DRAFT FINAL
Field Sampling Plan for the Department of Toxic Substances Control Arsenic Relative Bioavailability Study

Empire Mine State Historic Park
Grass Valley, California

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Prepared by the Department of Toxic Substances Control
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SIGNATURE PAGE

Field Sampling Plan for the Department of Toxic Substances Control Arsenic Relative Bioavailability Study

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1.0 INTRODUCTION

This Field Sampling Plan (FSP) was prepared by the Department of Toxic Substances Control (DTSC) to support sampling activities for the arsenic relative bioavailability study (Study) being conducted by DTSC under an U.S. EPA (EPA) Brownsfield Training, Research and Technical Assistance grant. The FSP is intended to address field screening using X-Ray Florescence (XRF), collection of samples, sieving of soil samples to reduce volume shipped and shipping of samples. This FSP will be used in conjunction with the project Quality Assurance Project Plan (QAPP) and site specific Health and Safety Plan (HASP; Appendix 5). The Empire Mine State Historic Park (EMSHP) has been selected as the first site to investigate for the Study.

1.1 Purpose of the Project

Arsenic is the key chemical of concern at the majority of Brownfields projects at former gold mines in the California Mother Lode and Southern California desert areas. This Study will investigate the relationship between the geochemistry and relative bioavailability of arsenic. DTSC intends to develop better tools for assessment of health effects of arsenic at Mine Scarred Lands (MSL) so that bioavailability of arsenic can be used in risk assessment and risk management decisions at these sites.

Currently, toxicity criteria for estimating health effects of arsenic are based on humans exposed to arsenic dissolved in water. However, arsenic at MSL is bound to soil and rock. To properly describe arsenic risks at MSL DTSC needs to evaluate its site-specific relative bioavailability (RBA), which is defined as the ratio of uptake of soil-bound arsenic to arsenic dissolved in water. The currently available techniques for estimating bioavailability of arsenic are expensive and time consuming. Animal studies (*in vivo* bioavailability) can be conducted for each site, but the costs are prohibitive. DTSC intends to focus on how to predict bioavailability from inexpensive, routine measurements.

Risk assessments commonly assume that RBA of arsenic in soil is 100%. DTSC believes that most naturally occurring arsenic sites have reduced arsenic RBA. The RBA of arsenic in soil can range as high as 98% (Ruby, et al., 1999) but DTSC believes RBA in soils from MSL tend to be lower. Therefore, using the customary default of 100% RBA leads to overestimation of risk and excessive cleanup costs. Consequently, many public and private entities avoid sites with arsenic contamination in favor of undeveloped sites.

1.2 Objectives of the Research

The objective of the Study is to develop an assessment tool that would allow consultants and risk assessors to reliably predict the *in vivo* RBA of arsenic in soil samples from MSL in a scientifically sound, defensible, and cost efficient manner. DTSC intends to produce an arsenic bioavailability guidance document in addition to the assessment tool that will assist in the proper characterization of MSL.

Implementation of this FSP is intended to produce soil and rock samples from the EMSHP that will be used in the RBA research project.

The FSP includes the following:

- A generalized methodology for establishing the type, quantity, and location of samples for screening of arsenic related to historical mining activities at EMSHP.
- A general description of the sampling techniques for soil, including X-Ray Florescence (XRF) measurements, and quantity of samples to be taken.
- A site specific Health and Safety Plan that will be followed by site personnel.

1.3 Project Organization

DTSC will provide overall project management for this project. DTSC has assembled an internal team to implement the project and has supplemented DTSC staff with leading researchers in the fields of arsenic geochemistry and bioavailability. Mr. Perry Myers will ensure that activities are performed adequately to meet project requirements. The researchers on the project will coordinate all activities through Dr. John Christopher and the DTSC Project Manager. Field sampling activities will be supervised by DTSC. Field activities will be conducted in consultation with Dr. Charlie Alpers of the United States Geological Survey (USGS). At the discretion of the California Department of Parks and Recreation (DPR), archeological and biological monitors will be present for all field activities. The project quality control officer will be Mr. Brad Parsons. California Environmental Quality Act (CEQA) activities will be supervised by Ms. Maria Gillette in coordination with the EMSHP. The DTSC team will coordinate all activities between individual researchers and act as the principal referee between researchers on Study related activities. Table 1 lists pertinent information for key individuals involved in the field sampling events.

The DTSC Team Members:

Mr. Randy Adams, P.G., C.E.G. - Principal Investigator responsible for the overall success of the proposed Study

Mr. Perry Myers, P.E., Hazardous Substances Engineer – Project Manager

Dr. Valerie Mitchell, Toxicologist – Coordination with researchers and technical support

Dr. John Christopher, Toxicologist – Technical coordination and support

Mr. Rick Fears, P.G., Engineering Geologist – GIS and field operations support

Ms. Maria Gillette, Hazardous Substances Scientist – California Environmental Quality Act (CEQA) coordination

Ms. Sandy Karinen, Hazardous Substances Scientist – Contract management, reporting and public outreach

Dr. John Quinn, Research Scientist Supervisor I, Environmental Chemistry Laboratory - Responsible for analytical services at the DTSC laboratory in Berkeley

United States Geological Survey:

Charles Alpers, Ph.D., Sacramento, CA and Andrea Foster, Ph.D., Dennis Eberl, Ph.D, Menlo Park, CA. The USGS is experienced in arsenic related studies and has access to and expertise in performing high energy spectral analysis and mineralogy. The USGS will assist with determining specific sample locations and will collect field notes on the properties of the samples. The USGS will analyze samples using bulk X-ray fluorescence, bulk X-ray diffraction, and X-ray diffraction using higher intensity X-rays.

Chapman University:
Dr. Christopher Kim. Dr. Kim will provide expertise in analytical chemistry in support of mineralogy. His efforts will include size fractionation, surface area analysis, speciation and extraction of collected samples. Dr. Kim's work at the Randsburg Complex mining area has furthered the work in multiple extraction techniques to predict RBA.

Ohio State University:
Dr. Nichlolas Basta. Dr. Basta will provide his expertise to implement improvements of the *in vitro* simulated gastro-intestinal assay for determining bioaccessibility of arsenic and routine assays of samples from mine sites in California. Samples will be homogenized and sieved at Ohio State University before shipment to the other Study participants. Dr. Basta will perform *in vitro* bioaccessibility testing on the samples and provide residua of these tests to the USGS for further analysis.

