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September 23, 2014

Mr. Mark Ripperda
U.S. Environmental Protection Agency, Mail Code SFD-6-2
75 Hawthorne St.
San Francisco, CA 94105

Re: Ruby Mines Site
U.S. EPA Region 9, CERCLA Docket No. 2013-07
Response to USEPA Comments, Phase 3 Work Plan

Dear Mr. Ripperda:

On July 30, 2014, the United States Environmental Protection Agency (USEPA) provided an email with comments on the Phase 2 Report for the above referenced site. For ease of presentation and review, each USEPA comment is restated in italics followed by a Western Nuclear, Inc. (WNI) response. In addition, I am submitting the revised Phase 2 which includes text changes and additional information requested by USEPA.

On September 10, 2014, the United States Environmental Protection Agency (USEPA) provided an email with comments on the Phase 3 Work Plan for the above referenced site. For ease of presentation and review, each USEPA comment is restated in italics followed by a Western Nuclear, Inc. (WNI's) response. In addition, I am submitting the revised Phase 3 Work Plan which includes text changes.

*Comment #1: Section 2.5: The fourth from the last MDCR equation should be 853/760 instead of 853*760.*

WNI Response: This was a typographical error in the text that has been revised. The calculated MDC value used presented in the Phase 3 work Plan is correct.

Comment #2: Section 2.5: The concluding paragraph of this section doesn't directly compare the calculated MDC to the 50% of the investigation level. The calculated MDC is 1.6 pCi/g while 50% of the investigation level is 1.34 pCi/g. This is close, and good enough for the continuous scans, but please add a sentence providing the calculated MDC for a 60 second static count. This will meet the required 50% level. You don't have to go through all the equations again, simply provide the answer.

WNI Response: A sentence has been added to Section 2.5 of the revised Phase 3 Work Plan providing the calculated MDC of 0.2 pCi/g for a 60-second static count time.

Comment #3: Section 2.7: Please sample the two waste rock piles at 5 foot intervals in the waste. This may help in determining locations and quantity of principal threat waste if that is necessary in the final action, and it may also aid in design of any final action to know distributions of lower and higher contamination levels.

WNI Response: WNI will sample waste rock piles at 5 foot intervals, the text of the revised Phase 3 Work Plan has been revised accordingly.

Comment #4: Section 2.7: What is the benefit of drilling 20 feet beyond the bottom of the waste rock piles, with samples every 5 feet? Seems like getting 5 feet beyond the bottom of the waste rock is sufficient confirmation that the bottom has been identified.

WNI Response: The text has been revised to clarify that the soil underneath the waste rock will be sampled every 5 feet until unimpacted native soil is reached based on field screening results to a maximum depth of 20 feet or until bedrock is reached.

Comment #5: Section 3.1.1.3: This section discusses scanning cores to aid the field team in determining whether unimpacted native soil has been reached. The text describes the difficulties posed by doing the scans over areas with elevated gamma levels and proposes possible solutions like shielding or moving the cores to unimpacted areas. Another solution is to use a one-half by one inch detector and lower it down the hole taking static readings at various intervals. This gets around all interference problems. Whatever method is used, you will need to take several borings in background areas, either to get cores to scan for comparison, or to have holes to lower the probe in for comparison.

WNI Response: The Phase 3 Work Plan has been updated to add downhole logging at the subsurface soil sample locations as an option for the field team to determine when unimpacted native soil has been reached. Downhole logging will not be performed at the waste rock pile due to implementability issues with DPT drilling and the expected depths of borings.

Comment #6: Section 3.1.2.2: Please take the required number of metals and uranium samples in the waste rock areas rather than from the work areas.

WNI Response: The Work Plan currently includes analysis of six metals, including uranium, from the waste rock areas and the work areas. The text and Table 2-2 have been revised for clarity. Primary COPCs for laboratory analysis include radium-226, arsenic, vanadium, molybdenum, selenium, uranium, and mercury.

Comment #7: Correlation Sample Locations: Many of the correlation samples seem to be focused on isolated hits surrounded by background. It seems like a few of these samples should be moved to areas that are in a more consistent 2-3 times background area. It's hard to tell of course just from looking at the figures, because the figures can't show a great level of detail other than less than 2 times background, 2-3 times background and greater than 3 times background. But if you are sampling isolated spots in the middle of background, then you will be biasing your correlations low, which will lead to more conservative clean up criteria for any decisions based on gamma scans.

WNI Response: A portion of the correlation samples will be moved from isolated locations to more central locations, such as work, step out, and dewatering areas.

Mr. Ripperda
September 23, 2014
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If you have any questions regarding our comment responses or the revised Phase 3 Work Plan, please contact me at your convenience.

Sincerely,

A handwritten signature in black ink, appearing to read "Stuart M. Brown". The signature is fluid and cursive, with the first name "Stuart" being more prominent than the last name "Brown".

Stuart M. Brown

Cc: Stanley Edison – Navajo Nation Environmental Protection Agency
Stan Curry – Gallagher & Kennedy

Ruby Mines Phase 3 Removal Site Evaluation Work Plan

Prepared for
Western Nuclear Inc.

September 2014

CH2MHILL®

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Acronyms and Abbreviations

°C	degrees Celsius
ANSI	American National Standards Institute
ASAO	Administrative Settlement Agreement and Order on Consent
bgs	below ground surface
Bi-214	bismuth-214
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COPC	constituent of potential concern
cpm	counts per minute
CSM	conceptual site model
DPT	direct-push technology
DQO	data quality objective
EE/CA	engineering evaluation/cost analysis
GPS	global positioning system
IDW	investigation-derived waste
LiDAR	light detecting and ranging
MARSSIM	<i>Multi-Agency Radiation Survey and Site Investigation Manual</i>
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
μR/hr	microRoentgen per hour
MMD	New Mexico Energy, Minerals, and Natural Resources Department Mining and Minerals Division
NaI	sodium iodide
NECR	Northeast Church Rock
NNEPA	Navajo Nation Environmental Protection Agency
Pb-214	lead-214
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PPE	personal protective equipment
PRG	preliminary remediation goal
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
Ra-222	radium-222

Ra-226	radium-226
RSL	Regional Screening Levels
site	Ruby Mines Site
SOP	standard operating procedure
SVOC	semivolatile organic compound
TPH	total petroleum hydrocarbons
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WNI	Western Nuclear Inc.

Introduction

This work plan describes activities to be performed for environmental characterization at the Ruby Mines Site (site) in accordance with Appendix A of the United States Environmental Protection Agency (USEPA) Administrative Settlement Agreement and Order on Consent (ASAOC) signed July 15, 2013 (USEPA, 2013). This is the third of three phases of work for the Ruby Mines Site evaluation.

The ASAOC defined Phase 3 as a site evaluation to characterize the lateral and vertical extent of constituents of potential concern (COPCs) in surface and subsurface soils and sediments in the areas of the site defined in the ASAOC and additional areas identified during Phase 2. A Removal Site Evaluation and Completion Report will be prepared to document the Phase 3 fieldwork and to combine and evaluate the data and information collected during Phases 1, 2, and 3

1.1 Objective

The objective of Phase 3 work at the Ruby Mines Site is to obtain data to characterize the lateral and vertical extent of COPCs in soil and sediment at the site. This includes information to characterize the extent of soil and sediment containing radium-226 (Ra-226), the primary COPC, as well as other COPCs identified in the ASAOC Scope of Work (SOW).

1.2 Ruby Mines History and Operations

The site consists of four inactive underground mines (Ruby Mines Nos. 1, 2, 3, and 4) located in northwestern New Mexico in McKinley County in the Smith Lake Chapter of the Navajo Nation. The site is approximately 8 miles north of the town of Thoreau, which is located at the intersection of Interstate Highway 40 and NM-371 (Figure 1-1). The four mines were contiguous and were mined by underground methods for uranium ore between September 1975 and February 1985. Ore was transported to an offsite processing facility, and waste rock was stockpiled and capped adjacent to Ruby Mines Nos. 1 and 3 adits. The Ruby Mines and locations of known surface features are within the boundary of Navajo Nation trust and allotment land, in Township 15 North, Range 13 West, Sections 21, 27, 26, and 25 (New Mexico Energy, Minerals, and Natural Resources Department, Mining and Minerals Division [MMD], 1995). The locations of Ruby Mines and known surface features are shown in Figures 1-2 and 1-3. A summary of ownership and surrounding land use, mining operations and reclamation, regulatory history, and previous work is contained in the Ruby Mines Phase 2 Work Plan (CH2M HILL, 2013).

The following areas are included in the Phase 3 investigation: former adits and selected vents, capped waste rock piles adjacent to the former Ruby Mines Nos. 1 and 3 adits, former haul roads, former Work Areas, step out areas, and drainages. Not included are areas screened during the Phase 2 investigation that had gamma radiation levels less than two times background levels and that are not expected to exceed the preliminary remediation goals (PRG) for Ra-226 specified in the SOW.

As part of Phase 1, open surface mine features (for example, vents, adits, shafts, and prospects) associated with the mines were closed (CH2M HILL, 2014a). Following closure, a gamma radiation survey was conducted, as part of Phase 2, to document radiological conditions at each mine feature. Additionally, a gamma radiation survey was conducted at historically closed surface mine features (that is, features closed during mine reclamation activities prior to Phase 1) that were located during Phase 1 reconnaissance. The status of surface mine features is summarized in Table 1-1.

The following activities were completed during Phase 2: background reference areas were defined and characterized, surface radiological conditions at the Ruby Mines features were documented, the conceptual site model (CSM) for the site was updated, and a preliminary correlation was developed between gamma radiation survey readings and Ra-226 concentrations in soil (CH2M HILL, 2014b). The Phase 2 investigation results indicated that gamma radiation levels at most of the areas surveyed were consistent with background levels. Gamma radiation levels that exceeded two times the background level are predominantly limited to the capped waste

rock piles at Ruby Mines Nos. 1 and 3, several vents, and scattered, localized areas in drainages and along former haul roads. The following Phase 2 recommendations were carried forward into Phase 3: (1) define the nature and lateral and vertical extent of COPCs in surface and subsurface soil and sediments, and (2) collect additional soil samples in the lower-concentration range (approximately 2 to 6 picocuries per gram [pCi/g] of Ra-226) to provide more accurate correlation between gamma radiation readings in the field and measured Ra-226 concentrations in a laboratory.

The following sections present the objectives of the work, the field sampling plan and analytical program, quality assurance (QA), project organization, and schedule.

Data Quality Objectives

Section 2 describes the type and quality of data needed for environmental decisions to be made during Phase 3 and the methods to be used for collecting and assessing the data. The methods were developed using the processes described in USEPA's data quality objective (DQO) process according to *Guidance on Systematic Planning Using the Data Quality Objectives Process EPA QA/G-4* (USEPA, 2006) and following guidance from the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARRSIM) (USEPA, 2000). The DQO process consists of the following steps, which guide the plan for acquisition of environmental data:

1. **State the problem.** Define the problem to be studied and describe the CSM. Review prior studies and existing information to gain understanding sufficient to define the problem. Identify the planning team members, including the decision makers. Prepare problem statements.
2. **Identify the Decision.** Define the decisions to be made. Describe how environmental data will be used in meeting objectives and solving the problem, identify study questions, define what actions may result from each decision, and develop decision statements.
3. **Identify the information inputs.** Identify the data that must be obtained and the measurements that must be taken to answer the decision statements.
4. **Define the boundaries.** Define the target population and characteristics of interest. Specify the temporal and spatial boundaries to which decisions will apply.
5. **Develop the Decision Rules.** Define the parameter of interest, specify the screening level, and develop the logic for drawing conclusions from findings.
6. **Specify the Tolerance on Decision Errors.** Develop performance criteria for data being collected. Define tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.
7. **Optimize the sampling design.** Evaluate information from the previous steps, and develop the sampling design that meets the decision statements.

DQOs are provided in the following subsections following USEPA guidance and *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM; USEPA, 2000). This Phase 3 Work Plan follows MARSSIM guidance for developing DQOs for characterization surveys, and its primary goals are to provide input to evaluate site radiological impacts and provide information for an EE/CA.

2.1 State the Problem (DQO Step 1)

Work conducted during Phase 2 (CH2M HILL, 2014b) documented the presence of radionuclides and largely defined the lateral extent of gamma radiation above background at the Ruby Mines Site, identified potential transport and exposure pathways, and updated the CSM. The CSM describes the physical, chemical, and biological relationships between sources of contaminants and potentially exposed populations. Specifically, the CSM describes and integrates information on the following (USEPA, 1989):

- COPCs and their sources
- COPC fate and transport pathways
- Potentially exposed populations under current and future scenarios
- Potentially complete exposure pathways between contaminated media and receptors

Each component of the CSM was updated after the Phase 2 work and is described in the following subsections.

2.1.1 Constituents of Potential Concern and Sources

One of the primary COPCs at the Ruby Mines Site is Ra-226 and its decay products (daughters). Other primary COPCs identified in the ASAO are metals, including arsenic, vanadium, molybdenum, selenium, uranium, and

mercury. The primary COPCs are naturally occurring; therefore, they are present at background levels in soil and sediments in the area.

The Phase 2 investigation results indicate that most of the areas surveyed had gamma radiation levels that were consistent with background levels. Gamma radiation exceeding two and three times background levels were detected at the capped waste rock piles at Ruby Mines Nos. 1 and 3 and several vents. Scattered, localized areas on former haul roads and in and adjacent to drainages close to the capped waste rock piles also exhibited radiation levels above background.

The following are potential sources of radiological and other naturally occurring COPCs (metals and Ra-226) at the Ruby Mines Site:

- Capped waste rock piles
- Fugitive dust emissions from vents and adits
- Ore spilled from haul trucks on the former haul roads (potential secondary source)

Of the potential sources, the capped waste rock areas represent the main sources of COPCs, based on the Phase 2 gamma radiation surveying results. Limited areas in the immediate vicinity of some vents, as well as on former haul roads and in and adjacent to drainages close to the capped waste rock piles, exhibited radiation levels above two times background. These areas are generally small and localized. Exploratory borehole areas do not constitute source areas because gamma readings collected during Phase 2 were less than two times the background levels over the entire screened area.

2.1.2 Fate and Transport Pathways

The following are the potential fate and transport pathways:

- Suspension and transport of dust by wind
- Transport of soil and sediment by surface water
- Uptake of COPCs from soil and water by vegetation

The soil caps maintained over the waste rock piles have controlled transport from these areas. Some erosion of the soil caps due to surface water runoff has been observed at both of the capped waste rock piles. Transport by surface water also appears limited because elevated gamma radiation activity in drainages was sporadic and generally confined to areas immediately downgradient of locations where cap erosion has exposed the capped waste rock.

Air monitoring performed during closure of surface features did not detect significant dust or radiation, and gamma readings potentially associated with transport of dust by wind do not extend beyond the mine features and their immediately adjacent areas.

2.1.3 Potentially Exposed Populations

Potential receptors evaluated in the Ruby Mines Phase 2 study were nearby residents, vegetation, and livestock. To evaluate whether waste rock may have been used for building materials or transported to residences for other uses, gamma radiation surveying of the foundations and areas around residences was performed.

The investigation revealed no significant radiation levels at residences, indicating that mine-impacted materials were not used in construction of buildings.

Section 5.3.4 of Appendix A of the ASAO discusses evaluation of groundwater and requests sampling of a nearby livestock well, DWR6T519. The livestock well is located approximately 3,200 feet (0.6 mile) east-northeast of RUBY-001, a former adit associated with Ruby Mine No. 1. The well appears to be powered by a windmill and collected water is stored in a large tank at the base of the windmill. Limited information is available about the construction of the well; however, the available information is provided in Appendix A of this report. A sample from the well was collected on July 10, 1986. The report indicated that the well depth and water levels were unknown (see Appendix A). Laboratory analytical data reported concentrations of Ra-226 of 0.044 picocuries per liter (pCi/L), significantly less than USEPA's compliance guidance for drinking water standards of 5 pCi/L (USEPA 2002b). The laboratory analysis also reported the following:

- U-234 – 14.084 pCi/L
- U-235 – 0.427 pCi/L
- U-238 – 9.227 pCi/L
- Th-230 – 0.047 pCi/L
- Pb-210 – 0.64 pCi/L

These total 24.4 pCi/L. Converting U-234, U-235 and U-238 to total uranium using their specific activities yields a total uranium concentration of 27.6 micrograms per liter, which is less than the MCL of 30 micrograms per liter.

Historical documents about mine operations, a general understanding of the physiographic characteristic of the Smith Lake region, and the results from Phase 2 work are useful in understanding potential impact to the livestock well from both historical mining activities and previous reclamation efforts. Available historical mine documents indicate that the ore body and underground mine working of Ruby Mines Nos. 1 and 2 did not extend to the area under the livestock well (Western Nuclear Inc. [WNI], 1979). During exploration activities at Ruby Mines Nos. 1 and 2, no significant amounts of groundwater were encountered, and most of the exploratory boreholes were dry (WNI, 1979). Available information indicates that the ore body is not in contact with groundwater-bearing zones; therefore, there is no source mechanism for radiation to enter the groundwater system. An advantage of the “decline” entry mining system used at the Ruby Mines is that, generally, underlying water-bearing aquifers are not penetrated by mine workings (WNI, 1977). Additionally, the major water-bearing member in the region, the Westwater Canyon Member, sequentially underlies both a confining layer, the Brushy Basin Member, and the ore-bearing Dakota Sandstone.

The results of the Phase 2 investigation indicate that mine-related surface soil impacts are localized in soil around historical mine features. Average annual rainfall in Smith Lake, New Mexico is 12.5 inches and the semi-arid desert nature of the area suggests that most of this precipitation succumbs to evapotranspiration forces and may not enter regional groundwater reservoirs. Although subsurface soil impacts will be investigated further during the Phase 3 work, regional impacts to groundwater are not anticipated, based on the lack of significant precipitation to drive mine impacts into groundwater and the distance (more than a 0.25 mile) to the livestock well.

Given the historical data showing no impact and the lack of a viable transport mechanism to groundwater from mine-related activities, Phase 3 activities do not include sampling of the livestock well as requested in the ASAOC.

2.2 Identify the Decision (DQO Step 2)

The principal study questions for Phase 3 involve characterizing the nature and extent (both lateral and vertical) of COPCs at the site. Quantifying the nature and extent of COPCs in soils and sediments related to historical mining activities at the site will provide information on the following:

- Concentrations of COPCs in the capped waste rock pile areas, including the following: soil caps, waste rock, and soil beneath the capped waste rock
- Concentrations of COPCs in surface and subsurface soil areas of the site where surface gamma screening showed that Ra-226 exceeded two times the background level, including Work Areas and step out areas around the capped rock piles, three vents, and portions of drainages and haul roads. Work Areas are areas located near the Ruby Mines No. 1 and 3 adits where structures associated with the mine operations were previously located. They were identified based on existing concrete pads and historical documents, which indicate that structures present at the sites included a mechanics shop, changing room, and office.
- Concentrations of Ra-226, metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), explosives including perchlorate, and total petroleum hydrocarbons (TPH) in soil at Work Areas.

In order to interpret the data on nature and extent, analysis is also required to assess what gamma radiation activity in counts per minute (cpm) is equivalent to Ra-226 concentrations in soil in pCi/g. The Phase 2 gamma screening and soil sampling (CH2M HILL, 2014b) delineated the lateral extent of surface radiation at the site. Background levels were also established in three different geologic settings in mine areas.

2.3 Identify the Information Inputs (DQO Step 3)

The following subsections present the information and criteria needed to implement Phase 3. They include the identification of investigation areas, COPCs, and background levels.

2.3.1 Investigation Areas

Table 2-1 lists areas investigated during Phase 2 and identifies those that will be investigated further in Phase 3 based on Phase 2 gamma screening results.

2.3.2 Constituents of Potential Concern at Ruby Mines Site

One primary COPC at the Ruby Mines Site is Ra-226 and its daughters. Other primary COPCs include the following metals identified in the SOW: arsenic, vanadium, molybdenum, selenium, uranium, and mercury. These metals and Ra-226 are all naturally occurring; therefore, they are present in soil and sediment at background levels. The SOW includes a requirement to sample for other COPCs from anthropomorphic sources (that is, not naturally occurring and potentially associated with activities conducted in the Work Areas), including VOCs, SVOCs, PCBs, and TPH. For the purposes of this investigation, the term primary COPCs for laboratory analysis include Ra-226 and the metals arsenic, vanadium, molybdenum, selenium, uranium, and mercury.

2.3.3 Soil Background Concentrations

During Phase 2, background reference areas in the Mancos Shale, colluvium, and Dakota Sandstone were identified. The background reference areas were selected to be representative of the three primary surficial geologic materials at the Ruby Mines Site in areas that are not impacted by historical mining activities. Soil samples were collected and analyzed for the primary COPCs (Ra-226 and metals) in the three background reference areas.

2.4 Define the Boundaries (DQO Step 4)

The lateral boundaries for Ruby Mines features will be defined by areas where soil/sediment have concentrations greater than the PRGs established in the ASAOC. They were initially established in the Ruby Mines Phase 2 report based on the gamma radiation survey results, historical records of past mining practices, site reconnaissance, previous radiological surveys conducted by USEPA (Weston, 2009a, b), ASAOC Scope of Work requirements, and professional judgment based on experience from other uranium mine sites. Lateral boundaries will be more fully defined by walkover gamma screening during Phase 3 at two locations: the Ruby Mine No. 1 Work Area/step out area and the Ruby Mine No. 3 Work Area. Work Areas are areas where equipment was stored and structures such as the mechanics shop, changing room, and office were located. Work Areas were identified based on historical documents and visual observation of existing concrete pads. The Ruby Mine No. 1 step out area encompasses areas to the north and east of the capped waste rock pile that exceeded two times the background calculated as part of the Phase 2 fieldwork. The step out area east of the Ruby Mine No. 1 capped rock pile also includes the historical Work Area. The Ruby Mine No. 3 Work Area is located southwest of the capped rock pile.

The vertical boundaries of the site features will be determined by soil borings and are soil/sediment that are found to have concentrations less than PRGs, or bedrock.

2.5 Develop the Decision Rules (DQO Step 5)

The following are the decision rules for the Phase 3 work:

- If concentrations in soil exceed PRGs or the soil correlation predicts results will exceed the PRG, then evaluate further.

If concentrations in soil are less than or equal to PRGs, or the soil correlation predicts that the results will be less than the Ra-226 PRG, then no further evaluation is required.

Section 4.4 of the ASAOC specifies that scanning measurements must meet a scan minimum detectable concentration (MDC) of 50 percent of the investigation level. For purposes of the Ruby Mines Removal Site

Evaluation, an investigation level for Ra-226 of 1.24 pCi/g above background was specified, which translates to a required MDC of 1.34 pCi/g¹.

The MARSSIM framework for determining the minimum detectable count rate (MDCR) in cpm for field-instrument scanning uses two stages of scanning that detect Ra-226 concentrations in soil. In the field, surveyors do not make decisions based on a single indication; rather, upon noting an increased number of counts, they pause briefly, and then decide whether to move on or take further measurements. Thus, scanning consists of two components: continuous and stationary scanning. Accordingly, field-instrument surveyor-scan MDCs, which are termed “MDCR_s,” are calculated to control the occurrence of Type I (false negative) and Type II (false positive) errors using the following MARSSIM equation:

$$MDCR_s = \frac{MDCR}{\sqrt{p\varepsilon}}$$

Where:

$MDCR_s$ = the minimum detector count rate using a surveyor

$MDCR$ = the minimum detectable count rate (cpm) for the field instrument

p = the surveyor efficiency [estimated in MARSSIM to be between 0.5 and 0.75, but use of electronic data-logging equipment will increase the surveyor efficiency to 1.0]

ε = the instrument efficiency in cpm per microRoentgen per hour (μ R/hr) as specified in Table 6.4 of *NUREG 1507 Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (U.S. Nuclear Regulatory Commission, 1997) as 760 cpm per μ R/hr.

In addition:

$$MDCR = s_i \left(\frac{60}{i} \right)$$

$$MDCR = 14.215 \text{ counts} \times (60/1 \text{ second})$$

$$MDCR = 853 \text{ counts}$$

Where:

$$s_i = d' \sqrt{b_i}$$

$$s_i = 1.38 \times \text{square root } [6,367 \text{ cpm} \times 1 \text{ second} \times (1 \text{ minute}/60 \text{ seconds})]$$

$$s_i = 14.215 \text{ counts}$$

Where:

s_i (counts) = the minimal number of net source counts required for a specified level of performance for the counting interval i (seconds)

d' = the index of sensitivity

b_i = the number of background counts in the interval, taken as the minimum detected count rate in the background reference area.

Index of sensitivity d' values are listed in MARSSIM Table 6.5 and are based on the proportions for required true positive and tolerable false positive occurrence rates. The index of sensitivity value selected for initial use at the

¹ The scan minimum detectable concentration (MDC) of 1.34 pCi/g was calculated using the lowest of the three background values for Ra-226: 1.44 pCi/g, adding 1.24 pCi/g, and calculating 50 percent of that value [(1.44 + 1.24) * 0.50 = 1.34].

Ruby Mines Site is 1.38, corresponding to a true positive proportion of 0.95 and a false positive proportion of 0.60 from MARSSIM.

Based on the above calculations, the MDCR can be calculated using a conversion factor from pCi/g to $\mu\text{R/hr}$ of 1.41 from Microshield™ (a photon/gamma ray shielding and dose assessment computer program) as recommended by NUREG 1507 (U.S. Nuclear Regulatory Commission, 1997):

$$MDCR_s = \frac{MDCR}{\sqrt{p\varepsilon}}$$

Where:

$$MDCR_s = MDCR \text{ (853 counts)} / [\text{square root } (1) \times 760 \text{ cpm}/\mu\text{R/hr}]$$

$$MDCR_s = 853 / 760$$

$$MDCR_s = 1.12 \mu\text{R/hr}$$

$$MDCR_s = 1.12 \mu\text{R/hr} \times (1.41 \text{ pCi/g}/1 \mu\text{R/hr}) \text{ conversion factor}$$

$$MDCR_s = 1.6 \text{ pCi/g}$$

The calculated $MDCR_s$ for a background count rate of 6,367 cpm is 1.6 pCi/g. Using the maximum detected count rate in the background reference area of 13,493 cpm, the $MDCR_s$ is 2.3 pCi/g. For the 1-minute static count rate measurements, the calculated MDC is 0.2 pCi/g.

The Ra-226 concentrations in background ranged between 0.63 to 1.71 pCi/g. In the field, the sodium iodide (NaI) detector was capable of distinguishing areas greater than the calculated background level.

2.6 Specify the Tolerance on Decision Errors (DQO Step 6)

Phase 3 sampling consists of a non-statistical approach and professional judgment focused on meeting DQOs.

2.7 Optimize Sampling Design (DQO Step 7)

DQO Step 7 identifies the process for collecting data and measuring the decision inputs for each feature at the site. The sampling rationale is described in this section, and details are provided in Section 3.

As shown in Table 2-2, Phase 3 investigations will be performed at features or sub-features where gamma radiation survey results exceeded two times the background level and have a potential to exceed PRGs. Additional sampling will not be performed at features where gamma radiation survey results were less than two times background levels. Sampling for anthropogenic COPCs will be performed in the Work Areas where materials containing these COPCs were potentially handled or stored. These Work Areas were located based on existing evidence such as concrete pads and historical documents showing the location of former structures, including shop areas, offices, and changing room. Phase 3 gamma surveys and soil sampling design considerations are described in the following subsections.

2.7.1 Additional Gamma Radiation Surveys

Additional gamma walkover radiation surveys will be performed at the Ruby Mine No. 1 step out area/Work Area and the Ruby Mine No. 3 Work Area to better define the lateral extent of gamma radiation activity in surface soils. Other features do not require additional radiation surveys because the Phase 2 work adequately defines the lateral extent of gamma radiation activity at the surface.

2.7.2 Soil Sampling

Surface and subsurface soil sample results will be used, along with the correlation with laboratory analyses, to define the lateral and vertical extent of contamination at areas where only gamma radiation survey results are available. Soil sampling will be performed in areas where gamma levels are more than two times the background level based on the following rationale:

Vents (RUBY-002, RUBY-004, and RUBY-019) exhibited elevated gamma readings in their immediate areas. Each vent area will be sampled at three locations to estimate the areal extent of COPCs. Because surface deposition of COPCs is unlikely to have impacted soil at depth, samples will be collected at depths of 0 to 0.5 and 1 to 1.5 feet bgs.

Ruby Mine No. 1 capped waste rock pile: Soil samples of the cap, waste rock, and soil will be collected at seven locations. The cap at Ruby Mine No. 1 is reported to be 10 feet thick but may be variable. Samples will be collected at depths of 0 to 0.5 feet bgs and every 5 feet thereafter until the bottom of the cap is encountered. Waste rock will be sampled every 5 feet until the bottom of the waste rock pile is encountered. Soil beneath the waste rock will be sampled from 1 to 1.5 feet below the waste rock. If visual observations and field screening indicate that unimpacted native soil has not been reached, then the boring will be advanced, and samples will be collected every 5 feet until native soil is reached up to 20 feet below the waste rock or until bedrock is encountered.

Ruby Mine No. 3 capped waste rock pile: Soil samples of the cap, waste rock, and soil will be collected at seven locations. The cap at Ruby Mine No. 2 is reported to be 1 foot thick and will be sampled at 0 to 0.5 foot bgs. Waste rock will be sampled every 5 feet until the bottom of the waste rock pile is encountered. Soil beneath the waste rock will be sampled from 1 to 1.5 feet below the waste rock. If visual observations and field screening indicate that unimpacted native soil has not been reached, then the boring will be advanced, and samples will be collected every 5 feet until unimpacted native soil is reached up to 20 feet below the waste rock or until bedrock is encountered.

Drainages and former haul roads: Three soil samples will be collected along each of the three drainages and two former haul roads that exhibited gamma survey measurement above background. Three samples will be collected at each of these five areas. As shown in Table 2-2, soil samples will be collected from 0 to 0.5, 1 to 1.5, and 5 to 5.5 feet bgs at each sample located within these five areas, except for an isolated location on Wolf Canyon Road where only a surface sample will be collected.

Work Areas at Ruby Mines Nos. 1 and 3 will each be sampled at 4 locations where historical information and current physical evidence indicate structures such as the mechanics shop, changing room, and office were located. Samples will be collected at 0 to 0.5, 1 to 1.5, and 5 to 5.5 feet bgs. Analyses will be performed for the full suite of COPCs, as well as the primary COPCs.

The Ruby Mine No. 1 step out area is an area located north and east of the capped waste rock pile where Phase 2 gamma scanning measurements exceeded two times background. This area also encompasses the Ruby Mine No. 1 Work Area. It will be sampled at five locations at 0 to 0.5, 1 to 1.5, and 5 to 5.5 feet bgs to better define the lateral and vertical extent of COPCs.

Four surface soil samples will be collected for analysis for agronomic parameters. At each of the two capped waste rock piles, one sample will be collected from the waste rock caps and one from an area near the cap, to be determined in the field. Samples will be collected on the waste rock pile caps from areas where the Phase 2 survey gamma levels were less than two times background. Engineering parameter analyses will also be performed on samples of waste rock cap soils to assist with assessing existing cover integrity.

An additional group of surface samples will be collected to improve the correlation between field measurements of gamma radiation and laboratory analysis of Ra-226 concentrations. A total of 30 samples will be collected at pre-selected locations that are expected to have lower Ra-226 concentrations (from 2 to 6 pCi/g). The samples will also be used to define lateral extent of contamination at the selected locations. Both a static measurement and a soil sample will be collected at each location. For static measurements, a surveyor will hold the radiation detector stationary 6 inches above the ground surface for 1 minute. The soil sample will be collected at the same location from 0 to 6 inches bgs as was done during the Phase 2 study and analyzed for Ra-226. The data will be combined with the Phase 2 static measurements and surface soil samples, as well as Phase 3 surface static measurements and surface soil samples, to create a combined and robust data set to improve the soil correlation results.

Field Sampling Plan

Section 3 presents the field sampling plan for the Ruby Mines Site Phase 3 investigation and presents the analytical program, field methods, management of investigation-derived waste (IDW), and sample-specific requirements.

3.1 Sampling Plan

Phase 3 sample locations are presented in Table 2-2, Appendix B, and Figures 3-1 through 3-9. The following subsections describe the field methods to be used for each sample type, such as static measurements, gamma radiation survey readings, surface soil samples, subsurface soil samples, and waste rock samples.

3.1.1 Gamma Radiation Measurement

Static, walkover, and sample on-contact gamma radiation measurements will be taken during the Ruby Mines Phase 3 investigation to optimize sampling locations and depths and support correlation analyses.

3.1.1.1 Static Measurement

To optimize soil boring or surface sample locations, gamma radiation measurements will be taken at 6 inches above the ground to target sample/boring locations, which will be recorded with a global positioning system (GPS). Direct gamma static measurements will be performed with a collimated and uncollimated Ludlum Model 44-10 2-inch-by-2-inch NaI scintillation detector. Both collimated (shielded) and uncollimated (unshielded) detector probes are used to evaluate the effect of radiation shine interference, especially from the capped waste rock piles. The detector will be connected to a Ludlum Model 2221 scaler/ratemeter or equivalent coupled to a GPS handset for automated data logging. Static counts will be performed for 1 minute and recorded prior to sample collection. Applicable portions of the standard operating procedures (SOPs) provided in Appendix C will be used as appropriate for the measurements. The static readings data will be used to correlate and calibrate the gamma-radiation-level measurements in cpm to surface soil Ra-226 concentrations in pCi/g. The field methods for the field gamma survey and the correlation study, as well as example MDC calculations, are described in Section 5.3.3 and in the SOPs.

3.1.1.2 Walkover Radiation Surveys

Gamma radiation surveys will be performed at the Ruby Mine No. 1 step out area and the Ruby Mine No. 3 Work Area using a Ludlum Model 44-10 2-inch-by-2-inch NaI scintillation detector connected to a Ludlum Model 2221 scaler/ratemeter or equivalent coupled to a GPS handset for automated data logging. The areas where the proposed walkover gamma radiation surveys will be performed is shown in Figure 3-1, which shows the Phase 2 gamma radiation survey results in addition to the proposed additional walkover areas. Transects at 6 feet apart will be surveyed with a detector height of no more than 6 inches above the ground surface at a survey rate of 1 to 2 feet per second. The survey will continue until the lateral extent of contamination is defined and the count rate is below approximately 13,000 cpm, the field-screening level calculated in the Phase 2 investigation. Applicable portions of the SOPs provided in Appendix C will be used as appropriate. The radiological instruments will be maintained and operated in accordance with their respective technical manuals and approved operating procedures. Each detector-scaler/ratemeter set will be calibrated in accordance with American National Standards Institute (ANSI) N323A, 1997, Radiation Protection Instrumentation Test and Calibration—Portable Survey Instruments. In addition, performance testing will be documented daily before use for each detector-scaler/ratemeter set to confirm a reproducible response to a radioactive check source.

3.1.1.3 Soil Sample Core Radiation Surveys

On-contact static gamma radiation measurements will be taken along the entire length of soil cores to assist the field team in assessing when unimpacted native soil is reached. The measurements will be taken on contact with the soil (or acetate sleeve), or as close as possible. The sample radiation survey data will be used to assess whether supplemental depths are needed in order to meet DQOs. The decision to collect a soil sample from a different interval or greater depth will be made by both the site geologist and radiation specialist. Soil samples will

be removed to an area where ground readings are not expected to significantly exceed those of target sample material. If soil sample readings are less than two times the background level, then samples will be screened on plywood or an elevated table to provide distance from ground radiation. A shielded counting container (collimator on a detector or a shielded container to place the sample into for survey) may be used if needed to meet DQOs and will be available onsite during sampling. The samples may also be taken to a lower background area in order to distinguish when unimpacted native soil is reached and measurements are consistent with background values. At shallow depths, such as 1 foot bgs, the 2-inch by 2-inch NaI detector can be placed directly into the sample hole if needed to determine when unimpacted native soil has been reached. A smaller 0.5-inch by 1-inch NaI detector on a 10-foot cable may also be used in the locations drilled or hand augered to 5 feet. If warranted, a plastic pipe would be installed into the hole and the detector lowered into the pipe. Lead shielding on the end of the pipe may be used if needed to mitigate the effects of radiation from adjacent soil. The detector probe would be extended to a depth lower than the PVC pipe into soil. A 1-minute static count measurement would be taken to evaluate if DQOs had been met or if the boring needs to be advanced deeper. The appropriate method will be determined in the field and documented in field notes. Soil sample locations are provided in Figures 3-2 through 3-9, and the sampling and analysis plan is presented in Appendix B. However, actual subsurface soil sample location and depth may be modified slightly in the field to provide the most representative material for laboratory analysis based upon DQOs. Final sample depths will be reflected in sample identifiers and in boring logs. Once the sample depth has been selected, a static measurement will be performed for 1 minute and recorded.

3.1.1.4 Soil Correlation Samples

In addition to gamma measurements at the designated sampling locations, static measurements and surface soil sampling will be performed at 30 additional locations to provide a correlation between field gamma radiation measurements in cpm and surface soil concentrations of Ra-226 in pCi/g at the lower concentration ranges. The locations are in areas in which Phase 2 gamma radiation survey results were greater than two times the background level. Planned soil correlation sampling locations are identified in the following: Table 2-2 and Figure 3-2 for samples near Ruby Mine No. 1, Figure 3-5 and Figure 3-6 for samples near Ruby Mine No. 3, and Figures 3-7, 3-8, and 3-9 for samples at RUBY-002, RUBY-004, and RUBY-019, respectively.

The field radiological measurements will consist of collimated and uncollimated direct gamma-radiation-level measurements using the 2-inch-by-2-inch NaI detector as described in Section 3.1.1.1. Soil sampling from 0 to 0.5 foot bgs as described in Section 3.1.2 will be performed to correlate and calibrate the gamma-radiation-level measurements in cpm to soil Ra-226 concentrations in pCi/g using a linear regression analysis. Correlations will be developed for both collimated and uncollimated measurements. This static gamma-radiation-level measurement for Ra-226 is consistent with criteria for selection of the direct-measurement method specified in Section 4.7.3 of MARSSIM (EPA, 2000). The field methods for the field gamma survey and the correlation study, as well as example MDC calculations, are described in Section 3.3 and SOPs RP-103, RP-104, and RP-106 in Appendix C.

3.1.1.5 Background Reference Area

At the manco shale, colluvium, and dakota sandstone background reference areas, a soil sample core will be collected to a depth of 5 feet. Continuous scans and static measurements on the soil core and static measurements using downhole gamma logging will also be performed at each location. The data will be used for comparison during the soil sample core radiation surveys to evaluate when unimpacted native soil has been reached.

3.1.2 Soil Sampling

Soil sampling locations are identified in Table 2-2 and shown in Figures 3-2 through 3-9. Features and rationale for sampling are described in the following paragraphs.

Vents (RUBY-002, RUBY-004, and RUBY-019) exhibited elevated gamma readings in their immediate areas. Each vent area will be sampled at three locations to estimate the areal extent of COPCs. Because surface deposition of COPCs is unlikely to have impacted soil at depth, samples will be collected at depths of 0 to 0.5 and 1 to 1.5 feet bgs.

Capped waste rock piles at Ruby Mines Nos. 1 and 3 will be investigated to determine the thickness and characteristics of three layers: the soil caps, waste rock, and extent of impacted native soil beneath the capped

waste rock piles. Seven soil boring locations will be sampled at each waste rock area. Visual observations and field screening will inform the depths of transitions between these layers and guide the selection of specific sample depths.

At the Ruby Mine No. 1 capped waste rock pile, soil samples of the cap, waste rock, and soil will be collected at seven locations. The cap at Ruby Mine No. 1 is reported to be 10 feet thick but may be variable. Samples will be collected at depths of 0 to 0.5 foot bgs and every 5 feet thereafter until the bottom of the cap is encountered. Soil beneath the waste rock will be sampled from 1 to 1.5 feet below the waste rock. If visual observations and field screening indicate that unimpacted native soil has not been reached, then the boring will be advanced, and samples will be collected every 5 feet until native soil is reached up to 20 feet below the waste rock or until bedrock is encountered.

At the Ruby Mine No. 3 capped waste rock pile, soil samples of the cap, waste rock, and soil will be collected at seven locations. The cap at Ruby Mine No. 2 is reported to be 1 foot thick and will be sampled at 0 to 0.5 feet bgs. Waste rock will be sampled every 5 feet until the bottom of the waste rock pile is encountered. Native soil beneath the waste rock will be sampled from 1 to 1.5 feet below the waste rock. If visual observations and field screening indicate that unimpacted native soil has not been reached, then the boring will be advanced, and samples will be collected every 5 feet until unimpacted native soil is reached up to 20 feet below the waste rock or until bedrock is encountered.

Drainages and former haul roads will each be sampled at 3 locations where Phase 2 gamma screening measurements were greater than two times background. Based on investigations at other mine sites, samples at these areas at Ruby Mines Nos. 1 and 3 will be collected at three depths between 0 to 0.5, 1 to 1.5, and 5 to 5.5 feet bgs, except for an isolated location on Wolf Canyon Road where only a surface sample will be collected.

Work Areas at Ruby Mines Nos. 1 and 3 will each be sampled at 4 locations where historical information and current physical evidence indicate structures such as the mechanics shop, changing room, and office were located. Samples will be collected at 0 to 0.5, 1 to 1.5, and 5 to 5.5 feet bgs. Analyses will be performed for the full suite of COPCs, as well as the primary COPCs.

The Ruby Mine No. 1 step out area is an area located north and east of the capped waste rock pile where Phase 2 gamma scanning measurements exceeded two times background. This area also encompasses the Ruby Mine No. 1 Work Area. It will be sampled at four locations at four depths between the surface and 5.5 feet bgs to better define the lateral and vertical extent of COPCs.

3.1.2.1 Surface Soil Sampling

Discrete soil samples will be collected at selected locations that had radiation survey results greater than two times the background level. At each proposed surface soil sample location, a static reading will be taken as described in Section 3.1.1. Surface vegetation and debris will be removed, and a discrete grab surface soil sample will be collected from 0 to 6 inches bgs using manual methods with hand auger. If large anomalies are detected, such as a large rock outcrop, which impede the accuracy of survey measurement or the ability to collect a sample, the location may be shifted to an immediate adjacent area. Final sample locations will be GPS-located.

The sample materials will be placed in disposable bags to allow for field screening and logging. Where possible, loose soil materials will be scooped using gloved hands, disposable trowels, and dedicated sample jars to prevent contact with metal implements. In dense, rocky, or indurated soils, decontaminated hand augers or digging bars may be used to loosen and collect samples.

Field measurements and observations will document gamma radiation measurements and lithologic properties. Samples will be collected as specified in Section 3.1.2 and the quality assurance project plan (QAPP) (Appendix D) using the appropriate field form (Appendix E) and SOPs (Appendix C). In areas where quality control (QC) sampling is designated, additional volume will be collected prior to sample description and logging.

3.1.2.2 Subsurface Soil

Subsurface soils will be sampled at the locations and depths described in Section 3.1.2, identified in Table 2-2 and shown in Figures 3-2 through 3-9. Samples will be analyzed for primary COPCs only (Ra-226 and metals), except in

Work Areas, which will also be subjected to anthropogenic analysis. A sampling and analysis table is presented in Appendix B. Subsurface soil sampling to depths shallower than 5 feet may be done by hand auger. Subsurface soil samples will be collected from representative material based upon lithologic description and radiological screening. Soil cores from the hand auger will be radiologically surveyed following the process described in Section 3.3. Downhole logging will also be performed at the discretion of the radiation specialist. In general, the locations of the subsurface samples were selected to be in the area with highest surface gamma radiation survey results because it is expected to have the greatest depth of contamination. Samples will be labeled with the soil boring location name followed by the depth of collection. For example, the first sample collected at RUBY-001 adit at a depth of 2 feet would be labeled RM01-ADIT01-1.0 to 2.0. Discrete samples will be placed into a container representing the entire 1-foot interval and sent for laboratory analysis.

The boreholes will be abandoned by filling with excess soil core where practicable. For borings where there is not sufficient core material to fill the boring to surface, the remainder of the void space will be abandoned by filling with bentonite clay chips and hydrating with water.

3.1.3 Capped Waste Rock Pile Sampling

Seven soil borings will be advanced at each of the Ruby Mines Nos. 1 and 3 capped waste rock piles as shown in Figures 3-2 and 3-5 and Appendix B. Sampling at these locations will use a combination of manual methods for shallow samples and DPT drilling for deeper samples. The borings will be advanced to native soil beneath the waste rock material, or to refusal. If refusal is encountered in DPT borings before penetrating the full thickness of waste rock, the rig will be relocated and another borehole will be attempted. If bedrock is encountered, the boring will be completed, and no additional subsurface sampling will be performed. The field geologist and radiological specialist will use training and professional judgment to evaluate how deep soil borings must be advanced and which sample depths comply with the DQOs.

Samples will be taken at seven locations across the footprint at each capped waste rock pile to develop volume estimates. Sampling at these locations will use a combination of manual methods for shallow samples and DPT drilling for deeper samples. Radiation surveys and visual observation by a geologist will be conducted to assess the transitions from cap material to waste rock and waste rock to soil, as well as when unimpacted native soil has been reached. Samples of soil cover, waste rock, and underlying soil will be collected at 5-foot intervals (1 to 1.5 feet and 5 to 5.5 feet) and every 5 feet thereafter up to 20 feet below the waste rock or until bedrock is encountered. Samples will be sent to ALS Laboratory for analysis of the primary COPCs Ra-226 and metals.

Two surface soil samples will be collected on each capped rock pile in areas where gamma scanning measurement was less than two times background and another two in the vicinity of each capped waste rock pile for analysis for agronomic parameters. The location of the samples will be determined in the field by the geologist and have been tentatively selected as documented in Appendix B. The samples require a larger volume of soil to be collected as shown in Table 3-1. Agronomic parameters to assess the density and diversity of current vegetative cover and evaluate potential cover seed mixtures, including pH, electrical conductivity, saturation percentage, texture, rock fragment percentage, sodium adsorption rate, nitrate, phosphorus, potassium, chloride, sulfate, and organic carbon.

The samples from the cover material will also be analyzed for engineering parameters to assist with cover integrity and design include soil moisture, grain-size distribution, dry density, and plasticity index. AMEC laboratories will perform the agronomic and engineering testing. Because the laboratory does not accept radiological materials, soil samples will be selected with gamma radiation levels consistent with background values.

The onsite geologist will aid in the classification of soil samples. The field geologist will log soil cores in sufficient detail to measure the thickness of soil cover and waste rock material and to describe the nature of waste rock and soil beneath waste rock. Core lengths will be measured with a tape measure and compared to the drill-pipe lengths to determine the thickness of logged material. Thickness measurements of soil core will be included, along with radiological screening data described in Section 3.3, in the soil boring log. Photographic documentation of soil cores will be collected during logging. Samples from capped waste rock pile borings will be analyzed for

primary COPC Ra-226 by USEPA Method 901.1 and select metals (arsenic, mercury, molybdenum, selenium, uranium, and vanadium) by SW 846 Methods 6020 and 7471A as shown in Table 3-1.

Boreholes will be abandoned with excess soil core where practicable. For borings where there is not sufficient core material to fill the boring to surface, the remainder of the void space will be abandoned with hydrated bentonite clay chips.

3.1.4 LIDAR

LiDAR (light detecting and ranging) remote sensing technology will be used at the Ruby Mines Nos. 1 and 3 capped waste rock piles and adjacent areas to develop detailed topographic information to support volume estimates, particularly for the waste rock piles, and drainage patterns. This technology uses optical reflection to survey the land surface. The LiDAR equipment will be mobilized to the site on a day with no snow cover and mounted on trucks or portable towers in a manner that will allow for coverage of each capped waste rock pile. The general aerial extent for LiDAR is shown in Figure 3-2 for Ruby Mine No. 1 and Figure 3-5 for Ruby Mine No. 3.

3.2 Analytical Program

Laboratory analysis of soil samples will be performed for the COPCs identified in the ASAOC. Chemical analyses are to be performed for primary COPCs (Ra-226 and six metals) and anthropogenic constituents (VOCs, SVOCs, PCBs, and TPH) as shown in Table 3-1. Also included in the analytical program are the agronomic parameters for samples from the capped waste rock pile caps and areas near the capped areas. Engineering parameters will be analyzed only for soil from the capped waste rock piles.

The chemical laboratory analysis will be subcontracted to a qualified laboratory with USEPA certification. QA/QC sampling will be included, and analytical data will be validated according to the QAPP (see Section 4.1).

3.2.1 Analyses

Soil samples will be analyzed for the primary COPCs Ra-226 and six metals as shown in Table 3-1. Ra-226 will be analyzed by USEPA Method 901.1, with a standard 21-day in-growth. In a closed system, the Ra-226 daughters are in equilibrium (equal activity concentrations) with their parent radionuclide. However, during sampling activities, Ra-226 and its daughters are partially depleted due to the emanation of radium-222 (Ra-222), which is a noble gas, at standard temperature and pressure. The loss of Ra-222 creates an unequilibrated lead-214 (Pb-214)/bismuth-214 (Bi-214) concentration. The fraction emanated varies with the containing matrix and atmospheric conditions. The typical emanation is in the range of 20 to 30 percent. That is, results of analysis of Pb-214/Bi-214 would indicate a 20 to 30 percent lower Ra-226 concentration. Once a sample is sealed, daughter product in-growth follows the 3.8-day half-life. After 3.8 days, half of the daughter products are restored. After 7.6 days, three-fourths of the daughter products have grown in, and at 20 days, about 97 percent have grown in. After 20 days, Pb-214/Bi-214 can be considered to be in equilibrium with parent Ra-226. At equilibrium, the higher-abundance Pb-214/Bi-214 provide a quantitative result for Ra-226, having less uncertainty than quantification from the lower-abundance 186-kiloelectron-volt gamma ray directly from Ra-226. Analysis by USEPA Method SW846 6020 will be performed for arsenic, mercury, molybdenum, selenium, uranium, and vanadium.

Samples from eight of the locations will be analyzed for the full suite of analytes shown in Table 2-2. Agronomic and engineering parameters for the capped waste rock piles are shown in Table 2-2. Comparable analytical methods will be evaluated according to accuracy and precision requirements during laboratory subcontract award.

3.2.2 Analytical Laboratory

ALS laboratories will perform the chemical analyses. If requested by USEPA, splits of soil samples will be collected at a rate of 10 percent per survey area and submitted to USEPA's laboratory. Agronomic and engineering parameters will be submitted to AMEC laboratories.

3.3 Field Methods

Field efforts include gamma radiation walkover surveys, static and soil sample surveys, and surface soil, subsurface soil, and waste rock sampling at the site. The following subsections describe the common field methods to be used during Phase 3, including sample documentation, field QC, decontamination, waste sample container management, documentation, and shipment. SOPs for radiological surveys and soil sampling are provided in Appendix C.

Each sample will be field screened and logged before being placed in a sample jar. The gamma radiation detector will be placed on the bagged sample, and the measurement will be recorded in the log as described in Section 3.1.2.2. The soil will be described according to Unified Soil Classification Standards methods as described in the SOP, information will be documented on field forms (Appendix E), and a GPS location will be recorded for the sample. The following minimum data will be recorded for each sample:

- Sample ID
- Sampling date and time
- Radiation measurement and units
- Soil texture, color, moisture, and primary mineralogy
- GPS location

After soil is described, radioactivity readings are taken, and sample depth is selected, the soil will be placed in labeled sample jars and stored for shipment to the analytical laboratory. For soil samples, pieces of organic debris, trash, and rock longer than 2 inches will be excluded from samples where possible. Samples will be contained in unpreserved wide-mouthed glass jars according to the method requirement listed in Table 3-1.

Soil samples collected for agronomic and engineering parameters will be collected at two of the seven boring locations from each waste rock pile, for a total of 4 samples. The sample locations will be selected to characterize the physical and chemical properties and suitability for vegetation growth of the cap material. Intact samples are not required. Samples will be collected by hand with a trowel and double bagged in 1-gallon sealed plastic bags.

3.3.1 Data Collection Locations

Soil sample and radiological measurement locations will be recorded during field investigations by GPS and post-processed to achieve submeter accuracies for the features. The geographic coordinate system used will be World Geodetic System 84.

3.3.2 Field Quality Control Samples

QA/QC samples will be collected as specified in the QAPP (Appendix D, Section 4). Field duplicates will be collected at a 10 percent frequency. If requested, replicate split samples will also be collected at a frequency of 10 percent and provided to USEPA for independent analysis and verification. Matrix spike and matrix spike duplicate samples will be collected at a 5 percent frequency. Equipment rinsate samples will be collected only if nondisposable, nondedicated trowels, scoops, hand augers, or digging bars are used.

Equipment rinsate samples will be collected from the portions of equipment most in contact with sample material subsequent to decontamination. Equipment rinsate samples will be collected with ASTM Type II deionized water at least once daily and once from each background location.

3.3.3 Decontamination Procedures

Decontamination procedures described in this section and in the SOPs are designed to minimize health hazards for field staff and to minimize transport of potentially radiologically contaminated materials. Gross decontamination of reusable personal protective equipment (PPE) and field equipment not used for sampling and field measurements will be performed to prevent transport of, and minimize exposure to, dust and soil with the potential for elevated radionuclide concentrations.

Soil sampling equipment such as trowels, augers, and scoops that come in contact with soils must be decontaminated prior to use for sampling. The equipment must be thoroughly decontaminated by brushing and

washing with distilled water and Alconox solution to remove sediments, and then rinsed twice in distilled water and dried.

Drilling equipment that is used for sampling will be decontaminated prior to collection of each sample. Other drilling tools that are used intrusively will be decontaminated between sample locations. The drill rig will be decontaminated and surveyed for radiation before leaving the job site.

For tools and equipment not used directly for sampling, or those susceptible to water damage, an alternative decontamination procedure should be used. Gross decontamination may be achieved by brushing, followed by wiping with chemical wipes, alcohol swabs, or moist disposable towels.

3.4 Sample Containers, Preservation, and Storage

Sample handling will comply with standard SOPs (Appendix C) and analytical method requirements. Sample materials will be contained in labeled, clean-certified, laboratory-provided containers after field screening. The containers will be stored on ice until they are shipped. Table 3-1 lists sample holding and storage requirements.

3.5 Disposal of Investigation-derived Waste

IDW for the proposed work is expected to be in the form of household garbage, PPE, soil, waste rock, and decontamination liquids. It is expected that a majority of the waste will be disposed of as household waste or managed in a way that prevents waste accumulation. Household garbage may include food, water bottles, packaging material, unused disposable sampling equipment, and wooden stakes or pin flags. The material will be bagged or otherwise containerized during field activities and disposed of in a container for municipal garbage.

Disposable PPE and decontamination wipes (including materials such as gloves, boot covers, chemical wipes, and paper towels) will be placed with like materials in labeled 5-gallon buckets with lids or in other suitable containers such as drums. The materials will be scanned with a radiation detector to allow evaluation of whether the material is suitable for disposable at a municipal landfill. If radiation levels from containerized PPE are greater than three times the background measurements, the waste will be labeled as potentially radiologically impacted waste and retained for additional characterization and proper disposal. Waste will be disposed according to applicable regulatory requirements.

Decontamination liquids will be managed to prevent accumulation of waste. Small quantities of liquids used to decontaminate PPE, such as glasses and boots, will be placed on the ground where decontamination occurs and allowed to evaporate. Field measurement, surface sampling, and hand-auger equipment will be decontaminated in a way that minimizes use of liquids (such as by use of dry brushing and chemical wipes). The decontamination liquids will be returned to the holes, along with the excess soil, and used to compact the material and restore the ground surface. Larger volumes of decontamination liquids will be generated to decontaminate drilling equipment. The liquids will be accumulated in a drum, holding tank, or in a temporary decontamination pad. Where possible, decontamination liquids will be used to hydrate bentonite seals that are used to abandon boreholes. Excess liquids will be allowed to evaporate from holding tanks or decontamination pad.

Soil IDW will be managed in a way that prevents waste accumulation. Where possible, soil IDW will be replaced in the boreholes from which they were sourced. Excess soil material will be spread on the ground surface in the area surrounding soil borings. Excess mine waste rock IDW from soil borings is expected to be of minimal volume of less than one cubic yard for each capped waste rock pile. The material will not be transported offsite, but will be buried onsite and covered with a minimum of 12 inches of local borrow fill to be sourced from adjacent native soil. Excess IDW soil that is not mine waste rock will be screened onsite, sampled, and profiled for offsite disposal at a CERCLA-permitted disposal facility.

3.6 Sample Documentation and Shipment

3.6.1 Field Notes

Field activities will be documented by field notes and photographs to provide a record of activities performed at the site. Field-note procedures should comply with SOPs and include the following information, at a minimum:

- Site conditions
- Staff onsite
- Safety briefing topic
- Activities performed, with description, date, and time
- Field measurements, with location and time
- Field samples collected, with time and sample identifiers

Photographic documentation of field procedures, sample locations, and site conditions is recommended. A detailed photographic log should be generated while collecting photographs.

3.6.2 Sample Identification

Sample identifiers should be consistent and will be in the following format:

AAAA-BBBBBBBB-CC-DDD

A: The first four digits will indicate the site location such as RM01 for Ruby Mine No. 1.

B: The next four to eight digits will be the specific sample identifiers, which include the mine feature and a consecutive numerical identifier. Examples are COR01 for the first correlation sample, and CWRP04 for the fourth capped waste rock pile sample. For QC samples that are not associated with a mine feature, for example, rinsate blanks, the digits should be the date of collection. For example, 14AUG2014.

C: The last two digits will indicate the interval of collection for the samples. Examples are 0.0-0.5 for surface soil samples, 00 for equipment rinsates, and 4.0-5.0 for samples from 4 to 5 feet.

D: The last two to three digits will indicate the type of QC sample, if applicable. For example, DUP is for a field duplicate, MS is for a matrix spike.

Guidance on sample identifiers is provided in Appendix B and shown in Figures 3-2 through 3-9. Sample identifiers will match across the GPS data, sample container data, and laboratory chains of custody. Any field changes or discrepancies will be recorded in the field logbook.

3.6.3 Labeling

Sample identification numbers and labels will be obtained from the CH2M HILL data manager before sampling is performed. Sample labels will be attached directly to the sample container.

The following information will be included on the sample label:

- Project name
- Unique sample ID
- Date sampled
- Time sampled (in military time)
- Initials of sampler(s)
- Parameter for which the container is intended

3.6.4 Chain of Custody

The chain-of-custody form is a vital document for samples collected, and it must be properly completed.

Sample identifiers will be in a consistent format that will incorporate the sample location, media, QA/QC type, and depth. It serves as a record of sample collection information, analysis requests, and sample tracking, and is crucial to maintain from the time of sample collection to final reporting and decision making.

The following information will be recorded in the chain-of-custody record at the time of sample collection:

- Project name
- Project number
- Field Team leader's name
- Sample date
- Sample time
- Unique sample ID
- Number of containers for each sample
- Parameters to be analyzed for each sample
- Special analytical requests (for example, fast turnaround requirement)
- Sampler's name
- Laboratory name

3.6.5 Packaging and Shipment

Sample possession will be traceable from the time of sample collection until receipt of the sample at the analytical laboratory. Sample possession will be documented according to the chain-of-custody procedures outlined in the following subsections.

3.6.5.1 Field Custody

Samples will be in the custody of the field sampler from the time of collection until they are transferred to the proper dispatcher. Samples will be packed with inert packing material (for example, bubble wrap or plastic netting) to prevent breakage. For samples requiring a 4 degrees Celsius (°C) holding temperature, samples will be packed in a cooler with ice packs or "blue ice." At the end of the sampling effort each day, the field team leader will inventory the samples against the chain-of-custody form.

3.6.5.2 Sample Transfer of Custody and Shipment

Generally, samples will be sent overnight to the laboratory using air or ground transport. In some cases, samples may be delivered to the analytical laboratory by a member of the CH2M HILL field sampling team, or a representative from the laboratory may pick up the samples onsite.

Upon transferring custody of the samples, the individuals relinquishing and receiving them will sign, date, and note the time of transfer on the chain-of-custody record(s). The method of shipment, courier name, and other pertinent information will be entered in the remarks section of the chain-of-custody record. Once the record is completed, the carbon copies will be separated. The field member who relinquished the samples will retain a copy, and the original will accompany the containers to the laboratory. The field copy will be delivered to the CH2M HILL data manager and stored in the project files.

Before a sample leaves the site by means other than laboratory courier or CH2M HILL personnel, the chain-of-custody record will be placed in a sealed plastic bag and taped to the inside of the sample shipment container. The container will be sealed with fiber tape, and a custody seal will be signed and dated by the relinquishing party and placed on the container so that the container cannot be opened without breaking the custody seal. CH2M HILL's carbon copy will be delivered within 24 hours to the CH2M HILL data manager. A chain-of-custody record will be maintained in the project files.

Within 24 hours of sample receipt, the laboratory will send a letter acknowledging sample receipt to the CH2M HILL data manager. In the acknowledgment letter, the laboratory will list the samples received, the associated laboratory IDs, and any problems encountered at sample receipt.

Changes to the analyses requested on the chain-of-custody record (that is, by follow-up phone call from CH2M HILL) will be noted, initialed, and dated on the chain-of-custody copies retained by both the laboratory and CH2M HILL. Upon completion of analysis, the analytical laboratory will send copies of the appropriate chain-of-custody record for each sample to the CH2M HILL data manager.

Quality Assurance Program

4.1 Quality Assurance Project Plan

A QAPP was developed for the project and is presented in Appendix D. The QAPP was prepared to describe the project requirements for field and contract laboratory activities, as well as data assessment activities associated with this work plan. The QAPP presents in specific terms the policies, organization, functions, and QA/QC requirements designed to meet the DQOs for the sampling activities described in this work plan. Additionally, the QAPP establishes the analytical protocols and documentation requirements involved with evaluating whether the data are collected, reviewed, and analyzed consistently. The QAPP was prepared in accordance with the USEPA guidance document *Guidance for Quality Assurance Project Plans*, EPA/240/R-02/009 (USEPA, 2002a).

4.2 Data Management

The QA program will follow CH2M HILL standard procedures for environmental data collection. Collection of environmental data for the program will follow the policies, procedures, and protocols of the project-specific data management plan. At a minimum, the data users must have rapid access to stored data and data entry capabilities. They must also manage sample data using unique sample identification numbers; establish a sample inventory of new data collected and provide methods of sample inventory reconciliation; store and provide sample-specific attributes, including location identifiers, sample type and media, and sample date; and provide reporting and delivery formats to support data analysis and reduction.

4.2.1 Archiving

Hard copy and electronic versions will be archived in project files and on electronic archive tapes for the duration of the project, 7 years, or as specified in ASAOC.

4.2.2 Data Flow and Transfer

The data flow from the laboratory and field to the project staff and data users will be sufficiently documented so that the data are properly tracked, reviewed, and validated for use.

4.2.3 Record Keeping

In addition to the laboratory data management procedures outlined in Section 7.1 of the QAPP (Appendix D), the laboratory will maintain electronic and hard copy records sufficient to recreate each analytical event. At a minimum, the laboratory will keep records containing raw data, including instrument printouts, bench worksheets, and/or chromatograms, with compound identification and quantitation reports, and laboratory-specific written SOPs for each analytical method and QA/QC function in place at the time of analysis of project samples.

4.3 Assessment and Oversight

4.3.1 Assessments and Response Actions

The counting systems and instruments used in support of this Phase 3 fieldwork will be calibrated in accordance with ANSI N323A, 1997, with a source traceable through the National Institute of Standards and Technology, at intervals not exceeding 12 months for laboratory counting systems and not exceeding 12 months for portable field survey instruments. The source used will be appropriate for the type and energy of the radiation to be detected. Calibrations will be documented, and the documentation will include the source data.

4.3.1.1 Source and Instrument Checks

Each day that a counting system and instrument are used, the system's response will be checked using an appropriate source before use. In addition, the following procedures will be followed:

- For field instrumentation, source-check acceptance criteria (for example, ± 2 sigma for direct [integrated] measurements and ± 20 percent for rate measurements) will be established prior to beginning the work.

- Source check results will be documented on appropriate forms.
- If a source check fails, it will be repeated. Consecutive failure will result in additional testing of the counting system, in accordance with the applicable procedure, and ultimately may require removing the counting system from service.
- Survey data acquired prior to an instrument failing a source check will be reviewed and documented by the onsite radiological field technician or radiation safety officer to determine the validity of the data.
- If an instrument fails in the field, the onsite radiological field technician or radiation safety officer will investigate suspect data and document the investigation.

4.3.2 Nonconformance and Corrective Action

Corrective action may be required as a result of deviations from field or analytical procedures. Deficiencies identified in audits and data quality evaluations may also call for corrective action. Project personnel have the responsibility, as part of normal work duties, to identify, report, and solicit approval of corrective actions for conditions adverse to data quality.

The QAPP has specified the corrective action to be taken when deviations from calibration and QC acceptance criteria occur. Field and laboratory staff may encounter conditions that require immediate corrective action that are not addressed in the work plan. The personnel will document conditions and the results of corrective actions in a field logbook or laboratory nonconformance report and communicate their actions as soon as feasible to the field team leader, laboratory supervisor, and, if necessary, the project chemist for immediate input. A mechanism will be in place to allow for supervisory review and/or client input for deviations or deficiencies. A corrective action reporting system that requires immediate documentation of deviations or deficiencies and for supervisory review of the actions taken to correct them will be established. At a minimum, the corrective action report should include the following information:

- The type of deviation or deficiency
- The date of occurrence
- The impact of the deviation or deficiency, such as samples affected
- The corrective action taken
- Documentation that the process has been returned to control

Each corrective action report must be reviewed and approved by an authority, such as the field team leader or laboratory supervisor. The laboratory QC manager is ultimately responsible for the laboratory corrective action process, and must confirm that out-of-control or nonconformance events are properly documented, approved, and closed out. A corrective action report will summarize each nonconformance condition, and will be forwarded to the field team leader or project chemist. Copies of corrective action reports must be maintained in the laboratory or field project files.

4.3.3 Data Validation and Usability

Data is validated to see that the requirements stated in the planning documents are implemented as prescribed and that the results of the data collection activities support the objectives of the work plan as documented in the QAPP. Data quality assessment is the scientific and statistical evaluation of data to assess whether the data are of the right type, quality, and quantity to support their intended use.

4.3.4 Verification and Validation Methods

Laboratories are required to submit a data package in accordance with the requirements defined in the QAPP. Data from contract laboratories associated with field activities will undergo Level III validation, and 10 percent of the data will undergo Level IV data validation. For Level III, summary forms are reviewed, but the raw data are not reviewed. The Level III review includes laboratory and field QC sample results to determine whether the analytical process is in control.

Each sample will be verified during validation to ensure that the procedures used to generate the data were implemented as specified. Data validation activities should determine how much a sample deviated beyond the acceptable limit so that the potential effects of the deviation can be evaluated during data quality assessment.

This work plan specifies the QC checks that are to be performed during sample collection, handling, and analysis to indicate the quality of data being produced by specific steps of the measurement process. Checks include calibration and analyses of check standards, blanks, spikes, and replicates.

Data validation should document any corrective actions that were taken, which samples were affected, and the potential effect of the actions on the validity of the data. When issues are identified in the verification and validation process, the validator will make appropriate comments and/or assign data flags to alert the data user to potential limitations on the usability of the data.

Level IV data validation consists of the following: reviewing and cross-checking all required data deliverables; reviewing all raw data; recalculating all values, including standards concentration, reagent preparation, percent moisture values, analytical results, etc.; comparing all recalculated values to the reported values; and flagging all data that were not produced in accordance with the specifications set forth in this work plan and laboratory QAPP. All electronic copy entries will be verified against hard-copy results reported by the laboratory and sampling personnel. If the hard copy is generated by the same information management system used to store the electronic data, this review is not required.

4.3.5 Reconciliation with User Requirements

Data collected during the field activities will be reconciled with the requirements of the data user.

The following are the five steps in the data QA process:

1. Review the DQOs and sampling design.
2. Conduct a preliminary data review.
3. Select the statistical test.
4. Verify the assumptions of the statistical test.
5. Draw conclusions from the data.

The data QA process is applied iteratively, and it progresses in a logical and efficient manner to promote understanding of how well the data will meet their intended use.

Project Management

5.1 Project Organization and Key Personnel

The responsibilities and contact information for key project personnel are listed in Table 5-1.

TABLE 5-1

Project Personnel Contact Information

Name	Organization	Title	Contact Information
Stuart Brown	WNI	Project Coordinator	Phone: 602/448-0972 Email: Stuart_Brown@fmi.com
Liz Dodge	CH2M HILL	Project Manager	Phone: 510/579-1002 Email: edodge@ch2m.com
Jennifer Laggan	CH2M HILL	Field Investigation Task Manager	Phone (work): 720/286-0513 Phone (mobile): 303/249-4273 Email: jlaggan@ch2m.com
Jeff Hilgaertner	CH2M HILL	Health and Safety Manager	Phone (work): 480/626-4632 Phone (mobile): 714/552-1971 Email: Jeffrey.hilgaertner@ch2m.com
Mark Fesler	CH2M HILL	Project Chemist	Phone (work): 530/229-3273 Phone (mobile): 530/524-8041 Email: Mark.Fesler@ch2m.com
Kira Sykes	CH2M HILL	Radiation Health Physics	Phone (work): 503/872-4510 Phone (mobile): 503/819-8660 Email: Kira.sykes@ch2m.com

The responsibilities for key project personnel are described in the following subsections.

5.1.1 Project Coordinator

The project coordinator, Stuart Brown, is responsible for the following: overall program execution and quality, execution of the work plan activities, and assurance of the quality of the data collected and interpretations presented in the investigation report. He is also the WNI lead on all agency communications.

5.1.2 CH2M HILL Project Manager

The CH2M HILL project manager, Liz Dodge, is responsible for project management, QC, document preparation and review, field activities, and preparation of the Phase 3 work plan and Phase 3 report.

5.1.3 CH2M HILL Field Investigation Task Manager and Data Manager

The CH2M HILL field investigation task manager, Jennifer Laggan, is responsible for coordinating the investigations and surveys, staffing and managing execution of field activities, and managing subcontractor personnel. She also is responsible for coordinating and overseeing compilation, updating, and maintenance of an electronic database of analytical data, field measurements, and associated data validation information.

5.1.4 Health and Safety Manager and Radiological Safety Officer

Jeff Hilgaertner is CH2M HILL's health and safety manager and is responsible for preparing and overseeing the implementation of the Ruby Mines health and safety plan included in Appendix F of this work plan. Jeff Thompson is the radiation safety officer serving as the principal technical resource to the team on radiation safety. He recommends and implements radiation safety policies and procedures. Field investigation team members Luke Hill and Ben Moayyad will also serve as site safety officers under the direction of the health and safety manager.

5.1.5 CH2M HILL Data Quality Manager and Project Chemist

The CH2M HILL data quality manager and project chemist, Mark Fesler, is responsible for overseeing project analytical activities and developing laboratory analytical reports in a timely manner. He is also responsible for managing the analytical laboratory, coordinating and overseeing the laboratory QA program, and validating the analytical data.

5.1.6 Radiological Specialist

The radiological technical specialist, Kira Sykes, is responsible for planning and overseeing the radiological surveys and sample collection subcontractor, Permafrix, as well as for evaluating and interpreting the results.

5.1.7 Field Investigation Team Members

Soil sample collection and radiation surveys will be performed by CH2M HILL's subcontractor, Permafrix. They will be overseen by CH2M HILL's field team member Ben Moayyad, who is responsible for implementing the field activities described in this work plan under the direction of the CH2M HILL field investigation task manager.

5.1.8 Regulatory Oversight

USEPA Region 9 will oversee the work. The USEPA Region 9 remedial project manager is Mark Ripperda. The Navajo Nation Environmental Protection Agency (NNEPA) representative is Stanley Edison.

5.2 Schedule and Deliverables

Fieldwork will begin within 30 days after USEPA's approval of this work plan. Access on Navajo trust lands, including grazing lands, has been obtained. An estimated 3 to 5 weeks will be needed to mobilize and to coordinate oversight by USEPA and NNEPA, conduct the fieldwork, and demobilize. Laboratory analysis will require 3 weeks for validated metals data, agronomic parameters, and engineering parameters. Analysis and validation of radionuclide data will require 6 weeks due to the in-growth time required.

The initial phase of the fieldwork will include performing the gamma radiation walkover survey. The DPT rig drilling in the capped waste rock piles will be conducted concurrently with surface soil and shallow subsurface soil sample collection that is done by manual methods. The data analysis and preparation of a draft investigation report will be submitted 90 days following receipt of validated analytical data.

A copy of unvalidated laboratory results will be provided to USEPA within 5 days of receiving the data per the ASAOC requirements.

A Final Removal Site Evaluation and Completion Report will be prepared documenting the results of the Phase 3 investigation following the requirements of the ASAOC. The report will include the following:

- A summary of fieldwork performed
- Updated figures of site features, including GPS coordinates
- Updated CSM and general extent of residual radioactivity from Phase 2 and 3 fieldwork (a combined data set)
- Summary of results, including figures with gamma radiation survey results and table of laboratory data for combined data set
- Results of the linear regression analysis for Ra-226
- QA/QC evaluations
- Laboratory reports
- Field data

A draft Ruby Mines Final Removal Site Evaluation and Completion Report will be submitted to USEPA and NNEPA for review. Comments will be submitted in writing, and once comments have been received, a comment response document will be provided to USEPA. A teleconference or meeting may be required to discuss comments and comment responses. The report will be revised based on comment adjudication.

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TABLE 1-1

Historical Ruby Mines Closed Features*Ruby Mines Phase 3 Work Plan*

Feature Description	Unique Identifier^a	Status
Ruby Mine No. 1 adit	RUBY-001	Closed during Phase 1
Ruby Mine vent	RUBY-002	Closed during Phase 1
Ruby Mine No. 3 adit	RUBY-003	Closed during Phase 1
Ruby Mine vent	RUBY-004	Closed during Phase 1
Shaft	RUBY-011	Historically Closed
Ruby Mine vent	RUBY-015	Historically Closed
Prospect	RUBY-016	Closed during Phase 1
Shaft	RUBY-017	Closed during Phase 1
Trash pit/Ruby Mine vent	RUBY-018	Closed during Phase 1
Ruby Mine vent	RUBY-019	Historically Closed
Prospect	RUBY-020	Closed during Phase 1
Shaft	RUBY-021	Closed during Phase 1
Ruby Mine vent	RUBY-022	Closed during Phase 1

^a“RUBY-XXX” is a unique location identifier assigned by the Freeport-McMoRan Historic Mine Opening Safety Program

TABLE 2-1

Ruby Mines Features For Investigation*Ruby Mines Phase 3 Work Plan*

Feature Designation	Feature Description
Ruby Mine No. 1	Capped waste rock pile Drainages A, B, C Former haul road to Wolf Canyon Road Former haul road at Wolf Canyon Road - isolated location near BIA Route 49 Work area within the step out area Step out area
RUBY-002	Ruby Mines vent
Ruby Mine No. 3	Capped waste rock pile Dewatering area Drainages Work Area
RUBY-004	Ruby Mines vent
RUBY-019	Ruby Mines vent

TABLE 2-2

Overview of Phase 3 Investigation*Ruby Mines Phase 3 Work Plan*

		Soil Sample Collection Program					
		Number of		Laboratory			
Feature Designation	Feature Description	Sample Locations	Proposed Sample Intervals (feet)	Analysis - Primary COPCs ^b	Laboratory Analysis - Full Suite ^c	Agronomic Parameters	Engineering Parameters
RUBY-002	Ruby Mines vent	3	0-0.5, 1-1.5	X			
RUBY-004	Ruby Mines vent	3	0-0.5, 1-1.5	X			
RUBY-019	Ruby Mines vent	3	0-0.5, 1-1.5	X			
Ruby Mine No. 1	Capped waste rock pile - cap	7	0-0.5 and every 5 feet thereafter until bottom of cap is reached.	X		X ^a	X ^a
	Capped waste rock pile - waste rock	7	Every 5 feet	X			
	Capped waste rock pile - soil beneath waste rock	7	Underlying soil: 1-1.5 and every 5 feet thereafter for 20 feet or until bedrock is reached.	X			
Ruby Mine No. 3	Capped waste rock pile - cap	7	0-0.5	X		X ^a	X ^a
	Capped waste rock pile - waste rock	7	Every 5 feet	X			
	Capped waste rock pile - soil beneath waste rock	7	Underlying soil: 1-1.5 and every 5 feet thereafter for 20 feet or until bedrock is reached.	X			
Ruby Mine No. 1	Drainages A, B, C	3	0-0.5, 1-1.5, 5-5.5	X			
Ruby Mine No. 3	Drainages	3	0-0.5, 1-1.5, 5-5.5	X			
Ruby Mine No. 3	Dewatering area	3	0-0.5, 1-1.5, 5-5.5	X			
Ruby Mine No. 1	Former haul road to Wolf Canyon Road	3	0-0.5, 1-1.5, 5-5.5	X			
Ruby Mine No. 1	Former haul road - Wolf Canyon Road - isolated location near BIA Route 49	3	0-0.5	X			
Ruby Mine No. 1	Step out area	5	0-0.5, 1-1.5, 5-5.5	X			
Ruby Mine No. 1	Work Area within the step out area	4	0-0.5, 1-1.5, 5-5.5	X	X		
Ruby Mine No. 3	Work Area	4	0-0.5, 1-1.5, 5-5.5	X	X		
Additional Correlation Samples		30	0 - 0.5	Ra-226 only			

Notes:

^a One surface soil sample will be collected on each waste rock cap for agronomic and engineering parameters. One sample will be collected near each waste rock cap for agronomic analysis only.

