide soil for bulk density and sieve analysis.

5.9.1 Sampling Locations

Soil samples will be collected from eight exploratory test pits in the flood plain portion of the CSMRI Site. The approximate locations of these test pits are shown in Figure 4-1.

One bulk soil sample will be collected from each pit and will be representative of the full saturated section by compositing samples from each bucket load.

Depth below ground surface (bgs) will be measured and included along with a sketch of each sampling location in the sampler's field notes.

5.9.2 Sample Collection

Soil samples collected from each location shown in Figure 4-1 will be taken in a way that they are representative of the region being sampled. Rocks and cobbles will be removed from the sample as directed by the laboratory. The remaining soil and fine material will be mixed until a homogeneous mixture has been achieved.

The homogeneous mixture shall be used to fill the applicable sample container(s), as listed in the table below. Each sample container will be labeled as previously described and custody sealed. Excess material shall be discarded back into the excavated stockpile. Sample collection will be documented on a Sample Collection Log and chain-of-custody forms.

Table 5-5
Exploratory Test Pit Soil Partitioning Samples

EPA Method	Laboratory Method	Sample Container	Preservation	Holding Time
	SWPE	5-gallon plastic bucket with lid	None	Na
	MLEP		None	Na
	Bulk density, sieve analysis, clay fraction		None	Na

5.9.3 Field QC

Duplicate samples will not be collected for the adsorption tests and geotechnical testing.

6 Quality Assurance Project Plan

The purpose of this Quality Assurance Project Plan (QAPP) is to document the procedures required for quality assurance (QA), quality control (QC), data verification and validation, and data quality assessment for the sampling and analysis activities for the CSMRI Site project. The goal of the QAPP is to identify and implement the QA/QC practices associated with sampling and analytical methodologies that limit the introduction of error into analytical data. The QAPP provides the methodology to ensure that project data will be of adequate quantity, quality, and usability for their intended purpose, and further ensures that such data are authentic, appropriately documented, and technically defensible.

Quality assurance elements are the procedures used to control those immeasurable components of a project such as using the proper sampling techniques, collecting a representative sample, specifying the proper analysis, etc. Although not measurable, quality assurance procedures are essential to produce quality information.

Quality control data are the data generated to estimate the magnitude of bias and variability in the processes for obtaining the environmental data. These processes include both the field processes for obtaining the data and the laboratory analyses.

Data quality assessment is the overall process of assessing the quality of the environmental data by reviewing the application of the QA elements, the analysis of the QC data, and results of the data verification and validation. Quality assessment encompasses both the measurable and immeasurable factors affecting the quality of the environmental data. Assessment of these factors may identify limitations that require modifications to procedures or protocols for sample collection and analysis or affect the desired interpretation and use of the data.

This QAPP was developed in accordance with the requirements in Guidance for Quality Assurance Project Plans (EPA 2002). This QAPP augments the information and requirements described in other sections of this work plan.

6.1 Project Description

A complete description of this project and the project objectives is provided in Sections 2 and 4 of this work plan.

The objectives of the flood plain site characterization are to gather additional data to better understand subsurface site conditions and aid in the development and planning of the upcoming site-wide characterization work. Site activities are designed with this objective in mind, and are described in greater detail in Section 4.

The SAP in Section 5 discusses the collection of field measurements and samples needed to generate the necessary data.

6.2 Measurement Data Acquisition and Performance Criteria

The data quality indicators that will be used to assess the laboratory data include precision, accuracy, representativeness, completeness, and comparability.

6.2.1 Precision

Precision measures the degree of agreement among repeated measurements of the same characteristic (EPA 1986). It may be determined by calculating the standard deviation (for three or more determinations or relative percent difference [RPD] for two samples) for samples taken from the same place at the same time. The EPA National Functional Guidelines set RPD as one of the required measurements of laboratory precision. Generally, precision is calculated for compounds positively detected in both the original and duplicate samples. For two samples, the following formula is used:

RPD = |(original-duplicate)/((original + duplicate)/2)|

Precision can be measured in laboratory analyses by evaluating matrix spike and matrix spike duplicate (MS/MSD) pairs and pairs of "unspiked" samples and the corresponding duplicates, as specified in each analytical report. The acceptable RPD range, called "advisory limits" is given on the Form III for each analytical report (EPA 1999). Analytical results in which the RPD is above those limits, is qualified, usually with an asterisk (*) or a "P".

6.2.2 Accuracy

Accuracy measures how close results are to the true value and is determined by comparing analysis of standard or reference samples to their actual value (EPA 1986). In practice, accuracy is determined by measuring the level of contamination in method and equipment rinsate blanks; evaluating performance against known laboratory control samples (LCS); evaluating surrogate recovery; and validating MS/MSD samples.

Results for blanks agree with values generally obtained in field investigations. The affected samples have been qualified and the detection limits have been appropriately corrected to reflect the accuracy of laboratory analyses.

EPA protocols tightly control LCS and LCS duplicate (LCSD) failures. The LCS percent recovery must be within the QC limits for the sample data to be accepted (EPA 1999). When an analytical run has LCS or LCSD failures that directly impact the analytes requested, the samples must be re-analyzed. Due to these tight controls, LCS and LCSD samples demonstrate that accuracy was met for each analytical run.

6.2.3 Representativeness

Representativeness is a qualitative measure that evaluates whether samples and measurements are collected in a manner such that the resulting data appropriately reflect the property to be measured (EPA 1998). Representativeness can be affected by the collection of the sample or by the analysis. Problems with representativeness arise if the samples collected do not extract the material from its natural setting in a way that accurately captures the qualities to be measured, or if a subsample is not representative of the sample because the subsample was collected from the most accessible portion of a non-homogenized sample (EPA 1998). Representativeness is most commonly addressed by defining protocols based on standard techniques and adhering to them throughout a study (EPA 1991). These standard techniques are most commonly addressed by using standard sample collection techniques (from SW-846 and other EPA guidance) and homogenizing samples prior to subsampling. The standard techniques to be used in this study are detailed in this work plan and will be implemented during field sampling activities.

6.2.4 Completeness

Completeness is the comparison between the amount of valid or usable data originally planned to be collected and the amount of data actually collected (EPA 1986). This initial study will collect data that will strive for an excess of 90 percent completeness.

6.2.5 Comparability

Comparability measures the extent that data can be compared between sample locations and periods of time within a project or between projects (EPA 1986). Data collected for the current CSMRI field work should be comparable with data collected from previous CSMRI field work, as long as past consultants followed the procedures outlined by the EPA (chemical data were obtained using EPA SW-846 methods [EPA 1986] and standard sampling techniques [from SW-846 and other EPA guidance]). Approved laboratories performed all analyses.

6.3 Special Training and Certifications

All field personnel are required to read the site-specific HASP, this work plan, and applicable procedures, as well as attend a safety briefing prior to commencement of work activities. Completion of required reading will be documented using a sign-in sheet or equivalent. Morning safety meeting attendance will be documented on a safety form.

Personnel using hand-held GPS equipment will be given instrument-specific training prior to using the equipment in the field. Personnel using field instrumentation, i.e., scintillator and other detectors, will be trained on those instruments prior to their use.

6.4 Documentation and Records

Field-generated documentation will consist of field logbooks, instrument calibration and operation logs, field survey and excavation documentation sheets, and sample collection logs.

Requirements for documentation include the following:

- Logbooks will be bound, with consecutively numbered pages.
- Removal of any logbook pages, even if illegible, is prohibited.
- Entries will be made legibly with black (or dark) waterproof ink.
- Entries will be made while activities are in progress or as soon afterward as possible.
- Name of person making the entry will be recorded.
- Each consecutive day’s first entry will be made on a new, blank page.
- At the conclusion of the field activities for the day, any unused space on the field logbook page will be “Z’d out” to prevent later entries.
- Unused portions of field forms and chains of custody will be “Z’d out” to prevent later entries.
- The date and time, based on a 24-hour clock (e.g., 0900 for 9 a.m. and 2100 for 9 p.m.) will appear on each page.
- Any photographs taken at the sampling location will be noted on the field sheets.

Documentation will be reviewed for discrepancies, missing information, missing signatures, etc., on a weekly basis (minimum) by the Project Lead, or designee, as evidenced by a review signature in the logbook or on the record sheet. Documentation deficiencies will be directed to the appropriate personnel as soon as possible for correction or augmentation.

Corrections to any document will be made by drawing a single line through the original entry allowing the original entry to be read. The corrected entry will be written alongside the original. Corrections will be initialed and dated and may require a footnote for explanation.

All documentation generated during this project will become part of the project record files.

6.4.1 Field Logbook

All field activities and observations that are not noted on other types of field-generated paperwork will be noted by the Project Lead in a field logbook. The field logbook will be a bound document containing the following information, at a minimum:

- Date and time of each entry,
- Personnel onsite, including documentation of any visitors,
- Area(s) being worked and types of samples collected,
- General observations, and
- Any changes that occur at the site (e.g., personnel, responsibilities, deviations from this work plan) and the reasons for these changes.

The Project Lead is responsible for ensuring that the field logbook and all field data forms are correct and complete. The descriptions will be clearly written with enough detail so that participants can reconstruct events later, if necessary.

In addition to the preceding requirements, the person recording the information must initial and date each page of the field logbook. If more than one individual makes entries on the same page, each recorder must initial and date each entry. The bottom of the page must be signed and dated by the individual who made the last entry.

6.4.2 Sample Collection Log

The Sample Collection Log will be used to document sample collection of all soil samples. Radiological surveys and dose rate surveys will be recorded on appropriate forms as described in Section 5, SAP. Forms shall identify, at a minimum, the released equipment (or personnel name, as appropriate), survey instrument used, survey results, background at the time of the survey, and name of the surveyor.

6.5 Sample Handling Requirements and Controls

All samples will be collected and handled in accordance with the requirements in Section 5, SAP. After collection, samples will be placed in the onsite sample staging locker or in a custody-sealed cooler with the corresponding chain of custody until they are shipped to the offsite laboratory. Metals samples will be stored in coolers on ice and shipped to the laboratory within one day of collection.

6.5.1 Field Procedures

The following steps must be taken by field personnel to ensure chain of custody on field samples.

- Use only approved containers for acquiring samples.
- Properly label all sample containers at the time of sample acquisition.
- Record all required sampling information in field logs and/or sample collection logs, as applicable.
- Ensure that labels are legible and intact after sampling or write information directly on sample container.
- Immediately place samples in a designated container (cooler, etc.) that accompanies the sampling personnel until custody of the samples is transferred.
- Place the sample in a secure location if not transferring to another individual.
- Document all changes of sample custody such as transfer to the onsite laboratory or the offsite laboratory.
- Use an appropriate custody seal on the sample container during shipment to ensure no tampering in route to the laboratory.
- Fill out the applicable chain-of-custody form.

6.5.2 Approved Sample Containers

Samples will be placed and transported in containers appropriate to the sample matrix and analytical parameters. Sample containers for samples submitted to the offsite laboratory are supplied by the laboratory. The bottles are required to be pre-cleaned and certified. The appropriate size and type of sample containers for the analytes being collected are specified in the applicable Sample Acquisition section of the SAP in Section 5.

6.5.3 Sample Label Requirements

Sample labels will be pre-printed whenever possible. Specific sample collection information, such as collection time, will be written on the sample labels at the time of sampling. Sample labels will be filled out with indelible ink. Samples will be labeled with the following information, at a minimum:

- Date and time sample was collected
- Unique sample number
- Name of sampler
- Requested analysis(es)
- Preservative, if applicable
- Client (Stoller) – Only required for offsite samples

6.5.4 Sample Documentation

Sampling activity is documented on a Sample Collection Log.

6.5.5 Preservatives

Metals samples shall be preserved with ice (4 ± 2°C).

6.6 Analytical Methods Requirements

Samples collected for method correlation or post-characterization sampling, as well as occupational health samples (if necessary), will be analyzed at a CDPHE-certified environmental/radionuclides laboratory. Samples designated for laboratory analysis will be analyzed in accordance with laboratory-specific internal procedures for the specified analytical method. The laboratory methods used for this project and the required detection limits are listed in the tables in Section 5.

6.7 Quality Control Requirements

The following sections describe the QC requirements anticipated for this project.