University of Missouri:
Dr. Stan Casteel. Dr. Casteel will provide his expertise to *in vivo* assays for determining bioavailability of arsenic. DTSC will work with Dr. Casteel to perform *in vivo* analysis using immature swine.

California Geological Survey:
Mr. John Clinkenbeard, P.G., C.E.G. and Dr. Ron Churchill, Ph.D. Dr. Churchill and Mr. Clinkenbeard are both in the Geologic Hazards Unit of the California Department of Conservation and have expertise in both arsenic mineralogy and it's occurrence in the State of California. DTSC may utilize their expertise in sample selection and in assisting in creating a mobile RBA determination model.

California Department of Parks and Recreation
Mr. Dan Millsap, P.E. – Project Manager for the remediation project at the EMSHP
Ms. Patti DuMont, Staff Park and Recreation Specialist – CEQA coordination for EMSHP
Mr. Ron Munson, Sierra Gold Superintendent – Contact person for the EMSHP

Table 1. Field Sampling Staff

Title/Responsibility	Name	Email Address	Telephone Number
DTSC Project Manager	Perry Myers	pmyers@dtsc.ca.gov	916-255-3708
DTSC QA Manager	Brad Parsons	bparsons@dtsc.ca.gov	916-255-3661
DTSC Field Staff	Rick Fears	rfears@dtsc.ca.gov	916-255-3802
DTSC Field Staff	Thomas Olson	tolson@dtsc.ca.gov	916-255-3801
DTSC Field Staff	Sam Martinez	Smartin2@dtsc.ca.gov	916-255-6583
USGS Lead	Charles Alpers	cnalpers@usgs.gov	916-278-3134

DPR lead	Dan Millsap	dmillsap@parks.ca.gov	916-698-5994
EMSHP Lead	Ron Munson	rmunson@parks.ca.gov	530-273-3884

2.0 BACKGROUND

2.1 Site Description and Location

DTSC has selected the Empire Mine State Historic Park, located at 10791 East Empire Street, Grass Valley, Nevada County, California, as the first location to investigate for the study. EMSHP is owned and operated by DPR and represents a group of gold mines in the Mother Load mining region of the Sierra Nevada Mountains. A general site location map and a more detailed EMSHP map are attached in Appendix 1. The EMSHP consists of numerous former mining locations and provides elevated concentrations of arsenic within waste rock overburden piles, mineralized ore zones, country rock and mill tailings. EMSHP consists of two large, nearly contiguous areas totaling ~856 acres. The larger area which comprises the primary historic area is located south of Hwy 174 and E Empire St while the smaller area lies to the north of Hwy 174. Mining operations within the present boundaries of the Park began in 1851 and ceased in 1956. During the operating life of the mines arsenic containing waste rock and slurry tailings from milling processes were deposited at locations within the EMSHP site.

2.2 Previous Investigations and Regulatory Involvement at EMSHP

Newmont USA Limited (Newmont) and DPR are conducting a remediation project under the oversight of DTSC and the Central Valley Regional Water Quality Control Board (RWQCB) at the EMSHP. Work to date has mostly been characterization of the potential threats to human health and the environment posed by the former mining operations. Building on the sampling efforts completed by Newmont and DPR, DTSC conducted field sampling using a portable XRF followed by laboratory analysis to identify areas of interest for the Study. Sample locations are depicted on Figure 3 in Appendix 1 and XRF results are listed in Table 2 below:

Table 2: Reconnaissance Sampling Results

SAMPLE	As (ppm)	Fe (ppm)	Feature	Location
E1-1	84	63193	Waste Rock Pile	Country Rock
E1-2	24	60272	Waste Rock Pile	Country Rock
E1-3	24	62002	Waste Rock Pile	Country Rock
E1-4	18	43257	Waste Rock Pile	Country Rock
E1-5	1198	48505	Waste Rock Pile	Josephine Lode
E1-6	661	26254	Waste Rock Pile	Josephine Lode
E1-7	82	52406	Waste Rock Pile	Country Rock
E1-8	647	69927	Waste Rock Pile	Betsy Mine
E1-9	461	54891	Waste Rock Pile	Betsy Mine

E2-10	224	67653	Waste Rock Pile	Sebastopol Mine
E2-11	3209	69028	Waste Rock Pile	Sebastopol Mine
E2-12	4201	54138	Waste Rock Pile	Prescott Hill Mill
E-2-13	225	72641	Waste Rock Pile	Prescott Hill Mine
E2-14	870	40986	Waste Rock Pile	Betsy Mine
E2-15	5046	64459	Waste Rock Pile	Woodbury Mine
E2-16	6084	76794	Waste Rock Pile	Woodbury Mine
E2-17	332	53303	Waste Rock Pile	Conlon Mine
E2-18	3199	78265	Waste Rock Pile	Conlon Mine
E2-19	55	18398	Waste Rock Pile	Sand Dam
E2-20	132	104515	Waste Rock Pile	Empire Mine
E2-21	1277	102256	Waste Rock Pile (Flat)	Empire Mine
E2-22	1196	83432	Waste Rock Pile (Flat)	Empire Mine
E2-23	362	27899	Mill Tailings	Sand Dam
E2-24	160	15336	Mill Tailings	Sand Dam

Notes: Samples 1-10 collected during first reconnaissance April 2, 2009, samples E2-10-E2-24 collected during second reconnaissance April 16 and 17, 2009. Data reported are un-corrected field XRF measurements.

2.3 Geological Information

2.3.1 Topography

The EMSHP's topography is variable, with elevations ranging from 1,900 to 2,900 feet above mean sea level (amsl). This topographic diversity influences vegetation and other biotic resources, and also results in micro-climate variations at the varying elevations. The steep to very steep rolling hills and perennial drainages in the EMSHP are interspersed with more gentle plateaus in a pattern representative of the western foothills of the Sierra Nevada. Piles of mine waste rock and mill tailing substantially affect the topography of those specific areas. The waste rock deposits generally occur as small to large conical mounds of cobble and sand, supporting only sparse vegetative cover.