^b Ra-226 and six metals (arsenic, vanadium, molybdenum, selenium, uranium, and mercury)

^c VOCs, SVOCs, PCBs, and TPH

TABLE 3-1

Sample Container, Preservative, and Holding Time Requirements*Ruby Mines Phase 3 Work Plan*

Parameter	Matrix	Method ^b	Sample Container and Size	Preservative	Holding Time	Storage Requirements
Primary Contaminants of Potential Concern						
Radium-226	Soil	USEPA 901.1	8-ounce wide-mouth bottle	None	NA	None
Select metals ^a	Soil	SW846 6020/7471A	4-ounce wide-mouth bottle	None	6 months	4 °C
Full Suite Analysis						
VOC	Soil	SW846 8260B	3 40-milliliter vials	methanol	7 days	4 °C
SVOC	Soil	SW846 8270C	8-ounce wide-mouth bottle	None	14 days	4 °C
PCB	Soil	SW846 8082	8-ounce wide-mouth bottle	None	14 days	4 °C
TPH	Soil	SW846 8015M	8-ounce wide-mouth bottle	None	14 days	4 °C
Perchlorate	Soil	SW846 6860	4-ounce wide-mouth bottle	None	14 days	4 °C
Agronomic Parameters						
pH	Soil	SW9045	8-ounce wide-mouth bottle	None	NA	4 °C
Anions by IC	Soil	SW9056	8-ounce wide-mouth bottle	None	NA	4 °C
Cations by ICP	Soil	SW6010B	8-ounce wide-mouth bottle	None	NA	4 °C
Electrical Conductivity	Soil	ASA No. 9; Method 10-3.3	8-ounce wide-mouth bottle	None	NA	None
Sodium Absorption Ratio (SAR)	Soil	ASA No. 9; Method 10-3.4	8-ounce wide-mouth bottle	None	NA	None
Organic Carbon by Walkley-Black Procedure	Soil	ASA No. 9; Method 29-3.5.2	8-ounce wide-mouth bottle	None	NA	4 °C
Engineering Parameters						
Soil Moisture	Soil	ASTM D2216	8-ounce wide-mouth bottle	None	7 days	4 °C
Grain Size Distribution	Soil	ASTM D422	Shelby Tube (sample must be of known volume)	None	NA	None
Dry Density	Soil	ASTM D2937	8-ounce wide-mouth bottle	None	NA	None
Plasticity Index (Atterberg Limits)	Soil	ASTM D4318	8-ounce wide-mouth bottle	None	NA	None

Notes:

^a Arsenic, mercury, molybdenum, selenium, uranium, and vanadium^b Comparable agronomic substitutions are ASTM D2216 water content, Calculation for SAR, and SW9060 for organic carbon

°C = degrees Celsius

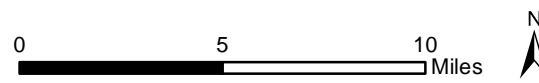


Figure 1-1
Ruby Mines General Location Map
Ruby Mines Phase 3
Removal Site
Evaluation Work Plan
CH2MHILL.

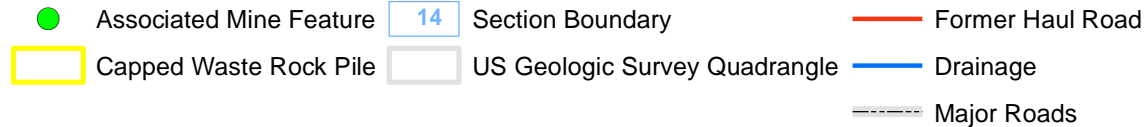
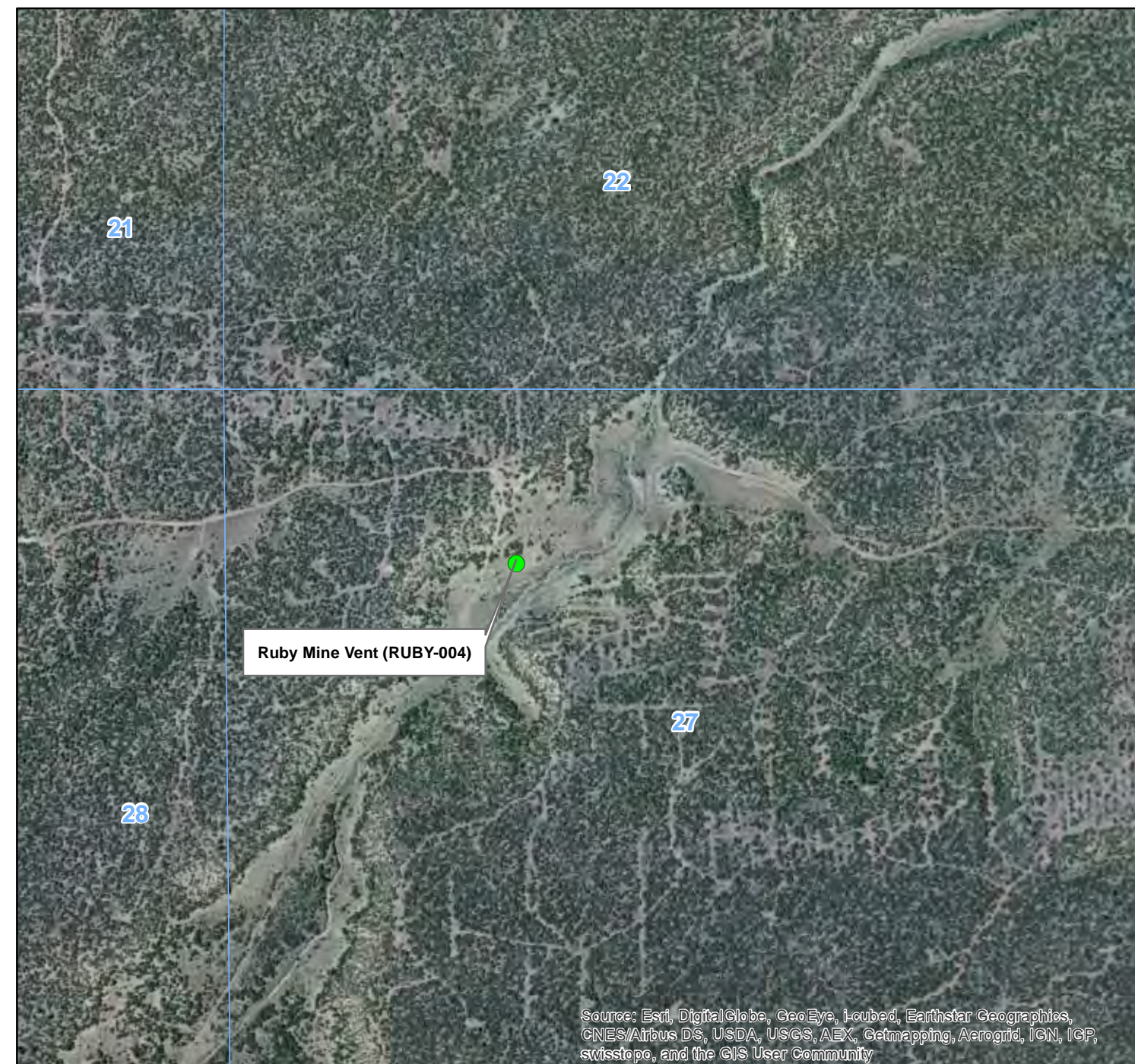
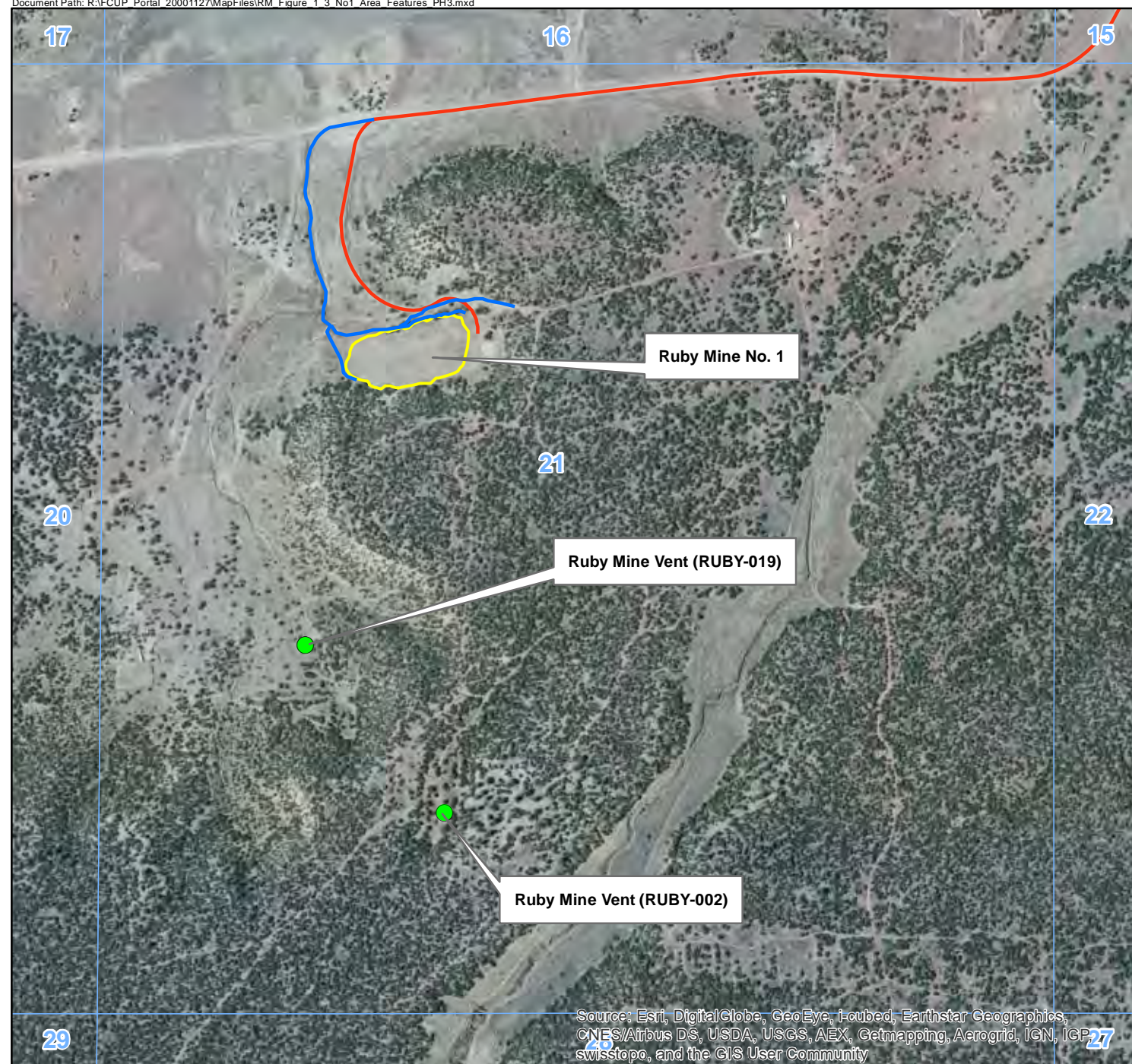


Figure 1-2
Ruby Mines Site Layout
Ruby Mines Phase 3 Removal Site Evaluation Work Plan



Legend

- Associated Mine Features
- Former Haul Road
- Drainage
- 14 Section Boundary
- Capped Waste Rock Pile

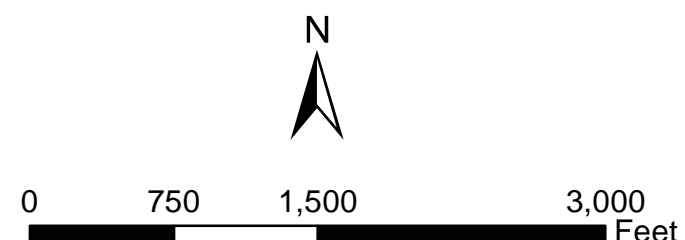
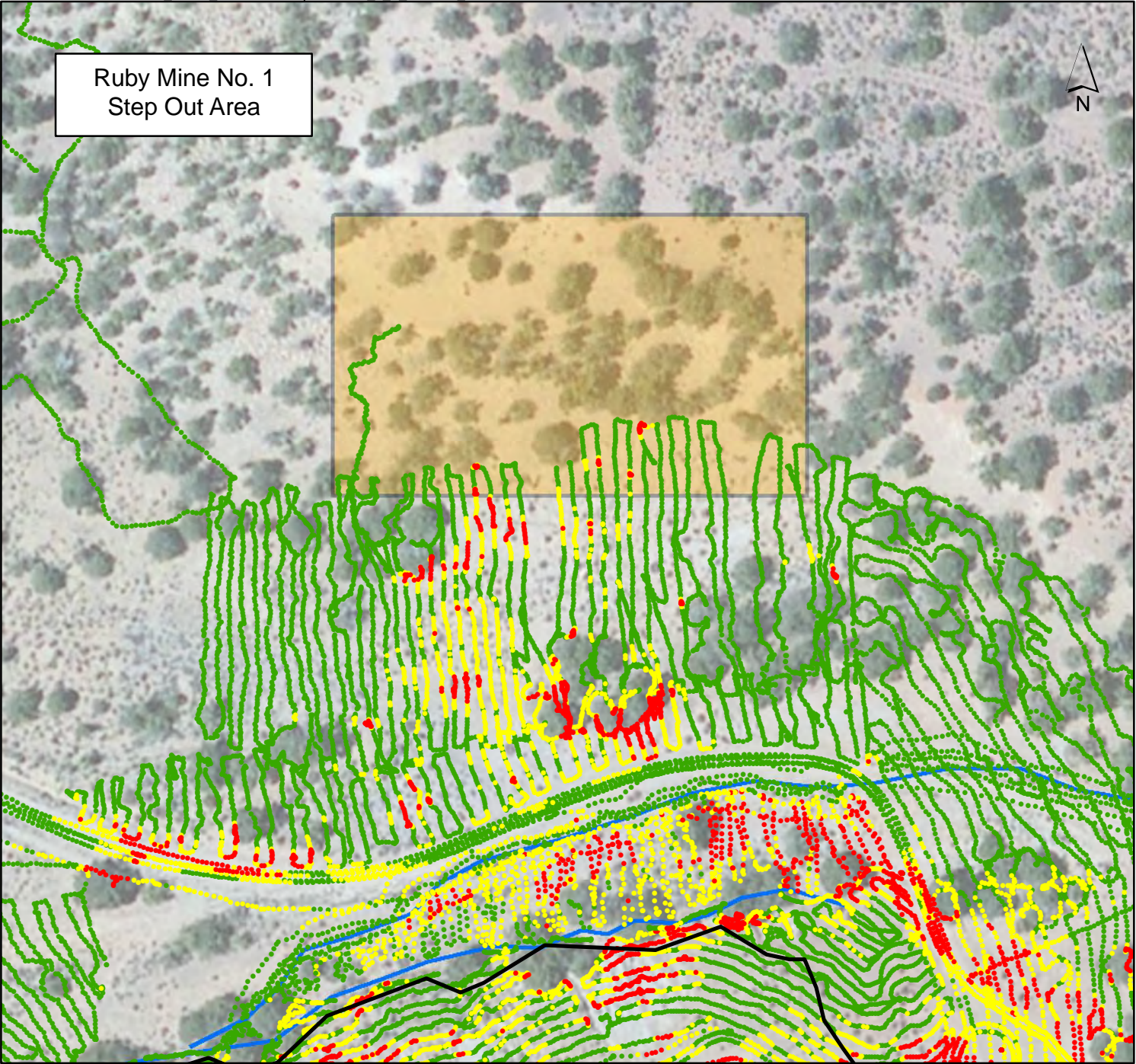


Figure 1-3
Ruby Mine No. 1 Features
Ruby Mines Phase 3 Removal Site Evaluation Work Plan

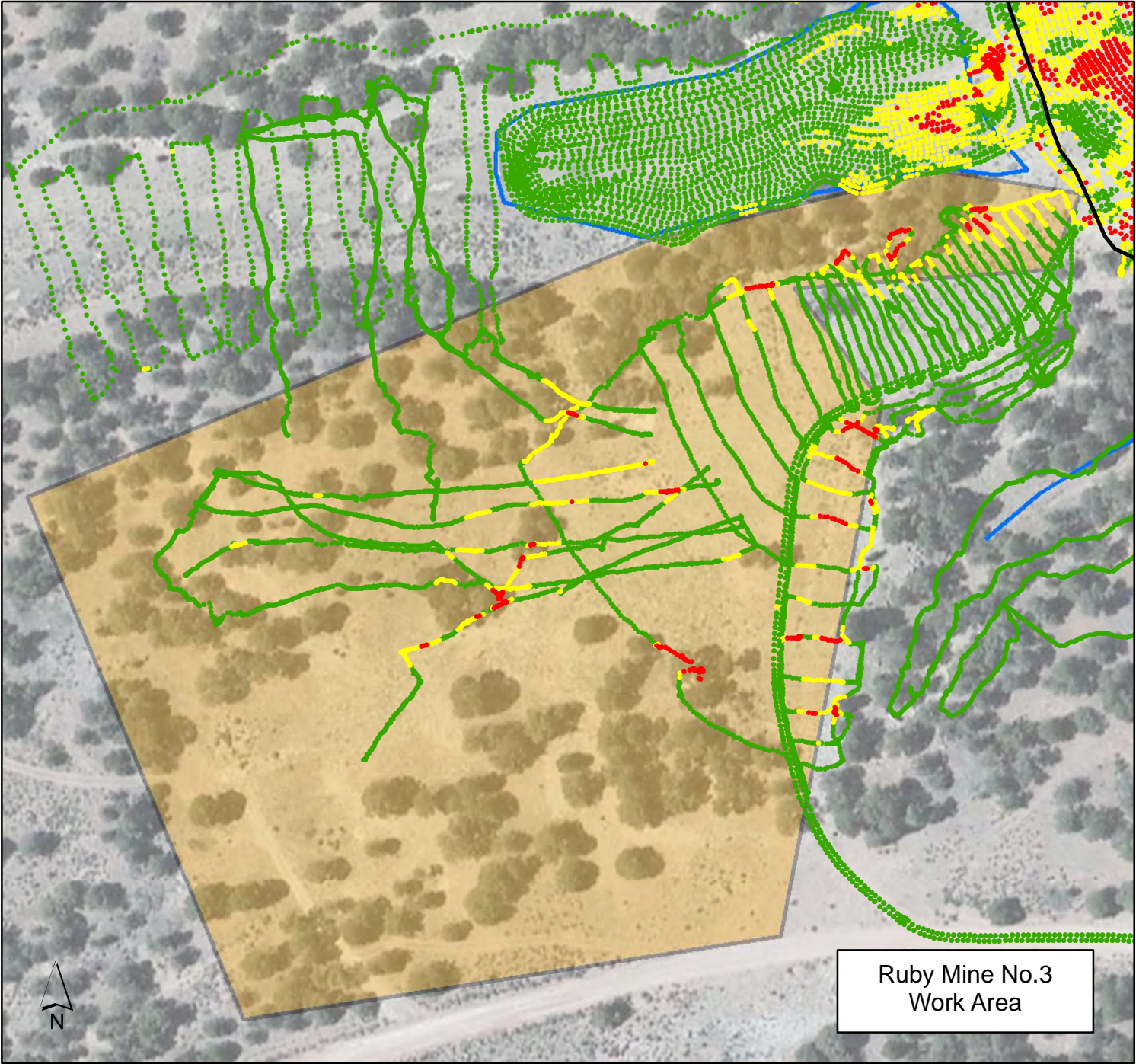


0 62.5 125 250
Feet

Phase 2 Gamma Radiation Survey Results (Ruby Mine No. 1)

- < 24808 (< 2x Background)
- 24809 - 37212 (2x Background - 3x Background)
- > 37213 (> 3x Background)

Approximate Area of Additional Gamma Radiation Survey



0 100 200 400
Feet

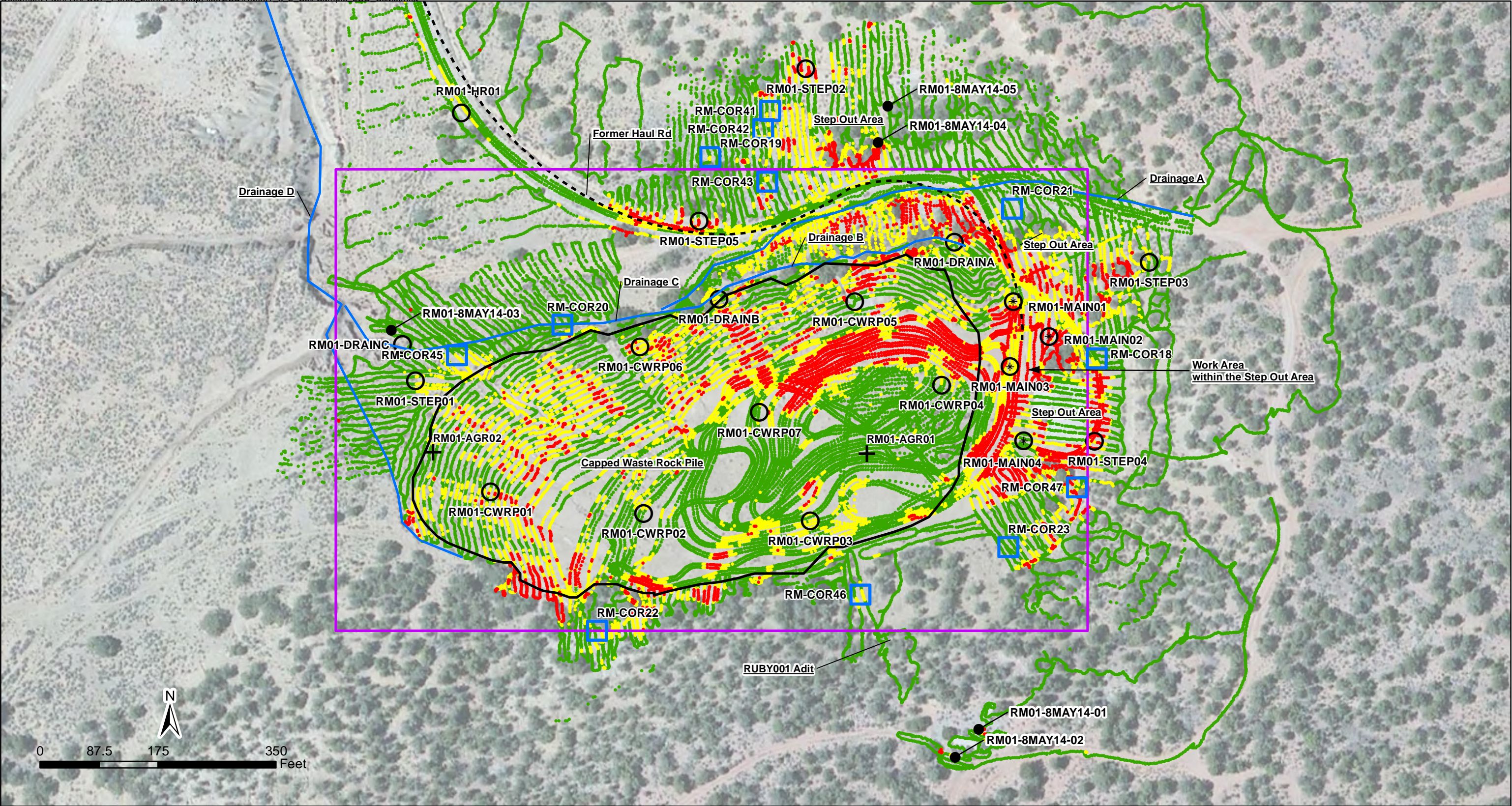
Phase 2 Gamma Radiation Survey Results (Ruby Mine No. 3)

- < 23892 (< 2x Background)
- 23893 - 35838 (2x - 3x Background)
- >35839 (> 3x Background)

Note * Predominant geology for Ruby Mine No. 3 is Mancos Shale
**Predominant geology for Ruby Mine No. 1 is Colluvium
Background Mancos Shale = Mean + 2 standard deviations = 11946 cpm
Background Colluvium = Mean + 2 standard deviations = 12404 cpm

Note: Area for survey is approximate and could extend beyond these boundaries.

Figure 3-1
Gamma Radiation Survey Areas
Ruby Mines Phase 3 Removal Site Evaluation Work Plan



Legend

Phase 2 Gamma Radiation Results (except Adit)*

- < 24808 (< 2x Background)
- 24809 - 37212 (2x Background - 3x Background)
- > 37213 (> 3x Background)

Phase 2 Gamma Radiation Results (Adit)**

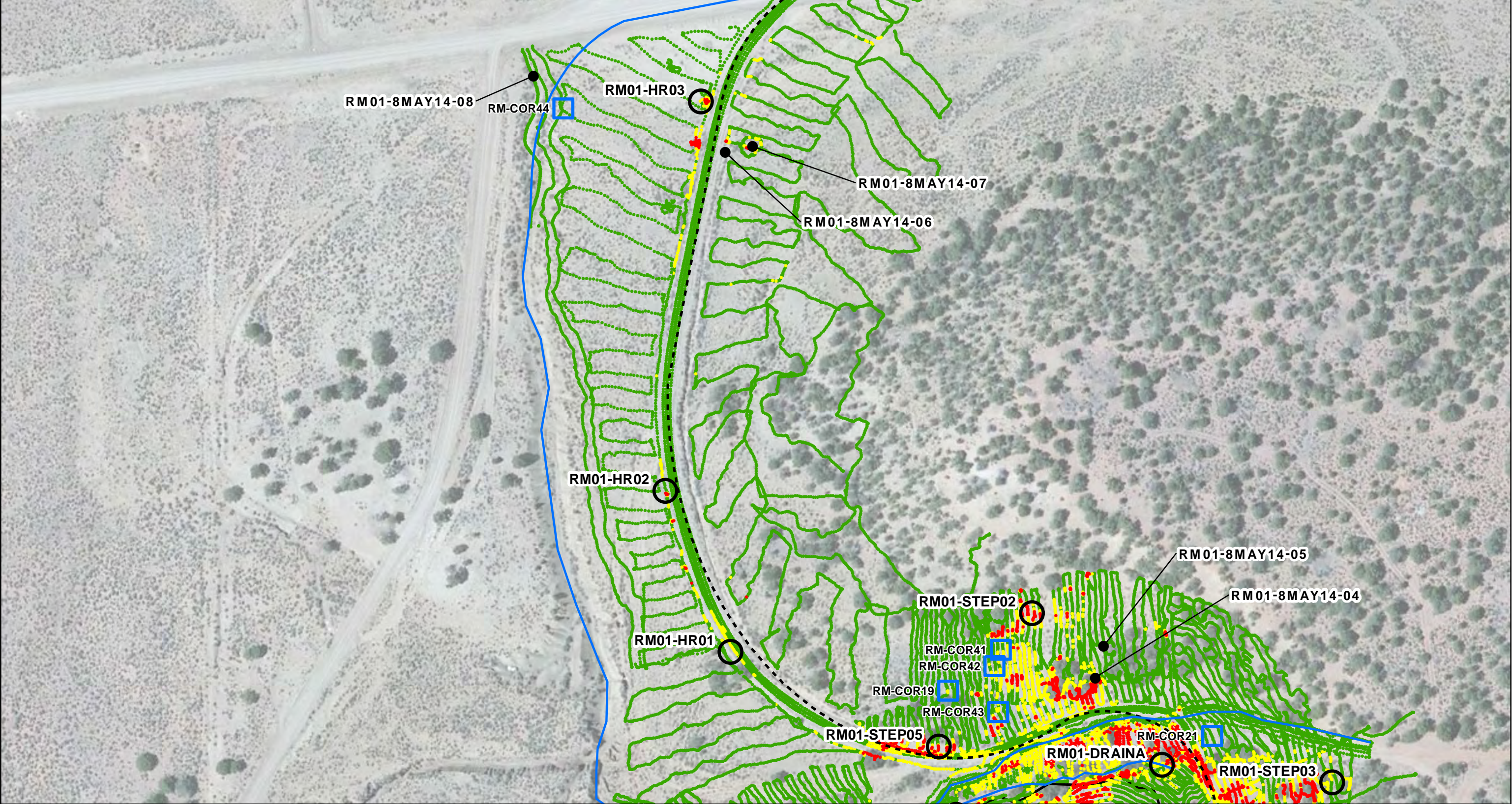
- < 23892 (< 2x Background)
- 23893 - 35838 (2x - 3x Background)
- > 35839 (> 3x Background)

- Phase 2 Soil Sample Location
- Agromatic Sample Location
- Proposed Soil Sample Location
- Proposed Soil Sample Location Selected for Full Suite Laboratory Analysis
- Approximate LiDAR Boundary

- Soil Correlation Sample Location
- Capped Waste Rock Pile
- Former Haul Road
- Drainage

Note* Predominant geology is Colluvium
**Geology for adit is Mancos Shale
Background Mancos Shale = Mean + 2 standard deviations = 11946 cpm
Background Colluvium = Mean + 2 standard deviations = 12404 cpm

Figure 3-2
Ruby Mine No. 1 Soil Sample Locations
Ruby Mines Phase 3 Removal Site
Evaluation Work Plan



Legend

Phase 2 Gamma Radiation Survey Results

- < 24808 (< 2x Background)
- 24809 - 37212 (2x Background - 3x Background)
- > 37213 (> 3x Background)

Note: Predominant geology is Colluvium
Background = Mean + 2 standard deviations = 12404 cpm

- Phase 2 Soil Sample Location
- Proposed Soil Sample Location
- Capped Waste Rock Pile
- Soil Correlation Sample Location
- Former Haul Road
- Drainage

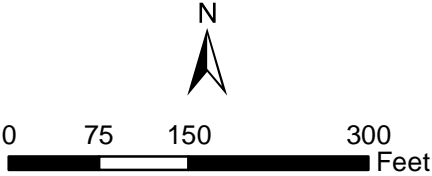


Figure 3-3
Ruby Mine No. 1 Former Haul Road Sample Locations
Ruby Mines Phase 3 Removal Site Evaluation Work Plan



Legend

Phase 2 Gamma Radiation Survey Results

- < 24808 (< 2x Background)
- 24809 - 37212 (2x Background - 3x Background)
- > 37213 (> 3x Background)

Note: Predominant geology is Colluvium
Background = Mean + 2 standard deviations = 12404 cpm

- Proposed Soil Sample Location
- Former Haul Road
- Paved Road

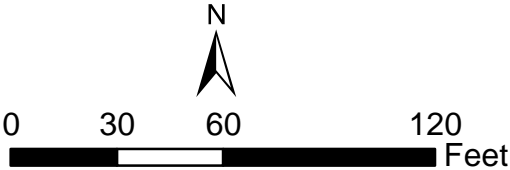
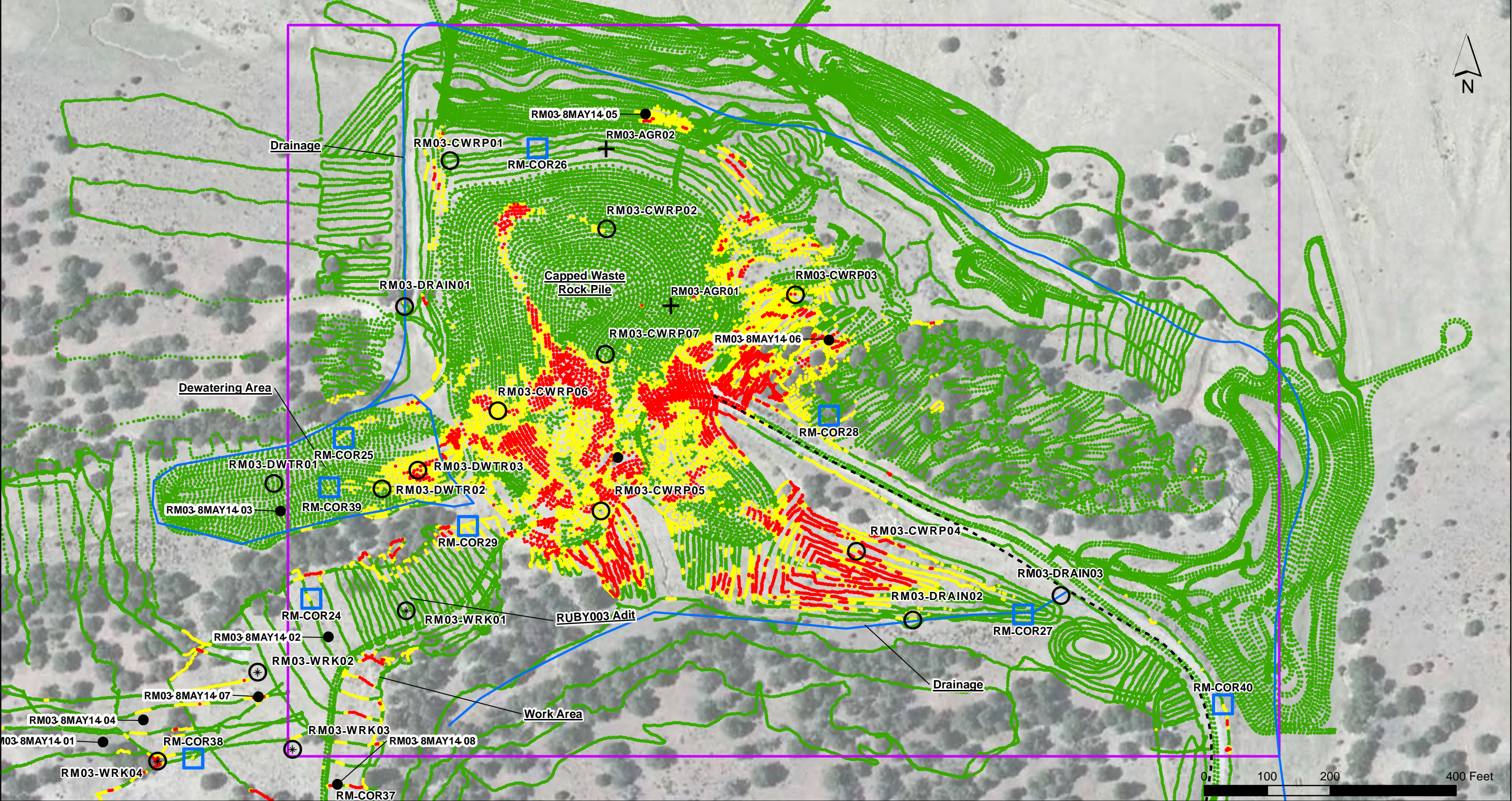


Figure 3-4
Isolated Location Near BIA Route 49 Soil Sample Locations
Ruby Mines Phase 3 Removal Site Evaluation Work Plan



Legend

Phase 2 Gamma Radiation Survey Results (Except Drainage)* Phase 2 Gamma Radiation (Drainage)**

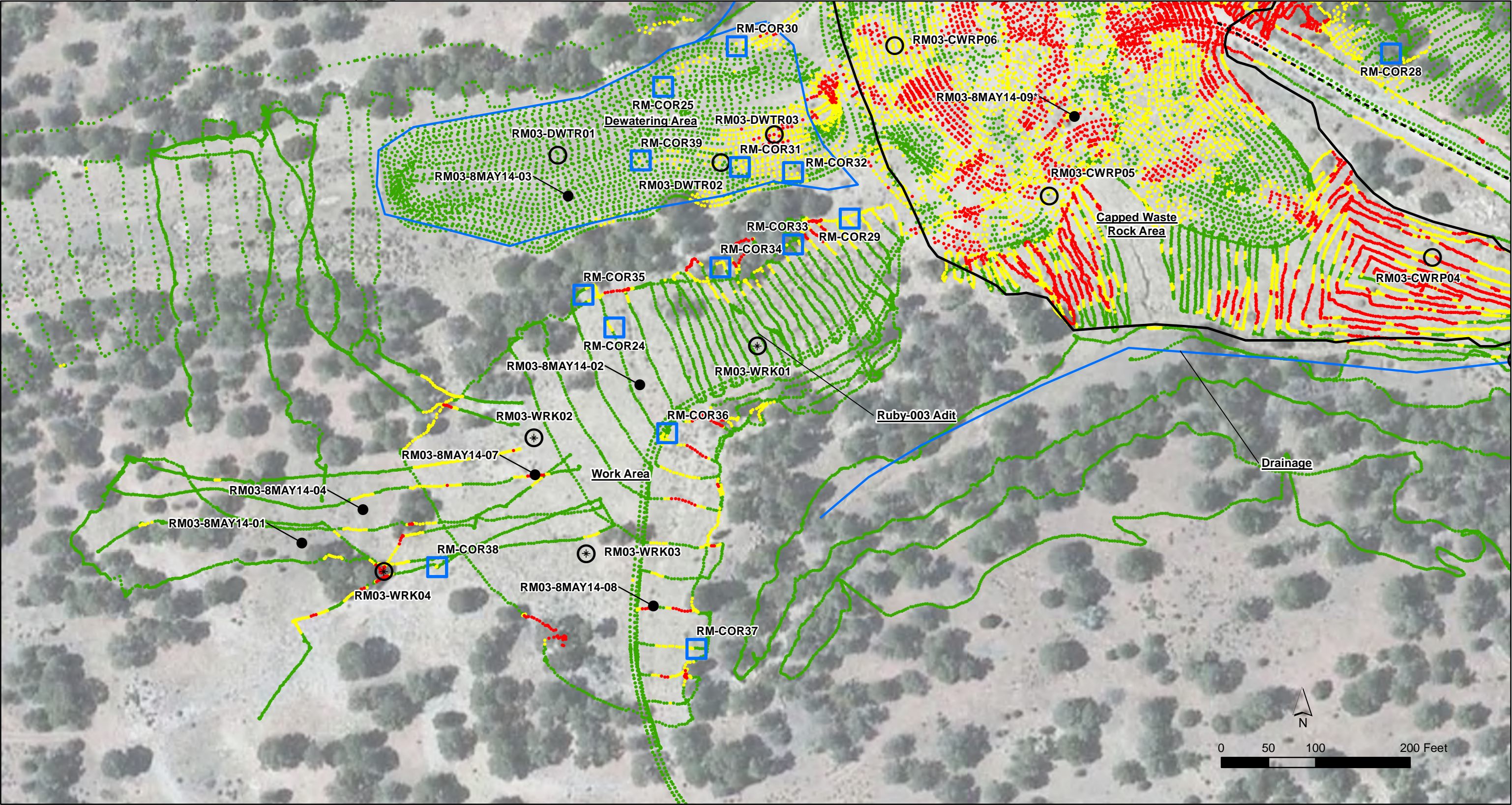
- | | |
|--|--|
| <ul style="list-style-type: none">< 23892 (< 2x Background)23893 - 35838 (2x - 3x Background)> 35839 (> 3x Background) | <ul style="list-style-type: none">< 24808 (< 2x Background)24808 - 37212 (2x - 3x Background)> 37212 (> 3x Background) |
|--|--|

- Proposed Soil Sample Location
- ⊕ Proposed Soil Sample Location Selected for Full Suite Laboratory Analysis
- ⊕ Agronomic Sample Location
- Capped Waste Rock Pile

- Approximate LiDAR Boundary
- Soil Correlation Sample Location
- Former Haul Road
- Drainage

Note * Predominant geology is Mancos Shale
**Geology for drainages is Colluvium
Background Mancos Shale = Mean + 2 standard deviations = 11946 cpm
Background Colluvium = Mean + 2 standard deviations = 12404 cpm

Figure 3-5
Ruby Mine No. 3 Soil Sample Locations
Ruby Mines Phase 3 Removal Site
Evaluation Work Plan



Legend

Phase 2 Gamma Radiation (Except Drainage)**

- < 23892 (< 2x Background)
- 23893 - 35838 (2x - 3x Background)
- >35839 (> 3x Background)

Phase 2 Gamma Radiation (Drainage)*

- < 24808 (< 2x Background)
- 24808 - 37212 (2x - 3x Background)
- >37212 (> 3x Background)

- Proposed Soil Sample Location
- ⊛ Proposed Soil Sample Location Selected for Full Suite Laboratory Analysis
- Phase 2 Soil Sample Location
- ▭ Capped Waste Rock Pile

- ▭ Soil Correlation Sample Location
- - - Former Haul Road
- Drainage

Ruby Mine No. 3 Dewatering and Work Area Soil Sample Locations
Ruby Mines Phase 3 Removal Site Evaluation Work Plan

Note: *Predominant geology is Mancos Shale
**Geology for drainages is Colluvium
Background Mancos Shale = Mean + 2 standard deviations = 11946 cpm
Background Colluvium = Mean + 2 standard deviations = 12404 cpm



Legend

Phase 2 Gamma Radiation Survey Results*

○ Proposed Soil Sample Location

- < 20636 (< 2x Background)
- 20637 - 30954 (2x Background - 3x Background)
- > 30955 (> 3x Background)

Note: *Predominant geology is the Dakota Sandstone
Background = Mean + 2 standard deviations = 10318 cpm

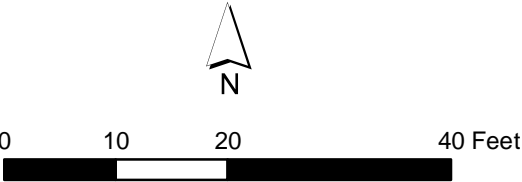


Figure 3-7
RUBY-002 Vent Soil Sample Locations
Ruby Mines Phase 3 Removal Site
Evaluation Work Plan



Legend

Phase 2 Gamma Radiation Survey Results

- < 24808 (< 2x Background)
- 24809 - 37212 (2x Background - 3x Background)
- > 37213 (> 3x Background)

Note: Predominant geology is Colluvium
Background = Mean + 2 standard deviations = 12404 cpm

○ Proposed Soil Sample Location

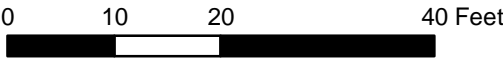
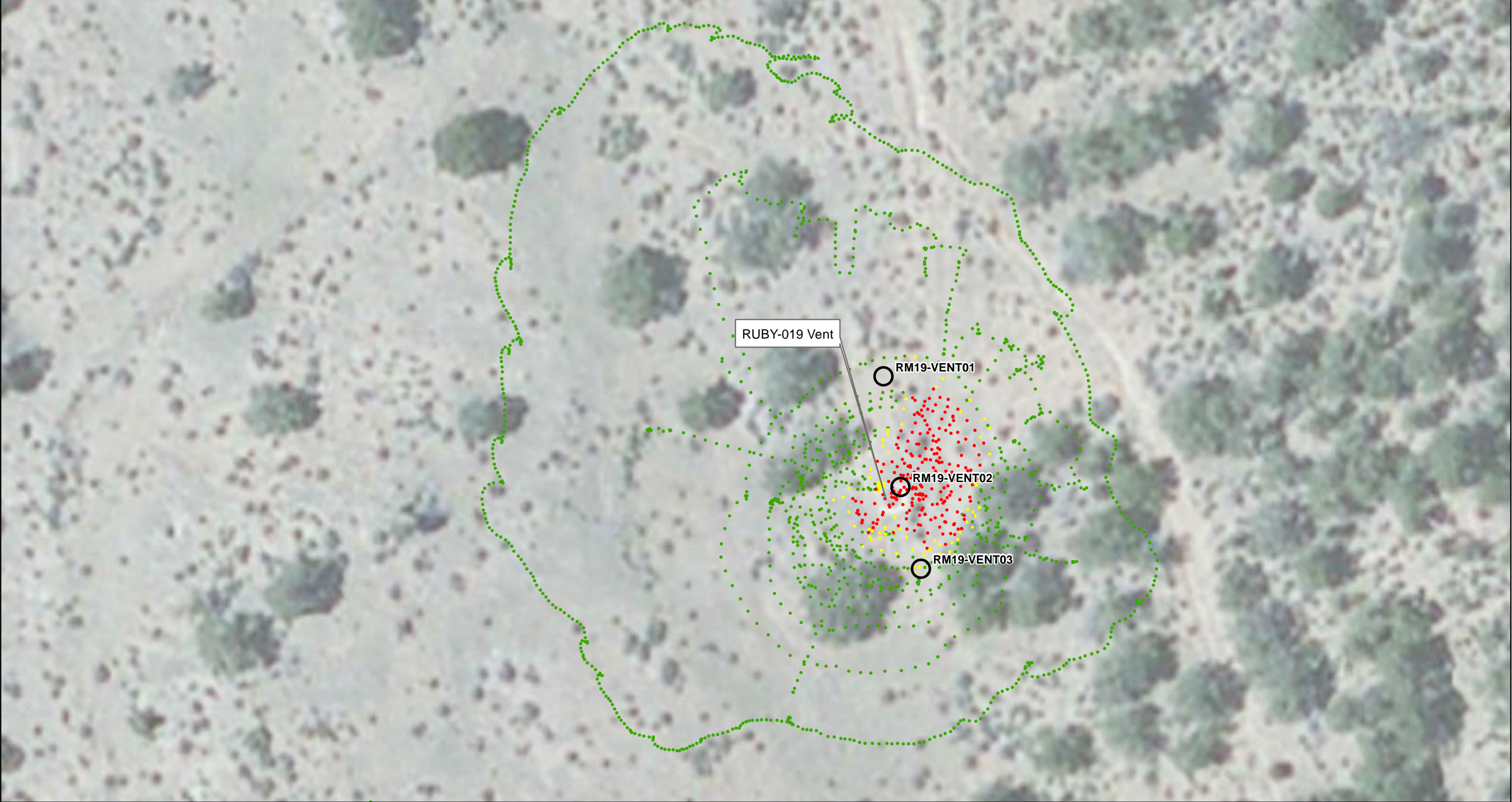


Figure 3-8
RUBY-004 Vent Soil Sample Locations
Ruby Mines Phase 3 Removal Site
Evaluation Work Plan



Legend

Phase 2 Gamma Radiation Survey Results*

○ Proposed Soil Sample Location

● < 24808 (<2 x Background)

● 24809 - 37212 (2 - 3 x Background)

● > 37212 (> 3x Background)

Note: *Predominant Geology is Colluvium
(Background = mean + 2 standard deviations = 12404 cpm)

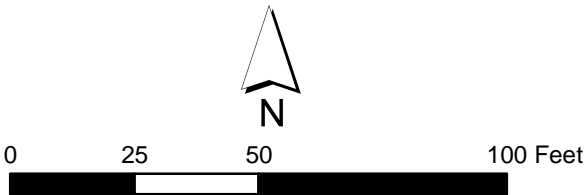


Figure 3-9
RUBY-019 Vent Soil Sample Locations
Ruby Mines Phase 3 Removal Site
Evaluation Work Plan

Appendix A
Livestock Well DWR6T519 Historical Information

REPORT TO: STEVEN J. CARY
Ground Water & Hazardous Waste Bureau
Environmental Improvement Division
Health & Environment Department
P.O. Box 968 - Crown Building
Santa Fe, NM 87504-0968

LAB NUMBER RC6 287
DATE RECEIVED 7-11-86
DATE REPORTED 4-Aug-86
Initials
SLD USER CODE NUMBER 53400

Well Location Address WESTERN NUCLEAR SITE

Point of Collection WINDMILL - approx 1/2 mile NE of site

Well Owner/User _____

Number of People Drinking Water from Well STOCK mainly

Collected 7/10/86 1123 By Gary Kauting EID
Date Time Name Agency

Well Depth Unknown pH _____

Water Level Unknown Conductivity (Uncorrected) _____ umho/cm

Taste? Odor? Color? Collectors Remarks Temperature _____ °C

Conductivity at 25°C _____ umho/cm

PROJECT: _____

From _____, A-H₂SO₄ Sample:

From _____, NA Sample:

Date Analyzed _____

☐ Nitrate-N⁺ _____ mg/l
Nitrite-N _____

☐ Ammonia-N _____ mg/l

☐ Chemical oxygen demand _____ mg/l

☐ _____

☐ Calcium _____ mg/l

☐ Potassium _____ mg/l

☐ Magnesium _____ mg/l

☐ Sodium _____ mg/l

☐ Bicarbonate _____ mg/l

☐ Chloride _____ mg/l

☐ Sulfate _____ mg/l

☐ Total Solids _____ mg/l

☐ _____

From 16, A-HNO₃ Sample: Th-230

☐ ICAP Scan

☐ Metals by AA (Specify) 16-210

Wet Chemistry. See Attached RECEIVED

This form accompanies 1 x 16 sample(s) marked as follows to indicate field treatment:

HF: Whole sample (no filtration)

F: Filtered in field with 0.45u membrane filter

A-H₂SO₄: Acidified with 2 ml conc H₂SO₄/l

A-HNO₃: Acidified with 5ml conc HNO₃/l

NA: No acid added

URANIUM, ISOTOPIC

SAMPLE TYPE: WATER

SAMPLE #: RC-86 0287

ANALYZED: 18-JUL-86 through 23-JUL-86
CALCULATED: 23-JUL-86

11 USER or 11 QC: 11 Known 11 Blank
11 Spike 11 Ref.

METHOD: SLD's RC determination of Uranium by sequential separation and alpha counting methods.

SAMPLE (Size & Description): 0.9000 LITER
of the user's sample which was modified at SLD by a pre-analytical treatment.

RESULTS:

Isotope	Activity
U-234 =	14.084 +/- 0.664 pCi/LITER
U-235 =	0.427 +/- 0.022 pCi/LITER
U-238 =	9.227 +/- 0.475 pCi/LITER
Sum =	23.739 +/- 0.884 pCi/LITER

Analytical Blanks Of:

0.260 +/- 0.060 pCi/Anal. for U-234, and
0.140 +/- 0.040 pCi/Anal. for U-238 were used in the calculation of the results.

U-232 Tracer Usage:

100.0 UL @ 0.086 +/- 0.001 pCi/UL = 8.60 +/- 0.10 pCi Added.
Tracer Batch: FER-84 U I Calibrated: FER-84
Chemical & Counting Efficiency: 0.264 cps/dps

Counting Data Summary:

	U-238 (cps)	U-234 (cps)	U-232 (cps)
Sample Gross:	0.08260 +/- 0.00287	0.12660 +/- 0.00356	0.08410 +/- 0.00290
Sample Bkgs:	0.00002 +/- 0.00002	0.00010 +/- 0.00004	0.00000 +/- 0.00000
Sample Net:	0.08258 +/- 0.00287	0.12650 +/- 0.00356	0.08410 +/- 0.00290
Ratio: U-234 / U-238	1.532 +/- 0.069		

REVIEWED/APPROVED:

JC Lusk, Analyst

DATE:

23 July 86
Book: U 18 P. 74

REMARKS

- Uncertainties are expressed as +/- one standard deviation.
- Small negative or positive results, which are <= two standard deviations, should be interpreted as including 'zero'; as 'not detected'; or as 'less than twice the standard deviation'.
- Reported U-235 result is a calculated value based on the measured U-238 content, i.e. U-235 = 4.63% of the measured U-238 result.

RECEIVED
AUG - 8 1986
LIQUID WASTE/GROUND WATER
SURVEILLANCE

THORIUM - 230

SAMPLE TYPE: WATER

SAMPLE #: RC-86 0287

ANALYZED: 18-JUL-86 through 23-JUL-86

USER or QC: Known Blank

CALCULATED: 23-JUL-86 08:03

Spike Rep.

METHOD: SLD's RC determination of Thorium by sequential separation and alpha counting methods.

SAMPLE (Size & Description): 0.9000 LITER of the user's sample which was modified at SLD by a pre-analytical treatment.

RESULTS:

Isotope	Activity
Th-230	= 0.047 +/- 0.106 pCi/LITER

Analytical Blanks Of:

0.280 +/- 0.070 pCi/Anal. for Th-230 was the blank used in the calculation of the result.

Th-230 Reference Sample:

50.0 uL of DCT-84 TH I Th-230 known solution at 1.520 +/- 0.040 pCi/uL = 76.000 +/- 2.00 pCi of Th-230 as the reference activity.

Th-234 Tracer Usage:

100.0 uL of 15-MAY-86 's tracer were added to the sample and 22.88 +/- 0.34 cps were recovered.
100.0 uL of 15-MAY-86 's tracer were added to the reference and 24.83 +/- 0.35 cps were recovered.
Recovery Ratio as Sample/Reference: 0.92

Counting Data Summary:

	Sample Th-230 (cps)		Reference Th-230 (cps)	
Gross:	0.00280 +/-	0.00053	0.69060 +/-	0.00831
Bkg:	0.00010 +/-	0.00004	0.00010 +/-	0.00004
Net:	0.00270 +/-	0.00053	0.69050 +/-	0.00831

REVIEWED/APPROVED:

JULUSK, Analyst

DATE:

Book: Th # 8 P. 14

REMARKS

- Uncertainties are expressed as +/- one standard deviation.
- Small negative or positive results, which are <= two standard deviations, should be interpreted as including 'zero'; as 'not detected'; or as 'less than twice the standard deviation'.

RECEIVED

AUG - 8 1986

LIQUID WASTE/GROUND WATER SURVEILLANCE

.. Ra-226 ANALYSIS

SAMPLE TYPE: WATER, filtered

SAMPLE #: RC-86-287 -00

ANALYZED: 22-JUL-86 through 29-JUL-86

CALCULATED: 29-JUL-86 14:16

1*1 USER or 11 QC: 11 Known 11 Blank
11 Spike 11 Rep.

METHOD: SLD RC Sequential

SAMPLE (Size & Description): 0.9000 Liter
of the user's sample which was modified at SLD
by a pre-analytical treatment.

RESULTS:

Isotope	Activity	Detection Limit
Ra-226	= 0.044 +/- 0.020 pCi/Liter	
DATE	TIME (HST)	MIN FROM T (sep)
22-JUL-86	13:51	-8307.
28-JUL-86	8:18	0.
28-JUL-86	12:48	270.
29-JUL-86	7:02	1364.

Bubbler purged....Rn-222 ingrowth begins.
Bubbler harvested by emanation to Lucas cell....Rn-222 ingrowth ends.
Daughters of Rn-222 begin their ingrowth.
Lucas cell placed in counting chamber for dark adjustment.
Start of counting period.
End of counting period....Analysis completed.

Gross Counts	Counting Period	Gross cpm
1098.	1094.	1.004

CALCULATIONS:

Decay-corrected Net Activity at T (sep):	0.206 +/- 0.038 cpm
Apply Counter's Efficiency:	0.036 +/- 0.007 pCi
Apply Rn-222 Ingrowth Factor:	0.056 +/- 0.010 pCi
Divide by Chemical Yield:	0.069 +/- 0.013 pCi
Subtract Reagent Blank:	0.039 +/- 0.016 pCi
Divide by Analytical Sample Size:	0.044 +/- 0.020 pCi/Liter

Using:

Chemical Yield(2):	80.0 +/- 4.0 % Recovery
Rn-222 Ingrowth:	64.7 % of Equilibrium
Counter's Background:	0.817 +/- 0.016 cpm
Counter's Efficiency:	5.72 +/- 0.14 cpm/pCi of Rn-222
Reagent Blank:	0.03 +/- 0.01 pCi

(2) 80% recovery is assumed, based on past experience.

(3) For propagating the uncertainties, 5% of the %-recovery was used as an estimate of its standard deviation.

REVIEWED/APPROVED:

D. Cress
Dianne Cress, Analyst

DATE:

July 30, 1986
Book: Ra26 # 40, p. 67

REMARKS

- Uncertainties are expressed as +/- one standard deviation.
- Small negative or positive results, which are <= two standard deviations, should be interpreted as including 'zero'; as 'not detected'; or as 'less than twice the standard deviation'.

RECEIVED

AUG - 8 1986

LIQUID WASTE WATER SURVEILLANCE

Pb-210 RESULTS FOR RC-86-0287

Analyst: AB

Pb-210 Log Book # 11 , p. 37

Date 7-30-86

Pb-210 ACTIVITY: .64 +/- .76; .78 pCi/L

RESULTS CALCULATED FROM:

Sample volume: 900 ml

Bi-car'r used: 1 ml 100% yield of 84.92 ug of
which 67.50 were recovered for a yield of 79.49 +/- 3.97 %
(sigma assigned as 5% of Bi recovery)

Bi-210 decay began on 860203 at 1225 MST

using:

0.8060 +/- 0.0222 cpm as BKG

0.3920 +/- 0.0050 cpm/dpm as Bi-210 Efficiency

0.3500 +/- 0.1200 pCi as reagent blank

Bi-210 Counting Data:

PT#	YY0DDD	HHMM	GROSS COUNTS	CNT TIME INT
1	860204	0450	91	40
2	860204	1951	100	40
3	860205	0942	98	40
4	860205	2034	78	40
5	860206	1101	87	40
6	860207	0051	81	40
7	860207	1442	86	40
8	860208	0433	89	40
9	860208	1824	105	40
10	860209	0902	90	40
11	860209	2253	95	40
12	860210	1243	64	40
13	860211	0234	74	40

RECEIVED
AUG - 8 1986
LIQUID WASTE/GROUND WATER
SURVEILLANCE

Appendix B

Sampling and Analysis Table

APPENDIX B

Ruby Mines Sample Identification*Ruby Mines Phase 3 Work Plan*

Location	Sample Type	Borehole	Depth (ft bgs)	Primary COPC		Full Suite	Other	
				Select Metals ^a (6020/7470A)	Ra-226 (901.1)	VOC (8260B), SVOC (8270C), PCB (8082), TPH (8015M)	Agronomic Parameters ^b	Engineering Parameters ^c
RUBY-002	Normal	RM02-VENT01	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal	RM02-VENT02	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal	RM02-VENT03	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
RUBY-004	Normal	RM04-VENT01	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal	RM04-VENT02	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal	RM04-VENT03	0 - 0.5	X	X			
	Duplicate		0 - 0.5	X	X			
RUBY-019	Normal	RM19-VENT01	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal	RM19-VENT02	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal	RM19-VENT03	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
Ruby Mine No. 1 Capped Waste Rock Piles	Normal	RM01-CWRP01	0 - 0.5	X	X			
	Normal		5 - 5.5	X	X			
	Duplicate		5 - 5.5	X	X			
	Normal		10 - 10.5	X	X			
	Normal		Mid ^d	X	X			
	Matrix Spike		Mid ^d	X	X			
	Matrix Spike Duplicate		Mid ^d	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal	RM01-CWRP02	0 - 0.5	X	X		X	X
	Normal		5 - 5.5	X	X			
	Normal		10 - 10.5	X	X			
	Normal		Mid ^d	X	X			
	Duplicate		Mid ^d	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal	RM01-CWRP03	0 - 0.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal		10 - 10.5	X	X			
	Normal		Mid ^d	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Duplicate		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Matrix Spike		Native ^e	X	X			
	Matrix Spike Duplicate		Native ^e	X	X			

APPENDIX B

Ruby Mines Sample Identification*Ruby Mines Phase 3 Work Plan*

Location	Sample Type	Borehole	Depth (ft bgs)	Primary COPC		Full Suite	Other	
				Select Metals ^a (6020/7470A)	Ra-226 (901.1)	VOC (8260B), SVOC (8270C), PCB (8082), TPH (8015M)	Agronomic Parameters ^b	Engineering Parameters ^c
	Normal	RM01-CWRP04	0 - 0.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal		10 - 10.5	X	X			
	Normal		Mid ^d	X	X			
	Duplicate		Mid ^d	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal	RM01-CWRP05	0 - 0.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal		10 - 10.5	X	X			
	Normal		Mid ^d	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Duplicate		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Matrix Spike		Native ^e	X	X			
	Matrix Spike Duplicate		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal	RM01-CWRP06	0 - 0.5	X	X			
	Duplicate		0 - 0.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal		10 - 10.5	X	X			
	Normal		Mid ^d	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Duplicate		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal	RM01-CWRP07	0 - 0.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal		10 - 10.5	X	X			
	Normal		Mid ^d	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Duplicate		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Matrix Spike		Native ^e	X	X			
	Matrix Spike Duplicate		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			

APPENDIX B

Ruby Mines Sample Identification*Ruby Mines Phase 3 Work Plan*

				Primary COPC		Full Suite	Other		
				Select Metals ^a (6020/7470A)	Ra-226 (901.1)	VOC (8260B), SVOC (8270C), PCB (8082), TPH (8015M)	Agronomic Parameters ^b	Engineering Parameters ^c	
Location	Sample Type	Borehole	Depth (ft bgs)						
Ruby Mine No. 3	Normal	RM03-CWRP01	0 - 0.5	X	X				
	Capped Waste		5 - 5.5	X	X				
	Rock Piles	Duplicate	5 - 5.5	X	X				
		Normal	10 - 11	X	X				
		Normal	Mid ^d	X	X				
		Matrix Spike	Mid ^d	X	X				
		Matrix Spike Duplicate	Mid ^d	X	X				
		Normal		Native ^e	X	X			
		Normal		Native ^e	X	X			
		Normal		Native ^e	X	X			
		Normal		Native ^e	X	X			
		Normal		Native ^e	X	X			
		Normal	RM03-CWRP02	0 - 0.5	X	X		X	X
				5 - 5.5	X	X			
				10 - 10.5	X	X			
				Mid ^d	X	X			
		Duplicate		Mid ^d	X	X			
		Normal		Native ^e	X	X			
		Normal		Native ^e	X	X			
		Normal		Native ^e	X	X			
		Normal		Native ^e	X	X			
		Normal		Native ^e	X	X			
		Normal	RM03-CWRP03	0 - 0.5	X	X			
				5 - 5.5	X	X			
				10 - 10.5	X	X			
				Mid ^d	X	X			
				Native ^e	X	X			
				Native ^e	X	X			
				Native ^e	X	X			
				Native ^e	X	X			
				Native ^e	X	X			
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			Native ^e	X	X				
			Native ^e	X	X				

APPENDIX B
Ruby Mines Sample Identification
Ruby Mines Phase 3 Work Plan

Location	Sample Type	Borehole	Depth (ft bgs)	Primary COPC		Full Suite	Other	
				Select Metals ^a (6020/7470A)	Ra-226 (901.1)	VOC (8260B), SVOC (8270C), PCB (8082), TPH (8015M)	Agronomic Parameters ^b	Engineering Parameters ^c
	Normal		Native ^e	X	X			

APPENDIX B

Ruby Mines Sample Identification*Ruby Mines Phase 3 Work Plan*

Location	Sample Type	Borehole	Depth (ft bgs)	Primary COPC		Full Suite	Other	
				Select Metals ^a (6020/7470A)	Ra-226 (901.1)	VOC (8260B), SVOC (8270C), PCB (8082), TPH (8015M)	Agronomic Parameters ^b	Engineering Parameters ^c
	Normal	RM03-CWRP06	0 - 0.5	X	X			
	Duplicate		0 - 0.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal		10 - 10.5	X	X			
	Normal		Mid ^d	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Duplicate		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal	RM03-CWRP07	0 - 0.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal		10 - 10.5	X	X			
	Normal		Mid ^d	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Duplicate		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Matrix Spike		Native ^e	X	X			
	Matrix Spike Duplicate		Native ^e	X	X			
	Normal		Native ^e	X	X			
	Normal		Native ^e	X	X			
Ruby Mine No. 1	Drainages	RM01-DRAIN A	0 - 0.5	X	X			
			1 - 1.5	X	X			
			5 - 5.5	X	X			
		RM01-DRAIN B	0 - 0.5	X	X			
			1 - 1.5	X	X			
			5 - 5.5	X	X			
		RM01-DRAIN C	0 - 0.5	X	X			
			0 - 0.5	X	X			
			1 - 1.5	X	X			
			5 - 5.5	X	X			
Ruby Mine No. 3	Drainages	RM03-DRAIN01	0 - 0.5	X	X			
			1 - 1.5	X	X			
			5 - 5.5	X	X			
		RM03-DRAIN02	0 - 0.5	X	X			
			1 - 1.5	X	X			
			5 - 5.5	X	X			
		RM03-DRAIN03	0 - 0.5	X	X			
			0 - 0.5	X	X			
			0 - 0.5	X	X			
			1 - 1.5	X	X			
			1 - 1.5	X	X			
			5 - 5.5	X	X			
Ruby Mine No. 3	Dewatering area	RM03-DWTR01	0 - 0.5	X	X			
			1 - 1.5	X	X			
			5 - 5.5	X	X			
		RM03-DWTR02	0 - 0.5	X	X			
			1 - 1.5	X	X			
			5 - 5.5	X	X			
		RM03-DWTR03	0 - 0.5	X	X			
			0 - 0.5	X	X			
			1 - 1.5	X	X			
			5 - 5.5	X	X			

APPENDIX B

Ruby Mines Sample Identification

Ruby Mines Phase 3 Work Plan

Location	Sample Type	Borehole	Depth (ft bgs)	Primary COPC		Full Suite	Other	
				Select Metals ^a (6020/7470A)	Ra-226 (901.1)	VOC (8260B), SVOC (8270C), PCB (8082), TPH (8015M)	Agronomic Parameters ^b	Engineering Parameters ^c
Ruby Mine No. 1 Former Haul Road to Wolf Canyon Road	Normal	RM01-HR01	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM01-HR02	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM01-HR03	0 - 0.5	X	X			
	Matrix Spike		0 - 0.5	X	X			
	Matrix Spike Duplicate		0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Duplicate		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
Ruby Mine No. 1 Wolf Canyon Road, Former haul road near BIA Route 49	Normal	RM01-HR04	0 - 0.5	X	X			
	Normal	RM01-HR05	0 - 0.5	X	X			
	Normal	RM01-HR06	0 - 0.5	X	X			
Ruby Mine No. 1 Step out area	Normal	RM01-STEP01	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM01-STEP02	0 - 0.5	X	X			
	Duplicate		0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM01-STEP03	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM01-STEP04	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM01-STEP05	0 - 0.5	X	X			
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
Ruby Mine No. 1 Work Area within step out area	Normal	RM01-STEP06	0 - 0.5	X	X	X		
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM01-STEP07	0 - 0.5	X	X	X		
	Matrix Spike		0 - 0.5	X	X	X		
	Matrix Spike Duplicate		0 - 0.5	X	X	X		
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM01-STEP08	0 - 0.5	X	X	X		
	Duplicate		0 - 0.5	X	X	X		
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM01-STEP09	0 - 0.5	X	X	X		
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
Ruby Mine No. 3 Work area	Normal	RM03-WRK01	0 - 0.5	X	X	X		
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM03-WRK02	0 - 0.5	X	X	X		
	Normal		1 - 1.5	X	X			
	Duplicate		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM03-WRK03	0 - 0.5	X	X	X		
	Normal		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			
	Normal	RM03-WRK04	0 - 0.5	X	X	X		
	Normal		1 - 1.5	X	X			
	Matrix Spike		1 - 1.5	X	X			
	Matrix Spike Duplicate		1 - 1.5	X	X			
	Normal		5 - 5.5	X	X			

APPENDIX B

Ruby Mines Sample Identification

Ruby Mines Phase 3 Work Plan

Location	Sample Type	Borehole	Depth (ft bgs)	Primary COPC		Full Suite	Other	
				Select Metals ^a (6020/7470A)	Ra-226 (901.1)	VOC (8260B), SVOC (8270C), PCB (8082), TPH (8015M)	Agronomic Parameters ^b	Engineering Parameters ^c
Correlation samples	Normal	RM-COR18	0 - 0.5		X			
	Normal	RM-COR19	0 - 0.5		X			
	Normal	RM-COR20	0 - 0.5		X			
	Normal	RM-COR21	0 - 0.5		X			
	Normal	RM-COR22	0 - 0.5		X			
	Normal	RM-COR23	0 - 0.5		X			
	Normal	RM-COR24	0 - 0.5		X			
	Normal	RM-COR25	0 - 0.5		X			
	Normal	RM-COR26	0 - 0.5		X			
	Normal	RM-COR27	0 - 0.5		X			
	Normal	RM-COR28	0 - 0.5		X			
	Normal	RM-COR29	0 - 0.5		X			
	Normal	RM-COR30	0 - 0.5		X			
	Normal	RM-COR31	0 - 0.5		X			
	Normal	RM-COR32	0 - 0.5		X			
	Normal	RM-COR33	0 - 0.5		X			
	Normal	RM-COR34	0 - 0.5		X			
	Normal	RM-COR35	0 - 0.5		X			
	Normal	RM-COR36	0 - 0.5		X			
	Normal	RM-COR37	0 - 0.5		X			
	Normal	RM-COR38	0 - 0.5		X			
	Normal	RM-COR39	0 - 0.5		X			
	Normal	RM-COR40	0 - 0.5		X			
	Normal	RM-COR41	0 - 0.5		X			
	Normal	RM-COR42	0 - 0.5		X			
	Normal	RM-COR43	0 - 0.5		X			
	Normal	RM-COR44	0 - 0.5		X			
	Normal	RM-COR45	0 - 0.5		X			
	Normal	RM-COR46	0 - 0.5		X			
	Normal	RM-COR47	0 - 0.5		X			

Notes:

^aSelect metals are arsenic, molybdenum, selenium, uranium, and vanadium by method SW 846 60200, and mercury by SW846

^bAgronomic parameters are pH (method 9045), anions (method 9056), cations (method 6010B), saturation percentage (Method 10-2.3.1), electrical conductivity *(Method 10-3.3), sodium absorption ration (Method 10-3.4), texture and rock fragment percentage (Method 15-5), and organic carbon (Method 29-3.5.2).

^cEngineering parameters are soil moisture (method D2216), grain size distribution (method D422), dry density (method D2937), and plasticity index (Method D4318).

^dMiddle depth to be determined based on observed site conditions.

^eNative soils to be sampled at depths of 1 and 5 feet beneath mine waste rock. Total depths below ground surface to be determined in the field. Site conditions may prevent collection of some samples.

** Numerical depths of sample identifier to be determined in the field.

Sample nomenclature will include the borehole name and the depth interval as described in Section 3.6.2. For example, the sample collected at RM19-VENT03 from the interval of 1-2 ft bgs will be labeled RM19-VENT03-1.0-2.0.

Appendix C

Standard Operating Procedures

STANDARD OPERATING PROCEDURES

EQUIPMENT DECONTAMINATION

SUMMARY

This SOP describes methods used for preventing, or reducing to the maximum practicable extent, cross-contamination during sampling. Decontamination is appropriate for any sampling equipment that cannot be discarded and must be reused. For soil, sediment, and other solid materials, such tools include hollow-stem augers and related bits and pipe, hand augers, trowels, thin-walled tube samplers, split spoons, Shelby tubes and other equipment. For water samples such tools may include non-disposable bailers, pumps, transducers, well slugs and other equipment.

Prevention or minimization of cross-contamination is important for preventing the introduction of measurement error (bias) into sampling results, and for protecting the health and safety of sampling personnel. These methods are effective for decontamination of sampling gear and supplies used at work sites impacted with relatively low levels of contamination. With regard to VOCs, this would mean that sampling equipment is not impacted by NAPL. Although it may be preferable to dedicate sampling equipment to the project, such low concentrations of contamination are quickly and effectively managed using decontamination techniques.

Contaminants can be physically removed from sampling equipment, or chemically neutralized and/or deactivated. Physical removal can involve abrasive or non-abrasive methods coupled with solubilization or emulsification of the contaminant. A soapy water wash followed by potable and distilled water rinses are most commonly used and are the subjects of this SOP. Under certain circumstances requiring extraordinary quality assurance of decontamination, acids and/or solvents may also be used. The use of these special cleaning agents is not included in this SOP.

DECONTAMINATION – SMALL TOOLS

1. Review project work plan and Health and Safety Plan ("HASP").
2. Assemble materials, supplies and equipment inventory.
3. Prepare a wash tub or sprayer of potable water and liquid soap.
4. Prepare a rinse tub of potable water.
5. Physically scrape or otherwise remove bulk material adhering to the tool. Dispose of removed contaminated material appropriately.
6. Wash equipment with bristled brushes until visible soil or residue is removed.
7. Change the wash water when it is no longer effective. Wash water should be disposed of with other contaminated liquids.
8. Rinse liberally with potable water.

9. Rinse liberally with distilled water.
10. Allow tool to air dry or dry with a paper towel if time or weather do not permit air drying.
11. If the equipment is to be stored prior to use, wrap in food grade paper, polyethylene, or aluminum foil or place it in a Zip-Lock® or plastic bag.

DECONTAMINATION RINSE BLANKS

1. If the work plan so directs, equipment or rinse blanks should be collected. These blanks are prepared immediately prior to using the equipment, for example, a rinse blank may be collected from a split spoon sampler immediately prior to using that sampler to verify effective decontamination.
2. A rinse blank is prepared by slowly pouring distilled water over the piece of equipment and then collecting that water in an appropriate sampling container. Utilize the appropriate type and size of container as specified in the Work Plan.
3. Record sample collection procedures in the field book.
4. Package and ship samples as described in the project work plan.

PROJECT PROCEDURE PERMA-FIX ENVIRONMENTAL SERVICES			
TITLE:	Operation of Portable Gamma Scintillation Dose Rate Instruments	NO.:	RP-107
		PAGE:	1 of 7 (incl. Attachments)
		DATE:	January 2013

1.0 PURPOSE

This work instruction specifies the methods for performing source checks and operating portable Gamma scintillation dose rate instruments, specifically, the Ludlum Model 19 uR and the Bicron Model Micro Rem. These instruments are used for the evaluation of exposure rates from radioactive materials and determining environmental radiation levels.

2.0 APPLICABILITY

This procedure specifically addresses those instruments that measure count rate from a scintillation detector and have displays that read in uR/hr (Ludlum 19) or uRem/hr (Bicron Micro Rem). The primary meter used at PESI Field Sites is the Bicron Micro Rem meter because it uses a plastic scintillation detector that has nearly a “tissue equivalent” response. The Ludlum Model 19s is available, but is normally used for engineering applications associated with historic radiation surveys at GCSS as it uses a sodium iodide scintillation detector that is not “tissue equivalent”.

This Project Procedure does not include associated instrument calibrations or cover the operation of exposure rate instruments that have an ion chamber (e.g. Eberline RO-2). Equivalent instruments that operate in a similar fashion to those identified in this section may be operated under this Project Procedure with RSO approval.

3.0 REFERENCES

1. ANSI N323A-1997, Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments.
2. Instrument Technical Manuals.
3. RPP-103, Radiological Surveys

4.0 RESPONSIBILITIES

4.1 Radiation Safety Officer (RSO)

- Reviewing and approving changes to this procedure and ensuring compliance with applicable regulations.
- Ensuring an adequate inventory of Radiation Protection instruments are available to support remediation activities.
- Overseeing the issue, control and accountability of Radiation Protection instrumentation per the requirements of this procedure.
- Ensuring transmittal of all issue, control and accountability records to the appropriate document control authority when applicable.