6.7.1 Sampling Quality Control Requirements

Samples must be collected from representative material using clean sampling equipment and the proper sample containers. Collection of the sample must be well documented. The samples must be properly stored and shipped. The Project Lead will supervise sampling personnel to verify sampling, storage, and shipping procedures are followed. If discrepancies are noted, corrective action will be initiated, which may include retraining and/or revising procedures.

Every effort will be made during the soil sample collection to produce well-mixed soil samples free of excessive gravel, pebbles, or organic material. Duplicate soil samples will be collected from a minimum of 10 percent of all sample sites. New disposable sampling equipment or reusable items that have been lined with a disposable liner will be used to collect all samples. Sufficient sample quantity will be provided for internal laboratory QC operations.

6.7.2 Radiation Detection Instrumentation

Daily performance checks shall be completed prior to instrument use each day. Results of the performance checks shall be documented, as specified in the applicable instrument operating procedure.

6.7.3 Laboratory Quality Control Requirements

Laboratory QC shall be performed in accordance with established internal laboratory procedures. Standard QA/QC procedures include initial calibration, continuing calibration, reagent blanks (where applicable), laboratory control samples (for radionuclide samples), laboratory duplicates, serial dilutions (as needed), tracer samples (both chemical and radionuclide), and MS/MSD (i.e., addition of known quantities of chemicals or radionuclides).

All laboratory quality control samples shall be reported along with the standard sample analyses. Problems with laboratory QC shall be reported in the laboratory data package. Analyses that are out of accepted laboratory QC ranges shall be reported to the Project Manager or QA Manager to determine if the samples need to be re-run. Problems with QC shall be corrected as soon as possible and affected samples may require re-analysis. In some instances, technical judgment may be required to determine if flagged data are of adequate quality for project needs.

6.7.4 Survey Data

Positional data will be recorded onsite through the use of GPS. Continual checks of the accuracy of these data will be made by maintaining GIS maps of the accumulated information and checking the locations against adjacent, mapped locations.

6.7.5 Documentation

Significant documentation shall be generated by this project. Documentation will be reviewed for discrepancies, completeness, etc., on a weekly basis (minimum) by the Project Lead or designee. Documentation deficiencies will be brought to the attention of the appropriate personnel as soon as possible for correction.

6.8 Instrument/Equipment Testing, Inspection, and Maintenance

All instrumentation used for this project requires testing, inspection, and maintenance. Equipment problems will be identified in a timely manner and the instrument will be repaired or replaced as soon as possible. Instrumentation that may be used on this project includes:

- Hand-held radiation survey instruments
- Field portable GPS

Manufacturer- or vendor-specified preventive maintenance procedures and/or consumable item replacement schedules shall be strictly followed for all field instrumentation/equipment. Field instrumentation/equipment will be function checked and/or calibrated before being assigned to the field activity. Function testing and/or calibration in the field will be performed daily or in conformance with the manufacturer's recommendations and recorded on the equipment log sheet. A sufficient inventory of repair items and consumable components will be maintained on the Site to keep the field instruments and equipment in service. Arrangements will be made with offsite vendors and service companies for repair and maintenance of instruments that require specialized equipment or skills. Maintenance problems shall be brought to the attention of the Project Lead if data quality is affected.

6.9 Inspection/Acceptance of Supplies and Consumables

Certified clean containers, supplied by the laboratory, shall be used for all samples submitted to the offsite laboratory.

Receipt of supplies and consumables shall be verified against the purchase order to verify that the order was properly and completely filled. If items were ordered with specification requirements, documentation of specification compliance (i.e., certificates, etc.) shall be reviewed for compliance.

6.10 Data Management

Data for this project will be generated in written and electronic form. Field data will be recorded in field notebooks, sample collection logs, chain-of-custody forms, instrumentation visual output, instrumentation digital output, and software-generated digital output. Laboratory data shall be delivered in electronic form in addition to the hard-copy report. These data must be accurately recorded and cross-checked to verify quality data are produced. The objectives for data management on this project are as follows:

- Track and organize all data pertaining to field activities, including surveys, in situ measurements, collection of samples, and data from associated laboratory analyses
- Ensure that the description of each data point is meaningful and complete
- Ensure that large volumes of data can be handled efficiently
- Ensure that each data point is accurate and readily accessible

Data created by the field work activities include the following:

- Field measurement data (radiological surveys and test pit data)
- Survey information
- Sample collection and tracking information
- Offsite laboratory analytical results

Surveys will be performed to record the exact location of each test pit. Coordinate information will be uploaded to a survey database. Sampling event forms will be completed. Analytical samples will receive Level III analyses and full validation. Analytical results will be uploaded into the test and results database. These data files will be used in a GIS to produce maps that illustrate the characterization project.

Data will be entered into the data management system through manual data entry, downloading from data loggers, and electronic files supplied by the laboratories. Data from the sampling event forms will be manually entered into the project database. Hard copies of these data will be generated and scrutinized for errors, omissions, and problems. Identified errors and omissions will be corrected. Problems will be researched and corrected before sampling has terminated. Field personnel will be closely involved in verifying and providing complete information regarding sampling events to ensure that QA/QC sampling objectives are met. Data quality assurance will consist of a variety of techniques depending on the source of the data. Manually entered data will be randomly verified. Newly entered data from all sources will be evaluated using queries to check for outliers or anomalous data. The data will be transferred into final database tables only after data quality has been assured by the Project Lead or designee. Hard-copy original data sheets will be maintained in the project files until project completion and closeout at which time project files will be turned over to the client.

6.11 Assessment and Response Actions

The Project Lead will perform or direct performance and system audits to verify that activities are performed in accordance with the procedures established by or provided in the SAP and this QAPP. Audits will include a review of applicable records, record-keeping practices, and field operations. Additionally, a field audit will take place at the commencement of the project to determine that personnel are aware of and capable of executing project activities in accordance with established procedures. Follow-up audits or surveillances, if deemed necessary, will be conducted to ensure that established procedures continue to be followed. Audits may also be performed to verify the implementation of specified corrective actions. The Project Lead will prepare a written record of any audits performed. Findings, including corrective actions recommended or required, will be included in this record.

The Project Lead will undertake the following actions when/if a malfunction or procedural non-compliance is discovered or reported:

- Identify the item that is not functioning properly.
- If possible, determine how long the item has been malfunctioning.
- Remove the item from service and order its repair or replacement.
- Instruct affected personnel in the proper procedure.

- Evaluate the effect of the malfunction or non-compliance on current and past operations or on data quality.
- Conduct follow-up inspections, observations, or audits to ensure that the procedure is being properly utilized.

The Project Lead will make a written record of the corrective action. If the condition results in the impairment of the quality of data already collected, the Project Lead will identify the affected data, evaluate the effect of the problem, and take appropriate action to correct the affected data, if possible. Corrected data will be noted as such, together with a statement of how the correction was performed. Data that cannot be corrected will be identified, and limitations on the future usability will be noted. The Project Lead will conduct a follow-up investigation to ensure the effectiveness of the corrective action.

In the event that project personnel discover errors or inconsistencies with laboratory data, the Project Lead will initiate an investigation to determine if laboratory data is impaired and if a corrective action is required. The laboratory is required to inform the Project Lead of any laboratory corrective actions and identify any data whose usefulness may be affected. This requirement applies for corrective actions initiated by the laboratory as well any corrective actions ordered by the Project Lead.

6.12 Reports to Management

The Project Lead will submit the start-up audit report to the Project Manager, as well as daily updates on project progress and issues.

6.13 Data Review, Validation, and Verification Requirements and Methods

Data review and validation will be performed that addresses the following parameters:

- Data Completeness
- Holding Times and Preservation
- Initial and Continuing Calibration Verification
- Contract Required Detection Limit
- Preparation/ Initial / and Continuing Calibration Blanks
- Interference Check Sample Results
- Matrix Spike Results
- Duplicate Sample Results
- Laboratory Control Samples Results
- Serial Dilution Sample Results
- Compound Quantitation and Reporting Limits (full validation only)

A summary of QA activities, including conditions or situations affecting data completeness or quality, corrective actions, and outcomes of corrective actions will be prepared as part of the final report. The report will address completeness and reliability of data generated during project activities, quality and completeness of documentation, and identify data and documentation that is incomplete or not in conformance with the project requirements.

7 References

Ecology & Environment, Inc. 1993. Volume 1 – Summary Report On Site Investigation And Removal Activities, CSMRI Creekside Site, Golden, Jefferson County, Colorado. TDDs T08-9202-017, T08-9205-018, T08-9210-011, T08-9210-012. March 17, 1993

EPA (U.S. Environmental Protection Agency), 1986. Test Methods for Evaluating Solid Waste, SW-846: Physical/Chemical Methods, Volume II: Field Methods, 3rd Edition, Office of Solid Waste and Emergency Response. Washington, D.C.

EPA, 1991. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions, Washington, D.C. OSWER Directive 9355.0-30.

EPA (U.S. Environmental Protection Agency), 1998. Guidance for Quality Assurance Project Plans QA/G-5: EPA/600/R-98/018, USEPA, Washington, D.C.

EPA, 1999. U.S. Environmental Protection Agency, Presumptive Remedy for Metals-in-Soil Sites, Office of Solid Waste and Emergency Response, EPA 540-F-98-054, OSWER-9355.0-72FS, PB99-963301.

EPA, 2002, U.S. Environmental Protection Agency, Guidance for Quality Assurance Project Plans

Stoller 2007a. Revised Remedial Investigation / Feasibility Study and Proposed Plan, Colorado School of Mines Research Institute, prepared for Colorado School of Mines by S.M. Stoller Corporation, revision date May 2007; original RI/FS date January 21, 2004.

Appendix A

Whetstone Associates

Whetstone Associates, Inc.
243 N. Main Street
Gunnison, Colorado 81230

Robert Hill
Stoller Corporation
105 Technology Drive, Suite 190
Broomfield, CO 80021

RE: Proposal and Cost Estimate for the Development of Soil Screening Levels and Site-Specific Soil Partition Coefficients for the Colorado School of Mines Research Institute Site.

The following proposal and cost estimate has been prepared at the request of the S.M. Stoller Corporation (Stoller) for the development of soil screening levels (SSLs) and site-specific soil partition coefficients (K_ds) at the Colorado School of Mines Research Institute (CSMRI) mineral processing site. The CSMRI site is a 6-acre area located adjacent to Clear Creek in Golden, Colorado. The facility operated from the late 1800s until 1980 during which time ore samples, some as large as several tons, were received for experimental processing. Tailings and excess samples from the research activities were placed as fill across the site. Wastewater was piped to a settling pond adjacent to Clear Creek. Remediation activities to date have included the demolition of buildings and removal of soil from the pond area. Water quality monitoring at the site indicates that uranium concentrations currently exceed the Federal Maximum Contaminant Level (MCL) of 0.03 mg/l. The scope of work addressed in this proposal is to develop site-specific soil screening levels (SSLs) for uranium that will be used to determine which soils require remediation or removal to ensure that groundwater below the site meets the federal standard.

BACKGROUND

EPA (1996) has developed generalized soil screening levels (SSLs) for a variety of chemicals and radionuclides for residential and commercial/industrial use scenarios. These SSLs address a variety of potential exposure pathways, including leaching to groundwater. The EPA guidance document (EPA 2002) presents two methods for determining SSLs for radio nuclides. The first method uses a generalized soil/water partition equation (SWPE). The second method uses the mass-limit equation procedure (MLEP).

The SWPE is calculated according to the following equation:

$$SLL = C_t = C_w\left(K_d + \frac{\theta_w}{\rho_b}\right)$$

where:

SSL = screening level in soil (mg/kg)
C_w = target soil leachate concentration (mg/L)
- equal to MCL × DAF
  - MCL – maximum contaminant level
  - DAF - dilution/attenuation factor
    - default DAF is 20 for a 0.5-acre source

K_d = soil-water partition coefficient (L/kg)
- radionuclide-specific; default value for uranium is 0.4

θ_w = water-filled soil porosity (Lwater/Lsoil)
- default value is 0.3 (30%)

ρ_b = dry soil bulk density (kg/L)
- default value is 1.5

A site-specific DAF can be calculated using the following equation:

$$DAF = 1 + Kid / IL$$

where:

K = aquifer hydraulic conductivity (m/yr)
i = hydraulic gradient (m/m)
d = mixing zone depth (m)
I = infiltration rate (m/yr)
L = source length parallel to groundwater flow (m)

and mixing zone depth is estimated as:

$$d = (0.0112L^2)^{0.5} + d_a\{1 - \exp[(-LI)/Kid_a)]\}$$

where:

d_a = aquifer thickness (m).