2.3.2 Climate

The EMSHP is located within a semi-Mediterranean climatic zone typical of the Sierra Nevada foothills. During the summer months, warm dry winds remove moisture from the vegetation and soil surface. Rainfall in the summer is rare and is usually generated from thunderstorms. Winters are generally mild and wet, with the majority of precipitation occurring from November through May. Rainfall averages approximately 53 inches per year and is usually accompanied by a southwest wind. Snowfall averages about 30 inches total per year, but depths rarely reach more than 8 inches at any one time. The annual evapotranspiration rate is about 54 inches per year. The average daily maximum temperature in January is 53°F while the average daily maximum temperature in July is 87°F. The average daily minimum temperature in January is 31°F and the average daily minimum temperature in July is 55°F.

2.3.3 Hydrology

The EMSHP is located within the Wolf Creek Watershed, a tributary to the Bear River. The Bear River flows into the Feather River, which drains into the Sacramento River system. Little Wolf Creek flows from east to west through the central part of the EMSHP, into the Sand Dam Area, and then continues westward to Wolf Creek. Small ephemeral drainages that carry water only during heavy storms are located throughout the EMSHP region.

Natural drainage patterns in the EMSHP have been modified and disrupted by past mining activities, which often involved channeling water into ditches for use in ore processing operations. The Little Wolf Creek drainage was modified during the mining era by the construction of the Sand Dam to prevent discharge of tailings materials. Little Wolf Creek now flows through the Sand Dam marsh area, which was created with the impounded tailing materials upstream of the dam.

Groundwater at the EMSHP occurs within a complex system of fractured bedrock and underground mine workings. Groundwater is present within the Empire Mine shaft at a water elevation of approximately 2,495 feet amsl. Water from a 240-foot-deep vertical well is extracted from the main shaft for use in irrigation and other non-potable water uses within the EMSHP. This well water meets RWQCB water-quality criteria for agricultural use. Shallower perched-water zones likely exist within the EMSHP, but have not been explored. The Nevada Irrigation District (NID) supplies potable water for the EMSHP.

2.3.4 Geology

The EMSHP lies within the foothills of the Sierra Nevada Mountain Range. The western slope of the Sierra Nevada is characterized by north to northwest trending belts of metamorphic rocks, which pre-date the Sierra Nevada granitic rock that underlies the eastern and higher portion of the range. The geology of the metamorphic region is complex due to the juxtaposition of multiple accreted terranes, which are blocks of former ocean floor sediment and volcanic rock that have been added to the western margin of the North America continent over a long period of time. Two fundamental groups of rocks are recognized in the Sierra foothills. The older group of rocks is called the “Bedrock Series” and consists of the older Paleozoic and Mesozoic metamorphic terranes. The younger group of rocks, called the “Superjacent Series,” includes Tertiary gravels and lava flows that were deposited over the older rocks after a period of intense faulting, metamorphism, and granitic intrusion.

The Empire Mine and other mines in the EMSHP are part of the Grass Valley Gold Mining District, which is centered on the City of Grass Valley. The central part of the district is characterized by the Grass Valley pluton, which is an elongated north trending body of Mesozoic granodiorite that intrudes the older metamorphic rocks. The Grass

Valley pluton is cut by various dike rocks that are heavily mineralized. The Grass Valley district was the most heavily mineralized and richest gold district in the state, with a number of productive veins.

3.0 SAMPLING QUALITY OBJECTIVES

The objective of the field sampling is to obtain 30 to 60 samples of mine waste material for the Study. The criteria used to select specific sampling locations will include:

- Presence of soil, rock, tailings or other wastes typical of gold mining in the Mother Lode region of the Sierra Nevada Mountains.
- Elemental concentrations of arsenic and iron and the ratio between them.
- Minerology
- Relative degree of weathering
- Other characteristics that may relate to the geochemistry of the material (pH, color, morphology, etc.)

Visual observations will be made by trained geologists and qualitative measurements of arsenic and iron will be taken using a field portable XRF instrument. The study area includes selected portions of the EMSHP. Preselected locations will be authoritatively sampled for a wide variation in arsenic concentrations and multiple mine features (waste rock, mill tailings, mineralized zone and country rock). Due to cost restraints, a maximum of 30 samples will be analyzed from the first sampling event with an additional maximum 30 selected later for a total maximum of 60 samples. Samples will be collected during fair weather, allowing time for the soil to be suitably dry. The quantity of each sample must be sufficient to ensure that subsequent processing provides 18 lbs (8kg) of <250µm material (passes through a No. 60 mesh sieve).

Sampling decisions will be made by DTSC in consultation with Dr. Charlie Alpers of the USGS. Additional requirements affecting sample locations and how samples are collected are listed in section 4.

3.1 First Field Sampling Event

All soil excavation and soil sampling will be completed under observation of an EMSHP approved archeologist and biologist as required by DPR. It is expected that samples will be collected from trenches using a small back-hoe or rubber tracked excavator and that 30 (3 samples each from 10 locations), approximate 5-gallon container, samples will be collected and field logged by a geologist consistent with ASTM Method D 2488 Standard Practice for Description and Identification of Soil (Visual-Manual Procedure) excluding section 10.6 (HCL Reaction). The samples will then be sieved using a nominal No. 4 Sieve to reduce the volume. If necessary to pass the nominal No. 4 sieve, samples will be air dried in the field. The portion passing the No. 4 Sieve will be sent under chain of custody to Dr. Basta at Ohio State University for additional sieving to produce approximately 18 lbs (8 kg) of <250 µm (No. 60 Sieve) soil. Prior to the additional sieving approximately 7 lbs (3 kg) will be reserved for size fractionation and surface area analysis by Dr. Kim at Chapman University. The <250 µm soil will then be split, according to SOPs (see QAPP), and the quantities listed in Table 3 will be shipped under chain of custody to the other investigators for individual analysis. The remaining sample material will be archived at an appropriate storage area at Ohio State University for the duration of the project. This round of analysis will include *in vitro* analysis, wet chemistry and mineralogical determination using XRF and X-Ray Diffraction (XRD). These results will be analyzed to determine which samples will undergo further analysis and, if necessary, the location and scope of the second round of sampling.

The purpose of the first sampling event is to:

1. Further explore the chemistry of wastes from MSL to identify areas that will fill in a range of arsenic concentrations and mineralogical environments across the EMSHP.
2. Create map of results including photographs.
3. Look for chemical trends within data (Fe/As and other ratios).
4. Locate additional areas to sample for *in vitro* and *in vivo* analysis for the second sampling event should it be deemed necessary.
5. Present findings and determinations to all parties involved in the project.
6. Provide sufficient <250 µm material from each field sample to complete the study should that sample be determined appropriate for *in vivo* bioavailability testing.