4.2 Radiation Protection Technician (RPT)

- Maintaining instrument documentation and records as required by this procedure.

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- Maintaining adequate instrument and equipment availability.
- Verifying current calibration and response test dates prior to issue or use of instruments.
- Promptly returning instruments to their proper location when work is complete.
- Ensuring that instruments are properly surveyed for contamination and decontaminated as necessary, after use.

5.0 PROCEDURE

5.1 General

1. Ensure the instrument selected is within their acceptable calibration periods. This is indicated on an attached calibration sticker. Illegible stickers should be replace prior to instrument use.
2. The RP Group will coordinate instrument calibration on a minimum annual basis and after major repair operations. Battery change-outs do not require re-calibration. Calibration procedures are outside of the scope of this instruction.
3. Pre-operational source checks are required daily, or prior to each intermittent use, whichever is less frequent. Post-operational source checks are performed as specified in work plans or procedures. Instruments used in the performance of daily activities do not normally require a post-operational source check.
4. Instrument set-up and subsequent operational checks should be performed in the same location, with consistent temperature and radiation background levels.
5. Use a gamma check source with an activity sufficient to produce contact exposure rates at least ten times higher than background. Cs-137 is typically used at GCSS since it emits 662 keV gamma rays which are representative of the mid-range of gamma energies encountered at GCSS. Alternate sources may be used with RSO approval.
6. Source positioning devices (i.e., jigs) should be used to ensure a reproducible geometry between instrument checks. Source geometry must be consistent between initial instrument set-up and subsequent operational checks.
7. The Ludlum 19 may be operated in the FAST response mode. Switch to SLOW response for obtaining precise readings.
8. Internal scintillation crystals are orientated towards the front of the instrument. Meter cases have visible indicators showing optimum locations to obtain measurements (i.e. effective detector center).
9. Allow instrument readings to maximize prior to recording instrument reading. This may take up to twenty seconds. Note that the needle may not rest on a single value, but may fluctuate slightly between two points on the scale. If this is the case, an average reading should be obtained by summing these two end points and dividing by two.
10. Instruments should be allowed to warm-up for at least one minute prior to obtaining readings.

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11. Report any abnormal instrument readings (e.g., unstable analog meter fluctuations), or background inconsistencies to the RSO, prior to continuing instrument use.
12. Instruments that fail operational checks or malfunction during use should be tagged or labeled “Out-of-Service,” or “Do Not Use,” and segregated from operational instruments. If possible, describe the problem on the tag / label and add initials and date.
13. Instruments leaving RPP Group control (i.e., repair, calibration, excess, etc.) shall be surveyed for unconditional release. The repair / calibration center may request a copy of the survey to accompany shipments of RP instruments.

5.2 Instrument Source Check

1. Obtain the selected instrument.
2. Obtain the corresponding GCSS Daily Field Source Check Log – Exposure Rate Instruments form, Attachment 1. This form will be referred to as the “Source Check Log.” Initiate a new Source Check Log, if necessary.
3. Perform a physical inspection of the instrument. Place particular emphasis on the following items:
 - Instrument case is not visibly damaged beyond minor scrapes and scratches.
 - Analog display is not cracked or otherwise damaged.
 - Switches and buttons are functional.
 - Audio, if present, is functional.
 - Calibration labels are legible and instrument is within calibration period.
4. Note results of physical inspection on the Source Check Log.
5. Verify the battery level is within the acceptable range on the analog display. Replace batteries and re-verify, as necessary.
6. Note battery check results on the Source Check Log.
7. Verify the high voltage (HV) level is within the acceptable range on the analog display, if present. Place the instrument out-of-service if the HV is outside the acceptable range.
8. Note the HV check results on the Source Check Log.
9. If acceptable background ranges have not been established, perform the following:
 - Obtain a blank GCSS Exposure Rate Instrument Set-Up Sheet, Attachment 2. This form will be referred to as the “Set-Up Sheet.”
 - Record the basic source and instrument information at the top of the form.
 - Using the instrument and the source jig (without source), obtain and record ten background readings. The instrument should be removed from the source jig and repositioned after each reading is obtained.

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Make sure the location where readings are obtained has stable background levels and is the location used for subsequent source checks.

- Calculate and record the average background value and +/- 20% values on both the set-up and source check logsheets.
10. Obtain and record an average background reading on the source check log.
 11. Compare the average background reading to the acceptable range. If background response is outside this range, report the condition to the RSO for evaluation, otherwise continue with source check process.
 12. Obtain the source to be used for instrument source checks.
 13. If acceptable source check ranges have not been established, perform the following:
 - Obtain the Set-Up Sheet used to determine acceptable background ranges for the instrument.
 - Using the instrument and the source jig (with source), obtain and record ten contact source readings. The instrument and source should be removed from the source jig and repositioned after each reading is obtained. Make sure the location where readings are obtained is the same location where previous background readings were obtained.
 - Calculate and record the average source value and +/- 20% values on both the set-up and source check logsheets.
 14. Load the source and instrument onto the source jig.
 15. Obtain and record the "CONTACT" reading.
 16. Verify the contact reading is within the acceptable range (+/- 20%).
 17. If the contact source reading falls outside the acceptable range, tag the instrument out of service and notify the RSO, otherwise continue.
 18. Complete the source check log including technician initials. The instrument is now ready for use.
 19. Ensure sources and forms are stored properly after use in the designated storage location. Forms are retained in RP Instrument logbooks of field files during instrument use (i.e. calibration) cycle. Records are then reviewed by the RSO, or designee for completeness and forward to Project Records for retention.

5.3 Operations

1. Verify that required source checks have been performed prior to initial instrument use.
2. Operate instrument in a manner that minimizes the potential for cross-contamination and physical damage.
3. Limit readings taken while the instrument is positioned sideways to minimize the effects of "geotropism" on the analog needle.
4. Obtain readings by positioning the instrument as close to the detector's "effective center" as possible. The detector effective center is represented on the instrument housing a cross inside a circle on the Bicon Micro Rem, and a

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small circular depression on the Ludlum 19. Overall optimum readings are collected from the front of the instrument housing.

5. Most instruments will operate in temperatures between 10 and 120 degrees Fahrenheit. However, anytime the temperature is outside of the 32 degree (freezing) or 100 degree ranges, observe the following precautions:
 - Be observant of instrument response to background. If the instrument begins to show a decreased response to expected background levels contact the RSO, or designee for guidance.
 - If practicable, perform a period response check of the instrument against a known source of radiation. If the instrument appears to be responding incorrectly contact the RSO or designee for guidance.
 - Contact the RSO for guidance anytime work is planned outside of the 10 to 120 degree range.
6. Protect instruments, to the extent possible, from exposure to moisture (i.e. rain, snow, etc.) during use. Instruments shall be stored in a safe manner when not in use.
7. Perform a post-operational source check after use, if directed by work plan, procedure, or the RSO.

6.0 ATTACHMENTS

- Daily Field Source Check Log – Exposure Rate Instruments (Attachment 1)
- Exposure Rate Instrument Set-Up Sheet (Attachment 2)

7.0 ATTACHMENTS

Attached forms are examples and may be modified by the RSO, as needed, without revision to this procedure.

Attachment 1 Daily Field Source Check Log – Exposure Rate Instruments (Typical)

Attachment 2 Exposure Rate Instrument Set-Up Sheet (Typical)

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Attachment 1

Daily Field Source Check Log – Exposure Rate Instruments (Typical)

MONTH / YEAR: _____

**FMSS DAILY FIELD SOURCE CHECK LOG
- EXPOSURE RATE INSTRUMENTS**

INSTRUMENT DATA		Date/Time	Physical	Battery	High Voltage	Audio	Background	Contact Source	PASS or FAIL	Tech. Initials
INSTRUMENT										
MODEL										
SERIAL#										
CAL DUE										
HV										
SOURCE DATA										
ISOTOPE										
SERIAL #										
ACTIVITY										
uCi										
INSTRUMENT RANGES										
Background	Contact Source									
+ 20 %										
- 20 %										
Units (Circle One)										
uR	urem	mR	mrem	R	rem					
Remarks:										Reviewed by:

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Attachment 2
Exposure Rate Instrument Set-Up Sheet (Typical)

FMSS EXPOSURE RATE INSTRUMENT SET-UP SHEET									
Set-Up Location: _____									
INSTRUMENT DATA		READING (n)	Background Rate	Contact Source Rate	CALCULATED AVERAGE AND RANGES				
INSTRUMENT					Background		Contact Source		
MODEL		1							
SERIAL #		2				Average + 20%			
CAL DUE DATE		3				Average			
HV		4							
		5				Average - 20%			
SOURCE DATA		6			Units (Circle One)				
ISOTOPE		7				uR	urem	mR	mrem R rem
SERIAL #		8			REMARKS				
ACTIVITY (uCi)		9							
		10							
Performed By:			Date/Time:		Reviewed By:		Date/Time:		

PROJECT PROCEDURE PERMA-FIX ENVIRONMENTAL SERVICES	
TITLE: Radiological Surveys	NO.: RP-103
	PAGE: 1 of 7 (incl. Attachment)
	DATE: December 2012

1.0 PURPOSE

This procedure establishes consistent methodology for performing radiation and contamination surveys at PESI Field Sites).

2.0 APPLICABILITY

This procedure is applicable to all personnel trained and qualified to perform radiation and contamination surveys at PESI Field Sites.

3.0 REFERENCES

1. 10 CFR 20, "Standards for Protection Against Radiation."
2. 10 CFR 19, "Notices, Instructions and Reports to Workers Inspection."

4.0 RESPONSIBILITIES

4.2 Radiation Safety Officer (RSO)

- Implementation of this procedure.
- Ensuring appropriate radiation surveys are performed to measure and document radiation levels.
- Ensuring all completed surveys are adequately reviewed.
- Providing technical direction to the RPTs.

4.3 Radiation Protection Technicians (RPT's)

- Conducting and documenting radiological surveys.
- Performing all necessary pre / post use operability checks.
- Creating neat, legible, and concise records.

5.0 PROCEDURE

5.1 General Instructions

1. Select the survey instrument based on the anticipated hazards and dose rates as determined by a review of previous survey data and ongoing work activities.
2. Perform pre-operational and response checks in accordance with the operating procedures for the instrument.
3. Remove any defective instrument from service.
4. Obtain survey forms and any other material required to document survey results.

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5.2 Routine Survey Frequencies

1. The RSO shall specify areas for routine monitoring surveys and the frequency of such surveys. The RSO should maintain a routine survey frequency schedule. The schedule is NOT considered a record, and does not need to be retained.
2. The following areas should be considered for a routine survey on a DAILY basis:
 - Designated eating, drinking, and smoking areas within Restricted Areas.
 - Radiological Counting Labs and sample prep areas.
 - Any other area specified by the RSO.
3. The following areas should be considered for a routine survey on a WEEKLY basis:
 - High Traffic areas on the GCS Site.
 - Field Trailers within Restricted Areas
 - Vehicle Cabs and floor boards within Restricted Areas
4. The following areas and equipment should be considered for a routine survey on a MONTHLY basis:
 - Occupied office trailers.
 - Storage areas.
5. The following should be done on an as-needed basis:
 - Incoming Surveys

The RSO can direct that incoming surveys be performed on equipment and materials arriving onto the site. The purpose of an incoming survey is to protect the client from financial liability associated with decontaminating equipment that arrived on the site with existing contamination. The degree of thoroughness of the survey and the requisite cleanliness of the equipment is at the discretion of the RSO.
 - Surveys of Materials Vehicles, and Personnel leaving Restricted Areas

All materials, vehicles, and personnel shall perform surveys upon leaving Restricted Areas that have a potential for spread of contamination. The RSO or designee can direct that additional surveys be performed as needed to monitor for spread of contamination.
 - Direct Total Contamination Surveys
 1. All items being surveyed should appear to be clean prior to being surveyed. To the extent possible, all interior and exterior surfaces should be free from oil and visible dirt. The RSO may dictate the required degree of cleanliness, based on the purpose of the survey and the history of the item being surveyed.

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2. Obtain proper instrumentation for the survey. Ensure that the instruments are currently calibrated and have been performance checked prior to the survey.
3. Determine and record the background count in the area to be surveyed. Ensure that the background is representative of the measurement to be taken. Calculate and record the MDA on the appropriate survey form. Verify the MDA has been calculated for the background at the point of use and is less than the applicable site release criteria. In no case shall the background count time be less than the sample count time.
4. Perform a scanning survey of the item. Concentrate survey measurements on areas most likely to be contaminated. The fraction of the total area scanned is subjective, based on technician experience, an item's use history, and RSO guidance. Typically, the scan frequency is a minimum of 10% of accessible surface areas.
5. Obtain static measurements at locations with the highest potential for contamination. The number of survey points selected is subjective, based on technician experience, an item's use history, and RSO guidance. The count time should be consistent with the MDA calculation. A typical count times is one minute for digital scalers and until the meter reading stabilizes for analog ratemeters.
6. Record and identify all locations surveyed on the appropriate survey form(s). The use of diagrams or sketches is recommended.
 - **Beta-Gamma Probe** - In high background areas it may not be possible to achieve the required survey MDAs. This should be noted on the survey cover sheet, and should be brought to the attention of the RSO.
 - **Alpha Probe** - The performance check background may be used in place of background count in the area to be surveyed. A good practice is to check the probe for light leaks or for faulty cables if positive results begin appearing.
7. All measurements shall be reported in units of "dpm" unless otherwise directed by the RSO. Examples include "dpm/100 cm²," and "dpm/probe."
8. Direct non-smearable hot spots may be averaged over 1 square meter to determine compliance with release levels. If the entire item is less than 1 square meter in area, the entire surface area may be averaged. Bolt on parts of a vehicle should not be considered separate items.
 - The method for determining an average activity is to mark a 1 square meter area on the piece to be surveyed that is roughly centered on the hot spot. Take 1 measurement at the highest activity point of the hot spot. Take 4 (or more) other measurements within the square meter at locations representative of the whole square meter. Record count-rate of each individual measurement. Calculate the activity of all measurements being averaged, including those that are less than the MDA and those with a calculated activity less than zero. Calculate the average of all measurements and record on the survey form.

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9. Complete the appropriate survey form.

5.3 Removable Contamination

With RSO approval, removable contamination surveys may be disregarded, provided that direct survey measurements and instrument MDAs are below site removable contamination limits for release.

1. All items being surveyed shall be clean prior to being surveyed. All interior and exterior surfaces should be free from oil and visible dirt. The RSO may dictate the required degree of cleanliness, based on the purpose of the survey and the history of the item being surveyed.
2. Wipe each location of interest with moderate pressure area using a standard 1 ¾-inch swipe. The area wiped should be approximately 100 cm². Larger areas may be wiped. It can be inferred that if the wipe meets the required limit for 100 cm² when it was actually taken from a larger area, the object will pass the 100 cm² criteria. No special documentation is required if the wiped area exceeds 100 cm². If the object is smaller than 100 cm², the area of the entire object should be wiped.
3. Large area wipes (LAW), also commonly referred to by the trade name "Masslinn" may be used to supplement smear surveys for removable contamination. The use of LAWs should be documented on the survey form with the notation "LAW," or equivalent.
4. Ensure each used swipe (i.e., smear or large area wipe) is handled, stored, and transferred in such a fashion as to prevent to loss of sampled material or cross-contamination with other personnel and other swipe samples.
5. Record the location of each wipe on the appropriate survey form. It is preferable to record the location by circling the sequential number location on a survey map where the wipe was taken.

5.4 Analyzing Swipes

1. Smear samples should be counted using available scintillation or gas-flow proportional laboratory counters, when practicable. Field instruments may be used for smear counting at the discretion of the RSO.
2. LAW samples may be counted using field instruments. The use of laboratory counters is inappropriate.
3. Determine and record the background count-rate. Calculate and record the MDA on the appropriate survey form. Verify the MDA has been calculated for the background at the point of use and is less than the applicable site release criteria. In no case shall the background count time be less than the sample count time.
4. Remove each swipe from the paper backing, as needed. The use of tweezers is recommended.
5. Place the swipe in the counter and close.
6. Count for the designated counting time.
7. Record the gross result under cpm in the appropriate column (either alpha or beta-gamma) of the survey form.

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8. Calculate and record the activity. Removable contamination survey results shall be reported in units of “dpm” unless otherwise directed by the RSO. Examples include “dpm/100 cm²” and “dpm/LAW.”

5.5 Gamma Walkover Surveys

1. Gamma walkover (or drive-over) surveys (GWS) are performed to measure surface gamma radiation levels of open land areas.
2. GWS are typically performed with sodium iodide (NaI) detectors which read-out in counts per minute (cpm) the site.
3. Obtain proper instrumentation for the survey. Ensure that the instruments are currently calibrated and have been performance checked prior to the survey.
4. The survey is performed by walking along a path while moving the NaI detector side-to-side or in a serpentine motion.
5. The side-to-side motion of the detector will cover approximately 0.5 meters per second.
6. Global positioning systems (GPS) may also be used in conjunction with field radiation detection systems. The following protocol is used to collect data with GPS data loggers:

5.5.1 Logging Data with TSC1 Data Collector Running Asset Surveyor

1. Turn the meter on. Make sure the meter is on fast response and rate meter.
2. Connect the cable in the backpack to the bottom port of the data logger, then connect the thin cord to the instrument and the other data logger cord, connect that hole cord to the top of the data logger.
3. Turn the Data Logger on by depressing the green button in the lower left corner.
4. It will take a minute or two for the receiver to register and locate satellites. You must have at least 4 satellites and PDOP < 6.0
5. You can then start logging data. From the main menu scroll to Data collection. Press **Enter**.
6. Enter a name for the file that you are going to collect data in. Press **Enter**.
7. It will then tell you that Carrier Phase works better in 3 D.
8. It will then give you a screen describing the antenna height and available memory. Press **Enter**.

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9. This will start the data logging process. You should see a ## on the bottom right of the screen. That number as well as a straight counter should be increasing at the rate of about 1 count per second. They may not increase at the same rate. If this is not occurring then check to make sure that your meter is on rate meter. If it is and the numbers are still not counting, check the cables connected to the meter.
10. If you press **Menu** while logging data and go to map, Press **Enter**. This will show you the path that you are walking as you move. You may have to zoom in a couple of times. Do this by pressing the **F2** key.
11. To stop logging data press **Menu**, then select Data collection, Press **Enter**. Then Press **Esc**. If you logged data for less than 10 minutes it will tell you insufficient carrier data. It will ask you if you wish to exit. Press **F1** to exit and **F5** to go back to collecting data. If you have logged data for more than ten minutes it will just ask you if you wish to exit Data collection.

5.6 Gamma Dose Rate Surveys

1. Obtain proper instrumentation. Ensure that the instrument is currently calibrated and has been performance checked prior to the survey.
2. When entering areas with known radiation levels, select the appropriate scale.
3. Perform gamma dose rate surveys as follows:
 - Monitor dose rates from the lower thighs to head level, recording the highest level as General Area Dose Rate.
 - Monitor dose rates 30 cm (12 inches) from a significant radiation source recording the highest level as General Area Dose Rate.
 - Perform contact gamma dose rate measurements with the detector within ½-inch of the surface to be surveyed.
 - Additional measurement locations should be clearly identified in survey documentation.
 - Record all survey results on the appropriate survey form.

5.7 CALCULATIONS

Sample Activity

$$DPM = \frac{\left(\frac{TotalSampleCounts}{SampleCountTime} \right) - \left(\frac{TotalBkgCounts}{BkgCountTime} \right)}{(E) (A)}$$

where:

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E = Instrument Efficiency
 A = Area correction factor, if applicable

Minimum Detectable Activity (MDA)

The following MDA equation is to be used for a background count time equal to the sample count time:

$$MDA = \left(\frac{(3 + 4.65\sqrt{B})}{(E)(A)(T_s)} \right)$$

where:

T_s = Sample count time
 E = Instrument efficiency
 A = Area correction factor, if applicable
 B = Background cpm

The following equation is to be used for a background count time equal to 5 or more times the sample count time:

$$MDA = \left(\frac{(3 + 3.29\sqrt{B})}{(E)(A)(T_s)} \right)$$

7.0 RECORDS

- Survey forms shall be completed in entirety. This includes attaching printouts, diagrams, or other supporting documentation, appending sequential page and survey tracking numbers, a review for completeness and accuracy, and appending the appropriate signatures of personnel performing the survey and / or analyzing samples.
- Once complete, the survey package shall be submitted to the RSO or designee, for final review and approval signature.
- Survey documentation shall be maintained according to established RP document control and retention requirements.

9.0 ATTACHMENT

Attachment 1 Acceptable Surface Contamination Levels

Attachment 1

Acceptable Surface Contamination Levels

NUCLIDE ^a	AVERAGE ^{b c} dpm/100 cm ²	MAXIMUM ^{b d} dpm/100 cm ²	REMOVABLE ^{b e} dpm/100 cm ²
U-nat, U-235, U-238 and associated decay products	5,000	15,000	1,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20

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Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000	15,000	1,000

Notes:

- a Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.
- b As used in this table, dpm means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
- c Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each object.
- d The maximum contaminated level applies to an area of not more than 100 cm².
- e The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

*Source:USCG / USEPA EM 385-1-80 Table 6-4 Acceptable Surface Contamination Levels, 1985.

Note: The acceptable surface contamination levels for Th-nat will be used unless subsequent sampling indicate the presence Ra-226, Ra-228, Th-230, Pa-231, or Ac-227 in concentrations greater than that of the parent nuclide. The RSO will determine if contamination limits should be modified for a specific activity or location based on available data.

PROJECT PROCEDURE PERMA-FIX ENVIRONMENTAL SERVICES	
TITLE: Survey Documentation and Review	NO.: RP-104
	PAGE: 1 of 6 (incl. Attachments)
	DATE: January 2013

1.0 PURPOSE

This procedure establishes consistent methodology for documenting radiological surveys and provides criteria for the review of these surveys.

2.0 APPLICABILITY

This procedure is applicable to all radiological surveys excluding air samples.

3.0 REFERENCES

1. 10 CFR 20, "Standards for Protection Against Radiation."
2. RP-103, "Radiological Surveys."

4.0 GENERAL

4.1 Discussion

The results of surveys will be documented on survey forms or in designated logs as approved by the Radiation Safety Officer (RSO). Survey data will contain enough detail to provide personnel with adequate information concerning radiological conditions existing in the area surveyed.

The RSO or designee will review completed survey documentation to ensure appropriate, adequate and complete information is recorded. The individual reviewing the survey will ensure that the recorded results are legible, in accordance with Radiological Protection Program (RPP) implementing procedures, consistent with anticipated levels, and will determine the reason for any variances.

4.0 RESPONSIBILITIES

4.1 Radiation Safety Officer (RSO)

- The Radiation Safety Officer (RSO) or designee is responsible for reviewing radiological surveys performed by Radiation Protection Technicians (RPT).

4.2 Radiation Protection Technician (RPT)

- RPTs are responsible for documenting surveys in a legible manner on approved forms.

5.0 PROCEDURE

The methods outlined in this procedure are intended to assure the clear and concise transfer of survey information. Variations or deviations from the protocols in this procedure are permitted if the clear transfer of information is maintained.

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5.1 Documentation

Survey log number book is to be used to assign a unique sequential number to each survey form package. This number provides the ability to track individual surveys as well as ensuring the submittal of a complete documentation package for archiving.

Unless otherwise directed by the RSO, survey numbers will be assigned with the following format:

PF-RS-yy-xxx

“PF” corresponds to “Perma-Fix,” “RS” refers to “Radiological Survey,” yy is the last two digits in the year, and xxx refers to the sequential survey number.

1. Record all information on survey forms in a neat and legible manner.
 1. Document all surveys on a form with approved project heading. Technician logbooks may be used for documenting surveys (e.g., daily routines, material transfers, minor posting changes, etc.) as authorized by the RSO and provided instrument serial numbers are documented with survey data.
 2. When recording information on survey forms, check all appropriate boxes and circle all appropriate answers.
 3. Use a survey form with pre-drawn diagrams when available. If not, draw a diagram or picture of the object surveyed. Should a diagram not be appropriate, use a lined survey form.
 4. Assign the next sequential survey number to the survey from the survey number logbook.
 5. Complete the following information for all surveys:
 - Date and time of survey
 - Location of survey
 - Instrument type and serial numbers and associated supporting information (i.e., detector efficiencies, calibration dates, background values, etc.)
 - Reason for survey
 - Name and signature of surveyor
 6. The use of Greek alphabet and other nuclear industry standard nomenclature (e.g., “k” = 1000) is acceptable when documenting surveys.
 7. Indicate general area (GA) dose rates by underlining the radiation level on the Survey Form at the appropriate location (Example: 25 uR/hr).
 8. Indicate CONTACT dose rates by recording the radiation level with an asterisk on the Survey Form at the appropriate location (Example: * 25 ur/hr). If there are corresponding 30 cm and GA readings, document them as follows:

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* CONTACT / @ 30 cm / GA

9. Use a legend to inform the reviewer of any other notation utilized or if deviating from standard protocol.
10. Indicate survey locations by placing sequential numbers within a circle on the Survey Sheet. The Survey Sheet has corresponding direct and transferable columns for both alpha and beta / gamma activity.

5.2 Technical Review

1. After completing the surveys, evaluate the results against previous surveys or anticipated results.
2. Take any immediate actions required based on survey results.
3. Ensure all relevant supporting documentation (e.g., count room print-outs, etc.) are attached to the survey package and that the package is properly paginated.
4. Submit documentation to the RSO or designee for supervisory review.
5. Ensure that the survey form is complete and legible.
6. Ensure that all required information has been completed.
7. Ensure that any changes, single line cross-outs, or deletions are initialed and dated at time performed.
8. Verify that results are consistent with those anticipated.
9. If results are not consistent, ensure that appropriate actions have been taken to explain the results or re-examine the area.
10. Sign-off in the appropriate review section of the survey form and submit package to RP Document Control for retention / transmittal to Project Files.

6.0 RECORDS

- Survey Form (Attachment 1)
- Survey Log Number Form (Attachment 2)
- Radiation Protection Technician (RPT) Logbooks

7.0 ATTACHMENTS

Note: Attachments may be revised without formal review of this procedure and are attached as examples only. Please contact the RSO for a current copy of these attachments.

Attachment 1 Survey Form (Typical)

Attachment 2 Survey Log Number Form (Typical)

Attachment 1 (Typical)

[illegible]

PROJECT PROCEDURE PERMA-FIX ENVIRONMENTAL SERVICES	
TITLE: Operation of Portable Count Rate Survey Instruments	NO.: RP-106
	PAGE: 1 of 9 (incl. Attachments)
	DATE: January 2013

1.0 PURPOSE

This work instruction specifies the methods for set-up, daily pre-operational check, and operation of portable count-rate survey instruments. These instruments are used for the detection of radioactivity on personnel, on or within material surfaces, and in the environment. This procedure does not include associated instrument calibrations or cover the operation of exposure rate instruments.

2.0 APPLICABILITY

This procedure specifically addresses those meter-probe combinations that report values in units of counts or counts per minute (cpm) such as Ludlum Measurements models 2221 and 2241 Scaler-Ratemeters; and the Ludlum Model 177 Alarming Ratemeter or equivalent. These meters are mated to probes including the Ludlum Model 44-10, 44-20, and 44-62 NaI Detectors, the Ludlum Model 43-5 Alpha Scintillation Detector, and the Ludlum Model 44-9 Pancake Geiger-Mueller detectors or equivalent. Additional equivalent meters and probes may be used under this procedure without revision as approved by the RSO.

3.0 REFERENCES

1. ANSI N323A-1997, Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments.
2. Instrument Technical Manuals.
3. RPP-103, Radiological Surveys

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4.0 RESPONSIBILITIES

4.1 Radiation Safety Officer (RSO)

- Reviewing and approving changes to this procedure and ensuring compliance with applicable regulations.
- Ensuring an adequate inventory of Radiation Protection instruments are available to support remediation activities.
- Overseeing the issue, control, and accountability of Radiation Protection instrumentation per the requirements of this procedure.
- Ensuring transmittal of all issue, control and accountability records to the appropriate document control authority when applicable.

4.2 Radiation Protection Technician (RPT)

- Maintaining instrument documentation and records as required by this procedure.
- Maintaining adequate instrument and equipment availability.
- Verifying current calibration and response test dates prior to issue or use of instruments.
- Promptly returning instruments to their proper location when work is complete.
- Ensuring that instruments are properly surveyed for contamination and decontaminated as necessary after use.

5.0 PROCEDURE

5.1 General

1. Ensure the meter-probe combination selected is within their acceptable calibration periods. The swapping of probes between meters is permitted, but not encouraged. The following precautions and limitations must be observed and the following action steps must be taken:
 - If the meter-probe combination is calibrated as a set, Probe swapping is not permitted, without specific RSO approval.
 - The HIGH VOLTAGE (HV) and THRESHOLD settings for the meter-probe combination shall be identical. Note that the Ludlum 177 and 2241 do not have user adjustable settings for HV and THRESHOLD.
 - An initial set-up must be performed for each meter-probe combination prior to field use.
 - A source with known pedigree must be counted to verify the efficiency is within 10% of the calibrated efficiency, as applicable.
2. The RP Group will coordinate the calibration of boxes and probes on a minimum annual basis and after major repair operations. Battery and / or cable change-outs do not require re-calibration. Calibration procedures are outside of the scope of this instruction.

TITLE:	Portable Count Rate Survey Instruments	NO.: RPP-106
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3. Pre-operational checks are required daily prior to use. Post-operational checks are performed as specified in work plans or procedures. Instruments used in the performance of daily activities do not normally require a post-operational check..
4. Instruments that fail operational checks or malfunction during use should be tagged or labeled “Out-of-Service” or “Do Not Use” and segregated from operational instruments. If possible, describe the problem on the tag / label and add initials and date.
5. Instruments leaving RP Group control (i.e., repair, calibration, excess, etc.) shall be surveyed for unconditional release according to the contamination criteria established in Table 1 of the Site RPP. The repair / calibration center may request a copy of the survey accompany any shipments of RP instruments.
6. Ensure meters with a “WINDOW” or “WIN” setting are set to “OUT.”
7. Instruments may be operated in the FAST response mode if necessary. This setting is recommended if the audible response cannot be heard. SLOW response shall be used when performing instrument set-up and operational checks.
8. Ludlum NaI crystals are located in the end of the probe opposite of the cable connection. Use this end for surveys.
9. Calibration stickers are attached to the instruments and detectors. Illegible stickers should be replaced prior to instrument use.
10. Instrument set-up and subsequent operational checks should be performed in the same location, with consistent temperature and background radiation levels.
11. Source positioning devices (i.e., jigs) may be used to ensure a reproducible geometry between instrument checks. Source geometry must be consistent between initial instrument set-up and subsequent operational checks.
12. Instruments that do not have scaler capability should be set-up and checked by replacing 1-minute timed counts with static count rate measurements. Each static measurement should last until the meter reading fully stabilizes.

5.2 Instrument Set-Up

1. Inspect the meter-probe combination for physical damage or defect.
2. Complete Section A of the Portable Instrument Set-Up Sheet (Attachment 1).
3. Perform 10 1-minute source counts alternating with 10 1-minute background counts. Remove / replace the source and reposition the probe after each count. During alternating background counts, ensure that the source is sufficiently shielded so as not to impact background values.

NOTE: Counts (Source and Background) performed with a Ludlum 43-5, or other large surface area probe, should be alternated between the Heel, Center, and Toe Positions, if the source surface is smaller than the active surface area of the probe. Instrument response can vary greatly across the probe surface.

4. Document each count on the Portable Instrument Set-Up Sheet.
5. Calculate and record the net count value by subtracting the corresponding background count from each source count.

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NOTE: Determining Sigma (Standard Deviation) values is useful when specific plans or activities require higher data quality objectives and / or when the development of control charts is necessary.

6. Calculate and record the following values from the obtained background counts:
 - Avg. Value (Sum of values / # of counts)
 - Sigma Value (Standard Deviation of all counts)
 - 20% Value (Avg. Value * 0.20)
7. Calculate and record the +/- 20% Values and the +/- 1,2, and 3 Sigma values using the AVG. VALUE as a reference point.
8. Repeat the previous two steps for determining NET COUNT acceptable ranges. The 3 Sigma value must be less than the +/- 20% value.
9. Obtain a blank Daily Field Source Check Logsheet (DFSCL) (Attachment 2) and transfer the instrument, source, and acceptable range data, as applicable, from the Portable Instrument Set-Up Sheet.
10. Place the DFSCL in the designated use location and forward the completed Portable Instrument Set-Up Sheet and submit to the RSO, or designee for review.
11. Ensure sources are stored properly after use in the designated source storage location.

5.3 Operational Check

1. Obtain the selected meter-probe combination and corresponding DFSCL (**Attachment 2**).
2. Record the date and time on the DFSCL.
3. Perform and document the following checks on the DFSCL, as applicable:
 - Perform a physical inspection. Observe for instrument damage. Alpha probes should be checked for light leaks by inverting the probe face towards a light source and observing instrument response. If the instrument fails to respond at all or over-responds this may be an indication of a light leak and should be investigated further, prior to proceeding.
 - Perform a battery check. Instrument Models differ in method. Some meters have a visible battery range on the meter face. The Ludlum Model 2241 has a battery indicator in the digital display that lights if the batteries require replacement. The Ludlum Model 2221 has a BAT button that brings up the battery level in the digital display. Ensure this value is at least 5.0v. Change batteries and retest as necessary.
 - Verify and adjust the HV, when possible, to match the initial set-up data. Minute differences in HV (+/- 5v) are acceptable without adjustment.
 - Perform an audio response check..

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4. Perform and record a 1-minute background count. Report any abnormal background responses to the RSO, prior to instrument use. Normally acceptable background levels < 5 cpm for alpha probes, and < 300 cpm for Pancake G-M probes. Acceptable background levels for NaI probes are variable due to crystal size and based on technician experience.
5. Perform and record a 1-minute source gross count using the same source and geometry applied during initial set-up.
6. Calculate and record the net count value.
7. Compare the net count value to the acceptable range. If the instrument response is outside the acceptable range, the process may be repeated a maximum of 1 additional time before placing the instrument out-of-service.
8. If the instrument fails the pre-operational checks, mark FAIL, initial the DFSCL, and place the instrument out-of-service. Deliver completed DFSCL to the RSO or designee, and explain the failed condition(s).
9. If all checks pass, mark PASS, initial the DFSCL, and return form to designated in-use storage location. This may be a binder, folder, or cabinet. The instrument is now ready for use.
10. If the instrument will be used for routine personnel exit monitoring ensure the alarm threshold is set to alarm and actuates at a level below the site removable contamination limits
11. Ensure sources are stored properly after use in the designated source storage location.

5.4 Operations

1. Operate instrument in a manner that minimizes the potential for cross-contamination and physical damage.
2. Evaluate the surface or area to be surveyed for potential scanning interferences. For example, thin layers of water or soil can prevent the detection of alpha contamination. Another example is the use of a NaI probe to qualify soil contamination. The presence of standing water can have a significant impact on instrument response. Initiate necessary corrective actions prior to survey or note conditions during survey reporting.
3. Most instruments will operate in temperatures between 10 and 120 degrees Fahrenheit. However, anytime the temperature is outside of the 32 degree (freezing) or 100 degrees ranges, observe the following precautions:
 - Use particular caution with NaI crystals that may shatter under extreme temperature changes. If the temperature difference is greater than 30 degrees between storage and usage locations, wrap the probe tightly in a cloth towel or other insulator and allow warming or cooling over at least one hour prior to use.
 - Periodically check the instrument against a known source of radiation or contamination. If the instrument appears to be responding incorrectly contact the RSO or designee for guidance.

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- Contact the RSO for guidance anytime work is planned outside of the 10 to 120 degree range.
- 4. Protect instruments to the extent possible from exposure to moisture (i.e., rain, snow, etc.) during use. Instruments shall be stored in a safe manner when not in use.
- 5. Minimum Detectable Activities (MDA) for each survey should be determined by evaluating field background levels, not background values obtained during operational checks. Calculate MDA using the formula provided in PP-8-805, "Radiological Surveys."
- 6. Determining activity in disintegrations per minute (dpm) should be performed using the instrument efficiency obtained during calibration. Efficiencies are normally not established for NaI probes, and therefore should not be used for quantifying activity concentrations. The use of NaI probes for activity quantification shall be evaluated by the RSO prior to performance.
- 7. Observe the following when performing survey scans and static measurements:
 - Alpha probes should be held within ¼-inch of the surface being surveyed. Probe speed should not exceed 1 probe width per second.
 - Beta probes should be held within ½-inch of the surface being surveyed. Survey speed should not exceed one probe width per second.
 - NaI probes should be held as close as possible to the surface being surveyed without contaminating the probe housing. Note that the crystal is located in the probe end opposite the cable connection. Use appropriate sleeving or wrapping in wet or dirty environments.
 - The scan speed for performing Gamma Walkover Surveys is approximately 0.5 m/sec. Move the detector side to side using a 1-meter path length. Each side-side swing should take 2 seconds to traverse the 1-meter path. Advance the probe forward as you go at a rate of approximately 0.5 m/sec. Use the audio function. When increased counts are detected, slow down and locate the source as would be done in a normal survey. Walk parallel paths to ensure that 100% of the area is surveyed. Ensure that the survey extends to the boundaries of the survey unit. Pay particular attention to low lying areas, ditches, and points of possible contamination.
 - Static measurements should be performed in any location where scans indicated the presence of activity. This is due to the fact that instrument MDAs are normally based on a 1-minute static measurement.
 - All static measurements should be at least 1 minute, if the instrument has a scaler function. If the instrument is a ratemeter only, static measurements should last until the meter reading has fully stabilized.
- 8. Perform a post-operational check after use if directed by work plan, procedure, or the RSO.

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6.0 RECORDS

- Portable Instrument Set-Up Sheet
- Daily Field Source Check Logsheet

7.0 ATTACHMENTS

Note: Attachments may be revised without formal review of this procedure and are attached as examples only. Please contact the RSO for a current copy of these attachments.

Attachment 1 Portable Instrument Set-Up Sheet (Typical)

Attachment 2 Daily Field Source Check Logsheet (Typical)

Attachment 1
Portable Instrument Set-Up Sheet (Typical)

PORTABLE INSTRUMENT SET-UP SHEET									
Set-Up Location: _____									
INSTRUMENT DATA		COUNT (n)	Source Counts	Source Count Time (min)	Source CPM	Background Counts	Background Count Time (min)	Background CPM	NET CPM
INSTRUMENT	DETECTOR	1							
MODEL		2							
SERIAL #		3							
CAL DUE		4							
HV		5							
THRESHOLD		6							
SOURCE DATA		7							
ISOTOPE		8							
SERIAL #		9							
ACTIVITY (uCi)		10							
ACTIVITY (dpm)									
REMARKS									
CALCULATED VALUES Background (CPM) Net CPM			ACCEPTABLE RANGES						
			Background (CPM) Net CPM						
			+ 20 %						
			+ 3 Sigma						
			+ 2 Sigma						
+ 1 Sigma									
- 1 Sigma									
- 2 Sigma									
- 3 Sigma									
- 20 %									
Reviewed By:			Date / Time:						
Performed By:			Date / Time:						

Attachment 2
Daily Field Source Check Logsheet (Typical)

MONTH / YEAR: _____

DAILY FIELD SOURCE CHECK LOG

INSTRUMENT DATA			Date/Time	Physical	Battery	High Voltage	Audio	Background CPM {A}	Source CPM {B}	Net CPM {C}	PASS or FAIL	Tech. Initials
INSTRUMENT	DETECTOR											
MODEL												
SERIAL #												
CAL DUE												
SOURCE DATA												
ISOTOPE												
SERIAL #												
ACTIVITY												
dpm												
INSTRUMENT RANGES												
	Background	Net CPM										
+ 20 %												
+ 3 Sigma												
+ 2 Sigma												
+ 1 Sigma												
- 1 Sigma												
- 2 Sigma												
- 3 Sigma												
- 20 %												
NET CPM CALCULATION {B} - {A} = {C}												
Remarks:			Reviewed by:									

CH2MHILL

STANDARD OPERATING PROCEDURE # 01 FIELD DOCUMENTATION

Proper field documentation is necessary to ensure the obtained data is defensible and to verify the quality and quantity of work performed in the field. Field log books, instrument calibration log (documented in the field log book), sample and operation log sheets, correspondence, sample labels, chain-of-custody forms, photographs, and analytical records are suitable documents for recording the work. All information pertinent to a field activity must be entered into a log book or on system operation log sheets.

EQUIPMENT AND SUPPLIES

- Log book and/or system operation log sheets
- Camera (disposable or digital)
- Chain-of-custody forms and custody seals
 - Sample identification labels and sampling log sheets
 - Work Plan
 - Pen and Sharpie
 - Health and Safety Plan

PROCEDURES

Planning for field documentation involves:

- Acquiring needed equipment and supplies;
- Reading the Work Plan and associated contract documents in order to understand the field documentation requirements; and
- Compiling or developing data sheets, labels, and other documentation forms.

LOG BOOK AND/OR OPERATION LOG SHEETS

All log books shall be numbered and bound with consecutively numbered pages. The Field Team Leader or individual designated to perform field activities and/or system operations shall keep an up-to-date field log book that documents and details the activities of each day including all personnel on site, conversations with clients, regulators, contractors, etc., and all work performed throughout the day. Specific log sheets related to each field task include:

- Project/Task Briefing Form
- Groundwater Sampling Log Form
- Soil Sampling Log Form

➤ Field Services Form

All log sheets shall be initialed by the system operator and stored sequentially in a field documentation repository (3-ring binder). Log book pages and data should never be removed. When information is to be changed in the field book or log sheet, a line will be drawn through the data or text and initialed. Permanent ink shall be used for recording the data. Log forms shall be completely filled out and missing data shall be noted and explained. All contractors on-site including Union Pacific employees and EICs shall sign off on the safety briefing form.

LABORATORY SAMPLE CHAIN-OF-CUSTODY FORM

The COC form is intended to trace sample possession from the time of collection to disposition. Every sample collected for laboratory analysis must be accounted for on a COC form. Completed COC forms shall contain the following information.

- Sample numbers;
- Signature of collector;
- Date and time of collection;
- Sample matrix;
- Sample Location;
- Number of containers;
- Parameters requested for analysis;
- Signature of all person(s) involved in the chain of sample possession;
- Inclusive dates of possession;
- Internal temperature of shipping container upon opening at the laboratory.

SAMPLE LABELS

Logs from each sampling event shall be retained in the documentation binder. Sample labels shall be attached to each sample container. The following information must be included on every sample label:

- Sample identification number;
- Initials of sample collector;
- Date and time of sample collection;
- Sample preservation method if required;
- Parameters required for analysis; and
- Comments as needed.

STANDARD OPERATING PROCEDURE 07

Direct-Push and Sonic Drilling Methods

Purpose and Scope

This SOP provides a general procedure for logging and sampling subsurface soil using a Rotosonic continuous coring or 4-foot Macro-Core® using direct-push probing methods, respectively.

Equipment and Materials

- Drill rig equipped with tooling for rotosonic drilling methods using continuous core pipe or hydraulic direct-push rig using 4-foot Macro-Core® samplers
- Field logbook and waterproof pen
- Clean plastic sheeting
- Equipment and supplies required for logging soil boring (see SOP, Soil Boring Logging)
- Clean Department of Transportation (DOT)-approved 55-gallon steel drums with labels
- Equipment/instrument decontamination materials (see SOP, Equipment Decontamination Procedures)
- Laboratory-supplied analytical sample containers
- Clean latex or nitrile gloves
- Leather gloves for cutting plastic liners
- Macro-Core® Liner Cutter for opening acetate liners
- Core polyurethane bags for collection of 4-inch soil core from rotosonic rig
- Markers/paint-pens or other label supplies

Procedures and Guidelines

- Set up and calibrate instruments in accordance with manufacturer's instructions.
- Ensure that all equipment and tooling used downhole or contacting soil samples at ground surface is clean. Decontaminate all non-dedicated equipment and tooling in accordance with the SOP, Equipment Decontamination Procedures.
- Verify that all site utilities have been cleared in accordance with the sampling and analysis plan (SAP).

- Place clean plastic sheeting on ground surface or surface on which the soil cores will be logged and sampled. It is preferable to log the soil cores in areas with relatively low radiological readings and away from drill rig activity.
- The subcontractor should use the proper tools/equipment necessary to ensure that the proper angle is kept during advancement of angled soil borings.
- Ensure that the subcontractor advances the samplers to the top depth of the next successive sample interval or the desired sampling depth.
- Ensure driller advances the sampler at a rate that ensures maximum recovery within the sampler. Samplers advanced at too rapid of a rate may result in poor recovery or sample quality.
- Ensure that subcontractor removes the drill rods and samplers from the soil boring. The samplers shall be opened by the drilling subcontractor and turned over to CH2M HILL field personnel.
- Wear latex or nitrile gloves.
- Ensure driller indicates which end of the sampler is the top and bottom. CH2M HILL field personnel should orient the sample cores the same direction when logging to minimize errors in logging the cores backwards. Core bags/sleeves should be labeled.
- Log the soil core in accordance with the SOP, Soil Boring Logging.
- Each soil core will be screened with a radiation detector and the results will be recorded in the field logbook or boring log.
- Place the sample containers in an ice-bearing cooler away from sources of cross contamination.
- Soil cuttings not collected for laboratory samples should be used in the abandonment of the soil borings. Soil cuttings should be placed back into the soil borings from which they originated. In the case where remaining soil cuttings does not fill the soil boring completely back to the surface, bentonite chips should be used to fill and plug borings. Water derived from decontamination of downhole equipment should be used to hydrate the bentonite chips during soil boring abandonment. All excess decontamination liquids should be drummed in DOT-approved 55-gallon steel drums and pending analysis labels should be placed on the outside of each drum.
- Decontaminate all non-dedicated equipment and tooling in accordance with the SOP, Equipment Decontamination Procedures.
- Mark the location with pin flag or surveyor stake, if appropriate.

Key Checks

- Verify that the drill rig is clean and in proper working order.

- Ensure that the driller thoroughly decontaminates the downhole equipment between soil borings.
- Ensure that the borehole has been backfilled and ground surface restored.
- Mark soil boring location with a labeled survey flag, if appropriate. Collect GPS or survey locations from all soil borings.

Attachments

None.

SURFACE AND SHALLOW SOIL SAMPLING

1.0 PURPOSE

The purpose of this technical procedure is to describe the methodology for collecting discrete or composite soil samples to document the areal and vertical extent of contaminated soil, and to determine the geotechnical, physical, and chemical properties of the soil.

2.0 SCOPE

This procedure applies to all CH2M HILL personnel and subcontractors who engage in collecting or otherwise handling samples of surficial or subsurface soil.

3.0 GENERAL

Soil sample collection shall adhere to the labeling and chain of custody requirements applicable to any site sampling activities. Refer to Sample Handling and Custody, for details on sample container labeling, handling, and chain of custody requirements. Sample packaging and shipping requirements are outlined in technical procedure Packing and Shipping – Environmental Samples.

All personnel who collect or handle the soil samples shall wear disposable nitrile gloves to prevent cross-contamination and provide personal protection. New gloves shall be donned for sample collection at each location, or whenever gloves are torn or otherwise compromised.

4.0 RESPONSIBILITIES

4.1 Project Manager

The *Project Manager* (PM) is responsible for overall compliance and training with these procedures.

4.2 Field Team Leader

The *Field Team Leader* (FTL) shall ensure that soil samples are collected according to this procedure. The FTL shall also be required to make rational and justifiable decisions when deviations from this procedure are necessary because of field conditions or unforeseen problems. The FTL shall consult the PM if significant deviations from the sample and analysis plan are necessary due to field conditions. The FTL shall also ensure that samples are handled, labeled, and shipped according to SOPs. The FTL shall also assure that all investigation derived waste (IDW) is managed according to the site-specific Waste Management Plan (WMP).

5.0 PROCEDURES

5.1 Equipment

Equipment that may be used to collect surface or subsurface soil samples includes, but is not limited to, the following items:

- plastic scoops/spoons
- stainless steel hand auger
- trowel
- digging bar
- plastic bowls or pans
- field logbook and boring log
- waterproof and permanent marker
- paper towels
- appropriate decontamination equipment
- appropriate health and safety equipment per the site-specific Health and Safety Plan (HSP)
- sample cooler with ice
- sample containers and labels
- chain-of-custody forms
- Munsell Soil Color Charts
- grain size charts
- Ziploc® (or comparable) freezer bags

5.2 Decontamination

Before collecting any soil samples, all sampling devices shall be decontaminated (or confirmed to be free off contaminants). Decontamination supplies must be on hand so that equipment can be decontaminated in the field if non disposable sampling equipment is used. Each piece of reusable sampling equipment shall be decontaminated between each sample location or interval. Spent decontamination fluids will be managed according to the site-specific WMP. Procedures presented in Decontamination Procedures SOP, will be followed for decontamination of field equipment and for personnel decontamination. Disposable sampling equipment will be used whenever it is feasible to minimize decontamination and the potential for cross-contamination.

5.3 Surface Soil Sampling

Surface soil is typically defined as the soil located between the ground surface and a depth of 2, and sometimes 3, feet below the surface. However, the depth that is considered surface soil may vary depending on site-specific project objectives, as defined in the project-specific Work Plan. Surface soil samples can be collected in paved and unpaved areas.

In paved locations, surface asphalt or concrete would need to be removed mechanically or by hand, as well as any base course located beneath the paving.

In unpaved locations, surface vegetation may need to be removed before sampling. Surface soil samples may be collected as either discrete or composite samples. Each surface soil sample will be collected using disposable plastic scoops where possible, or a stainless steel trowel or auger for dense or rocky soils. The sampler, wearing clean disposable nitrile gloves, will remove materials, including pebbles and roots, from the mixture as the sample is collected. Each sample will be collected by thoroughly homogenizing material from the appropriate depth interval bgs (as stated in the project specific Work Plan) from the respective sampling location. A decontaminated scoop or trowel will be used to collect the soil sample.

Each soil sample fraction collected for inorganic analyses will be thoroughly homogenized in a clean, dedicated container or disposable plastic bag. The homogenized material will then be divided among the appropriate sample containers. The sample containers will then be sealed tightly. Care should be taken to ensure that the container used for homogenization and the sampling utensils do not interfere with the analytes of interest.

Composite samples shall be collected by placing equal amounts (or aliquots) of soil collected from multiple locations into a decontaminated, dedicated collection container. The aliquots will then be homogenized using the sample collection tool (such as a scoop or spoon). Then the homogenized material will be divided equally among the appropriate sample containers, and the sample containers will be sealed tightly.

5.4 Shallow Subsurface Soil Sampling (Depth Obtainable with Hand Tool Equipment)

Each subsurface soil sampling location should be checked and cleared before intrusive activities commence.

Shallow subsurface soil samples may be collected as either discrete (grab) or composite samples. Subsurface soil samples can be collected using a wide variety of sampling equipment and devices. Common equipment used to collect shallow subsurface soil samples include thin-wall tube samplers and various types of hand augers, including bucket-type hand augers, continuous-flight hand augers, and posthole hand augers. Of these, only the thin-wall tube sampler collects an undisturbed soil sample. Depending on field conditions or sampling objectives, several types of sample collection equipment can be used to collect a soil sample at a single location.

Using a decontaminated hand auger (or similar equipment), the soil borehole will be advanced to the depth immediately above the sampling interval, and all cuttings will be removed from the

borehole. During advancement of the auger, cuttings from in and around the borehole will be periodically removed and placed on a plastic sheet. If the sample is to be collected using the same hand auger, the auger bucket will be decontaminated (or replaced with a decontaminated bucket) before collecting the sample. The discrete sample will then be collected by advancing the sampling equipment to the appropriate depth interval and retrieving the soil sample.

Each soil sample fraction collected for inorganic analyses will be thoroughly homogenized in a clean, dedicated container or plastic bag. Care should be taken to ensure that the container used for homogenization and the sampling utensils do not interfere with the analytes of interest (for example, an aluminum pan should not be used for soil samples submitted for metals analyses). The homogenized material will then be divided equally among the appropriate sample containers. Depending on the number of sample containers to be filled at each location, additional soil sample media may be required from the sample location.

Composite samples will be collected by placing equal amounts (or aliquots) of soil collected from multiple locations into a decontaminated, dedicated decontaminated collection container. The aliquots will then be homogenized using a the sample collection tool (such as a scoop or spoon). The homogenized material will then be divided equally among the appropriate sample containers. The sample containers will then be sealed tightly.

5.5 Shallow Subsurface Soil Sampling (Depth Obtainable with Drilling or Excavation Equipment)

Each subsurface soil sampling location should be checked and cleared before intrusive activities commence.

Subsurface soil samples may be collected as either discrete (grab) or composite samples. Subsurface soil samples can be collected using a wide variety of sampling equipment and devices. Common equipment used to collect subsurface soil samples include coring tools and sleeves, split spoon samplers, Shelby tubes, and excavator buckets. Depending on field conditions or sampling objectives, several types of sample collection equipment can be used to collect a soil sample at a single location.

Using decontaminated drilling or excavation equipment, the soil borehole/excavation will be advanced to the depth immediately above the sampling interval, and all cuttings will be removed from the hole. Cuttings will be staged on plastic sheeting, bins, or drums. Discrete sample will be collected by advancing the sampling equipment to the appropriate depth interval and retrieving the soil sample. Samples may also be composited by collected by either random or specified depth discrete increments.

Each soil sample fraction collected for inorganic analyses will be thoroughly homogenized in a clean, dedicated container or plastic bag. Care should be taken to ensure that the container used for homogenization and the sampling utensils do not interfere with the analytes of interest (for example, an aluminum pan should not be used for soil samples submitted for metals analyses). The homogenized material will then be divided equally among the appropriate sample containers. Depending on the number of sample containers to be filled at each location, additional soil sample media may be required from the sample location.

Composite samples will be collected by placing equal amounts (or aliquots) of soil collected from multiple locations into a decontaminated, dedicated decontaminated collection container. The aliquots will then be homogenized using a the sample collection tool (such as a scoop or spoon). The homogenized material will then be divided equally among the appropriate sample containers. The sample containers will then be sealed tightly.

5.6 Soil Lithologic Descriptions

This section discusses the protocol for recording basic lithologic data, including, but not limited to, the major lithology present, secondary lithologic components, Munsell Color Chart classification, grain size, moisture content, bedding, and other lithologic components. In describing lithologies, it is helpful to have a set of references covering items such as the grain size, particle shape, degree of sorting, and comparison chart of estimating percentages.

A list of equipment that will be useful in completing lithologic descriptions is provided below:

- Field logbook and lithologic field forms
- Clip board
- Plastic sheeting
- Indelible black ink pens or markers
- Reference field charts
- Personal protective clothing and equipment
- Health and safety monitoring equipment
- Folding table and chairs
- Camera and ruler (or similar) for photo
- Sample jars (if required)
- Grain size chart
- Munsell Color Chart

The following descriptive protocol should be used to classify and document the lithologic description of the lithology recorded. The information gathered will be recorded in the "Description" column on the soil boring log field form.

5.6.1 Predominant Lithology

Determine the predominant lithology or lithologies within the sample interval using the grain-size classification guide provided in Attachment 2 in this procedure or other reference, as appropriate. Dominant lithology classification is determined based on the predominant (that is, 50 percent or greater) grain size present in a sample. For example, if the SAND and GRAVEL portion comprises more than 50 percent, the predominant lithology classification is either SAND or GRAVEL, depending on which portion is greater. Similarly, if SAND and GRAVEL comprises 50 percent or less, the sediment is named either CLAY or SILT, whichever comprises the greatest percentage of the sample. This will be the primary descriptor used to identify the soil.

In some instances, a secondary constituent may alter the primary lithology if that constituent comprises between 35-44 percent of the total sample. The descriptor for that constituent should be placed before for the primary constituent with a "Y" ending. See Section 5.1.8.2 for

further details and examples. In other cases, two soil types equally comprise the predominant lithology of a sample. In these cases, the term “and” should be used between the terms for each lithologic descriptor (for example “SAND and GRAVEL”).

NOTE: Samples from split spoons and small-diameter core tools are not always representative of coarse-grained strata (those with grain sizes of a diameter greater than that of the diameter of the particular coring apparatus used). Be sure to check driller’s logs and soil cuttings for boulders, cobbles, gravels, and the like, which were encountered during advancement of the boring, and note their presence on the soil boring log field form.

Special consideration needs to be taken when dealing with soil samples in which the predominant grain size is fine grained (that is, CLAY or SILT). Because of the fine size of clay and silt, physical properties other than grain size must be used as criteria for identification in the field. The dilatancy or “shaking test” may be used to distinguish between the fractions of clay and silt. In this test, a small amount of soil is mixed with water to a very soft consistency in the palm of the hand. The back of the hand is then lightly tapped. If the sediment is silty, water rises quickly to the surface of the mixture and gives it a glistening or shiny appearance. Because of the difficulty in distinguishing between silt and clay, it is not necessary to provide the relative percentage of each.

The property of plasticity is characteristic of clays and may be determined using a simple field test. If a sample of moist fine-grained soil can be rolled into a long thin thread in the palm of the hand, it contains a significant amount of clay. Silt can seldom be rolled into a thread without severe cracking. If a sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation before rolling.

5.6.2 Secondary Constituents

Secondary and tertiary constituents are those portions of the lithology that comprise less than 50 percent of the sample. Estimate the percentages of these constituents using Attachments 2 and 4. For mixed-grain sizes, estimate the relative percentages of the sediment sizes within the sample. Table 1 provides a set of descriptive adjectives that should be used to identify secondary lithologies based on the estimated percent composition. Once the actual percentage for each constituent is known, it can be assigned a descriptive adjective from this table that is recorded in the lithologic description.

Table 1
Descriptive Adjectives for Secondary Lithologies

Description	Percent Composition
Trace (tr)	<5%
Trace-little (tr to ltl)	5-11%
Little (ltl)	12-24%
Some (sm)	25-34%
“Y” ending	35-44% (for example, silty sand)
“And”	45-50% (for example, silt and sand)

For example, a sample consisting of predominantly sand with 40 percent silt would be recorded: SILTY SAND. Sand with 15 percent silt would be: SAND: little silt.

5.6.3 Secondary Modifiers

Identify applicable secondary modifiers (for example, grain size, sorting, structural and textural features, bedding laminations) and use abbreviated qualifying adjectives as needed. A list of abbreviated qualifying adjectives is presented as Attachment 6.

- **Relative Density**

Relative density can be based on blow counts during hollow-stem auger drilling and is used as a prefix in primary lithologic descriptions (Table 2).

Table 2
Relative Densities Based on Blow Counts

Cohesive Soils (Silts and Clays)		Noncohesive Soils (Sands and Gravels)	
No. of Blows	Relative Density	No. of Blows	Relative Density
0-4	Soft (sft)	0-4	Very Loose (v.lsc)
5-8	Firm (frm)	5-10	Loose (lsc)
9-15	Stiff (stiff)	11-30	Medium Dense (m.dnse)
16-30	Very Stiff (v.stiff)	31-50	Dense (dnse)
31-50	Hard (hrd)	Over 50	Very Dense (v.dnse)
Over 50	Very Hard (v.hard)		

- **Consistency**

For intact fine-grained soil only, consistency can be described using the terminology in Table 3. The thumb and thumbnail are used to conduct this test.

Table 3
Consistency Test by Hand

For Cohesive Soils (Silts & Clays)	
Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

- **Color**

Color descriptions shall be made using Munsell soil color charts. The description shall include the color designation and the verbal description (for example, 10 YR. 5/6 yellowish brown). While color is not an important physical property in itself, it is often an indicator of more important properties. For example, dark green and brown are often an indication of organic matter. When the color of the sediment is uniform, record this with the singular term from the Munsell Color Chart. If two major and distinct colors are mottled through the sediments, the color description can be modified by the term mottled with the two Munsell color descriptions (for example, brown and bluish gray) with the color designation following both verbal descriptions (for example, mottled brown [10 YR 4/3] and yellowish brown [10 YR 5/6]).

- **Particle Shape**

Particle shape descriptions (for coarse sand and larger, such as gravel) can be made based on the figure included in this procedure as Attachment 3, which was taken from *Compton's Manual of Field Geology*. An example is "rounded coarse gravel."

- **Odor**
Describe any unusual odors. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. Other unusual odors may be because of contamination or other sources.
- **Moisture Content**
Moisture condition in soil should be described using terminology in Table 4.

Table 4
Criteria for Describing Moisture Condition

Description	Criteria
Dry	Little or no perceptible moisture
Moist	Soil has perceptible damp condition in which soils exhibit some signs of cohesion among particles
Wet or Saturated	Pores and voids filled with water

Relevant Observations

Record any other relevant observations, such as signs of contamination, cementation of particles, mineralogy, bedding, contacts between strata, and unconformities. These may be noted in the description column of the lithologic log.

5.6.4 Rock Lithologic Descriptions

Lithologic descriptions for competent rock should not follow USCS conventions, but should instead be focused on descriptions pertinent to rock classifications that are possible to perform in the field without a microscope or other laboratory equipment. Ideally lithologic rock descriptions provided in the boring log will be sufficient to characterize the lithology according to mapped formations. When rock coring is performed, more detailed rock descriptions can be presented. At a minimum the rock type, weathering and source of material for descriptions should be noted. The source of material can be core, or cuttings in fluid or chips. Lack of recover should be noted when logging rock from cuttings.

Classification of Rocks

Rocks are grouped into three main divisions: sedimentary, igneous and metamorphic. If the specific rock type cannot be determined in the field, chip or core samples may be collected for further determination, and the major division should be noted in the log. Sedimentary rocks are the most common type of rock near the surface. The following basic names are applied to the type of rocks found in sedimentary sequences:

- **Sandstone** – Made up predominantly of granular materials ranging between 1/16 and 2 inches diameter. Sand mineralogy and grain size may be noted in log.
- **Siltstone** – Made up of granular materials less than 1/16-inch diameter. Fractures irregularly.
- **Claystone** – Very fine-grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.
- **Shale** – A fissile, very fine-grained rock. Fractures along bedding planes.

- **Limestone** – Rock made up predominantly of calcite. Effervesces upon the application of hydrochloric acid. Shells and fossils should be noted where evident.
- **Coal** – Rock consisting mainly of organic remains.
- **Others** – Numerous other rock types are present. When the specific type of rock cannot be determined, a thorough description should be presented.

Igneous and metamorphic rocks are most often encountered at depth and near uplifts. A great many varieties of igneous and metamorphic rock exist, however many of these cannot easily be identified in the field. The following are some of the most common igneous and metamorphic rocks that are encountered over mappable distances:

- **Granite** – A felsic intrusive igneous rock. This is the most common igneous rock encountered on the continental cores, and can be identified by a large quartz and feldspar composition.
- **Diorite** – An intermediate intrusive igneous rock. These rocks are often less dense than granites and have more mafic (dark) minerals.
- **Ash/Tuff** – Volcanic ash and tuff are extrusive rock that is most easily identified by a large degree of void space. These rocks are often soft and are readily weathered.
- **Rhyolite** – A felsic extrusive igneous rock. These fine-grained rocks may not be easily identified in the field, due to the difficulty in identification of finely crystallized minerals. They may be distinguished by light color and high density.
- **Basalt** – A mafic extrusive igneous rock. These fine-grained volcanic may be identified by dark color, surface textures and volcanic gas voids.
- **Slate** – A low grade, fissile, fine-grained, metamorphic rock. This rock can be identified by its platy nature, and is derived from fine sedimentary rock.
- **Gneiss** – A medium grade, foliated, recrystallized metamorphic rock. The foliation and presence of larger garnet or mica minerals distinguishes this rock.
- **Schist** – A high grade, recrystallized metamorphic rock. There are various types of schist derived from various source rock. All schists are highly reworked and recrystallized.
- **Others** – Numerous other rock types are present. When the specific type of rock cannot be determined, a thorough description should be presented.

When describing rocks the following characteristics may be noted:

- Rock Type
- Color
- Bedding Thickness
- Crystal size
- Texture
- Hardness
- Fracturing
- Weathering
- Mineralogy (if discernible)
- Other Characteristics including fossils, organic matter and dip of bedding or fractures.

Rock Type

As described previously, there are numerous names for sedimentary rocks. In most cases a rock will be combination of several rock types, therefore a modifier such as sandy siltstone or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is

composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Grain diameters are used for the classification of classic sedimentary rock. The following is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different than the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks.

Particle Name Grain Size Diameter

- Cobbles > 64 mm
- Pebbles 4 - 64 mm
- Granules 2 - 4 mm
- Very Coarse Sand 1 - 2 mm
- Coarse Sand 0.5 - 1 mm
- Medium Sand 0.25 - 0.5 mm
- Fine Sand 0.125 - 0.25 mm
- Very Fine Sand 0.0625 - 0.125 mm
- Silt 0.0039 - 0.0625 mm
- Clay < 0.0625 mm

Color

The color of a rock can be determined in the same manner as for soil samples. Rock core samples should be classified while wet, when possible, and air-cored samples should be scraped clean of cuttings prior to color classifications. Rock color charts may be used, and are distinct from soil color charts.

Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. Hardness can be determined with a bladed tool (knife, screwdriver, scissors) and a hammer from intact core, and can also be estimated by drill speed and chatter.

- Soft – Weathered rock and loosely consolidated rocks (such as some volcanic ash, poorly cemented sandstones and siltstones, and poorly compacted claystones) can be soft. Drill speeds should be only slightly slower than in dense soils. Soft rock can be easily gouged by a blade or scratched by fingernail. Soft rock crushes or deforms when hammered.
- Medium soft – Slight erosion of core, slightly gouged by a blade, or breaks with crumbly edges from single hammer blow.
- Medium hard – Often applied to some non-weathered sedimentary or metamorphic rock, or some lightly weathered igneous rock. Medium hard rock can be easily scratched by a blade or breaks with sharp edges from single hammer blow.
- Hard – Often applied to some non-weathered metamorphic and igneous rock. Hard rock cannot be easily scratched by a blade and breaks with difficulty upon hammering.

Weathering

The following terms can be applied to distinguish the degree of weathering:

- Fresh – Little or no staining, with bright and clear mineral coloring.
- Slight – Rock has some discoloration, particularly along joints, cracks or exposed surfaces. Chemical alteration of feldspar and mafic minerals on weathered surfaces may be noted.

- Moderate – Significant staining and chemical alteration evident. Rock is weakened due to weathering and can be easily broken with hammer.
- Severe – Weathering has penetrated through rock and significant fracturing and dissolution may be noted. The rock may be soft and friable.

5.6.5 Presentation Order

Once the information described in Section 5.0 has been gathered for the sample, the sample description should be recorded on the lithologic field log. In order to maintain consistency, it is recommended that the lithologic description be presented in the following order:

- * MAJOR LITHOLOGY: Munsell Color classification, grain shape (in the case of gravel) and size, secondary components (including their percentage, grain shape [in the case of gravel] and size), relative density, moisture content, sedimentary structures and bedding, and other descriptive modifiers, as necessary

EXAMPLE: A sample is visually examined in the field and is found to be comprised of approximately 55 percent medium-grained sand and 40 percent silt. The structure of the sample is massive and the color is yellowish brown. The sample is damp to moist, and the standard penetration test produced a penetration resistance (N) of 16. The description would be as follows: SILTY SAND: 10 YR 5/6 Yellowish Brown, medium-grained, trace clay, firm, moist to damp.

5.7 Quality Assurance/Quality Control Procedures and Samples

Quality Assurance/Quality Control (QA/QC) samples shall be collected during soil sampling, according to the site-specific QAPP. QA/QC samples shall be assigned unique sample identification and submitted to the laboratory with the other field samples.

5.7.1 Equipment Blanks

Equipment blanks shall be collected at a frequency specified in the site-specific UFP-QAPP. An equipment blank sample is collected in the field by running American Society for Testing Materials (ASTM) Type II Reagent-Grade water (or deionized water with less than 15 microSiemens conductivity) across the surface of re-usable, decontaminated sampling equipment (typically the split-spoon or drive shoe of the macrocore sampler) and into appropriate sample containers.

5.7.2 Field Duplicate Samples

Field duplicates will be collected at a frequency specified in the site-specific UFP-QAPP. Field duplicate samples will be collected simultaneously or in immediate succession to the normal samples using identical sampling techniques.

5.7.3 Trip Blanks

Trip blank samples shall accompany all normal volatile samples that are not preserved with alcohol or packaged in dry ice. Trip blank samples will be provided by the laboratory and shall consist of preserved ASTM Type II laboratory grade deionized water that will be analyzed for the volatile method equivalent to the normal sample analysis method for VOC, volatile petroleum organics or total petroleum hydrocarbons.

5.7.4 Matrix Spikes and Matrix Spike Duplicates

Matrix spike/matrix spike duplicate (MS/MSD) samples will be collected at a frequency specified in the site-specific UFP-QAPP. MS/MSD samples will be collected simultaneously or in immediate succession to the normal samples using identical sampling techniques.

5.7.5 Sample Identification, Handling, and Documentation

Samples shall be identified, handled, and recorded as described in this technical procedure and according to standard sample handling protocols indicated in SOP-29.

6.0 RECORDS

All records shall be documented in a bound field logbook according to SOP-01 or a soil boring log provided in SOP-05.

7.0 REFERENCES

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Powers, M.C. *A New Roundness Scale for Sedimentary Particles*. *Journal of Sedimentary Petrology*. Vol. 23, p. 117-119. 1953.

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8.0 DEFINITIONS

1. Composite soil sample: a combination of soil aliquots collected at various locations, or at various depths at a single location. Analysis of composite samples yields a value representing an average over the various sampled sites or depths from which individual samples were collected.
2. Discrete soil sample: a discrete aliquot from a distinct sampling interval (of a specific sample size) that is representative of one specific location at a specific point in time.
3. Surface soil: generally considered to be the top 6 inches of a soil horizon profile (that is, soil from 0 to 6 inches below ground surface [bgs]), soil down to depths of 2 feet bgs may be considered surface soil. For the purposes of this procedure, surface soil represents the soil in the 0- to 6-inch depth interval bgs.
4. Subsurface soil: the soils, silts, sands, and clays below surface soil.

9.0 ATTACHMENTS

None.

GLOBAL POSITIONING SATELLITE SYSTEM (GPS) SURVEYING

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to identify requirements for conducting land mapping activities using resource-grade Global Positioning Satellite (GPS) system instruments.

2.0 SCOPE

This SOP applies to all CH2M HILL personnel and subcontractors who engage in mapping activities using resource-grade GPS.

3.0 GENERAL

This standard operating procedure (SOP) outlines the standard operating procedures for the use of surveys that may utilize resource-grade GPS system instruments. These instruments will be used to collect positional (horizontal) data, which can be in the form of individual point features, the description of linear items, and the delineation of areas of interest. All items must be accompanied by a feature identification note, and, if necessary a detailed list of attributes of the feature.

4.0 RESPONSIBILITIES

4.1 Field Team Leader

Each *Field Team Leader* (FTL) is responsible for ensuring overall compliance with this technical procedure. The FTL will receive training by someone who has completed GPS training before collecting field data.

5.0 PRE-DATA COLLECTION PROCEDURE

5.1 GPS Management

Projects that intend to utilize GPS for field data collection, field verification, or general navigation should determine the minimum accuracy requirements, appropriate mobile device, system configuration, and postprocessing requirements. This will ensure that field teams can collect data, verify their accuracy, and use the data for project activities while minimizing costs.

For mapping or Geographical Information System (GIS), resource-grade GPS receivers (with differential corrections applied either in real-time or in post-processing) must be rated at "sub-meter" (approximately 1 meter or better) horizontal accuracy.

Most GPS software requires data to be in a specific format with limited import and export compatibility. This SOP will focus on TerraSync™ compatibility and resource-grade GPS receivers.

5.2 Device Setup

Wherever possible, the GPS receivers will be used with a radio receiver linked to the GPS unit to receive GPS differential corrections. This enables the GPS system to generate corrected positions in real-time, allowing for positional checks during operation and accurate navigation to pre-determined or pre-recorded positions. If the navigation beacon is not used, then base station data for post-processing must be obtained from a reliable source. This can be from a project base station set up locally for the purpose, or a community base station, public or private, from which the appropriate data can be obtained. Data should be collected into the coordinate system specified in contract terms.

5.3 Data Collection

Quality assurance and quality control (QA/QC) procedures should include checks to known points during data collection. To the extent practicable, known point positions such as existing benchmarks or monitoring wells that have known coordinates should be recorded to help verify positional accuracy. Side trips to known points may be made to include selected known points in project records.

Coordinate data should be collected according to the procedures outlined below:

1. Data collection, whether differential corrections are applied in real-time or by post-processing methods, will require four or more satellite signals. Data collection is initiated in any of three modes: (1) point feature, (2) line feature, and (3) area feature.
 - A point feature is collected by occupying the item statically, generally for at least 30 seconds. The description and its attributes can be entered during the data collection time.
 - A line feature is collected by initiating the line feature mode, then traveling along the feature (for example, walk, drive, boat) while the instrument is collecting positions on a predetermined interval.
 - An area feature is collected in the same manner as a line feature, except that the software assumes a closed figure from the beginning position to the end position, allowing an area to be computed as well as describing the perimeter shape.
2. To collect a point feature, allow the device to record a minimum of 30 positions. The GPS software will average the distribution of the individual positions and generate a single point feature. Line and area features are collected in the same manner, except once position logging is started the GPS device needs to be moved (Ex. walking) along the feature that is being mapped.
3. When data collection is completed, close the main data collection window and verify that the data is stored.

5.3.1 File Transfer

After the fieldwork is complete, data from the data collector are downloaded to a computer, using Trimble® GPS Pathfinder® Office software. To transfer a data file from the data collector to a computer using Trimble Pathfinder Office, the synchronization program Microsoft ActiveSync® is required to be installed on the computer that data are to be transferred to. The current version (as of October 2008) is version 4.5 and is free to download from Microsoft at:

http://www.microsoft.com/windowsmobile/en-us/downloads/eulas/eula_activesync45_1033.msp?ProductID=76

The Data Transfer Utility program is also required to be installed on the computer that data are to be transferred to. The current version (as of October 2008) is version 1.45 and is free to download from Trimble at:

<http://www.trimble.com/datatransfer.shtml>

To transfer a data file from the data collector, open Trimble Pathfinder Office software. Set up a new project using the name of the project site and assign a project folder. This will automatically create a backup folder, base folder, and export folder within the folder you assigned. The download process automatically creates a copy of data collected that day and stores it in the “backup” folder. This will insure we have an unadulterated copy of the original data. All export shapefiles will be output to the “export” folder for viewing and use.

Connect the data collector to the computer using the USB connection. In Trimble Pathfinder Office, select the **Utilities** function. Then select the “*Data Transfer...*” option. Select **GIS Datalogger on Windows CE** from the *Device* drop-down menu to specify the type of mobile device. Select the **Receive** tab. Select the *Data File* option from the drop-down menu in the **Add** button. In the display window within the **Receive** tab, highlight the file(s) you want to transfer and click the **Transfer All** button. This will transfer the selected files to the folder destination that was previously determined during the setting up of the new project.

When data files are transferred from the mobile device to the computer, there are several files created for each data file. The only file that is really important is the *.ssf (Trimble standard storage format) file. This is the file that should be transferred to the home office. The rest of the files, which have various file extensions, are intermediate files used to create the *.ssf file.

5.3.2 Post Processing

Data downloaded from the data collector will be in an *.ssf file format (rover file). This information must be corrected using satellite data from a nearby base station within 90 days of the date the GPS points were collected. (This is critical because base stations do not retain satellite data for longer than 90 days and an *.ssf file cannot be properly corrected without it.)