The SWPE method tends to overestimate leaching to groundwater because it assumes an infinite contaminant source.

The MLEP is calculated as follows:

$$SSL = C_t = \frac{C_w \times I \times ED}{\rho_b \times d_s}$$

where:

SSL = screening level in soil (mg/kg)
C_w = target soil leachate concentration (mg/L)
- equal to MCL × DAF
  - MCL – maximum contaminant level
  - DAF - dilution/attenuation factor
    - default DAF is 20 for a 0.5-acre source

I = infiltration rate (m/yr)
ED = exposure duration (yr)
ρ_b = dry soil bulk density (kg/L)
- default value is 1.5

d_s = average source depth (m)

The advantages of using the MLEP is that it:

- Corrects the possible mass-balance violation in the infinite-source SSLs
- Does not require development of a finite source model to calculate SSLs.
- Is appropriate for screening, being based on the conservative assumption that all of the radionuclide present leaches over the period of exposure.
- It is easy to develop and implement, requiring only very simple algebraic equations and input parameters that are, with the exception of source depth, already used to calculate SSLs.

SCOPE OF WORK AND APPROACH

The scope of work for Whetstone would be to perform batch adsorption tests to develop site-specific soil partition coefficients (K_ds) for the CSMRI site and calculate the appropriate SSL for uranium. The work would be performed under the direction of Stoller who would be responsible for providing all samples of soil and water needed for the analyses. Stoller would also provide estimated or site-specific values for hydraulic and soil parameters as noted in the previous section.

Sample Requirements and Testing Methodology

Samples required to complete the geochemical testing would include:

- Approximately 20 to 30 L of contaminated leachate from the CSMRI site.
- Eight soil samples. The samples should be representative of the various soil types present at the site and weigh approximately 5 kg each.

A split of the contaminated leachate from the site would be submitted for analysis of the parameters listed in Table 1. Results of the analysis would be used to support geochemical modeling of precipitation and adsorption mechanisms for uranium. Geochemical modeling is not required for the calculation of SSLs but will aid in the interpretation of the attenuation mechanisms that may affect uranium transport in the subsurface.

Table 1. Analytical Suite for Groundwater Leachate

Parameter
pH
Alkalinity, Bicarbonate
Alkalinity, Carbonate
Alkalinity, Total
Hardness as $CaCO_3$
Calcium
Magnesium
Sodium
Potassium
Chloride
Fluoride (Undistilled)
Sulfate as SO_4
Ammonia (Undistilled) as N
Nitrate + Nitrite as N
Total Dissolved Solids
Electrical Conductivity
Cations, sum of
Anions, sum of
Cation/Anion Balance
Aluminum (total and dissolved)
Iron (total and dissolved)
Manganese (total and dissolved)
Molybdenum (total and dissolved)
Uranium (total and dissolved)

The batch adsorption tests would be completed in two phases according to methodology described in EPA/530-SW-87-006-F (EPA, 1992). The first phase of testing would consist of a series of eight 24-hour bottle roll tests for each sample using solid:solution ratios ranging from 1:4 to 1:500. The second phase of testing would consist of a series of four bottle roll tests for each sample with fixed solid:solution ratios and durations of 1, 24, 48, and 72 hours. The resultant solutions from both phases of testing would be decanted, filtered (0.45µm), preserved (temp <4 °C and HNO_3 to pH <2), and analyzed for pH, electrical conductivity, and dissolved uranium. A sample of the head solution collected at the start of each batch test would also be submitted for laboratory analysis.

Quality control procedures for the batch adsorption tests would include preparation of an equipment blank for each series, consisting of a reaction with test solution and no adsorbent. The blanks would be analyzed to determine effects of adsorption/desorption from reaction containers. In the event the difference between blank and initial solute concentration(s) is greater than 3%, the adsorption data would be corrected following procedures specified in EPA/530-SW-87-006-F, ch17-section 8.5.11. A method blank using deionized water would also be prepared. The method blank would be subject to the same handling, storage, batch testing, and preparation methods as the test solutions, without contact with the rock matrix.

Data Analysis and Calculation of SSLs

The batch adsorption tests would be evaluated by plotting Phase I concentrations against the amount of solute adsorbed per unit mass of adsorbent and regressing a line through the data. The equation of the line is used to calculate the distribution coefficient (K_d). Freundlich isotherms and Langmuir isotherms are most commonly used to describe adsorption in solid-liquid systems. The Freundlich isotherm describes ionic adsorption that is strong at low solution:adsorbent ratios and decreases with increasing ratios. Langmuir isotherms describe similar adsorption behavior that becomes asymptotic with increasing solution:adsorbent ratios. Selection of the appropriate isotherm would be based on inspection of the data. The resulting soil partition coefficients (K_ds) would be used to calculate SSLs using the SWPE and MLEP methods. Equilibration times for uranium sorption on soil will be calculated using Phase II data. The equilibration time is defined as the minimum time at which the change in solute concentration is less than 5% during a 24-hour interval.

In addition to the to the calculation of soil partition coefficients and SSLs for uranium, Whetstone would perform geochemical modeling of the leachate using PHREEQCi to speciate the solution and evaluate potential precipitation and sorption mechanisms that may attenuate uranium concentrations along the groundwater flow path. The results and discussion of the analysis would be presented in a report with the data and analysis from the batch adsorption tests.

DELIVERABLE ITEMS

Deliverable items for this scope of work would include an initial memorandum that describes sample requirements, collection methodology and handling procedures, and testing protocols for the for the batch attenuation tests. The results of the study, including laboratory reports, validated analytical data, calculations for K_ds and SSLs, and geochemical modeling would be presented in a separate technical report. Draft copies (1 each) of the sampling/ testing plan and the technical report would be prepared for review and comment by Stoller/CSMRI. The final sampling / testing plan and the technical report would incorporate comments provided by the reviewers. All deliverables would be provided in digital format.

KEY PROJECT PERSONNEL

Scott Effner, P.G**.,** Principal Geochemist / Hydrogeologist for Whetstone would be responsible for the technical content and timely completion of project work. Mr. Effner has completed over 75 projects during the last 20 years in which groundwater hydrology, geochemical characterization, or numerical modeling of contaminant fate and transport were the focus of work. A resume for Mr. Effner is attached with this proposal and cost estimate.

SCHEDULE

Whetstone Associates could begin work on the project immediately on approval of the scope of work described in this submittal. The draft sampling and testing plan would be completed within 10 days of the notice to proceed. The draft report would be completed within two weeks after receipt of analytical data from the laboratory.

COST ESTIMATE AND TERMS

The cost estimate for the scope of work described in this proposal was prepared according to Whetstone Associates Contract Conditions for 2010. The estimated costs include professional services provided by Whetstone and are presented in Attachment B. Whetstone Associates is an equal opportunity employer and maintains $5,000,000 general liability/excess umbrella liability insurance, $2,000,000 professional liability insurance, and workers' compensation insurance as required by statute.

The cost of the proposed geochemical study is estimated to be $19,186 U.S. dollars. All work would be performed on time and materials basis not to exceed the proposed amount without prior written approval by the client. A table showing detailed costs is presented in Attachment A

It has been a pleasure to prepare this proposal for CSMRI site. Please do not hesitate to contact us if you have additional questions about our submittal.

REFERENCES

EPA (United States Environmental Protection Agency), 1992. Batch-Type Procedures for Estimating Soil Adsorption of Chemicals, Technical Resource Document, Office of Solid Waste and Emergency Response, EPA/530/SW-87/006-F.

EPA (United States Environmental Protection Agency), 1996. Soil Screening Guidance: User's Guide, OSWER Publication 9355.4-23, EPA 540/R-96/018, 2nd Ed., July.

EPA (United States Environmental Protection Agency), 2002. Soil Screening Guidance for Radionuclides: User's Guide, OSWER Publication 9355.4-16A, EPA 540/R-00/007, October.

Sincerely,
Whetstone Associates, Inc.

Scott Effner, P.G.
Principal Geochemist / Hydrologist

File:9120.100503

ATTACHMENT A

COST ESTIMATE AND WHETSTONE ASSOCIATES CONTRACT CONDITIONS

Whetstone Associates

Cost Estimate

Cost Estimate -CSMRI Research Site

		Task 1		Task 2		Task 3		Totals	
		Study Plan		Batch Adsorption Testing		Report Preparation and Analysis			
STAFF MEMBER	($/Hr)	Hrs.	$	Hrs.	$	Hrs.	$	Hrs.	$
Scott Effner, P.G. - Principal Geochemist / Hydrogeologist	$105.00	16	$1,680.00	8	$840.00	24	$2,520.00	48	$5,040.00
Susan Wyman, P.E., P.G. - Principal Hydrologist / Civil Engineer	$105.00	2	$210.00			4	$420.00	6	$630.00
Christa Whitmore - Project Geochemist	$65.00	8	$520.00	32	$2,080.00	16	$1,040.00	56	$3,640.00
Professional Services Subtotal		26	$2,410.00	40	$2,920.00	44	$3,980.00	110	$9,310.00
EXPENSES:	Unit Cost			Units	$	Units	$		
Phase I and II Batch Testing	$750.000			8	$6,000.00				$6,000.00
ACZ Analytical Cost for Contact Solution	$28.80			120	$3,456.00				$3,456.00
ACZ Analytical Cost Groundwater	$220.00			1	$220.00				$220.00
Shipping to Labroatory	Lump				$200.00				$200.00
Expenses Subtotal			$0.00		$9,676.00		$0.00		$9,876.00
TOTAL			**$2,410.00**		**$12,596.00**		**$3,980.00**		**$19,186.00**

Whetstone Associates

Schedule of Rates

PROFESSIONAL SERVICES

Susan Wyman, P.E., P.G........Principal Hydrologist / Civil Engineer $105.00/hr
Scott Effner, P.G. ....Principal Geochemist / Hydrogeologist $105.00/hr
Nathan Page. ....Project Hydrogeophysicist $75.00/hr
Christa Whitmore..................Project Geochemist / Hydrogeologist $65.00/hr
Andrew Payton......................Geologist $55.00/hr

SUPPORT SERVICES

CAD Technician .... $ 55.00/hr
Clerical .... $ 25.00/hr

EQUIPMENT

4WD Vehicle $0.55/mile
Oakton T/pH/SC Meter.. $90.00/week
Peristaltic Pump $75.00/week
Dissolved Oxygen Meter $150.00/week
HACH DR2010 Spectrophotometer $450.00/week
Grundfos Redi-Flo2 Sampling Pump.. $475.00/week
Pneumatic Wellhead Assembly $50.00/week
Water Level Sounder $90.00/week
Pressure Transducer $50.00/day

Photocopies ....$ 0.15/copy
11"x17" B&W Drafting Plots...$ 1.00/plot
11"x17" Color Drafting Plots ....$ 2.50/plot
Large B&W Drafting Plots ....$ 25.00/plot
Large Color Drafting Plots...$ 40.00/plot

EXPENSES

All direct expenses reasonably incurred during the performance of the project will be billed to the client as a part of the total project charges. These expenses (including airfare, lodging, meals, postage, and telephone charges) will be passed on to the client at cost.

Any subcontracts which are carried by Whetstone will be assessed a 10% fee to cover contract administration, liability and processing of such expenses.

TERMS

Invoices are provided monthly. Terms of payment are US funds, net 30 days from receipt of invoice. Interest of 1.5% per month may be charged for late payment.

Effective Jan 1, 2010.

Whetstone Associates, Inc.
243 N. Main Street ♦ Gunnison, Colorado 81230 ♦ Phone 970-641-7471 ♦ Fax 970-641-7431

ATTACHMENT B
RESUME FOR SCOTT EFFNER

SPECIALIZATION

Scott Effner, Principal Geochemist/Hydrogeologist for Whetstone Associates, specializes in groundwater hydrology, geochemistry, and water resource studies for mining, energy, and industrial projects. Mr. Effner has been involved with over 75 projects during the last 20 years in which groundwater hydrology, geochemical characterization, water quality monitoring, or numerical modeling were the focus of work. Mr. Effner has broad experience performing hydrologic and geochemical studies for mine permitting and construction, and is knowledgeable about water resource and geochemical issues related to NEPA studies. Mr. Effner's main areas of expertise are in hydrogeologic characterization and testing, design of water control systems, numerical modeling of aqueous geochemistry and groundwater flow, design of water quality monitoring networks, and preparation of geochemical characterization studies.