All samples will be delivered to the various investigators following approved chain-of-custody procedures. Appropriate quality assurance/quality control (QA/QC) samples will be collected, see Section 5.0, Quality Control/Quality Assurance, for details.

Table 3: Sample Quantities by Investigator

Investigator	**Quantity**
USGS (Eberl)	0.1 kg < 250µm
USGS (Foster)	0.1 kg < 250µm
Chapman University	1.6 kg < 250µm + 3.0 kg of No. 4 sample
Ohio State University	0.3 kg < 250µm
University of Missouri	1.0 kg < 250µm
DTSC	0.1 kg < 250µm

3.2 Second Field Sampling Event

If evaluation of the results from the first sampling event indicates an insufficient number of those samples are candidates for *in vivo* bioavailability testing or that other locations identified within the EMSHP have a higher probability of providing samples for *in vivo* bioavailability testing that would provide more useful information to the Study, a second sampling event will be conducted. The second sampling event will explore five sample locations for *in vivo* and *in vitro* sampling and analysis. All soil excavation and soil sampling will be completed under observation of an EMSHP approved archeologist and biologist as required by DPR. It is expected that these samples will be collected from trenches using a small back-hoe or rubber tracked excavator and that 15 (3 samples from each location), approximate 5-gallon container, samples will be collected and field logged by a geologist consistent with ASTM Method D 2488 the Standard Practice for Description and Identification of Soil (Visual- Manual Procedure) excluding section 10.6 (HCL Reaction). The samples will then be sieved using a nominal No. 4 Sieve to reduce the volume. If necessary to pass the nominal No. 4 sieve, samples will be air dried in the field. The portion passing the No. 4 Sieve will be sent under chain of custody to Dr. Basta at Ohio State University for additional sieving to produce approximately 18 lbs (8 kg) of <250 µm (No. 60 Sieve) soil. Prior to the additional sieving approximately 7 lbs (3 kg) will be reserved for size fractionation and surface area analysis by Dr. Kim at Chapman University. The <250 µm soil will then be split, according to SOPs (see QAPP), and the quantities listed in Table 3 will be shipped under chain of custody to the other investigators for individual analysis. The remaining sample material will be archived at an appropriate storage area at Ohio State University for the duration of the project. This round of analysis will include *in vitro* analysis, wet chemistry and mineralogical determination using XRF and XRD. These results will be analyzed to determine which samples will undergo *in vivo* analysis.

The purpose of the second sampling event is to:
1. Provide a direct link between wet chemistry, *in vitro* analysis and *in vivo* analysis that will assist researchers in assigning relative bioavailability values to soils encountered at the EMSHP.
2. Create a map of results including photographs.
3. Look for chemical trends within data (Fe/As and other ratios).
4. Present findings and determinations to all parties involved in the project.
5. Provide sufficient <250 µm material from each field sample to complete the study should that sample be determined appropriate for *in vivo* bioavailability testing.

3.3 Analytical Methods and Reporting Limits

Analytical methods and reporting limits for the analyses performed by the various investigators are listed in the QAPP. Analysis in the field using a portable XRF instrument will be performed in accordance with the SOP in Appendix 3, Standard Operation Procedures for XRF Measurements.

4.0 SAMPLING DESIGN and FIELD PROCEDURES

4.1 Conceptual Site Model

Data from previous environmental site investigation work indicates that arsenic was associated with gold that was mined from the EMSHP and is still present in the ranges appropriate for assessing bioavailability (100 ppm to greater than 10,000 ppm). The primary sources of arsenic at the EMSHP are overburden waste rock piles associated with a particular mine and waste rock dumps from the crushing/processing of ore and tailings from the milling process associated with a particular mill. Secondary sources of arsenic are soils that have been transported via surface water runoff or fugitive dust deposited some distance from the primary source. After being placed on the land, the mine wastes have undergone various forms of weathering. For example a waste rock pile would be exposed to the atmosphere, freeze thaw processes and precipitation as compared to the same material that was not mined. Humans are typically exposed to the solid form of arsenic via direct contact with soil or inhalation and incidental ingestion of fugitive dust. Soil that is less than 250 µm will adhere to the skin and is respirable. The majority of locations with arsenic containing materials are represented by waste rock piles. In most locations waste rock piles appear to represent the area immediately adjacent to commercially viable ore rock within individual mines. If sampled and processed to provide sufficient quantities of <250 µm soil, wastes found at the EMSHP appear to be adequate for purposes of this study.

4.2 Sample Locations and Medium

Because the objective of the Study is to develop an assessment tool that will allow consultants and risk assessors to reliably predict the *in vivo* relative bioavailability of arsenic in soil samples from MSL only soil and rock samples will be collected. Based on the reconnaissance sample results listed in Table 1, DTSC will initially target 24 general sampling locations for the first sampling event with the intent to sample ten of those locations. XRF measurements were taken at the 24 locations in an effort to locate arsenic concentrations ranging from 100 ppm to 10,000 ppm. Specific sampling locations are subject to change based on a number of factors including but not limited to restrictions by DPR, inconsistencies with arsenic concentrations as detected by field XRF and/or the identification of more suitable sampling locations. The general areas are depicted in Figure 3 and include; the Betsy Mine, Conlon Mine, Empire Mine waste dump, Pennsylvania Mine, Prescott Hill Mine, Sebastopol Mine, Sand Dam area, Woodbury Mine, Power Line Trail (several areas along this trail segment) and Stacy Lane Pond. Specific sampling locations in the identified general areas will be selected in the field in consultation with USGS and DPR to meet the needs of the Study and minimize impacts to cultural and biological resources. Sample location selection will take into account the need to restore the topography of each location to its original profile to preserve the cultural resource. Locations will be trenched, if possible, and samples taken along the exposed vertical profile. The trench depth will be approximately four feet or encountered bedrock. Specific sample locations are dependent on the physical characteristics of each general location (e.g., presence of waste rock and tailings, access for equipment). XRF measurements will be taken near the surface (after any duff is removed) and the parameters listed in section 3.0 will be used to evaluate potential specific sampling locations. It is anticipated that a maximum of three depth discrete samples will be taken at each specific sample location if the soil characteristics change with depth. Combined with the number of sample locations this will yield an expected 30 individual soil samples for the first sampling event and 15 individual soil samples for the second sampling event. The soil samples will be approximately 5 gallons in volume, yielding an expected maximum volume of 15 gallons per sampling location. The maximum number of soil samples will not exceed 60 and the maximum volume removed from the EMSHP is expected to be slightly over five 55 gallon drums in total. Sampling will commence after completion of a satisfactory CEQA review and access permission is granted by the DPR.