5.3.3 Data Quality Check and Outlier Position Removal

Before performing the differential correction, the rover file(s) should be checked for data quality and outlier positions should be removed. To perform this, open the rover file within Trimble

Pathfinder Office software. At the top of the screen, ensure that the “Feature Properties...” and “Position Properties...” options are selected. Manually select each data feature collected and check their data properties within the Feature Properties and Position Properties windows. For any feature that has a standard deviation (Std Deviation) greater than 1 meter, click the Delete button within the Feature Properties window. This will not permanently delete the feature, but will show the individual positions recorded to make up that feature. A standard deviation greater than 1 meter is indicative of either a bad PDOP, bad data collection technique (such as not averaging enough positions [ideally 15 or more]), walking away without saving that particular point, or a multipath event, which occurs when a signal bounces off a fence, building, or tree before reaching the antenna. Manually select and delete outlier positions using the Erase tool to improve the standard deviation. Do the same thing with the “Horizontal Accuracy” column and look for numbers greater than one. Once outlier positions have been removed, the rover file is ready for differential correction.

5.3.4 Differential Correction

In order to achieve the best accuracy, a differential correction must be performed using data that a base station records at the same time as the GPS field data are collected.

To perform the differential correction using Trimble Pathfinder Office software, select the Utilities function. Then select the “Differential Correction...” option. In the Differential Correction Wizard, select the rover file(s) to be differentially corrected. Select Next. For processing Type, select Automatic H-Star Carrier and Code Processing only. Select Next until you are asked to select a Base Provider Group.

IMPORTANT: Different base stations provide different solutions, some better than others. The Integrity Index is useful to help prevent selecting base data that may provide a bad differential correction result. The quality indicator has a range of 0 to 100, where 0 represents low quality base data and 100 represents high quality base data. When you are selecting a base provider you are able to sort by their quality indicator. Select the nearest base station that has a good integrity index to perform the differential correction.

For differential correction of data collected on Oahu, Hawaii, the preferred base station to use is the CORS, Honolulu Tide Gage, HI base station. If the differential correction cannot be performed using the CORS, Honolulu Tide Gage, HI base station, alternative base stations are the CORS, Haleakala, HI base station located on Maui, Hawaii, or the CORS, Kokee Park Geophysical Observatory, HI base station located on Kauai, Hawaii.

Once the base station has been selected, click Next. Select the desired output folder and filename. Click Start to begin the automated differential correction. When the differential correction is complete, the software will export a *.cor (corrected file) file into the export folder within your assigned project folder.

6.0 RECORDS

Documentation of GPS field data collection activities shall follow guidelines contained in this technical procedure and noted in the field logbook (SOP-01).

Electronic data files generated during the transfer of GPS data from the GPS hand-held receiver device, as well as files generated during post-processing, will be kept on file electronically in the project folder on the CH2M HILL server.

7.0 REFERENCES

A manual for operating TerraSync™ software on GPS receivers is available at:

http://www.trimble.com/terrasync_ts.asp?Nav=Collection-4573

8.0 DEFINITIONS

1. CORS: Continuously Operating Reference Station
2. DMA: Defense Mapping Agency
3. NMEA: National Marine Electronics Association
4. PDOP: Position dilution of precision
5. Resource-grade GPS: one of three levels of GPS receivers generally capable of attaining sub-meter accuracy
6. SNR: signal to noise ratio
7. SBAS: Satellite Based Augmentation System
8. USB: Universal serial bus
9. USNG: United States National grid
10. UTM: Universal Transverse Mercator
11. WGS: World Geodetic System

9.0 ATTACHMENTS

None.

SAMPLE HANDLING AND CUSTODY

1.0 PURPOSE

The purpose of this technical procedure is to delineate protocols for sample handling and custody.

2.0 SCOPE

This procedure applies to all CH2M HILL personnel and subcontractors engaged in collecting environmental samples for CH2MHILL projects.

3.0 GENERAL

An essential part of the sampling activities of any environmental project is assuring the integrity of the sample from collection through data reporting. Sample labels and CoC forms are used to document identification and handling of samples from the time of collection through the completion of chemical analysis. Accountability of the history of a sample must be available to demonstrate that the data are a true representation of the environment. In some projects, analytical data may be used in litigation. The CoC record is used as evidence in legal proceedings to demonstrate that a sample was not tampered with or altered in any way that may bias the analytical accuracy of the laboratory results. It is extremely important that chain-of-custody records be complete, accurate, and consistent.

4.0 RESPONSIBILITIES

4.1 Project Manager

The *Project Manager* (PM) shall ensure that staff conducting these procedures are properly trained. In addition the PM shall be consulted if any complications arise with following these critical sample handling and custody procedures.

4.2 Field Team Leader

The *Field Team Leader* (FTL) shall be aware of these sampling handling procedures and schedule accordingly, taking into account that packing hazardous samples requires more materials (for example, properly labeled paint cans and manifests) and more time than packing non-hazardous samples. The FTL shall take responsibility for or delegate the packing of the sample shipping coolers, ensure that the CoC forms are correct, and ship the samples according to the analytical laboratory requirements and according to DoT regulations. The FTL shall determine or seek guidance as to which samples are potentially hazardous and ship them accordingly.

4.3 Sample Collector

The Sample Collector shall ensure that the samples are correctly collected, labeled, tracked by CoC, and stored until they are delivered directly to the FTL for shipping or the on-site laboratory. The Sample Collector shall maintain custody of the samples until they are relinquished to the FTL or on-site laboratory. The Sample Collector shall be responsible for informing the FTL of sampling conditions and if any of the samples are potentially hazardous. (Note: The FTL, Sample Collector, and Sample Shipper may be the same person.)

4.4 Field Data Coordinator

The Field Data Coordinator shall assure that the systems are maintained to create CoC forms from the sample-tracking database. In addition, the Field Data Coordinator is responsible for production of CoC forms and sample labels for the field crews.

4.5 Sample Custodian

The Sample Custodian is any individual who is responsible for the custody of samples and completion of associated documentation.

5.0 PROCEDURE

5.1 Sample Custody

Sample custody procedures are designed to ensure that sample integrity is maintained from collection to final disposition. A critical aspect of sound sample collection and analysis protocols is the maintenance of strict CoC procedures, as described in this technical procedure. CoC procedures include tracking and documentation during sample collection, shipment, and laboratory processing. A sample is considered to be in an individual's custody if it is (1) in the physical possession of the responsible party, (2) in view of the responsible party after being in their possession, (3) secured to prevent tampering, or (4) placed in a designated, secure area that is controlled and restricted by the responsible party.

Custody will be documented throughout all sampling activities on the CoC record for each day of sampling. This record will accompany the samples from the site to the laboratory. All personnel with sample custody are required to sign, date, and note on the record the time when receiving and relinquishing samples from their immediate custody. Any discrepancies will be noted at this time. Samples will be shipped to subcontractor laboratories via overnight air courier. Bills of lading will be used as custody documentation during this time and will be retained as part of the permanent sample custody documentation. In some cases, samples may be hand delivered to the laboratory; hand delivery will be noted on the CoC form. The subcontractor laboratory is responsible for sample custody once samples are received.

5.2 Sample Labels

A label will be attached to all sample containers at the time of sample collection. The label will typically be generated along with the CoC form using a sample-tracking database, or similar appropriate method, depending on the sample container. For certain types of samples (for example, Summa™ soil gas canisters), blank labels are provided by the laboratory when the lab provides sample containers. Labels generated by the sample-tracking database will be preprinted with the following information:

- Unique CoC control number
- Sample ID
- Analyses requested
- Preservative used

The same information listed above will be handwritten on labels not preprinted by the sample tracking database, if necessary.

When the sample collection is complete, the Sample Collector fills in the following information in indelible ink:

- Date and time of sample collection
- Sampler's initials

Once complete, the label will be covered with clear tape, unless using waterproof labels, and prepared for shipment following all applicable DoT label requirements. Samples collected in 40 ml volatile organic analysis (VOA) glass containers (for example, for Methods 8260/8015-g) will not be taped to avoid possible cross contamination from volatile organic compounds (VOCs) in the tape. Labeling for other types of containers (such as soil gas and air samples) will follow laboratory specified procedures identified by the sample coordinator or FTL.

5.3 Chain-of-Custody Record

CoC forms are a legal document of the disposition of samples. To maintain a record of sample collection, transfer of samples between personnel, shipment of samples, and receipt of samples at the laboratory, CoC forms will be filled out for each sample/analysis at each sampling location.

The Field Data Coordinator generates the CoC form. Information entered by the Field Data Coordinator includes:

- Project name and project number or task order
- Name and address of laboratory to receive the samples
- CoC control number
- Sample type, sample method
- Location ID, sample ID
- Matrix code

- Analyses requested
- Field quality control (QC) for matrix spike and matrix spike duplicate (MS/MSD) samples, if applicable
- Container type, size and number
- Preservatives used
- Turn-around-time for laboratory analysis
- Comments to Laboratory or Sample Collector, if applicable

The Sample Collector will enter the following information using indelible black or blue ink:

- Sampler's initials
- Date of collection
- Time of collection (24-hour format)
- Depths, if applicable
- Void reason, if applicable

The Sample Collector shall verify that the CoC record is complete, accurate in all aspects, and consistent with all other sample documentation (for example, number of samples, sample labels, field logs). The Sample Collector will sign the "Sampled By" and "Relinquished By" fields on the CoC record, marking the date and time custody is transferred to the Sample Shipper or other authorized person.

The Sample Shipper will perform the following duties:

- Obtain the signature of the Sample Collector to transfer sample custody
- Record the carrier service and airbill number on the CoC
- Sign and enter the date and time relinquished to the shipper
- Prepare the samples for shipment from the field to the laboratory

The Sample Shipper or sample custodian will sign the "Received By" box, marking the date and time of receipt of the samples from the Sample Collector or other sample custodian. Every transfer of physical custody shall be documented on the CoC record.

Any corrections to the CoC form entries will be made by a single-line strike mark through the incorrect item, and then entering the correct entry adjacent to the strikeout item. Corrections will be initialed and dated by the person making the change. After the form has been inspected and determined to be satisfactorily complete, the sample shipper will sign, date, and note the time of transferal and will reference a shipper tracking number on the form. The CoC form will be placed in a recloseable plastic bag and placed inside the cooler after the sample packer has detached or made an appropriate copy of the form. Field copies of the completed CoC forms are maintained in project files by the data services group.

5.4 Overnight Sample Storage

In some cases, samples that cannot be shipped immediately to a laboratory must be temporarily stored in a secured CH2M HILL facility until arrangements can be made for delivery. The samples must be placed in a secured area with sufficient ice in order to maintain 2° to 6° C

storage temperatures. A temperature blank and CoC must accompany samples stored overnight.

Samples temporarily stored overnight must be received by the custodian that placed them in storage, and in turn, may be "relinquished to" the appropriate laboratory, the Sample Shipper, or another sample custodian. Each transfer of custody shall be recorded on the appropriate CoC form(s).

6.0 RECORDS

Distribution of the CoC record:

- Original - sealed in plastic bag and taped inside the top of the shipping container
- Copies to Project Chemist and PM or Task Manager

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA), Office of Emergency and Remedial Response. EPA/540/R-96/0. Dec 96 - *Sampler's Guide to the Contract Laboratory Program*.

EPA. Office of Emergency and Remedial Response. EPA/540/R-941/013. Feb 94 - *User's Guide to the Contract Laboratory Program*.

American Society for Testing and Materials. 1996. *Standard Guide for Sampling Chain-of-Custody Procedures*. D 4840-95.

8.0 DEFINITIONS

1. Custody: physical possession or control. A sample is under custody if it is in possession or under control so as to prevent tampering or alteration of its characteristics.
2. Sample Label: a record attached to samples to ensure legal documentation of traceability.
3. Chain-of-Custody Record: legal documentation of custody of sample materials and instructions for analytical laboratory.

9.0 ATTACHMENTS

Chain of Custody Modification Form

Chain of Custody (CoC) Modification Form

1. List Today's Date:
2. List CoC number:
3. List the collection date for samples on CoC:
4. Identify item on CoC to be modified:
5. List the replacement item that will appear on the new CoC:
6. Has the CoC already been submitted to the laboratory? If yes, go to Procedure A. If no, go to Procedure B.

Procedure A

- ☐ Make modification in Sample Tracking and Scheduling Program (STSP).
- ☐ Print new copy of CoC.
- ☐ Circle new item on CoC.
- ☐ At the top of the new CoC document your initials, today's date, and write "Modified CoC" at the top.
- ☐ Fax new CoC to laboratory project manager with cover letter instructing the laboratory to attach the modified CoC to the existing CoC (which they already have), and make appropriate changes to any analyses that have been scheduled or already performed. Indicate that the CoC modifications should be reflected in the hardcopy and edata submittals.
- ☐ Fax CoC Modification Form and new CoC to CH2M HILL Redding, California office with instructions for Redding to file with the applicable hardcopy data package.
- ☐ Attach a copy of the new CoC and the CoC Modification Form to the modified CoC in the CoC files kept at CH2M HILL field services trailer on site.

Procedure B

- ☐ Make modification in STSP.
- ☐ Print new copy of CoC.
- ☐ Locate CoC to be modified. Transcribe any sampling notes on existing CoC to new CoC, and locate appropriate people to re-sign new CoC if necessary.
- ☐ Discard existing CoC and ship new CoC with samples.

Appendix D
Quality Assurance Project Plan

Quality Assurance Project Plan for the Ruby Mines Removal Site Evaluation Work Plan

Prepared for
Western Nuclear Inc.

August 2014

CH2MHILL®

155 Grand Avenue
Suite 800
Oakland, CA 94612

Quality Assurance Project Plan

Site Name: Ruby Mines Phase 3 Removal Site Evaluation Work Plan

Site Location: Smith Lake, New Mexico

Prepared By: CH2M HILL Date: August 2014

Address: 155 Grand Avenue, Suite 800

City/State/Zip: Oakland, CA 94612

Telephone: (510) 587-7669

Project Manager: Liz Dodge

Approved _____ Date _____
CH2M HILL Project Manager

Approved _____ Date _____
CH2M HILL Project Chemist

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Acronyms and Abbreviations

°C	degrees Celsius
ASA	American Society of Agronomy
CVAA	cold vapor atomic adsorption spectrometry
CLP	Contract Laboratory Program
DQO	data quality objective
GC-FID	gas chromatography-flame ionization detector
HPLC	high-performance liquid chromatography
ICP-ICS	inductively coupled plasma-interference check sample
ICP-MS	inductively coupled plasma-mass spectrometry
LC-MS	liquid chromatography–mass spectrometry
LCS	laboratory control sample
MARRSIM	<i>Multi-Agency Radiation Survey and Site Investigation Manual</i>
MDL	method detection limit
mg/kg	milligram per kilogram
MDA	minimum detectable activity
MDL	method detection limit
mm	millimeter
MS	matrix spike
MSD	matrix spike duplicate
NIST	National Institute of Standards and Technology
PARCC	precise, accurate, representative, complete, and comparable
PCB	polychlorinated biphenyl
PE	performance evaluation
QA	quality assurance
QAM	Quality Assurance Manual
QAPP	quality assurance project plan
QC	quality control
RF	response factor
RPD	relative percent difference
RSD	relative standard deviations
s	standard deviation
S ²	variance
SAR	sodium absorption ratio

SOP	standard operating procedure
SVOC	semivolatile organic compounds
TPH	total petroleum hydrocarbons
USEPA	United States Environmental Protection Agency
VOC	volatile organic compounds
WNI	Western Nuclear Incorporated

Introduction

This CH2M HILL quality assurance project plan (QAPP) presents quality assurance (QA)/quality control (QC) procedures, policies, and requirements for the Ruby Mines Removal Site Evaluation to guide collection of data that are scientifically valid and defensible. This QAPP is a component of the Ruby Mines Phase 3 Removal Site Evaluation Work Plan prepared specifically for the site. The work plan contains a description of the site, site background, constituents of concern, proposed sampling activities, and this QAPP, and describes the project requirements for field, sample analysis, and data assessment activities associated with this project.

This QAPP is intended for use by CH2M HILL and its subcontractors who provide services associated with the environmental data collection effort. The QAPP supplements the work plan and any other project-specific documents. Guidance set forth in this QAPP will be followed in the absence of the aforementioned documents.

1.1 Background

See Section 1.2 of the Phase 3 work plan for a detailed description of the site history and physical setting.

1.2 Data Quality Objectives

This QAPP presents the QA/QC requirements designed to guide collection of environmental data of the appropriate quality to achieve the objectives defined in Section 2 of the work plan. Specific protocols for sampling, sample handling and storage, chain of custody, laboratory analyses, data handling, and data evaluation and assessment are discussed in this QAPP. Requirements for performance evaluations (PEs), corrective actions, and preventive maintenance of equipment are also specified.

The QAPP was prepared in accordance with the United States Environmental Protection Agency (USEPA) guidance document *Guidance for Quality Assurance Project Plans; USEPA/240/R-02/009* (USEPA, 2002). The following are the objectives of the QAPP:

- Standardize data collection and measurement procedures among the project team.
- Monitor the performance of the various measurement systems being used to maintain statistical control and provide rapid feedback so that corrective measures, if needed, can be taken before data quality is compromised.
- Periodically assess the performance of these measurement systems and their components.
- Define the levels of data precision, accuracy, representativeness, completeness, and comparableness (PARCC), so that data are suitable for their intended use.

The data quality objectives (DQOs) for this project were established based on the USEPA document *Guidance on Systematic Planning Using the Data Quality Objectives Process USEPA QA/G-4* (USEPA, 2006) and following guidance from the document *Multi-Agency Radiation Survey and Site Investigation Manual (MARRSIM; USEPA, 2000)*. The DQOs are the basis for the design of the data collection plan and therefore specify the type, quality, and quantity of data to be collected and explain how the data are to be used to make the appropriate decisions for the project. The DQOs were developed through a seven-step process, and are listed in Section 2 of the work plan.

Project Organization and Responsibility

2.1 Project Organization

The responsibilities and contact information for key project personnel are listed in Table 2-1.

The responsibilities for key project personnel are described in the following subsections.

2.1.1 Western Nuclear Incorporated Representative

The WNI representative, Stuart Brown, is responsible for overall project execution and quality, as well as the execution of the work plan activities and the quality of the data collected and interpretations presented in the investigation report. He is also the WNI lead on agency communications.

2.1.2 CH2M HILL Project Manager

The CH2M HILL project manager, Liz Dodge, is responsible for overall project management, QC, document preparation and review, field activities, and preparation of the Phase 3 investigation report.

2.1.3 CH2M HILL Field Investigation Task Manager and Data Manager

The CH2M HILL field investigation task manager, Jennifer Laggan, is responsible for coordinating the investigations and surveys, staffing and overseeing execution of field activities, and managing subcontractor personnel. She also is responsible for coordinating and overseeing the compilation, updating, and maintenance of an electronic database of analytical data, field measurements, and associated data validation information.

2.1.4 Health and Safety Manager and Radiological Safety Officer

Jeff Hilgaertner is CH2M HILL's health and safety manager responsible for preparing and overseeing the implementation of the Ruby Mines Phase 3 health and safety plan included in Appendix D of the work plan. Jeff Thompson is the radiological safety officer. He serves as the principal technical resource to the team on radiation safety, and recommends and implements radiation safety policies and procedures.

2.1.5 CH2M HILL Data Quality Manager and Project Chemist

The CH2M HILL data quality manager and project chemist, Mark Fesler, is responsible for overseeing project analytical activities and developing laboratory analytical reports in a timely manner. He is also responsible for management of the analytical laboratory, coordination and oversight of the laboratory QA program, and validation of the analytical data.

2.1.6 Radiological Specialist

The radiological technical specialist, Kira Sykes, is responsible for planning and overseeing the gamma surveys and directing the gamma survey subcontractor, Permafrix, as well as for evaluation and interpretation of the results.

2.1.7 Field Investigation Team Members

Surface soil sample collection and gamma surveys will be performed by CH2M HILL's subcontractor, Permafrix. They will be overseen by CH2M HILL's field team members Luke Hill and/or Ben Moayyad, who are responsible for implementing the field activities described the work plan under the direction of the CH2M HILL field investigation task manager.

2.1.8 Regulatory Oversight

USEPA Region 9 and the Navajo Nation Environmental Protection Agency (NNEPA) will oversee the work. The USEPA Region 9 Remedial Project Manager is Mark Ripperda. The NNEPA representative is Stanley Edison.

2.2 Training and Certification Requirements

Personnel engaged in field activities will have completed the Occupational Safety and Health Administration 40-hour health and safety training that meets the requirements of 29 *Code of Federal Regulations* 1910.120 and Title 8 *California Code of Regulations* 5192. Subcontracted project personnel will read the project-specific health and safety plan. Documentation will be maintained to demonstrate that requirements of the plan are followed.

Laboratories participating in analytical services will be certified as required by applicable state and/or federal agencies for the fields of testing relevant to the requirements for each individual project.

Data Quality Indicators and Quality Assurance Program

3.1 Data Quality Indicators

The PARCC parameters are indicators of data quality. Ideally, the end use of the measurement data will define the necessary PARCC parameters. Both definitive and screening data will be subject to PARCC requirements.

3.1.1 Precision

Precision is a measure of reproducibility of analytical results. It can be defined as the degree of mutual agreement among individual measurements obtained under similar conditions. Total precision is a function of the variability associated with both sampling and analysis. Precision will be evaluated as the relative percent difference (RPD) between field duplicate sample results or between the matrix spike (MS) and matrix spike duplicate (MSD) results. Field duplicates will compose 10 percent of the sampling effort. MS/MSD samples will be field-designated at a 5 percent frequency.

3.1.2 Accuracy

Accuracy is the degree of agreement between a measured value and the “true” or expected value. It represents an estimate of total error from a single measurement, including both systematic or matrix error (bias) and random error that may reflect variability due to imprecision. Accuracy is evaluated in terms of percent recoveries calculated from results of MS/MSD and laboratory control sample (LCS) analyses.

3.1.3 Representativeness

Representativeness is the degree to which sample data accurately reflect the characteristics of a population of samples. It is achieved through a well-designed sampling program and by using standardized sampling strategies, techniques, and analytical procedures. Factors that can affect representativeness include site homogeneity, sample homogeneity at a single point, and available information around which the sampling program is designed. Using multiple methods to measure an analyte can also result in non-representativeness of sample data.

3.1.4 Completeness

Completeness is the amount of valid measurements compared to the total amount generated. It will be calculated for each method, matrix, and analyte combination. The completeness goals for this project were optimized to meet the DQOs. The goals for this program are 90 percent completeness for soil samples.

3.1.5 Comparability

Comparability is the confidence with which one data set can be compared to another. It is achieved by maintaining standard techniques and procedures for collecting and analyzing samples and reporting the analytical results in standard units. Results of PE samples and systems audits will provide additional information for assessing comparability of data among participating subcontractor laboratories.

3.2 Method Detection Limits, Minimum Detectable Activity, and Reporting Limits

3.2.1 Method Detection Limits

The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. Each participating laboratory will establish the MDL for each method, matrix, and analyte for each instrument that will be used

to analyze samples. MDLs will be established for the analysis of metals by USEPA Method SW6020 for this project. The MDLs are established prior to analyzing samples, and are revised at least once every 12 months.

1. Estimate the MDL using one of the following:
 - a. The concentration value that corresponds to an instrument signal/noise ratio in the range of 2.5 to 5
 - b. The concentration equivalent of 3 times the standard deviation of replicate measurement of the analyte in reagent water
 - c. The region of the standard curve where there is a significant change in sensitivity (that is, a break in the slope of the standard curve).
2. Prepare (for example, extract or digest) and analyze seven samples of an MS (ASTM Type II water for aqueous methods, Ottawa sand for soil methods, and glass beads of 1 millimeter (mm) diameter or smaller for metals) containing the analyte of interest at a concentration three to five times the estimated MDL.
3. Determine the variance (S^2) for each analyte as follows:

$$S^2 = \frac{1}{n-1} \left[\sum_{i=1}^n (x_i - \bar{x})^2 \right] \quad (1)$$

where:

x_i = the i th measurement of the variable x and

\bar{x} = the average value of x

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n x_i \quad (2)$$

4. Calculate the standard deviation (s) for each analyte as follows:

$$s = (S^2)^{1/2}$$

5. Calculate the MDL for each analyte as follows:

$$\text{MDL} = 3.14(s)$$

(note: 3.14 is the one-sided t -statistic at the 99 percent confidence level appropriate for determining the MDL using seven samples)

6. If the spike level used in step 2 is more than 10 times the calculated MDL, repeat the process using a smaller spike level.

3.2.2 Minimum Detectable Activity

The minimum detectable activity (MDA) is the smallest amount of activity or mass of an analyte in a sample that will be detected with a probability β of nondetection (Type II error), while accepting a probability α of erroneously deciding that a positive (non-zero) quantity of analyte is present in an appropriate blank sample (Type I error). The MDA is specific to the analysis of radionuclides by USEPA Method 901.1 for this project.

3.2.3 Reporting Limits

Reporting limits will be equal to or greater than two times the calculated MDL. Reporting limits used by the laboratory will not be greater than the project-specific limit objectives listed in Tables 3 and 4 in Attachment 1.

When using a multipoint calibration of instruments, a standard at a concentration equal to or less than the reporting limit must be included. The following options will be used when reporting data for this project:

1. Analytes at concentrations greater than the laboratory's MDL but less than the reporting limit will be flagged as estimated with a "J" qualifier and reported. Analytes that are not detected at or above the laboratory's MDL will be reported as not detected at the MDL, and flagged "U."
2. Only analytes at concentrations greater than the laboratory's MDA will be reported. Analytes that are not detected greater than the MDL will be reported as not detected at the MDL and flagged "U."

Reporting limits and sample results will be reported to two significant figures if less than 10 and to three significant figures otherwise. Sample results will be reported on a dry-weight basis for soil samples.

3.3 Field Quality Control Samples

QC samples will be collected to monitor accuracy, precision, and the presence of field contamination. The frequency of collection of the QC samples outlined in the following subsections is recommended, and collection will follow the protocols for sample collection outlined in the work plan.

3.3.1 Field Duplicate Samples

A field duplicate is an independent sample collected as close as possible to the original sample from the same source under identical conditions, and is used to document sampling and analytical precision and representativeness. Field duplicates will be collected at a minimum frequency of 10 percent or one per sampling event, whichever is more frequent, for each matrix and for each type of analysis. Field duplicate samples will be blind to the laboratory and sent along with regular field samples such that the laboratory will not know the duplicate/parent sample relationship.

3.3.2 Equipment Blanks

Equipment rinsate samples will be collected only if nondisposable nondedicated trowels, scoops, hand augers, or digging bars are used. If necessary, equipment rinsate blanks will be collected to evaluate field sampling and decontamination procedures by pouring (ASTM) Type II or deionized water over the decontaminated equipment. Equipment rinsate blanks will be collected at least once per day and once from each background location. The equipment blanks will be analyzed for the same parameters specified for the corresponding sample matrix.

3.3.3 Trip Blanks

Trip blanks are used to monitor for contamination during sample shipping and handling and for cross-contamination through volatile organic compound (VOC) migration among the collected samples. They are prepared in the laboratory by pouring ASTM Type II or deionized water into a VOC sample container. They are then sealed, transported to the field, stay sealed while VOC samples are taken, and then transported back to the laboratory in the same cooler as the VOC samples. One trip blank must accompany each VOC sample cooler, except for soil samples if they are frozen at the time of collection.

3.3.4 Matrix Spike/Matrix Spike Duplicate

An MS/MSD consists of duplicate field sample aliquots spiked by the laboratory with analytes of concern to evaluate the effects of the matrix on the recoveries of these analytes. MS/MSD samples should be collected for each analysis, and designated on the chain-of-custody form for use as MS/MSD by the laboratory. The duplicate aliquots for MS/MSD analyses should be collected simultaneously or in immediate succession with the parent sample. They will be treated in exactly the same manner as the parent sample during storage and shipment. The sampling locations for the MS/MSD will be documented in the field logbook.

3.4 Laboratory Elements of Quality Control

Laboratory QC checks indicate the state of control that prevailed at the time of sample analysis and includes calibrations, method blanks, and LCSs. QC checks that involve field samples, such as MS, surrogate spikes, field duplicates, and laboratory sample duplicates, provide an indication of the presence of matrix effects. Field-originated blanks provide a way to monitor for potential contamination to which field samples are subjected.

Laboratory QC will be in accordance with method specifications, including, but not limited to, the following:

- Method blanks
- Hold time
- Initial calibrations
- Continuing calibrations
- Second source check samples
- Instrument tuning
- LCS
- MS/MSD
- Surrogates
- Post-digestion spikes and serial dilutions
- Internal standards

3.4.1 Analytical Batch

A laboratory QC batch is defined as a method blank, an LCS, an MS/MSD, or a sample duplicate depending upon the method, and consists of 20 or fewer environmental samples of similar matrix that are digested or analyzed together. Each preparation or analytical batch should be identified so that environmental samples can be associated with the appropriate laboratory QC samples.

3.4.2 Instrument Calibration

Laboratory instruments will be calibrated by qualified personnel prior to sample analysis according to the procedures specified in each method. Calibration will be verified at method-specified intervals throughout the analysis sequence. The frequency and acceptance criteria for calibration are specified for each analytical method. Samples should be diluted, if necessary, to bring analyte responses within the calibration range. Data that exceed the calibration range cannot be reported by the laboratory. The initial calibration curve will be verified as accurate with a standard purchased or prepared from an independent second source. The initial calibration verification involves analysis of a standard containing the target analytes, typically in the middle of the calibration range, each time the initial calibration is performed. Quantitation based on extrapolation is not desirable.

3.4.2.1 Initial Calibration

The following outlines the acceptable calibration options available for this project, which the laboratory should use for establishing the initial calibration:

- **Linear calibration using average calibration or response factors (RFs)—Organic Methods.** Calibration factors for external calibrations or RFs for internal calibrations must have relative standard deviations (RSD) not exceeding 20 percent or 15 percent, respectively, to be used for quantitation. A minimum RF of 0.05 for most target analytes, and 0.01 for the least-responsive target analytes must be achieved to ensure detectability.
- **Linear calibration using a linear regression equation ($y=mx+b$)—Organic and/or Inorganic Methods.** The correlation coefficient (r) must equal 0.995 or more. The line should NOT be forced through the origin. The equation and a plot of the linear regression must be included in the raw data to be generated by the laboratory, and made available in the data package on the client's request.

3.4.2.2 Continuing Calibration

Periodic verification of the initial calibration is essential in generating analytical data of known quality. The continuing calibration verification analyses evaluate if the instrument has been adversely affected by the sample matrix or other instrument failures that would increase or decrease the sensitivity or accuracy of the method. The laboratory will perform continuing calibration for sample methods according to the specific requirements in the method and laboratory standard operating procedure (SOP).

The use of the average of analyte percent drift or recovery to meet the continuing calibration requirements for the method will not be allowed. If a continuing calibration is accepted as compliant by the laboratory but has individual compounds that exceed criteria, a list of those analytes that exceeded the criteria will be provided in the laboratory report. For analyses conducted under this QAPP, these notifications shall be accomplished through provision of the lists in the laboratory case narrative of those compounds outside these criteria and the actual values of the percent drift or recovery.

3.4.3 Method Blank

Blanks are used to monitor each preparation or analytical batch for interference and/or contamination from glassware, reagents, and other potential contaminant sources within the laboratory. A method blank is analyte-free matrix (for example, Ottawa sand or Teflon chips for soil samples) to which reagents are added in the same amount or proportions to samples. It is processed through the entire sample preparation and analytical procedure, along with the samples in the batch. There should be at least one method blank per preparation or analytical batch. If a target analyte is found at a concentration that exceeds the reporting limit, corrective action must be taken to identify and eliminate the contamination source. Associated samples must be re-prepared and/or reanalyzed after the contamination source has been eliminated. No analytical data may be corrected for the concentration found in the blank.

3.4.4 Laboratory Control Sample

The LCS will consist of analyte-free matrix (for example, Ottawa sand or Teflon chips for soil samples) spiked with known amounts of analytes that come from a source different from that used for calibration standards. Target analytes specified in the QAPP will be spiked into the LCS. The spike levels should be less than or equal to the midpoint of the calibration range. If LCS results are outside the specified control limits, corrective action must be taken, including sample re-preparation and/or reanalysis, if appropriate. If more than one LCS is analyzed in a preparation or analytical batch, the results of all the LCSs must be reported. Any LCS recovery outside of QC limits affects the accuracy for the entire batch and requires corrective action.

3.4.5 Surrogates

Surrogates are organic analytes that behave similarly as the analytes of interest, but are not expected to occur naturally in the samples. They are spiked into the standards, and into the samples and QC samples prior to sample preparation. Recoveries of surrogates are used as an indicator of accuracy, method performance, and extraction efficiency. If surrogate recoveries are outside the specified control limits, corrective action must be taken, including sample re-preparation and/or re-analysis, if appropriate.

3.4.6 Matrix Spike/Matrix Spike Duplicate

A sample matrix fortified with known quantities of specific compounds is called an MS. It is subjected to the same preparation and analytical procedures as the native sample. Target analytes specified in the QAPP are spiked into the sample. MS recoveries are used to evaluate the effect of the sample matrix on the recovery of the analytes of interest. An MSD is a second fortified sample matrix. The RPD between the results of the duplicate MS measures the precision of sample results. Only project-specific samples designated on the chain-of-custody form will be spiked. The spike levels will be less than or equal to the midpoint of the calibration range.

3.4.7 Internal Standards

Some methods require the use of internal standards to compensate for losses during injection or due to viscosity. Internal standards are compounds that have similar properties as the analytes of interest, but are not expected to occur naturally in the samples. A measured amount of the internal standard is added to the standards, and to the samples and QC samples following preparation. When the internal standard results are outside the control limits, corrective action must be taken, including sample reanalysis, if appropriate.

3.4.8 Laboratory Sample Duplicate

A sample duplicate selected by the laboratory is called a laboratory sample duplicate. It is subjected to the same preparation and analytical procedures as the native sample. The RPD between the results of the native sample and laboratory sample duplicate measures the precision of sample results. The data collected may also yield information on whether the sample matrix is homogenous or heterogeneous.

3.4.9 Interference Check Samples

The interference check samples are used in inductively coupled plasma analyses to verify background and inter-element correction factors. They consist of two solutions, A and B. Solution A contains the interfering analytes, and Solution B contains both the analytes of interest and the interfering analytes. Both solutions are analyzed at the beginning and at the end of each analytical sequence. When the interference check sample results are outside the control limits, corrective action must be taken, including sample reanalysis, if appropriate.

3.4.10 Holding Time

The holding-time requirements specified in this QAPP must be met. For methods requiring both sample preparation and analysis, the preparation holding time will be calculated from the time of sampling to the completion of preparation. The analysis holding time will be calculated from the time of completion of preparation to the time of completion of the analysis, including any required dilutions, confirmation analysis, and reanalysis. For methods requiring analysis only, the holding time is calculated from the time of sampling to completion of the analysis, including any required dilutions, confirmation analysis, and reanalysis.

3.4.11 Sample Dilution

Dilution of a sample results in elevated reporting limits and ultimately affects the usability of the data related to potential actions at the sampling site. It is important to minimize dilutions and maintain the lowest possible reporting limits. When dilutions are necessary because of high concentrations of target analytes, lesser dilutions should also be reported to characterize the sample for each analyte. The level of the lesser dilution should be such that it will provide the lowest-possible reporting limits without having a lasting deleterious effect on the analytical instrumentation.

3.4.12 Standard Materials and Other Supplies and Consumables

Standard materials must be of known high purity and traceable to an approved source. Pure standards must not exceed the manufacturer's expiration date or 1 year following receipt, whichever comes first. Solutions prepared by the laboratory from the pure standards must be used within the expiration date specified in the laboratory's SOP.

Other supplies and consumables must be inspected prior to use to compare the requirements specified in the appropriate SOP. The laboratory's inventory and storage system should track and record their use within the manufacturer's expiration date and storage under proper conditions.

3.4.13 Manual Integration

The laboratory is required to provide analysts performing methods that rely on interpretation of chromatographic data with training on appropriate software or manual integration practices. The laboratory also will make every effort to minimize the use of manual integration of data. If the need arises to use manual integration to correct a software auto-integration error, the manual integration will be clearly identified in the instrument data. Before and after enlargements of the region of the chromatogram where

the manual integration was performed will be provided on an appropriate scale that allows an independent reviewer to evaluate the need and quality of the manual integration. The analyst will also document the reason for the manual integration on the chromatogram, along with their date and initials. The laboratory manager or designee will approve the manual integration by dating and initialing the chromatogram.

3.4.14 Laboratory Quality Assurance Program

The laboratory will maintain a quality assurance manual (QAM) or equivalent document. The QAM will define the laboratory's internal procedures for QA/QC as follows:

- QA policies, objectives, and requirements
- Organization and personnel
- Document control
- SOPs (analytical methodology and administrative)
- Data generation
- Software verification
- QA
- QC
- Nonconformance/corrective action procedures
- Data review

3.4.14.1 Laboratory Standard Operating Procedures

The laboratory will maintain SOPs for analytical methods and laboratory operations. The format for SOPs will conform to the following references:

- *Test Methods for Evaluating Solid Waste, Physical and Chemical Methods*, SW-846, 3rd Edition, Update III, Section 1 (USEPA, 1996)
- *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, (USEPA 600/4-80-032, (USEPA, 1980) [Modified for soil matrix]
- "Good Laboratory Practices" in *Principles and Guidance to Regulations for Ensuring Data Integrity in Automated Laboratory Operations* (USEPA, 1995)

SOPs must have a unique identification number that is traceable to previous revisions of the same document.

3.4.14.2 Demonstration of Capability

Laboratory QA department personnel will maintain records documenting the ability of each analyst to perform applicable method protocols. Documentation will include annual checks for each method and analyst. In addition, internal blind PE samples for each method and matrix demonstrating overall laboratory performance must be submitted annually. The laboratory may receive additional blind PE samples in conjunction with this program.

Sampling Procedures, Handling, and Custody

4.1 Sampling Design

The number and location of samples are specific to the project based on DQOs and are discussed in Section 3 of the work plan. The rationale for the sampling design is also described in the work plan. The sampling design is a function of the matrix sampled, information about the sampling site, the type of data to be collected, and how the data are to be used. The work plan also provides minimum procedures for sampling of soil and investigation-derived wastes as well as equipment decontamination.

4.2 Containers and Preservatives

The contracted analytical laboratory will provide the required sample containers for samples, including QC. Containers will have been cleaned and certified free of the analytes of concern for this project. No sample containers will be reused. The contracted laboratory will add preservatives, if required, prior to shipping the sample containers to the field. The laboratory, upon receipt of the samples, will verify the adequacy of preservation and will add additional preservative, if necessary. For volatile components, one of the vials will be checked for adequacy of preservation. The vial will be clearly marked so that it is not used for the analysis of volatile components.

The containers, minimum sample quantities, required preservatives, and maximum holding times for many parameters are shown in Table 3-2 of the work plan.

4.3 Sample Documentation and Tracking

Detailed procedures for sample handling, documentation, and shipment can be found in Section 3.6 of the work plan.

Sample containers should be received from the laboratory pre-labeled with the preservative. The sample identification, date, and time of sampling are entered on the label immediately after collection. The labels must be secured using clear tape to maintain the identification of each sample.

Vital information on the collection of each sample will be recorded in a field logbook. A separate logbook will be used for this project. It will be bound and have consecutively numbered pages. Entries will be legibly written in black ink and signed and dated by the individual making the entries. Factual and objective language will be used. Entries will be complete and accurate enough to allow reconstruction of each field activity.

4.3.1 Laboratory Sample Custody

Once the samples reach the laboratory, they will be checked against information on the chain-of-custody form for anomalies. The condition, temperature, and appropriate preservation of samples will be checked and documented on the chain-of-custody form. The occurrence of any anomalies in the received samples and their resolution will be documented in laboratory records. Sample information will then be entered into a tracking system, and unique analytical sample identifiers will be assigned. A copy of this information will be reviewed by the laboratory for accuracy. Sample holding-time tracking begins with the collection of samples and continues until the analysis is complete. **Samples analyzed that are not preserved or analyzed in accordance with the requirements in this QAPP will be resampled and analyzed, at no additional cost to CH2M HILL.**

Subcontracted analyses will be documented with the chain-of-custody form. Procedures ensuring internal laboratory chain of custody will also be implemented and documented by the laboratory. Ideally, sample custody will be maintained using an internal custody system that requires samples to be kept in a secured and restricted area when not in use, and to be checked out and checked back in by the analysts who use them. Internal custody records must be maintained by the laboratory as part of the documentation file for each

sample. Specific instructions for the analysis specified for each sample will be communicated to the analysts. Analytical batches will be created, and laboratory QC samples will be introduced into each batch.

While in the laboratory, samples will be stored in limited-access, temperature-controlled areas. Refrigerators, coolers, and freezers will be monitored for temperature 7 days a week. The acceptance criterion for the temperature of the refrigerators and coolers is 4 degrees Celsius ($^{\circ}\text{C}$) \pm 2 $^{\circ}\text{C}$. The acceptance criterion for the temperature of the freezers is less than 0 $^{\circ}\text{C}$. The cold storage areas will be monitored by thermometers that have been calibrated with a National Institute of Standards and Technology (NIST)-traceable thermometer. As indicated by the findings of the calibration, correction factors will be applied to each thermometer. Records that include acceptance criteria will be maintained. Samples will be stored after analysis until disposed of in accordance with applicable local, state, and federal regulations. Disposal records will be maintained by the laboratory.

Along with sample receipt documentation, the following information will be documented on sample receipt forms by the sample custodian:

- Date samples received
- CH2M HILL sample identification number
- Laboratory sample identification number
- Analytical tests requested for the sample batch
- Sample matrix
- Number of samples in the batch
- Container description and location in the laboratory
- Verification of sample preservation

SOPs describing sample control and custody will be maintained by the laboratory.

4.4 Sample Packaging and Transport

Section 3.6.5 of the work plan contains guidelines for sample packaging and transport.

SECTION 5

Analytical Procedures

Section 5 describes the analytical procedures that will be used for the acquisition of laboratory data. Table 5-1 includes the analytical procedures that will be required for this project. The specific analytical methods for this project are from the following documents:

- USEPA. 1996. *Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, SW-846, 3rd Edition, Update III, Section 1*. December.
- USEPA. 1980. *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*. August. [Modified for soil matrix]
- American Society of Agronomy, Inc. (ASA). 1982. *Methods for Soil Analysis, Number 9 (Part 2), 2nd Edition*.

Attachment 1 contains various tables that list the analytes of concern, the methods to be used, and a reporting limit objective. The reporting limits included in Attachment 1 reflect quantifiable levels that are attainable with a specified degree of confidence using the specified methods, and in most cases, are low enough to meet the project cleanup goals or action limits. For those compounds where the reporting limits exceed the action limits, the compound has been shaded gray. Analytical results are reported down to the MDL as indicated in Section 3.2.3, Item 1, which will be below the action limit.

Also included in Attachment 1 are tables to define the calibration and QC requirements specified for each method. Appropriate corrective action will be taken when acceptance criteria are not met. If corrective action is not effective, and data quality is potentially degraded, the occurrence must be documented in a corrective action report and in the data package case narrative. The laboratory manager or a designated person must notify the CH2M HILL project chemist.

5.1 Digestion/Extraction Procedures

Note that Table 5-1 does not define specific digestion procedures. The required digestion procedures are defined within the method and must be followed when using each method.

Calibration Procedures and Frequency

6.1 Field Calibration Procedures

Field equipment will be calibrated before the start of work and at the end of the sampling day.

Any instrument drift from prior calibration should be recorded in the field notebook. Calibration will be in accordance with procedures and schedules outlined in the particular instrument's operations manual.

Calibrated equipment will be uniquely identified by using either the manufacturer's serial number or other means. A label with the identification number and the date when the next calibration is due will be physically attached to the equipment. If this is not possible, records traceable to the equipment, for example, showing the equipment identification, will be readily available for reference. In addition, the results of calibrations and records of repairs will be recorded in the logbook.

Scheduled periodic calibration of testing equipment does not relieve field personnel of the responsibility of using properly functioning equipment. If an individual suspects an equipment malfunction, the device must be removed from service and tagged so that it is not inadvertently used, and the appropriate personnel must be notified so that a recalibration can be performed or substitute equipment can be obtained.

Equipment that fails calibration or becomes inoperable during use will be removed from service and either segregated to prevent inadvertent use or tagged to indicate it is out of calibration. Such equipment will be repaired and satisfactorily recalibrated. Equipment that cannot be repaired will be replaced.

6.2 Laboratory Calibration Procedures

Laboratory calibration requirements are discussed in Section 3 and in Attachment 1.

Data Reduction, Validation, and Reporting

7.1 Laboratory Data Management

Data reduction will be done manually or by using appropriate application software. Quantitation procedures specified for each method must be followed. If data reduction is done manually, the documentation must include the formulas used. Any application software used for data reduction must have been previously verified by the laboratory for accuracy. Documentation of the software's verification must be maintained on file in the laboratory. Documentation of data reduction must allow re-creation of the calculations.

Data will undergo a minimum of three levels of review at the laboratory prior to release. The analyst performing the tests will initially review 100 percent of the data. After the analyst's review has been completed, 100 percent of the data will be reviewed independently by a senior analyst or by the section supervisor for accuracy, compliance with calibration, and QC requirements, holding-time compliance, and completeness. Analyte identification and quantitation must be verified. Calibration and QC results will be compared with the applicable control limits. Reporting limits should be reviewed to make sure they meet the project objectives. Results of multiple dilutions should be reviewed for consistency. Any discrepancies must be resolved and corrected. Laboratory qualifiers will be applied when there are nonconformances that could potentially affect data usability. The qualifiers must be properly defined as part of the deliverables. Issues that are relevant to the quality of the data must be addressed in a case narrative. The laboratory QC manager will review a minimum of 10 percent of data or deliverables generated for this program against the project-specific requirements. A final data review will be conducted by the Laboratory manager or client services representative to ensure that required analyses were performed on samples and that documentation is complete.

The hardcopy and electronic laboratory reports for samples and analyses will contain the information necessary to perform data evaluation.

Hardcopy deliverables, in summary format, equivalent to those specified in the latest versions of USEPA Contract Laboratory Program (CLP) Statements of Work for Organics and Inorganics Analyses (or CLP-like) are preferred. The laboratory data report should be organized in a format that facilitates identification and retrieval of data. A Level 4 data package deliverable will be required for this project that encompasses the same information included in Levels 1, 2, and 3.

A **Level 1** report will include, at a minimum, the following information (when applicable):

- Cover Letter complete with the following information:
 - Title of report and laboratory unique report identification (Sample Delivery Group Number)
 - Project name and site location
 - Name and location of laboratory and second-site or subcontracted laboratory
 - Client name and address
 - Statement of authenticity and official signature and title of person authorizing report release
- Table of contents
- Summary of samples received that correlates field sample IDs with the laboratory IDs
- Laboratory qualifier flags and definitions
- Field identification number
- Date received

- Date prepared
- Date analyzed
- Preparation and analytical methods
- Result for each analyte (dry-weight basis for soils)
- Percent solids results for soil samples
- Dilution factor (provide both diluted and undiluted results when available)
- Sample-specific reporting limit adjusted for sample size, dilution/concentration
- Sample-specific MDL adjusted for sample size, dilution/concentration (when project objectives require reporting less than the reporting limit)
- Units

A **Level 2** report will consist of the elements included in a Level 1 deliverable, plus the following:

- Case narrative that addresses the following information at a minimum:
 - Sample receipt discrepancies, such as broken sample containers, temperature exceedances, etc.
 - Descriptions of all nonconformances in the sample receipt, handling, preparation, analytical, and reporting processes and the corrective action taken in each occurrence
 - Identification and justification for sample dilution
- MS/MSD and LCS spike concentrations, native sample results, spiked sample results, percent recoveries, RPDs between the MS and MSD results, and associated QC limits
- Method blank results
- Analytical batch reference number that cross references samples to QC sample analyses
- Executed chain of custody and sample receipt checklist

A **Level 3** report will consist of all the elements included in Level 1 and 2 reports, plus the following:

- Analytical sequence or laboratory run log that contains sufficient information to correlate samples reported in the summary results to the associated method QC information, such as initial and continuing calibration analyses
- Calibration blank results for inorganic analyses (required in hardcopy format only)
- ICP-ICS true and measured concentrations and percent recoveries (required in hardcopy format only)
- Method of standard addition results (if applicable; required in hardcopy format only)
- Post-digestion spike recoveries (if applicable; required in hardcopy format only)
- Initial calibration summary, including standard concentrations, correlation coefficients, and calibration plots or equations, if applicable (required in hardcopy format only)
- Continuing calibration verification summary, including expected and recovered concentrations and percent differences (required in hardcopy format only)
- Instrument tuning and mass calibration information for ICP/MS analyses
- Any other method-specific QC sample results

A **Level 4** report will include elements outlined above for the Level 1 through 3 report formats and of the associated raw data. It is imperative that the relative scale used for chromatographic and other instrument data be supplied on a scale that facilitates review from hardcopy. Sufficient “blow ups” of complex areas of sample chromatograms will be provided. The following additional information will also be supplied:

- Sample preparation logs that include the following:
 - Preparation start and end times
 - Beginning and ending temperatures of water baths, digestion blocks, and so forth
- Example calculation for obtaining numerical results from at least one sample for each matrix analyzed; provide algorithm

7.1.1 Hardcopy and Electronic Deliverables

Within the timeframe specified in the laboratory statement of work, contract, or purchase order from sample receipt, the laboratory will deliver hardcopy documentation as specified in this document. In addition, the laboratory will deliver one electronic copy of the data as specified in the format described in the laboratory contract.

Electronic data files will match the final hardcopy results. CH2M HILL requires receipt of final hardcopy results in conjunction with submittal of electronic files.

Raw data will be maintained on file in the laboratory and will be available upon request by project management. Complete documentation of sample preparation and analysis and associated QC information will be maintained in a manner that allows easy retrieval in the event that additional validation or information is required. Documentation must be retained for a minimum of 7 years after data acquisition.

The primary responsibility for the implementation of these procedures within the laboratory will reside with the laboratory manager or equivalent. The laboratory manager will approve laboratory reports before transferring the information to CH2M HILL.

7.2 Data Validation and Verification

Based on the project-specific objectives, the analytical results of the data collection effort will be validated by CH2M HILL. For this project, 90 percent of the analytical data will undergo Level 3 validation, and 10 percent of the data will undergo Level 4 validation.

7.2.1 Level 3 and 4 Validation Procedures

Personnel involved in the data validation function will be independent of any data generation effort. The project chemist will have responsibility for oversight of the data validation effort. Data validation will be carried out when the data packages are received from the laboratory. It will be performed on an analytical batch basis using the summary results of calibration and laboratory QC, as well as those of the associated field samples. Data packages will be reviewed for all constituents of concern. Raw data will be reviewed when deemed necessary by the project chemist. Data validation procedures will include the following:

- Review of the data package for completeness
- Review of chain-of-custody records for discrepancies that might degrade data quality
- Review for compliance with holding time and QC frequency requirements
- Evaluation of all calibration and QC summary results against the project requirements
- Verification of analyte identification and calculations for at least 10 percent of the data
- Qualification of the data using appropriate qualifier flags, as necessary, to reflect data usability limitations
- Initiation of corrective actions, as necessary, based on the data review findings

In general, data validation will be patterned after the USEPA document *Contract Laboratory National Functional Guidelines for Inorganic Data Review*, January 2010 and *Contract Laboratory National Functional Guidelines for Organic Data Review*, June 2008, substituting the calibration and QC

requirements specified in this QAPP for those specified in the guidelines. The flagging criteria presented in Tables 7-1 and 7-2 will be used.

Data qualifier flags, if required, are defined in Table 7-3 and will be applied to the electronic sample results. If multiple flags are required for a result, the most severe flag will be applied to the electronic result. The hierarchy of flags from the most severe to the least severe will be as follows: R, UJ, U, and J.

A validation report will be generated for each method and sample delivery group. A copy will be retained with the data package in the project file. Any significant data quality problems will be brought to the attention of the project chemist.

Performance Evaluations

To assess sample and data collection procedures, PEs will be conducted and will consist of technical systems audits and performance audits.

8.1 Technical Systems Audits

8.1.1 Laboratory Audits

The laboratories participating in the data-collection effort will have been pre-qualified by the project management team. A surveillance audit program that requires technical systems audits to be performed on a routine basis will be instituted. Laboratory prequalification and the surveillance audits may also be undertaken by the regulatory agencies. Laboratory prequalification audits will be performed as either onsite audits, desk audits, or a combination of both.

8.1.1.1 Onsite Laboratory Prequalification Audit

An onsite laboratory prequalification audit will start with a pre-audit meeting between the auditor and the laboratory staff during which the auditor will discuss the purpose of the audit, the schedule and areas to be audited, and the procedures that will be followed. The pre-audit meeting may include a brief tour of the laboratory. The audit will then be conducted. The auditor will assemble the findings at the conclusion of the audit and will discuss the findings with laboratory staff in a post-audit meeting.

Critical items that will be covered in a technical systems audit of the laboratory include the following:

- Calibration procedures and documentation
- Treatment and handling of standards
- Completeness of data forms, notebooks, and other reporting requirements
- Data review and verification procedures
- Data storage, filing, and recordkeeping procedures
- Sample custody procedures
- QC procedures, tolerances, and documentation
- Operating conditions of facilities and equipment
- Documentation of staff training and instrument maintenance activities
- Systems and operations overview

A written audit report will then be sent to the laboratory within a specified time. A copy of the audit report will be sent to the project-specific project manager. A copy will be retained in the project files.

The need for follow-up action will be evaluated based on the laboratory's responses. If an audit identifies an unacceptable condition or unacceptable data, the auditor will be responsible for developing and initiating corrective action. The project manager will be notified if the nonconformance impacts the project and requires resources not normally available to the project team. In such cases, the project manager will decide whether resources to pursue corrective action will be made available. Disposition may include the following:

- Reanalysis of samples if holding time has not expired
- Resampling and analysis
- Amending analytical procedures
- Acceptance of suspect data and acknowledging the limits on usability

8.1.1.2 Desk Prequalification Audit

In some cases, a prequalification audit will be performed by sending non-critical or split samples to the laboratory to ascertain the laboratory's ability to generate quality data. In general, this process involves reviewing instrument output, analytical reports, and other documentation specific to a batch of samples.

The data will be validated using the Level 4 protocol addressed in Section 7.2, as well as by reviewing SOPs, laboratory policies, and the laboratory's QAM. The corrective actions outlined in Section 8.1.1.1 to findings from the desk audit may also apply.

8.1.2 Field Audits

Field audits will be performed once a year to verify the execution of field procedures. The following will be evaluated during the audit:

- Sample containers and preservatives
- Sample collection and identification procedures
- Sample custody, handling, and shipping procedures
- Equipment decontamination procedures
- Calibration of field instruments and performance of field tests
- Documentation of field activities, maintenance of field records, and document control

8.2 Performance Audits

8.2.1 Performance Evaluations

Laboratories are required to participate in a PE program. Any method or analyte failure in a PE evaluation program that affects the certification status of the laboratory with the National Environmental Laboratory Accreditation Program or the state or agency programs must be immediately communicated to the program chemist.

8.2.2 External Audits

Announced and unannounced audits of the field operations and of the laboratories may be conducted during any stage of the project.

8.2.3 Internal Audits

Annual audits of the laboratory must be conducted by the laboratory's quality assurance officer. The audits must verify, at a minimum, that written SOPs are being followed; standards are traceable to certified sources; documentation is complete; data review is being done effectively and is properly documented; and data reporting, including electronic and manual data transfer, is accurate and complete. All audit findings must be documented in QA reports to management. Necessary corrective actions must be taken within a reasonable timeframe. The quality assurance officer must verify that such actions are effective and complete, and document their implementation in an audit closeout report to management.

Preventive Maintenance

The primary objective of a preventive maintenance program is to promote the timely and effective completion of a measurement effort. The maintenance program should be designed to minimize the downtime of crucial sampling and/or analytical equipment from expected or unexpected component failure. In implementing this program, efforts should be focused in the following three primary areas:

- Establishment of maintenance responsibilities
- Establishment of maintenance schedules for major and/or critical instrumentation and apparatus
- Establishment of an adequate inventory of critical spare parts and equipment

9.1 Maintenance Responsibilities

Laboratory instrument maintenance is the responsibility of the participating laboratory. Generally, the laboratory manager or supervisor is responsible for the instruments in his or her work area. This responsible person will establish maintenance procedures and schedules for each instrument.

Maintenance responsibilities for field equipment are assigned to the field team leader for specific sampling tasks. However, the field team using the equipment is responsible for checking the status of the equipment prior to use and reporting any problems encountered. The field team is also responsible for ensuring that critical spare parts are included as part of the field equipment checklist. Non-operational field equipment should be removed from service and a replacement obtained. Field instruments will be properly protected against inclement weather conditions during the field investigation.

9.2 Maintenance Schedules

The effectiveness of any maintenance program depends, to a large extent, on adherence to specific maintenance schedules for each piece of equipment. Other maintenance activities are conducted as needed. Manufacturers' recommendations should provide the primary basis for establishing maintenance schedules. Manufacturers' service contracts may be used for implementing the scheduled maintenance.

Each analytical instrument should be assigned an instrument logbook. Maintenance activities will be documented in this logbook. The following information is to be entered in the logbook:

- Date of service
- Person performing service
- Type of service performed and reason for service
- Replacement parts installed (if appropriate)
- Date of next scheduled service
- Any other useful information

9.3 Spare Parts

In addition to a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment down time. The inventory includes those parts and supplies that:

- Are subject to frequent failure
- Have limited useful lifetimes
- Cannot be obtained in a timely manner if failure occurs

Field managers and the respective laboratory managers are responsible for maintaining an adequate inventory of spare parts. In addition to spare parts and supply inventories, an in-house source of backup equipment and instrumentation should be available.

Data Assessment

10.1 Data Quality Assessment

Data generated will be evaluated according to the QA acceptance criteria specified in Tables 3 through 7 of Attachment 1. Limitations on data usability will be assigned, if appropriate, as a result of the validation process described in Section 7.

10.2 Reconciliation with Project Objectives

The program includes projects/sites with various tasks and objectives. The procedure for data reconciliation will be a function of the project-specific objectives and will be addressed in the project-specific documents.

Corrective Action

Corrective action may be required as a result of deviations from field or analytical procedures. Deficiencies identified in audits and data quality evaluations may also call for corrective action. Project personnel have the responsibility, as part of the normal work duties, to identify, report, and solicit approval of corrective actions for conditions adverse to data quality.

The QAPP has specified the corrective action to be taken when deviations from calibration and QC acceptance criteria occur. Field and laboratory staff may encounter conditions that require immediate corrective action that are not addressed in the work plan. The personnel will document conditions and the results of corrective actions in a field logbook or laboratory nonconformance report and communicate their actions as soon as feasible to the field team leader, laboratory supervisor, and, if necessary, the project chemist for immediate input. A mechanism will be in place to allow for supervisory review and/or client input for all deviations or deficiencies. A corrective action reporting system that requires immediate documentation of deviations or deficiencies and for supervisory review of the actions taken to correct them will be established. At a minimum, the corrective action report should include the following:

- The type of deviation or deficiency
- The date of occurrence
- The impact of the deviation or deficiency, such as samples affected
- The corrective action taken
- Documentation that the process has been returned to control

Each corrective action report must be reviewed and approved by a person of authority, such as the field team leader or laboratory supervisor. The ultimate responsibility for the laboratory corrective action process is the laboratory QC manager, who must ensure that proper documentation, approval, and closeout of all out-of-control or nonconformance events is performed. A corrective action report will summarize each nonconformance condition, and will be forwarded to the field team leader or project chemist. Copies of corrective action reports must be maintained in the laboratory or field project files.

Quality Assurance Reports

The project chemist will submit a data quality assessment report to the project manager at the end of each sampling interval. The report will summarize the results of the data validation and the data assessment. The results should be presented in a manner that facilitates decision-making. Any significant quality problems and recommended solutions should be included in the report. Limitations on data usability that were identified during data validation should be highlighted. The results of data assessment should be reconciled with the project objectives.

Data Management

This program will follow CH2M HILL standard procedures for environmental data collection. Environmental data collected for the program will follow the policies, procedures, and protocols required in the project-specific data management plan. At a minimum, the data users must have rapid access to stored data, data entry capabilities, and ability to manage sample data using unique sample identification numbers. They also must establish a sample inventory of new data collected and provide methods of sample inventory reconciliation; store and provide sample-specific attributes, including location identifiers, sample type and media, and sample date; and provide reporting and delivery formats to support data analysis and reduction.

13.1 Archiving

Hardcopy and electronic versions will be archived in project files and on electronic archive tapes for the duration of the project, 5 years, or as specified in contractual agreements.

13.2 Data Flow and Transfer

The data flow from the laboratory and field to the project staff and data users will be sufficiently documented to ensure that data are properly tracked, reviewed, and validated for use.

13.3 Recordkeeping

In addition to the data management procedures outlined in Section 7.1 for analytical data, the laboratory will ensure that it maintains electronic and hardcopy records sufficient to re-create each analytical event. At a minimum, the laboratory will keep records that contain the following:

- Raw data, including instrument printouts, bench worksheets, and/or chromatograms with compound identification and quantitation reports
- Laboratory-specific written SOPs for each analytical method and QA/QC function in place at the time of analysis of project samples

SECTION 14

Works Cited

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American Society of Agronomy, Inc. (ASA). 1982. *Methods for Soil Analysis, Number 9 (Part 2), 2nd Edition*.

TABLE 2-1

Project Personnel Contact Information*Ruby Mines Site Phase 3*

Name	Organization	Title	Contact Information
Stuart Brown	Western Nuclear Incorporated (WNI)	WNI Representative	Phone: 602/448-0972 Email: Stuart_Brown@fmi.com
Liz Dodge	CH2M HILL	Project Manager	Phone: 510/579-1002 Email: edodge@ch2m.com
Jennifer Laggan	CH2M HILL	Field Investigation Task Manager	Phone work: 720/286-0513 Phone mobile: 303/249-4273 Email: jlaggan@ch2m.com
Kira Sykes	CH2M HILL	Gamma Survey; Health Physics (radiological specialist)	Phone work: 503/872-4510 Phone mobile: 503/819-8660 Email: ksykes@ch2m.com
Jeff Hilgaertner	CH2M HILL	Health and Safety Manager	Phone work: 480/626-4632 Phone mobile: 714/552-1971 Email: jeffrey.hilgaertner@ch2m.com
Mark Fesler	CH2M HILL	Data Quality Manager; Project Chemist	Phone work: 530/229-3273 Email: mark.fesler@ch2m.com

TABLE 5-1

Analytical Methods*Ruby Mines Site Phase 3*

Analytical Method	Parameter
SW6020	Select metals by inductively coupled plasma mass spectrometry (ICP-MS)
SW7471A	Mercury by cold vapor atomic adsorption spectrometry (CVAA)
USEPA 901.1	Radium-226 (with 21-day in-growth)
SW8015B	Total petroleum hydrocarbons (TPH) by gas chromatography-flame ionization detector (GC-FID)
SW8082	Polychlorinated biphenyls (PCBs) by GC-electron capture detector
SW8260B	VOCs by GC/MS
SW8270C	Semivolatile organic compounds (SVOCs) by GC/MS
SW8270C-SIM	Polynuclear aromatic hydrocarbons by GC/MS
SW9045	pH
SW9056	Anions by IC
SW6010B	Cations by ICP
ASA No. 9; Method 10-2.3.1	Saturation percentage
ASA No. 9; Method 10-3.3	Electrical conductivity
ASA No. 9; Method 10-3.4	Sodium absorption ratio (SAR)
ASA No. 9; Method 15-5	Texture
ASA No. 9; Method 15-5	Rock Fragment percentage
ASA No. 9; Method 29-3.5.2	Organic carbon by Walkley-Black Procedure
	Soil moisture
	Grain size distribution
ASTM D7263	Dry density
	Plasticity index

TABLE 7-1

Flagging Conventions—Minimum Data Evaluation Criteria for Inorganic Methods*Ruby Mines Site Phase 3 Work Plan*

Quality Control Check		Evaluation	Flag	Samples Affected
Holding Time		Holding time exceeded for extraction, digestion, or analysis	J positive results; R nondetects for mercury; UJ nondetects for other analytes	Sample
		Holding time for digestion or analysis exceeded by a factor of 2	J positive results; R nondetects	
Sample Preservation		Sample preservation requirements not met (If sample preservation was not done in the field, but was performed at the laboratory upon sample receipt, no flagging is required)	J positive results; R nondetects	Sample
Initial Calibration (Multi-point only)		Correlation coefficient $r \leq 0.995$	J positive; UJ nondetects	Associated samples in analytical batch
Calibration verification (initial calibration verification, continuing calibration verification)	%R > UT		J positive results	Associated samples in analytical batch
	%R < LT		J positive results, UJ nondetects	
Interference check sample (SW6010B/SW6020 only)	%R > UT		J positive results	Associated samples in analytical batch
	%R < LT		J positive results; UJ nondetects	
LCS	%R > UT		J positive results	Samples in preparation batch
	%R < LT		J positive results; UJ nondetects	
Calibration Blank (ICB,CCB)				Samples in preparation batch or analytical batch, whichever one applies, associated with method blank or calibration blank
Method Blank		Multiply the highest blank concentration by 5	U positive sample results < 5x highest blank concentration	
Equipment Blank				Samples, same site, matrix and date
MSs	%R > UT	J positive results		Samples from same site as parent sample
	%R < LT	J positive results UJ nondetects		
	RPD > UT	J positive results		

TABLE 7-1

Flagging Conventions–Minimum Data Evaluation Criteria for Inorganic Methods*Ruby Mines Site Phase 3 Work Plan*

Quality Control Check	Evaluation	Flag	Samples Affected
Dilution Test	If concentration is >25 times the reporting limit and percent difference >UT. UJ nondetects	J positive results	Samples from same site as parent sample if analytical spike not performed
Post-digestion Spikes/Recovery Test (metals only)	Spike results indicate performance of MSA required, but MSA not done. %R > UT %R < LT	J positive J positive results, UJ nondetects	Samples in digestion batch if MSA not performed
Field Duplicates	Concentration of reported analytes are greater than 5 times the reporting limit in either sample and RPD greater than 20%. J positive results		Field duplicate pair
Laboratory Sample Duplicates	One or both sample results less than 5 times the reporting limit and a difference of ± 2 times the reporting limit UJ non detects	J positive results	

Notes:

QA/QC criteria are included in Tables 13 through 29 of Attachment 1 and will be used for validation criteria.

Spike recovery limits do not apply when sample concentration exceeds the spike concentration by a factor of 4 or more.

CCB = continuing calibration blank ICB = initial calibration blank. MSA = Method of standard addition

LT = lower tolerance MB = method blank

%R = Percent recovery ValAdj = value reported by laboratory adjusted due to matrix issues

UT = upper tolerance LabA&P = laboratory accuracy and precision criteria not met

TABLE 7-2

Flagging Conventions--Minimum Data Evaluation Criteria for Organic Methods*Ruby Mines Site Phase 3*

Quality Control Check	Evaluation	Flag	Samples Affected
Holding Time	Holding time exceeded for extraction or analysis	J positive results; UJ nondetects	Sample
	Holding time exceeded by a factor of two	J positive results; R nondetects	
Sample Preservation SW8260B	Sample not preserved	J positive results; UJ nondetects	Sample
Sample Integrity SW8260B	Bubbles in VOA vial used for analysis	J positive hits; UJ nondetects	Sample
Temperature	Greater than 6°C	J positive results; UJ nondetects	Samples in same cooler
Initial Calibration	RRF less than 0.30 or 0.050 most target analytes; RRF less than 0.010 for least responsive analytes (SW8260B and SW8270C)	J positive results, R nondetects	Associated samples in analysis batch
	%RSD greater than 15.0% (SW8260B and SW8270C), or greater than 20% (SW8015B, SW8082, and SW8330B), <u>AND</u> calibration curve not used; <u>OR</u> calibration curve used, but with coefficient of correlation r less than 0.995	J positive results, UJ nondetects	

TABLE 7-2

Flagging Conventions—Minimum Data Evaluation Criteria for Organic Methods*Ruby Mines Site Phase 3*

Quality Control Check	Evaluation	Flag	Samples Affected
Calibration Verification (Second-source and continuing calibration verification)	RRF less than 0.30 or 0.050 most target analytes; RRF less than 0.010 for least responsive analytes (SW8260B and SW8270C)	J positive results, R nondetects	Associated samples in analysis batch
	%Drift greater than 25.0% (SW8260B and SW8270C) or greater than 20% (SW8015B, SW8082, and SW8330B)	J positive results, UJ nondetects	
LCS	%R greater than UT	J positive results	Samples in preparation batch
	%R less than LT	J positive results, UJ nondetects	
Method Blank			Samples in preparation batch or analytical batch, whichever one applies, associated with method blank or calibration blank
Equipment Blank	Convert blank concentration to soil units, if applicable; multiply the highest blank concentration by 5	U positive sample results less than 5 times the highest blank concentration	Samples, same site, matrix and date (water) or samples, same site, matrix (soil) associated with equipment blank
Trip Blank			Samples shipped in the same cooler as the trip blank

TABLE 7-2

Flagging Conventions—Minimum Data Evaluation Criteria for Organic Methods*Ruby Mines Site Phase 3*

Quality Control Check	Evaluation	Flag	Samples Affected
MSs			
% Recoveries	%R greater than UT	J positive results	MS analytes in parent sample and field duplicate, if any
	%R less than LT	J positive results, UJ nondetects	
RPDs	RPD greater than UT	J positive results	MS analytes in parent sample and field duplicate, if any
Surrogates			
SW8260B; SW8015B; SW8082; SW8330B	%R greater than UT	J positive results	Analytes in sample
	%R less than LT and none less than 10%	J positive results; UJ nondetects	
	%R less than 10%	J positive results; R nondetects	
SW8270C	2 or more surrogates in same fraction with %R greater than UT	J positive results	Analytes in same fraction in sample
	2 or more surrogates in same fraction with %R less than LT but not less than 10%	J positive results; UJ nondetects	
	2 or more surrogates in same fraction with %R less than LT and less than 10%	J positive results; R nondetects	

TABLE 7-2

Flagging Conventions--Minimum Data Evaluation Criteria for Organic Methods*Ruby Mines Site Phase 3*

Quality Control Check	Evaluation	Flag	Samples Affected
Internal Standards (SW8260B; SW8270C, SW8270CSIM)	Area greater than UT	J positive results	
	Area less than LT but not less than 10%	J positive results; UJ nondetects	Associated analytes in sample
	Area less than 10%	J positive results; R nondetects	
Field duplicates	Concentration of reported analytes are greater than 5 times the reporting limit in either sample and RPD greater than UT (30% for water samples; 50% for soil samples)	J positive results	Field duplicate pair
	One or both sample results less than 5 times the reporting limit and a difference of ± 2 times the reporting limit for water (± 4 times for soil).	J positive; UJ nondetect	

Notes:

QA/QC criteria are included in Tables 513 through 29 and will be used for validation criteria.

Spike recovery limits do not apply when sample concentration exceeds the spike concentration by a factor of 4 or more.

For methods requiring confirmation, the qualification applies to primary analysis results (either of the two columns/detectors may be designated as the primary column/detector).

Where one MS recovery meets acceptance criteria and the other MS of the pair does not, professional judgment may be used to determine if the parent sample should be qualified for matrix effects by comparing the MS recoveries to other QC results within the batch or sample site.

Qualifier may not apply in cases where a surrogate coelutes with a non-target analyte, or when sample dilution is required.