EDUCATION

M.S., Geology, University of Idaho, Moscow, Idaho 1992
B.A., Geology, Western State College, Gunnison, Colorado 1988

PROFESSIONAL AFFILIATIONS AND CERTIFICATION

Professional Geologist, Wyoming, Registration # PG-3434
Professional Geologist, Idaho, Registration # 1077
International Mine Water Association, 1993 - present
National Groundwater Association, 1998 to present
MSHA 40-Hour Training for Surface and Underground Miners
OSHA 24-hour Hazardous Waste Operations Training

WORK HISTORY

Whetstone Associates, Principal Hydrogeologist/Geochemist, 1999 to present

TRC Hydro-Geo Consultants, Lakewood, CO, Senior Geochemist/Hydrogeologist, 1993 to 1999

Empresa Minera Can-Mex, Hermosillo, México, Geologist 1992 to 1993

Tenneco Minerals Company Lakewood, CO, Geologist 1989 to 1991

REPRESENTATIVE PROJECT EXPERIENCE

- *Monsanto Blackfoot Bridge Mine EIS, Idaho – Water Resources and Geochemistry Technical Lead* – Responsible for the design and implementation of baseline water resource and geochemical characterization studies for the Blackfoot Bridge Phosphate Mine Environmental Impact Statement (EIS). Project work included oversight of all technical aspects of the water resources and geochemical characterization studies, preparation of the EIS impact analysis, and numerical modeling of groundwater flow and contaminant transport. The project is in progress with an expected completion date in 2010.
- *Agrium, Rasmussen Ridge Mine EIS, Idaho – Water Resources and Geochemistry Technical Lead* – Responsible for the development of the water resources impact analyses and geochemical evaluation for the North Rasmussen Ridge Mine Environmental Impact Statement (EIS). Project work included the review and development of baseline characterization studies, analysis of hydrologic and geochemical data, numerical modeling (MODFLOW/MT3D) of contaminant fate and transport, and senior review of geochemical modeling (PHREEQCi).

- *FMC, Dry Valley Mine, Idaho – Project Manager* – Prepared surface water, groundwater and aquatic monitoring plans, groundwater and surface water mitigation plans, and quality assurance project plans. Project work included negotiation of sampling sites and monitored parameters with agencies, preparation of SOP's, and development of text for the South Extension Mitigation Plan. Particular emphasis was placed on the selenium and sediment issues in Dry Valley Creek which is listed as a 303(d) impaired stream.

- *Cotter Corporation, Swartzwalder Mine, Colorado – Senior Geochemist* – Hydrologic characterization report for the closure of the Swartzwalder Uranium Mine. Project work included analysis of the rate and projected level of mine flooding, geochemical modeling (PHREEQci) to predict discharge water quality, and preparation of recommendations for monitoring and mitigation of impacts to water quality.

- *Southern Perú Copper Corporation, Perú – Project Manager* – Environmental audit. Reviewed and audited surface and groundwater monitoring network for Toquapala and Cuajone mines, related tailings facilities and smelter and port facilities. Presented short courses for design of groundwater monitoring networks, groundwater modeling (MODFLOW/MT3D), and geochemical modeling (PHREEQC/MINTEQA2).

- *Dudley and Associates, Seminole Road Project EIS, Hanna Basin Wyoming – Senior Hydrogeologist* – Prepared numerical groundwater flow model (MODFLOW) for the Seminoe Road Coal Bed Methane Project Environmental Impact Statement. The model was used to evaluate potential drawdown impacts in the Hanna Basin caused by pumping from over 1,200 wells which will be installed at full production. The model was also used to evaluate impacts caused by injection of produced water into the Dad sandstone of the Lewis Formation.

- *Dudley and Associates, Seminole Road CBM Pilot Project, Hanna Basin Wyoming – Senior Geochemist* - Geochemical modeling (PHREEQC/MINTEQA2) to support design of water treatment facility for discharge from coal bed methane wells.

- *Agapito Associates, Mountain Coal Dear Creek Mine, Colorado – Senior Hydrogeologist* - Hydrogeologic investigation for the # 4 shaft at the Deer Creek Mine. Project work include field permeability testing of the shaft pilot borehole and preparation of an inflow analysis to support shaft sinking.

- *Agapito Associates, Dominion Power Roanoke Rapids Dam, North Carolina – Senior Hydrogeologist* - Permeability study for the Roanoke Rapids Dam. Project work include field permeability testing of the dam and bedrock contact and analysis to support rehabilitation engineering study.

- *Nicolet Minerals Company, Crandon Project, Wisconsin – Senior Hydrogeologist* – Hydrologic characterization and permeability testing to support numerical modeling of groundwater for the Crandon Mine Environmental Impact Statement (EIS). Project work included the development and implementation of field testing programs, data analysis, and preparation of supporting documents for the EIS.

- *Nicolet Minerals Company, Crandon Project, Wisconsin – Senior Hydrogeologist* - Grouting feasibility study and pilot testing program. Project work included the design and implementation of a pilot test to evaluate the feasibility of a large-scale grouting program to control groundwater inflow to the proposed underground mine.

- *Minera San Xavier, Cerro San Pedro Mine, San Luís Potosí, México – Project Manager* - Hydrologic characterization study for open-pit mine and leach pad. Project work included the installation and testing of a monitoring well network, preparation of groundwater and storm water monitoring plans, and development of mitigation measures to prevent the release of ARD from the pit and waste rock facilities.

- *Nicolet Minerals Company, Crandon Project, Wisconsin – Project Manager* – Developed an analysis to relate weathering intensity, fracture frequency and aperture dimensions to hydraulic conductivity and groutability to evaluate the reductions in permeability that could be achieved by a large-scale grouting program.

- *Lac Minerals U.S.A., Ortiz Mine, New Mexico – Senior Hydrogeologist* - Designed and installed a grout curtain below an acid rock drainage (ARD) interceptor system to reduce seepage in fractured bedrock. Laboratory testing and geochemical modeling (PHREEQE) were performed to evaluate grout resistance to chemical attack.

- *Akzo-Nobel Salt, Hampton Corners Mine, New York– Senior Hydrogeologist* - Hydrologic characterization for shaft sinking. Project work included the design and implementation of a drilling and packer permeability testing program for the shaft site and calculation of the anticipated groundwater inflow during sinking.
- *Coeur Alaska, Kensington Mine, Alaska – Senior Hydrogeologist* – Hydrologic characterization study. Reviewed existing studies and data to characterize hydrologic conditions for the Kensington underground mine. Mine dewatering and water handling recommendations were made, and a geochemical evaluation (PHREEQC/MINTEQA2) was performed to evaluate the potential long term water quality in the mine.
- *Cyprus Minerals Company, Cerro Verde Mine, Peru – Senior Hydrogeologist* - Hydrogeologic characterization of a site for the construction of a copper heap leach facility. Project work included geologic evaluation and mapping, installation and testing of monitoring wells, packer permeability testing, and infiltration testing of unconsolidated sediments. Seepage estimates from the facility were prepared along with recommendations for facility monitoring.
- *McIntosh Redpath Engineering, Monarch Mine, Venezuela– Project Manager* - Hydrogeologic characterization for shaft sinking. Project work consisted of underground drilling and packer permeability testing, calculation of inflow to the shaft during sinking and preparation of recommendations for water control and handling.
- *Getchel Gold Corporation, Turquoise Ridge Mine, Nevada – Senior Hydrogeologist* - Hydrologic characterization and water control study for the Turquoise Ridge Mine. Performed and evaluated pumping tests, and developed a numerical groundwater flow model (MODFLOW) to predict inflow to the shafts during construction.
- *Sociedad Mineria El Brocal, El Brocal Mine, Peru - Senior Hydrogeologist* – Numerical modeling of pit dewatering. Developed a finite-difference groundwater flow model (MODFLOW) to predict inflow to the planned open pit. The effectiveness of using surface extraction wells to dewater the mine was evaluated along with the potential impacts to surface water resources.
- *Meridian Gold, Bear Track Mine, Idaho – Senior Hydrogeologist* – Hydrologic characterization and dewatering study. Project work included the design, installation and testing of dewatering wells for the south pit, and spreadsheet modeling of groundwater flow.
- *Meridian Gold, Beartrack Mine, Idaho – Senior Hydrogeologist* – Pit Filling Study. Performed analytical calculation of flooding for South Pit at the cessation of dewatering.
- *Fluor Daniel, Alumbrera Project, Argentina – Senior Hydrogeologist* – Construction of water supply well field. Developed a groundwater supply well field for the construction and operation of a large copper porphyry mine in northern Argentina. Project work included evaluation of groundwater potential, field exploration for groundwater, the installation and testing of 7 large diameter (16-inch) production wells, and numerical modeling (MODFLOW) of the water supply well field.
- *Fluor Daniel, Alumbrera Project, Argentina– Senior Hydrogeologist* – Construction of a seepage capture well field for the Minera Alumbrera tailings facility. Project duties included the design, installation, and testing of a well field to capture bedrock seepage. Work performed for the project included on-site management of a two million dollar drilling program to locate, construct, and test nine large diameter (12-inch) extraction wells to depths of 200 meters.
- *Fluor Daniel, Alumbrera Project, Argentina – Senior Hydrogeologist* – Hydrogeologic investigation and evaluation of bedrock for tailings dam foundation. Project work included the design and installation of monitor wells, implementation of a packer permeability testing program, and evaluation of the hydrologic characteristics of bedrock.
- *Agrium, North Rasmussen Ridge Mine, Idaho – Project Manager* – Prepared Surface Water and Groundwater Monitoring Plan and Quality Assurance Project Plan for Annual Water Quality Sampling Program.

- *Agrium, North Rasmussen Ridge Mine, Idaho – Project Manager* – Installation and design of deep wells (>1,000 ft.) for compliance monitoring.
- *FMC, Dry Valley Mine, Idaho – Senior Geochemist* – Geochemical modeling and evaluation of chemical loading and transport in ground and surface water from proposed waste rock dumps for the Dry Valley Mine
- *Astaris, Dry Valley Mine, Idaho – Project Manager* – Prepared annual surface and groundwater monitoring reports for submittal to IDEQ for the years 1998 through 2008.
- *Astaris, Dry Valley Mine, Idaho – Project Manager* – Installation and design of deep wells (>1,000 ft.) for baseline and compliance monitoring of the C and D panel expansions.
- *Hecla Mining Company, Rosebud Mine EA, Nevada – Senior Geochemist* – Geochemical characterization study for the Rosebud Mine Environmental Assessment (EA). Project work included geochemical characterization of waste rock and ore (ABA testing, humidity cell, meteoric water mobility tests), hydrogeologic characterization of the project area, and evaluation of the potential impacts to groundwater quality from underground mining. A geochemical model (PHREEQE) was developed to evaluate changes in groundwater quality that would be caused by the project.
- *Hecla Mining Company, Rosebud Mine, Nevada – Senior Hydrogeologist* - Water supply study. Project work included the design and implementation of a groundwater exploration program, installation and testing of production wells in fractured bedrock.
- *Coeur Alaska, Kensington Mine, Alaska – Senior Geochemist* – Developed geochemical characterization program for cemented paste backfill containing flotation and cyanide tailings which incorporated column testing, acid-base accounting, NMWMT testing.
- *ENSR, Three Oaks Mine EIS, Texas – Senior Hydrogeologist* - Review and sensitivity analysis of “Brazos Region G” and “Three Oaks” numerical groundwater flow models (MODFLOW) for the Three Oaks Mine Environmental Impact Statement (EIS).
- *Sociedad Contractual Minera El Abra, Chile – Senior Hydrogeologist* – Third party review and hydrogeologic/geochemical characterization study for 180 mt. run-of-mine dump leach facility. Project work included the review of previous hydrologic studies and the development of an integrated hydrogeologic model for the site. Leaching and attenuation studies for substrate materials were also performed using synthetic PLS. The main focus of the study was for permitting of the facility and to determine potential impacts to downstream users.
- *Kinross, Kettle River Operations, Washington – Senior Hydrogeologist* – Prepared numerical groundwater flow and contaminant transport model (MODFLOW/MT3DMS) to evaluate mitigation strategies for groundwater contamination at the Key Mill Tailings Facility. The model incorporated multiple contaminant sources, and was calibrated to 14 years of water quality and water level data.
- *Arch Coal, Carbon Basin, Wyoming – Project Manager* – Geochemical characterization study. Prepared geochemical evaluation for D-5 permit application and developed stratigraphic correlation for acid producing potential and constituents of concern.
- *Minera Hecla, La Choya Mine, Mexico – Senior Geochemist* - Designed and supervised sampling program for waste rock and spent ore to characterize material for site closure. A review of the existing geochemical data was performed to determine adequacy for mine closure.
- *Barrick Goldstrike Mine, Nevada – Senior Geochemist* – Geochemical modeling (PHREEQC/MINTEQA2) of sorption and mineral precipitation/dissolution reactions for the Betze-Screamer Pit Lake. Particular emphasis was placed on modeling the sorption behavior of arsenic to precipitating ferrihydrite using the program PHREEQC and a modified MINTEQA2 thermodynamic database.
- *CESEL Ingenieros, Cerro de Pasco, Peru – Project Manager* – Review and preparation of closure alternatives for Quiulacocha tailings facility and Excelsior waste rock dump, senior review of geochemical and hydrologic characterization programs, design of water quality monitoring program, numerical modeling (UNSAT-H) of seepage for cap/cover design.