4.3 Soil Sampling

Field work will require a minimum of two DTSC employees and up to two sub-contractors that may include the USGS and Holdrege and Kull or the DTSC designated contractor. Soil sampling will be implemented using an excavator and or hand tools from layers identified during excavation to a maximum depth of four feet below ground surface. Backhoe or small track excavator work will be completed by a DTSC designated contractor. Field work will be divided into two separate events. All soil excavation and soil sampling will be completed under observation of a DPR approved archeologist and/or biologist as required by DPR. Each sampling event is expected to last 3-5 days and will be conducted during daylight hours Monday through Friday. A primary staging location for equipment will be established in consultation with DPR. Each sampling location will have a secondary staging location that is expected to encompass a few hundred square feet. The total area used for staging and excavation is expected to be less than 10,000 square feet. Large equipment will be limited to that necessary to complete sampling activities and is expected to include: a small rubber tracked excavator towing a trailer with a water tank, two “gator” vehicles to transport equipment and personnel and a standard pickup truck to transport samples. During sample collection the excavator will deposit soil from the area of interest onto a stacked set of screens to collect the fraction that is less than ¾” in size. Water will be employed, as needed, to reduce dust in the area but will not be sprayed on the separation screens. Sieving from the ¾” fraction through a nominal No. 4 sieve (4 openings/inch) will be done by hand employing dust control methods described in the HASP (Appendix 5). The HASP includes dust action levels and air monitoring for the protection of sampling personnel that are also protective of the public. All excess material removed during sampling will be replaced back in the excavation and efforts will be made to re-contour to the original profile. Additional sampling requirements are described in section 4.6.

4.4 Sample Numbering System

Laboratory samples will be identified by the following identification system:

- The first two capital letters will identify the Site (e.g., EM- Empire Mine).
- The first two digits will identify the sample number (e.g., 01).
- The last digit will identify the depth of the sample in feet (e.g., 1-1 foot).

The following is an example for sample number EM-01-4. Empire Mine, sample 01, taken at a depth of 4 feet bgs.

XRF measurements will have the same numbering system except that XRF measurement numbering will be preceded by X. The following is an example of an XRF measurement for sample number X-EM-01-4. XRF measurement, Empire Mine, sample 01, taken at a depth of 4 feet bgs.

Sample identification will be assigned in the field as each sample is collected.

4.5 Sample Documentation, Containers and Shipment

Samples will be field logged by a geologist consistent with ASTM Method D 2488 the Standard Practice for Description and Identification of Soil (Visual Manual-Procedure), excluding section 10.6 (HCL Reaction). GPS coordinates will be recorded and photographs will be taken, as needed, for each specific sample location. Sample information will be written on the outside of the container. Sample information will include at a minimum: date, location, sample ID number, project name and who collected the sample.

Soil samples from the first and second sampling events will be collected in sealable 5 gallon plastic containers. Metals concentrations in the samples are considered stable and will not require any preservation.

Sample container lids will be secured with packaging tape to prevent spillage during shipping. Containers from the field sampling events will be shipped under chain of custody to Ohio State University for further processing consistent with SOP 1 (Bulk Soil Processing for Laboratory Studies). Once final processing is completed by Ohio State University, samples will be shipped to investigators under chain of custody according to the information in Table 3 in appropriate containers and packaged to prevent spillage.

4.6 Standard Project Requirements

Table 5 is a partial summary of standard and specific project requirements developed for the EMSHP remediation project by DPR in conjunction with Newmont, DTSC and the RWQCB. Project requirements that are not applicable to the Study were not included in the table but the original numbering system was maintained to prevent confusion. To comply with project requirement Hazmat-4 DTSC will follow DPR's Fire Safety Plan for the EMSHP. DTSC will obtain appropriate and required permits prior to start of construction activities.

Table 5:
SUMMARY OF STANDARD AND SPECIFIC PROJECT REQUIREMENTS FOR THE EMSHP

Project Requirements	Action
AESTHETICS	
Specific Project Requirement AES-2: Storage of Materials in the Viewshed of State Route 174.	• All materials required for interim and/or remediation actions will be stored outside of the viewshed of State Route 174.
AIR QUALITY	
Standard Project Requirement AIR-1: Dust and Ozone Reduction	• During dry, dusty conditions, all active construction areas will be lightly sprayed at least twice daily to reduce dust without causing runoff. • All trucks or light equipment hauling soil, sand, or other loose materials on public roads will be covered or required to maintain at least two feet of freeboard. • All gasoline-powered equipment will be maintained according to manufacturer's specifications, and in compliance with all state and federal requirements. • Paved streets adjacent to the Park shall either be swept or washed at the end of each day, or as required, to remove excessive accumulations of silt and/or mud which could have resulted from remediation construction activities. • Excavation and grading activities will be suspended when sustained winds exceed 15 miles per hour (mph), instantaneous gusts exceed 25 mph, or when dust occurs from remediation related activities where visible emissions (dust) cannot be controlled by watering or conventional dust abatement controls.
BIOLOGICAL RESOURCES	
Specific Project Requirement BIO-1: Humboldt Lily	• Excavated soils will not be side-cast along the side of trails or into the surrounding habitat at any work location in order to minimize impacts to the Humboldt Lily.
Standard Project Requirement BIO-2: True's Manzanita Avoidance	• Prior to the start of Program Actions, and under the direction of a DPR-qualified biologist, the Project Proponent will flag and/or fence all True's Manzanita for avoidance within the Remediation Area; fencing will be removed after remediation has been completed.
Standard Project Requirement BIO-4: Nesting Bird Species	• All outside Project Actions with the potential to affect nesting birds (as determined by a DPR-qualified biologist) will occur during the non-breeding season (September 1 – February 29). • If Project Actions are required during the California Spotted Owl breeding season (March 1 - August 31), protocol-level surveys to determine nesting status will be required. If the owl pair is determined to be non-breeding, Program Actions will be permitted. If the owl pair is determined to be breeding, no Project Actions with the potential to create noise disturbance will be allowed within 1,000 feet of the active nest until after the young have fledged and have the ability to fly out of the area of disturbance, as determined by a DPR-qualified biologist. If the 1,000 foot buffer is not feasible, the