LT = lower tolerance

MB = method blank

UT = upper tolerance

RPD = relative percent difference

%R = percent recovery

TABLE 7-3

Qualifier Flag Definitions*Ruby Mines Site Phase 3*

Flag	Definition
J	Analyte was present but reported value may not be accurate or precise.
R	This result has been rejected.
U	This analyte was analyzed for but not detected at the specified detection limit.
UJ	The analyte was not detected above the detection limit objective. However, the reported detection limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

Attachment 1
Reporting Limits, Quality Control Limits, and
Corrective Action Tables

Reporting Limits, Quality Control Limits, and Corrective Action Tables

The analytical requirements are presented in the following tables:

TABLE 1

Reporting Limit Objectives for Metals by ICP-MS/CVAA (SW6020/SW7471A)

Analyte	Project Screening Criteria ^a (mg/kg)	Reporting Limits (mg/kg)
Arsenic	0.67	0.25
Mercury (SW7471A)	9.4	1.0
Molybdenum	390	1.0
Selenium	390	1.0
Uranium	230	1.0
Vanadium	390	1.0

^aBased on USEPA Regional Screening Levels (RSLs) Residential Soil (May 2014)

mg/kg = milligram per kilogram

TABLE 2

Reporting Limit Objectives for Radium-226 by Gamma Spectroscopy (USEPA 901.1)

Analyte	Project Screening Criteria (pCi/g)	Reporting Limits (pCi/g)
Radium-226	1.24 ^a	1.0

^aThe investigative goal for this project is 1.24 pCi/g above background. Assuming no background, the most conservative screening criteria would be 1.24 pCi/g

pCi/g = picocuries per gram

TABLE 3

Reporting Limit Objectives for Perchlorate by LC-MS (SW6850)

Analyte	Project Screening Criteria ^a (mg/kg)	Reporting Limits (mg/g)
Perchlorate	55	0.004

^aBased on USEPA Regional Screening Levels (RSLs) Residential Soil (May 2014)

TABLE 4

Reporting Limit Objectives for TPH by GC-FID (SW8015B)

Analyte	Project Screening Criteria ^a (mg/kg)	Reporting Limits (mg/kg)
TPH-Purgable (gas range organics)	82	1.0
TPH-Extractable (diesel range organics)	96	10
TPH-Extractable (motor oil range)	2500	20

^aBased on USEPA Regional Screening Levels (RSLs) Residential Soil (May 2014)

TABLE 5
Reporting Limit Objectives for PCBs by GC/ECD (SW8082)

Analyte	Project Screening Criteria ^a (mg/kg)	Reporting Limits (mg/kg)
Aroclor-1016	4.0	0.033
Aroclor-1221	0.15	0.033
Aroclor-1232	0.15	0.033
Aroclor-1242	0.24	0.033
Aroclor-1248	0.24	0.033
Aroclor-1254	0.24	0.033
Aroclor-1260	0.24	0.033

^aBased on USEPA Regional Screening Levels (RSL) Residential Soil (May 2014)

TABLE 6
Reporting Limit Objectives for VOCs by GC/MS (SW8260B)

Analyte	Project Screening Criteria ^a (mg/kg)	Reporting Limits (mg/kg)
1,1,1,2-Tetrachloroethane	2.0	0.005
1,1,1-Trichloroethane	8100	0.005
1,1,2,2-Tetrachloroethane	0.6	0.005
1,1,2-Trichloroethane	1.1	0.005
1,1,2-Trichlorotrifluoroethane	40,000	0.005
1,1-Dichloroethane	3.6	0.005
1,1-Dichloroethene	230	0.005
1,2,3-Trichloropropane	0.0051	0.005
1,2,4-Trichlorobenzene	24	0.005
1,2,4-Trimethylbenzene	58	0.005
1,2-Dibromo-3-chloropropane	0.0053	0.005
1,2-Dichlorobenzene	1800	0.005
1,2-Dichloroethane	0.46	0.005
1,2-Dichloropropane	1.0	0.005
1,3,5-Trimethylbenzene	78	0.005
1,3-Dichlorobenzene	N/A	0.005
1,4-Dichlorobenzene	2.6	0.005
2-Butanone	27,000	0.010
2-Chlorotoluene	1600	0.005
4-Methyl-2-Pentanone	5300	0.010
Acetone	61,000	0.020
Benzene	1.2	0.005
Bromobenzene	290	0.005
Bromodichloromethane	0.29	0.005
Bromoform	67	0.005

TABLE 6
Reporting Limit Objectives for VOCs by GC/MS (SW8260B)

Analyte	Project Screening Criteria ^a (mg/kg)	Reporting Limits (mg/kg)
Bromomethane	6.8	0.005
Carbon Disulfide	770	0.005
Carbon Tetrachloride	0.65	0.005
Chlorobenzene	280	0.005
Chloroethane	N/A	0.005
Chloroform	0.32	0.005
Chloromethane	110	0.005
Cis-1,2-Dichloroethene	160	0.005
Dibromochloromethane	0.73	0.005
Dichlorodifluoromethane	87	0.005
Ethylbenzene	5.8	0.005
Ethylene Dibromide	360	0.005
Isopropylbenzene	1900	0.005
m,p-Xylene	560	0.005
Methyl tert-Butyl Ether	47	0.005
Methylene Chloride	57	0.010
n-Butylbenzene	3900	0.005
n-Propylbenzene	3300	0.005
o-Xylene	650	0.005
Sec-Butylbenzene	7800	0.005
Styrene	6000	0.005
tert-Butylbenzene	7800	0.005
Tetrachloroethene	24	0.005
Toluene	4900	0.005
Trans-1,2-Dichloroethene	1600	0.005
Trichloroethene	0.94	0.005
Vinyl Chloride	0.059	0.005
Xylene (Total)	580	0.005

^aBased on USEPA Regional Screening Levels (RSLs) Residential Soil (May 2014)

TABLE 7

Reporting Limit Objectives for PAHs and SVOCs by GC/MS (SW8270C-SIM/SW8270C)

Analyte	Project Screening Criteria ^a (mg/kg)	Reporting Limits (mg/kg)
SW8270C		
1,2,4-trichlorobenzene	24	0.33
1,2-dichlorobenzene	1800	0.33
1,3-dichlorobenzene	N/A	0.33
1,4-dichlorobenzene	2.6	0.33
2,4-Dinitrotoluene	1.7	0.33
2,6-dinitrotoluene	0.36	0.33
2,4,5-Trichlorophenol	6200	1.6
2,4,6-Trichlorophenol	48	0.33
2,4-Dichlorophenol	180	0.33
2,4-Dimethylphenol	1200	0.33
2,4-Dinitrophenol	120	1.6
2-Chloronaphthalene	6300	0.33
2-Chlorophenol	390	0.33
2-Methyl-4,6-Dinitrophenol	4.9	1.6
2-Methylphenol	3100	0.33
2-Nitroaniline	610	1.6
3-Nitroaniline	N/A	1.6
3,3'-Dichlorobenzidine	1.2	0.33
4-Nitroaniline	27	1.6
4-Chloroaniline	2.7	0.33
4-Methylphenol	6200	0.33
4-Nitrophenol	N/A	1.6
Bis (2-chloroethyl) ether	0.23	0.33
Bis (2-chloroisopropyl) ether	4.9	0.33
Bis (2-ethylhexyl) phthalate	38	0.33
Butyl benzyl phthalate	280	0.33
Dibenzofuran	72	0.33
Diethyl phthalate	49,000	0.33
Dimethyl phthalate	7800	0.33
Di-n-butyl phthalate	620	0.33
Di-n-octyl phthalate	620	0.33
Hexachlorobenzene	0.33	0.33
Hexachlorobutadiene	6.8	0.33
Hexachloroethane	13	0.33
Isophorone	560	0.33
Nitrobenzene	5.1	0.33
n-Nitroso-di-n-propylamine	0.076	0.33
n-Nitrosodiphenylamine	110	0.33

TABLE 7

Reporting Limit Objectives for PAHs and SVOCs by GC/MS (SW8270C-SIM/SW8270C)

Analyte	Project Screening Criteria ^a (mg/kg)	Reporting Limits (mg/kg)
Pentachlorophenol	0.99	1.6
Phenol	18,000	0.33
SW8270C-SIM		
Acenaphthene	3500	0.010
Acenaphthylene	N/A	0.010
Anthracene	17,000	0.010
Benzo (a) anthracene	0.15	0.010
Benzo (a) pyrene	0.015	0.010
Benzo(b)fluoranthene	0.15	0.010
Benzo (g,h,i) perylene	N/A	0.010
Benzo(k)fluoranthene	1.5	0.010
Chrysene	15	0.010
Dibenz(a,h)anthracene	0.015	0.010
Fluoranthene	2300	0.010
Fluorene	2300	0.010
Indeno(1,2,3-c,d)pyrene	0.15	0.010
Naphthalene	3.8	0.010
Phenanthrene	N/A	0.010
Pyrene	1700	0.010

^aBased on USEPA Regional Screening Levels (RSLs) Residential Soil (May 2014)

TABLE 8

Reporting Limit Objectives for Explosives/Energetics by HPLC (SW8330B)

Analyte	Project Screening Criteria^a (mg/kg)	Reporting Limits (mg/kg)
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	3800	0.5
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	6.0	0.5
1,3,5-Trinitrobenzene	2200	0.5
1,3-Dinitrobenzene	6.2	0.5
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	120	0.5
Nitrobenzene	5.1	0.5
2,4,6-Trinitrotoluene	21	0.5
4-Amino-2,6-dinitrotoluene	150	0.5
2-Amino-4,6-dinitrotoluene	150	0.5
2,4-Dinitrotoluene	1.7	0.5
2,6-Dinitrotoluene	0.36	0.5
2-Nitrotoluene	3.2	0.5
3-Nitrotoluene	6.2	0.5
4-Nitrotoluene	33	0.5

^aBased on USEPA Regional Screening Levels (RSLs) Residential Soil (May 2014)

TABLE 9

Reporting Limit Objectives for Anions by IC (SW9056)

Analyte	Project Screening Criteria ^a (mg/kg)	Reporting Limits (mg/kg)
Chloride	N/A	1.0
Nitrate	130,000	1.0
Sulfate	N/A	1.0

^aBased on USEPA Regional Screening Levels (RSLs) Residential Soil (May 2014)

TABLE 10

Reporting Limit Objectives for Cations by ICP (SW6010B)

Analyte	Project Screening Criteria ^a (mg/kg)	Reporting Limits (mg/kg)
Calcium	N/A	10
Magnesium	N/A	10
Phosphorus	N/A	50
Potassium	N/A	10
Sodium	N/A	10

^aBased on USEPA Regional Screening Levels (RSLs) Residential Soil (May 2014)

TABLE 11

Accuracy and Precision for Metals by ICP-MS/CVAA (SW6020/SW7471A)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
Arsenic	80-120	75-125	≤ 20
Mercury (SW7471A)	75-125	75-125	≤ 20
Molybdenum	80-120	75-125	≤ 20
Selenium	80-120	75-125	≤ 20
Uranium	80-120	75-125	≤ 20
Vanadium	80-120	75-125	≤ 20

R = recovery

RPD = relative percent difference

TABLE 12

Accuracy and Precision for Radium-226 by Gamma Spectroscopy (USEPA 901.1)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
Radium-226	75-125	N/A	≤ 20

NA = not applicable

R = recovery

RPD = relative percent difference

TABLE 13

Accuracy and Precision for Perchlorate by LC-MS (SW6850)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
Perchlorate	85-115	75 – 125	≤ 20
R =	recovery		
RPD =	relative percent difference		

TABLE 14

Accuracy and Precision for TPH by GC-FID (SW8015B)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
TPH-Purgable (gas range organics)	70-130	65-135	≤ 30
Surrogate:			
Dichlorobenzene	70-130		
TPH-Extractable (diesel range organics)	60-140	50-150	≤ 30
TPH-Extractable (motor oil range)	60-140	50-150	≤ 30
Surrogates (Choose 2):			
Octacosane	50-150		
Ortho-Terphenyl	60-140		
Fluorobenzene	60-140		
Tricontane	50-150		
R =	Recovery		
RPD =	Relative percent difference		

TABLE 15

Accuracy and Precision for PCBs by GC/ECD (SW8082)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
Aroclor-1016	60-140	50-150	≤ 30
Aroclor-1260	60-140	50-150	≤ 30
Surrogate:			
Decachlorobiphenyl	50-150		
R =	Recovery		
RPD =	Relative percent difference		

TABLE 16
Accuracy and Precision for VOCs by GC/MS (SW8260B)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
1,1,1,2-Tetrachloroethane	70-130	65-135	≤ 30
1,1,1-Trichloroethane	70-130	65-135	≤ 30
1,1,2,2-Tetrachloroethane	70-130	65-135	≤ 30
1,1,2-Trichloroethane	70-130	65-135	≤ 30
1,1,2-Trichlorotrifluoroethane	70-130	65-135	≤ 30
1,1-Dichloroethane	70-130	65-135	≤ 30
1,1-Dichloroethene	70-130	65-135	≤ 30
1,2,3-Trichloropropane	70-130	65-135	≤ 30
1,2,4-Trichlorobenzene	70-130	65-135	≤ 30
1,2,4-Trimethylbenzene	70-130	65-135	≤ 30
1,2-Dibromo-3-chloropropane	70-130	65-135	≤ 30
1,2-Dichlorobenzene	70-130	65-135	≤ 30
1,2-Dichloroethane	70-130	65-135	≤ 30
1,2-Dichloropropane	70-130	65-135	≤ 30
1,3,5-Trimethylbenzene	70-130	65-135	≤ 30
1,3-Dichlorobenzene	70-130	65-135	≤ 30
1,4-Dichlorobenzene	70-130	65-135	≤ 30
2-Butanone	65-135	50-150	≤ 30
2-Chlorotoluene	70-130	65-135	≤ 30
4-Methyl-2-Pentanone	65-135	50-150	≤ 30
Acetone	65-135	50-150	≤ 30
Benzene	70-130	65-135	≤ 30
Bromobenzene	70-130	65-135	≤ 30
Bromodichloromethane	70-130	65-135	≤ 30
Bromoform	70-130	65-135	≤ 30
Bromomethane	70-130	65-135	≤ 30
Carbon Disulfide	70-130	65-135	≤ 30
Carbon Tetrachloride	70-130	65-135	≤ 30
Chlorobenzene	70-130	65-135	≤ 30
Chloroethane	70-130	65-135	≤ 30
Chloroform	70-130	65-135	≤ 30
Chloromethane	70-130	65-135	≤ 30
Cis-1,2-Dichloroethene	70-130	65-135	≤ 30
Dibromochloromethane	70-130	65-135	≤ 30
Dichlorodifluoromethane	70-130	65-135	≤ 30
Ethylbenzene	70-130	65-135	≤ 30
Ethylene Dibromide	70-130	65-135	≤ 30

TABLE 16
Accuracy and Precision for VOCs by GC/MS (SW8260B)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
Isopropylbenzene	70-130	65-135	≤ 30
m,p-Xylene	70-130	65-135	≤ 30
Methyl tert-Butyl Ether	70-130	65-135	≤ 30
Methylene Chloride	70-130	65-135	≤ 30
n-Butylbenzene	70-130	65-135	≤ 30
n-Propylbenzene	70-130	65-135	≤ 30
o-Xylene	70-130	65-135	≤ 30
Sec-Butylbenzene	70-130	65-135	≤ 30
Styrene	70-130	65-135	≤ 30
tert-Butylbenzene	70-130	65-135	≤ 30
Tetrachloroethene	70-130	65-135	≤ 30
Toluene	70-130	65-135	≤ 30
Trans-1,2-Dichloroethene	70-130	65-135	≤ 30
Trichloroethene	70-130	65-135	≤ 30
Vinyl Chloride	70-130	65-135	≤ 30
Xylene (Total)	70-130	65-135	≤ 30
Surrogates:			
Dibromofluoromethane	75-125		
4-Bromofluorobenzene	75-125		
Toluene-d8	81-120		
1,2-Dichloroethane-d4	62-139		

R = Recovery

RPD = Relative percent difference

TABLE 17

Accuracy and Precision for PAHs and SVOCs by GC/MS (SW8270C-SIM/SW8270C)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
1,2,4-trichlorobenzene	60-140	50-150	≤ 30
1,2-dichlorobenzene	60-140	50-150	≤ 30
1,3-dichlorobenzene	60-140	50-150	≤ 30
1,4-dichlorobenzene	60-140	50-150	≤ 30
2,4-Dinitrotoluene	60-140	50-150	≤ 30
2,6-dinitrotoluene	60-140	50-150	≤ 30
2,4,5-Trichlorophenol	60-140	50-150	≤ 30
2,4,6-Trichlorophenol	60-140	50-150	≤ 30
2,4-Dichlorophenol	60-140	50-150	≤ 30
2,4-Dimethylphenol	60-140	50-150	≤ 30
2,4-Dinitrophenol	60-140	50-150	≤ 30
2-Chloronaphthalene	60-140	50-150	≤ 30
2-Chlorophenol	60-140	50-150	≤ 30
2-Methyl-4,6-Dinitrophenol	60-140	50-150	≤ 30
2-Methylphenol	60-140	50-150	≤ 30
2-Nitroaniline	60-140	50-150	≤ 30
3-Nitroaniline	60-140	50-150	≤ 30
3,3'-Dichlorobenzidine	60-140	50-150	≤ 30
4-Nitroaniline	60-140	50-150	≤ 30
4-Chloroaniline	60-140	50-150	≤ 30
4-Methylphenol	60-140	50-150	≤ 30
4-Nitrophenol	60-140	50-150	≤ 30
Bis (2-chloroethyl) ether	60-140	50-150	≤ 30
Bis (2-chloroisopropyl) ether	60-140	50-150	≤ 30
Bis (2-ethylhexyl) phthalate	60-140	50-150	≤ 30
Butyl benzyl phthalate	60-140	50-150	≤ 30
Dibenzofuran	60-140	50-150	≤ 30
Diethyl phthalate	60-140	50-150	≤ 30
Dimethyl phthalate	60-140	50-150	≤ 30
Di-n-butyl phthalate	60-140	50-150	≤ 30
Di-n-octyl phthalate	60-140	50-150	≤ 30
Hexachlorobenzene	60-140	50-150	≤ 30
Hexachlorobutadiene	60-140	50-150	≤ 30
Hexachloroethane	60-140	50-150	≤ 30
Isophorone	60-140	50-150	≤ 30
Nitrobenzene	60-140	50-150	≤ 30
n-Nitroso-di-n-propylamine	60-140	50-150	≤ 30

TABLE 17

Accuracy and Precision for PAHs and SVOCs by GC/MS (SW8270C-SIM/SW8270C)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
n-Nitrosodiphenylamine	60-140	50-150	≤ 30
Pentachlorophenol	60-140	50-150	≤ 30
Phenol	60-140	50-150	≤ 30
Acenaphthene	60-140	50-150	≤ 30
Acenaphthylene	60-140	50-150	≤ 30
Anthracene	60-140	50-150	≤ 30
Benzo (a) anthracene	60-140	50-150	≤ 30
Benzo (a) pyrene	60-140	50-150	≤ 30
Benzo(b)fluoranthene	60-140	50-150	≤ 30
Benzo (g,h,i) perylene	60-140	50-150	≤ 30
Benzo(k)fluoranthene	60-140	50-150	≤ 30
Chrysene	60-140	50-150	≤ 30
Dibenz(a,h)anthracene	60-140	50-150	≤ 30
Fluoranthene	60-140	50-150	≤ 30
Fluorene	60-140	50-150	≤ 30
Indeno(1,2,3-c,d)pyrene	60-140	50-150	≤ 30
Naphthalene	60-140	50-150	≤ 30
Phenanthrene	60-140	50-150	≤ 30
Pyrene	60-140	50-150	≤ 30
Surrogates:			
2,4,6-Tribromophenol	25-134		
2-Fluorobiphenyl	43-125		
2-Fluorophenol	25-125		
Nitrobenzene-d5	32-125		
Phenol-d5	25-125		
Terphenyl-d14	42-126		

R = Recovery

RPD = Relative percent difference

TABLE 18

Accuracy and Precision for Explosives/Energetics by HPLC (SW8330B)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	60-140	50-150	≤ 30
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	60-140	50-150	≤ 30
1,3,5-Trinitrobenzene	60-140	50-150	≤ 30
1,3-Dinitrobenzene	60-140	50-150	≤ 30
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	60-140	50-150	≤ 30
Nitrobenzene	60-140	50-150	≤ 30
2,4,6-Trinitrotoluene	60-140	50-150	≤ 30
4-Amino-2,6-dinitrotoluene	60-140	50-150	≤ 30
2-Amino-4,6-dinitrotoluene	60-140	50-150	≤ 30
2,4-Dinitrotoluene	60-140	50-150	≤ 30
2,6-Dinitrotoluene	60-140	50-150	≤ 30
2-Nitrotoluene	60-140	50-150	≤ 30
3-Nitrotoluene	60-140	50-150	≤ 30
4-Nitrotoluene	60-140	50-150	≤ 30

R = Recovery

RPD = Relative percent difference

TABLE 19

Accuracy and Precision for Anions by IC (SW9056)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
Chloride	80-120	75-125	≤ 20
Nitrate	80-120	75-125	≤ 20
Sulfate	80-120	75-125	≤ 20

R = Recovery

RPD = Relative percent difference

TABLE 20

Accuracy and Precision for Cations by ICP (SW6010B)

Analyte	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	Precision (% RPD)
Calcium	80-120	75-125	≤ 20
Magnesium	80-120	75-125	≤ 20
Phosphorus	80-120	75-125	≤ 20
Potassium	80-120	75-125	≤ 20
Sodium	80-120	75-125	≤ 20

R = Recovery

RPD = Relative percent difference

TABLE 21

Calibration and QC Requirements for Metals by SW610B/SW6020

QC Check	Frequency	Criteria	Corrective Action
Initial calibration (a blank and at least one standard)	Before initial sample analysis, every 24 hours, whenever modifications are made to the analytical system, or when continuing calibration verification fails	N/A	N/A
Second-source calibration verification	Immediately following each initial calibration	All analytes within $\pm 10\%$ of expected value	Correct problem and repeat initial calibration
Calibration blank	After every Second-source or Continuing calibration verification analysis	No analytes detected at or above the reporting limit	Correct the problem, then reanalyze previous 10 samples
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within $\pm 10\%$ of expected value	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification
Method Blank	At least one per analytical batch	No analytes detected at or above the reporting limit	Correct the problem and re-prepare and reanalyze all associated samples
Interference check standard	At the start and end of each analytical sequence or twice during an 8-hour period, whichever is more frequent	All analytes within $\pm 20\%$ of expected value	Correct the problem, recalibrate, reanalyze ICS and all affected samples
MS/MSD	One set per 20 project-specific samples. MSD is optional if a laboratory sample duplicate is performed	All analytes within limits specified in Accuracy and Precision table	None
Laboratory sample duplicate	Once per analytical batch if MSD not performed	Concentration of reported analytes are greater than 5 times the reporting limit in either sample and RPD greater than 20%. One sample result less than RL and a difference of ± 2 times the reporting limit	None
LCS	At least one per analytical batch	All analytes within limits specified in Accuracy and Precision table	Correct the problem, and re-prepare and reanalyze the LCS and all samples in the analytical batch
Dilution test	Each new sample matrix	Result from 1:5 dilution must be within $\pm 10\%$ of the undiluted sample result (applies only if undiluted sample result is at least 25 times the reporting limit)	Perform post-digestion spike addition
Post-digestion spike addition	When dilution test fails	Recovery within 75-125% of expected value	None

TABLE 22

Calibration and QC Requirements for Mercury by SW7471A

QC Check	Frequency	Criteria	Corrective Action
Multi-point initial calibration (a blank and at least five standards)	Before initial sample analysis, every 24 hours, whenever modifications are made to the analytical system, or when continuing calibration verification fails	Correlation coefficient (r) of linear regression is ≥ 0.995	Correct the problem and repeat the initial calibration
Second-source calibration verification	Immediately following each initial calibration	All analytes within $\pm 20\%$ of expected value	Correct the problem and repeat initial calibration
Calibration blank	After every Second-source or Continuing calibration verification analysis	No analytes detected at or above the reporting limit	Correct the problem, then reanalyze previous 10 samples
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within $\pm 20\%$ of expected value	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification
Method Blank	At least one per analytical batch	No analytes detected at or above the reporting limit	Correct the problem and re-prepare and reanalyze all associated samples
MS/MSD	One set per 20 project-specific samples. MSD is optional if a laboratory sample duplicate is performed	All analytes within limits specified in Accuracy and Precision table	None
Laboratory sample duplicate	Once per analytical batch if MSD not performed	Concentration of reported analytes are > 5 times the reporting limit in either sample and RPD $> 20\%$. One sample result $< RL$ and a difference of ± 2 times the reporting limit	None
LCS	At least one per analytical batch	All analytes within limits specified in Accuracy and Precision table	Correct the problem, and re-prepare and reanalyze the LCS and all samples in the analytical batch
Dilution test	Each new sample matrix	Result from 1:5 dilution must be within $\pm 10\%$ of the undiluted sample result (applies only if undiluted sample result is at least 25 times the reporting limit)	Perform recovery test
Recovery test	When dilution test fails	Recovery within 85-115% of expected value	Analyze all samples by MSA

TABLE 23

Calibration and QC Requirements for Radium-226 by USEPA 901.1

QC Check	Frequency	Criteria	Corrective Action
Energy Calibration (Matrix and Geometry specific)	Before initial sample analysis, whenever modifications are made to the analytical system, or when continuing calibration verification fails	No specific criteria, depending on total channel and range of energy of desired nuclides	Correct the problem and repeat the calibration
Calibration Verification (Performance Check)	Daily, or once per batch, whatever is more frequent	Within lab control limits (3 σ)	Correct the problem and repeat calibration
Background Counting	Monthly (when in use)	No analytes detected at or above the reporting limit	Correct the problem, then reanalyze samples
Method Blank	One per batch of 20 samples or less	<MDA, or <5% sample isotope concentration, or <5% decision level, whichever is greater	Correct the problem and re-prepare and reanalyze all associated samples
LCS	One per batch of 20 samples or less	All analytes within limits specified in Accuracy and Precision table	Correct the problem, and re-prepare and reanalyze the LCS and all samples in the analytical batch
Laboratory sample duplicate	One per batch of 20 samples or less	RPD < 35% when results >5x MDA	None

TABLE 24
Calibration and QC Requirements for Perchlorate by SW6850

QC Check	Frequency	Criteria	Corrective Action
Mass calibration	Daily, before sample analysis	Tuning standards should span the working range for the analysis. Mass assignments should be within ± 0.3 mass units of target values	Retune instrument and verify
Multi-point initial calibration (a blank and at least five standards)	Before initial sample analysis, every 24 hours, whenever modifications are made to the analytical system, or when continuing calibration verification fails	Correlation coefficient (r) of linear regression is ≥ 0.995	Correct the problem and repeat the initial calibration
Second-source calibration verification	Immediately following each initial calibration	Analyzed result within $\pm 25\%$ of the expected value	Correct problem and repeat initial calibration
Calibration blank	After every Second-source or Continuing calibration verification analysis	No analytes detected at or above the reporting limit	Correct the problem, then reanalyze previous 10 samples
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within $\pm 20\%$ of expected value (% D)	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification
Internal Standards (ISs)	Every sample, spiked sample, standard, and method blank	Retention time ± 30 seconds from retention time of the IS in the ICAL mid-point std. Peak area within $\pm 50\%$ of area from IS in ICAL mid-point standard	Inspect mass spectrometer and GC for malfunctions. Reanalysis of samples analyzed while the system was malfunctioning is mandatory.
^{35}Cl : ^{37}Cl isotope ratio (perchlorate only)	Every sample, spiked sample, standard, and method blank	Isotopic ratio between 2.35 – 3.85 ($\pm 25\%$ of theoretical)	Reanalyze. If necessary, re-prepare sample and repeat analysis
Method Blank	At least one per analytical batch	No analytes detected at or above the reporting limit	Correct the problem and re-prepare and reanalyze all associated samples
MS/MSD	One set per 20 project-specific samples. MSD is optional if a laboratory sample duplicate is performed	All analytes within limits specified in Accuracy and Precision table	None
Laboratory sample duplicate	Once per analytical batch if MSD not performed	Concentration of reported analytes are > 5 times the reporting limit in either sample and RPD $> 20\%$. One sample result $< \text{RL}$ and a difference of ± 2 times the reporting limit	None
LCS	At least one per analytical batch	All analytes within limits specified in Accuracy and Precision table	Correct the problem, and re-prepare and reanalyze the LCS and all samples in the analytical batch

TABLE 25

Calibration and QC Requirements for TPH, PCB, Explosives/Energetics by SW8015B, SW8082, SW8330B

QC Check	Frequency	Criteria	Corrective Action
Multi-point initial calibration (minimum five points) Multi-point calibration for Aroclors 1016 and 1260 only, but include mid-point standard for all other Aroclors for pattern recognition	Prior to sample analysis, or when calibration verification fails	If the %RSD is $\leq 20\%$, the average RRF may be used for quantitation; otherwise use calibration curve with coefficient of correlation $r \geq 0.995$.	Correct the problem and repeat the initial calibration
Continuing calibration verification	At the start of each analytical sequence and after every 10 samples, and at the end of the sequence	Analytes within $\pm 20\%$ of expected value	Correct the problem, then recalibrate and reanalyze all samples since the last acceptable continuing calibration verification
Method Blank	At least one per analytical batch	No analytes detected at or above the reporting limit	Correct the problem and re-prepare and reanalyze all associated samples
Surrogate spike	Every standard, sample, method blank, MS/MSD, and LCS	All surrogates in samples, method blank, MS/MSD, and LCS within limits specified in Accuracy and Precision table	Correct the problem and reanalyze (re-prepare if necessary)
MS/MSD	One set per 20 samples	Within limits specified in Accuracy and Precision table	None
LCS	At least one per analytical batch	Within limits specified in Accuracy and Precision table	Correct the problem, and re-prepare and reanalyze the LCS and all samples in the analytical batch
Second detector or second column confirmation (does not apply to SW8015B)	All samples with results above the reporting limit objectives must be confirmed within the holding time.	Confirmation to be done using a second detector (for SW8330B), or second column of dissimilar phase and retention characteristics (or gas chromatography/mass spectrometry if sample concentration is sufficiently high). All calibration and QC acceptance criteria specified for primary analysis must be met in the confirmation analysis.	Failure to perform confirmation will result in potential resampling and analysis at no cost to the project

TABLE 26

Calibration and QC Requirements for PAHs, VOC, SVOC by SW8270C-SIM, SW8260B, SW8270C

QC Check	Frequency	Criteria	Corrective Action
BFB Tuning	Prior to initial calibration and calibration verification (every 12 hours)	Refer to criteria listed in the method	Retune instrument and verify
Multi-point initial calibration (minimum five points)	Prior to sample analysis, or when calibration verification fails	<p>SPCCs: RRF $\geq 0.30a$ (≥ 0.050 for SW8270C)</p> <p>CCCs: %RSD for RFs $\leq 30\%$</p> <p>and one option below:</p> <hr/> <p>Option 1:</p> <p>Mean %RSD for all analytes $\leq 15\%$ with no individual analyte RSD $> 30\%$,</p> <hr/> <p>Option 2:</p> <p>Least squares regression $r \geq 0.995$</p>	Correct the problem and repeat the initial calibration
Second-source calibration verification	Once for each multi-point initial calibration	All analytes within $\pm 25\%$ of expected value	Correct the problem and repeat initial calibration
Continuing calibration verification	At the start of each analytical sequence and every 12 hours thereafter	<p>SPCCs: RRF $\geq 0.30a$ (≥ 0.050 for SW8270C)</p> <p>CCCs: %RSD for RFs $\leq 20\%$</p> <p>All other analytes within $\pm 25\%$ of expected value.</p>	Correct the problem, then recalibrate and reanalyze all samples since the last acceptable continuing calibration verification
Retention time window calculated for each analyte	Each analyte	Relative retention time of each analyte within ± 0.06 relative retention time units of the continuing calibration verification	Not applicable (used for identification of analyte)
Internal Standards	Each sample and QC sample, method blank, MS/MSD, and LCS	<p>Retention time within ± 30 seconds from retention time of the daily continuing calibration verification standard.</p> <p>EICP area within -50% to $+100\%$ of the daily continuing calibration verification standard</p>	Inspect mass spectrometer and gas chromatography for malfunctions; reanalyze all affected samples
Method Blank	At least one per analytical batch	No analytes detected at or above the reporting limit	Correct the problem, then re-prepare and reanalyze all associated samples
Surrogate spike	Every standard, sample, method blank, MS/MSD, and LCS	All surrogates in samples, method blank and LCS within limits specified in Accuracy and Precision table	Correct the problem and reanalyze (re-prepare if necessary).
MS/MSD	One set per 20 project-specific samples	Within limits specified in Accuracy and Precision table	None
LCS	At least one per analytical batch	Within limits specified in Table 17	Correct the problem, then re-prepare and reanalyze the LCS and all samples in the analytical batch

^aSPCC average RRF ≥ 0.10 for bromoform, chloromethane, 1,1-dichloroethane.

TABLE 27

Calibration and QC Requirements for Anions by SW9056

QC Check	Frequency	Criteria	Corrective Action
Multi-point initial calibration (a blank and at least five standards)	Before initial sample analysis, every 24 hours, whenever modifications are made to the analytical system, or when continuing calibration verification fails	Correlation coefficient of linear regression is ≥ 0.995	Correct the problem and repeat the initial calibration.
Second-source calibration verification	Immediately following each initial calibration	All analytes within $\pm 10\%$ of expected value	Correct the problem and repeat initial calibration.
Calibration blank	After every Second-source or Continuing calibration verification analysis	No analytes detected at or above the reporting limit	Correct the problem, then reanalyze previous 10 samples.
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within $\pm 10\%$ of expected value	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification
Method Blank	At least one per analytical batch	No analytes detected at or above the reporting limit	Correct the problem and re-prepare and reanalyze all associated samples
MS/MSD	One set per 20 project-specific samples. MSD is optional if a laboratory sample duplicate is performed	All analytes within limits specified in Accuracy and Precision table	None
Laboratory sample duplicate	Once per analytical batch if MSD not performed	Concentration of reported analytes are greater than 5 times the reporting limit in either sample and RPD greater than 20%. One sample result less than RL and a difference of ± 2 times the reporting limit	None
LCS	At least one per analytical batch	All analytes within limits specified in Accuracy and Precision table	Correct the problem, and re-prepare and reanalyze the LCS and all samples in the analytical batch

Appendix E

Field Forms



RUBY MINES DAILY FIELD SUMMARY REPORT

Date:

Weather/Precipitation:

Locations Worked:

CH2M HILL and Subcontractor Personnel On Site:

Visitors To Field Site (name and comments of visitors):

Health & Safety Issues Encountered:

Work Performed (borings advanced/method, type of samples collected, areas completed):

Field Measurements Performed (Instruments):

Field Equipment (model, SN, calibration, background readings, problems, etc.)

Problems and Corrective Actions/Subcontractor Standby-Down Time:

Anticipated Work for the Following Day/ Following week:

Additional Comments.

Signature and Date:



SHEET 1 OF

DRILLING LOG

LOGGER :

[illegible]



CH2MHILL


PROJECT NUMBER
461446

BORING NUMBER

SHEET 2 OF

DRILLING LOG

DEPTH BELOW SURFACE (ft)				USCS CODE	SOIL DESCRIPTION	COMMENTS
SAMPLE INTERVAL (ft)					SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEBRIS ENCOUNTERED, RAD RESULTS, SAMPLE COLLECTION (date, time, sample ID)
RECOVERY (ft)						
#/TYPE						
50						
60						
70						
80						

 CH2MHILL	PROJECT NUMBER 461446	BORING NUMBER <div style="text-align: right;">SHEET 1 OF</div>
	<h2 style="margin: 0;">DRILLING LOG</h2>	

PROJECT : Ruby Mines	LOCATION :	ELEVATION (TBM or MSL) :
DRILLING CONTRACTOR :	NAME OF DRILLER :	
DRILLING METHOD/EQUIPMENT:	SIZE/TYPE OF BIT :	
DIRECTION OF HOLE :		
GPS COORDINATES (SYSTEM):	TOTAL DEPTH OF BORING :	
WATER LEVELS :	START :	END :
		LOGGER :

DEPTH BELOW SURFACE (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	#/TYPE	SOIL DESCRIPTION	COMMENTS
				SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEBRIS ENCOUNTERED, RAD RESULTS, SAMPLE COLLECTION (date, time, sample ID)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					



CH2MHILL

PROJECT NUMBER
461446

BORING NUMBER

SHEET 2 OF

DRILLING LOG

DEPTH BELOW SURFACE (ft)				SOIL DESCRIPTION	COMMENTS
	SAMPLE INTERVAL (ft)	RECOVERY (ft)	#/TYPE	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEBRIS ENCOUNTERED, RAD RESULTS, SAMPLE COLLECTION (date, time, sample ID)
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					



SHEET 1 OF

MULTIPLE SOIL SAMPLE LOG

LOGGER :

[illegible]

NOTES:

[illegible]

NOTES:

[illegible]



CH2MHILL

PROJECT NUMBER 461446	TEST PIT NUMBER SHEET 1 OF 1
TEST PIT LOG	

PROJECT : Ruby Mines	GPS LOCATION :	LOGGER :
ELEVATION :	CONTRACTOR :	
EXCAVATION EQUIPMENT USED :	DATE EXCAVATED:	
WATER LEVEL :	APPROX. DIMENS: Length:	Width: Max. Depth:

DEPTH BELOW SURFACE (FT)		SOIL DESCRIPTION	COMMENTS
	INTERVAL (FT)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE, GRADATIONAL CONTACTS, TESTS, INSTRUMENTS.
	NUMBER AND TYPE		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

Appendix F
Site Health and Safety Plan

Ruby Mines Site Investigation

Waste Removal Evaluation

Prepared for
Freeport McMoRan

Ruby Mines, NM

August 2014



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Emergency Contacts

24-hour CH2M HILL Injury Reporting– 1-866-893-2514
24-hour CH2M HILL Serious Incident Reporting Contact – 720-286-4911

Medical Emergency – 911

Mountain View Regional Medical Center
4311 E. Lohman Ave.
Las Cruces, NM 88011
575) 556-7600

CH2M HILL- Medical Consultant

WorkCare
Dr. Peter Greaney M.D.
300 S. Harbor Blvd, Suite 600
Anaheim, CA 92805
800-455-6155/866-893-2514
714-978-7488

Fire/Spill Emergency – 911

Facility Fire Response #: 911
Local Fire Dept #: 911

CH2M HILL Director – Health, Safety, Security & Environment

Andy Strickland/DEN
(720) 480-0685 (cell) or (720) 286-2393 (office)

Security & Police – 911

Local Police #:911

CH2M HILL Responsible Health and Safety Manager (RHSM)

Name: Jeffrey T. Hilgaertner
Phone: 714-552-1971

Utilities Emergency Phone Numbers

Water: 911
Gas: 911
Electric: 911

CH2M HILL Human Resources Department

Phone: Employee Connect toll-free number
1-877-586-4411
(U.S. and Canada)

CH2M HILL Project Manager

Name: Jennifer Laggan
Phone: (303) 249-4273

CH2M HILL Worker's Compensation:

Contact Business Group HR dept. to have form completed
or contact Jennifer Rindahl after hours: (720)891-5382

CH2M HILL Safety Coordinator (SC)

Name: Jim Crew
Phone: (205) 531-6916

Media Inquiries Corporate Strategic Communications

Name: John Corsi
Phone: (720) 286-2087

CH2M HILL Project Environmental Manager

Name: Liz Luecker
Phone: (425) 647-6073

Automobile Accidents

Rental: Jennifer Rindahl/DEN: 720-286-2449
CH2M HILL owned vehicle: Linda George/DEN: 720-286-2057

Federal Express Dangerous Goods Shipping

Phone: 800/238-5355

CHEMTEL (hazardous material spills)

Phone: 800/255-3924

Facility Alarms: TBD
None

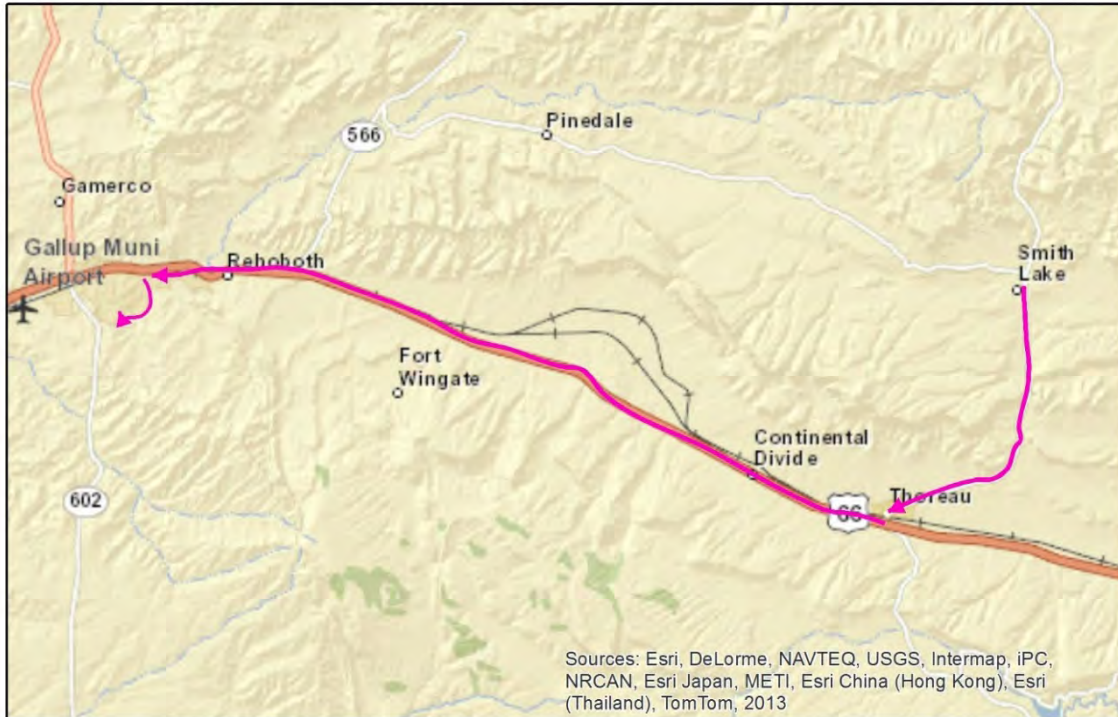
Evacuation Assembly Area(s): Main facility parking area

Facility/Site Evacuation Route(s): To be determined

Directions and MAP to Local Hospital

Local Hospital:
Rehoboth McKinley Christian Hospital
800 Hospital Drive, Gallup, NM 87301 (505) 722-9520

Route To Hospital - Western Nuclear/Ruby Mines Site



Local Hospital:
Rehoboth McKinley Christian Hospital
800 Hospital Drive, Gallup, NM 87301
(505) 722-9520

1. Start at Smith Lake at intersection of BIA Route 49 and NM-371
 2. Drive south for 12.6 miles and pass through Thoreau NM
 3. Merge on I-40 heading west (second right turn after stop sign and right before overpass).
 4. Continue west on I-40 for 26.8 miles to exit, EXIT 26, toward E. Gallup.
 5. Keep left to take the ramp toward Gallup.
 6. Turn left onto NM-118 / E Highway 66.
 - GIANT #6075 is on the corner
 7. Turn left onto S Boardman Ave / NM-564.
 - S Boardman Ave is just past Mine Run St
 - McDonald's is on the corner
 - If you reach S Valentina Dr you've gone about 0.2 miles too far
 8. Turn right onto College Dr.
 - College Dr is 0.6 miles past Catalpa Wash Rd
 - If you reach NM-602 you've gone about 0.6 miles too far
 9. Turn right onto Hospital Dr.
 - Hospital Dr is just past Government Cir
 - If you reach Nizhoni Blvd you've gone a little too far
 10. 800 HOSPITAL DR is on the right.
 - Your destination is just past Redrock Dr
- If you are on Redrock Dr and reach Nizhoni Blvd you've gone about 0.3 miles too far

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ATTACHMENTS

- ESBG HSSE Guidelines
- Project Forms/Templates
- Fact Sheets
- Project Activity Self-Assessment Checklists
- CH2M HILL AHAs

Approval

This site-specific Health & Safety Plan (HSP) has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific project and site conditions and identified scope(s) of work and must be amended if those conditions or scope(s) of work change.

By approving this HSP, the Responsible Health and Safety Manager (RHSM) certifies that the personal protective equipment has been selected based on the project-specific hazard assessment.

ORIGINAL PLAN

Original Plan Written by: Jeffrey T. Hilgaertner **Date:** 20 August 2013

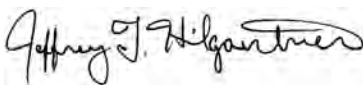
RHSM Approval:  **Date:** 20 August 2013

Project Manager Approval:  **Date:** 26 August 2013

REVISIONS:

Revisions Made By: Jeffrey T. Hilgaertner **Date:** 24 July 2014

Description of Revisions to Plan: Updated to include new tasks.

Revisions Approved By:  **Date:** 24 July 2014

1. Applicability

This HSP applies to:

- All CH2M HILL staff, including subcontractors and tiered subcontractors of CH2M HILL working on the site
- All visitors to CH2M HILL construction sites in the custody of CH2M HILL (including visitors from the Client, the Government, the public, and other staff of any CH2M HILL company).

In addition, Subcontractors and tiered subcontractors shall also follow any of their company HSE programs, and site-specific safety plans and AHAs.

This HSP does not apply to the third-party contractors, their workers, their subcontractors, their visitors, or any other persons not under the direct control or custody of CH2M HILL.

This HSP defines the procedures and requirements for the health and safety of CH2M HILL staff and visitors when they are physically on the work site. The work site includes the project area (as defined by the contract documents) and the project offices, trailers, and facilities thereon.

This HSP will be kept onsite during field activities and will be reviewed as necessary. The HSP will be revised as project activities or conditions change or when supplemental information becomes available. The HSP adopts, by reference, the CH2M HILL Enterprise-wide Core Standards and Standard Operating Procedures (SOPs), as appropriate. In addition, applicable requirements contained in the Environmental Services Business Group (ESBG) Health, Safety, Security, and Environment (HSSE) Guidelines (Guidelines) will be implemented. The Guidelines are available as a stand-alone handbook at the project site. The HSP may adopt procedures from the project Work Plan and any governing regulations. If there is a contradiction between this HSP and any governing regulation, the more stringent and protective requirement shall apply.

All CH2M HILL staff and subcontractors must sign the employee sign-off form (at the end of this HSP) to acknowledge review of this document. Copies of the signature page will be maintained onsite by the Safety Coordinator (SC).

2. General Project Information

2.1 Project Information and Background

Project Number:	461446	Project/Site Name:	Ruby Mines Site Investigation
Client:	Freeport McMoRan	Site Address:	Smith Lake, NM
CH2M HILL Project Manager:	Jennifer Laggan	CH2M HILL Office:	DEN
DATE HSP Prepared:	20 August 2013	Date(s) of Site Work:	Various

2.2 Site Background, Setting, and Map

The Ruby Mines consist of four claims (Ruby Mines Nos. 1, 2, 3, and 4) located in McKinley County, New Mexico near the Smith Lake Chapter of the Navajo Nation and approximately eight miles north of the city of Thoreau in western New Mexico (Figure 1). Ruby Mines Nos. 1 through 4 are located within the boundary of the Navajo Nation in Township 15 North, Range 13 West, Sections 21, 27, 25, and 26, respectively (MMD, 1995).

Reconnaissance of the Ruby Mines in October 2012, January 2013, March 2013, and August 2013 revealed several open historical mine features throughout the areas. These have been fenced once found and warning signs posted. Bimonthly fence monitoring is performed to evaluate the integrity of the fences and the Freeport McMoRan Hazardous Mine Openings Safety Program (HMOSP) are contacted to perform any necessary repairs. Once approval of the cultural resource assessment is obtained, HMOSP will permanently close the open mine features.

The site is located in the southeastern part of the Colorado Plateau Physiographic Province. The terrain is characterized by broken terrain, including steep mountains, plateaus, mesas, and incised valleys with dry arroyos. The Ruby Mines are in areas of moderate relief with ground elevations ranging from approximately 7,400 to 7,900 feet above mean sea level (amsl), with moderate slopes dipping to the north-northeast, broken by incised drainage features. Vegetation cover across the area includes Ponderosa Pine, Juniper-Piñon forest, sage scrubland, dry prairie grass, with small areas of unvegetated sandy and rocky soils (USDA, 2005). Average daily high temperatures in Thoreau are 63.5 degrees Fahrenheit (°F), and average daily low temperatures are 30.7 °F (Fizber, 2013). Warmest temperatures occur in July (average 86.0 °F high), and coolest temperatures occur in January (average 22.2 °F low) (Fizber, 2013). Average annual precipitation is 14.4 inches, with highest snowfalls occurring in February, and highest rainfalls occurring in August (Fizber, 2013). Relative humidity is low for most of the year, but can be moderate during the summer monsoon season.

2.3 Description of Tasks

Below is a description of the tasks covered by this plan. Any additions or changes in scope will require a revision to this HSP; see Change Management below.

Scope of work covered by the 2013 HSP includes:

- Oversee a cultural resources subcontractor to perform a Cultural Resource Survey of the areas to be disturbed.
- Surficial soil samples will be collected and analyzed for radionuclides and select metals at the two background areas.
- Oversee a radiological subcontractor to conduct gamma transect scans.
- Perform visual inspections of existing fencing around known adits and vents, until such time as the openings are permanently closed by Freeport McMoRan

Additional tasks for the 2014 season include:

- Direct push drilling and core sampling to 30 feet

- Hand auger and surface soil sampling to 2 feet

2.4 Change Management

Changes to this HSP shall be documented and approved by the CH2M HILL Responsible Health and Safety Manager for the project. The following are examples of changes that may require a revision to the plan:

- Change in CH2M HILL staff;
- New subcontractor to perform work;
- New chemicals brought to site for use;
- Change in scope or addition of new tasks;
- Change in contaminants of concern (COCs) or change in concentrations of COCs; and
- New hazards or hazards not previously identified that are not addressed in this HSP.

2.5 Changes to Health and Safety Plans

Changes to the HSP shall be documented and accepted by using the Health and Safety Field Change Request (FCR) form (included in Attachments) or by resubmitting a revised HSP for acceptance. A revised HSP should be produced when a large number of changes (e.g., 15 or more not including AHAs) using FCRs has been employed. The CH2M HILL Project Manager (PM) and RHSM shall be responsible for the review and acceptance of the FCR, and the RHSM will maintain an FCR log of approved changes. Field Change Requests are not required for safety-related changes that a Safety Coordinator (SC) or RHSM would normally make in the field, such as upgrade or downgrade to PPE within pre-established action levels, expansion or reduction of work control zones based on air monitoring results, and similar changes made within the operating parameters of the HSP. The field copy of the HSP shall be kept up to date by annotating the appropriate section (i.e., update to AHA) to indicate that an FCR is in effect; copies of FCRs should be kept with the HSP. The FCR number must be referenced in the HSP and available for review.

2.6 Daily Safety Meetings and Pre-Task Safety Plans

Safety meetings are to be held with all project personnel in attendance to review the hazards, controls, and required procedures/AHAs that apply for each day's activities:

- Everyone involved in the day's work needs to sign a sign-in form to show they've had a briefing/attended a meeting.
- Pre-Task Safety Plans (PTSPs) serve the same purpose as general safety meetings, but the PTSPs are completed by individual crews to focus on those hazards posed by their specific work.
- For smaller crews, or if there is just one activity, the PTSP is often used as a means to document the overall Safety Meeting.

A copy of the PTSP and Daily Safety Meeting sign-in sheet is included as an Attachment.

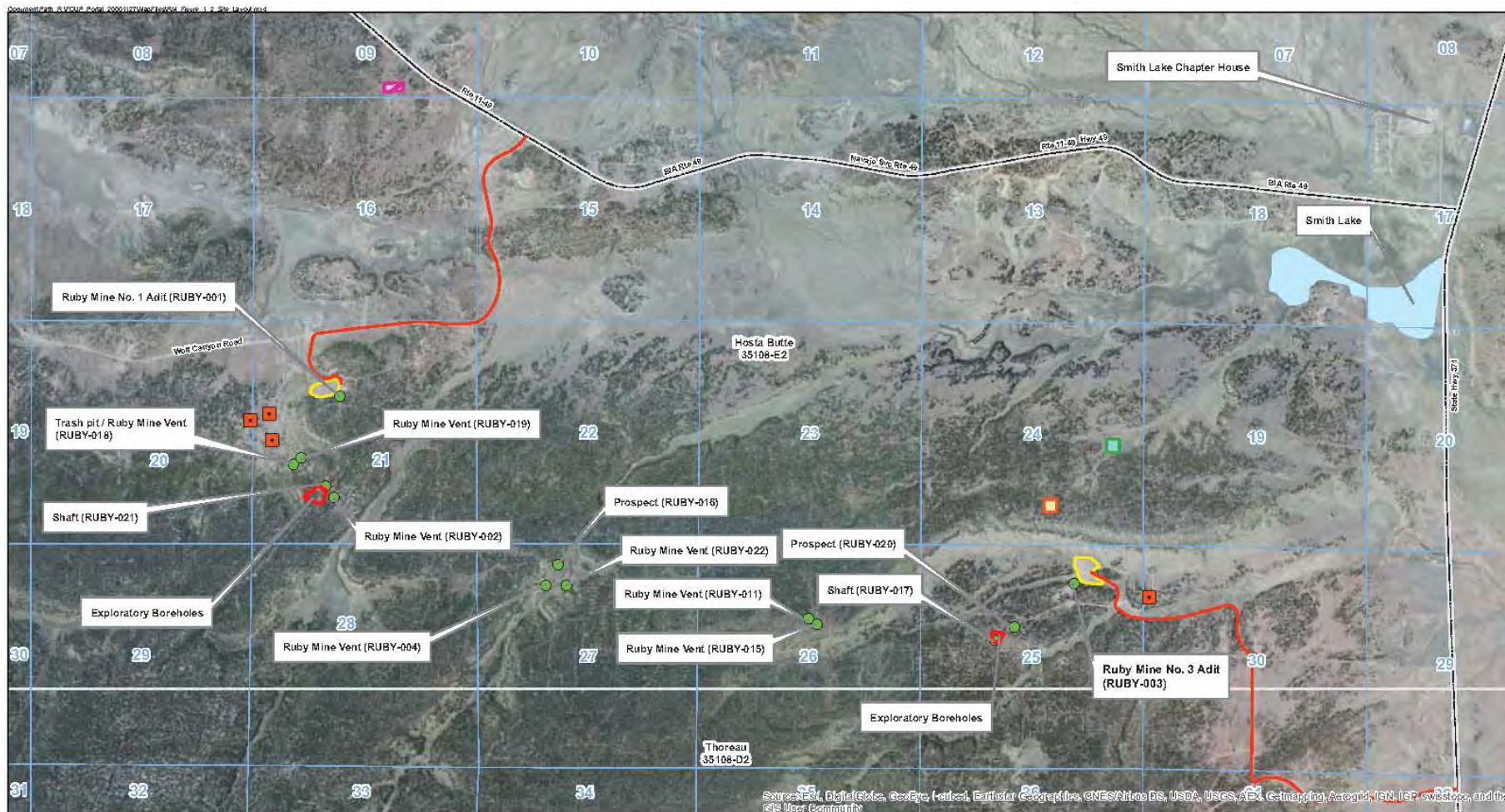


Figure 1-2
Ruby Mines Site Layout
Ruby Mines Phase 2 Report

CH2MHILL

3. Project Organization and Responsibilities

A full description of responsibilities, including Employee Responsibilities and Authority, can be found in the Guidelines, Section 3, "Roles and Responsibilities."

3.1 Client

Contact Name:	Stuart Brown
Phone:	602-448-0972

3.2 CH2M HILL

Project Manager:	
PM Name:	Jennifer Laggan
Office:	DEN
Telephone number:	(720) 286-0513 x60513
Cellular Number:	(303) 249-4273

Environmental Manager:	
EM Name:	Carla Rellergert
Office:	DEN
Telephone number:	(720) 286-0707
Cellular Number:	

Responsible Health and Safety Manager:	
RHSM Name:	Jeffrey T. Hilgaertner
Office:	TUK
Telephone number:	520-333-2718
Cellular Number:	714-552-1971

Safety Coordinator:	
SC Name:	Ben Moayyad
Office:	ABQ
Telephone	505 855-5201
Cellular Number:	505 504-2214

3.3 CH2M HILL Subcontractors

Subcontractor: Radiological	
Contact Name:	Perma-Fix
Telephone number:	
Cellular Number:	

Subcontractor: Cultural Resources	
Contact Name:	Dinetahdoo CRM – Rena Martin
Telephone	505-960-9478
Cellular Number:	

Subcontractor: Drilling	
Contact Name:	TBD
Telephone number:	
Cellular Number:	

Subcontractor: Waste Hauler	
Contact Name:	TBD
Telephone	
Cellular Number:	

3.4 Client Contacts

Client Contacts:	
Contact Name:	HMOSP – Sarah Dahlin, Mine Engineer
Telephone number:	520-498-6524
Cellular Number:	520-647-1595

Client Contacts:	
Client Name:	
Telephone	
Cellular Number:	

This HSP does not cover contractors that are contracted directly to the client or the owner. CH2M HILL is not responsible for the health and safety or means and methods of the client contractor's work, and we must never assume such responsibility through our actions (such as advising on health and safety issues).

4. Standards of Conduct

All individuals associated with this project must work injury-free and drug-free and must comply with the standards of conduct stated in the Guidelines, (Section 4, “Standards of Conduct”), comply with all requirements of this HSP, and Subcontractors must also comply with the safety requirements of the Subcontractor HSP. Forms related to Subcontractor Safety (i.e., Observation Hazard Form and Stop Work Order Form) are attached to this HSP.

5. Project Hazard Analysis

A health and safety risk analysis (Table 1) has been completed for this project. Specific project activities are listed in Table 1 with a designation of who performs the task, CH2M HILL (C) or Subcontractor (S). An Activity Hazard Analysis has been developed for each project activity. AHAs prepared for CH2M HILL activities are included as an attachment to this HSP.

CH2M HILL subcontractors are required to provide AHAs specific to their scope of work on the project for acceptance by CH2M HILL prior to the start of work. Each subcontractor shall submit AHAs for their field activities, as defined in their scope of work, along with their project-specific safety plan and procedures. Additions or changes in field activities, equipment, tools, or material used to perform work or hazards not addressed in existing AHAs requires either a new AHA to be prepared or an existing AHA to be revised.

TABLE 1

Health and Safety Risk Analysis Table

Associated Hazard Section	Project Activity	Oversight	Survey	Soil Sampling	Potholing with excavator	Drilling	Hand auger sampling		
General Hazards – Refer to General Hazards and Controls in HSSE Guidelines, Section 7.									
Bloodborne Pathogens		CS	CS	CS	CS	CS	CS		
Chemical Storage									
Driving Safety		CS	CS	CS	CS	CS	CS		
Electrical Safety		CS	CS	CS	CS	CS	CS		
Field Vehicles		CS	CS	CS	CS	CS	CS		
Fire Prevention		CS	CS	CS	CS	CS	CS		
General Practices and Housekeeping		CS	CS	CS	CS	CS	CS		
Hazard Communication		CS	CS	CS	CS	CS	CS		
Knife Use					CS	CS	CS		
Lighting		CS	CS	CS	CS	CS	CS		
Manual Lifting		CS	CS	CS	CS	CS	CS		
Personal Hygiene		CS	CS	CS	CS	CS	CS		
Personal Security		CS	CS	CS	CS	CS	CS		
Shipping and Transportation of Hazardous Waste					CS	CS	CS		
Substance Abuse		CS	CS	CS	CS	CS	CS		
Project-Specific Hazards – Refer to HSSE Guidelines, Section 8, and the additional project-specific controls in this plan when specified.									
Barbed Wire Fences		CS	CS	CS	CS	CS	CS		
Blasting/Explosives									
Drum Sampling Safety						CS			
Fall Protection		CS	CS			CS			

TABLE 1
Health and Safety Risk Analysis Table

Associated Hazard Section	Project Activity	Oversight	Survey	Soil Sampling	Potholing with excavator	Drilling	Hand auger sampling		
Firearms, Explosives and Weapons		CS	CS	CS	CS	CS	CS		
Hand and Power Tools			S	C	CS	CS	C		
Hunting Season Safety		CS	CS	CS	CS	CS	CS		
Off-Road Driving Safety		CS	CS	CS	CS	CS	CS		
Portable Generators					CS	CS			
Steep Slopes and Uneven Walking Surfaces		CS	CS	CS	CS	CS	CS		
Utilities (underground)				C	CS	CS	C		
Working Alone		CS	CS	C			C		
Physical Hazards – Refer to Physical Hazards in HSSE Guidelines, Section 9, and the additional project-specific controls in this plan when specified.									
Ultraviolet Light exposure (sunburn)		CS	CS	CS	CS	CS	CS		
Naturally Occurring Radiation Materials (NORM)s		CS	CS	CS	CS	CS	CS		
Radiological Hazards		CS	CS	CS	CS	CS	CS		
Temperature Extremes		CS	CS	CS	CS	CS	CS		
Biological Hazards – Refer to Biological Hazards in HSSE Guidelines, Section 10, and the additional project-specific controls in this plan when specified.									
Cactus		CS	CS	CS	CS	CS	CS		
Cougars/Mountain Lions		CS	CS	CS	CS	CS	CS		
Coyotes		CS	CS	CS	CS	CS	CS		
Feral Dogs		CS	CS	CS	CS	CS	CS		
Mosquito Bites		CS	CS	CS	CS	CS	CS		
Scorpions		CS	CS	CS	CS	CS	CS		
Snakes		CS	CS	CS	CS	CS	CS		
Spiders – Brown Recluse and Black Widow		CS	CS	CS	CS	CS	CS		

C – Hazard section applicable to CH2M HILL personnel

S – Hazard section applicable to Subcontractor personnel

6. Hazards and Controls

Safe work practices and hazard control measures to reduce or eliminate potential hazards as identified in Table 1 are stated in the Guidelines, Sections 7-10, the associated CH2M HILL SOP, and are addressed in project AHAs. Any additional project-specific control measures, or those hazards requiring additional emphasis, are identified in the following sections.

Always consult the appropriate CH2M HILL Enterprise SOP to ensure all requirements are implemented. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the RHSM for clarification.

6.1 Additional Project-Specific Hazard Controls

Site-specific concerns for this work result from the remoteness of the site, the potential presence of low-level radiation, and physical hazards.

Because the site is very remote, access to modern conveniences is limited. Toilet facilities are available only at the Chapter House. AT&T and local carriers provide adequate service, but it is sometimes inconsistent, and Verizon does not have cell service in the area. External radiological dose to workers from naturally occurring radiological material (NORM) is the primary radiological hazard; therefore, only properly trained and authorized personnel will be authorized to work at the site.

Best practices for reducing radiological dose include:

- Avoid making and breathing dust.
- Avoid touching waste rock, ore, and potentially contaminated material.
- Limit time adjacent to NORM; for instance, move away from a capped waste rock pile to fill out paperwork or have discussions.
- Set up base camp in a low dose rate area.
- Spend as little time as possible in high dose rate areas (defined for this project as areas above 0.05 milliroentgen per hour [mR/hr]). Perform only necessary activities in higher dose rate areas, and then go to lower dose rate areas. For example, take pictures and observe geology if necessary in higher dose rate areas, but prepare field notes and conduct team discussions in lower dose rate areas.
- Be cognizant of potential intake hazards and control potential contamination. For example, do not set down equipment or supplies within the drainage channel or on a rock pile. While “areas” greater than 2 mR/hr are not expected at the mines, do not enter them if they are discovered. Do not touch uranium ore.
- Before crossing over the boundaries of the former mine site after performing tasks that may result in contamination, have the radiological subcontractor perform a frisking survey. If radiological contamination is found, follow subcontractor procedures for radiological decontamination.
- Refer to CH2M HILL’s documents *Corporate Health and Safety Program*; *Program and Training Manual*; and *Corporate Health and Safety Program, Radiation Protection Program Manual* for standards of practice in contaminated areas and as low as reasonably achievable (ALARA) practices. These materials are on the Virtual Office (VO) under Operations/Health, Safety, & Environment/Manuals (under the Policy, Procedures, Manuals tab).

Best practices for avoiding physical hazards at this site include:

- Traverse steep slopes diagonally rather than going straight up or down. Choose footing carefully and avoid rocky areas if possible.

Be aware that there are shafts and vents in the area. If you come across an unmarked shaft or vent, mark it and report the hazard immediately.

7. Hazard Communication

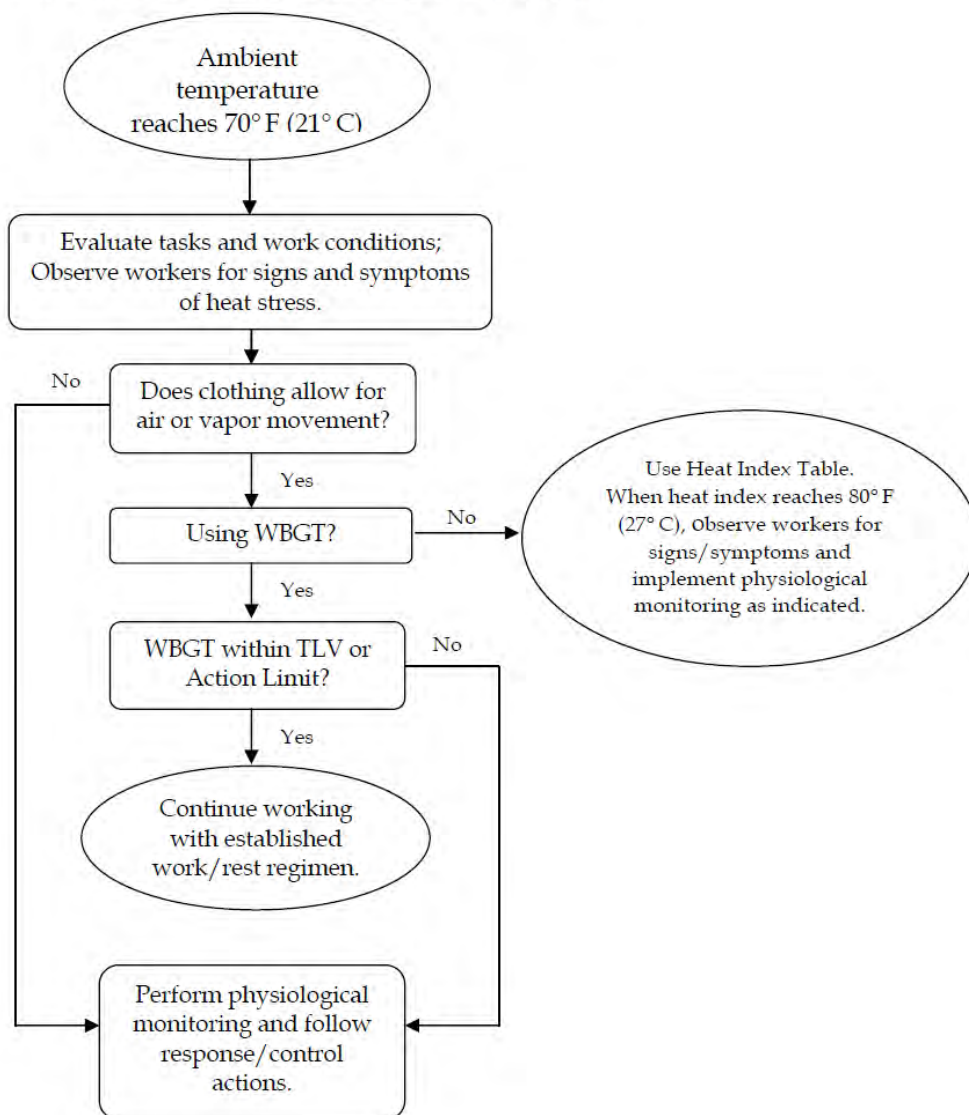
As indicated in Section 7, “Hazard Communication,” in the Guidelines, the hazard communication (HazCom) coordinator (the SC or qualified designee) must perform the following (additional HazCom duties are outlined in the Guidelines):

- Complete an inventory of chemicals brought on site by CH2M HILL using the chemical inventory form included as an attachment to this HSP;
- Confirm that an inventory of chemicals brought on site by CH2M HILL subcontractors is available;
- Before or as the chemicals arrive on site, obtain a Safety Data Sheet (SDS) for each hazardous chemical and include on the chemical inventory sheet (attached to this HSP) and add the SDS to the SDS attachment section of this HSP;
- Give employees required chemical-specific HazCom training using the chemical-specific training form included as an attachment to this HSP.

7.1 Heat Stress Monitoring Flow Chart

Use the flow chart below and refer to the applicable protocol in Section 9 of the Guidelines of the Guidelines for heat stress monitoring.

Thermal Stress Monitoring Flow Chart



8. Personal Protective Equipment

(Reference CH2M HILL- SOP HSE-117, Personal Protective Equipment, and Section 11 of the Guidelines))

8.1 Required Personal Protective Equipment

PPE must be worn by employees when actual or potential hazards exist and engineering controls or administrative practices cannot adequately control those hazards.

A PPE assessment has been conducted by the RHSM based on project tasks (see PPE specifications below). Verification and certification of assigned PPE by task is completed by the RHSM that approved this plan. Refer to the Guidelines, Section 11, "Personal Protective Equipment," and Section 12 of the Guidelines for specific requirements on the use, care, and maintenance of PPE.

The table below outlines PPE to be used according to task based on project-specific hazard assessment. If a task other than the tasks described in this table needs to be performed, contact the RHSM so this table can be updated.

Project-Specific Personal Protective Equipment Requirements ^a				
Task	Level	Body	Head	Respirator ^b
General field work and non-intrusive oversight	D	<input checked="" type="checkbox"/> Work clothes (sleeved shirt, long pants) <input checked="" type="checkbox"/> Safety-toed Boots <input checked="" type="checkbox"/> Gloves (leather) ^c <input checked="" type="checkbox"/> Other: (specify) Snake guards/chaps during summer months	<input checked="" type="checkbox"/> ANSI Z89.1 Hardhat ^c <input checked="" type="checkbox"/> ANSI Z87.1 Safety glasses <input type="checkbox"/> Hearing protection ^d	None required
Drilling, Excavator work, Hand Auger and Surface Soil Sampling	D	<input checked="" type="checkbox"/> Work clothes <input checked="" type="checkbox"/> Cotton coveralls ^c <input checked="" type="checkbox"/> Uncoated Tyvek ^c <input checked="" type="checkbox"/> Safety-toed boots <input checked="" type="checkbox"/> Inner surgical-style nitrile <input type="checkbox"/> Outer Leather Gloves ^c <input type="checkbox"/> Other: (specify)	<input type="checkbox"/> ANSI Z89.1 Hardhat ^c <input checked="" type="checkbox"/> ANSI Z87.1 Safety glasses <input type="checkbox"/> Hearing protection ^d	
Work near vehicular traffic ways or earth moving equipment.	NA	<input checked="" type="checkbox"/> ANSI/ISEA 107-2010 high visibility vest	NA	NA

Reasons for Upgrading or Downgrading Level of Protection (with approval of the RHSM)

Upgrade ^f	Downgrade
<ul style="list-style-type: none"> Request from individual performing tasks. Change in work tasks that will increase contact or potential contact with hazardous materials. Occurrence or likely occurrence of particulate emission. Known or suspected presence of dermal hazards. Instrument action levels in the "Site Monitoring" section exceeded. 	<ul style="list-style-type: none"> New information indicating that situation is less hazardous than originally thought. Change in site conditions that decrease the hazard. Change in work task that will reduce contact with hazardous materials.

^a Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.

^b No facial hair that would interfere with respirator fit is permitted.

^c Hardhat and splash-shield areas are to be determined by the SC.

^d Hearing protection should be worn when conversations cannot be held at distances of 3 feet (1 meter) or less without shouting.

^e See cartridge change-out schedule.

^f Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the RHSM, and an SC qualified at that level is present.

9. Worker Training and Qualification

9.1 CH2M HILL Worker Training

(Reference CH2M HILL SOP HSE-110, Training, and Section 12 of the Guidelines)

The following training is required for CH2M HILL personnel working onsite. Copies of training will either be available onsite, or readily available from the CH2M HILL HandS training database system.

Required CH2M HILL Worker Training	CH2M HILL Task or Equipment-Specific Training (if performing task)
<input checked="" type="checkbox"/> CH2M HILL HSP Training	<input type="checkbox"/> Aerial Lift Operator Training
<input checked="" type="checkbox"/> CH2M HILL ESBG HSSE Guidelines	<input type="checkbox"/> Confined Space Entry Training
<input checked="" type="checkbox"/> CH2M HILL AHAs	<input type="checkbox"/> Excavation Competent Person
<input checked="" type="checkbox"/> Subcontractor HSP/Safety Plan/AHAs	<input checked="" type="checkbox"/> Fall Protection (site-specific)
<input checked="" type="checkbox"/> Hazard Communication	<input type="checkbox"/> Forklift Operator
<input type="checkbox"/> 10-hour OSHA Construction Safety Training	<input type="checkbox"/> On-Track Railroad Safety Training
<input checked="" type="checkbox"/> At least one SC-C (refer to worker category for all applicable training needed)	<input type="checkbox"/> NFPA 70E Training (energized electrical safety training)
<input type="checkbox"/> Scaffold Training	<input type="checkbox"/> Qualified Earthmoving Equipment Operator
<input type="checkbox"/> Other (specify):	<input type="checkbox"/> Other (specify):
<input type="checkbox"/> Other (specify):	
Project-Specific Required (VO) Training	
<input type="checkbox"/> 3R Munitions Safety Awareness Training	<input checked="" type="checkbox"/> Hand Safety Training
<input type="checkbox"/> Arsenic Training	<input type="checkbox"/> Hydrogen Sulfide Hazard Recognition Training
<input type="checkbox"/> Asbestos Awareness Training	<input checked="" type="checkbox"/> Ionizing Radiation Training
<input type="checkbox"/> Bear Awareness Training	<input type="checkbox"/> Lead Exposure Training
<input type="checkbox"/> Benzene Training	<input type="checkbox"/> Lockout/Tagout Training
<input type="checkbox"/> Cadmium Training	<input checked="" type="checkbox"/> Manual Lifting Training
<input type="checkbox"/> Chromium Training	<input type="checkbox"/> Methylene Chloride Training
<input type="checkbox"/> Confined Space Awareness Training	<input type="checkbox"/> Noise Training
<input type="checkbox"/> Drum Handling Training	<input type="checkbox"/> Radio Frequency Safety Awareness
<input type="checkbox"/> Electrical Safety Training	<input type="checkbox"/> Railroad Safety On-line Training
<input type="checkbox"/> Excavation Safety Training	<input type="checkbox"/> Respirators Level C Training
<input checked="" type="checkbox"/> Fall Protection Training	<input type="checkbox"/> Stairways and Ladders
<input type="checkbox"/> Formaldehyde Training	<input checked="" type="checkbox"/> Traffic Safety Training
<input type="checkbox"/> Drum Handling Training	<input type="checkbox"/> Vinyl Chloride Training

9.2 Subcontractor Worker Training

The following training is required for Subcontractor personnel working onsite. Copies of training shall be available onsite.

Required Subcontractor Worker Training	Subcontractor Task or Equipment-Specific Training (required if performing this work)
<input checked="" type="checkbox"/> CH2M HILL HSP Training	<input type="checkbox"/> Certified Crane Operator
<input type="checkbox"/> CH2M HILL ESG HSSE Guidelines	<input type="checkbox"/> Crane Assembly/Disassembly Competent Person
<input checked="" type="checkbox"/> Subcontractor HSP/Safety Plan/AHAs	<input type="checkbox"/> Demolition Competent Person
<input type="checkbox"/> 10-hour OSHA Construction Safety Training	<input type="checkbox"/> Excavation Competent Person
<input type="checkbox"/> 30-hour OSHA Construction Safety Training	<input checked="" type="checkbox"/> Fall Protection (site-specific)
<input type="checkbox"/> Respiratory Protection Training	<input type="checkbox"/> Flagger Training
<input checked="" type="checkbox"/> First Aid/CPR/BBP – at least 2 people	<input type="checkbox"/> Forklift Operator
<input type="checkbox"/> Aerial Lift Operator Training	<input type="checkbox"/> Hazard Communication
<input type="checkbox"/> Asbestos Competent Person	<input type="checkbox"/> Ladder Safety Training
<input type="checkbox"/> Asbestos Training (Supervisor, Worker)	<input type="checkbox"/> Lead Training
<input type="checkbox"/> Confined Space Entry Training	<input type="checkbox"/> Lockout/Tagout Training
<input type="checkbox"/> NFPA 70E Training (energized electrical safety training)	<input type="checkbox"/> On-Track Railroad Safety Training
<input type="checkbox"/> Qualified Drill Rig Operator	<input type="checkbox"/> Qualified Crane Signaler
<input type="checkbox"/> Qualified Earthmoving Equipment Operator	<input type="checkbox"/> Scaffold Training
<input type="checkbox"/> Qualified Rigger	<input type="checkbox"/> Other (specify):
	<input type="checkbox"/> Other (specify)

10. Air Monitoring

Instrument	Task	Action Level	Protection	Frequency	Calibration
Radiation Meter: Gamma Radiation Detector Ludlum Model 3, Bicron, or equivalent	All	> 0.05 mR/hr	Notify radiological subcontractor. Limit duration in area to only as much time as necessary to perform task. See 6.1, Additional Project-Specific Hazard Controls	During all intrusive and non-intrusive work	Daily check

11. Site-Control Plan

(Reference Section 14 of the Guidelines)

Site control is established to ensure that only authorized individuals are permitted into potentially hazardous areas. Task-specific control measures are listed below. **Use of the Buddy System will be implemented unless a Working Alone protocol has been established and approved as indicated in Sections 5 and 6 above.**

Site Control for General Work Area(s)			
<input checked="" type="checkbox"/> Perimeter fencing	Location: Around open holes/shafts	<input type="checkbox"/> Barricades	Location:
<input checked="" type="checkbox"/> Signage	Location:	<input type="checkbox"/> Other: _____	Location:
<input type="checkbox"/> Traffic control devices	Location:	<input type="checkbox"/> None: _____	

12. Communications

A primary and backup means of communication for field crews have been established as described below:

Type of Communication	Primary Means	Backup Means
Communication between field crew	<input checked="" type="checkbox"/> Voice <input type="checkbox"/> Radio <input type="checkbox"/> Phone	<input type="checkbox"/> Voice <input checked="" type="checkbox"/> Radio <input type="checkbox"/> Phone
Communication with Office crew	<input type="checkbox"/> Radio <input checked="" type="checkbox"/> Phone	<input type="checkbox"/> Radio <input type="checkbox"/> Phone
Communication with Fire and Emergency Services	<input type="checkbox"/> Radio <input checked="" type="checkbox"/> Phone	<input type="checkbox"/> Radio <input type="checkbox"/> Phone

13. Required Facilities and Equipment

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

Facility	Type	Location
<input checked="" type="checkbox"/> Restrooms		Smith Lake Chapter House
<input type="checkbox"/> Supplementary Illumination		
<input type="checkbox"/> Emergency Eyewash		
<input checked="" type="checkbox"/> First aid kit/supplies		Field Vehicles
<input checked="" type="checkbox"/> Fire extinguishers		Field Vehicles
<input type="checkbox"/> Spill Kit(s)		
<input checked="" type="checkbox"/> Potable Water		Field Vehicles
<input checked="" type="checkbox"/> Shade/rest area		Field Vehicles
<input type="checkbox"/> Heated rest area		
<input type="checkbox"/> Other _____		

14. Emergency Response Plan

(Reference CH2M HILL SOP HSE-106, Emergency Planning, and Section 16 of the Guidelines)

Personnel responsible for coordinating emergency situations during site activity are identified below. The Emergency Contacts Page is at the front of this Plan. A site map showing assembly points and directions to the authorized medical facility is attached. Documented rehearsal and critique of this plan is required at least once during the task, or more often as necessary.

Responsibility	Name	Phone Number(s)
SC-HW/SC-Construction	Ben Moayyad/ABQ	(505) 504-2214
Other field team member – Assigned each day		
Type (desk or field) and frequency of rehearsal		

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

Evacuation Step	Methods and comments:
Notify affected workers	
Evacuate to safe location	
Assemble and account for workers	
Notify Project Manager	
Complete incident report	

Potential emergency situations and response actions are identified below.