- *Fluor Daniel, Batu Hijau Project, Indonesia, - Senior Hydrogeologist* – Numerical modeling of groundwater flow. Developed a finite difference groundwater model (MODFLOW) to simulate a pumping well field in a shoestring alluvial aquifer. The model was used to design a water supply well field for the mine and to predict the effects of pumping on surface water resources. The potential for sea water incursion into the aquifer was also evaluated.
- *Minera Alumbrera, Alumbrera Mine, Argentina – Senior Geochemist* – Prepared standard operating procedure manual for groundwater and surface water monitoring program.
- *American Electric Power, Windsor Mine, W. Virginia – Senior Hydrogeologist* – Prepared Probable Hydrologic Consequences (PHC) document for C-Panel expansion. Project work included the design and installation of a water quality/quantity monitoring network for the C-Panel area, determination of PHC's, and preparation of permitting document.
- *American Electric Power, 44 Hollow Mine, W. Virginia – Senior Hydrogeologist* – Prepared Probable Hydrologic Consequences (PHC) document for the proposed underground fine refuse disposal in the 6 East Panel, 44 Hollow Mine. Project work included the development of site hydrogeology, evaluation of mine flooding and seepage, and preparation of PHC document.
- *Cyprus Foidal Creek Coal Mine, Colorado– Senior Hydrogeologist* – Prepared study of long wall mining operation on surface and groundwater resources, including permit to mine under an alluvial valley floor.
- *Cyprus Twentymile Coal Company, Colorado – Senior Hydrogeologist* – Prepared salt loading evaluation of mine spoils on local drainages tributary to the Yampa River.
- *LAC Minerals U.S.A., Ortiz Mine, New Mexico – Senior Geochemist* - Developed a predictive geochemical model (PHREEQE) for the Ortiz Pit Lake. Equilibrium methods were used to identify and constrain geochemical controls of the pit lake water composition. The model incorporated humidity cell, acid-base accounting, XRD, microprobe and limnologic data to estimate the long-term water quality. Chemical profiles were developed from samples collected at various depths to investigate the potential for stratification of the lake.
- *LAC Minerals U.S.A., Coliseum Mine, California – Senior Geochemist* - Developed a predictive geochemical model (PHREEQE) for closure of the Coliseum Pit Lake. The model used equilibrium methods to identify and constrain geochemical controls of pit lake water quality, and incorporated humidity cell, acid-base accounting, and whole rock geochemical data. Chemical profiles were developed to investigate the potential for stratification of the lake.
- *Echo Bay Minerals Company, Key West Mine, Washington – Senior Geochemist* - Developed a predictive geochemical model (PHREEQE) for the Key West Pit Lake. Equilibrium methods were used to identify and constrain geochemical controls of pit lake water quality. The study incorporated humidity cell, acid-base accounting, and whole rock geochemical data.
- *Echo Bay Minerals Company, Key West Mill Site, Washington – Senior Hydrogeologist* – Hydrologic study and impact evaluation for the Key Mill near Republic Washington. The study incorporated analysis of the physical and chemical impacts to ground and surface water from milling operations and tailings disposal at the site.
- *Envirocare Clive Facility, Utah – Senior Geochemist* – Developed soil partition coefficients (K_ds) for organic constituents and radionuclides for the 11e.(2) and Western Low Activity Radioactive Waste (LARW) disposal cells.
- *Canyon Resources, Briggs Project, Nevada – Senior Hydrogeologist* – Developed Standard Operating Procedures Manual for groundwater and surface water sampling the mine. Prepared a statistical analysis of baseline water quality data to determine regulatory levels for constituents of concern.
- *Tenneco Minerals, Goldstrike Mine, Utah – Geologist/Geochemist* - Characterized the spatial distribution of trace metals in relation to structural features and ore-grade gold mineralization in the Humbolt Pit. The study included the design and implementation of the sampling program, laboratory characterization of wall rocks, and statistical analysis of trace metal correlation with gold.

- *Minera Yanacocha, La Quinua Pit, Perú – Project Geochemist* – Performed mixing and pH calculations for pit dewatering discharge and receiving surface waters.
- *Coeur, Rochester Mine, Nevada – Senior Hydrogeologist* – Installation and hydrologic testing of a 14-inch water supply well to a depth of 1,000 feet.
- *Coeur, Rochester Mine, Nevada – Senior Hydrogeologist* – Numerical modeling of groundwater flow a contaminant transport (MODFLOW/MT3D) for the Stage I Heap Leach Facility.

PUBLICATIONS

Effner, S., Straskraba, V., Vandersluis, G., 1995. Pressure Grouting of Fractured Bedrock to Control Acid Mine Drainage. Proceedings of the 1995 Annual Meeting of The American Institute of Hydrology and the International Mine Water Association, Water Resources at Risk.

Straskraba, V. and Effner, S., 1998. Water Control in Underground Mines - Grouting or Drainage?, Proceedings of the 1998 Annual Meeting of The American Institute of Hydrology and the International Mine Water Association, Water Resources at Risk.

Vandersluis, G., Straskraba, V., and Effner, S., 1995. Hydrogeological and Geochemical Aspects of Lakes Forming in Open Pit Mines, Proceedings of the 1995 Annual Meeting of The American Institute of Hydrology and the International Mine Water Association, Water Resources at Risk.

Appendix B

S.M. Stoller Corporation
Site-Specific Health and Safety Plan

Colorado School of Mines Research Institute
Flood Plain Characterization

Revision 0
May 18, 2010

S.M. STOLLER CORPORATION
SITE-SPECIFIC HEALTH AND SAFETY PLAN

Project Location:	Colorado School of Mines Research Institute (CSMRI); Golden, CO
Task Name:	Environmental Characterization of CSMRI Site Flood Plain Site
Duration of Activities:	Duration of contract. This HASP will be modified, as necessary, if new tasks are added.

APPROVALS

Title/Organization:	*Printed name:*	*Signature:*	*Date:*
Project Manager	Steve Brinkman		
Radiation Safety Officer	Jerry Mattson		
Health and Safety Lead	James Voorhies		
Health and Safety Director	Darin Dobbins		

SCOPE OF WORK

Breakdown and description of work activities:

1. Mobilize and establish work zones and equipment/materials staging areas.
2. Conduct applicable training of field personnel.
3. Excavate test pits using heavy equipment.
4. Collect samples for off-site laboratory analyses.
5. Backfill disturbed areas.
6. Demobilize from site.

Should any off-normal event occur, work will immediately stop and will not commence until the hazards have been addressed and the necessary THA, procedure, or HASP modification completed.

All personnel working on the project have **STOP WORK AUTHORITY** if they witness any event, condition or practice, on the project, that could reasonably be expected to cause death or serious physical harm to a person.

PERSONNEL

Assigned Responsibility:	*Name and Organization:*	*Phone Number:*
Program Manager	Steve Brinkman, RG	303-546-4388 office, 303-638-8082 cell
Project Manager	Harry Bolton, RG	303-546-4351 office, 303-435-4872 cell

Health and Safety Lead	James Voorhies, CSP	303-546-4335 office, 303-598-1867 cell
Radiation Safety Officer (RSO)	Stacey Alderson, CHP	702-295-2239 office, 702-335-6146 cell
Alternate RSO	Jerry Mattson, RRPT	303-546-4326 office, 303-748-0125 cell

TASK HAZARD ANALYSIS (THA)

Task-specific hazard control measures are specified in each Task Hazard Analysis (THA). THAs have been developed for the following activities and are included as attachments.

Activities with procedures have hazard abatement incorporated into the procedure and do not have THAs.

THA Number and Activities:
THA-1 General Site/Visitor THA-2 Heavy Equipment Operations THA-3 Field Sampling

PERMITS

Required permits must be signed before work commences.

Permit:	No	Yes	Notes and Comments:
Hot Work	X		This type of work is not anticipated.
Confined Space	X		This type of work is not anticipated.
Lockout/Tagout	X		Any electrical activities (mobilization, demobilization) will be undertaken by a licensed electrician operating under their LOTO procedures and confirmed by the Project H&S Manager. All other electrical activities involve the use of portable electrical equipment and shall be properly de-energized and removed from a power source. No other systems are expected to be used on the project that have stored energy.
Excavation/Intrusive Soil Activity	X		No permit is required. Utilities have previously been identified. Known locations will be confirmed and marked prior to any excavation activities.
Other:			

PERSONAL PROTECTIVE EQUIPMENT

The following personal protective equipment (PPE) will be used for the identified activities. PPE requirements may be increased or decreased at the discretion of H&S after an evaluation of the hazards has been performed and other controls have been evaluated.

It is not anticipated that respiratory protection will be required for this project. However, if monitoring data indicates levels of air contaminants above action levels, work will be halted, hazards will be assessed and the Stoller Respiratory Protection program will be initiated. Also, personnel may utilize dust masks for their own comfort, if desired. Personnel using dust masks for comfort purposes shall acknowledge that they will use the mask in accordance with the manufacturer's instructions.

Activity	Head/Face	Foot	Hands	Clothing
Site preparation, general maintenance, and support functions	Safety glasses, hard hat when overhead hazards exist, hearing protection as necessary	Sturdy, hard toed work boots/shoes *Boot covers may be worn to minimize contamination*	Appropriate work gloves when using tools	Standard work clothing, high-visibility vest or clothing, when heavy equipment is operating onsite
Soil sampling, radiological surveys and decontamination	Safety glasses, hard hat when overhead hazards exist, hearing protection as necessary, face shield (as necessary)	Sturdy, hard toed work boots/shoes *Boot covers may be worn to minimize contamination*	Appropriate gloves depending on the work application (nitrile, latex, rubber, leather)	Standard work clothing, coated Tyvek suit or rain suit as necessary (per H&S direction), high-visibility vest or clothing, when heavy equipment is operating onsite
Equipment Operator	Safety glasses, hard hat, hearing protection *Above items are not required when inside operators cab.*	Sturdy, hard toed work boots/shoes *Boot covers may be worn to minimize contamination*	Driver/operator gloves, as appropriate	Standard work clothing, high-visibility vest or clothing, when outside of operators cab
Visitor	Safety glasses, hard hat (when overhead hazards exist), hearing protection (as necessary)	Sturdy, hard toed work boots/shoes *Boot covers may be worn to minimize contamination*	NA	Standard work clothing, high-visibility vest or clothing, when heavy equipment is onsite
The Project Health & Safety Lead, designated as the competent person, certifies that a hazard assessment for the identified activities and tasks has been performed and the selection of appropriate PPE is based on best available information.				

TASK HAZARD(S) SUMMARY

The potential health and safety hazards of these tasks are summarized below. The potential for encountering these hazards is ranked (high, medium, or low) based on the work to be performed and the hazard control measures to be used.