Project Requirements	Action
	Project Proponent will consult with the USFWS and DFG, as appropriate. • If Project Actions that could potentially cause take of other nesting bird species (as determined by a DPR-qualified biologist) are necessary during the breeding season (March 1 - August 31), pre-construction surveys will be required. If nesting sensitive birds, raptors, and/or migratory birds are found at the Park, a buffer area of 1,000 feet, 250 feet or 100 feet, respectively, will be established around the nest(s); no Project Actions that could potentially cause nest failure will be permitted until the nest is vacated and the juveniles have fledged, as determined by a DPR-qualified biologist. • At the discretion of a DPR-qualified biologist, Project Actions will be monitored to ensure that impacts to nesting sensitive birds, raptors, and/or migratory birds are minimized.
Standard Project Requirement BIO-7: Minimize Area Necessary for Project Actions	• Prior to implementation of Program Actions, the Project Proponent will determine the minimum area necessary for Program Actions, including staging and access, and place orange construction fencing or flagging around the boundaries of the proposed work area. Existing disturbed areas will be utilized to the extent possible. Unless prior approval is obtained from DPR, remediation actions will remain within the designated work area(s).to minimize habitat disturbance.
Standard Project Requirement BIO-8 Avoidance or Minimization of Impacts to Federally Protected Wetlands	• The Project Proponent and/or Construction Contractor will avoid or minimize impacts to federally protected wetlands to the extent practicable by conducting work in upland areas whenever feasible.
CULTURAL RESOURCES	
Standard Project Requirement CULT-1: Cultural Resources Recordation and Mapping	• Prior to the start of Project Actions and to the extent not already completed, a DPR-qualified cultural resources specialist will map and record all historic features within the proposed Remediation Area to a level appropriate to Secretary of Interior Standards.
Standard Project Requirement CULT-3: Cultural Resource Avoidance	• Prior to the start of Program Actions, and at the discretion of a DPR-qualified cultural resources specialist, the Project Proponent will flag and/or fence all cultural resources within 15 feet of Program Actions for avoidance within the Remediation Area; fencing will be removed after remediation has been completed. • At the discretion of a DPR-qualified cultural resources specialist, all Program Actions could be monitored. The Project Proponent and/or Construction Contractor will notify the Northern Service Center Cultural Resource Section a minimum of three weeks prior to the start of Program Actions to schedule monitoring, unless other arrangements are made in advance. • If intact cultural features are uncovered during Program Actions, the DPR-qualified cultural resources specialist will record and evaluate the find and implement avoidance, preservation, or recovery measures, if feasible. • If avoidance is required, the Project Proponent will modify Program Actions to avoid the cultural resources. The proposed modified Program Actions will be implemented upon review and approval of a DPR-qualified cultural resources specialist and DTSC and/or RWQCB.
Standard Project Requirement CULT-4:	• In the event that the DPR-qualified cultural resources specialist at the Park determines that

Project Requirements	Action
Previously Undocumented Resources	potentially significant, previously undocumented/unflagged cultural resources (including but not limited to dark soil containing shellfish, bone, flaked stone, groundstone, or deposits of historic material) are encountered during Program Actions, all work in that location will be temporarily halted and diverted to another location, until DPR's State Representative is contacted; a DPR-qualified cultural resource specialist will record and evaluate the find and work with the Project Proponent and/or Construction Contractor to implement avoidance, preservation, or recovery measures, as appropriate, prior to any work resuming at that specific location. • In the event that previously undocumented cultural resources are encountered during Project implementation and a DPR-qualified cultural resources specialist is not on-site, the DPR State Representative will be contacted immediately and work within the immediate vicinity of the find will be temporarily halted or diverted until a DPR-qualified cultural resources specialist evaluates the find and determines the appropriate treatment and disposition of the cultural resource. • Prior to the start of Program Actions, a DPR-qualified cultural resources specialist will prepare a 'Construction Monitoring and Unanticipated Discovery Response Plan' (CMUDRP) to be implemented if an unanticipated discovery is made. Elements of the CMUDRP will include: – Implementation of worker and supervisor response procedures to be followed in the event of an unanticipated discovery, including appropriate points of contact for professionals qualified to make decisions regarding the potential significance of any find; – Identification of, and on-call contact information for, persons authorized to stop or redirect work that could affect the discovery; – Provisions for monitoring of Project Actions in resource-sensitive areas; – Stipulations of a minimum radius around any discovery within which construction work will be halted until the significance of the resource has been evaluated and implementation of avoidance, preservation, or recovery measures, as appropriate; and – Consultation procedures for contacting identified Native Americans, as appropriate.
Standard Project Requirement CULT-5: Human Remains	• In the event that human remains are discovered during Program Actions, all work at that location will be temporarily halted and diverted to another location. Any human remains and/or funerary objects will be left in place. The Project Proponent and/or Construction Contractor will immediately contact the DPR State's Representative who will then contact the DPR Sector Superintendent. The DPR Sector Superintendent (or authorized representative) will notify the County Coroner, in accordance with §7050.5 of the California Health and Safety Code, and the Native American Heritage Commission (NAHC) will be notified within 24 hours of the discovery if the Coroner determines that the remains are Native American. The NAHC will designate the "Most Likely Descendent" (MLD) of the deceased Native American. The MLD will recommend an appropriate disposition of the remains. If a Native American monitor is at the Park at the time of the discovery, and that person has been designated the MLD by the NAHC, the monitor will make the recommendation of the appropriate