In case of:	Response actions:
Injury or illness	Call 911, have a designee give location and directions to ambulance service if needed. If CH2M HILL employee, call occupational physician at 1-866-893-2514.
Chemical exposure	
Fire or explosion	Call 911, have a designee give location and directions to Fire department service if needed.
Adverse weather	
Heat Stroke	Call 911, have a designee give location and directions to ambulance service if needed. If CH2M HILL employee, call occupational physician at 1-866-893-2514.
Material spill or release	

Evacuation Signals:	Meaning:
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

In the event of a **large quantity spill** notify emergency services. Personnel discovering a spill shall (only if safe to do so):

- Stop or contain the spill immediately (if possible) or note source. Shut off the source (e.g., pump, treatment system) if possible. If unsafe conditions exist, then leave the area, call emergency services, inform nearby personnel, notify the site supervisors, and initiate incident reporting process. The SC shall be notified immediately;
- Extinguish sources of ignition (flames, sparks, hot surfaces, cigarettes);
- Clear personnel from the spill location and barricade the area;
- Use available spill control equipment in an effort to ensure that fires, explosions, and releases do not occur, recur, or spread;
- Use sorbent materials to control the spill at the source;
- Construct a temporary containment dike of sorbent materials, cinder blocks, bricks or other suitable materials to help contain the spill;
- Attempt to identify the character, exact source, amount, and extent of the released materials. Identification of the spilled material should be made as soon as possible so that the appropriate cleanup procedure can be identified;
- Contact the RHSM and Project EM in the event of a spill or release immediately so evaluation of reportable quantity requirements and whether agency reporting is required;
- Assess possible hazards to human health or the environment as a result of the release, fire or explosion; and
- Follow incident notification, reporting, and investigation section of this plan.

15. Incident Notification, Reporting, and Investigation

(Reference Section 16 of the Guidelines for complete definitions and protocol)

15.1 Incident Notification

All employees and subcontractors' employees shall immediately report any incident (including "near misses,") in which they are involved or witness to their supervisor.

The CH2M HILL or Subcontractor supervisor, upon receiving an incident report, shall inform his immediate superior and the CH2M HILL SC.

The SC shall immediately report the following information to the RHSM and PM by phone and e-mail:

- Project Name and Site Manager;
- Date and time of incident;
- Description of incident;
- Extent of known injuries or damage;
- Level of medical attention; and
- Preliminary root cause/corrective actions

If the incident was an environmental permit issue (potential permit non-compliance, other situation that result in a notice of violation) or a spill or release, contact the Project EM immediately so evaluation of reportable quantity requirements and whether agency reporting is required;

15.2 Drug and Alcohol Testing for CH2M HILL Employees

As required by CH2M HILL Policy 810, U.S. Employees are subject to post-incident and reasonable suspicion drug and alcohol testing. The Employee must submit to drug and alcohol testing if the supervisor has a reasonable suspicion, and when any of the following occur:

- Work-related injury requiring off-site medical attention;
- Incident resulting in property damage over USD\$500 as determined by the Employee's supervisor;
- Incident considered to be a serious near-miss injury that occurs in the field or in the office as determined by the supervisor;
- Other circumstances as dictated by Employee Relations; or
- An Employee contributes to any of the above Work-related injury requiring off-site medical attention;

Refer to the ESG HSSE Guidelines and CH2M HILL Policy 810 for additional information and specific requirements.

15.3 Drug and Alcohol Testing for Subcontractors

The drug and alcohol testing requirements stated above apply to subcontractors when required by the subcontract.

15.4 HITS System and Incident Report Form

The SC shall complete an entry into the Hours and Incident Tracking System (HITS) database system located on CH2M HILL's Virtual Office (or if VO not available, use the hard copy Incident Report Form and Root Cause Analysis Form and forward it to the RHSM) within 24 hours and finalize those forms within 3 calendar days.

15.5 Injury Management/Return-to-Work (for US/Puerto Rico based CH2M HILL Staff Only)

In the event of an injury, the following actions shall be taken:

- Employee informs their supervisor.
- Employee calls the Injury Management Program toll free number 1-866-893-2514 immediately and speaks with the Occupational Injury Nurse. This number is operable 24 hours per day, 7 days a week. **Employees are encouraged to enter this phone number into their cell phones prior to starting field work.**
- Supervisor ensures employee immediately calls the Injury Management Program number. Supervisor makes the call with the injured worker or for the injured worker, if needed.
- Nurse assists employee with obtaining appropriate medical treatment, as necessary schedules clinic visit for employee (calls ahead, and assists with any necessary follow up treatment). The supervisor or SC accompanies the employee if a clinic visit is necessary to ensure that employees receive appropriate and timely care.
- Supervisor or SC completes the HITS entry or Incident Report Form immediately (within 24 hours) and forwards it to the Project Manager and RHSM.
- Nurse notifies appropriate CH2M HILL staff by e-mail (supervisor, Health & Safety, Human Resources, Workers' Compensation).
- Nurse communicates and coordinates with and for employee on treatment through recovery.
- Supervisor ensures suitable duties are identified and available for injured or ill workers who are determined to be medically fit to return to work on transitional duty (temporary and progressive).
- Supervisor ensures medical limitations prescribed (if any) by physician are followed until the worker is released to full duty.

15.6 Serious Incident Reporting Requirements

Serious incidents include the following:

- Work related death, or life threatening injury or illness of a CH2M HILL employee, subcontractor, or member of the public;
- Kidnap or missing person;
- Acts or threats of terrorism;
- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than \$ 500,000 in damage; or
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

If an incident meets the "Serious Incident" criteria, the Project Manager is to immediately contact the Crisis Manager at 720-286-4911, then follow the standard incident reporting procedure.

16. Inspections

16.1 Project Activity Self-Assessment Checklists

The following self-assessment checklists are required when the task or exposure is initiated and weekly thereafter. The checklists shall be completed by the SC or other CH2M HILL representative and maintained in project files.

Hand and Power Tools

Drilling

Biological Hazards

PPE

16.2 Safe Behavior Observations

The SC or designee shall perform at least one SBO each week for any field work performed by subcontractors or when there are at least two CH2M HILL personnel performing field work.

E-mail completed forms to:

- Commercial Sector: [CH2M HILL ES COM Safe Behavior Observation](#)

17. Records and Reports

Refer to the Guidelines, Section 19, “Records and Reports,” for a complete description of HSE recordkeeping requirements. Below are examples of records that must be maintained as the project progresses:

- Exposure records includes air monitoring data (including calibration records), MSDSs, exposure modeling results
- Training records
- Respiratory fit test records
- Incident reports, investigations and associated back-up information
- Federal or state agency inspection records
- HSE audits and assessments
- Confined space entry permits
- Equipment inspections
- Equipment maintenance
- Emergency equipment inspection records
- SBOs
- Self-assessment checklists
- Daily Safety Meeting Sign-In forms/PTSPs

18. Employee Signoff Form

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

The CH2M HILL project employees and subcontractors listed below have been provided with a copy of this HSP, have read and understood it, and agree to abide by its provisions.

Project Name:

Project Number:[illegible]

Attachment 1
ESBG HSSE Guidelines

ESBG Health, Safety, Security, and Environment Guidelines

February 2013



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ATTACHMENTS:

Employee Sign-Off Form

Subcontractor Sign-Off Form

1. Introduction

1.1 CH2M HILL Policy and Commitment

1.1.1 Safe Work Policy

It is the policy of CH2M HILL to perform work in the safest manner possible. Safety must never be compromised. To fulfill the requirements of this policy, an organized and effective safety program must be carried out at each location where work is performed.

CH2M HILL believes that all injuries are preventable, and we are dedicated to the goal of a safe work environment. To achieve this goal, every employee on the project must assume responsibility for safety.

Every employee is empowered to:

- Conduct their work in a safe manner;
- Stop work immediately to correct any unsafe condition that is encountered; and
- Take corrective actions so that work may proceed in a safe manner.

Safety, occupational health, and environmental protection will not be sacrificed for production. These elements are integrated into quality control, cost reduction, and job performance, and are crucial to our success.

1.1.2 Health and Safety Commitment

CH2M HILL has embraced a philosophy for health and safety excellence. The primary driving force behind this commitment to health and safety is simple: employees are CH2M HILL's most significant asset and CH2M HILL management values their safety, health, and welfare. Also, top management believes that all injuries are preventable. CH2M HILL's safety culture empowers employees at all levels to accept ownership for safety and take whatever actions are necessary to eliminate injury. Our company is committed to world-class performance in health and safety and also understands that world-class performance in health and safety is a critical element in overall business success.

CH2M HILL is committed to the prevention of personal injuries, occupational illnesses, and damage to equipment and property in all of its operations; to the protection of the general public whenever it comes in contact with the Company's work; and to the prevention of pollution and environmental degradation.

Company management, field supervisors, and employees plan safety into each work task in order to prevent occupational injuries and illnesses. The ultimate success of CH2M HILL's safety program depends on the full cooperation and participation of each employee.

CH2M HILL management extends its full commitment to health and safety excellence.

1.1.3 Project-Specific Health, Safety, and the Environment Goals

All management and employees are to strive to meet the project-specific Health, Safety, and the Environment (HSE) goals outlined below. The team will be successful only if everyone makes a concerted effort to accomplish these goals. The goals allow the project to stay focused on optimizing the health and safety of all project personnel and, therefore, making the project a great success.

The Project has established eleven specific goals and objectives:

- Create an injury-free environment;
- Have zero injuries or incidents;
- Provide management leadership for HSE by communicating performance expectations, reviewing and tracking performance, and leading by example;
- Ensure effective implementation of the project safety plan through education, delegation, and team work;

- Ensure 100 percent participation in HSE compliance;
- Continuously improve our safety performance;
- Maintain free and open lines of communication;
- Make a personal commitment to safety as a value;
- Focus safety improvements on high-risk groups;
- Continue strong employee involvement initiatives; and
- Achieve health and safety excellence.

2. Applicability

These Health, Safety, Security, and Environment Guidelines (Guidelines) apply to:

- All CH2M HILL staff, including subcontractors and tiered subcontractors of CH2M HILL working on the site; and
- All visitors to the construction site in the custody of CH2M HILL (including visitors from the Client, the Government, the public, and other staff of any CH2M HILL company).

These Guidelines do not apply to the third-party contractors, their workers, their subcontractors, their visitors, or any other persons not under the direct control or custody of CH2M HILL.

These Guidelines define the procedures and requirements for the health and safety of CH2M HILL staff and visitors when they are physically on the work site. The work site includes the project area (as defined by the contract documents) and the project offices, trailers, and facilities thereon.

These Guidelines will be kept onsite during field activities and will be reviewed as necessary. The Handbook will be amended or revised as project activities or conditions change or when supplemental information becomes available. The Handbook adopts, by reference, the Enterprise-wide Core Standards and Standard Operating Procedures (SOPs), as appropriate. In addition, the Handbook may adopt procedures from the project Work Plan and any governing regulations. If there is a contradiction between these Guidelines and any governing regulation, the more stringent and protective requirement shall apply.

These Guidelines incorporate the regulatory requirements described in the State of California OSHA agency – Cal/OSHA Title 8 CCR, Section 3203, Injury and Illness Prevention Program (IIPP), and section 1509, Construction Injury and Illness Prevention Program. The current version of [CH2M HILL Cal/OSHA IIPP written program](#) can be accessed on the HSSE website under Programs.

All CH2M HILL staff and subcontractors must sign the employee sign-off form included at the end of this document to acknowledge review of this document. Copies of the signature page will be maintained by the SPA or onsite by the Safety Coordinator (SC).

3. Roles and Responsibilities

The sections below describe the roles and responsibilities of personnel referred to in the project-specific safety plan.

3.1 CH2M HILL Project Manager

The project manager (PM) is responsible for providing adequate resources (budget and staff) for project-specific implementation of the HSE management process. The PM has overall management responsibility for the tasks listed below. The PM may explicitly delegate specific tasks to other staff, as described in sections that follow, but retains ultimate responsibility for completion of the following in accordance with this document and applicable safety plans:

- Incorporate standard terms and conditions, and contract-specific HSE roles and responsibilities in contract and subcontract agreements (including flow-down requirements to lower-tier subcontractors).
- Select safe and competent subcontractors by:
 - Choosing potential subcontractors based on technical ability and HSE performance;
 - Implementing the subcontractor prequalification process;
 - Ensuring that acceptable certificates of insurance, including CH2M HILL as named additional insured, are secured as a condition of subcontract award; and
 - Ensuring HSE submittals, subcontract agreements, and appropriate site-specific safety procedures are in place and accepted prior field mobilization.
- Ensure copies of training and medical monitoring records, and site-specific safety procedures are being maintained in the project file accessible to site personnel.
- Provide oversight of subcontractor HSE practices per the site-specific safety plans and procedures.
- Manage the site and interfacing with 3rd parties in a manner consistent with the contract and subcontract agreements and the applicable standard of reasonable care.
- Ensure that the overall, job-specific, HSE goals are fully and continuously implemented.
- Provide visible support and motivation for HSE programs, rules, procedures, processes, and training, leading by example and encouraging CH2M HILL employees to take ownership of HSE issues.
- Intervene or stop work when an unsafe condition or behavior is observed, and/or when an environmentally compromising condition is encountered.
- Make available to and require CH2M HILL employees to complete required HSE training within established timelines and provide project numbers for such training.
- Consistently and even-handedly enforce HSE rules, procedures, and requirements at the office and/or on project work sites.
- Promptly report all work-related HSE incidents or near misses.
- Wear any required personal protective equipment.
- Ensure CH2M HILL employees complete required HSE training within established timelines.
- Conduct, cooperate, or assist with HSE incident investigations.
- Consult with the Human Resources Delivery Partner before taking any disciplinary action (other than verbal counseling) associated with CH2M HILL Policy 203 and/or HSE programs rules, procedures, processes and training.

3.2 CH2M HILL Responsible Health and Safety Manager

The RHSM is responsible for the following:

- Review and evaluate subcontractor HSE performance using the pre-qualification process;
- Approve HSP and its revisions as well as Activity Hazard Analyses (AHA);
- Review and evaluate subcontractor site-specific safety procedures for adequacy prior to start of subcontractor's field operations;
- Support the oversight (or SC's direct oversight) of subcontractor and tiered subcontractor HSE practices;
- Permit upgrades and downgrades in respiratory protection after reviewing analytical data;
- Conduct audits as determined by project schedule and coordination with PM; and
- Participate in incident investigations, lessons learned, loss and near loss reporting.

3.3 CH2M HILL Project Environmental Manager

The Project EM is responsible for the following:

- Provide environmental program support in areas such as training, auditing, planning, permit tracking, and subcontractor oversight as needed or as specified in the project environmental plan or equivalent plan;
- Review and evaluate qualifications for subcontractors with a history of environmental non-compliance and for waste transportation and disposal subcontractors;
- Evaluate any spills, releases, or environmental permit incidents for appropriate follow-up actions, notifications, and recordkeeping requirements; and
- Provide environmental compliance and environmental management expertise and advice to the project team as needed during the course of the project.

3.4 CH2M HILL Safety Coordinator

The SC is responsible for verifying that the project is conducted in a safe manner including the following specific obligations:

- Verify the project safety plan is current and amended when project activities or conditions change;
- Verify CH2M HILL site personnel and subcontractor personnel read the safety plan and sign the Employee Sign-Off Form, prior to commencing field activities;
- Verify CH2M HILL site personnel have completed any required specialty training (for example, fall protection, confined space entry, among others) and medical surveillance as identified in the project safety plan;
- Verify that project files include copies of subcontractor training and medical monitoring records, and accepted site-specific safety procedures prior to start of subcontractor's field operations;
- Act as the project "Hazard Communication Coordinator" and perform the responsibilities outlined in the project safety plan;
- Act as the project "Emergency Response Coordinator" and perform the responsibilities outlined in the project safety plan;
- Post the Occupational Safety and Health Administration (OSHA) job-site poster; the poster is required at sites where project field offices, trailers, or equipment-storage boxes are established. If you work in a state with an OSHA State Plan, make sure the State Plan poster is posted, if required;
- Hold and/or verify that safety meetings are conducted and documented in the project file initially and as needed throughout the course of the project (as tasks or hazards change);

- Verify that project health and safety forms and permits are being used as outlined in the project safety plan;
- Perform oversight and assessments of subcontractor HSE practices per the site-specific safety plan and verify that project activity self-assessment checklists are being used as outlined in the project safety plan;
- Coordinate with the RHSM regarding CH2M HILL and subcontractor operational performance, and 3rd party interfaces;
- Verify appropriate personal protective equipment (PPE) use, availability, and training;
- Ensure that the overall, job-specific, HSE goals are fully and continuously implemented;
- Conduct accident investigations including root cause analysis;
- Calibrate and conduct air monitoring in accordance with the project safety plan; maintain all air monitoring records in project file;
- Maintain HSE records and documentation;
- Facilitate OSHA or other government agency inspections including accompanying inspector and providing all necessary documentation and follow-up;
- Deliver field HSE training as needed based on project-specific hazards and activities;
- Consistently and even-handedly enforce HSE rules, procedures, and requirements at the office and/or on project work sites;
- Wear any required personal protective equipment;
- Conduct, cooperate, or assist with HSE incident investigations;
- Contact the PM and RHSM when standards of conduct or CH2M HILL Policy 203 has been violated by a CH2M HILL employee;
- Contact the RHSM and PM in the event of an incident;
- Contact the RHSM and Project EM in the event of a spill or release immediately so evaluation of reportable quantity requirements and whether agency reporting is required;
- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, stop affected work until adequate corrective measures are implemented, and notify the PM and RHSM as appropriate; and
- Document all verbal health and safety-related communications in project field logbook, daily reports, or other records.

3.5 CH2M HILL Employees

All personnel are assigned responsibility for safe and healthy operations. This concept is the foundation for involving all employees in identifying hazards and providing solutions. For any operation, individuals have full authority to stop work and initiate immediate corrective action or control. In addition, each worker has a right and responsibility to report unsafe conditions or practices. This right represents a significant facet of worker empowerment and program ownership. Through shared values and a belief that all accidents are preventable, our employees accept personal responsibility for working safely.

Each employee is responsible for the following performance objectives:

- Understanding and abiding by CH2M HILL and client HSE programs, rules, procedures, processes, and training, including any that are project-specific;
- Completing all required HSE training made available and accessible within established timelines;
- Always wearing any required personal protective equipment;

- Intervening or stopping work for you or other CH2M HILL employees when an unsafe condition or behavior is encountered or observed, and/or when an environmentally compromising condition exists;
- Promptly notifying a supervisor, PM, SC, or RHSM when an unsafe condition or behavior is observed, and/or when an environmentally compromising condition exists;
- Promptly reporting a supervisor, PM, SC, or RHSM all work-related health, safety, and environmental incidents or near misses;
- Attending required project HSE pre-task briefings and meeting prior to performing work; and
- Cooperating or assisting with HSE incident investigations.

3.5.1 Employee Authority

Each employee on the project has the obligation and authority to shut down any perceived unsafe work and during employee orientation, each employee will be informed of their authority to do so.

3.6 CH2M HILL Subcontractors

Subcontractors must comply with the following activities, and are responsible to:

- Comply with all local, state, and federal safety standards;
- Comply with project and owner safety requirements;
- Actively participate in the project safety program and either hold or attend and participate in all required safety meetings;
- Provide a qualified safety representative to interface with CH2M HILL;
- Maintain safety equipment and PPE for their employees;
- Maintain and replace safety protection systems damaged or removed by the subcontractor's operations;
- Notify the SC of any accident, injury, or incident (including spills or releases) immediately and submit reports to CH2M HILL within 24 hours;
- Install contractually required general conditions for safety (for example, handrail, fencing, fall protection systems, floor opening covers);
- Conduct and document weekly safety inspections of project-specific tasks and associated work areas;
- Conduct site-specific and job-specific training for all subcontractor employees, including review of the CH2M HILL safety plan, subcontractor safety plans, and subcontractor AHAs and sign appropriate sign-off forms; and
- Determine and implement necessary controls and corrective actions to correct unsafe conditions.

Subcontractors may be required to submit their own site-specific safety plan and other plans such as lead or asbestos abatement compliance plans. Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit their plans to CH2M HILL for review and acceptance before the start of field work.

Subcontractors are also required to prepare AHAs before beginning each activity posing hazards to their personnel. The AHA shall identify the principle steps of the activity, potential health and safety hazards for each step and recommended control measures for each identified hazard. In addition, a listing of the equipment to be used to perform the activity, inspection requirements, and training requirements for the safe operation of the equipment listed must be identified.

3.7 Client Contractors

CH2M HILL project safety plans do not cover contractors that are contracted directly to the client or the owner. CH2M HILL is not responsible for the health and safety or means and methods of the contractor's work, and we must never assume such responsibility through our actions (such as advising on health and safety issues). In addition to these instructions, CH2M HILL team members should review contractor safety plans so that we remain aware of appropriate precautions that apply to us. Self-assessment checklists are to be used by the SC and CH2M HILL team members to review the contractor's performance only as it pertains to evaluating CH2M HILL exposure and safety. The RHSM is the only person who is authorized to comment on or approve contractor safety procedures.

Health and safety-related communications with contractors should be conducted as follows:

- Request the contractor to brief CH2M HILL team members on the precautions related to the contractor's work;
- When an apparent contractor non-compliance or unsafe condition or practice poses a risk to CH2M HILL team members:
 - Notify the contractor safety representative;
 - Request that the contractor determine and implement corrective actions;
 - If necessary, stop affected CH2M HILL work until contractor corrects the condition or practice; and
 - Notify the client, PM, and RHSM as appropriate.

If apparent contractor non-compliance or unsafe conditions or practices are observed, inform the contractor safety representative (CH2M HILL's obligation is limited strictly to informing the contractor of the observation; the contractor is solely responsible for determining and implementing necessary controls and corrective actions).

If an apparent imminent danger is observed, immediately warn the contractor employee(s) in danger and notify the contractor safety representative (CH2M HILL's obligation is limited strictly to immediately warning the affected individual(s) and informing the contractor of the observation; the contractor is solely responsible for determining and implementing necessary controls and corrective actions).

All verbal health and safety-related communications will be documented in project field logbook, daily reports, or other records.

4. Standards of Conduct

All individuals associated with this project must work injury-free and drug-free and must comply with the following standards of conduct, and the safety requirements of CH2M HILL. Commonly accepted standards of conduct help maintain good relationships between people. They promote responsibility and self-development. Misunderstandings, frictions, and disciplinary action can be avoided by refraining from thoughtless or wrongful acts.

4.1 Standards of Conduct Violations

All individuals associated with this project are expected to behave in a professional manner. Violations of the standards of conduct would include, but not be limited to:

- Failure to perform work;
- Inefficient performance, incompetence, or neglect of work;
- Willful refusal to perform work as directed (insubordination);
- Negligence in observing safety regulations, poor housekeeping, or failure to report on-the-job injuries or unsafe conditions;
- Unexcused or excessive absence or tardiness;
- Unwillingness or inability to work in harmony with others;
- Discourtesy, irritation, friction, or other conduct that creates disharmony;
- Harassment or discrimination against another individual;
- Failure to be prepared for work by wearing the appropriate construction clothing or bringing the necessary tools; or
- Violation of any other commonly accepted reasonable rule of responsible personal conduct.

4.2 Disciplinary Actions

The Environmental Services (ES) business group employees, employees working on ES business group projects, and subcontractor employees are subject to disciplinary action for not following HSE rules and requirements. Potential disciplinary action is equally applicable to all employees including management and supervision. Disciplinary action may include denial of access to the worksite, warnings, reprimands, and other actions up to and including termination depending on the specific circumstances.

4.3 Subcontractor Safety Performance

CH2M HILL should continuously endeavor to observe subcontractors' safety performance and adherence to their plans and AHAs. This endeavor should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M HILL oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s).

4.3.1 Observed Hazard Form

When apparent non-compliance or unsafe conditions or practices are observed, notify the subcontractor's supervisor or safety representative verbally, and document using the Observed Hazard Form, included as an attachment to the project safety plan, and require corrective action.

If necessary, stop subcontractor's work using the Stop Work Order Form until corrective actions is implemented for observed serious hazards or conditions. Update the Observed Hazard Form to document corrective actions have been taken. The subcontractor is responsible for determining and implementing necessary controls and corrective actions.

4.3.2 Stop Work Order

CH2M HILL has the authority, as specified in the contract, and the responsibility to stop work in the event any CH2M HILL employee observes unsafe conditions or failure of the subcontractor to adhere to its safe-work practices, or observes a condition or practice that may result in a release or violation of an environmental requirement. This authority and action does not in any way relieve the subcontractor of its responsibilities for the means and methods of the work or, therefore, of any corrective actions. Failure to comply with safe work practices can be the basis for restriction or removal of the subcontractor staff from the job site, termination of the subcontract, restriction from future work, or all three.

When an apparent imminent danger is observed, immediately stop work and alert all affected individuals. Remove all affected CH2M HILL employees and subcontractor staff from the danger, notify the subcontractor's supervisor or safety representative, and do not allow work to resume until adequate corrective measures are implemented. Notify the PM, Contract Administrator (KA) and RHSM.

When repeated non-compliance or unsafe conditions are observed, notify the subcontractor's supervisor or safety representative and stop affected work by completing and delivering the Stop Work Order Form (attached to the project safety plan) until adequate corrective measures are implemented. Consult the KA to determine what the contract dictates for actions to pursue in event of subcontractor non-compliance including work stoppage, back charges, progress payments, removal of subcontractor manager, monetary penalties, or termination of subcontractor for cause.

4.4 Incentive Program

Each project is encouraged to implement a safety incentive program that rewards workers for exhibiting exemplary safety behaviors. Actions that qualify are those that go above and beyond what is expected. Actions that will be rewarded include spotting and correcting a hazard, bringing a hazard to the attention of your foreman, telling your foreman about an incident, coming up with a safer way to get the work done, or stopping a crew member from doing something unsafe. The program will operate throughout the project, covering all workers. The incentive program will be communicated to all employees during the project employee orientation and project safety meetings.

4.5 Reporting Unsafe Conditions/Practices

Responsibility for effective health and safety management extends to all levels of the project and requires good communication between employees, supervisors, and management. Accident prevention requires a pro-active policy on near misses, close calls, unsafe conditions, and unsafe practices. All personnel must report any situation, practice, or condition which might jeopardize the safety of our projects. All unsafe conditions or unsafe practices will be corrected immediately. CH2M HILL has zero tolerance of unsafe conditions or unsafe practices.

No employee or supervisor will be disciplined for reporting unsafe conditions or practices. Individuals involved in reporting the unsafe conditions or practices will remain anonymous.

The following reporting procedures will be followed by all project employees:

- Upon detection of any unsafe condition or practice, the responsible employee will attempt to safely correct the condition;
- The unsafe condition or practice will be brought to the attention of the worker's direct supervisor, unless the unsafe condition or practice involves the employee's direct supervisor. If so, the SC needs to be notified at once by the responsible employee;

- Either the responsible employee or responsible employee's direct supervisor is responsible for immediately reporting the unsafe condition or practice to the SC;
- The SC will act promptly to correct the unsafe condition or practice; and
- Details of the incident or situation will be recorded by the SC in the field logbook or use the Observed Hazard Form if subcontractor was involved.

5. Safety Planning and Change Management

5.1 Daily Safety Meetings and Pre-Task Safety Plans

Daily safety meetings are to be held with all project personnel in attendance to review the hazards posed and required HSE procedures and AHAs that apply for each day's project activities. The Pre-Task Safety Plans (PTSPs) serve the same purpose as these general assembly safety meetings, but the PTSPs are held between the crew supervisor and their work crews to focus on those hazards posed to individual work crews.

At the start of each day's activities, the crew supervisor completes the PTSP, provided as an attachment to the project safety plan, with input from the work crew, during their daily safety meeting. The day's tasks, personnel, tools and equipment that will be used to perform these tasks are listed, along with the hazards posed and required HSE procedures, as identified in the Handbook and AHA. The use of PTSPs promotes worker participation in the hazard recognition and control process while reinforcing the task-specific hazard and required HSE procedures with the crew each day.

5.2 Change Management

These Guidelines and the project safety plan address all known activities and associated hazards. As work progresses, if significant changes are identified which could affect health and safety at the site, coordinate with the RHSM to determine whether an update to the safety plan and/or these Guidelines are necessary. Follow the change management protocol in the safety plan.

The following are examples of changes that may require a revision to the plan:

- Change in CH2M HILL staff;
- New subcontractor to perform work;
- New chemicals brought to site for use;
- Change in scope or addition of new tasks;
- Change in contaminants of concern (COCs) or change in concentrations of COCs; and
- New hazards or hazards not previously identified that are not addressed in these Guidelines or the project safety plan.

5.3 Agency Inspection Guidance

(Reference CH2M HILL SOP HSE-201, *Agency Inspections and Communications*)

Agency inspections (e.g., OSHA, EPA, other regulatory agencies) are on the rise. CH2M HILL implements safety and environmental programs in order to ensure safety to workers, the public, and the environment. Field personnel need to contact the RHSM to update the project safety plan if hazards are encountered that are not addressed.

[SOP HSE-201](#) addresses agency inspections in detail. It is critical to make immediate notification to the RHSM if an inspector arrives (and EM if it is environmental-related); they can help facilitate and make additional notifications.

Review the Target Zero Bulletin attached to the project safety plan. Make it a topic at a safety meeting and keep it readily available in the event of an inspection.

6. Project Hazard Analysis

A health and safety risk analysis is performed for each task of a given project. In the order listed below, the RHSM considers the various methods for mitigating the hazards. Employees are trained on this hierarchy of controls during their hazardous waste training and reminded of them throughout the execution of projects:

- Elimination of the hazards (use remote sampling methodology to avoid going into a confined space);
- Substitution (reduce exposure to vapors by using of a geoprobe instead of test pitting);
- Engineering controls (ventilate a confined space to improve air quality);
- Warnings (establish exclusion zones to keep untrained people away from hazardous waste work);
- Administrative controls (implement a work-rest schedule to reduce chance of heat stress); or
- Use of PPE (use of respirators when action levels are exceeded).

Employees are trained on the hierarchy of controls during their hazardous waste training and reminded of them throughout the execution of projects.

6.1 Activity Hazard Analysis

An AHA must be developed for each CH2M HILL field activity. The AHA shall define the work tasks required to perform each activity, along with potential HSE hazards and recommended control measures for each hazard. In addition, a listing of the equipment to be used to perform the activity, inspection requirements to be performed and training requirements for the safe operation of the equipment listed must be identified. Workers are briefed on the AHA before performing the work and their input is solicited prior, during, and after the performance of work to further identify the hazards posed and control measures required.

6.2 Subcontractor Activity Hazard Analysis

CH2M HILL subcontractors are required to provide AHAs specific to their scope of work on the project for acceptance by CH2M HILL. Each subcontractor shall submit AHAs for their field activities, as defined in their scope of work, along with their project safety plan and procedures. Additions or changes in field activities, equipment, tools, or material used to perform work or hazards not addressed in existing AHAs requires either a new AHA to be prepared or an existing AHA to be revised.

7. General Hazards and Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. It is a summarized list of requirements. Always consult the appropriate CH2M HILL SOP to ensure all requirements are implemented.

7.1 Bloodborne Pathogens

(Reference CH2M HILL SOP HSE-202, *Bloodborne Pathogens*)

Exposure to bloodborne pathogens may occur when rendering first aid or cardiopulmonary resuscitation (CPR), or when coming into contact with landfill waste or waste streams containing potentially infectious material (PIM).

Employees trained in first-aid/CPR or those exposed to PIM must complete CH2M HILL's 1-hour bloodborne pathogens computer-based training module annually. When performing first-aid/CPR the following shall apply:

- Observe universal precautions to prevent contact with blood or other PIMs. Where differentiation between body fluid types is difficult or impossible, consider all body fluids to be potentially infectious materials;
- Always wash your hands and face with soap and running water after contacting PIMs. If washing facilities are unavailable, use an antiseptic cleanser with clean paper towels or moist towelettes; and
- If necessary, decontaminate all potentially contaminated equipment and surfaces with chlorine bleach as soon as possible. Use one part chlorine bleach (5.25 percent sodium hypochlorite solution) diluted with 10 parts water for decontaminating equipment or surfaces after initially removing blood or other PIMs. Remove contaminated PPE as soon as possible before leaving a work area.

CH2M HILL will provide exposed employees with a confidential medical examination should an exposure to PIM occur. This examination includes the following procedures:

- Documenting the exposure;
- Testing the exposed employee's and the source individual's blood (with consent); and
- Administering post-exposure prophylaxis.

7.2 Chemical Storage

The following is general guidance for storing chemicals and other hazardous materials:

- Keep acids away from bases;
- Keep oxidizers (nitric acid, nitrates, peroxides, chlorates) and organics away from inorganic reducing agents (metals);
- Keep flammables and corrosives in appropriate storage cabinets;
- Do not store paper or other combustibles near flammables;
- Use secondary containment and lipped shelving that is secured; and
- Have a fire suppression system available.

7.2.1 Storage of Flammable/Combustible Liquids

- Only approved containers and portable tanks shall be used for storage and handling of flammable and combustible liquids.
- Approved safety cans shall be used for the handling and use of flammable liquids in quantities of 5 gallons (19 liters) or less. Do not use plastic gas cans.

- For quantities of 1 gallon (3.78 liters) or less, the original container may be used for storage and use of flammable liquids.
- Flammable or combustible liquids shall not be stored in areas used for stairways or normally used for the passage of people.

7.2.2 Indoor Storage of Flammable/Combustible Liquids

- No more than 25 gallons (95 liters) of flammable or combustible liquids shall be stored in a room outside of an approved storage cabinet.
- Quantities of flammable and combustible liquids in excess of 25 gallons (95 liters) shall be stored in an acceptable or approved cabinet.
- Cabinets shall be conspicuously lettered: "FLAMMABLE: KEEP FIRE AWAY."
- Not more than 60 gallons (228 liters) of flammable or 120 gallons (456 liters) of combustible liquids shall be stored in any one storage cabinet. Not more than three such cabinets may be located in a single storage area.

7.2.3 Outside Storage of Flammable/Combustible Liquids

- Storage of containers (not more than 60 gallons [228 liters] each) shall not exceed 1,100 gallons (4,180 liters) in any one area. No area shall be within 20 feet (6.1 meters) of any building.
- Storage areas shall be graded to divert spills away from buildings and surrounded by an earthen dike.
- Storage areas may not be located near a storm drain. Overflow and spills must be diverted away from storm drains or surface waters.
- Storage areas shall be free from weeds, debris, and other combustible materials.
- Outdoor portable tanks shall be provided with emergency vent devices and shall not be closer than 20 feet (6.1 meters) to any building.
- Signs indicating no smoking shall be posted around the storage area.

7.2.4 Storage of Hazardous Waste

- All facilities storing ignitable and combustible liquids and hazardous wastes must be designed, constructed, maintained, and operated to minimize the possibility of a fire, explosion, or any release of hazardous constituents.
- Flammable wastes should be stored more than 50 feet from the property line.

7.2.5 Storage of Chemical Injection Chemicals/Materials

- When chemical injection remediation technologies are being used at a site, the following storage guidelines must be followed:
- Some injection chemicals, such as strong oxidizers, may have stringent storage requirements per local or National Fire Codes. Verify that appropriate storage provisions are in place prior to starting work.
- NOTE: Counties and cities may have requirements specific to storing these chemicals. Also, storage and use of certain chemicals such as potassium permanganate and hydrogen peroxide may be subject to the new Chemical Facility Anti-Terrorism Standards of the Department of Homeland Security – the applicability depends on the chemical, quantity/concentration, and type of facility. Please contact the project Environmental Manager to determine whether chemicals are subject to these standards.
- Injection chemicals must be stored in a designated, secured area with spill prevention capabilities. Review Safety Data Sheet (SDS) or other information to determine potential incompatible materials. Incompatible materials shall not be stored together. Ensure all containers are labeled.

7.3 Driving Safety

(Reference CH2M HILL HSE Policy 205, Distracted Driving – Wireless Devices, Vehicle Safety Core Standard)

All CH2M HILL employees are prohibited from using wireless devices while operating a motor vehicle when conducting company business regardless of the location or vehicle ownership and whether or not during regular working hours.

All CH2M HILL contractors and subcontractors are prohibited from using wireless devices while operating a CH2M HILL- or CH2M HILL client-owned, leased, or rented motor vehicle, or while operating any other Motor Vehicle on the project site.

Avoid distractions from wireless devices (e.g., mobile phones, smartphones, voice recognition systems, PDAs, notebook, tablets, or laptops) by turning off or silencing the wireless devices before operating a motor vehicle.

- Prohibited use includes the following:
 - Dialing or speed dialing
 - Using a hands-free or voice recognition (blue tooth) device to dial or speed dial
 - Engaging in conversation or listening to a conversation using a wireless device
 - Checking emails or surfing the internet using a wireless device
 - Texting or e-mailing (reading, sending, or screening) with a wireless device
 - Programming or entering coordinates into a global positioning system (GPS) device (following directions by a GPS is permitted)
 - Using a wireless device for voice recording or dictation
 - Employees, contractors, and subcontractors who need to use a wireless device must pull off the road to a safe location, with the vehicle securely stopped and emergency flashers on, or wait until they reach their destination.

Follow the guidance below when operating a vehicle:

- All vehicles have blind spots to the side and the rear. Follow these safe practices for backing up:
 - Walk around your vehicle prior to moving
 - Try to position your vehicle so that you don't have to back up
 - Back into the space if possible when you're parking
 - Back to the left, if possible, so that you can see objects on the driver's side
 - Have a spotter guide your vehicle when you're backing up
 - Apply GOAL (Get Out And Look)
- Obey speed limits; be aware of blind spots or other hazards associated with low visibility. Practice defensive driving techniques, such as leaving plenty of room between your vehicle and the one ahead of you;
- Do no drive while drowsy. Drowsiness can occur at any time, but is most likely after 18 hours or more without sleep;
- Maintain focus on driving. Eating, drinking, smoking, adjusting controls can divert attention from the road. Take the time to park and perform these tasks when parked rather than while driving; and

- Ensure vehicle drivers are familiar with the safe operation of vehicles of the type and size to be operated. Large vehicles such as full size vans and pick-ups have different vision challenges and handling characteristics than smaller vehicles.

7.4 Electrical Safety

(Reference CH2M HILL SOP HSE-206, *Electrical Safety*)

Below are the hazard controls and safe work practices to follow when using electrical tools, extension cords, and/or other electrical-powered equipment or when exposed to electrical hazards. Ensure the requirements of the referenced SOP are followed:

- Only qualified personnel are permitted to work on unprotected energized electrical systems;
- Only authorized personnel are permitted to enter high-voltage areas;
- CH2M HILL employees who might from time to time work in an environment influenced by the presence of electrical energy must complete Awareness Level Electrical Safety Training located on the CH2M HILL Virtual Office;
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented;
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment, remove from service;
- CH2M HILL has selected Ground Fault Circuit Interrupters (GFCIs) as the standard method for protecting employees from the hazards associated with electric shock;
 - GFCIs shall be used on all 120-volt, single phase 15 and 20-ampere receptacle outlets which are not part of the permanent wiring of the building or structure.
- An assured equipment grounding conductor program may be required under the following scenarios:
 - GFCIs cannot be utilized;
 - Client requires such a program to be implemented; or
 - Business group decides to implement program in addition to GFCI protection.
- Extension cords must be equipped with third-wire grounding. Cords passing through work areas must be covered, elevated or protected from damage. Cords should not be routed through doorways unless protected from pinching. Cords should not be fastened with staples, hung from nails, or suspended with wire;
- Electrical power tools and equipment must be effectively grounded or double-insulated and Underwriters Laboratory (UL) approved;
- Operate and maintain electric power tools and equipment according to manufacturers' instructions;
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet (3 meters) from overhead power lines for voltages of 50 kV or less, and 10 feet (3 meters) plus 0.4 inches (1.0 cm) for every 1 kV over 50 kV;
- Temporary lights shall not be suspended by their electric cord unless designed for suspension. Lights shall be protected from accidental contact or breakage; and
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

7.5 Field Trailer/Office Setup and Maintenance

- Determine trailer placement by considering all potential hazards that could impact “office” work. Trailers usually are placed in the support zone and out of construction zones. Think about what type of PPE will be necessary when exiting the trailer, parking needs, biological hazards or other hazards that could impact location.
- Check utility configuration prior to placement, including electrical, water, and sewer.
- Use spotters when placing trailer.
- Set on flat ground.
- Be sure trailer wheels are chocked.
- When disconnecting trailer from hitch—watch pinch points and wear leather gloves.
- Carefully jack trailer using the appropriately rated jacks and following manufacturer’s recommendations.
- Secure and anchor trailer to protect from wind or other severe weather.
- Place cones in front of hitch.
- Ensure proper stairs and secure stairs next to doors. Ensure stairs are “no slip” and that the platform or landing of the stairs is flush the door threshold.
- Use only qualified electricians to establish electrical service.
- Consider ergonomics when furnishing trailer with desks and chairs.
- Place fire extinguishers near doors, and place signage.
- Put up emergency contacts, evacuation and rally point map, and route to the hospital
- Place right to know posters (OSHA required information).
- Place signage on exit doors.
- Never place porta-johns at HVAC intake (usually HVAC is located at the front of trailer).
- Have capability to properly store food—temporary field offices can quickly develop rodent issues if food is not stored properly or the trailer isn’t cleaned regularly.

7.6 Field Vehicles

- Field vehicles may be personal vehicles, rental vehicles, fleet vehicles, or project vehicles.
- Maintain a first aid kit and bloodborne pathogen kit in the field vehicle.
- Assess whether maintaining a fire extinguisher in the field vehicle is feasible. If fire extinguishers are readily available, for example on heavy equipment, or if the project is short duration, a fire extinguisher would not be necessary. Fire extinguishers in field vehicles need to be properly secured and inspected on a monthly basis.
- Utilize a rotary beacon on vehicle if working adjacent to active roadway.
- Familiarize yourself with rental vehicle features prior to operating the vehicle:
 - Vision Fields and Blind Spots
 - Vehicle Size
 - Mirror adjustments
 - Seat adjustments

- Cruise control features, if offered
- Pre-program radio stations and Global Positioning System (GPS), if equipped
- Always wear seatbelt while operating vehicle.
- Adjust headrest to proper position.
- Tie down loose items if utilizing a van or pick-up truck.
- Close car doors slowly and carefully. Fingers can get pinched in doors.
- Park vehicle in a location where it can be accessed easily in the event of an emergency. If not possible, carry a phone.
- Have a designated place for storing the field vehicle keys when not in use.
- Ensure back-up alarms are functioning, if equipped. Before backing a vehicle, take a walk around the vehicle to identify obstructions or hazards. Use a spotter when necessary to back into or out of an area.
- See the Vehicle Incident Guidance attached to the project safety plan, if a vehicle incident is experienced in a rental or fleet vehicle.

7.7 Fire Prevention

(Reference CH2M HILL SOP HSE-403, *Hazardous Material Handling*)

Follow the fire prevention and control procedures listed below.

7.7.1 Fire Extinguishers and General Fire Prevention Practices

- Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet (30.5 meters). When 5 gallons (19 liters) or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet (15.2 meters). Extinguishers must:
 - be maintained in a fully charged and operable condition;
 - be visually inspected each month; and
 - undergo a maintenance check each year.
- The area in front of extinguishers must be kept clear.
- Post “Exit” signs over exiting doors, and post “Fire Extinguisher” signs over extinguisher locations.
- Combustible materials stored outside should be at least 10 feet (3 meters) from any building.
- Solvent waste and oily rags must be kept in a fire resistant, covered container until removed from the site.
- Keep areas neat. Housekeeping is important.

7.7.2 Dispensing of Flammable/Combustible Liquids

- Areas in which flammable or combustible liquids are dispensed in quantities greater than 5 gallons (22.7 liters) (shall be separated from other operations by at least 25 feet (7.6 meters).
- Drainage away from storm drains or surface waters or other means of containment shall be provided to control spills.
- Adequate natural or mechanical ventilation shall be provided to maintain the concentration of flammable vapor at or below 10 percent of the lower flammable limit.
- Dispensing of flammable liquids from one container to another shall be done only when containers are electrically interconnected (bonded).

- Dispensing flammable or combustible liquids by means of air pressure on the container or portable tanks is prohibited.
- Dispensing devices and nozzles for flammable liquids shall be of an approved type.

7.8 General Practices and Housekeeping

The following are general requirements applicable to all portions of the work:

- Site work should be performed during daylight hours whenever possible;
- Good housekeeping must be maintained at all times in all project work areas;
- Common paths of travel should be established and kept free from the accumulation of materials;
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions;
- Provide slip-resistant surfaces, ropes, or other devices to be used;
- Specific areas should be designated for the proper storage of materials;
- Tools, equipment, materials, and supplies shall be stored in an orderly manner;
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area;
- Containers should be provided for collecting trash and other debris and shall be removed at regular intervals;
- All spills shall be quickly cleaned up; oil and grease shall be cleaned from walking and working surfaces;
- Review the safety requirements of each job you are assigned to with your supervisor. You are not expected to perform a job that may result in injury or illness to yourself or to others;
- Familiarize yourself with, understand, and follow jobsite emergency procedures;
- Do not fight or horseplay while conducting the firm's business;
- Do not use or possess firearms or other weapons while conducting the firm's business;
- Report unsafe conditions or unsafe acts to your supervisor immediately;
- Report emergencies, occupational illnesses, injuries, vehicle accidents, and near misses immediately;
- Do not remove or make ineffective safeguards or safety devices attached to any piece of equipment;
- Report unsafe equipment, defective or frayed electrical cords, and unguarded machinery to your supervisor;
- Shut down and lock out machinery and equipment before cleaning, adjustment, or repair. Do not lubricate or repair moving parts of machinery while the parts are in motion;
- Do not run in the workplace;
- When ascending or descending stairways, use the handrail and take one step at a time;
- Do not apply compressed air to any person or clothing;
- Do not wear steel taps or shoes with metal exposed to the sole at any CH2M HILL project location;
- Do not wear finger rings, loose clothing, wristwatches, and other loose accessories when within arm's reach of moving machinery;
- Remove waste and debris from the workplace and dispose of in accordance with federal, state, and local regulations;
- Note the correct way to lift heavy objects (secure footing, firm grip, straight back, lift with legs), and get help if needed. Use mechanical lifting devices whenever possible; and
- Check the work area to determine what problems or hazards may exist.

7.9 Hazard Communication

(Reference CH2M HILL SOPs HSE-107, *Hazard Communication* and HSE-403, *Hazardous Material Handling*)

The hazard communication coordinator is to perform the following:

- Complete an inventory of chemicals brought on site by CH2M HILL using the chemical inventory form included as an attachment to the project safety plan;
- Confirm that an inventory of chemicals brought on site by CH2M HILL subcontractors is available;
- Request or confirm locations of safety data sheets (SDSs) from the client, contractors, and subcontractors for chemicals to which CH2M HILL employees potentially are exposed;
- Before or as the chemicals arrive on site, obtain an SDS for each hazardous chemical and include on the chemical inventory sheet (attached to the project safety plan) and add the SDS to the SDS onsite notebook;
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly;
- Give employees required chemical-specific HAZCOM training using the chemical-specific training form included as an attachment to the project safety plan; and
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

7.10 Knife Use

Open-bladed knives (for example, box cutters, utility knives, pocket knives, machetes, and multi-purpose tools with fixed blades such as a Leatherman™) are prohibited at worksites except where the following three conditions are met:

- The open-bladed knife is determined to be the best tool for the job;
- An approved Activity Hazard Analysis (AHA) or written procedure is in place that covers the necessary safety precautions (work practices, PPE, and training); and
- Knife users have been trained and follow the AHA
- Employees are responsible for using cutting tools in the way they are intended, maintaining them in good working order and reporting faulty or unusable items. PPE as specified in the AHA is to be used.
- Those engaging and supervising subcontractors are to ensure that the requirements of this policy are communicated.
- The most appropriate gloves shall be identified within the AHA. In general, cut resistant gloves (e.g., Kevlar) are to be worn when using a knife in an occupational setting. Other types of gloves may be required and will be identified within the AHA. An example may be leather gloves may be worn when using the acetate sleeve cutter.
- All employees that will use a cutting tool must be trained in the proper use.
- Position the item to be cut on a stable surface. Secure it to prevent slippage, wherever possible. Select a work location which does not put your body in the line of fire of a knife slippage or failure.
- When using a knife do not cut towards yourself.
- When cutting, make the force of the cut carry the blade away from any part of your body. If you have a situation where this is not possible, protect yourself with a leather apron, or other material placed between you and the blade. Consider putting the material to be cut in a vise, or other holding device.
- Many tasks using a utility knife require a knife edge but not a sharp point. For these tasks you can add protection against puncture wounds by using a rounded-tip blade.

- In general, a pocket knife is not the preferred tool of choice as there are alternatives (e.g., retracting safety blade). If you use a folding knife, it must be a locking blade type. Never use a knife that will fold under pressure. If you use a fixed blade knife, make sure there is a handle guard to keep your hand from slipping forward. Also, make sure the handle is dry and non-greasy/slippery to assure a better grip. If you carry a fixed blade knife, use a sheath or holder.
- Store utility knives safely, retract the blade or sheath an open blade before storing. Never, leave a knife with the blade exposed on the floor, on a pallet, on a work surface, or in a drawer or cabinet.
- Keep your knife sharp. A dull blade requires you to use more force to cut, and consequently increases the risk of slip or mistake.
- Knives used on the job, but not carried with you, must be properly stored when not in use
- Never use a defective knife.
- Utility knife blades are brittle and can snap easily. Don't bend them or apply side loads to them by using them to open cans or pry loose objects. Use the knife only to cut. It was not designed to work as a pry bar, screwdriver, or hole punch.

7.11 Lighting

Lighting shall be evaluated when conducting work inside buildings, confined spaces, or other areas/instances where supplemental light may be needed (e.g., work before sunrise or after sunset). A light meter can be used to evaluate the adequacy of lighting. The following are common requirements for lighting and the conditions/type of work being performed:

- While work is in progress outside construction areas shall have at least 33 lux (lx);
- Construction work conducted inside buildings should be provided with at least 55 lux light;
- The means of egress shall be illuminated with emergency and non-emergency lighting to provide a minimum 11 lx measured at the floor. Egress illumination shall be arranged so that the failure of any single lighting unit, including the burning out of an electric bulb will not leave any area in total darkness.

7.12 Manual Lifting

(Reference CH2M HILL SOP HSE-112, *Manual Lifting*)

Back injuries are the leading cause of disabling work and most back injuries are the result of improper lifting techniques or overexertion. Use the following to mitigate the hazards associated with lifting:

- When possible, the task should be modified to minimize manual lifting hazards;
- Lifting of loads weighing more than 40 pounds (18 kilograms) shall be evaluated by the SC using the Lifting Evaluation Form contained in SOP HSE-112;
- Using mechanical lifting devices is the preferred means of lifting heavy objects such as forklifts; cranes, hoists, and rigging; hand trucks; and trolleys;
- Personnel shall seek assistance when performing manual lifting tasks that appear beyond their physical capabilities;
- In general, the following steps must be practiced when planning and performing manual lifts: Assess the situation before you lift; ensure good lifting and body positioning practices; ensure good carrying and setting down practices; and
- All CH2M HILL workers must have training in proper manual lifting training either through the New Employee Orientation or through Manual Lifting module located on the VO.

7.13 Personal Hygiene

Good hygiene is essential for personal health and to reduce the potential of cross-contamination when working on a hazardous waste site. Implement the following:

- Keep hands away from nose, mouth, and eyes during work;
- Keep areas of broken skin (chapped, burned, etc.) covered; and
- Wash hands with soap and water prior to eating, smoking, or applying cosmetics.

7.14 Personal Security

Follow the guidelines below for personal security measures. The RHSM and Firm-Wide Security Office can be contacted if additional, specific measures are needed (e.g., such as evaluating the needs for security service).

General Safety and Security Guidelines

CH2M HILL Corporate Security Department recommends the following guidelines for workers in the United States:

- Stay alert and be aware of your surroundings. Avoid pre-occupations with mobile devices, while in an unfamiliar area.
- Whenever possible use the buddy system with another employee or client or subcontractor employee.
- Trust your intuition; if a situation appears strange or wrong, it probably is.
- Be confident in your walk or stride; do not give the appearance you are new in town.
- Avoid carrying and displaying large sums of cash.
- If you sense or see dangerous situations along your route, change your route and depart the area quickly. If you feel that you are being followed, go to the nearest police station or safe location and file a complaint with the police. Provide a description of the person, their vehicle, license plate number and any other useful information.
- Only walk short distances that are safe and secure while visiting an unfamiliar city or location.
- Take host approved transportation for long distances.
- “Fight or Flight?” Leaving the possible or dangerous area is always better than staying to fight.
- Always report suspicious activity to the nearest local law enforcement agency.
- Locate emergency exits in your hotel or where you are staying to ensure you know where to go in case of a fire or a natural or man-made disaster.
- Secure your electronic devices when left in your room or take them with you if you are not able to secure them properly.
- If you feel your life is in danger, call 911. Be sure to speak clearly, concisely and give the dispatcher a good description of where you are physically located.

Operating or Riding in Vehicles

- When waiting for public transportation or a taxi, remain in a store or restaurant as long as possible before catching your ride and never wait by yourself in an isolated area.
- Approach your vehicle with keys firmly in your hand and ready to unlock the car.
- Quickly check your car before entering it to determine damage or presence of an intruder.
- Vulnerable times can be stopping to find your keys to enter your vehicle or stepping out of your vehicle in an isolated area. Be aware of your surroundings before you perform these activities.

- Always keep your doors locked during transit and when the vehicle is parked.
- Never leave your vehicle unlocked, even when to performing a quick task such as checking in a hotel, getting gas or going picking up food.
- If confronted by an individual inside a vehicle pointing a weapon at you, run the opposite way from where the vehicle is facing and scream as loud as you can. This evasive action will probably cause the individual to drive away.
- If an individual in a passing car points at your tires or engine to indicate a malfunction, only pull over in a well-lit and populated gas or rest stop. Never pull over in an isolated or dimly lit area. You may have a malfunction or the passing motorist may be attempting to rob you.
- Always park your vehicle in a well-lit and secure area. If your vehicle is parked in a dimly lit or isolated area in a parking garage; ask an attendant or friend to accompany you to your vehicle.
- Secure your valuables in the trunk, or place them out of sight or cover them with a blanket or coat if there is no secure storage area in the vehicle. The would-be-perpetrator likes to see what to steal and not knowing what you have concealed will normally prevent a break in.

Riding in a Taxi

- Have your host or a designated travel agent suggest or reserve a reputable taxi service for you during your stay.
- Only use a taxi service that was vetted for safety and reliability.
- If possible, place luggage, laptop and personal belongings inside the taxi.
- When you first enter the taxi, check the driver photo identification card, normally located on the driver's visor with the driver to ensure they match.

Walking

- If you experience automotive trouble, remain inside the locked vehicle and call for assistance.
- If you can't reach assistance via a mobile phone, only walk for help in a safe area facing the traffic.
- If while walking, you are shadowed or followed by a vehicle, run back in the direction of your vehicle and enter the vehicle if possible. File a police report on the incident as soon as practicable.
- Be aware of your surroundings and those around you while walking and do not be distracted by using electronic devices.
- Regularly change your route if you are walking to and from meetings or conferences and choose only well-lit areas to walk in at night.
- If walking long distances, identify a "safe house, shop, store or restaurant" to duck into if confronted by a perpetrator.

Jogging or Running

- Always jog or run in an area that is safe, secure, and used for exercising.
- Avoid running along busy roads or highways.
- If you chose to venture out on a jog or run, check the route by vehicle prior to beginning to exercise.
- Let the host or a friend know when you leave, when you plan to return, and the route you will take during exercising.
- Take a photo identification and mobile phone with you for emergencies.
- Avoid physically over-extending yourself since reflexes and decision-making ability can be impaired.

Clothing and Jewelry

- Dress to blend in with locals, maintain a low profile and avoid drawing attention to yourself.
- Travel with inexpensive clothing and jewelry.
- Avoid wearing CH2M HILL distinctive clothing or using CH2M HILL logos on luggage or laptops.

Emergency Numbers and Information

- Leave your itinerary and emergency contact numbers where you can be reached with family members and only those that have a need to know.
- Pre-program emergency numbers in the mobile device you are traveling with.
- Carry a list of current medications and specific doses in your purse or wallet.
- Record medical emergency information on a document that can be readily available if you are unable to speak or unconscious.
- Have a photo copy of your driver's license, passport, and credit card information separately in case your wallet or purse is stolen.

7.15 Shipping and Transportation of Hazardous Materials

(Reference CH2M HILL SOP HSE-417, *Hazardous Materials Transportation*)

The U.S. Department of Transportation (DOT) has specific regulations governing shipping of hazardous materials (also called dangerous goods). Chemicals brought to the site might be defined as hazardous materials by the U.S. DOT. Hazardous wastes that may be shipped offsite are also defined as hazardous materials by U.S. DOT. Other wastes may also be U.S. DOT hazardous materials. To confirm whether a material or a waste is a U.S. DOT hazardous material, check with the ESG Waste Coordinator (Lisa Schwan/ATL), the project EM, or the CH2M HILL Dangerous Goods Shipping Coordinators (John Blasco/BAO or Rob Strehlow/MKW).

All staff who affect shipment of hazardous materials, including receiving hazardous materials, preparing profiles or manifests, packaging hazardous wastes, labeling, or transporting hazardous materials by road, are called HazMat employees (note CH2M HILL cannot transport hazardous wastes by public road). HazMat employees must receive CH2M HILL online training in shipping dangerous goods. CH2M HILL's online Dangerous Goods Shipping course can be found on the CH2M HILL HSSE website.

All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. If the material is a product that is being shipped (e.g., calibration gas), use the HazMat ShipRight tool on the CH2M HILL virtual office (under Company Resources – Online Shipping). Contact the Dangerous Goods Shipping coordinators, the ESG Waste Coordinator or the project EM for additional information.

49 CFR 172 requires that all hazmat employees be aware of potential transportation security concerns. Hazardous materials security is addressed in CH2M HILL's Hazardous Materials SOP (HSE-403). The following points are provided as an overview of security measures to increase awareness of this important matter:

- It is essential that each employee understand the security risks involved with transporting hazardous materials;
- All transporters of hazardous materials must be prequalified by a Contracts Administrator who evaluate the carrier's safety rating, security measures, and employee screening procedures;
- When shipping hazardous materials, check driver credentials and ask about shipping details;
- When receiving a hazardous materials shipment, inspect packages for signs of tampering or damage to the contents. Verify the drivers and company information on the form with the driver; and

- If there is suspicious or unusual behavior (e.g., driver without credentials, evasive answers) or any discrepancies identified, do not offer or accept the shipment, and immediately notify the project manager or the RHSM.

Employees responsible for shipping hazard materials must also review the CH2M HILL Transportation Security Plan (HSE-417 Appendix A).

7.16 Substance Abuse

(Reference CH2M HILL SOP HSE-105, *Drug-Free Workplace*)

Employees who work under the influence of controlled substances, drugs, or alcohol may prove to be dangerous or otherwise harmful to themselves, other employees, clients, the company, the company's assets and interests, or the public. CH2M HILL does not tolerate illegal drug use, or any use of drugs, controlled substances, or alcohol that impairs an employee's work performance or behavior.

Prohibitions onsite include:

- Use or possession of intoxicating beverages while performing CH2M HILL work;
- Abuse of prescription or nonprescription drugs;
- Use or possession of illegal drugs or drugs obtained illegally;
- Sale, purchase, or transfer of legal, illegal or illegally obtained drugs; and
- Arrival at work under the influence of legal or illegal drugs or alcohol.

Drug and/or alcohol testing is applicable under CH2M HILL Constructors, Inc. and munitions response projects performed in the United States. In addition, employees may be required to submit to drug and/or alcohol testing as required by clients. When required, this testing is performed in accordance with SOP HSE-105, *Drug-Free Workplace*. Employees who are enrolled in drug or alcohol testing are required to complete annual training located on the CH2M HILL Virtual Office (VO).

7.17 Unknown or Suspect Objects/Materials

If unknown or suspect objects/materials are encountered (i.e., exposed or partially buried drums, biological waste, cylinders, glass containers, munitions of explosive concern, unexpected stained/discolored soil) are encountered during site operations, ongoing activities shall be immediately suspended. CH2M HILL or subcontractor personnel encountering unknown or suspect objects or materials shall:

- Secure the area and identify the location of the object/material to the extent possible, without causing bodily injury to yourself or others and without disturbing the object.
- Evacuate the work area.
- Immediately notify the project manager/HSM of the encountered condition.
- Do not further disturb or otherwise handle the suspect object or material.

The site supervisor or SC shall contact the Project Manager and the RHSM to evaluate potential hazards associated with the specific situation encountered. The project team will then address the need for the use of special procedures, engineering controls, PPE or specialized subcontract personnel to safely mitigate the situation.

8. Project-Specific Hazard Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of either the work or the particular hazard. Each person onsite is required to abide by the hazard controls. Always consult the appropriate CH2M HILL SOP to ensure all requirements are implemented. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the RHSM for clarification.

8.1 Abrasive Blasting

(Reference CH2M HILL SOP HSE-122, *Abrasive Blasting*)

Abrasive blasting is the cleaning or preparing of a surface by forcibly propelling a stream of abrasive material against the surface using sand, glass bead, aluminum oxide, grit, garnet, steel shot, slag, walnut shells, and others. Below are the hazard controls and safe work practices to follow when overseeing or performing abrasive blasting.

- CH2M HILL employees who work on projects with abrasive blasting operations are required to complete the CH2M HILL 10-Hour Construction Safety Awareness training and waste management training.
- Abrasives and the surface coatings on the materials blasted are shattered and pulverized during blasting operations and the dust formed will contain particles of respirable size. The composition and toxicity of the dust from these sources shall be considered in making an evaluation of the potential health hazards. Air monitoring instruments shall be provided if the potential for a hazardous atmosphere exists.
- Personnel shall remain a safe distance from the abrasive blasting area to reduce exposure to hazardous airborne contaminants.
- Abrasive blasting equipment shall be inspected each day, before use, to ensure safe operational condition.
- Non-silica containing abrasive blasting materials must be used to the extent possible.
- Blast nozzles must be equipped with an operating valve that must be held open manually.
- Eating, drinking, and smoking shall be prohibited in areas where blasting is performed. Employees shall wash their face and hands before eating, drinking or smoking.
- Abrasive blasting debris shall be cleaned up by using dust-free methods. Wet clean-up methods and vacuum cleaners with High Efficiency Particulate Air (HEPA) filters are recommended.
- Fugitive dust must be controlled during abrasive blasting operations by using water sprays or other methods.
- Noise must be monitored and controlled as required by state or local regulations.
- Complete the abrasive blasting self-assessment checklist when performing or when subcontractors perform this operation.

8.2 Aerial Lifts

(Reference CH2M HILL, SOP HSE-301, *Aerial Lifts*)

Below are the hazard controls and safe work practices to follow when working around or operating aerial lifts. Ensure the requirements in the referenced SOP are followed:

- Operate aerial lifts only if you are authorized and trained to do so;
- Inspect aerial lifts and test lift controls prior to use;

- Wear a full-body harness, with a lanyard attached to the boom or platform (see also SOP HSE-308, *Fall Protection*). When working within a standard guardrail system with scissors lifts, the full-body harness and lanyard are not required;
- Do not attach lanyard to any adjacent structures or equipment while working from an aerial lift;
- Stand firmly on the floor of the platform and do not sit or climb on the railings of the platform, or use planks, ladders, or other devices to increase working height;
- Remain on the platform at all times and do not leave the platform to climb to adjacent structures;
- Position aerial lifts on firm, level surfaces when possible, with the brakes set. Use wheel chocks on inclines. If outriggers are provided, position them on solid surfaces or cribbing;
- Maintain safe clearance distances between overhead power lines and any part of the aerial lift or conducting material, unless the power lines have been de-energized and grounded, or insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet (3 meters) from overhead power lines for voltages of 50 kilovolts (kV) or less, and 10 feet (3 meters) plus 0.4 inches (1.0 cm) for every 1 kV over 50 kV;
- Do not exceed the boom and basket load limits;
- Do not use aerial lifts as cranes, unless specifically designed and approved by the lift manufacturer;
- Do not work or stand below aerial lift operations;
- Do not use aerial lifts when winds exceed 30 miles per hour (48 km per hour) or per manufacturers recommendations; and
- Complete the self-assessment checklist for aerial lifts whenever aerial lifts are being used.

8.3 All-Terrain Vehicles and Utility-Type Vehicle Safety

An all-terrain vehicle (ATV) means any recreational vehicle with three or more tires, has handlebar steering, and a seat designed to be straddled by the operator and are not intended for use on paved roads.

Utility-type vehicle (UTV) means any recreational motor vehicle other than an ATV, motorbike, or snowmobile designed for and capable of travel over designated roads, traveling on four (4) or more tires.

ATVs/UTVs shall not be operated on site unless determined to be the most appropriate vehicle(s) to use and their use is pre-approved by the PM and RHSM.

Operators shall be trained and qualified before operation of the ATV or UTV onsite and will possess a valid driver's license.

ATV/UTV operators are prohibited from using any wireless device while operating ATVs/UTVs. Equipment must be stopped before using devices such as two way radios or cell phones. If a wireless device is required for a certain operation, the PM and HSM must authorize the wireless use on a case by case basis and make sure limitations are addressed in the project safety plan.

Training shall consist of manufacturer's operating manual, hands-on training by a competent person, a demonstration of basic skills, and when required by the state, completion of an ATV safety course. An AHA shall also be developed for the use of ATVs/UTVs and operators shall be trained on the AHA. All individuals are required meet all training aspects before ATV/UTV use and documentation of training shall be maintained at the site.

Some states listed below as requiring an ATV license actually require an ATV or even a motorcycle endorsement on the operator's current driver's license. Be sure to contact the local division of motor vehicles (DMV) office for details. The following are states that require a specialized driver's license: Arizona, Oregon, Georgia, and Illinois. New Hampshire's and Montana's requirements vary by city.

Keep in mind, that states not mentioned above may still:

- Impose age restrictions for operating ATVs;
- Require an ATV safety or education course certification (even if you're older than 18);
- Require ATV insurance.

Daily inspections of vehicles for safety and maintenance are required.

Minimum PPE required for operators and passengers on ATVs include:

- Safety glasses, goggles, or face-shield at all times when moving;
- Leather boots or shoes (if safety-toed boots are not required by the project safety plan); and
- A properly fitted DOT/ANSI/SNELL-approved helmet.

Other safety requirements include:

- ATVs with fewer than four wheels are not allowed on site;
- ATVs and UTVs shall be operated in accordance with the manufacturer's operating manual, any state or client requirements, and task-specific AHA;
- Speed is not to exceed 20 mph. Keep all parts of your body inside any roll over protection;
- Always use the seat belt on UTVs;
- Make sure the engine is turned off before dismounting the vehicle;
- Avoid driving over any extremely large obstacles (i.e., wood/logs, fences, boulders, etc);
- When using trailers, watch your turning radius;
- Shut engine down prior to refueling;
- ATVs/UTVs must have fenders;
- Utilize high visibility flag and wear high visibility vest when operating adjacent to heavy equipment or haul vehicles.

8.4 Arsenic

(Reference CH2M HILL, SOP HSE-501, *Arsenic*)

Arsenic is considered a "Confirmed Human Carcinogen." CH2M HILL is required to control employee exposure to arsenic when exposures are at or above 5.0 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), or if there is the possibility of skin or eye irritation from arsenic. The elements of the CH2M HILL arsenic program include the following:

- Exposure monitoring;
- Methods of control, including PPE and respirators;
- Medical surveillance;
- Training on hazards of arsenic and control measures (includes project-specific training and the computer-based training on CH2M HILL's Virtual Office, *Arsenic Exposure*); and
- Recordkeeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations, notify the RHSM to ensure the above have been adequately addressed. Full implantation of SOP HSE-501, Arsenic, will be required. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Avoid skin and eye contact with liquid and particulate arsenic or arsenic trichloride;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and
- Review the fact sheet included as an attachment to the SOP.

8.5 Asbestos

(Reference CH2M HILL SOP HSE-502, *Asbestos*)

Asbestos is a cancer-causing mineral that was included in many building materials. When disturbed harmful asbestos fibers can be released and inhaled and ingested by workers. Materials suspected of containing asbestos shall be treated as asbestos unless documentation and testing results indicate otherwise. Where the presence of asbestos is suspected, if at all possible, design all operations to avoid contact.

When there is a risk of disturbing asbestos and making it friable (able to release fibers when the materials are crushed, abraded or cut) the activity becomes regulated. The asbestos standard for construction regulates asbestos exposure for the following activities:

- Demolishing or salvaging structures where asbestos is present in concentrations greater than 1 percent;
- Removing or encapsulating asbestos-containing materials (1 percent or greater asbestos content);
- Constructing, altering, repairing, maintaining, or renovating asbestos-containing structures or substrates;
- Installing asbestos containing products;
- Cleaning up asbestos spills/emergencies; and
- Transporting, disposing, storing, containing and housekeeping involving asbestos or asbestos containing products on a construction site.

CH2M HILL is required to control employee exposure to asbestos when exposures are at or above 0.1 fibers per cc (f/cc) by implementing a program that meets the requirements of the OSHA Asbestos standard, 29 Code of Federal Regulations (CFR) 1926.1101. The elements of the CH2M HILL asbestos program include the following:

- Exposure monitoring;
- Methods of control, including PPE and respirators;
- Medical Surveillance;
- Training on hazards of asbestos and control measures; and
- Record keeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;

- Avoid skin and eye contact asbestos;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person;
- Review the fact sheet included as an attachment to the SOP; and
- Do not disturb waste or other materials labeled “Danger - Asbestos Fibers.”

Subcontractors performing asbestos abatement activities are required to obtain state or special licenses and permits and have a written compliance/abatement plan that has been reviewed and accepted by CH2M HILL before work begins. Subcontractors are required to provide proof that all asbestos workers medically qualified, training and a competent person has been appointed before work begins.

8.6 Benzene

(Reference CH2M HILL SOP HSE-503, *Benzene*)

Benzene is considered a “Confirmed Human Carcinogen.” CH2M HILL is required to control employee workplace exposure to benzene when personal exposures is at or above 0.5 parts per million (ppm) as an 8-hour time-weighted average (TWA) or above 5.0 ppm short term exposure limit (STEL), by implementing a program that meets the requirements of the OSHA Benzene standard, 29 CFR 1910.1028. The elements of the CH2M HILL benzene program include the following:

- Exposure monitoring;
- Methods of control, including personal protective equipment (PPE) and respirators;
- Medical surveillance;
- Training on hazards of benzene and control measures (includes project-specific training and the computer-based training on CH2M HILL’s Virtual Office, *Benzene*); and
- Record keeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and
- Review the fact sheet included as an attachment to the SOP.

8.7 Cadmium

(Reference CH2M HILL SOP HSE-504, *Cadmium*)

Cadmium is considered a “Suspected Human Carcinogen.” CH2M HILL is required to control employee workplace exposure to cadmium when personal exposure is at or above 2.5 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) by implementing a program that meets the requirements of the OSHA Cadmium standard, 29 *Code of Federal Regulations* (CFR) 1926.1127. The elements of the CH2M HILL cadmium program include the following:

- Exposure monitoring;
- Methods of control, including PPE and respirators;
- Medical surveillance;

- Training on hazards of cadmium and control measures (includes project-specific training and the computer-based training on CH2M HILL's Virtual Office, *Cadmium*); and
- Recordkeeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and
- Review the fact sheet included as an attachment to the SOP.

8.8 Chainsaws

(Reference CH2M HILL SOP HSE-210, *Hand and Power Tools*)

Below are the hazard controls and safe work practices to follow when working around or operating chainsaws. Ensure the requirements in the referenced SOP are followed.

8.8.1 Equipment

Only chainsaws equipped with a spark arrestor and fully functioning chain brake or "safety chain" shall be used. The following safety equipment shall be readily available while operating a chainsaw:

- Chainsaw operator's manual;
- Fully stocked first aid kit;
- Multipurpose fire extinguisher;
- Grounded extension cord approved for outdoor use and ground fault circuit interrupter (GFCI) for electrical-powered chainsaws;
- Approved safety gasoline container and funnel or flexible nozzle for refueling gasoline-powered chainsaws; and
- Sledge hammer and non-metallic wedges when necessary to prevent pinching of the chain.

8.8.2 PPE Requirements

The following personal protective equipment shall be worn while operating chainsaws:

- Safety glasses with side shields and face shield to prevent injury from wood chips, sawdust, or other flying objects;
- Hard hat with properly fitted suspension to prevent head injury from falling debris;
- Steel-toed safety shoes or boots to prevent foot injury from falling objects and accidental contact with the moving chain;
- Hearing protection to prevent permanent damage to hearing. Ear muffs or plugs will have a decibel noise reduction rating (NRR) assigned to them. The higher the rating, the greater the protection offered;
- Non-leather, fabric work gloves to prevent hand injury from abrasions, splinters and cuts;
- Clothing that is well-fitted and free of loose edges that could become entangled in the saw; and
- Protective chaps or leggings that cover the area from the groin to about 2 inches (5.08 cm) above the ankles should be used. These chaps are made from synthetic fabrics that are designed to prevent the running saw chain from coming in contact with your legs.

8.8.3 Safe Operation

The following safe operation guidelines shall be followed regardless of the purpose for using a chainsaw:

- Inspect the chainsaw prior to use;
- Chainsaws shall be held firmly with both hands, with thumbs and fingers encircling both chain saw handles;
- Stand slightly to the left side of the saw, out of the plane of the cutting chain and guide bar to reduce the risk of injury in the event of a kickback;
- Position saw so that it is between the waist and mid-chest level. Overreaching or cutting above the mid-chest height shall be avoided;
- Maintain a full throttle setting while cutting. Chainsaws are designed to be run at full speed;
- Always be aware of what is in the saw's downward path after the cut;
- Do not attempt to cut material that is larger than the guide bar of the saw;
- Avoid cuts that will cause the chainsaw to jam. Always cut into the compression wood first until the cut starts to close; then cut from the other side toward the compression cut;
- Use a non-metallic wedge to prevent the compression cut jamming on the blade;
- Chainsaws are designed to feed themselves into the wood and require only light pressure to cut efficiently. If extra force is required to keep cutting, the chain requires sharpening. Additional signs of a dull chain include a saw that is cutting crooked, results in fine sawdust instead of chips, or the smell of burnt wood. Do not use a dull chain;
- Bystanders and helpers shall be kept at a safe distance from operation;
- Do not operate a chainsaw when fatigued; take frequent breaks;
- Work slowly; don't rush; and
- A fire extinguisher shall be present at all times when operating the chainsaw in forest or brushy areas.

8.8.4 Refueling the Engine

The fuel for gasoline-powered chainsaws shall be mixed in accordance with the manufacturer's recommendations as outlined in the chainsaw operator's manual. Fuel shall be stored and transported in an approved safety container. The following precautions should also be followed:

- The engine shall be shut off and allowed to cool before refueling; never refuel a hot engine;
- A fire extinguisher shall be present during fueling and refueling;
- Smoking around fueling or refueling operations shall be prohibited; and
- A funnel or a flexible nozzle shall be used to avoid spilling fuel on the engine.

8.9 Chemical Injections

When the remedial action objectives for a project include subsurface injection of chemicals, the procedures and handling practices identified below must be implemented.

Pre-Injection

Review the Safety Data Sheets (SDSs) for the materials which are expected to be utilized in the chemical injection processes for this contract task order and:

- Document training in accordance with the Hazard Communication section of these Guidelines.
- Ensure that appropriate spill response materials are present (e.g., absorbent media for oil, neutralizing agents for potassium permanganate, secondary containment for larger chemical tanks).