Summary	***Hazard Potential*** ***(High, medium, or low)***	***Description of potential hazards*** ***(List each potential hazard)***
☒ Safety *Walking and working surfaces, falls, power and hand tools, materials handling*	Medium	• Slips, trips, or falls due to uneven walking surface or wet/muddy conditions. • Hand tools (hammers, shovels, screwdrivers, pliers). • Various supplies for project use.
☒ Utilities *Buried, overhead, or in general work area*	Low	• Overhead utilities. • Water & sewer lines near project excavation areas.
☒ Chemical *Identify chemicals of concern here, and attach MSDSs*	Low	• See information in the Hazardous Chemicals Section
☒ Physical *Heat, cold, noise*	Medium	• Heavy metal contamination from inhalation & ingestion minimized through work controls. Data indicates exposure to be minimal due to concentration levels in soil. • Potential heat stress for personnel wearing Tyvek PPE. • Potential cold stress due to weather.
☒ Radiological	Low	• Radiological contamination from inhalation, ingestion of contaminated soil. Data indicates that concentrations in soil and air are sufficiently low that the current work controls for each task will eliminate exposure potential.
☒ Biological *Plants, animals, insects, spiders, infectious waste*	Medium	• Spiders/insects may be present. • Other animals that are native to the area include mountain lions, snakes, birds, mice, elk, deer, rabbits, raccoons, foxes, coyotes, and squirrels. • Native plant species in area may present allergens to some susceptible workers.
☒ Other - Heavy Equipment Operation	Medium	• Soil moving equipment will be onsite. • Personnel are trained to make eye contact with operators prior to entering into equipment work zones. All personnel in vicinity of heavy equipment will wear high visibility clothing. • Spotters will be used for equipment operations, as necessary, where sight lines are limited.

SITE MONITORING

Direct Reading Exposure Monitoring (to assess potential worker exposure)			
Activity(s)	***Instruments***	***Action Level(s) and Actions***	***Frequency***

Radiological assessment of equipment and personnel monitoring	Ludlum Model 19 dose rate survey instrument (or equivalent) Alpha/beta scintillation detector with rate meter/scaler for contamination surveys Direct reading and smear surveys	Monitoring to be conducted periodically and as needed to evaluate site conditions and keep personnel exposures as low as reasonably achievable (ALARA). Prior investigations indicate dose rates to be less than 100 mrem/yr. Length of time for the project is expected to be less than 1 week. Anomalous dose rates (above prior general area levels) in the work area will be investigated and appropriate radiological precautions taken to minimize exposure and contamination.	All personnel and equipment leaving the potentially contaminated area will be surveyed. General area dose rate surveys shall be performed and documented prior to start of the project. Additional radiation and contamination surveys will be performed if routine monitoring shows increasing levels or levels greater than Colorado State regulations.

Integrated Personal Air Monitoring (full-shift worker exposure sampling and/or analysis)

Activity(s)	***Contaminant***	***Method***	***Frequency***
All project activities	Metals: lead, arsenic, mercury, molybdenum, uranium and vanadium Radionuclides: Ra-226	No personal air monitoring is required. Risk of exposure to uranium and arsenic is minimum based on the type of work and using maximum site concentrations of metals and radionuclides from the RI/FS evaluation.	If radiological levels change, an evaluation shall be performed to assess the need for personal air monitoring.

Perimeter or Work Area Monitoring (ambient work area or fence line monitoring)

Activity(s) /Location	***Contaminant(s)***	***Method***	***Frequency***
Soil excavation activities	Metals: lead, arsenic, mercury, uranium, molybdenum and vanadium Radionuclides: Ra-226	No perimeter or work area monitoring is required. Risk of exposure to uranium and arsenic is minimum based on the type of work and using maximum site concentrations of metals and radionuclides from the RI/FS evaluation.	If radiological levels change, an evaluation shall be performed to assess the need for perimeter air monitoring.

Comments or special instructions: Operations will be evaluated by the project lead during high wind conditions (>20 mph). If dust cannot be adequately controlled, activities will be shut down.

SITE CONTROL

Site Control for General Work Area(s)

Location	***Site Control Procedure (discuss important elements such as signs, barricades, fencing, briefings, sign-in/out logs, etc.)***
	A predetermined work period will be determined for the project. Individual time in the work area will be documented in log books or a sign-in log. A tailgate meeting will be completed for activities conducted at the site on a daily basis. The work site is fenced, gated and posted to limit public access.
Site Control for Potentially Contaminated Area(s)	
Location	***Site Control Procedure (discuss important elements such as signs, barricades, briefings, qualifications, required supplies and equipment, sign-in/out logs, etc.)***
Support Zone	The work site is fenced, gated and posted to limit public access.
Contamination Reduction Zone	All areas on the flood plain itself are considered potentially contaminated. All personnel and equipment working on the flood plain shall be monitored prior leaving the site.
Exclusion Zone	NA

DECONTAMINATION

Type of decontamination	***Identify activity(s) requiring decontamination and describe decontamination steps, location, required equipment, and collection and disposal of potentially contaminated liquids and solids.***
Personnel decontamination	Proper doffing and disposal of booties, gloves, and Tyvek as sanitary waste. Decontamination material shall be disposed of as sanitary waste. Personnel shall be monitored for radiological contaminants with appropriate radiological instruments. Contaminated personnel will be decontaminated using water and non-abrasive wiping. Further monitoring shall be performed to determine effectiveness of decontamination.
Equipment decontamination	Soil excavation equipment will be visually inspected to ensure the exterior is free from waste material. Excavation equipment will be decontaminated using wet methods, as necessary. Materials, equipment, sample bottles and other field equipment that is not disposable will be analyzed for radiological contamination and decontaminated, if necessary.
Other:	Radiological surveys will be conducted on all personnel and equipment leaving the work site. Visual surveys shall be performed to determine if decontamination is required to remove mud/dirt from equipment or personnel.

COMMUNICATIONS

A primary and back-up means of communications for field crews shall be established as described.

Type of communication	**Primary means**	**Back-up means**
Communications with corporate office Stoller Office 303-546-4300	Cell phones	Land line phones located at school

Communications among field personnel	Cell phones, voice communications, hand signals or radio	Same as primary
Communications with client CSMRI 303-273-3998	Cell phones, face-to-face	Land line phones (school or office)
Emergencies - 911	Cell phone	Land line phones located at school

MEDICAL SURVEILLANCE AND QUALIFICATION

The following medical surveillance is required for onsite personnel working in the field.

Required medical surveillance:	**Job-specific medical testing:**
☐ Hazardous Waste ☐ Respirator Use ☐ Hearing Conservation ☐ Other:	Describe: NA

HAZARDOUS CHEMICALS

Hazardous chemicals (as defined in 29 CFR 1910.1200) that may be brought on or used onsite are identified below. This chemical inventory will be maintained and Material Safety Data Sheet(s) shall be maintained on the site.

Chemical Name	Amount	Location	Purpose
1. Diesel fuel		• In vehicles	Vehicle/equipment fuel
2. Unleaded gasoline		• In vehicles	Vehicle/equipment fuel
3. Grease, oils, lubricants		• In vehicles	Vehicle/equipment lubrication

REQUIRED FACILITIES AND EQUIPMENT

The following facilities and equipment are required for safe completion of work.

Facility	*Type:*	*Location:*
☐ Worker Showers/Lockers	NA	NA
☒ Restrooms	Public facility Portable facility	Public facility at the school or close proximity. Portable toilet will be on-site only during extended field activities.
☐ Emergency eyewash/shower	NA	NA

☒ First Aid Supplies	Bottles of eyewash solution will be included in first aid kits	Vehicles
☒ Fire Extinguishers	20 lb ABC, 10 lb ABC, as appropriate	Vehicles, Heavy Equipment
☒ Spill Containment/Clean-up	Solid waste spills: shovels, plastic bags, wipes, decon solution. Liquid waste spills: vermiculite or other absorbent, plastic bags, and shovel.	Vehicle
_____ Other:	NA	NA

TRAINING

The following training is required for on-site personnel working in the field. Copies of training certificates and training records will be kept on-site

_____ 40-hour General Site Worker _____ 8-hour Supervisor _____ 3-day On-the-Job _____ 8-hour Refresher _x___ HASP Orientation (for all workers) _x*__ Hazard Communication (HazCom) _x*__ Hearing Conservation _x___ Site Specific Training (applicable THA) _____ Radiation Worker _x___ Visitor Orientation _____ DOT	• Project field personnel shall be trained on the requirements of the health and safety plan, PPE requirements and applicable THAs. • *Hearing conservation training is required for workers exposed to 85 dBA or more (8 hr.TWA). • *HazCom training is required if any hazardous chemicals are used, stored or delivered to the project site. • Visitors shall be informed of the site hazards through an orientation and will be escorted by a trained project employee. • Hazards of uranium and heavy metals are covered in the site-specific training.

EMERGENCY ACTION AND RESPONSE

If an emergency situation develops that requires evacuation of the work area, the following steps shall be implemented.

Evacuation Step	*Methods and comments:*
Notify affected workers	Cell phones, hand signals, or voice communications
Evacuate to safe location	Parking area, immediately offsite
Assemble and account for workers	At parking area at the top of the terrace slope
Notify emergency services *(This step can be performed at the same time as previous steps are occurring)*	Call 911
Complete incident report	Affected worker and/or supervisor

Potential emergency situations and response actions are identified below:

In case of:	***Response actions:***
Fire or personnel injury	Call 911

ATTACHMENTS

Applicable attachments to the task-specific health and safety plan are identified below:

Attachment Number:	***Title:***
1	Site Map
2	Map to Hospital
3	Daily Toolbox Safety Meeting Sign-In Sheet
4	Task Hazard Analysis Forms • THA-1 General Site/Visitor • THA-2 Heavy Equipment Operations • THA-3 Field Sampling

Attachment 1
Project Site Map

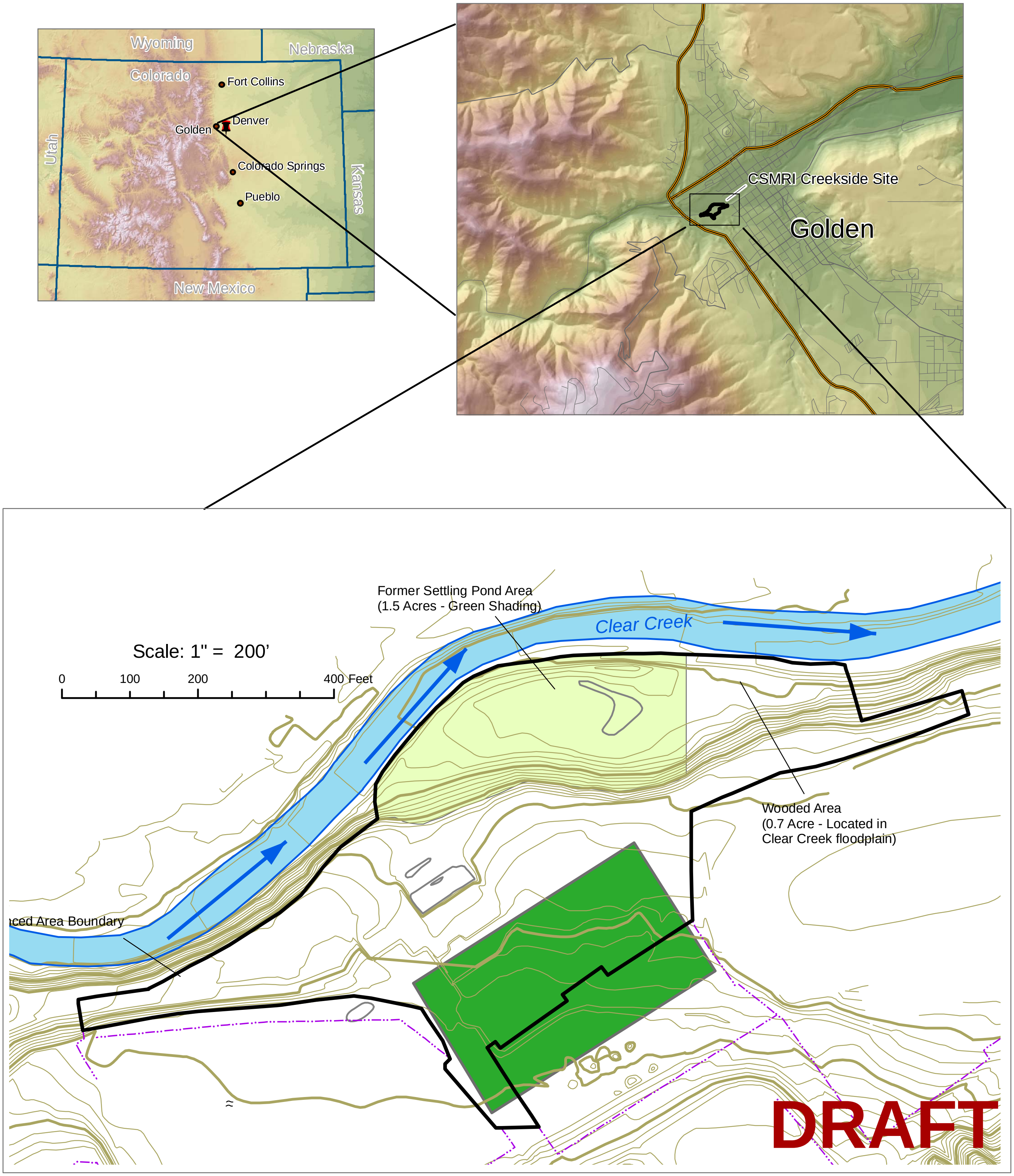


Figure 1-1

CSMRI
Original 2006
Site Location Map

Explanation

	2006 CSMRI Creekside Site Boundary
	Fences
	Topography (1 ft Intervals)
	Topography (5 ft Intervals)
	Former Settling Pond Area
	Aproximate Location of Soccer Field