Project Requirements	Action
	disposition. Work will not resume in the area of the find until proper disposition is complete (PRC §5097.98). No human remains or funerary objects will be cleaned, photographed, analyzed, or removed from the site prior to determination. If it is determined the find indicates a sacred or religious site, the site will be avoided to the maximum extent practicable. .
Standard Project Requirement CULT-6: Secretary of the Interior's Standards	• The Project Proponent and/or Construction Contractor will conduct all Program Actions in a manner consistent with the Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings (1995).
Specific Project Requirement GEO-2: Subsidence Evaluations of Shallow Mine Workings	• As part of Project design and prior to ground disturbing activities with heavy equipment, DPR will inspect and evaluate the ground surface over known shallow mine workings to assess the potential ground subsidence hazard associated with underground collapse of the workings.
HAZARDS AND HAZARDOUS MATERIALS	
Specific Project Requirement HAZMAT-1: Transport of Hazardous Materials	• Materials, that are removed during Program Actions and exceed clean-up goals, will either be deposited in the Park consistent with Remediation Option Placement of Removed Soils or Materials within the Park, which provides on-site management of materials, or removed and transported to a licensed disposal facility in accordance with applicable federal, state, and local regulations. • Prior to the start of Program Actions, the Project Proponent and/or Construction Contractor will prepare and submit a Materials Management Plan will avoid or minimize risks to be developed to include protocols and procedures that will protect human health and the environment from the potential exposure to metals and dust during remediation and/or maintenance activities that cause disturbances to the native soil and/or mine and mill materials. The protocols and procedures that will be implemented will meet the specific applicable requirements of California Regional Water Quality Control Board (RWQCB) and Department of Toxics Substance Control (DTSC). Components of the Materials Management Plan will be developed to avoid or minimize human health and environmental risks from the potential exposure to metals and dust resulting from materials disturbances. All work will be performed in accordance with a Site Health and Safety Plan. The Materials Management Plan will include, but not be limited to the following (where applicable). - Requirement for staff to have appropriate training in compliance with 29 CFR, Section 1910.120 - Methods to assess risks prior to starting work; – Procedures for the management and disposal of waste soils generated during construction activities or other activities that might disturb contaminated soil; – Monitoring requirements; – Storm water controls; – Record keeping; and, Emergency response plan

Project Requirements	Action
Standard Project Requirement HAZMAT-2: Suspension of Work	• All Project Actions will be suspended during heavy precipitation events (at least ½ inch of precipitation in a 24-hour period) or when heavy precipitation events are forecasted.
Standard Project Requirement HAZMAT-3: Decontamination of Project Vehicles and Equipment	• The Project Proponent and/or the Construction Contractor will set up decontamination areas for vehicles and equipment at Park entry/exit points and maintain the existing decontamination wash facility located in the Maintenance Yard. The decontamination areas will be designed to completely contain all wash water generated from washing vehicles and equipment. The Project Proponent and/or Construction Contractor will install BMPs, as necessary, to prevent the dispersal of wash water beyond the boundaries of the decontamination area, including over-spray.
Standard Project Requirement HAZMAT-4: Wildfire Avoidance and Response	• Prior to the start of Program Actions, the Project Proponent and/or Construction Contractor will develop a Fire Safety Plan and submit to the DPR Sector Superintendant for approval. • Spark arrestors or turbo-charging (which eliminates sparks in exhaust) and fire extinguishers will be required for all heavy equipment. • Construction crews will be required to park vehicles away from flammable or combustible materials, such as fuels, dry grass or brush. At the end of each workday, heavy equipment will be parked over a non-combustible surface to reduce the chance of fire. • DPR personnel will have a State Park radio at the Park, which allows direct contact with CalFire and a centralized dispatch center, to facilitate the rapid dispatch of control crews and equipment in case of a fire. • In the event that conditions at the Remediation Area are dry, a filled water truck will be at the Park for all Project Actions involving equipment with the potential to start a fire.
NOISE	
Standard Project Requirement NOISE-1: Noise Exposure	• Project Actions will be limited to the daylight hours, Monday through Friday. However, weekend work could be implemented to accelerate construction or address emergency or unforeseen circumstances. If weekend work is necessary, no work will occur on those days before 8:00 a.m. or after 6:00 p.m. • Internal combustion engines used for the implementation of Program Actions will be equipped with a muffler of a type recommended by the manufacturer. Equipment and trucks used for Project-related activities will utilize the best available noise control techniques (e.g., engine enclosures, acoustically attenuating shields or shrouds, intake silencers, ducts, etc.) whenever feasible and necessary. • Stationary noise sources and staging areas will be located as far from potential sensitive noise receptors, as possible. If they must be located near potential sensitive noise receptors, stationary noise sources will be muffled or shielded to the extent feasible, and/or where practicable, enclosed within temporary sheds.
TRANSPORTATION / TRAFFIC	
Specific Project Requirement TRAFFIC-1:	• Prior to delivery and/or removal of Project-related equipment or materials that could impede or block access to driveways, cross streets, or street parking, DPR will coordinate with the local jurisdictions

Project Requirements	Action
Traffic Control	to develop and implement traffic control measures.
Specific Project Requirement TRAFFIC-2: Overflow Parking in the Red Dirt Pile	• The main parking lot will be reserved for Park visitors; all Program Action-related vehicles will use the overflow parking lot on the Red Dirt Pile, if feasible.

4.7 Sampling Equipment /Decontamination Procedures

Sampling equipment will be the type typically used in accordance with the soil or aggregate being sampled. Samples will be collected by excavator and/or hand equipment.

All field equipment shall be decontaminated before being brought onsite to prevent introducing invasive plant species and other potential contaminants from other sites. Equipment that comes into contact with potentially contaminated material will be decontaminated consistently to assure the quality of samples collected. Disposable sampling devices (plastic hand trowel) or metal sampling devices (hand trowel) which are reused will be rinsed with potable water after each use and at the end of each day. Shovels will be decontaminated by removing loose soil and rinsing with potable water before the start of sampling activities and after each sample is collected. Loose soil and aggregate will be removed from the excavator bucket and arm before leaving a specific sampling location to prevent cross contamination. The bucket and arm may be rinsed with potable water if necessary. The excavator will be more fully decontaminated before it leaves the site. Decontamination activities will be carried out in compliance with project requirement Hazmat-3.

4.8 Preparatory Activities

Field sampling activities are planned over a period of several weeks (Appendix 6, Schedule). Prior to each Site visit, the agencies, investigators and respective contractors will coordinate by telephone and\or e-mail to ensure that project needs are met. The following checklist will be referred to during preparatory activities for field activities. Additional equipment needed for XRF measurements are given in Appendix 4.