Evaluate potential for “daylighting” of chemical injection in the work area:

- Evaluation should identify known or potential pathways such as existing monitoring wells screened at the same depth interval as the planned injection, wells that were not properly abandoned, and utility corridors.
- Identify potential surface release areas such as nearby sensitive areas (e.g., wetlands) storm drains, ditches, or streams, and ensure that mitigation measures are in place (e.g., temporarily blocking storm sewer drains).
- Contact the project Environmental Manager for assistance in identifying release scenarios and mitigation measures.

Injection Operations

- Operate and maintain pressure vessels, pumps and hosing in accordance with the manufacturer’s recommendations.
- Do not exceed the rated pressure of the vessels and associated piping or hoses of the system.
- The system must be provided with a pressure relief valve/controller that safely reduces the system pressure to within the system rated pressure.
- The pressure relief valve must be rated at no more than 110 percent the rated pressure of the system and must be tested at regular intervals.
- Each vessel must be equipped with a functioning pressure gauge to monitor pressure.
- For PPE and air monitoring requirements, refer to the PPE section and Site Monitoring section of the project safety plan. PPE shall be used to minimize potential exposure to identified site contaminants of concern and injection solutions during site injection operations. In addition, good personal hygiene practices and procedures must be practiced.
- Use face shields in combination with safety glasses or goggles when the potential for exposure to chemical splashes may exist.
- If repairs to injection delivery system components are necessary after the subsurface injection operations have been initiated, the injection lines must be relieved of pressure and drained before conducting repair work. See also the Lockout/Tagout section of these Guidelines.
- Drums/containers of injection material shall be moved using a drum “dolly” or other appropriate material handling equipment where the weight of the drum can be properly managed and secured during the movement.
- Empty containers may require special preparation/rinsing prior to disposal. Verify requirements with the project Environmental Manager.
- Only qualified personnel, by prior training or experience, may operate the injection system delivery components/array(s).
- Appropriate spill response materials for all chemicals must be present at the job site. Only qualified (by training and previous experience) who have proper PPE and equipment available shall provide spill response operations.

- Station a portable eye wash in the immediate work area where chemical injections are occurring, along with wash facilities for hygienic practices and PPE decontamination.
- If PPE becomes saturated and may potentially impact work clothing, dermal surfaces, or mucous membranes, change PPE immediately.
- Verify the competency and integrity of the chemical injection hoses/piping and connection points
- Confirm hose/piping rated for 100 psi.
- Verify the any cam-lock fitting on the injection hose/piping, well head, or direct push technology (DPT) rods are structurally sound and free of defects. Where hoses are used, ensure fittings have been secured to the hose surface via mechanical banding equipment to prevent whipping.
- When injecting under pressure, stand at a sufficient distance (i.e., ~ 20 feet) from the injection well head/point. Keep unessential project personnel away from the injection system, array, and well head(s) during injection operations.
- Remove/stow all unnecessary equipment and material in the area.
- The injection system/array must be monitored/attended at all times during the injection process and when not in use, components must be properly secured, de-energized, or stowed. If the system will operate without an attendant, plans for operating unattended must be in place and approved by the PM and HSM/EM.
- All pressured lines and fittings should be 'tethered' or otherwise secured to minimize whipping or 'launching' of lines in the event of an equipment failure. Any "quick connect" type fittings (compressed air or fluid) should be secured with appropriate pins, clips to prevent accidental disengagement of the fitting during operation.
- Inspect all equipment, hoses, pressure lines, and fittings daily and prior to pressurizing.

Chemical Storage

- Some injection chemicals, such as strong oxidizers, may have stringent storage requirements per local or National Fire Codes. Verify that appropriate storage provisions are in place prior to starting work.
- NOTE: Counties and cities may have requirements specific to storing these chemicals. Also, storage and use of certain chemicals such as potassium permanganate and hydrogen peroxide may be subject to the new Chemical Facility Anti-Terrorism Standards of the Department of Homeland Security – the applicability depends on the chemical, quantity/concentration, and type of facility. Please contact the project Environmental Manager to determine whether chemicals are subject to these standards.
- Chemicals must be stored in a designated, secured area with spill prevention capabilities. Review SDS or other information to determine potential incompatible materials. Incompatible materials shall not be stored together. Ensure all containers are labeled.

8.10 Compressed Gas Cylinders

(Reference CH2M HILL SOP HSE-403, *Hazardous Materials Handling*)

Below are the hazard controls and safe work practices to follow when working around or using compressed gas cylinders. Ensure the requirements in the referenced SOP are followed.

- Cylinders and pressure-controlling apparatus shall be inspected for defects and leakage prior to use. Damaged or defective items shall not be used. If a cylinder is found to be defective, the gas distributor shall be notified and subsequent instructions followed. If a leak should develop at a fuse plug or other safety device, the cylinder shall be removed from the work area.
- Cylinders shall be labeled with the identity of the contents. Cylinders not labeled shall be sent back to the cylinder distributor. The color of the cylinder shall not be used exclusively to identify cylinder contents.
- Valve caps must be in place when cylinders are transported, moved, or stored.

- Cylinders must be secured in an upright position at all times.
- Cylinder valves must be closed when cylinders are not being used and when cylinders are being moved.
- Cylinders must be secured on a cradle, basket, or pallet when hoisted; they may not be hoisted by choker slings.
- Eye protection (safety glasses or goggles) shall be worn when using cylinders.
- Cylinders must be shielded from welding and cutting operations and positioned to avoid being struck or knocked over; contacting electrical circuits; or exposed to extreme heat sources.
- Cylinders inside buildings shall be stored in dry, well-ventilated locations at least 20 feet (6.1 meters) from highly combustible materials. Cylinders should be stored in definitely assigned places away from elevators, stairs, or gangways. Assigned storage areas shall be located where cylinders will not be knocked over or damaged.
- Oxygen cylinders in storage shall be separated from fuel gas cylinders or combustible materials by a minimum of 20 feet (6.1 meters) or by a noncombustible barrier at least 5 feet (1.5 meters) high, having a fire resistance rating of at least 0.5 hour.
- Signs indicating no smoking shall be provided for storage areas containing flammable gas cylinders.
- Complete the self-assessment checklist for compressed gas cylinders are being used.

8.11 Concrete Work and Masonry Construction Activities (Including well pad construction)

(Reference CH2M HILL SOP HSE-302, *Concrete and Masonry*)

Below are the hazard controls and safe work practices to follow when working around or performing concrete and masonry activities. Ensure the requirements in the referenced SOP are followed.

- Wear PPE to avoid contact with concrete including gloves, mud boots, hard hat, safety glasses, long sleeved shirt and long pants.
- Consult the glove supplier or the cement manufacturer's SDS for help in choosing the proper gloves. Butyl or nitrile gloves (rather than cotton or leather gloves) are frequently recommended for caustic materials such as Portland cement.
- Use only well-fitting gloves. Loose-fitting gloves let cement in. Often the use of gloves and clothing makes exposure worse when cement gets inside or soaks through the garment. Use glove liners for added comfort.
- Wash your hands before putting on gloves. Wash your hands every time that you remove your gloves.
- Dry your hands with a clean cloth or paper towel before putting on gloves.
- Protect your arms and hands by wearing a long sleeve shirt with the sleeves duct-taped to your gloves to prevent wet cement from getting inside the gloves.
- Follow proper procedures for removing gloves, whether reusing or disposing them.
- Clean reusable gloves after use. Before removing gloves, clean the outside by rinsing or wiping off any wet cement. Follow the manufacturer's instructions for glove cleaning. Place clean and dry gloves in a plastic storage bag and store them in a cool, dry place away from tools.
- Throw out grossly contaminated or worn-out gloves.
- Keep the inside of gloves clean and dry.

- Wear waterproof boots when necessary to prevent wet cement from coming into contact with your skin. It is as important to protect your legs, ankles, and feet from skin contact with wet cement as it is to protect your hands.
- Boots need to be high enough to prevent wet cement from getting inside. Tuck pants inside and wrap duct tape around the top of the boots to prevent wet cement from entering.
- Change protective boots if they become ineffective or contaminated on the inside with wet cement while in use.
- Change out of any work clothes that become contaminated with wet cement and keep contaminated work clothes separate from your street clothes.
- When kneeling on wet cement use waterproof kneepads or dry kneeboards to prevent the knees from coming into contact with the cement.
- Wear proper eye protection when working with Portland cement.
- Perform hazard communication training for concrete. Read SDSs heed the manufacturers' recommendations for safety precautions.
- Protruding reinforcing steel (rebar), onto which personnel could fall, must be guarded to eliminate the hazard of impalement
- During post-tensioning, only those personnel essential to the operation are permitted behind the tensioning jacks.
- Personnel shall not ride concrete buckets nor position themselves in areas where buckets are lifted overhead.
- Personnel shall maintain a safe distance from formwork and shoring being removed from concrete structures.
- Personnel shall maintain a safe distance from precast and lift-slab concrete being lifted into position until physically secured.
- Personnel shall not enter limited access zones during masonry wall construction.
- When CH2M HILL is in control of concrete and masonry operations, a lift slab competent person will oversee all the concrete and masonry operations.
- Complete the self-assessment checklist for concrete and masonry activities whenever those activities are being performed.

8.12 Concrete Core Drilling

(Reference CH2M HILL SOP HSE-204, *Drilling*)

Below are the hazard controls and safe work practices to follow when working around or performing concrete core drilling.

- Operators must read and understand the Operators Manual(s) for the equipment that will be used.
- Follow all manufacturers' operating instructions and comply with all warning labels on the equipment.
- Inspect equipment to ensure it is in proper operating condition prior to use. Equipment damage or missing parts must be corrected prior to operation.
- Follow all requirements for use of PPE. Minimum PPE includes hearing protection, safety glasses with side shields, safety toed boots. A face shield over safety glasses or liquid splash goggles may be required for wet coring.
- Inspect areas to be cored to ensure there are no obstructions, for example utilities on the opposite side of a wall to be cored through. Follow utility locate procedures for when coring slab on grade.

- Provide dust control (wet coring or local exhaust for dry coring) to avoid potential silica exposure.
- Make sure that all electrical wiring is grounded.
- The power supply line (electric cord, pneumatic or hydraulic line) must be protected from damage and routed to prevent it becoming a tripping hazard.
- When hydraulic coring equipment is used, all workers must be aware of hydraulic lines running to the coring equipment. Preparations must be made for containment/clean up in the event of a ruptured hydraulic line.
- All workers must keep their hands and body away from the cutting saw/cable.
- The power supply must be disconnected when changing bits or conducting other maintenance on the equipment.
- Slippery conditions may exist in wet coring operations. Water needs to be controlled during cutting and proper safety toed footwear used to minimize slip potential.
- Use the Drilling Self-Assessment checklist to evaluate coring operations.

8.13 Concrete Saw Cutting

- Ensure operators are trained and familiar with the equipment are operating the saw. Operators must read and understand the Operators Manual(s) for the equipment that will be used.
- Inspect equipment to ensure it is in proper operating condition prior to use. Equipment damage or missing parts must be corrected prior to operation.
- Cutting blades shall be the correct size, installed properly, guarded at all times, and speed should not exceed the manufacturer's suggested operating speed.
- Workers shall use the correct blade for the job and inspect it for defects before each use.
- Saws shall be maintained and kept clean from dust build-up. Workers shall not push against the saw during operation to avoid the blade jumping out of the cutting path and loss of operator control.
- Inspect areas to be sawed to ensure there are no obstructions, for example rocks or other debris. Follow utility locate procedures prior to cutting.
- Personal protective equipment (PPE) saw use shall include hard hats, safety-toed boots, safety glasses and face shields, hearing protection, and leather gloves.
- The dust created by the concrete saw needs to be controlled using the application of water or local exhaust ventilation (i.e., removes dust at the source) to reduce the amount of airborne dust generated. If dust cannot be controlled, suspend work and contact the RHSM to determine if air monitoring/respiratory protection will be necessary.
- If equipped, the power supply line (electric cord, pneumatic or hydraulic line) must be protected from damage and routed to prevent it becoming a tripping hazard. The power supply must be disconnected when changing blades or conducting other maintenance on the equipment.
- Ensure all utilities have been marked and located in accordance with the underground utilities section of these Guidelines.
- Slippery conditions may exist in wet cutting operations. Water needs to be controlled during cutting and proper safety toed footwear used to minimize slip potential.

8.14 Confined Space Entry Activities

(Reference CH2M HILL, SOP HSE-203, *Confined Space Entry*)

A confined space is defined as a space that has all of the following characteristics:

- Large enough to allow personnel to enter the space with their entire body;
- Limited openings for entry and exit; and
- Not designed for continuous human occupancy;

Examples of possible confined spaces include underground vaults, pipelines, ducts, tunnels, storage tanks, sewers, process vessels, and pits. Entry into a confined space is defined as breaking the plane of a confined space with any part of the body.

The following requirements apply when entering a permit-required confined space (PRCS), an Alternate Procedure Confined Space, or a PRCS reclassified as a non-permit confined space (NCS). Ensure the requirements in the referenced SOP are followed.

- Entrants, Attendants, and the Entry Supervisor shall have successfully completed Confined Space Entry training.
- The appropriate confined space entry permit shall be completed as outlined in CH2M HILL SOP HSE-203, *Confined Space Entry*.
- The completed permit or certificate shall be posted for review near the space entrance point.
- The Entry Supervisor shall conduct a pre-entry briefing with all Authorized Entrants and Attendants prior to entry in accordance with SOP HSE-203.
- Entrants and Attendants shall verify that the Entry Supervisor has authorized entry and that all requirements of the permit or certificate have been satisfied prior to each entry.
- Atmospheric monitoring for oxygen, combustible gases, and potential toxic air contaminants shall be conducted at the frequency provided on the permit or certificate. Entry shall not be permitted if an atmospheric hazard is detected above acceptable safe levels. Atmospheric monitoring shall be performed in accordance with the Site Monitoring Section of the project safety plan and SOP HSE-203.
- Entrants shall evacuate the space upon orders of the Attendant or Entry Supervisor, when an alarm is sounded, or when a prohibited condition or dangerous situation is recognized.
- Entrants and Attendants shall inform the Entry Supervisor of any hazards confronted or created in the space, or any problems encountered during entry. The Entry Supervisor shall inform the owner of such issues.
- The Entry Supervisor shall provide a copy of the canceled permit or certificate to the SC for review and maintain it in the project file.
- Complete the self-assessment checklist for confined space entry whenever entries are being performed.

8.15 Cranes

(Reference CH2M HILL SOP HSE-303, *Cranes*)

Below are the hazard controls and safe work practices to follow when working around or operating cranes. Ensure the requirements in the referenced SOP are followed.

- Crane operators are prohibited from using any wireless device while operating a crane. Equipment must be stopped before using devices such as two way radios or cell phones. If a wireless device is required for a certain operation, the PM and HSM must authorize the wireless use on a case by case basis and make sure limitations are addressed in the project safety plan.

- Cranes shall be operated by a certified crane operator. After November 10, 2014, only operators possessing a certificate from a nationally accredited testing organization, an audited employer training program, or U.S. military or state-issuing agency will be authorized to operate cranes.
- The crane's operations manual and load chart specifically designed for the crane shall be in the crane at all times.
- The crane must have a current annual inspection to include load test certification (within the last 12 months) that meets all state and federal safety standards. Documentation of this inspection must be available for review.
- A competent person will inspect the crane daily to ensure it is in safe operating condition. The daily crane inspection log provided within the crane manufacturer's operations manual shall be used. See also the requirements for monthly inspections, among others, in SOP HSE-303.
- All rigging equipment must be inspected by a competent person prior to use for signs of excessive wear; equipment found to be damaged will be tagged and removed from service.
- A qualified and competent Assembly/Disassembly (A/D) Director shall be assigned when cranes must be assembled onsite. The A/D Director is responsible for ensuring the crane is assembled and disassembled according to manufacturer requirements; performing training for the A/D crew; and ensuring sufficient ground conditions exist for crane placement; among other responsibilities (see SOP HSE-303).
- The assembly/disassembly process must comply with requirements in HSE-303, including having an AHA for the task.
- A critical lift plan shall be prepared when the lift is estimated to be greater than 75 percent of the crane capacity or when two cranes will be used to make a lift.
- A pre-lift meeting will be conducted to include all parties involved in that day's crane operation.
- Only one qualified person shall be designated to signal the crane operator. This person shall be thoroughly familiar with the ANSI standard method of hand signals and an illustration of these signals shall be posted at the job site.
- No personnel shall be permitted under the load at any time.
- Tag lines shall be attached to every load being made by the crane.
- The swing radius of the rear rotating superstructure (counterweight) of the crane shall be barricaded and no entrance allowed.
- Suspended loads shall not pass over workers or occupied buildings at any time.
- Complete the self-assessment checklist for crane-suspended personnel platforms whenever they are being used.
- CH2M HILL employees exposed to hazards posed by crane operations, must be trained in hazards awareness and control procedures. See requirements for training in HSE-303.

Power Line Safety

It must be determined whether equipment operations including assembly/disassembly, positioning, and crane operation (including traveling with a load) will occur in proximity to power lines within 20 feet (6.1 meters) for line voltage up to 350 kilo volts (kV), and within 50 feet (15.2 meters) for line voltage between 350 kV to 1000 kV. For power lines over 1000 kV, the distance must be determined by the utility/operator or qualified registered professional engineer in electrical power transmission and distribution.

If equipment operations are within proximity of aforementioned distances to power lines, one of the following options must be implemented to prevent encroachment and electrocution:

- Option 1: Deenergize and ground the power. Confirm from the utility/operator that the power line has been deenergized and visibly grounded at the worksite
- Option 2: If the voltage is not determined, ensure that no part of the equipment, load line, or load (including rigging and lifting accessories), gets closer than 20 feet (6.1m) by:
 - Conduct a planning meeting with the operator and other workers in the area to review the actions that will be taken to prevent encroachment and electrocution. Training requirements for working around energized power lines are described in Section 6.0, Training.
 - Use non-conductive tag lines.
 - Erect and maintain an elevated warning line, barricade or line of signs in view of the operator, either with flags or other high-visibility markings at 20 feet (1.6m) from the power line. A spotter must be used when the operator does not have clear line of sight to the elevated warning line.
 - To prevent encroachment, the operator can use a proximity alarm, or position a dedicated spotter with visual aids to demarcate the encroachment and constant communication access to the operator.

If the line voltage can be determined, and if any part of the equipment, line load or load (including rigging and lifting accessories) would encroach within that specified distance listed in Table 1, then the requirements listed in Option 2 must be implemented.

TABLE 1
Minimum Clearance Distances

Voltage (nominal, kV, alternating current)	Minimum Clearance – Feet (meters)
Up to 50	10
Over 50 to 200	15
Over 200 to 350	20
Over 350 to 500	25
Over 500 to 750	35
Over 750 to 1000	45
Over 1000	Established by the utility owner/operator or by a qualified registered professional engineer in electrical power transmission and distribution

For equipment traveling within 20 feet (6.1m), under or near power lines without a load, the clearance distances described in Table 2 must be maintained and the following actions implemented.

- A dedicated spotter is assigned during equipment travel, positioned to effectively gauge the clearance distance, and is in continuous communication with the operator.
- During equipment travel, the boom/mast and support system are sufficiently lowered to ensure clearance distances are maintained, along with taking into consideration of the effects of speed and terrain.

TABLE 2

Minimum Clearance Distances While Traveling With No Load

Voltage (nominal, kV, alternating current)	Minimum Clearance – Feet (meters)
Up to 0.75	4
Over 0.75 to 50	6
Over 50 to 345	10
Over 345 to 750	16
Over 750 to 1000	20
Over 1000	Established by the utility owner/operator or by a qualified registered professional engineer in electrical power transmission and distribution

8.16 Crystalline Silica

(Reference CH2M HILL SOP HSE-511, Crystalline Silica)

CH2M HILL subcontractors shall control employee exposure to crystalline silica when exposures are at or above the ACGIH TLV of 0.025 mg/m³ by submitting for review and approval a crystalline silica exposure monitoring plan. The elements of an exposure monitoring plan include, but are not limited to the following:

- A bulk sample representative of the material to be demolished must be sent with the air monitoring sample media for analysis;
- Initial monitoring and personal air sampling must be conducted to determine the potential worker exposure to respirable crystalline silica;
- Real-time particulate monitors with a 10 micron respirable size fraction attachment may be used as part of the initial and ongoing monitoring plan to evaluate the potential worker exposure. This must include an action level established by their corporate or site health and safety professional and include actions required (e.g., implement engineering, administrative controls, respiratory protection);

Other exposure control measures include:

- Maintaining surfaces as clean as practicable to minimize accumulation of crystalline silica containing particulate material;
- Clean surfaces with a HEPA-filter vacuum or equivalent method;
- Implement dust suppression during demolition;
- Restricting access to the work area where crystalline silica exposure may exist to only those authorized to perform work or enter the area;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in these areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and

8.17 Demolition

(Reference CH2M HILL SOP HSE-305, *Demolition*)

This section is applicable to all forms of demolition. Demolition is defined as the removal or dismantling of structures or equipment by disassembly.

An engineering survey shall be completed prior to start of demolition operations. The survey shall determine the condition of the structure framing, floors, and walls; the presence of asbestos, polychlorinated biphenyls (PCBs),

lead paint, or other regulated hazardous substances; the presence of hazardous materials in tanks, pipes, and equipment; and the possibility of unplanned collapse of any portion of the structure. Any adjacent structure where personnel may be exposed shall also be similarly evaluated. The survey shall be conducted by a competent person and a written record of the survey findings shall be maintained at the project site.

The demolition contractor working on this project will provide CH2M HILL with a demolition safety plan prior to the start of work. CH2M HILL will use this plan to verify that the subcontractor is implementing the necessary safety precautions during this activity. In addition, the following safety precautions shall be implemented by CH2M HILL personnel. Below are the hazard controls and safe work practices to follow when working around or performing demolition. Ensure the requirements in the referenced SOP are followed.

- Appropriate warning and instructional safety signs shall be conspicuously posted where necessary.
- Fugitive dust must be controlled during demolition by using water spray or other methods.
- Remain a safe distance from the demolition zone to reduce exposure to fragmentation of glass, steel, masonry, and other debris during demolition operations.
- Do not enter the demolition zone unless completely necessary, and only after the competent person has assessed the condition of the structure and has authorized entry.
- Follow all requirements established by the competent person. The competent person shall inform personnel of the areas that are safe to enter and the areas where entry is prohibited. When possible, the competent person should escort CH2M HILL personnel while in the demolition zone.
- All demolition activities that may affect the integrity of the structure or safety of personnel must cease until personnel have exited the demolition zone.
- During the course of demolition, work areas, passageways, stairs, ladders, and exits shall be kept free of demolition debris.
- Stay as clear as possible of all hoisting operations. Loads shall not be hoisted overhead of personnel
- Proper control measures shall be in place before welding or cutting on surfaces covered by coatings containing flammable or hazardous materials such as lead, cadmium, zinc, etc. Highly flammable or toxic coatings may require stripping of the coating a sufficient distance from the area to be heated. Welding and cutting shall be performed in accordance with the provisions of OSHA 1926, Subpart J, "Welding and Cutting." Follow "Welding and Cutting" SOP HSE-314.

The following lead-exposure-control procedures will be implemented during demolition operations involving potential exposure to lead:

- Site personnel will be provided lead-awareness training;
- Site personnel will be provided with hand-washing facilities and will wash their hands daily;
- An excavator equipped with hydraulic shears will be used only to cut painted wooden, concrete, and metal structures;
- Neither hand-held band/chop saws nor torch cutting equipment will be used on painted surfaces without proper PPE and engineering controls in place or removal of paint prior to cutting;
- During all demolition operations to control potential exposures to LBP, wet methods using water mist will be used;
- A direct-reading dust monitor will be used to monitor demolition operations that pose a potential lead-exposure hazard (that is, those with an action level requiring that additional dust control measures be employed and/or that respiratory protection be used.);
- Personal air samples will be collected and analyzed for lead to confirm that no personnel are exposed to levels above the lead action level of 30 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$); and

- The selection of respiratory protection and other exposure controls will be based on the most recent exposure monitoring results obtained from the lead-exposure-competent person.
- For more information see CH2M HILL SOP HSE-508, Lead.

8.18 Drilling Safety

(Reference CH2M HILL SOP HSE-204, *Drilling*)

Below are the hazard controls and safe work practices to follow when working around or performing drilling. Ensure the requirements in the referenced SOP are followed.

- The drill rig is not to be operated in inclement weather.
- The driller is to verify that the rig is properly leveled and stabilized before raising the mast.
- Personnel should be cleared from the sides and rear of the rig before the mast is raised.
- The driller is not to drive the rig with the mast in the raised position.
- The driller must check for overhead power lines before raising the mast. Maintain a minimum distance of 10 feet (3 meters) between mast and overhead lines (<50 kV) and an additional 0.4 inches for every 1 kV over 50kV. Verify the voltage of nearby overhead power lines to determine the minimum distance.
- If the project site is suspected of munitions or explosives of concern (MEC) contamination, requirements of the *Explosives Usage and Munitions Response (MR)* SOP HSE-610 shall be followed. MECs include unexploded ordnance (UXO), discarded military munitions, materials that present a potential explosive hazard, chemical warfare materials, munitions constituents, and contaminated soil or groundwater. "Down-hole" avoidance support may be required to prevent accidental contact with UXO. Safety requirements will be based on the risk assessment identified within the MR (safety) ORE (Opportunity Risk Evaluation).
- Personnel should stand clear before rig startup.
- The driller is to verify that the rig is in neutral when the operator is not at the controls.
- Become familiar with the hazards associated with the drilling method used (cable tool, air rotary, hollow-stem auger, etc.).
- Do not wear loose-fitting clothing, watches, etc., that could get caught in moving parts.
- Do not smoke or permit other spark-producing equipment around the drill rig.
- The drill rig must be equipped with a kill wire or switch, and personnel are to be informed of its location.
- Be aware and stand clear of heavy objects that are hoisted overhead.
- The driller is to verify that the rig is properly maintained in accordance with the drilling company's maintenance program.
- The driller is to verify that all machine guards are in place while the rig is in operation.
- The driller is responsible for housekeeping (maintaining a clean work area).
- The drill rig should be equipped with at least one fire extinguisher.
- If the drill rig comes into contact with electrical wires and becomes electrically energized, do not touch any part of the rig or any person in contact with the rig, and stay as far away as possible. Notify emergency personnel immediately.
- Use the drilling self-assessment checklist to evaluate drilling operations.

8.19 Drum and Portable Tank Handling

Below are the hazard controls and safe work practices to follow when overseeing the movement of drums or when handling drums:

- Ensure that personnel are trained in proper lifting and moving techniques to prevent back injuries;
- Ensure drum or tank bungs and lids are secured and are labeled prior to moving;
- Ensure that drums and tanks remain covered except when removing or adding material or waste. Covers and/or lids will be properly secured at the end of each workday;
- Provide equipment to keep the operator removed from the drums to lessen the likelihood of injury. Such equipment might include: a drum grappler attached to a hydraulic excavator; a small front-end loader, which can be either loaded manually or equipped with a bucket sling; a rough terrain forklift; Roller conveyor equipped with solid rollers; drum carts designed specifically for drum handling;
- Make sure the vehicle selected has sufficient rated load capacity to handle the anticipated loads, and make sure the vehicle can operate smoothly on the available road surface;
- Ensure there are appropriately designed Plexiglas cab shields on loaders, backhoes, etc., when handling drums containing potentially explosive materials;
- Equipment cabs should be supplied with fire extinguishers, and should be air-conditioned to increase operator efficiency;
- Supply operators with appropriate respiratory protective equipment when needed;
- Ensure that drums are secure and are not in the operator's view of the roadway;
- Prior to handling, all personnel should be warned about hazards of handling;
- Before moving anything, determine the most appropriate sequence in which the various drums, portable tanks, and other containers should be moved (e.g., small containers may have to be removed first to permit heavy equipment to enter and move the drums);
- Overpack drums and an adequate volume of absorbent should be kept near areas where minor spills may occur;
- Use containers or overpacks that are compatible with the waste or materials;
- Drums containing liquids or hazardous waste will be provided with secondary containment and may not be located near a storm water inlet or conveyance;
- Allow enough aisle space between drum pallets and between drums and other equipment that the drums can be easily accessed (at least 2 to 3 feet) by fire control equipment and similar equipment.; and
- Make sure that a spill kit is available in drum or tank storage areas (or where liquids are transferred from one vessel to another).

8.20 Drum Sampling Safety

Personnel are permitted to handle and/or sample drums containing certain types of waste (drilling waste, investigation-derived waste, and waste from known sources) only. Handling or sampling drums with unknown contents requires a plan revision or amendment approved by the RHSM. The following control measures will be taken when sampling drums:

- Minimize transportation of drums;
- Sample only labeled drums or drums from a known waste stream;
- Do not sample bulging or swollen drums. Contact the RHSM;

- If drums contain, or potentially contain, flammable materials, use non-sparking tools to open;
- Use the proper tools to open and seal drums;
- Reseal bung holes or plugs whenever possible;
- Avoid mixing incompatible drum contents;
- Sample drums without leaning over the drum opening;
- Transfer/sample the content of drums using a method that minimizes contact with material;
- Use the PPE and perform air monitoring as specified in the PPE and Site Monitoring sections of the project safety plan;
- Take precautions to prevent contaminated media from contacting the floor or ground, such as having plastic under the sampling area, having a spill kit accessible during sampling activities; and
- If transferring/sampling drums containing flammable or combustible liquids, drums and liquid transfer equipment should be grounded and bonded to reduce the potential of a static discharge.

8.21 Earthmoving Equipment

(Reference CH2M HILL, SOP HSE-306, *Earthmoving Equipment*)

Below are the hazard controls and safe work practices to follow when working around or operating heavy equipment. Ensure the requirements in the referenced SOP are followed.

- CH2M HILL authorizes only those employees qualified by training or previous experience to operate material handling equipment.
- CH2M HILL employees must be evaluated prior to operating earthmoving equipment by a CH2M HILL earthmoving equipment operator evaluation designated person. This evaluation will be documented according to SOP HSE-306, Earthmoving Equipment.
- Heavy equipment operators are prohibited from using any wireless device while operating equipment. Equipment must be stopped before using devices such as two way radios or cell phones. If a wireless device is required for a certain operation, the PM and HSM must authorize the wireless use on a case by case basis and make sure limitations are addressed in the project safety plan.
- Equipment must be checked at the beginning of each shift to ensure the equipment is in safe operating condition and free of apparent damage. The check should include: service brakes, parking brakes, emergency brakes, tires, horn, back-up alarm, steering mechanism, coupling devices, seat belts and operating controls. All defects shall be corrected before the equipment is placed in service. Documentation of this inspection must be maintained onsite at all times (use the Earthmoving Equipment Inspection form if operated by CH2M HILL).
- Equipment must be on a stable foundation such as solid ground or cribbing; outriggers are to be fully extended.
- Equipment must not be used to lift personnel; loads must not be lifted over the heads of personnel.
- Equipment, or parts thereof, which are suspended must be substantially blocked or cribbed to prevent shifting before personnel are permitted to work under or between them. All controls shall be in a neutral position, with the motors stopped and brakes set.
- Equipment which is operating in reverse must have a reverse signal alarm distinguishable from the surrounding noise or a signal person when the operators view is obstructed.
- When equipment is used near energized power lines, the closest part of the equipment must be at least 10 feet (3 meters) from the power lines less than 50 kilovolts (kV). Provide an additional 4 feet (1.2 meters) for every 10 kV over 50 kV. A person must be designated to observe clearances and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means. All overhead power

lines must be considered to be an energized until the electrical utility authorities indicate that it is not an energized line and it has been visibly grounded.

- Underground utility lines must be located before excavation begins; refer to the Utilities (underground) section.
- Operators loading and unloading from vehicles are responsible for seeing that vehicle drivers are in the vehicle cab or in a safe area.
- The parking brake shall be set whenever equipment is parked; wheels must be chocked when parked on inclines.
- When not in operation, the blade or bucket must be blocked or grounded; the master clutch must be disengaged when the operator leaves the cab. When equipment is unattended, power must be shut off, brakes set, blades or buckets landed and shift lever in neutral.

8.22 Energized Electrical Work

(Reference CH2M HILL SOP HSE-221, *Energized Electrical*)

Energized electrical work is defined as work performed on or near energized electrical systems or equipment with exposed components operating at 50 volts or greater. Working near energized live parts is any activity inside a Limited Approach Boundary.

All electrical systems shall be considered energized unless lockout/tagout procedures are implemented and verified.

Electrical wiring and equipment shall be de-energized prior to conducting work unless it can be demonstrated that de-energizing introduces additional or increased hazards or is unfeasible due to equipment design or operational limitations. When energized electrical work is the only means that work can be performed, all requirements of SOP HSE-221 must be implemented including the following:

- Only qualified personnel are permitted to work on unprotected energized electrical systems. These personnel shall complete the CH2M HILL energized electrical safety training and must be designated by their supervisor as an Energized Electrical Qualified Person (EEQP). CPR and AED training must be completed by these personnel annually.
- An Electrical Hazard Analysis must be performed to identify energized electrical safe work practices before any person approaches exposed live parts within the Limited Approach Boundary (as determined by the shock hazard analysis), by performing both shock hazard analysis and flash hazard analysis, which comprise the electrical analysis.
- The Energized Electrical Work Permit must be completed prior to working on unprotected energized electrical systems.
- CH2M HILL employees designated as qualified persons working on live parts of energized electrical systems 480 volts and above shall implement the buddy system. This means that two EEQPs must be engaged in this work. Working on live parts of energized electrical systems 480 volts and above means actual contact with live parts or working within the Prohibited Approach Boundary, which is one inch (2.54 cm) for 480 volt systems.
- The buddy system requires the presence of an additional EEQP who shall stand by and render assistance, or summon help for the first person, in the event the first person is inadvertently shocked while performing the work. The second person shall not be assigned to additional distracting duties or tasks while the energized electrical work is being performed and shall know the location of the isolation device(s) for the equipment being worked on.
- Workers designated as qualified persons shall wear the required electric shock and arc-flash PPE, as specified by the qualified person responsible for the energized electrical operations.

- Safety signs, safety symbols or accident prevention tags, meeting applicable American National Standards Institute (ANSI) Standards, shall be used where necessary to warn employees about electrical hazards.
- Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing live parts. Conductive barricades shall not be used where it may cause an electrical hazard. Barricades shall be placed no closer than the Limited Approach Boundary.
- If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect unqualified employees. The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside a work area where the unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.
- Employees shall not perform tasks near exposed energized parts where lack of illumination or an obstruction precludes observation of the work. Employees shall not reach blindly into areas that may contain energized parts.
- Work shall be performed in accordance with National Fire Protection Association (NFPA) 70E requirements (2012 edition).
- Follow all control measures and procedures identified on the Energized Electrical Work Permit and the AHA.

8.23 Excavation Activities

(Reference CH2M HILL SOP HSE-307, *Excavation and Trenching Safety*)

The requirements in this section shall be followed whenever excavation is being performed. Refer to the Earthmoving Equipment section and SOP for additional requirements applicable to operating/oversight of earthmoving equipment. Below are the hazard controls and safe work practices to follow when working around or performing excavation. Ensure the requirements in the referenced SOP are followed.

- If the project site is suspected of munitions or explosives of concern (MEC) contamination, requirements of the *Explosives Usage and Munitions Response (MR)* SOP HSE-610 shall be followed. MECs include unexploded ordnance (UXO), discarded military munitions, materials that present a potential explosive hazard, chemical warfare materials, munitions constituents, and contaminated soil or groundwater. "Down-hole" avoidance support may be required to prevent accidental contact with UXO. Safety requirements will be based on the risk assessment identified within the MR (safety) ORE (Opportunity Risk Evaluation).
- Do not enter the excavations unless completely necessary, and only after the excavation competent person has completed their daily inspection and has authorized entry. An inspection shall be conducted by the competent person prior to the start of work, as needed throughout the shift, after every rainstorm, and after any hazard increasing occurrence. Documentation of the inspection must be maintained onsite at all times.
- Follow all excavation entry requirements established by the excavation competent person and any excavation permit being used.
- Sloping, benching, shoring, shielding, or other protective systems are required to protect personnel from cave-ins except when the excavation is made entirely in stable rock or is less than 5 feet deep (1.5 meters) and there is no indication of possible cave-in, as determined by the excavation competent person. Protective systems for excavations deeper than 20 feet (6.1 meters) must be designed or approved by a registered professional engineer.
- Trenches greater than 4 feet (1.2 meters) deep shall be provided with a ladder, stairway, or ramp positioned so that the maximum lateral travel distance is no more than 25 feet (7.6 meters).
- The atmosphere of excavations greater than 4 feet (1.2 meters) deep shall be tested prior to entry when a hazardous atmosphere exists or could reasonably be expected to exist, such as excavating landfills, hazardous waste dumps; or areas containing sewer or gas utility systems, petroleum distillates, or areas where hazardous substances are stored nearby.

- Spoil piles, material, and equipment must be kept at least 2 feet (61 centimeters) from the edge of the excavation, or a retaining device must be used to prevent the material from falling into the excavation.
- Excavations shall not be entered when:
 - Protective systems are damaged or unstable;
 - Objects or structures above the work location may become unstable and fall into the excavation;
 - The potential for a hazardous atmosphere exists, unless the air has been tested and found to be at safe levels; or
 - Accumulated water exists in the excavation, unless precautions have been taken to prevent excavation cave-in.
- The excavation self-assessment checklist shall be used to evaluate excavations prior to entry.

Excavation Operations

Refer to the Excavation Entry section when entering excavations controlled by other parties. When CH2M HILL performs the excavating, a CH2M HILL excavation competent person will oversee all excavation operations and entry into excavations. The competent person shall:

- Complete the CH2M HILL Excavation Permit to ensure HSE requirements have been satisfied during excavation activities;
- Complete the CH2M HILL Daily Excavation Inspection Checklist to ensure HSE requirements have been satisfied, document that an inspection has been conducted, and to authorize entry into the excavation. A new Checklist shall be completed each day, authorizing excavation entry. Inspections should be continued as needed throughout the work shift, and after any event that could increase the potential for cave-in (e.g., rainfall); and
- Conduct daily safety briefings prior to excavation entry.

8.24 Fall Protection Activities

(Reference CH2M HILL, SOP HSE-308, *Fall Protection*)

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are exposed to unprotected heights. Ensure the requirements in the referenced SOP are followed.

- Fall protection systems must be used to eliminate fall hazards when performing construction activities at a height of 6 feet (1.8 meters) or greater and when performing general industry activities at a height of 4 feet (1.2 meters) or greater.
- CH2M HILL staff exposed to fall hazards must complete initial fall protection training by completing either the CH2M HILL 10-Hour Construction Safety Awareness training course or the Fall Protection computer-based training module. Staff must also receive project-specific fall protection training using the fall protection evaluation form attached to the project safety plan. Staff shall not use fall protection systems for which they have not been trained.
- The SC or designee must complete the Project Fall Protection Evaluation Form and provide project-specific fall protection training to all CH2M HILL staff exposed to fall hazards.
- The company responsible for the fall protection system shall provide a fall protection competent person to inspect and oversee the use of fall protection system. CH2M HILL staff shall be aware of and follow all requirements established by the fall protection competent person for the use and limitation of the fall protection system.
- When CH2M HILL designs or installs fall protection systems, staff shall be qualified as fall protection competent persons or work directly under the supervision of a CH2M HILL fall protection competent person.

- When horizontal lifelines are used, the company responsible for the lifeline system shall provide a fall protection qualified person to oversee the design, installation, and use of the horizontal lifeline.
- Inspect personal fall arrest system components prior to each use. Do not use damaged fall protection system components at any time, or for any reason. Fall protection equipment and components shall be used only to protect against falls, not to hoist materials. Personal fall arrest systems that have been subjected to impact loading shall not be used. SC shall periodically inspect CH2M HILL fall protection equipment using the Fall Protection Inspection Log form.
- Personal fall arrest systems shall be configured so that individuals can neither free-fall more than 6 feet (1.8 meters) or contact any lower level.
- Only attach personal fall arrest systems to anchorage points capable of supporting at least 5,000 pounds (2,268 kg). Do not attach personal fall arrest systems to guardrail systems or hoists.
- Remain within the guardrail system when provided. Leaning over or stepping across a guardrail system is not permitted. Do not stand on objects (boxes, buckets, bricks, blocks, etc.) or ladders to increase working height on top of platforms protected by guardrails.
- Only one person shall be simultaneously attached to a vertical lifeline and shall also be attached to a separate independent lifeline.

8.25 Flight Line Safety

Always assume that the airfield is active. An active airfield means there is the possibility, even if an area is “closed”, that aircraft or other vehicles will need access on or through a work area. There is always the potential for an incursion. If in an area of the airfield where radio contact with the control tower is required, the potential for miscommunication exists. Any mistake in communication has the potential to cause a problem with Air Operations. When maneuvering on the airfield, there are fuel trucks, helicopter rotors, jet blast, etc., all of which are potential hazards for workers. Pilots of aircraft do not expect workers to be on the airfield. If equipment is not properly marked, it may go unnoticed by pilots and present the potential for an incursion.

An aircraft always has the right of way. When working in a confined area that is “closed” to traffic, outline the work area with traffic cones or barricades that will provide a warning to other airfield traffic. This will also serve to keep vehicles from running through wet paint. Have one person designated as the point of contact who will be responsible for monitoring the radio and communicating with the control tower. That person shall be properly trained in the use of the radio, and check in daily with Air Operations to confirm work areas. Properly train workers to be aware of airfield operations going on around them, to give way to all moving aircraft, to allow great distances from aircraft, parked or running, when maneuvering on airfield.

It is inherent upon the contractor to be visible to everyone operating on the airfield. Orange and white checkered flags, flashing amber beacons, cones and/or barricades should be in good condition and clearly visible.

Speed limits on airfield area are enforced. Speed limits on an airfield are very low relative to speeds on the roads. Speeding on the airfield can lead to a possible incursion. Restricted areas, particularly on a military installation, must be strictly enforced. They are usually outlined with a red line and often have certain “Entry Control Points” painted along the red line where entry into the area is permitted. Entry into the restricted area without permission may subject the workers to arrest.

There are safety areas around runways on the airfield. All equipment and materials must be stored behind these areas. If a crew working on the runway is instructed to clear the runway, all workers and equipment must be moved beyond the safety area until given clearance by the control tower to return to the runway.

8.26 Forklift Operations

(Reference CH2M HILL, SOP HSE-309, *Forklifts*)

Below are the hazard controls and safe work practices to follow when working around or operating forklifts. Ensure the requirements in the referenced SOP are followed.

- Forklift operators are prohibited from using any wireless device while operating forklifts. If a wireless device is required for a certain operation, the PM and HSM must authorize the wireless use on a case by case basis and make sure limitations are addressed in the project safety plan.
- A rated lifting capacity must be posted in a location readily visible to the operator.
- A forklift truck must not be used to elevate employees unless a platform with guardrails, a back guard, and a kill switch is provided on the vehicle. When guardrails are not possible, fall arrest protection is required.
- The subcontractor operating the forklift must post and enforce a set of operating rules for forklift trucks.
- Only certified forklift operators shall operate forklifts.
- Stunt driving and horseplay are prohibited.
- Employees must not ride on the forks.
- Employees must never be permitted under the forks (unless forks are blocked).
- The driver must inspect the forklift once a shift and document this inspection.
- The operator must look in the direction of travel and must not move the vehicle until all persons are clear of the vehicle.
- Forks must be carried as low as possible.
- The operator must lower the forks, shut off the engine, and set the brakes (or block the wheels) before leaving the forklift operator's position unless maintenance or safety inspections require the forklift to be running.
- Trucks must be blocked and have brakes set when forklifts are driven onto their beds.
- Extreme care must be taken when tilting elevated loads.
- Every forklift must have operable brakes capable of safely stopping it when fully loaded.
- Forklifts must have parking brakes and an operable horn.
- When the operator is exposed to possible falling objects, industrial trucks must be equipped with overhead protection (canopy).
- If using certified CH2M HILL forklift operators—forklifts must be inspected and documented daily using the forklift inspection form.

8.27 Groundwater Sampling/Water Level Measurements

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are performing groundwater sampling and/or water level measurements.

- Full coolers are heavy. Plan in advance to have two people available at the end of the sampling effort to load full coolers into vehicles. If two people won't be available use several smaller coolers instead of fewer large ones.
- Wear the appropriate PPE when sampling, including safety glasses, nitrile gloves, and steel toe boots (see PPE section of the project safety plan).
- Monitor headspace of wells prior to sampling to minimize any vapor inhalation (refer to the "Site Monitoring" section of the project safety plan).

- Use caution when opening well lids. Wells may contain poisonous spiders and hornet or wasp nests.
- Use the appropriate lifting procedures (see CH2M HILL SOP HSE-112) when unloading equipment and sampling at each well.
- Avoid sharp edges on well casings.
- If dermal contact occurs with groundwater or the acid used in sample preservation, immediately wash all affected skin thoroughly with soap and water.
- Avoid eating and drinking on site and during sampling.
- Use ear plugs during sampling if sampling involves a generator.
- Containerize all purge water and transport to the appropriate storage area.
- Use two people to transport full coolers/containers whenever possible. If two people are not available use a dolly to move coolers. If the coolers weigh more than 40 pounds Attachment 1 of the HSE-112, *Manual Lifting*, shall be completed by the SC. If the coolers weigh more than 50 pounds they should never be lifted by one person.

8.28 Hand and Power Tools

(Reference CH2M HILL, SOP HSE-210, *Hand and Power Tools*)

Hands are one of the most complex parts of the body. Every employee uses their hands to help them make a living. There are more on-the-job injuries to hands than any other body part.

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are using hand and power tools. Ensure the requirements in the referenced SOP are followed.

General

- Always select the right tool for the job;
- Keep cutting tools sharp—less force will be needed for the cut. Do not use pocket knives—only safety cutting tools and if using these be sure to comply with the “Knife Use” section of these Guidelines;
- Carry and store tools correctly and never put sharp or pointed tools in your pocket or belt;
- Tools shall be inspected prior to use and damaged tools will be tagged and removed from service;
- Store tools properly in a place where they will not be damaged or come in contact with hazardous materials; and
- Tools used in an explosive environment must be rated for work in that environment (that is, intrinsically safe, spark-proof, etc.).

Hand and Power Tools

- Hand and power tools will be used for their intended use and operated in accordance with manufacturer’s instructions and design limitations;
- Screwdrivers are one of the most used and abused tools, never:
 - Hammer with a screwdriver
 - Use as a pry bar
 - Use with a broken handle
 - Use with worn out tips

- Maintain all hand and power tools in a safe condition;
- Use PPE (such as gloves, safety glasses, earplugs, and face shields) when exposed to a hazard from a tool;
- Do not carry or lower a power tool by its cord or hose;
- Portable power tools will be plugged into GFCI protected outlets;
- Portable power tools will be Underwriters Laboratories (UL) listed and have a three-wire grounded plug or be double insulated;
- Disconnect tools from energy sources when they are not in use, before servicing and cleaning them, and when changing accessories (such as blades, bits, and cutters);
- Safety guards on tools must remain installed while the tool is in use and must be promptly replaced after repair or maintenance has been performed;
- If a cordless tool is connected to its recharge unit, both pieces of equipment must conform strictly with electrical standards and manufacturer's specifications; and
- Working with manual and pistol-grip hand tools may involve highly repetitive movement, extended elevation, constrained postures, and/or awkward positioning of body members (for example, hand, wrist, arm, shoulder, neck, etc.). Consider alternative tool designs, improved posture, the selection of appropriate materials, changing work organization, and sequencing to prevent muscular, skeletal, repetitive motion, and cumulative trauma stressors.

Machine Guarding

- Ensure that all machine guards are in place to prevent contact with drive lines, belts, chains, pinch points or any other sources of mechanical injury;
- Unplugging jammed equipment will only be performed when equipment has been shut down, all sources of energy have been isolated and equipment has been locked/tagged and tested; and
- Maintenance and repair of equipment that results in the removal of guards or would otherwise put anyone at risk requires lockout of that equipment prior to work.

8.29 Haul Trucks

Below are the hazard controls and safe work practices to follow when working around or operating haul trucks:

- Haul truck operators are prohibited from using any wireless device while operating trucks on site. Trucks must be stopped before using devices such as two way radios or cell phones. If a wireless device is required for a certain operation, the PM and HSM must authorize the wireless use on a case by case basis and make sure limitations are addressed in the project safety plan.
- Haul truck operators should be familiar with their equipment and inspect all equipment before use;
- Haul truck operators should ensure all persons are clear before operating truck or equipment. Before moving operators should sound horn or alarm, all equipment should be equipped with a working back up alarm;
- Haulage trucks or equipment with restricted visibility should be equipped with devices that eliminate blind spots;
- Employees should stay off haul roads. When approaching a haul area, employees should make eye contact and communicate their intentions directly with the equipment operator;
- If possible minimize steep grades on haul roads;
- Where grades are steep provide signage indicating the actual grade as well as measures for a runaway truck;

- Trucks are to be operated within the manufacturer's recommendations (for example- retarder charts indicate the combination of loads, grades and speeds that should not be exceeded if the truck's retarder is to work properly – to ensure the truck does not descend grade at speeds greater than listed);
- Haul roads should be well lit, sufficiently wide (at least 50 percent of the width of the equipment on both sides of road) and equipped with reflectors to indicate access points;
- Haul roads should have adequate right-of-way signs indicating haul directions;
- Haul trucks will follow designated haul roads; and
- Haul trucks will comply with posted speed limits.

8.30 Hoists

(Reference CH2M HILL SOP HSE-315, *Hoists*)

- Below are the hazard controls and safe work practices to follow when working around or operating hoists. Ensure the requirements in the referenced SOP are followed.
- Manufacturer's specifications and limitations applicable to the operation of material hoists shall be followed. Where manufacturer's specifications are not available, the limitations assigned to the equipment shall be based on the determinations of a professional engineer competent in the field.
- Rated load capacities, recommended operating speeds, and special hazard warnings or instructions shall be posted on hoists.
- Hoisting ropes shall be installed in accordance with the wire rope manufacturer's recommendations.
- The installation of live booms on hoists is prohibited.
- Operating rules shall be established and posted at the operator's station of on hoists.
- No person shall be allowed to ride on material hoists except for the purposes of inspection and maintenance.
- All entrances of the hoistways shall be protected by substantial gates or bars, which guard the full width of the landing entrance.
- Overhead protective coverings of 2-inch planking, ¾-inch plywood, or other solid material of equivalent strength, shall be provided on the top of every material host cage or platform.
- All hoistway entrance bars and gates shall be painted with diagonal contrasting colors, such as black and yellow.
- A qualified hoist operator will operate, inspect, maintain and oversee all hoist operations. The SC or designee shall verify hoist operator qualifications (e.g., operator to provide for the type of hoist being operated—years of experience, training, background).
- CH2M HILL employees who are required to operate hoists shall read the hoist manufacturer's operations and maintenance manual, be evaluated and approved as qualified hoist operators. The CH2M HILL may require operators to complete separate hoist operations training, provided by commercial training specialists.

8.31 Hydrogen Sulfide

Hydrogen sulfide (H₂S) is a colorless, toxic, and flammable gas responsible for the odor of rotten eggs. It often results from the bacterial break down of organic matter in the absence of oxygen, such as in sewers. It also occurs in gases, natural gas and in well waters. H₂S may be produced during the biological process when biological substrates are used to expedite the remediation process.

Chemical Properties

Hydrogen sulfide is heavier than air and may travel along the ground. It collects in low-lying and enclosed, poorly-ventilated areas such as basements, manholes, sewer lines, and underground telephone vaults. For work within confined spaces, use appropriate procedures for identifying hazards, monitoring and entering confined spaces (see Confined Space Entry section of these Guidelines or the project safety plan). Additionally, H₂S is a highly flammable gas and gas/air mixtures can be explosive. It may travel to sources of ignition and flash back. If ignited, the gas burns to produce toxic vapors and gases, such as sulfur dioxide.

Routes of Exposure and Exposure Limit

The primary route of exposure to H₂S is inhalation, and the gas is rapidly absorbed by the lungs. Absorption through the skin is minimal. People can smell the “rotten egg” odor of H₂S at low concentrations in air. However, with continuous low-level exposure, or at high concentrations, a person loses his/her ability to smell the gas even though it is still present; this is called olfactory fatigue. This can happen very rapidly and at high concentrations, the ability to smell the gas can be lost instantaneously. Therefore, DO NOT rely on your sense of smell to indicate the continuing presence of H₂S or to warn of hazardous concentrations.

About half of the population can smell H₂S at concentrations as low as 0.5 parts per billion (ppb) in air, and more than 90 percent can smell it at levels of 50 ppb. At higher concentrations H₂S rapidly deadens the sense of smell. For most people, this occurs at approximately 150 ppm.

The American Conference of Governmental Industrial Hygienists (ACGIH) 8-hr time-weighted average (TWA) exposure limit for H₂S is 1 ppm; the 15-minute short term exposure limit (STEL) is 5 ppm.

The Immediately Dangerous to Life or Health (IDLH) in air is 100 ppm, with exposure of 800 to 1,000 ppm fatal in 30 minutes.

Effects on the Body

Hydrogen sulfide is both an irritant and a chemical asphyxiant with effects on both oxygen utilization and the central nervous system. Its health effects can vary depending on the level and duration of exposure. Low concentrations irritate the eyes, nose, throat and respiratory system (e.g., burning/tearing of eyes, cough, shortness of breath). Asthmatics may experience breathing difficulties. The effects can be delayed for several hours, or sometimes several days, when working in low-level concentrations. Repeated or prolonged exposures may cause eye inflammation, headache, fatigue, irritability, insomnia, digestive disturbances and weight loss.

Moderate concentrations can cause more severe eye and respiratory irritation (including coughing, difficulty breathing, and accumulation of fluid in the lungs), headache, dizziness, nausea, vomiting, staggering and excitability.

High concentrations can cause shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma and death.

H₂S as a Project Hazard

Elevated levels of H₂S have not been reported during normal drilling activities, but experience has shown that high levels of H₂S may be present in the well space and in the breathing zone following the injection of emulsified oil, once the biological process has had time to progress. Engineering controls shall be considered to bring the concentrations of H₂S down to an acceptable level in the breathing zone, followed by administrative controls, and respiratory protection.

All employees will receive orientation on the emergency contingency plan for the specific actions to follow when there is an H₂S release from equipment, fire involving H₂S, or medical emergency involving exposure to H₂S.

Air Monitoring

Follow the air monitoring action levels in the project safety plan. If elevated levels of H₂S are encountered, first implement engineering controls to reduce exposures to allowable levels. If that is not possible, then an upgrade in PPE may be required; refer to the PPE section of the project safety plan.

8.32 Lead

(Reference CH2M HILL SOP HSE-508, *Lead*)

CH2M HILL is required to control employee exposure to lead when exposures are at or above 30 µg/m³ by implementing a program that meets the requirements of the OSHA Lead standard, 29 CFR 1910.1025 and 29 CFR 1926.62. The elements of the CH2M HILL lead program include the following:

- Exposure monitoring;
- Methods of control, including personal protective equipment (PPE) and respirators;
- Medical surveillance;
- Training on hazards of lead and control measures (includes project-specific training and the computer-based training on CH2M HILL's Virtual Office, *Lead Exposure Training*); and
- Record keeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and
- Review the fact sheet included as an attachment to the SOP.

8.33 Lockout/Tagout Activities

(Reference CH2M HILL SOP HSE-310, *Lockout and Tagout*)

Lockout/tagout (LO/TO) shall be performed whenever service or maintenance is necessary on equipment that could cause injury to personnel from the unexpected equipment energizing or start-up or unexpected release of stored energy. Energy sources requiring lockout/tagout may include electrical, pneumatic, kinetic, and potential.

If work on energized electrical systems is necessary—contact the RHSM. Specific training and procedures are required to be followed before any work on energized electrical systems can be performed and are NOT covered in this section. Energized electrical work is defined as work performed **on or near** energized electrical systems or equipment with exposed components operating at 50 volts or greater. Working near energized live parts is any activity inside a Limited Approach Boundary (anywhere from 3.5 feet to 24 feet [1 meter 7.3 meters] depending on voltage). Examples of energized electrical work include using a voltmeter to troubleshoot electrical systems and changing out controllers.

When lockout/tagout is necessary to perform maintenance/repair of a system, all the requirements of SOP HSE-310, Lockout and Tagout, shall be met including the following bulleted items:

- When CH2M HILL controls the work, CH2M HILL must verify that subcontractors affected by the unexpected operation of equipment develop a written lockout/tagout program, provide training on lockout/tagout procedures and coordinate its program with other affected subcontractors. This may include compliance with the owner or facility lockout/tagout program.

- When CH2M HILL personnel are affected by the unexpected operation of equipment they must complete the electrical safety awareness module on the VO. Authorized personnel shall inform the affected personnel of the LO/TO. Affected personnel shall not tamper with LO/TO devices.
- Standard lockout/tagout procedures include the following six steps: 1) notify all personnel in the affected area of the lockout/tagout, 2) shut down the equipment using normal operating controls, 3) isolate all energy sources, 4) apply individual lock and tag to each energy isolating device, 5) relieve or restrain all potentially hazardous stored or residual energy, and 6) verify that isolation and deenergization of the equipment has been accomplished. Once verified that the equipment is at the zero energy state, work may begin.
- All safe guards must be put back in place, all affected personnel notified that lockout has been removed and controls positioned in the safe mode prior to lockout removal. Only the individual who applied the lock and tag may remove them.
- CH2M HILL authorized employees shall complete the LO/TO training module on the VO and either the electrical safety training module on the VO or 10-hour construction training. The authorized employee must also be trained and qualified on the system they are working on (e.g., qualified electrician for working on electrical components of a system).
- When equipment-specific LO/TO procedures are not available or when existing procedures are determined to be insufficient, CH2M HILL authorized employees shall also complete the Equipment-Specific LO/TO Procedure Development Form, provided as an attachment to the SOP, to create an equipment-specific lockout/tagout procedure.

8.34 Avoidance of Munitions and Explosives of Concern (MEC) and/or Materials Potentially Posing an Explosives Hazard (MPPEH)

(Reference CH2M HILL, SOP HSE-610, Explosives Usage and Munitions Response)

If work will be conducted on a government/military facility or ex-government/military facility; area currently or previously used as a range; or if military munitions, MEC, or unexploded ordnance (UXO) are associated with the scope of work or location immediately contact the CH2M HILL Central Point of Contact for Explosives Usage and Munitions Response. The following will be required prior to any field work:

- Setting up a conference call with all required personnel to conduct a basic safety risk assessment over the phone.
- Providing written directions detailing job-specific requirements and what actions to take to ensure safety during the work.
- “3R Training” will be required for all affected project personnel. This training teaches personnel to Recognize, Retreat, and Report.

8.35 Marijuana Cultivation Sites

Marijuana grow sites are illegal on public lands, but are becoming more common. These sites may be encountered when working in undeveloped or “back country” areas. These sites pose risks to workers, the public, and the environment and are most often associated with organized crime. The potential for violent confrontations is high.

Grow sites have been discovered in California forest areas including Shasta Trinity National Forest other national forest areas including San Bernardino, Los Padres, and Angeles.

Most marijuana grow sites have someone always watching the site. Even unattended sites pose a significant risk. Recognize the signs of marijuana cultivation sites, and if you think you are near one, be quiet and leave the area immediately.

How to recognize a cultivation site:

- Sometimes marijuana smells like a skunk on hot days.
- Hoses or drip lines (made of black or white PVC piping or rubber hose) located in unusual or unexpected places.
- Discarded containers of herbicides, pesticides or other chemicals. A variety of chemicals for pest and animal control, including chemicals that may be so hazardous they are illegal in the United States are sometimes encountered.
- A well-used trail where there shouldn't be one.
- People standing along roads without vehicles present, or in areas where loitering appears unusual.
- Grow sites are usually found in isolated locations, in rough steep terrain. Look for signs of cultivation, cleared vegetation, soil disturbance.
- Food cached near trailheads or alongside roads.
- Sights or sounds of human activity in remote forest areas.
- Camps containing cooking and sleeping areas with food, fertilizer, weapons, garbage, rat poison, and/or dead animals.
- Small propane bottles, used to avoid the detection of wood smoke.
- Individuals armed with rifles outside of hunting season.
- Paper cups, chicken wire or plastic sheets used for starting and protecting plants.

As soon as you become aware that you have come upon a cultivation site, leave the way you came in immediately and make as little noise as possible. Never engage the growers as these are extremely dangerous people. If you can identify a landmark or it is helpful for authorities, but put your own safety first. The growers may be present and may or may not know that you have found their grow site. Get to a safe place and report as much detail about the location and incident as you can recall to authorities. Ensure you contact the RHSM and Project Manager as soon as possible.

Other precautions to take include:

- Check with local law enforcement officers to see whether they know of any dangers or concerns in the area where you will be working.
- Establish and follow check-in and checkout procedures every day.
- Make sure your supervisor and the dispatch office know where you will be working.
- If necessary, agree on a phrase that you would use to let your co-workers (SC, RHSM, or PM) know you are in danger and need law enforcement assistance immediately at your last known location.
- Make sure you have a working communication device.
- Use the buddy system. Work in pairs.
- Park your vehicle so it's pointing in the direction of escape.

8.36 Methane (as a Product of Injection Activities)

Methane is a colorless, odorless gas with a wide distribution in nature. Methane is created when organic matter decomposes (rots) without any oxygen present ("anaerobic" decomposition) and is common in landfills, marshes, septic systems and sewers.

Methane may be produced as a by-product of the biological process when biological additives are used in a remediation process (such as when emulsified oil is injected to enhance dechlorination of contaminated groundwater).

Experience has shown that methane may be present in the well space following the injection of emulsified oil, once the biological process has had time to progress. This needs to be considered when returning to collect ground water samples. Although methane degrades Engineering controls shall be considered to bring the concentrations of methane down to an acceptable level in the breathing zone.

Methane is a “simple asphyxiant,” which means that it can displace available oxygen. Methane is combustible and mixtures of methane with air are explosive within the range 5-15 percent by volume of methane (the lower and upper explosive limits). At room temperature, methane is lighter than air, so in an outdoor environment, it tends to dissipate.

Methane is not toxic when inhaled, but it can produce suffocation by reducing the concentration of oxygen inhaled. When exposed to concentrations high enough to displace oxygen, you may experience dizziness, deeper breathing, possible nausea and eventual unconsciousness.

The primary danger is from fire and explosion, so ensure that you work in a well-ventilated area, and that there is no source of ignition present. Use spark-proof tools and intrinsically safe equipment, if necessary. If working in a confined space, make sure that appropriate controls are in place and follow an approved permit-required confined space entry plan.

8.37 Methane (as Landfill Gas or Shale Formations)

Landfill gas is normally made up of 50 percent methane and 50percent carbon dioxide

Shale formations can produce methane that has the potential to be released during drilling or groundwater sampling.

Other constituents have been found in the landfill gas. These may include hydrogen sulfide, tetrachloroethene, ethyl benzene, toluene, and xylenes.

- Continuous monitoring is required when performing intrusive activities (e.g., excavation, drilling) in a methane area. This includes refuse and any cover material.
- Monitoring will be conducted with oxygen/combustible gas meters.
- All instruments will be calibrated according to manufacturer’s specifications. Instruments will be calibrated at the frequency specified by the manufacturer.
- Ventilation is the primary control to reduce the fire potential from methane. The action required for ventilation include:
- Natural Ventilation – If the wind speed across the bore hole or sampling apparatus is over 5 mph (8 kph) then natural ventilation is sufficient. Equipment and personnel must be located upwind of the potential methane source to prevent any ignition source from contacting methane in air.
- Forced Ventilation – If the wind speed across the bore hole or sampling apparatus is less than 5 mph (8 kph) then forced ventilation is required. Large air movers are preferable but standard ventilation fans may be used if the air flow is directed to the bore hole or the location in the sampling apparatus where the methane first encounters open air.

8.38 Methylene Chloride

(Reference CH2M HILL SOP HSE-509, *Methylene Chloride*)

Methylene chloride has a faint, sweet odor which is not noticeable at dangerous concentrations. Methylene chloride is shipped as liquefied compressed gas and will cause frostbite on contact.

CH2M HILL is required to control employee workplace exposure to methylene chloride when personal exposures are at or above 12.5 parts per million (ppm) as an 8-hour time-weighted average (TWA) or above 125 ppm short-term exposure limit (STEL) by implementing a program that meets the requirements of the OSHA Methylene

Chloride standard, 29 *Code of Federal Regulations* (CFR) 1910.1052. The elements of the CH2M HILL methylene chloride program include the following:

- Exposure monitoring;
- Methods of control, including personal protective equipment (PPE) and respirators;
- Medical surveillance;
- Training on hazards of methylene chloride and control measures (includes project-specific training and the computer-based training on CH2M HILL's Virtual Office, *Methylene Chloride*) and;
- Recordkeeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person;
- Appropriate air-supplied respirators must be used when methylene chloride exposures exceed PEL or STEL;
- Air supplied to respirators must meet Grade D breathing air requirements; and
- Review the fact sheet included as an attachment to the SOP.

8.39 Naturally Occurring Radiation Materials (NORM)

Naturally Occurring Radiation Materials (NORM) is found in the earth's crust, soil, plants and many living organisms. The geologic formations that contain oil and gas deposits also contain NORM, commonly consisting of the elements of uranium, radium, thorium and their associated decay products. If present, these radio nuclides dissolve in water and can be bound into the scale deposited in production equipment handling produced water. Radon gas follows the propane/ethane streams of produced (natural) gas and the radon gas byproducts (radon daughters) can be deposited on the inside surfaces of gas handling equipment. Land can be contaminated with NORM from descaling operations, contaminated sludges, and/or residual from produced water.

Equipment that can contain NORM-contaminated scale includes equipment associated with the separators (separate gas from the oil and water) and heater treaters (divide the oil and water phases) such as flowlines, pumps, valves, and piping (especially transition pieces such as elbows and reducer) and filters.

Gas processing equipment can also be contaminated with NORM (radon daughters). This contamination, unlike scales, can be in the form of an invisible film inside gas equipment and can only be detected by internal surveying with appropriate instrumentation.

Natural gas liquid equipment can also be contaminated by radon in the gas. Sludges accumulated in this equipment may contain the heavy metal radon daughters that have attached to dust and other particles that become part of the sludge.

While NORM has generally been associated with exploration and production activities, there is some industry experience to indicate that some refinery process equipment can also be contaminated with NORM, including natural gas stream equipment, crude tank bottoms, desalters, overhead atmospheric pipestill equipment, and exchanger deposits/sludge.

Hazards of NORM

NORM generally does not present an external radiation (Gamma) hazard to employees working around closed process equipment. This is particularly the case with NORM associated with scale inside equipment handling

production water due to attenuation by the scale and steel pipe wall. Recent field experience, however, indicates that some in-service gas processing equipment, particularly valves, elbows, or transition piping pieces, may have fairly high external Gamma radiation levels. If gas-processing equipment is out of service for more than 4 hours, external Gamma measurements will not detect internal accumulation of the radon daughters.

Work procedures are recommended when maintaining NORM contaminated equipment such as pipelines, filters, pumps, lines, sludge or wellhead equipment. The exposure risk is highest when grinding, cutting, polishing, or performing other work that may generate dust. These dusts present inhalation hazards that result in internal exposures to radioactive material.

- Radium, radon, and their decay products are radioactive elements of concern in petroleum production and gas processing. Exposure may occur when contaminated dusts and sludge are inhaled or ingested (internal exposure) or when radiation from surrounding equipment strikes the body (external exposure).
- Radium is found in most oil and gas fields in the world in varying concentrations. There is potential to find radium in significant amounts in almost all types of equipment. Radon is found in most natural gas deposits in the world.
- Radon itself does not present a health hazard because it is not easily absorbed into the body and is quickly cleared when absorbed.
- Radon's radioactive breakdown products, called radon "daughters," may be hazardous. Radon naturally breaks down into radioactive metals before becoming non-radioactive lead.
- Radon daughters may be inhaled or ingested when attached to scale or dust generated during equipment inspection and repair. Radon daughter overexposure has been associated with an increased risk of lung cancer.

NORM Hazard Control Measures

- For operations where NORM is a potential hazard, a qualified individual (s) will be assigned for implementing radiological protection of employees, members of the public, and the environment.
- Surveys and monitoring must be conducted to evaluate the potential radiological hazards. The surveys must include measurements for radiation levels based on the concentrations or quantities of radioactive material, along with any other measurements or evaluations necessary to characterize the potential radiological hazards that could be present.
- Equipment contaminated with NORM must be labeled.
- Gas processing equipment should be opened to allow gas to escape, and allowed to stand idle for at least 4 hours prior to any entry.
- Water washing of any equipment prior to entry is recommended when practical.
- Personal protective equipment (PPE) must be selected based on the hazards (both radiological and non-radiological) work activities to be conducted, and the contamination levels in the work area,
 - Level D PPE must be worn to minimize skin contact with NORM such as gloves and appropriate body protection. Disposable clothing such as TYVEK is preferred since NORM contaminated clothing should be laundered.
 - Level C PPE using full-face air-purifying respirator with high efficiency particulate air (HEPA filters) must be worn if dust exposure is expected.
- Do not sand, grind, cut, or weld on surfaces contaminated with NORM without appropriate cleaning. Equipment should be resurveyed after cleaning prior to these activities.
- NORM-contaminated equipment or material should not be shipped offsite for repair or disposal without first contacting the designated NORM coordinator (may be the RHSM and/or REM)

8.40 PCB/Ballast Handling

Fluorescent lighting used in many older buildings use ballast resistors that contain polychlorinated biphenyl (PCB) oil. PCB is colorless to light-colored, viscous liquid with a mild, hydrocarbon odor.

PCB has been found to cause, irritation eyes; chloracne; liver damage; reproductive effects; and has shown to cause cancer in lab animals.

When work requires the handling or removal of fluorescent ballast resistors, extra care and attention needs to be taken. While ballasts are usually well sealed, it is not uncommon to find a ballast resistor that has leaked. Below are the hazard controls and safe work practices to be followed when PCBs are present.

- A survey must be made to determine whether ballast resistors contain PCB fill.
- Leaking resistors must be identified and handled with appropriated PPE.
- Exposure Routes are inhalation, skin absorption, ingestion, skin and/or eye contact
- Prevent skin contact by using chemical resistant gloves, wear eye protection, and thoroughly wash hands before eating or smoking.
- Ensure eyewash is available.
- In the event of exposure, follow the following First Aid procedures:
Eyes: Irrigate immediately
Skin: Soap wash immediately
Ingestion: Seek medical attention immediately
- Dispose of PCB ballast resistors in accordance with Federal, State and Local environmental regulations.

8.41 Portable Generator Hazards

(Reference CH2M HILL SOP HSE-206, Electrical Safety)

- Portable generators are useful when temporary or remote electric power is needed, but they also can be hazardous. The primary hazards to avoid when using a generator are carbon monoxide (CO) poisoning from the toxic engine exhaust, electric shock or electrocution, and fire.
- NEVER use a generator indoors or in similar enclosed or partially-enclosed spaces. Generators can produce high levels of carbon monoxide (CO) very quickly. When you use a portable generator, remember that you cannot smell or see CO. Even if you can't smell exhaust fumes, you may still be exposed to CO.
- If you start to feel sick, dizzy, or weak while using a generator, get to fresh air RIGHT AWAY. DO NOT DELAY. The CO from generators can rapidly lead to full incapacitation and death.
- If you experience serious symptoms, get medical attention immediately. Inform project staff that CO poisoning is suspected. If you experienced symptoms while indoors have someone call the fire department to determine when it is safe to re-enter the building.
- Follow the instructions that come with your generator. Locate the unit outdoors and away from doors, windows, and vents that could allow CO to come indoors.
- Ensure the generator is grounded in accordance with the manufacturer's operation manual.
- Keep the generator dry and do not use in rain or wet conditions. To protect from moisture, operate it on a dry surface under an open, canopy-like structure. Dry your hands if wet before touching the generator.
- Plug appliances directly into the generator. Or, use a heavy duty, outdoor-rated extension cord that is rated (in watts or amps) at least equal to the sum of the connected appliance loads. Check that the entire cord is free of cuts or tears and that the plug has all three prongs, especially a grounding pin.

- Most generators come with Ground Fault Circuit Interrupters (GFCI). Test the GFCIs daily to determine whether they are working
- If the generator is not equipped with GFCI protected circuits plug a portable GFCI into the generator and plug appliances, tools and lights into the portable GFCI.
- Never store fuel near the generator or near any sources of ignition.
- Before refueling the generator, turn it off and let it cool down. Gasoline spilled on hot engine parts could ignite.

8.42 Powder-Actuated Tools

(Reference CH2M HILL SOP HSE-210, *Hand and Power Tools*)

Below are the hazard controls and safe work practices to follow when working around or using powder-actuated tools. Ensure the requirements in the referenced SOP are followed.

- Only trained personnel are permitted to operate powder-actuated tools.
- Inspect and test powder-actuated tools each day before they are loaded per manufacturer's instruction. Remove from service any tool that is not in proper working order.
- Wear appropriate personal protective equipment (eye, face, and hearing protection) when using powder-actuated tools.
- Never point powder-actuated tools at other workers, whether empty or loaded. Tools shall not be loaded until just before use. Never leave loaded tools unattended.
- Do not drive fasteners into very hard or brittle materials such as, cast iron, glazed tile, surface-hardened steel, glass block, live rock, face brick, or hollow tile.
- Avoid driving fasteners into easily penetrable materials unless backing is provided. Pins or fasteners can otherwise become flying missiles when they pass right through such materials.
- Use powder-actuated tools with the manufacturer's specified guard, shield, or other attachment.
- Do not use powder-actuated tools in explosive or flammable atmospheres.

8.43 Pressure Line/Vessel Systems

- Operate and maintain pressure vessels, pumps and hosing in accordance with the manufacturer's recommendations.
- Do not exceed the rated pressure of the vessels and hosing of the system.
- The system must be provided with a pressure relief valve/controller that safely reduces the system pressure to within the system rated pressure.
- The pressure relief valve must be rated at no more than 110 percent the rated pressure of the system and must be tested at regular intervals.
- Each vessel must be equipped with a functioning pressure gauge to monitor pressure.

8.44 Pressure Washing Operations

Below are the hazard controls and safe work practices to follow when working around or performing pressure washing.

- Only trained, authorized personnel may operate the high-pressure washer.
- Follow manufacturer's safety and operating instructions.
- Inspect pressure washer before use and confirm deadman trigger is fully operational

- The wand must always be pointed at the work area.
- The trigger should never be tied down
- Never point the wand at yourself or another worker.
- The wand must be at least 42 inches (1.1 meter) from the trigger to the tip and utilize greater than 10 degree tips.
- The operator must maintain good footing.
- Non-operators must remain a safe distance from the operator.
- No unauthorized attachment may be made to the unit.
- Do not modify the wand.
- All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service.
- Polycoated Tyvek or equivalent, 16-inch-high steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves will be worn, at a minimum.

8.45 Process Safety Management

(Reference CH2M HILL SOP HSE-213, *Process Safety Management*)

- All CH2M HILL projects require a systematic evaluation of processes to prevent, or minimize the consequences of, catastrophic releases of toxic, reactive, flammable, or explosive chemicals at or above the specified threshold quantities listed in Appendix A, List of Highly Hazardous Chemicals, Toxics, and Reactives in OSHA Standard 29 CFR 1910.119, Process Safety Management.
- A Process Hazard Analysis (PHA) is required of all processes covered by PSM.
- Operating procedures shall be developed and implemented that provide clear operating instructions consistent with the process safety information.
- Contractors, whether considered to be CH2M HILL or a subcontractor of CH2M HILL, performing maintenance or repair, turnaround, major renovation, or specialty work on or adjacent to a covered process shall be informed by the client of the known potential fire, explosion, and toxic release hazards related to the contractor work and the provisions of the emergency action plan.
- CH2M HILL projects shall develop and implement the written procedure requirements to maintain the mechanical integrity of pressure vessels, storage tanks, piping systems, relief and vent systems, emergency shutdown systems, and controls and pumps process systems.
- A hot work permit shall be completed for any CH2M HILL work involving welding, cutting, brazing, or similar flame- or spark-producing operations conducted near a covered process.
- Written procedures shall be developed, updated, and implemented to manage changes in chemicals, technology, equipment, and facilities.
- An incident report form (IRF) shall be completed within 24 hours of a PSM-related incident. Incidents involving a release of highly hazardous chemicals shall be reported following the Serious Incident Reporting section of SOP HSE-111.
- An investigation shall be initiated as soon as possible, but no later than 48 hours following an incident that resulted in, or could reasonably have resulted in, a catastrophic release of a highly hazardous chemical.
- An emergency action plan shall be developed and implemented for the entire plant, including procedures for handling small releases.
- A facility or process audit shall be performed every three years to certify compliance with the PSM standard.