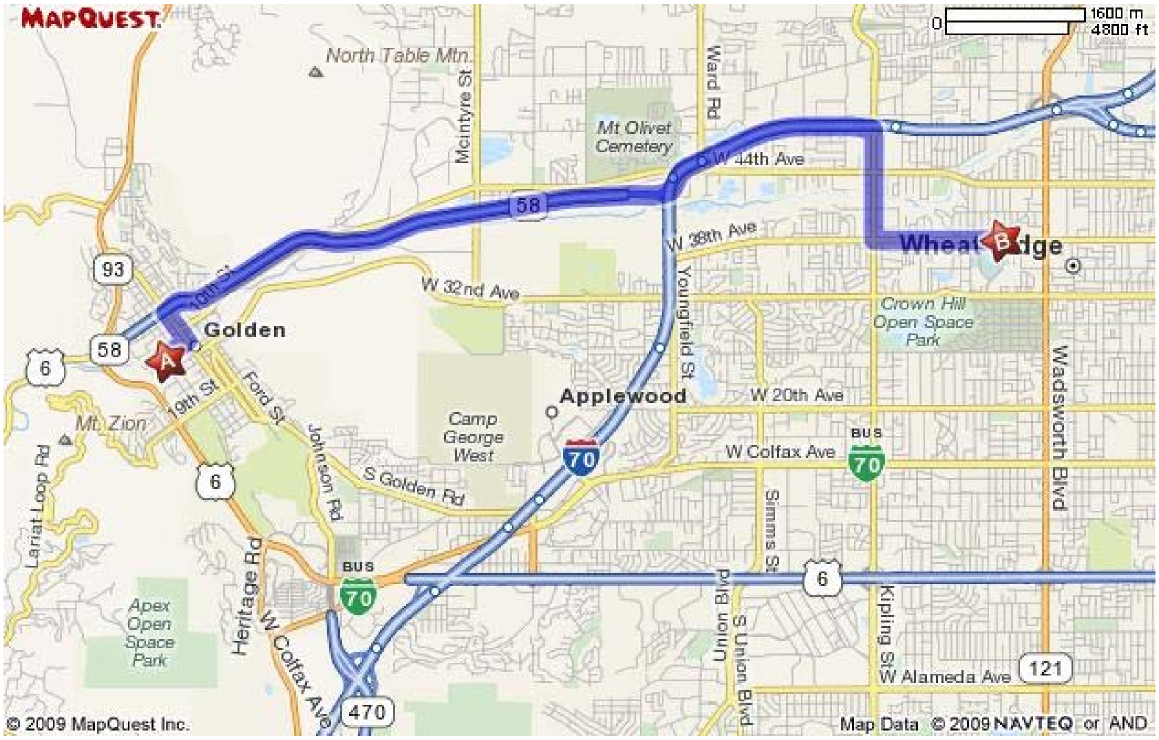
CSMRI
Flood Plain
Site Characterization

Stoller

J:\projects\CSMRI\CSMRI_FldPlnSiteChrter_Figure1_1.mxd

Attachment 2

Route Map from CSMRI to Exempla Lutheran Medical Center



Route to Exempla Lutheran Medical Center
8300 W 38th Ave, Wheat Ridge, CO 80033
(303) 425-2087

Total Travel Estimate : **9.26 miles - about 14 minutes**

1. From 1100 Maple St, Golden, CO, go NORTHEAST on 11TH ST.
2. Turn LEFT onto WASHINGTON AVE.
3. Turn right and merge onto CO-58 E.
4. Merge onto I-70 E via the exit on the LEFT.
5. Merge onto EXIT 267 and turn RIGHT onto Kipling Avenue.
6. Turn LEFT onto 38TH AVE.
7. End at Exempla Lutheran Medical Center, 8300 W. 38TH AVE., Wheat Ridge, CO

Attachment 3
Daily Toolbox Safety Meeting Sign-In Sheet

CSMRI ENVIRONMENTAL FLOOD PLAIN CHARACTERIZATION GOLDEN, CO

DAILY TOOLBOX SAFETY MEETING SIGN-IN SHEET

Date:______________________ Person Conducting Briefing: ______________________________

1. AWARENESS (e.g., special EHS concerns, pollution prevention, recent incidents, etc.):

2. OTHER ISSUES (HASP changes, new THAs, attendee comments, etc.):

3. DISCUSSION OF DAILY ACTIVITIES/TASKS AND SAFETY MEASURES TO BE USED:

NAME	COMPANY	JOB/TASK/POSITION	Signature
1. Steve Brinkman	Stoller	Project Manager	
2. Harry Bolton	Stoller	Project Lead	
3. James Voorhies	Stoller	Health & Safety	
4. Jerry Mattson	Stoller	Radiation Safety	
5. Nick Malczyk	Stoller	Field Sampling Lead	
6. Robert Hill	Stoller	Hydrogeologist	
7. Ralph Rupp	Stoller	Geologist	
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Attachment 4

Task Hazard Analysis (THA) Forms

- THA-1 General Site/Visitor
- THA-2 Heavy Equipment Operations
- THA-3 Field Sampling

<table>
<tr><td rowspan="6">Stoller</td><td rowspan="6">Project & Location:
Colorado School of Mines Research Institute
Golden, CO</td><td rowspan="6">CSMRI THA #1
General Site & Visitor</td><td>THA Prepared By:</td><td rowspan="2">Date:</td></tr>
<tr><td></td></tr>
<tr><td>Peer Review By:</td><td rowspan="2"></td></tr>
<tr><td></td></tr>
<tr><td>Project H&S Manager Approval:</td><td rowspan="2"></td></tr>
<tr><td></td></tr>
</table>

Description of Job:
This THA encompasses activities a general site worker and a visitor would conduct on the site, hazards that may be present and methods to eliminate and/or minimize those hazards.

Minimum Work Clothing:	Full length trousers, sleeved shirt (covers the shoulders), hard toed work shoes, safety glasses.
Additional Work Clothing:	High visibility clothing if heavy vehicles are operating on site. Hard hats required if bump hazards or the potential of falling/flying objects are present. Appropriate hand protection based on the hazard (chemical, heat, cold, mechanical, vibration, etc).

Sequence Of Basic Job Steps	Potential Hazards	Hazard Control/PPE
1. Visitors receive THA orientation and sign visitor log	Loss of site control	Adhere to THA requirements. Escorted by trained project employee.
2. Site workers receive THA orientation and other site specific training	Loss of site control	Adhere to requirements of the H&S Plan and applicable THAs. Use buddy system while on site.
3. Park/walk in designated areas	Loss of site control Slips, trips and falls Potential spread of contaminants	Designated parking locations. Designated walking and work locations.
4. Observing site activities	Struck by vehicle Struck by flying debris	Wear high visibility clothing. Wear hard hat and safety glasses.
5. Contact with contaminated material	Loss of contamination control	No removal of material from site. Walk around standing water. Wear disposable boot covers as directed.

6. Lifting objects	Back strain / musculoskeletal disorder	Use proper lifting techniques at all times, regardless of the weight to be lifted. Do not lift more than 50 lbs without assistance (mechanical or other worker). Use appropriate work rest cycles, especially for repetitive tasks.
7. Ladder Use	Falls	Use appropriate ladder for retrieving elevated materials. Inspect ladders prior to use. Remove from service damaged ladders. Do not exceed ratings for ladders. Use ladders for intended purpose.
8. Electrical equipment use	Electrical shock or electrocution	Only licensed electricians are authorized to perform maintenance on electrical equipment. Extension cords will be inspected before use for any noticeable damage. Cords, plugs and receptacles will not be exposed to weather, unless approved for outdoor use. Do not lift hand tools by electrical cords. Use grounded or double insulated tools. GFCIs will be used on all electrical connections in the field, or where used in or around wet conditions. GFCIs will be installed at or as close to the power source as possible.
9. PPE use	Loss of contamination control Heat/cold stress	Wear PPE as specified by manufacturer. Wear disposable booties and coveralls as directed by H&S. Follow proper doffing techniques for PPE. Dispose of PPE in receptacles provided and as directed. Properly store PPE on site. Decontaminate PPE prior to removal from site. Monitor environmental temperature, humidity and work activities for symptoms of heat or cold stress.
10. Unauthorized entry of personnel on site	Loss of site control	Project management to monitor site activities. Visitors shall sign into the site and shall receive appropriate orientation. Unauthorized persons on site will be asked to leave. Project management will be notified of any persons on site.
11. Emergencies	Fire or explosion Loss of site control Personnel not accounted for	Contact 911. Immediately notify project management of any anomalies or off normal occurrences. If evacuation is announced, meet in designated assembly area. Shelter in the project trailer, if directed. Follow directions provided by Stoller project manager on site.

		Visitors escorted by trained project employee follow directions of escort.
	Medical	Call for medical assistance by dialing 911. Remain on line with the operator and follow their instructions. Render aid, if qualified as an emergency responder with first aid training. Offer comfort to any victim until emergency personnel arrive on the scene.
12. General Labor Tasks	Vehicular and pedestrian traffic	Signs, barricades, flagmen and other traffic control devices will be used, as necessary. All vehicles will have properly operating lights and signals. All vehicles will maintain clear windows when in operation. Personnel shall wear high visibility clothing, when exposed to vehicular traffic.
	Biological Hazards (insects, rodents and animals)	Identify workers with known allergic reactions. Apply mosquito repellent on exposed skin during active mosquito season, as necessary. Avoid contact with animal and insects, including areas of likely habitation. Do not disturb habitation areas. Avoid areas of accumulated animal or bird droppings. Notify project management of unusual, abnormal or otherwise unknown animal activity on the project.
	Biological Hazards (plants, vegetation, foliage)	Identify workers with known allergic reactions. Wear appropriate clothing to cover skin. Wear appropriate PPE to prevent contact with plants and vegetation. Apply creams and/or ointments to minimize any reaction to contact with vegetation. Avoid contact with plants and vegetation that is known to be allergenic, toxic or poisonous to humans.
	Tool use	Use appropriate work rest cycles especially in the case of repetitive tasks and extreme temperatures. Tool selection will be based on the task to be completed. Use the right tool for the job. Use tools according to manufacturer’s instructions. Tools will be inspected prior to use. Tools not in good working order will be discarded or tagged out and/or repaired before use. If unfamiliar with tool use, don’t use until properly trained.
	Hazardous chemical spills	MSDSs reviewed and maintained on-site at project office. Report spills immediately to project management.