- First Aid Kit
- Drinking Water
- Cell phone
- This field sampling plan, including health and safety plan
- Sampling equipment for soil
- Sampling containers, labels, laboratory analysis forms and chain of custody forms
- Potable water for decontamination of field sampling equipment and dust suppression
- XRF Instrument
- GPS instrument
- Dust meter
- EMSHP coordination/notification
- Mobilization

4.9 Field Documentation

Field logbooks will document where, when, how, and from whom any vital project information was obtained. Logbook entries will be complete and accurate enough to permit reconstruction of field activities. Logbooks will be bound with consecutively numbered pages. All entries will be legible, written in ink, and signed by the individual making the entries. Language will be factual, objective, and free of personal opinions or other terminology, which might prove inappropriate. If an error is made, corrections will be made by crossing a line through the error and entering the correct information. Corrections will be dated and initialed. No entries will be obliterated or rendered unreadable.

Entries in the field logbook will include at a minimum the following for each day:

- Site name
- Recorder's name
- Team members and their responsibilities
- Time of site arrival/entry on site and time of site departure
- Other personnel on site
- Weather conditions including air temperature, precipitation, or high wind conditions
- A summary of any on-site meetings
- Deviations from sampling plans, or site safety plans
- Levels of safety protection
- Calibration readings for any equipment used

At a minimum, the following information will be recorded during the collection of each sample:

- Sample identification number
- Sample location, description and note that global positioning satellite (GPS) information was documented
- Site sketch showing sample location
- Sampler name(s)
- Date and time of sample collection
- Type of sample (i.e., matrix)
- Field observations and details important to analysis or integrity of samples (e.g., heavy rains, odors, colors)
- Instrument readings (e.g., dust monitor)
- Shipping arrangements
- Recipient laboratory(ies)

Photographs will be taken as needed during sampling activities. They will serve to verify information entered in the field logbook. When a photograph is taken, the following information will be written in the logbook or will be recorded in a separate field photography log:

- Time, date, location, and, if appropriate, weather conditions
- Description of the subject photographed, including sample identification number (if appropriate)
- Point-of-view orientation of the photo (e.g., to the west; to the east-southeast)

Copies of field data sheets for sample collection and photographs are included in Appendix 7.

5.0 QUALITY ASSURANCE/QUALITY CONTROL

The specific sampling locations will be preselected based on authoritative means (observable characteristics) and previous analyses. During the sampling events visual observations will confirm that sample lots are obtained from the same source material.

The XRF analyzer will be operated in accordance with the manufacturer operator instructions and the SOP in Appendix 3. XRF data will be downloaded, formatted, validated and made part of the record. Raw electronic data will be downloaded intact and archived until the end of the Study, but for not less than two years. The XRF will be used in a survey mode to primarily verify that the relative concentrations of arsenic and iron are within the ranges of interest and are consistent with previously determined measurements. Samples will be measured using modified in-situ techniques (minor sieving into a bag, homogenizing and measuring, or sieving back onto the soil, compacting and measuring, etc.). Quality control will be limited to instrument calibration and measurements of a blank and a known standard at the start and end of sample measurements. Results should be within 20% of the known standard concentrations. Split samples will not be sent for laboratory analysis. The SOP in Appendix 3 describes the model XLT 793. An upgraded model XL3t 500S will be used that is more capable but has the same type of interface as described in the SOP. The newer model also has a mining mode of operation based on fundamental parameters. The mining mode may or may not be used in addition to the soils mode, depending on field circumstances and the desire for more accurate iron concentrations.

To verify decontamination procedures are effective, rinseate blanks will be collected at a minimum frequency of one per day in one liter glass or plastic containers preserved with nitric acid to a pH of less than or equal to 2 (minimum 5 ml/L nitric acid). Samples will be wrapped in bubble wrap to prevent breakage, placed in a cooler on ice and shipped under chain of custody to the DTSC Environmental Chemistry Lab in Berkeley for analysis by Total Recoverable Metals by SW 3005/6010. A sample of the potable water used for decontamination will be analyzed in the same manner.

Since field samples will be processed at Ohio State University to produce actual samples for analysis by the investigators, duplicate soil samples will not be collected in the field. Instead, increased volumes of material will be collected for at least one of every 10 soil samples so that an additional 7 lbs of <250µm material is produced and run through all analyses as duplicates. Specific sample locations where increased volumes are collected will be determined in the field based on the total number of samples taken for the sampling event and the desire to vary the arsenic and iron concentrations of the duplicate samples.

6.0 HEALTH and SAFETY

All staff involved with field sampling activities will follow the Heath and Safety Plan and Hazard Appraisal and Recognition Plan (HARP) Pre Site Visit Form (Appendix 5). Respective agency and contract staff will be responsible for ensuring their field staff has appropriate and current health and safety training for performing the activities described in this FSP. Staff will not enter tanks, shafts, adits, or pits to conduct sampling activities. In addition to the Health and Safety Plan, participants in Study activities at the EMSHP will comply with the conditions set forth in the Right of Entry Permit approved by DPR.

7.0 ASSIGNMENTS

The following is a description of roles and responsibilities, by entity, that are related to this FSP.

DTSC:

- Provide a minimum of two staff to participate in all field sampling activities
- Coordinate with EMSHP staff in the location of all soil samples and record all sample locations by longitude and latitude and elevation using GPS technology.
- Field logging and recording sample information.
- DTSC staff will be the site safety officer. All agency staff and their contractors have responsibility for ensuring their respective staff has current appropriate health and safety training. All field staff will comply with the Health and Safety Plan.

DTSC's contractor or Holdredge and Kull:

- Provide a minimum of one staff and a tracked excavator to participate in field sampling activities.

USGS:

- Assist with selecting sample locations for sampling events.
- Field logging and recording sample information.
- Analysis of samples at USGS facilities in Colorado and California per the QAPP.

Ohio State University:

- Process samples as described in sections 3.1 and 3.2.

DPR:

- Provide appropriate staff to assist in selecting specific sample locations to minimize/eliminate impacts to cultural or biological resources.
- Provide small equipment and facilities, when possible, to assist the Study and reduce impacts to the EMSHP.

8.0 REFERENCES

Ruby, M.V et al. Advances in evaluating the oral bioavailability of inorganics in soil for use in human health risk assessment. 1999. Environ. Sci. Technol. 33: 3697-3705.