		Clean small spills using appropriate equipment, materials and precautions.
	Lightning or thunderstorms	Current and forecasted weather will be discussed in daily toolbox meetings. Weather conditions will be monitored continuously during the work day. Work will be halted, as necessary, when adverse weather or lightning conditions exist or appear to be approaching work area. Work will be halted if lightning is within audible range (within 15 seconds) of the site. Notifications will include any precautions necessary based on the current work being performed. Primary refuge location is in the project trailer. Rubber tired vehicles can act as an alternate refuge location, if necessary.
	High wind conditions	Current and forecasted weather will be discussed in daily toolbox meetings. Wind speeds will be monitored continuously during the work day. Outdoor work will be halted if sustained winds are >30 mph. Wind gusts that are >30 mph will be monitored and notifications given for appropriate actions to take. Notifications will include any precautions necessary based on the current work being performed.
	Slips, trips and falls	Good housekeeping practices will be maintained at all times. Work areas will be visually inspected continuously for signs of poor housekeeping. Avoid muddy/icy areas. Wear boots with aggressive tread or snow/ice cleats, as necessary. Identified slip and trip hazards will be removed or guarded. Exposed trip hazards and slick surfaces will be identified, posted, barricaded or demarcated, as necessary. Appropriate illumination will be maintained in the work areas during work periods (5 foot-candles for general construction, The interior of the office spaces and hallways require 30 foot-candles of general lighting for navigation and general construction purposes). Common walking pathways will be kept free from obstructions. Personnel performing activities exposed to a fall of 6-feet or more shall be protected with a fall protection system.
	Heat stress and sunburn	Drink ample fluids before and during work. Use suntan lotion with adequate protection rating, as necessary. Wear appropriate head covering.

		Monitor environmental temperature, humidity and work activities. Follow work/rest guidelines as recommended by project H&S and based on conditions of the work environment.
	Cold stress	Wear winter clothing, head covering and gloves. Layer clothing to regulate comfort based on workload. Take warm up breaks as recommended by project H&S and based on cold stress guidelines.

Stoller	Project & Location: Colorado School of Mines Research Institute Golden, CO	CSMRI THA #2 Heavy Equipment Operation	THA Prepared By:	Date:
			Project H&S Manager Approval:	

Description of Job:
This THA encompasses activities associated with heavy equipment operation.
Hazards that may be present as a result of these activities and methods to eliminate and/or minimize those hazards is also addressed in this THA.

Minimum Work Clothing:	Full length trousers, sleeved shirt (covers the shoulders), hard toed work shoes, safety glasses.
Additional Work Clothing:	High visibility clothing if heavy vehicles are operating on site. Hard hats required if bump hazards or the potential of falling/flying objects are present. Appropriate hand protection based on the hazard (chemical, heat, cold, mechanical, vibration, etc).

Sequence Of Basic Job Steps	Potential Hazards	Hazard Control/PPE
1. General Labor Tasks	See CSMRI THA#1 General Site and Visitors for general hazards	See CSMRI THA#1 General Site and Visitors Hazard controls.
2. Notifications	Contact with heavy equipment	High visibility clothing shall be worn by all ground personnel. Ground personnel shall get the attention (eye contact) and receive acknowledgement from equipment operators in the area that they are working.
3. Daily Preparation and General Requirements	Equipment malfunction	Heavy equipment shall be acceptable for their intended use. Heavy equipment will be inspected daily prior to use. Use the Equipment's Operation and Maintenance Manual for reference. All defects and damage shall be repaired prior to equipment being placed into operation.
	Cross contamination	All equipment must be surveyed and decontaminated, if necessary, before leaving the site. Dry mechanical methods of decontamination will be used within the area that the contamination occurred.
	Fires	All heavy equipment will be fitted with a 5-lb or 10-lb ABC fire extinguisher with a valid monthly inspection tag. Fire extinguishers will be located so that the equipment operator can easily access them.

		Extinguishers shall be checked as part of the daily equipment inspection.
	Slips, trips and falls	Use three points of contact when climbing onto or off of equipment. Do not climb on or exit heavy equipment while it is in motion. Clean boots and steps prior to climbing onto equipment. Personnel performing activities exposed to a fall of 6-feet or more shall be protected with a fall protection system. All work requiring elevated access shall be conducted using an appropriate ladder or manufacturer's designated step.
4. Loading and unloading of equipment	Heavy equipment hazards	All heavy equipment will be equipped with appropriate roll over protection and back up alarms. Ground personnel shall use eye contact/radio contact as applicable before approaching equipment. Operators shall acknowledge and grant permission for ground personnel to approach.
	Equipment off-loading/loading and placement hazards	Only necessary personnel will be allowed in the immediate area. Ground personnel and operators shall be familiar with appropriate hand signals. All personnel will stay out of the tip + 10 feet zone. Spotters may be used when loading and unloading equipment. Personnel shall not place their head, limbs or body where they can be caught between the equipment and a solid structure. Personnel shall not stand behind the equipment or in an area where they can become entrapped or rolled over. Equipment shall not be off-loaded/loaded near overhead power-lines.
5. Heavy Equipment Operations, Excavations	Heavy equipment hazards	Only trained, qualified and authorized personnel shall operate and/or perform maintenance and repairs on heavy equipment. Operators shall wear seat belts (restraint) when the heavy equipment is in motion. Modifications to driver restraint system and any other safety features are prohibited. Windshields and other glass shall be maintained clean and unbroken. Headlights shall be turned on when the equipment is in operation. To avoid a tip-over, travel straight up or down a slope, do not try to traverse it at an angle. The manufacturer's safety and operations manual will be reviewed and followed by operators. Inspection, operation and maintenance will be performed in accordance with the

		manufacturer's recommendations. A trained spotter shall be used when operators of heavy equipment have limited visibility. Ground personnel and operators will be familiar with appropriate hand signals. At no time will any ground personnel position themselves under hydraulically operated equipment or loads. Personnel shall not be within the boom radius of heavy equipment while it is operating. When collecting samples from the excavator bucket it must be placed on the ground in a de-energized position and the operator must remove their hands from the controls prior to any personnel approaching the equipment. Ground personnel shall not approach heavy equipment from the rear.
	Parking	Equipment shall have an operator present when the engine is running. Equipment with implements may be grounded by placing the implements firmly on the ground. Equipment shall be parked at a zero energy state (i.e. bucket or forks on ground).
	Excavations & trenches	Excavated materials will be placed at least two (2) feet from the edge of excavation. Trenches four feet deep or deeper shall be sloped, shored or benched in accordance with OSHA excavation guidelines. Excavations shall be protected from equipment intrusion or falls by the use of berms, barricades, stop-blocks or other appropriate protective methods. Spotters may be used for equipment backing towards open excavation. Personnel must stay back a safe distance form any open excavation.
	Underground utilities	All excavation areas will be assessed for underground utilities prior to performing any excavation work.
	Overhead obstructions, power lines, guy wires, and other obstacles	Evaluate overhead obstructions and location of all overhead utilities, poles and guy wires before mobilization. Spotters shall be used when moving equipment is operating near overhead obstructions. Obstacles in the field such as drainage pipes, survey markers, guy wires, etc. shall be well marked and visible prior to heavy equipment working in the area. Electrical energy shall be relocated, de-energized or otherwise protected from contact, as necessary.
	High noise levels	Hearing protection is required while working near heavy equipment unless noise surveys indicate hearing protection is not required.

		Noise levels greater than 85dBA (TWA) shall require the use of hearing protection. Hearing protection shall be made available for employee use on the project.
	Spills & Leaks	No amount of leakage on a piece of equipment is considered to be acceptable. Hoses and fittings will be inspected daily for signs of wear and breakage. Items that have been identified as damaged will be replaced immediately. Immediately report all spills regardless of material or size to project H&S staff. Ensure adequate containment for spills. Clean up spills and leaks immediately. Spill control devices (spill kits) will be close and accessible to each work location.
6. Towing and pushing stuck or disabled equipment	Equipment Damage or Physical Injury	Appropriate equipment shall be used to assist (push or tow) stuck or disabled equipment. Communications shall be established between vehicle operators that are being pushed or towed. Vehicles shall only be towed using the appropriate attachment points on the towed and towing equipment. The preferred method is to push stuck or disabled equipment with a bulldozer when the appropriate bumper block attachment is present on the disabled vehicle. A winch may be used for pulling equipment. The winch shall be appropriately hooked to the disabled vehicle at a designated attachment point. Only properly rated straps, chains or slings shall be used for pulling after it has been inspected for defects by a competent person. Ground personnel shall stay clear of equipment that is being pushed or pulled. Ground personnel shall stay clear of straps, chains and slings under tension. Personnel shall not stand in an area where equipment could roll (front or rear) should the towing/pulling operation fail.

Stoller	**Project & Location:** **Colorado School of Mines Research Institute** **Golden, CO**	**CSMRI THA #3** **Field Sampling**	**THA Prepared By:** **Project H&S Manager Approval:**	**Date:**

Description of Job:
This THA encompasses activities associated with field sampling.
Hazards that may be present as a result of these activities and methods to eliminate and/or minimize those hazards is also addressed in this THA.

Minimum Work Clothing:	Full length trousers, sleeved shirt (covers the shoulders), hard toed work shoes, safety glasses.
Additional Work Clothing:	High visibility clothing if heavy vehicles are operating on site. Hard hats required if bump hazards or the potential of falling/flying objects are present. Appropriate hand protection based on the hazard (chemical, heat, cold, mechanical, vibration, etc). PPE as directed by project H&S personnel.

Sequence Of Basic Job Steps	Potential Hazards	Hazard Control/PPE
1. General Labor Tasks	See CSMRI THA#1 General Site and Visitors for general hazards	See CSMRI THA#1 General Site and Visitors Hazard controls.
2. Notifications	Loss of site control	Survey crew shall notify project management of locations of intended work.
	Contact with heavy equipment	High visibility clothing shall be worn by all ground personnel. Survey crew shall get the attention and receive acknowledgement from equipment operators in the area that they are working. Maintain communication with heavy equipment operators. Do not approach equipment from the rear. Maintain line-of-site with the operator.
3. Radiological Instruments	Radiation	Radiological check sources shall be maintained in a locked cabinet when not in use. Only trained and authorized personnel shall handle radiological check sources.
	Equipment Operability	Radiological instruments shall have a valid calibration prior to use on the project.

		Instruments shall be performance checked daily prior to use. Only trained and authorized personnel shall use radiological equipment.
4. Conduct of survey activities	Physical strain	Use proper lifting techniques whenever lifting objects, regardless of weight to be lifted. Do not lift greater than 50 pounds without assistance from another person or use of mechanical aid. Use equipment as specified by the manufacturer.
	Knee Injury	Personnel must be aware of ground conditions prior to kneeling. Personnel may wear knee pads as a precaution to impacts and constant pressure on the knees due to field work.
	Radiological Hazards	Wear appropriate PPE: Gloves. Tyvek coveralls or rain suit and/or boot covers as necessary and directed by H&S. If PPE is worn follow proper doffing techniques. Do not touch face while working. Get monitored after doffing PPE using alpha/beta frisker. Stand upwind of loading operations if windy conditions are present.
	Slips, trips and falls	Care must be taken when walking on uneven terrain and working around excavations. Avoid muddy/icy areas and unstable terrain. Wear boots with aggressive tread or snow/ice cleats, as necessary.
	Biological Hazards (insects, rodents and animals)	Identify workers with known allergic reactions. Apply mosquito repellent on exposed skin during active mosquito season, as necessary. Avoid contact with animal and insects, including areas of likely habitation. Do not disturb habitation areas. Avoid areas of accumulated animal or bird droppings. Notify project management of unusual, abnormal or otherwise unknown animal activity on the project.
	Biological Hazards (plants, vegetation, foliage)	Identify workers with known allergic reactions. Wear appropriate clothing to cover skin. Wear appropriate PPE to prevent contact with plants and vegetation. Apply creams and/or ointments to minimize any reaction from contact with vegetation. Avoid contact with plants and vegetation that is known to be allergenic, toxic or poisonous to humans.
	Heat stress and sunburn	Drink ample fluids before and during work.

		Use lotion/spray with adequate protection rating, as necessary. Wear appropriate head covering. Follow work/rest guidelines as recommended by project H&S and based on conditions of the work environment.
	Cold stress	Wear winter clothing, head covering and gloves. Layer clothing to regulate comfort based on workload. Take warm up breaks as recommended by project H&S and based on cold stress guidelines.