- All information regarding compliance with PSM requirements shall be made available to affected personnel without regard to possible trade secret status.
- CH2M HILL employees shall be trained before operating a newly assigned process or when involved in maintaining equipment. Refresher training shall be provided at least every three years and more often if necessary to assure the employee understands and adheres to the current operating procedures of the process.

8.46 Radar Hazards

Airports and all branches of the military use radar of significant power for buildings, towers, aircraft, ships, armor vehicles, and installations in general. Radar devices may emit harmful microwave radiation emissions. Microwave radiation is absorbed by the body and dissipated in the tissue as heat.

The penetration ability of the radiation depends on the wavelength. Microwave wavelengths of 25-200 centimeters have the ability to reach the internal organs with potentially damaging effects. Wavelengths less than 25 centimeters are absorbed and dissipated by the skin and the human body is thought to be transparent to microwave wavelengths greater than 200 centimeters. The health effects of microwave radiation include deep burns and thermal damage to any organ or organ system with low blood flow, most notably the lenses of the eyes. If adequate time has elapsed between exposures, the repair mechanisms of the lens seem to limit damage. Microwave radiation cannot be seen and its effects cannot be felt until serious damage has already occurred.

The OSHA exposure limit is 10 milliwatts per square centimeter (10 mW/cm²) averaged over any 6-minute period.

Warning signs must be posted in areas where potentially damaging microwave radiation exists.

The prevention method for microwave radiation exposure is to not be in the path of radar or other microwave emitting devices by either ensuring that the device is not operating or ensuring that there is sufficient shielding between you and the microwave source.

8.47 Rail Road Safety

Careful observation of railroad safety requirements is essential and is governed by the Federal Railroad Administration (FRA). For railroads involving Union Pacific Railroads (UPRR), refer to the "Minimum Safety Requirements for Engineering Department Contractors," of the ESBG HSSE SharePoint site which addresses training, minimum PPE, and safety requirements.

Permission to enter railroad property must be obtained from the local railroad. Working alone is not anticipated for this work. Contact the RHSM if working alone in the vicinity of railroads becomes necessary. Additional hazard controls will be evaluated by the RHSM and incorporated into the project safety plan.

If required by the client or railroad, all employees must participate in and comply with any job briefings conducted by the railroad's employee in charge (EIC). During these briefings, the railroad's EIC will specify safe work procedures, the potential hazards of the job, and emergency response procedures.

The following PPE must be worn when working around trains and rail-yards.

- Reflective/high-visibility safety vests (orange or green-yellow);
- ANSI Z87.1-approved safety glasses shall be worn to protect from flying debris;
- ANSI-approved hard hat;
- Safety-toed boots;
- Hearing protection is required when employees are within 100 feet of locomotive or roadway/work equipment; 15 feet of power operated tools 150 feet of jet blowers or pile drivers 150 feet of retarders in use (when within 10 feet, employees must wear dual ear protection – plugs and muffs); and
- Any other PPE as required by the PPE section of the project safety plan.

Other general safety requirements include:

- Any work conducted within 25 feet of active tracks must first be approved by the client and any EIC requirements addressed (preferably in an AHA). Training (i.e., On-track Railroad Safety Training) is required by the Federal Railroad Administration in these instances. Coordinate this training with the RHSM or Safety Program Assistant (SPA).
- Attend client's safety training courses, as required, and carry or maintain proof of training as required by the client;
- Always pay attention to moving trains – never assume they are looking out for you;
- Work as far from traveled way as possible to avoid creating confusion for trains;
- Use the “buddy system” when work does not face the direction in which trains are coming from.
- The railroad must be promptly notified of any reportable injury;
- The railroad must be promptly notified of any damage to railroad property;
- All waste must be properly disposed of. No fires are permitted;
- All contractor's vehicles stop at all railroad crossings to ascertain the way is clear;
- Always be on alert for moving equipment in either direction on the tracks. Do not stop or walk on the top of rail, frog, switches, guard rails, or other track components.
- When walking around a standing rail car, stay at least 20 feet behind it. Do not walk between rail cars unless there is a 50 feet clearance between cars. Do not sit on, lie under, or cross between cars.
- No tools or materials are to be left close to the track when trains are passing.

8.48 Rigging

(Reference CH2M HILL SOP HSE-316, *Rigging*)

Below are the hazard controls and safe work practices to follow when personnel are overseeing or performing rigging. Ensure the requirements in the referenced SOP are followed.

8.48.1 General

- All rigging equipment shall be used only for its intended purpose, inspected by a competent person prior to use, and shall not be loaded in excess of its capacity rating. Defective rigging shall be removed from service.
- When CH2M HILL is in control of rigging operations, CH2M HILL shall provide a rigging competent person that will inspect, maintain oversee all rigging operations. The competent person shall use the appropriate rigging inspection log form to inspect wire rope, synthetic slings and/or shackles.
- Tag lines shall be attached to every load being lifted by a crane.
- Rigging equipment shall be protected from flame cutting and electric welding operations, and or contact avoided with solvents and chemicals.
- Rigging equipment, when not in use, shall be stored in an area free from damage caused by environmental elements, hazardous substances, and other factors that may compromise equipment integrity and performance.
- No modification or addition, which that could affect the capacity and or safe operation of the equipment, shall be made without the manufacturer's written approval.
- Rigging equipment shall not be shortened with knots, bolts or other makeshift devices.
- All rigging equipment shall be load tested at least annually by a competent person and documented.

- Special hoisting devices, slings, chokers, hooks, clamps, or other lifting accessories shall be marked to indicate the safe working loads and shall be proof -tested prior to initial use to 125 percent of their rated load. Vendors or suppliers will provide documentation of proof testing documentation.

8.48.2 Equipment

- Protruding end strands of wire rope shall be covered or blunted.
- Wire rope shall not be used, if in any length of eight diameters, the number of total number of visible broken wires exceeds 10 percent of the total number of wires, or if the rope shows other signs of excessive wear, corrosion, or defect.
- When inspecting the end fittings of wire rope slings, if more than one wire in a lay is broken in the fitting, do not use the sling.
- Synthetic web slings shall be immediately removed from service if any of the following conditions are present:
 - acid or caustic burns; melting or charring of any part of the sling
 - surface; snags, punctures, tears or cuts; broken or worn stitches; distortion of fittings;
 - discoloration of or rotting; red warning line showing.
- Never use makeshift hooks, links or other fasteners. Job or shop hooks and links, or makeshift fasteners, formed from bolts, rods, etc., or other such attachments, shall not be used.
- Alloy steel chains shall have permanently affixed identification stating size, grade, rated capacity and reach.
- Shackles and hooks shall be constructed of forged alloy steel with the identifiable load rating on the shackle or hook.

8.48.3 Rigging Use

- Rigging shall not be pulled from under a load when the load is resting on the rigging.
- Place sling(s) in center bowl of hook.
- When attaching slings to the load hoist hook, corners and sharp edges should be “packed” to prevent cutting or damaging the rope or slings.
- Never use nylon, polyester, or polypropylene web slings, or web slings with aluminum fittings shall not be used where fumes, vapors, sprays, mists or liquids of acids, caustics or phenolics are present.
- Natural and synthetic fiber rope slings, except for wet frozen slings, may be used in a temperature range from minus 20° F to plus 180° F without decreasing the working load limit. For operations outside this temperature range, and for wet frozen slings, the sling manufacturer’s recommendations shall be followed.
- When used for eye splices, the U-bolt shall be installed so that the “U” section is in contact with the dead end of the rope.

8.49 Scaffolds

(Reference CH2M HILL SOP HSE-311, *Scaffolds*)

Below are the hazard controls and safe work practices to follow when personnel or subcontractor personnel are using scaffolds. Ensure the requirements in the referenced SOP are followed.

8.49.1 Working from Scaffolds

- All scaffolds must be designed by a qualified person and installed under the supervision of a competent person.
- Do not access scaffolds until the competent person has completed the work shift inspection and has authorized access.
- Follow all requirements established by the competent person or as identified on the scaffold tag.

- Do not access scaffolds until authorized by the competent person.
- Do not access scaffolds that are damaged or unstable at any time and for any reason.
- Only access scaffolds by means of a ladder, stair tower, ladder stand, ramp, integral prefabricated scaffold access, or other equivalent safe means of access. Scaffold cross-bracing shall not be used to access scaffold platforms.
- Remain within the scaffold guardrail system when provided. Leaning over or stepping across a guardrail system is not permitted.
- Use personal fall arrest systems when required by the competent person and when working from suspension scaffolds or boatswains' chairs.
- Do not stand on objects (boxes, buckets, bricks, blocks, etc.) or ladders on top of scaffold platforms to increase working height unless the platform covers the entire floor area of the room.
- Do not work on scaffolds covered with snow, ice, or other slippery material or work on scaffolds during storms or high winds unless personal fall arrest systems or wind screens are provided and the competent person determines it is safe to remain on the scaffold.
- Do not overload scaffold planks over their rated weight bearing capacity. When feasible, place loads directly over the scaffolds vertical weight bearing structures.

8.49.2 Supported Scaffolds

This section covers the erection, use, and dismantling of supported scaffolds. Supported scaffolds consist of one or more platforms supported by outrigger beams, brackets, poles, legs, uprights, posts, frames, or similar rigid support. Supported scaffolds include frame, fabricated frame, tube and coupler, pole, bricklayer's, and step platform. The common requirements for all supported scaffolds are addressed here; the competent person shall ensure scaffold type specific requirements are included as applicable.

- CH2M HILL staff erecting, dismantling, or working on scaffolds must complete the CH2M HILL 10-Hour Construction Safety Awareness training course. Staff must also and receive project-specific scaffold training from a qualified person. Staff shall not use scaffold systems for which they have not been trained.
- A CH2M HILL scaffold competent person shall be assigned to direct and oversee the erection, dismantling, and use of scaffolds. Additionally, they must inspect scaffolds each day prior to use.
- Scaffolds shall be designed by a qualified person and shall be constructed and loaded in accordance with that design.
- Stationary scaffolds over 125 feet (38.1 meters) in height and rolling scaffolds over 60 feet (18.3 meters) in height must be designed by a professional engineer.
- A tag and permit system shall be used to inform personnel of the construction status of the scaffold. At a minimum, the system used shall inform users when a scaffold is complete and safe to be used and when a scaffold is under construction and is not ready to be used. When additional precautions are required to use the scaffold safely, for example, the use of fall protection systems, the system shall identify the precautions to be taken. The tag or permit shall be placed at each means of access to the scaffold. The competent shall be responsible for the tag and permit system.
- A daily safety briefing shall be conducted with all scaffold personnel to discuss the work planned for the day and the HSE requirements to be followed.
- Scaffolds and scaffold components must be capable of supporting, without failure, their own weight and at least 4 times their maximum intended load.
- The site must be inspected to determine ground conditions, strength of supporting structure, and for proximity of electric power lines, overhead obstructions, wind conditions, the need for overhead protection or weather protection coverings.

- Supported scaffolds must be set on base plates, mudsills, or other adequate firm foundation.
- Frame spacing and mudsill size can only be determined after the total loads to be imposed on the scaffold and the strength of the supporting soil or structure are calculated and considered. This analysis must be done by a qualified person.
- Base plates or screwjacks with base plates must be in firm contact with both the sills and the legs of the scaffolding. Compensate for uneven ground with screwjacks with base plates. DO NOT USE unstable objects such as blocks, loose bricks, etc.
- Scaffolds and scaffold components must be inspected for visible defects before each shift by a competent person, and after each occurrence that could affect a scaffold's integrity (such as being struck by a crane).
- Maintain scaffolding and materials (e.g., paint roller extensions, building material) at least 10 feet (3 meters) from overhead power lines for voltages of 50 kV or less, and 10 feet (3 meters) plus 0.4 inch (1.0 cm) for every 1 kV over 50 kV.
- All portable electric equipment must be protected by ground-fault circuit interrupters (GFCIs) or an assured equipment grounding conductor program.

8.49.3 Suspended Scaffolding

Suspension scaffolds consist of one or more platforms suspended by ropes or other non-rigid means from an overhead structure(s). The common requirements for suspended scaffolds are addressed here; the competent person shall ensure scaffold type specific requirements are included as applicable.

- CH2M HILL staff erecting, dismantling, or working on scaffolds must complete the CH2M HILL 10-Hour Construction Safety Awareness training course. Staff must also and receive project-specific scaffold training from a qualified person. Staff shall not use scaffold systems for which they have not been trained.
- A CH2M HILL scaffold competent person shall be assigned to direct and oversee the erection, dismantling, and use of scaffolds. Additionally, they must inspect scaffolds each day prior to use.
- Scaffolds shall be designed by a qualified person and shall be constructed and loaded in accordance with that design.
- A tag and permit system shall be used to inform personnel of the construction status of the scaffold. At a minimum, the system used shall inform users when a scaffold is complete and safe to be used and when a scaffold is under construction and is not ready to be used. When additional precautions are required to use the scaffold safely, for example, the use of fall protection systems, the system shall identify the precautions to be taken. The tag or permit shall be placed at each means of access to the scaffold. The competent shall be responsible for the tag and permit system.
- A daily safety briefing shall be conducted with all scaffold personnel to discuss the work planned for the day and the HSE requirements to be followed.
- Scaffolds and scaffold components must be capable of supporting, without failure, their own weight and at least 4 times their maximum intended load.
- The site must be inspected to determine the strength of supporting structure, and for proximity of electric power lines, overhead obstructions, wind conditions, the need for overhead protection or weather protection coverings.
- Scaffolds and scaffold components must be inspected for visible defects before each shift by a competent person, and after each occurrence that could affect a scaffold's integrity (such as being struck by a crane).
- Maintain scaffolding and materials (e.g., paint roller extensions, building material) at least 10 feet (3 meters) from overhead power lines for voltages of 50 kV or less, and 10 feet (3 meters) plus 0.4 inch (1.0 cm) for every 1 kV over 50 kV.
- All portable electric equipment must be protected by ground-fault circuit interrupters (GFCIs) or an assured equipment grounding conductor program.

8.49.4 Fall Protection on Suspended Scaffolds

- Each employee on a multi-point or two-point adjustable suspension scaffold must be protected by both a guardrail system and a personal fall arrest system.
- Personal fall-arrest systems used on scaffolds shall be attached by lanyard to a vertical lifeline, horizontal lifeline, or scaffold structural member.
- Guardrail systems must be installed along all open sides and ends of platforms, and must be in place before the scaffold is released for use by employees other than erection/dismantling crews.

8.50 Stairways and Ladders

(Reference CH2M HILL SOP HSE-214, *Stairways and Ladders*)

Below are the hazard controls and safe work practices to follow when using stairways and ladders. Ensure the requirements in the referenced SOP are followed.

- Stairway or ladder is generally required when a break in elevation of 19 inches (48.3 cm) or greater exists.
- Personnel should avoid using both hands to carry objects while on stairways; if unavoidable, use extra precautions.
- Personnel must not use pan and skeleton metal stairs until permanent or temporary treads and landings are provided the full width and depth of each step and landing.
- Ladders must be inspected by a competent person for visible defects prior to each day's use. Defective ladders must be tagged and removed from service.
- Always obey and pay attention to warning labels or stickers on the specific ladder being used.
- Ladders must be used only for the purpose for which they were designed and shall not be loaded beyond their rated capacity.
- Ladder safety training on safe use (take the Stairways and Ladders safety training module located on the VO).
- Only one person at a time shall climb on or work from an individual ladder.
- User must face the ladder when climbing; keep belt buckle between side rails.
- Ladders shall not be moved, shifted, or extended while in use.
- User must use both hands to climb; use rope to raise and lower equipment and materials.
- Straight and extension ladders must be tied off to prevent displacement.
- Ladders that may be displaced by work activities or traffic must be secured or barricaded.
- Personnel climbing ladders shall face the ladder and maintain 3 points of contact with the ladder.
- Portable ladders must extend at least 3 feet (91.5 cm) above landing surface.
- Straight and extension ladders must be positioned at such an angle that the ladder base to the wall is one-fourth of the working length of the ladder.
- Stepladders are to be used in the fully opened and locked position.
- Users are not to stand on the top two steps of a stepladder; nor are users to sit on top or straddle a stepladder.
- Fixed ladders \geq 24 feet (7.3 meters) in height must be provided with fall protection devices.
- Fall protection should be considered when working from extension, straight, or fixed ladders greater than six feet (1.8 meters) from lower levels and both hands are needed to perform the work, or when reaching or working outside of the plane of ladder side rails.

8.51 Steel Erection

(Reference CH2M HILL SOP HSE-312, *Steel Erection*)

Below are the hazard controls and safe work practices to follow when working around or performing steel erection activities. Ensure the requirements in the referenced SOP are followed.

- Protruding reinforcing steel (rebar), onto which personnel could fall, must be guarded to eliminate the hazard of impalement.
- Structural steel loads shall not be released from the hoisting line until the members are secured with at least two bolts, or the equivalent at each connection and drawn up wrench tight.
- Tag lines shall be used for controlling loads.
- Containers shall be provided for storing or carrying rivets, bolts, and drift pins, and secured against accidental displacement when aloft.
- Air line hose sections shall be secured together, except when quick disconnect couplers are used to join sections.
- Impact wrenches used for bolting shall be provided with a locking device for retaining the socket.
- Turnbuckles shall be secured to prevent unwinding while under stress.
- Plumbing-up guys shall be removed only under the supervision of a competent person.
- Metal decking of sufficient strength shall be laid tight and secured to prevent movement.
- Provisions shall be made to secure temporary flooring against displacement. Planks shall overlap the bearing on each end by a minimum of 12 inches (30.5 cm). Wire mesh, exterior plywood, or equivalent, shall be used around columns where planks do not fit tightly.
- All unused openings in floors, temporary or permanent, shall be completely planked over or guarded.

8.52 Slips, Trips and Falls

General

- Institute and maintain good housekeeping practices.
- Designate foot traffic paths in and out of sites, when necessary, to ensure paths are kept free from slip, trip, and fall hazards or to deter personnel from taking “shortcuts” where slip, trip, hazards may be.
- Mitigate icy conditions by keeping foot traffic paths clear of ice and snow.
- Watch footing as you walk to avoid trip hazards, animal holes, or other obstacles, especially in tall grassy areas.

Muddy Conditions

- Muddy conditions present a slipping hazard. Use mats or other similar surface to work from if footing cannot be stabilized.
- Take shortened steps across muddy areas.
- Use a walking staff or other similar means to assist with balance.

Steep Slopes/Uneven Ground/Rock and Vertical Slopes

- Be aware that escarpments can slough. Avoid these areas.
- Exercise caution in relying on rocks and trees/tree stumps to support yourself – many times they are loose.
- Whenever possible, switchback your way up/down steep areas, and maintain a slow pace with firm footing.

- Employees walking in ditches, swales and other drainage structures adjacent to roads or across undeveloped land must use caution to prevent slips and falls which can result in twisted or sprained ankles, knees, and backs.
- Whenever possible observe the conditions from a flat surface and do not enter a steep ditch or side of a steep road bed.
- If steep terrain must be negotiated coordinate with RHSM to evaluate the need for ladders or ropes to provide stability.

8.53 Stream Crossing

Traversing streams present significant hazards, including drowning, hypothermia, and abrasions. When crossing streams, be sure to implement the bulleted items below.

- When walking in streams, first plan the route. Look ahead for exits should there be any difficulty during the crossing, and “read” the water for spots to avoid such as drop offs, sunken logs, and tricky currents.
- Do seek out the safest route – narrow, low flow, shallow. Evaluate deeper and faster moving sections with caution. Backtracking is often dangerous or impossible once committed.
- If streams to be crossed are deeper than “knee deep”, find an alternate crossing location that is less deep.
- Streams should be crossed while facing upstream, stepping side to side, and using a sturdy walking stick. When possible, wade a stream diagonally, moving downstream. Move slowly, keeping the foot on the upstream side in the lead and pointed forward. Your rear, or anchor, foot should point downstream and be at right angles to the lead foot. Move the lead foot forward about half a step, feeling for a solid hold. Next, move the anchor foot forward the same distance – shuffle across so that your anchor foot never passes the lead. This way both feet are always in position to lend support. If you must turn around, do so toward the upstream direction.
- Don’t attempt to cross above rocky rapids or a cascade. Step on submersed rocks with great care.
- If you are working in streams, algae covered rocks should be assumed slippery until tested. Always be alert for unstable and extremely slippery rocks.
- Rocks with green moss or attached plants offer better traction or even better, look for gravel and sand pockets among the stream boulders, which are much more stable, and use a wading staff (if not carrying one, find a suitable one nearby) to steady your balance while crossing. Use a solid wading staff instead of the collapsible type.
- Be cautious of areas where there are submerged or partially submerged trees/tree branches – these can create entanglement hazards during a crossing or a “swim”.
- If streams are crossed that are deeper than “crotch deep”, personnel must use either ropes and/or wear chest waders.
- Choose the right waders (with RHSM/SC involvement).
- Footwear with felt-bottom soles are ideal for rocky bottom streams. The rough texture cuts through algae growing on the rocks and grips well. For very slippery conditions, consider studded felt soles or a slipover, studded sandal. However, felt soles do not provide good traction on muddy, slippery banks. Cleated soles work well for mud or sand bottom streams (a hard molded tread pattern similar to a hiking boot).
- Wear a wading belt with chest waiters to keep your waders from billowing out like a parachute; the currents will carry you and move you in ways you don’t want to move.
- Never wade alone.
- If the wader fills with water, don’t panic. Waders full of water weigh less in water than on land and the water inside doesn’t add any weight as long as you are in the water. Also a common fear is that air trapped in the

waders will raise the feet higher than the head and force the face underwater is unfounded. Waders do streamline your legs and kicking is useless. Follow these steps if the waders fill with water:

- Don't try to take them off in the water
 - In calm water, wade or swim to shore
 - In fast-moving water, ride the current:
 - Pull your feet up in front of you, bend your knees
 - Point your feet downstream (so the feet, not the head will bounce off the rocks)
 - Sculling with your hands will help direct to the nearest shallow area
 - When you reach calm water, go ashore and empty your waders
 - Don't waste energy in the vertical position going for the bottom. This position is virtually impossible to maintain and leads quickly to exhaustion (the major cause of drowning).
 - Concentrate on getting out of the water and not saving the equipment.
- The higher the elevation you are at, the steeper the stream gradient is. This means the stream can rise quicker and return to lower flow more quickly.
 - Always wait out a swollen stream if at all possible.
 - If you do slip into the water and are being swept downstream, don't panic. Cold water will be a shock for 2-3 seconds. Pull your knees up, face your feet downstream and lean back, using your hands as best you can to navigate and get to the bank. Keep your head up; you don't want your head underwater banging into rocks. If you stay calm, you can reach water where you can stand up or swim to the bank.
 - When walking along stream banks and not entering streams, wear work boots.

8.54 Traffic Control

(Reference CH2M HILL SOP HSE-216, *Traffic Control*)

The following precautions must be taken when working around traffic, and in or near an area where traffic controls have been established by a sub contractor. Ensure the requirements in the referenced SOP are followed.

- Exercise caution when exiting traveled way or parking along street – avoid sudden stops, use flashers, etc.
- Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier.
- All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.
- Eye protection should be worn to protect from flying debris.
- Remain aware of factors that influence traffic related hazards and required controls – sun glare, rain, wind, flash flooding, limited sight-distance, hills, curves, guardrails, width of shoulder (i.e., breakdown lane), etc.
- Always remain aware of an escape route (e.g., behind an established barrier, parked vehicle, guardrail, etc).
- Always pay attention to moving traffic – never assume drivers are looking out for you.
- Work as far from traveled way as possible to avoid creating confusion for drivers.
- When workers must face away from traffic, a “buddy system” should be used, where one worker is looking towards traffic.
- When working on highway projects, obtain a copy of the contractor's traffic control plan.
- Work area should be protected by a physical barrier – such as a K-rail or Jersey barrier.

- Review traffic control devices to ensure that they are adequate to protect your work area. Traffic control devices should: 1) convey a clear meaning, 2) command respect of road users, and 3) give adequate time for proper traffic response. The adequacy of these devices are dependent on limited sight distance, proximity to ramps or intersections, restrictive width, duration of job, and traffic volume, speed, and proximity.
- Either a barrier or shadow vehicle should be positioned a considerable distance ahead of the work area. The vehicle should be equipped with a flashing arrow sign and truck-mounted crash cushion (TMCC). All vehicles within 40 feet (12.2 meters) of traffic should have an orange flashing hazard light atop the vehicle.
- Except on highways, flaggers should be used when 1) two-way traffic is reduced to using one common lane, 2) driver visibility is impaired or limited, 3) project vehicles enter or exit traffic in an unexpected manner, or 4) the use of a flagger enhances established traffic warning systems.
- Lookouts should be used when physical barriers are not available or practical. The lookout continually watches approaching traffic for signs of erratic driver behavior and warns workers.
- Vehicles should be parked at least 40 feet (12.2 meters) away from the work zone and traffic. Minimize the amount of time that you will have your back to oncoming traffic.
- Traffic control training module on the VO shall be completed when CH2M HILL workers who work in and around roadways and who exposed to public vehicular traffic.

8.55 Utilities (underground)

An assessment for underground utilities must be conducted where there is a potential to contact underground utilities or similar subsurface obstructions during intrusive activities. Intrusive activities include excavation, trenching, drilling, hand augering, soil sampling, or similar activities.

The assessment must be conducted before any intrusive subsurface activity and must include at least the following elements:

- A background and records assessment of known utilities or other subsurface obstructions.
- Contacting and using the designated local utility locating service.
- Conducting an independent field survey to identify, locate, and mark potential underground utilities or subsurface obstructions. *Note: This is independent of, and in addition to, any utility survey conducted by the designated local utility locating service above.*
- A visual survey of the area to validate the chosen location.

When any of these steps identifies an underground utility within 5 feet (1.5 meters) of intrusive work, then non-aggressive means must be used to physically locate the utility before a drill rig, backhoe, excavator or other aggressive method is used.

Aggressive methods are never allowed within 2 feet of an identified high risk utility (see paragraph below).

Any deviation from these requirements must be approved by the Responsible HS Manager and the Project Manager.

Background and Records Assessment of Known Utilities

Identify any client- or location-specific permit and/or procedural requirements (e.g., dig permit or intrusive work permit) for subsurface activities. For military installations, contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Obtain available utility diagrams and/or as-built drawings for the facility.

Review locations of possible subsurface utilities including sanitary and storm sewers, electrical lines, water supply lines, natural gas lines, fuel tanks and lines, communication lines, lighting protection systems, etc. Note: Use caution in relying on as-built drawings as they are rarely 100 percent accurate.

Request that a facility contact with knowledge of utility locations review and approve proposed locations of intrusive work.

Designated Local Utility Locating Service

Contact your designated local utility locating service (e.g., Dig-Safe, Blue Stake, One Call) to identify and mark the location of utilities. Call 811 in the U.S. or go to www.call811.com to identify the appropriate local service group. Contacting the local utility locating service is a legal requirement in most jurisdictions.

Independent Field Survey (Utility Locate)

The organization conducting the intrusive work (CH2M HILL or subcontractor) shall arrange for an independent field survey to identify, locate, and mark any potential subsurface utilities in the work area. This survey is in addition to any utility survey conducted by the designated local utility locating service.

The independent field survey provider shall determine the most appropriate instrumentation/technique or combinations of instrumentation/techniques to identify subsurface utilities based on their experience and expertise, types of utilities anticipated to be present, and specific site conditions.

A CH2M HILL or subcontractor representative must be present during the independent field survey to observe the utility locate and verify that the work area and utilities have been properly identified and marked. If there is any question that the survey was not performed adequately or the individual was not qualified, then arrangements must be made to obtain a qualified utility locate service to re-survey the area. Obtain documentation of the survey and clearances in writing and signed by the party conducting the clearance. Maintain all documentation in the project file.

If the site owner (military installation or client) can provide the independent field survey, CH2M HILL or the subcontractor shall ensure that the survey includes:

- Physically walking the area to verify the work location and identify, locate, and mark underground utility locations:
- Having qualified staff available and instrumentation to conduct the locate;
- Agreeing to document the survey and clearances in writing.
- Should any of the above criteria not be met, CH2M HILL or subcontractor must arrange for an alternate independent utility locate service to perform the survey.
- The markings from utility surveys must be protected and preserved until the markings are no longer required. If the utility location markings are destroyed or removed before intrusive work commences or is completed, the PM, SC, or designee must notify the independent utility locate service or the designated local utility locating service to resurvey and remark the area.

Visual Assessment before and during Intrusive Activities

Perform a “360 degree” assessment. Walk the area and inspect for utility-related items such as valve caps, previous linear cuts, patchwork in pavement, hydrants, manholes, utility vaults, drains, and vent risers in and around the dig area.

The visual survey shall include all surface landmarks, including manholes, previous liner cuts, patchwork in pavement, pad-mounted transformers, utility poles with risers, storm sewer drains, utility vaults, and fire hydrants.

If any unanticipated items are found, conduct further research before initiating intrusive activities and implement any actions needed to avoid striking the utility or obstruction.

Subsurface Activities within 5 feet of an Underground Utility or if there is Uncertainty

When aggressive intrusive activities will be conducted within 5 feet (1.5 meters) of an underground utility or when there is uncertainty about utility locations, locations must be physically verified by non-aggressive means such as air or water knifing, hand digging, or human powered hand augering. Non-conductive tools must be used if

electrical hazards may be present. If intrusive activities are within 5 feet (1.5 meters) and parallel to a marked existing utility, the utility location must be exposed and verified by non-aggressive methods every 100 feet (30.5 meters). Check to see if the utility can be isolated during intrusive work.

Intrusive Activities within 2 feet of an Underground Utility

Use non-aggressive methods (hand digging, vacuum excavation, etc.) to perform intrusive activities within 2 feet of a high risk utility (i.e., a utility that cannot be de-energized or would cause significant impacts to repair/replace). Hazardous utilities shall be de-energized whenever possible.

Spotter

A spotter shall be used to monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon, presence of pea gravel or sand in soils, presence of concrete or other debris in soils, refusal of auger or excavating equipment). If any suspicious conditions are encountered stop work immediately and contact the PM or RHSM to evaluate the situation. The spotter must have a method to alert an operator to stop the intrusive activity (e.g., air horn, hand signals).

8.56 Utilities (overhead)

Proximity to Power Lines

It must be determined whether equipment operations including, positioning, and traveling will occur in proximity to power lines within 20 feet (6.1 meters) for line voltage up to 350 kilo volts (kV), and within 50 feet (15.2 meters) for line voltage between 350 kV to 1000 kV. For power lines over 1000 kV, the distance must be determined by the utility/operator or qualified registered professional engineer in electrical power transmission and distribution.

Operations adjacent to overhead power lines are PROHIBITED unless one of the following conditions is satisfied:

- Power has been shut off, positive means (such as lockout) have been taken to prevent the lines from being energized, lines have been tested to confirm the outage, and the utility company has provided a signed certification of the outage.
- The minimum clearance from energized overhead lines is as shown in the table below, or the equipment will be repositioned and blocked to ensure that no part, including cables, can come within the minimum clearances shown in the table.

MINIMUM DISTANCES FROM POWERLINES

Powerlines Nominal System Kv	Minimum Required Distance, Feet (Meters)
0-50	10 (3.0)
50-200	15 (4.6)
201-350	20 (6.1)
351-500	25 (7.6)
501-750	35 (10.7)
751-1000	45 (13.7)
Over 1000	Established by utility owner/operator or by a professional engineer in electrical power transmission/distribution

(These distances have been determined to eliminate the potential for arcing based on the line voltage.)

- The power line(s) has been isolated through the use of insulating blankets which have been properly placed by the utility. If insulating blankets are used, the utility will determine the minimum safe operating distance; get this determination in writing with the utility representative's signature.
- All inquiries regarding electric utilities must be made in writing and a written confirmation of the outage/isolation must be received by the PM prior to the start of work.

8.57 Vacuum Trucks

When CH2M HILL personnel are exposed to vacuum truck operations, the following safe work practices/hazard controls shall be implemented.

- A pre-operational check should be performed on the vacuum truck before use. Operators must be familiar with the operator's manual.
- Operators of vacuum trucks should be trained and familiar with the equipment. At least one person should be operating the boom and one person signaling and assisting the boom operator.
- Before use the hoses and lines should be checked for fraying and connections checked for leakage. Proper selection of hose diameter and type of hose (smooth bore hose vs. corrugated hose) is vital before the job is performed.
- The amount of force produced by a vacuum truck can kill hose operators. If an eight-inch hose gets stuck to your body at 27 inches Hg, it can be fatal. All trucks should be equipped with an emergency release the hose operator or assistant can initiate if a worker gets sucked into a hose. A remote release, manual release near the truck and an inline "T" should be present on the truck. The inline "T" should be installed between the very last section of hose and the working section of hose. The cord that releases the in-line relief should be tethered to the hose handler's belt or a watch buddy should be nearby holding the cord and ready to relieve in the event of an emergency. Operators should never attempt to vacuum hose with any part of their body to check for suction.
- Tanks on vacuum trucks are a confined space. Before the tank is opened and anyone enters a confined space assessment should be performed.
- The truck should always be grounded before use. The static electricity produced when sucking materials into the system can produce a spark and ignite anything in the tank or hose. Use of a grounding wire will prevent static electric explosions. Vacuum trucks should not be used to pump mixtures with a flash point less than 140 degrees or less - this is an accepted industry standard - refer to the operators manual for more information.
- When positioning truck to work, be extra cautions of personnel and other equipment located next to truck.
- Wet and dry material should not be mixed in the tank.
- When swinging the boom, change directions slowly.
- Do not load dump body beyond rated capacity. Be aware of possible load surge when turning or braking.

8.58 Vinyl Chloride

(Reference CH2M HILL, SOP HSE-512, *Vinyl Chloride*)

Vinyl Chloride is considered a "Confirmed Human Carcinogen." Vinyl Chloride has a mild, sweet, chloroform-like odor.

CH2M HILL is required to control employee workplace exposure to vinyl chloride when personal exposures are at or above 1.0 ppm as an 8-hour time-weighted average (TWA) or above 5.0 ppm short term exposure limit (STEL), by implementing a program that meets the requirements of the Occupational Safety and Health Administration (OSHA) Vinyl Chloride standard, 29 CFR 1910.1017. The elements of the CH2M HILL vinyl chloride program include the following:

- Exposure monitoring
- Methods of control, including personal protective equipment (PPE) and respirators
- Medical surveillance
- Training on hazards of vinyl chloride and control measures (includes project-specific training and the computer-based training on CH2M HILL's Virtual Office, *Vinyl Chloride*)
- Record keeping requirements

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.
- Review the fact sheet included as an attachment to the SOP.

8.59 Welding and Cutting

(Reference CH2M HILL, SOP-314, *Welding and Cutting*)

Below are the hazard controls and safe work practices to follow when working around or performing welding and cutting. Ensure the requirements in the referenced SOP are followed.

- Workers designated to operate welding and cutting equipment shall have been properly instructed and qualified to operate such equipment.
- Before welding or cutting is permitted, the area shall be inspected by the individual responsible for authorizing the welding or cutting operation. The authorization, preferably in the form of a written permit, shall detail precautions to be taken before work is to begin.
- Suitable fire extinguishing equipment shall be immediately available in the work area.
- Flame-resistant blankets shall be used to control sparks produced by welding and cutting operations from traveling to lower levels or adjacent surfaces.
- If the valve on a fuel-gas cylinder is found to leak around the valve stem, the valve shall be closed and the gland nut tightened. If this does not stop the leak, the cylinder is to be tagged and removed from service.
- Nothing should be placed on top of a cylinder or manifold that will damage it or interfere with the quick closing of the valve.
- Flow gages and regulators shall be inspected prior to use and removed from cylinders when not in use.
- Hoses, leads, and cables shall be not be routed through doorways and walkways unless covered, elevated, or protected from damage. Where hoses, leads, and cables pass through wall openings, adequate protection shall be provided to prevent damage.
- Flash arresters shall be installed at the torch handle.
- Arc welding electrodes shall not be struck against compressed gas cylinders to strike an arc.
- All arc welding or cutting operations shall be shielded by noncombustible or flame resistant screens to protect employees or other persons in the vicinity from the direct rays of the arc.
- Proper ventilation shall be provided so as to maintain the level of contaminants in the breathing zone of welders below applicable permissible exposure limits.

- Minimum personal protective equipment includes the following:
 - Safety-toed shoes or boots, hard hats, and safety glasses
 - Body protection (such as gloves, coveralls, or Tyvek) when chemical hazards exist
 - Hearing protection when working in close proximity to loud equipment and machinery
 - Protective clothing and gloves to prevent burns
 - Suitable eye protective equipment for the type of welding or cutting performed
 - Opaque screens to block arc flash from arc welding and cutting operations
 - Mechanical ventilation systems for welding and cutting operations conducted in enclosed or confined spaces
 - Air monitoring or sampling equipment to evaluate airborne concentrations of welding and cutting contaminants
 - Respiratory protection when airborne concentrations of contaminants exceed regulatory limits

8.59.1 Compressed Gas Cylinders

- Cylinders being transported, moved, or stored shall have valve protection caps installed. When transported by motor vehicle, hoisted, or carried, cylinders shall be in the vertical position.
- Oxygen cylinders in storage shall be separated from fuel-gas cylinders or combustible materials by a minimum of 20 feet (6.1 meters) or by a noncombustible barrier at least 5 feet (1.5 meters) high having a fire resistant rating of at least one half hour.
- Inside of buildings, cylinders shall be stored in well-ventilated, dry locations at least 20 feet (6.1 meters) from highly combustible materials. Cylinders should be stored in definitely assigned places away from elevators, stairs, or gangways. Assigned storage areas shall be located where cylinders will not be knocked over or damaged.
- During use, cylinders shall be kept far enough away from the actual welding and cutting operations to prevent sparks, hot slag, or flames from reaching them. When impractical, fire resistant shields shall be provided.
- Cylinders containing oxygen or fuel-gas shall not be taken into confined spaces.
- If cylinders are frozen, warm (not boiling) water shall be used to thaw them.

8.59.2 Welding and Cutting Equipment

- Fuel-gas and oxygen hoses shall be easily distinguishable from each other and shall not be interchangeable between fuel-gas and oxygen.
- Hoses shall be inspected at the beginning of each shift. Defective hoses shall be removed from service.
- Hose couplings shall be designed to be disconnected with a rotary motion, not by straight pull.
- Torches shall be inspected at the beginning of each shift for leaking valves, connections, and couplings. Defective torches shall be removed from service.
- Torches shall be ignited with friction lighters, not open flames or hot work.

8.59.3 Arc Welding and Cutting

- Only manual electrode holders that are designed for arc welding or cutting and are capable of safely handling the maximum rated current shall be used.
- Only cable that is free from repair or splices for a minimum distance of 10 feet (3 meters) from the cable's attachment to the electrode holder shall be used.

- Any current-carrying part that arc welders or cutters grip in their hand, as well as the outer surfaces of the jaws of the holder, shall be fully insulated against the maximum voltage encountered to ground.
- The frames of arc welding or cutting machines shall be grounded. Grounding circuits, other than by means of the structure, shall be checked to ensure that the circuit between the ground and the grounded power conductor has resistance low enough to permit sufficient current flow to cause the fuse or circuit breaker to interrupt the current.
- When electrode holders are left unattended, the electrode shall be removed and the holder placed where it cannot harm employees.
- Hot electrode holders shall not be dipped in water to cool them.
- When welding or cutting is stopped for any appreciable length of time, or before the welding or cutting machine is moved, the power shall be shut off.
- Before starting welding or cutting operations, all connections to the machine shall be checked.

8.59.4 Toxic Fumes and Gases

- General mechanical or local exhaust ventilation shall be provided when welding or cutting in a confined space.
- Contaminated air exhausted from the work area shall be discharged into the open air or otherwise clear of the intake air.
- Other employees exposed to the same atmosphere as the welder or cutter shall be protected in the same manner as the welder or cutter.
- In enclosed spaces, all surfaces covered with toxic preservative coatings shall be stripped to a distance of at least four inches from the area to be heated, or the worker shall be protected with an air-line respirator.
- Welding or cutting in an enclosed space shall be performed with local exhaust ventilation or air-line respirators when the following metal bases, fillers, or coatings are involved: lead, cadmium, mercury, zinc, stainless steel, or beryllium.
- Employees welding or cutting in the open air and who are exposed to the metals noted above shall be protected with filter-type respirators; however, when working with beryllium, the employee shall be protected with an air-line respirator.

8.59.5 Fire Prevention

- When the potential for an explosive atmosphere exists in the immediate area of welding or cutting operations, air monitoring instruments shall be used to verify that no explosive atmosphere is present before or during welding or cutting operations.
- When welding or cutting on walls, floors, or ceilings, the same precautions shall be taken on the opposite side as for the welding or cutting side.
- Whenever openings or cracks in the floor, walls, or doorways cannot be closed, precautions shall be taken to prevent combustible materials in other areas from coming in contact with sparks.
- To prevent fire in enclosed spaces, the gas supply to the torch shall be shut off at some point outside the enclosed space whenever the torch is not in use or is left unattended.
- Drums or hollow structures that have contained toxic or flammable substances shall be filled with water or thoroughly cleaned, ventilated, and tested before welding or cutting on them.
- Before heat is applied to a drum, container, or structure, a vent or opening shall be provided to release built-up pressure during the application of heat.
- Before welding or cutting on any surface covered by a preservative coating whose flammability is unknown, a competent person shall test to determine its flammability.

- Preservative coatings shall be considered highly flammable when scrapings burn rapidly.
- When preservative coatings are determined to be highly flammable, they shall be stripped from the area to be heated.

8.60 Working Around Material Handling Equipment

When CH2M HILL personnel are exposed to material handling equipment, the following safe work practices/hazard controls shall be implemented:

- Never approach operating equipment from the rear. Always make positive contact with the operator, and confirm that the operator has stopped the motion of the equipment.
- Never approach the side of operating equipment; remain outside of the swing and turning radius.
- Maintain distance from pinch points of operating equipment.
- Never turn your back on any operating equipment.
- Never climb onto operating equipment or operate contractor/subcontractor equipment.
- Never ride contractor/subcontractor equipment unless it is designed to accommodate passengers and equipped with firmly attached passenger seat.
- Never work or walk under a suspended load.
- Never use equipment as a personnel lift; do not ride excavator buckets or crane hooks.
- Always stay alert and maintain a safe distance from operating equipment, especially equipment on cross slopes and unstable terrain.
- Wear a high visibility safety vest or high visibility clothing.

8.61 Working Alone

(Reference CH2M HILL Core Standard, *Working Alone*)

Personnel can only be tasked to work alone by the Project Manager who shall assess potential hazards and appropriate control measures, with assistance from the Responsible Health and Safety Manager (RHSM).

“Lone workers” with an accountability system in place is permitted, depending on the hazards presented during the execution of the task. Reference the “Lone Worker Protocol” included as an attachment to the project safety plan.

Only limited operations task are permitted to be performed alone. Activities that are not permitted to be performed by a lone worker include the following:

- Working at heights (e.g., on ladders, lifts, scaffolding);
- Energy isolation (e.g., lockout/tagout);
- Any entry into a confined space; and
- Work involving electricity or other hazardous equipment (e.g., chainsaws);
- Work over or near water; and
- Working in an area where there is an increased potential for violence.

An AHA shall be developed that shall include:

- Type or nature of work to be conducted by the lone worker;
- Location of the work
- Length of time the worker will be working alone; and
- Any characteristics of the individual working alone which may increase the risk to the worker (e.g., medical conditions).

The employee working alone shall at all times be equipped with a working voice communication device such as a cellular phone, satellite phone, personal alarms, or two-way radio to check-in to their project contact (s) at pre-determined times. For some work, a satellite-based communication system may be appropriate (i.e., a “SPOT” device).

Call-In System for Lone Worker Accountability

The employee working alone shall at all times be equipped with a working voice communication device such as a cellular phone, satellite phone, personal alarms, or two-way radio to check-in to their project contact (s) at pre-determined times.

Each time before going into the field, a “Call in contact Form” shall be completed by the lone worker and given to the call-in office worker contact prior to going into the field.

During field work, a copy of “The Lone Worker Call-In Contact Form” should be maintained by both the “Office Contact Worker” and the field-worker (“Lone Worker”). Lone Worker and Office Contact Worker must both have cell phones and each others’ phone number, plus one other alternate phone number.

Lone worker shall call the office contact worker when he/she has arrived on-site, before exiting his/her vehicle. On this phone call, a time shall be arranged for a “check-in” call to be made by the field worker, based on duration of task. On each “check-in” call a time should be arranged for the next “check-in” call. Document these times on the form.

Lone Worker shall carry his or her cell-phone throughout the field event and put the ringer on its loudest setting as wind or other noise can muffle the sound. If, for any reason the cell-phone becomes inoperable, the field-worker shall immediately stop work, leave the site and find an alternative method of contacting the Office Contact Worker to verify their safety and to inform them of the issue.

Work shall not proceed in the field until the Lone Worker has a working device that provides communication with the Office Contact Worker.

Upon completion of work activities, Lone Worker should pack up all materials and prepare to leave site. Then, before starting the engine of the vehicle to leave site, the Lone Worker should contact the office-worker and inform him or her that work is complete and that he or she is leaving the site. A final call shall be made by the lone work to the office worker to confirm he/she has reached their destination.

If at any time, the Office Contact Worker does not receive a “check-in” call at the scheduled time he/she should attempt to contact Lone Worker. If no contact is made then the Office Contact Worker should contact the facility contact person to check on the Lone Worker.

If no contact is made with the Lone Worker, then the Office Contact Worker shall contact the PM and/or RHSM to let them know they are going to inform emergency services inform that there is a possible emergency and instruct them to go to the field location and assist the Lone Worker. The Office Contact Worker will provide to emergency services the Lone Worker’s name, their last known location, vehicle description and their contact information.

Call in contact Form shall be completed by lone worker and given to call in contact prior to going into the field. Refer to the “Lone Worker Protocol” attached to the project safety plan.

8.62 Working Over Water

If any activities pose a risk to drowning implement the following during the activity:

- Fall protection should be provided to prevent personnel from falling into water. Where fall protection systems are not provided and the danger of drowning exists, U.S. Coast Guard-approved personal flotation devices (PFDs), or a life jacket, shall be worn.
- Provide employees with an approved (USCG for U.S. operations) life jacket or buoyant work vest.
 - Employees should inspect life jackets or work vests daily before use for defects. Do not use defective jackets or vests.

- Post ring buoys with at least 90 feet (27.4 meters) of 3/8-inch solid-braid polypropylene (or equal) line next to the work area. If the work area is large, post extra buoys 200 feet (61 meters) or less from each other.
- Provide at least one life saving skiff, immediately available at locations where employees are working over or adjacent to water.
 - Ensure the skiff is in the water and capable of being launched by one person and is equipped with both motor and oars.
- Designate at least one employee on site to respond to water emergencies and operate the skiff at times when there are employees above water.
 - If the designated skiff operator is not within visual range of the water, provide him or her with a radio or provide some form of communication to inform them of an emergency.
 - Designated employee should be able to reach a victim in the water within three to four minutes.
- Ensure at least one employee trained in CPR and first aid is on site during work activities.

9. Physical Hazards and Controls

Physical hazards include exposure to temperature extremes, sun, noise, and radiation. If you encounter a physical hazard that has not been identified in these Guidelines or the project safety plan, contact the RHSM so hazard controls can be addressed.

9.1 Noise

(Reference CH2M HILL SOP HSE-108, *Hearing Conservation*)

CH2M HILL is required to control employee exposure to occupational noise levels of 85 decibels, A-weighted, (dBA) and above by implementing a hearing conservation program that meets the requirements of the OSHA Occupational Noise Exposure standard, 29 CFR 1910.95. A noise assessment may be conducted by the RHSM or designee based on potential to emit noise above 85 dBA and also considering the frequency and duration of the task.

- Areas or equipment emitting noise at or above 90dBA shall be evaluated to determine feasible engineering controls. When engineering controls are not feasible, administrative controls can be developed and appropriate hearing protection will be provided.
- Areas or equipment emitting noise levels at or above 85 dBA, hearing protection must be worn.
- Employees exposed to 85 dBA or a noise dose of 50 percent must participate in the Hearing Conservation program including initial and annual (as required) audiograms.
- The RHSM will evaluate appropriate controls measures and work practices for employees who have experienced a standard threshold shift (STS) in their hearing.
- Employees who are exposed at or above the action level of 85 dBA are required to complete the online Noise Training Module located on CH2M HILL's virtual office.
- Hearing protection will be maintained in a clean and reliable condition, inspected prior to use and after any occurrence to identify any deterioration or damage, and damaged or deteriorated hearing protection repaired or discarded.
- In work areas where actual or potential high noise levels are present at any time, hearing protection must be worn by employees working or walking through the area.
- Areas where tasks requiring hearing protection are taking place may become hearing protection required areas as long as that specific task is taking place.
- High noise areas requiring hearing protection should be posted or employees must be informed of the requirements in an equivalent manner and a copy of the OSHA standard 29 CFR 1910.95 shall be posted in the workplace.

9.2 Ultraviolet Radiation (sun exposure)

Health effects regarding ultraviolet (UV) radiation are confined to the skin and eyes. Overexposure can result in many skin conditions, including erythema (redness or sunburn), photoallergy (skin rash), phototoxicity (extreme sunburn acquired during short exposures to UV radiation while on certain medications), premature skin aging, and numerous types of skin cancer. Implement the following controls to avoid sunburn.

Limit Exposure Time

- Rotate staff so the same personnel are not exposed all of the time.
- Limit exposure time when UV radiation is at peak levels (approximately 2 hours before and after the sun is at its highest point in the sky).
- Avoid exposure to the sun, or take extra precautions when the UV index rating is high.

Provide Shade

- Take lunch and breaks in shaded areas.
- Create shade or shelter through the use of umbrellas, tents, and canopies.
- Fabrics such as canvas, sailcloth, awning material and synthetic shade cloth create good UV radiation protection.
- Check the UV protection of the materials before buying them. Seek protection levels of 95 percent or greater, and check the protection levels for different colors.

Clothing

- Reduce UV radiation damage by wearing proper clothing; for example, long sleeved shirts with collars, and long pants. The fabric should be closely woven and should not let light through.
- Head protection should be worn to protect the face, ears, and neck. Wide-brimmed hats with a neck flap or “Foreign Legion” style caps offer added protection.
- Wear UV-protective sunglasses or safety glasses. These should fit closely to the face. Wrap-around style glasses provide the best protection.

Sunscreen

- Apply sunscreen generously to all exposed skin surfaces at least 20 minutes before exposure, allowing time for it to adhere to the skin.
- Re-apply sunscreen at least every 2 hours, and more frequently when sweating or performing activities where sunscreen may be wiped off.
- Choose a sunscreen with a high sun protection factor (SPF). Most dermatologists advocate SPF 30 or higher for significant sun exposure.
- Waterproof sunscreens should be selected for use in or near water, and by those who perspire sufficiently to wash off non-waterproof products.
- Check for expiration dates, because most sunscreens are only good for about 3 years. Store in a cool place out of the sun.
- No sunscreen provides 100 percent protection against UV radiation. Other precautions must be taken to avoid overexposure.

9.3 Temperature Extremes

(Reference CH2M HILL SOP HSE-211, *Heat and Cold Stress*)

Each employee is responsible for the following:

- Recognizing the symptoms of heat or cold stress;
- Taking appropriate precautionary measures to minimize their risk of exposure to temperature extremes (see following sections); and
- Communicating any concerns regarding heat and cold stress to their supervisor or SC.

9.3.1 Heat

California has a specific heat illness prevention regulation that must be implemented. This includes,

- Having enough water onsite so that each worker can consume at a minimum, one quart per hour per shift.
- Frequent reminders and/or water breaks shall be taken so that each person can consume enough water.

- Access to shade (i.e., blockage from direct sunlight) shall be provided at all times and shall be reasonably close to the work area. Keep in mind that a vehicle or other enclosed area with no air conditioning is NOT considered shade. Must be a well ventilated area or have air conditioning.
- Workers suffering from heat illness-related symptoms OR if needed for preventative recovery shall be provided access to shade for at least 5 minutes, or longer, for recovery. (if heat related symptoms are occurring, contact the RHSM).
- Training on risk factors, signs and symptoms of heat illness, importance of hydration and acclimatization, and importance of reporting symptoms and what to do in case of heat illness emergency, and contacting emergency medical services (see sections that follow).

Heat-related illnesses are caused by more than just temperature and humidity factors.

Physical fitness influences a person's ability to perform work under heat loads. At a given level of work, the more fit a person is, the less the physiological strain, the lower the heart rate, the lower the body temperature (indicates less retained body heat—a rise in internal temperature precipitates heat injury), and the more efficient the sweating mechanism.

Acclimatization is a gradual physiological adaptation that improves an individual's ability to tolerate heat stress. Acclimatization requires physical activity under heat-stress conditions similar to those anticipated for the work. With a recent history of heat-stress exposures of at least two continuous hours per day for 5 of the last 7 days to 10 of the last 14 days, a worker can be considered acclimatized. Its loss begins when the activity under those heat-stress conditions is discontinued, and a noticeable loss occurs after 4 days and may be completely lost in three to four weeks. Because acclimatization is to the level of the heat-stress exposure, a person will not be fully acclimatized to a sudden higher level; such as during a heat wave.

Dehydration reduces body water volume. This reduces the body's sweating capacity and directly affects its ability to dissipate excess heat.

The ability of a body to dissipate heat depends on the ratio of its surface area to its mass (surface area/weight).

Heat dissipation is a function of surface area, while heat production depends on body mass. Therefore, overweight individuals (those with a low ratio) are more susceptible to heat-related illnesses because they produce more heat per unit of surface area than if they were thinner. Monitor these persons carefully if heat stress is likely.

When wearing **impermeable clothing**, the weight of an individual is not as important in determining the ability to dissipate excess heat because the primary heat dissipation mechanism, evaporation of sweat, is ineffective.

SYMPTOMS AND TREATMENT OF HEAT STRESS

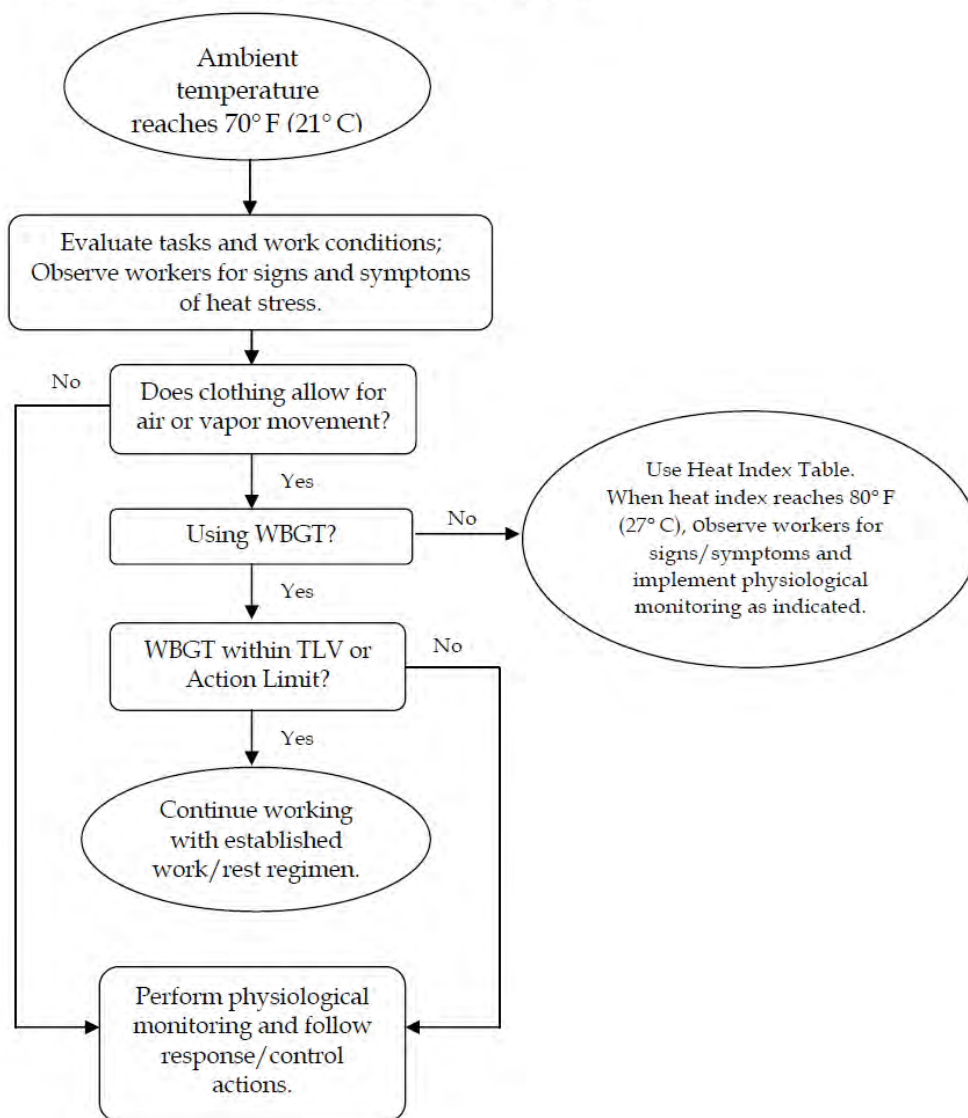
	Heat Syncope	Heat Rash	Heat Cramps	Heat Exhaustion	Heat Stroke
Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature.
Treatment	Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.	Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.	Remove to cooler area. Rest lying down. Increase fluid intake.	Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.	Cool rapidly by soaking in cool—but not cold—water. Call ambulance, and get medical attention immediately!

Precautions

- Drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50°Fahrenheit (10 degrees Celsius [C]) to 60°Fahrenheit (F) (15.6 degrees C) should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons (7.5 liters) per day. Remind employees to drink water throughout their work shift.
- Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate to site work conditions by slowly increasing workloads; for example, do not begin site work with extremely demanding activities. Closely monitor employees during their first 14 days of work in the field.
- Supervisors and SCs must continually observe employees throughout the work shift for signs and symptoms of heat stress or illness. Employees must monitor themselves for heat stress as well as observe their co-workers.
- Effective communication must be maintained with employees throughout the work shift either by voice, observation, or electronic device.
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Avoid direct sun whenever possible, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shade to protect personnel against radiant heat (sun, flames, hot metal).
- Use portable fans for convection cooling or in extreme heat conditions, an air-conditioned rest area when needed.
- In hot weather, rotate shifts of workers.
- Maintain good hygiene standards by frequent changes of clothing and showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should consult medical personnel.
- Brief employees initially before the project work begins and routinely as part of the daily safety briefing, on the signs and symptoms of heat-relatedness illnesses, precautions and emergency procedures to follow as described in the project safety plan.
- Observe one another for signs of heat stress. PREVENTION and communication is key.

Thermal Stress Monitoring

Thermal Stress Monitoring Flow Chart



Permeable Clothing – Monitoring Using WBGT

A Wet Bulb Globe Thermometer (WBGT) is the established and preferred means of measuring the environmental factors associated with heat stress and for providing indication of when physiological monitoring or rest regimens should be incorporated into the work schedule. The WBGT is the composite temperature used to estimate the effect of temperature, humidity, wind speed, and solar radiation on the human body.

When permeable work clothes are worn (street clothes or clothing ensembles over modesty clothes), physiological monitoring may be required based on the outcome of the WBGT measurements, taking into account the clothing adjustment factors. Use of the WBGT should generally begin when the heat index reaches 80° F (27° C) as indicated in the Heat Index Table below, or when workers exhibit symptoms of heat stress as indicated above.

If the WBGT is within the TLV (acclimatized workers) or Action Limit (unacclimatized workers) per the tables below, then work may continue while maintaining the established work/rest regimen. If the WBGT reading meets or exceeds either the TLV or Action Level for a work/rest regimen of 15 minutes work and 45 minutes rest, then physiological monitoring will be implemented.

Screening Criteria for TLV and Action Limit for Heat Stress Exposure

Allocation of work in a cycle of work and recovery	TLV (WBGT Values in °F/°C) (Acclimatized Workers)				Action Limit (WBGT Values in °F/°C) (Unacclimatized Workers)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75-100%	88/31	82/28	—	—	82/28	77/25	—	—
50-75%	88/31	84/29	82/28	—	83/29	79/26	75/24	—
25-50%	90/32	86/30	84/29	82/28	85/30	81/27	78/26	76/25
0-25%	91/33	89/32	87/31	86/30	86/30	84/29	82/28	81/27

Work Category Descriptions:

Light	Sitting or standing with light manual work using hands or arms; occasional walking.
Moderate	Sustained moderate hand, arm, and leg work; light pushing and pulling; normal walking.
Heavy	Intense arm and trunk work, carrying, shoveling, manually sawing, pushing and pulling heavy loads, walking at a fast pace.
Very Heavy	Very intense activity at fast to maximum pace.

Notes:

WBGT values are expressed to the nearest degree.

“—” Dashes indicate the need for physiological monitoring because screening criteria are not recommended for this type of work.

Clothing Adjustment Factors for Some Clothing Ensembles*

Clothing Type	Addition to WBGT °F/°C
Work Clothes (sleeved shirt and pants)	0/0
Cloth (woven material) coveralls	0/0
Double-layer woven clothing	5.4/3
Polypropylene coveralls	0.9/0.5
Limited Use Vapor barrier coveralls	19.8/11

* These values must not be used for completely encapsulating (impermeable) coveralls/suits. Coveralls assume that only modesty clothing is worn beneath.

Thermal Stress Monitoring – Permeable or Impermeable Clothing

When **permeable work clothes** are worn (street clothes or clothing ensembles over street clothes), regularly observe workers for signs and symptoms of heat stress and implement physiological monitoring as indicated below. This should start when the heat index reaches 80° F (27° C) [see Heat Index Table below], or sooner if workers exhibit symptoms of heat stress indicated in the table above. These heat index values were devised for shady, light wind conditions; exposure to full sunshine can increase the values by up to 15°F (8°C). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

When wearing **impermeable clothing** (e.g., clothing doesn't allow for air or water vapor movement such as Tyvek), physiological monitoring as described below shall be conducted when the ambient temperature reaches 70° F (21° C) or sooner when climatic conditions may present greater risk of heat stress combined with wearing unique variations of impermeable clothing, or workers exhibit symptoms of heat stress

Heat Index Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution
 Extreme Caution
 Danger
 Extreme Danger

Heat Index	Possible Heat Disorders	Minimum Frequency of Physiological Monitoring
80°F - 90°F (27°C - 32°C)	Fatigue possible with prolonged exposure and/or physical activity	Conduct initial monitoring as baseline and observe workers for signs of heat stress and implement physiological monitoring if warranted.
90°F - 105°F (32°C - 41°C)	Sunstroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity	Conduct initial monitoring as baseline, then at least every hour, or sooner, if signs of heat stress are observed.
105°F - 130°F (41°C - 54°C)	Sunstroke, heat cramps, or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity.	Conduct initial monitoring as baseline, then every 30 minutes or sooner if signs of heat stress are observed.
130°F or Higher (54°C or Higher)	Heat/Sunstroke highly likely with continued exposure.	Conduct initial monitoring as baseline, then every 15 minutes or sooner if signs of heat stress are observed.

Source: National Weather Service

Physiological Monitoring and Associated Actions

For employees wearing permeable clothing, follow the minimum frequency of physiological monitoring listed in the Heat Index Table.

For employees wearing impermeable clothing, physiological monitoring should begin initially at a 15 minute interval, then if the employee's heart rate or body temperature is within acceptable limits, conduct the subsequent physiological monitoring at 30 minutes, and follow the established regimen protocol below.

When physiological monitoring is required, use either radial pulse or aural temperature and follow actions below:

- The sustained heart rate during the work cycle should remain below 180 beats per minute (bpm) minus the individual's age (e.g., 180 – 35 year old person = 145 bpm). The sustained heart rate can be estimated by measuring the heart rate at the radial pulse for 30 seconds as quickly as possible prior to starting the rest period.

- The heart rate after one minute rest period should not exceed 120 beats per minute (bpm).
- If the heart rate is higher than 120 bpm after the FIRST minute into the rest period, the next work period should be shortened by 33 percent, while the length of the rest period stays the same.
- If the pulse rate still exceeds 120 bpm at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent.
- Continue this procedure until the rate is maintained below 120 bpm after the FIRST minute into the rest period.

Alternately, the body temperature can be measured, either oral or aural (ear), before the workers have something to drink.

- If the oral or aural temperature exceeds 99.6° F (37.6 ° F) at the beginning of the rest period, the following work cycle should be shortened by 33 percent.
- Continue this procedure until the oral or aural (ear) temperature is maintained below 99.6 ° F (37.6° C). While an accurate indication of heat stress, oral temperature is difficult to measure in the field, however, a digital aural (aural) thermometer is easy to obtain and inexpensive to purchase.

Procedures for when Heat Illness Symptoms are Experienced

- Always contact the RHSM when any heat illness related symptom is experienced so that controls can be evaluated and modified, if needed.
- In the case of cramps, reduce activity, increase fluid intake, move to shade until recovered.
- In the case of all other heat-related symptoms (fainting, heat rash, heat exhaustion), and if the worker is a CH2M HILL worker, contact the occupational physician at 1-866-893-2514 and immediate supervisor.
- In the case of heat stroke symptoms, call 911, have a designee give location and directions to ambulance service if needed, follow emergency medical treatment section of the project safety plan.
- Follow the Incident Notification, Reporting, and Investigation section of these Guidelines.

9.3.2 Cold

General

Low ambient temperatures increase the heat lost from the body to the environment by radiation and convection. In cases where the worker is standing on frozen ground, the heat loss is also due to conduction.

Wet skin and clothing, whether because of water or perspiration, may conduct heat away from the body through evaporative heat loss and conduction. Thus, the body cools suddenly when chemical protective clothing is removed if the clothing underneath is perspiration soaked.

Movement of air across the skin reduces the insulating layer of still air just at the skin's surface. Reducing this insulating layer of air increases heat loss by convection.

Non-insulating materials in contact or near-contact with the skin, such as boots constructed with a metal toe or shank, conduct heat rapidly away from the body.

Certain common drugs, such as alcohol, caffeine, or nicotine, may exacerbate the effects of cold, especially on the extremities. These chemicals reduce the blood flow to peripheral parts of the body, which are already high-risk areas because of their large surface area to volume ratios. These substances may also aggravate an already hypothermic condition.

Precautions

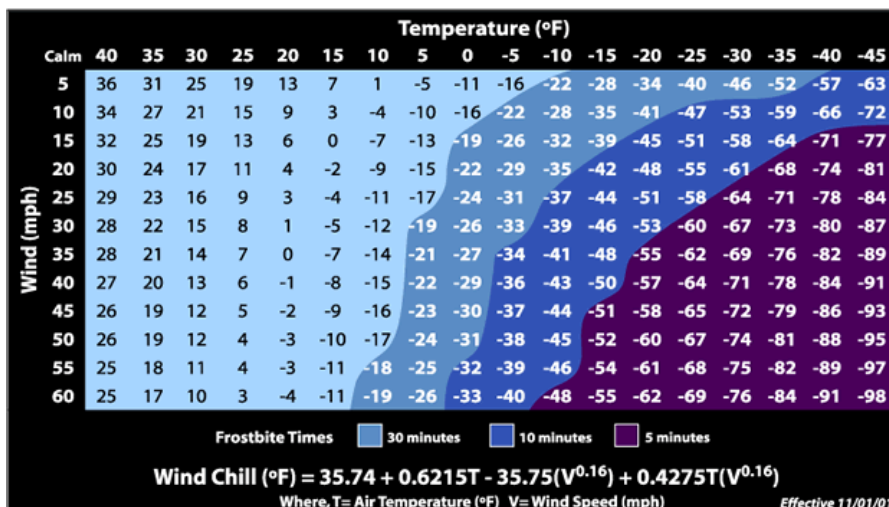
- Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in wet weather.
- Consider monitoring the work conditions and adjusting the work schedule using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council (NSC).
- Wind-Chill Index (below) is used to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it should only be used as a guideline to warn workers when they are in a situation that can cause cold-related illnesses.
- Persons who experience initial signs of immersion foot, frostbite, and/or hypothermia should report it immediately to their supervisor/PM to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast – be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

SYMPTOMS AND TREATMENT OF COLD STRESS

	Immersion (Trench) Foot	Frostbite	Hypothermia
Signs and Symptoms	Feet discolored and painful; infection and swelling present.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Treatment	Seek medical treatment immediately.	Remove victim to a warm place. Re-warm area quickly in warm—but not hot—water. Have victim drink warm fluids, but not coffee or alcohol. Do not break blisters. Elevate the injured area, and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids, but not coffee or alcohol. Get medical attention.



Wind Chill Chart



10. Biological Hazards and Controls

Biological hazards are everywhere and change with the region and season. During project planning stages, ask the site Point of Contact if there are insect or other biological hazards have been noted in any of the work sites.

Biological hazards are everywhere and change with the region and season. If you encounter a biological hazard that has not been identified in the project safety plan or in these Guidelines, contact the RHSM so that hazard controls can be addressed. Whether it is contact with a poisonous plant, a poisonous snake, or a bug bite, do not take bites or stings lightly. If there is a chance of an allergic reaction or infection, or to seek medical advice on how to properly care for the injury, contact the occupational nurse at 1-866-893-2514.

10.1 Black Bears

Bears may inhabit wooded areas where there is scarce continuous human presence. Make your presence known—especially when vegetation and terrain make it hard to see. Make noise, sing, or talk loudly. Avoid thick brush. Try to walk with the wind at your back so your scent will warn bears of your presence.

Give bears plenty of room. Every bear has a “personal space” - the distance within which a bear feels threatened – that can be from a few feet to a few hundred feet. If you stray within that zone, a bear may act aggressively. Never approach bears, even if only out of curiosity, and never attempt to feed bears.

If a bear cannot recognize you, he may come closer or stand on his hind legs for a better view. You may try to back away slowly diagonally, but if the bear follows, stop and stand your ground. If the bear moves closer or acts aggressively, stay close together and wave your arms and shout.

Do not climb a tree – black bears are good climbers.

Do not run. Bears have been clocked at speeds of up to 35 mph, and like dogs, will chase fleeing animals. Bears often make bluff charges, sometimes up to 10 feet away without making contact. Continue waving your arms and shouting. Never imitate bears sounds or use high-pitched squeals.

If attacked, do not run. Clasp your hands tightly over the back of your neck or if you are carrying a backpack use it to protect your head and neck and remain still.

For Black bears, if the attack lasts for more than a few seconds, respond aggressively - use sticks, rocks, your fists or noise. Black bears will sometimes back off if they are challenged.

10.2 Bees and Other Stinging Insects

Bees and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people who are allergic.

Precautions include:

- Watching for and avoiding nests.
- Keep exposed skin to a minimum.
- Carry a kit if you have had allergic reactions in the past, and inform your supervisor and/or a buddy. When working at a remote location, ensure that first-aid kits contain over-the-counter allergy and itch medication (e.g., Benadryl, Claritin, etc) as well as other over-the-counter medications that may not be available to aid in symptom treatment.
- If bees or other stinging insects are known to be present, determine whether additional protective clothing should be donned before entering/working in brushy areas.
- Before entering a heavily vegetated or brushy area, observe the area for several minutes to see if bees or other stinging insects may be present. If nests or individual insects are observed, retreat and inquire whether a specialist or a client service can be contacted to clear the area before work proceeds.

- Consider if heavy-weight clothing or tyvek, or head netting would provide additional protection in areas where wasps/bees are known or suspected. Be aware of heat stress conditions additional clothing may cause.
- Use insect repellent on clothing. Wear light-colored clothing and remove bright reflective safety-colored clothing if not working near a roadway as these may attract the wasps.
- Wear fragrance-free or lightly-scented sunscreen, and body lotions. Bees are attracted to sweet scents. Avoid using floral scented soaps, shampoos, or conditioners.
- Move slowly and calmly through vegetated areas and try to avoid major disturbance of vegetation as wasps/bees often react to aggressive movement.
- If you encounter a wasp, back away slowly and calmly, do not run or swat at the insect. Wait for it to leave, or gently move or brush it off gently with a piece of paper or other light object. Do not use your hand.

If you are stung, contact the occupational nurse at 1-866-893-2514, no matter how minor it may seem. If a stinger is present, remove it as soon as possible using something with a thin, hard edge (e.g., credit card) to scrape the stinger out. Be sure to sanitize the object first with hand sanitizer, alcohol or soap and water. Wash and disinfect the wound, cover it, and apply ice. Watch for an allergic reaction if you have never been stung before. Call 911 if the reaction is severe.

10.3 Bird Droppings

Large amounts of bird droppings may present a disease risk. The best way to prevent exposure to fungus spores in bird droppings is to avoid disturbing it. A brief inhalation exposure to highly contaminated dust may be all that is needed to cause infection and subsequent development of fungal disease.

If disturbing the droppings or if removal is necessary to perform work, follow these controls:

- Use dust control measures (wetting with water or HEPA vacuuming) for all activities that may generate dust from the accumulated droppings.
- Wear Tyvek with hoods, disposable gloves and booties, and air-purifying respirators with a minimum N95 rating.
- Put droppings into plastic/poly bags and preferably into a 55-gallon drum to prevent bag from ripping.

10.4 Cactus

Cacti are present onsite. Contact with cacti can result in dermatitis as well as causing immunologic and infectious reactions. The spines can scratch the skin or induce wounds and multiple abrasions. Some cacti have glochids (hair-like spines or short prickles, generally barbed). Glochids can induce more troublesome, more persistent, dermatological manifestations such as papules or nodules.

Set up the work area to ensure avoidance of cacti. Wear leather glove if working near cacti. Keep any clothing such as jackets away from cacti as spines can become lodged into the clothing and can be contacted by the skin later. Contact the occupational nurse if cactus contact occurs.

10.5 Cougars/Mountain Lions

Like bears, cougars will often retreat if given the opportunity. Walking in groups and making noise will give the cougar the chance to retreat and reduce the likelihood of a sudden encounter. Be especially cautious during dusk and dawn.

If you see a cougar—do not play dead, do not run. Running may trigger an attack. Face the cougar and retreat slowly maintaining eye contact. If the cougar continues advancing, raise your arms above your head to make yourself look larger than normal. This may help to intimidate the cougar. Sometimes aggressive yelling and rock throwing may scare it off.

If attacked, fight back with whatever is at hand (without turning your back)—people have utilized rocks, jackets, garden tools, tree branches, and even bare hands to turn away cougars.

10.6 Coyotes

While far from domesticated, coyotes show little fear of humans and have become comfortable living in close proximity to our communities. Although they tend to do most of their hunting after dusk, coyotes can be active at any time. Under normal circumstances, a coyote is not a danger to humans. They are, however, territorial and will respond aggressively if they or their family are threatened.

If you encounter a coyote that behaves aggressively, you have probably gotten too close to its prey or its family. Try to scare the coyote by yelling and waving your arms. Throw rocks, sticks or other objects. Do not turn away and run.

10.7 Feral Dogs

Avoid all dogs – both leashed and stray. Do not disturb a dog while it is sleeping, eating, or caring for puppies. If a dog approaches to sniff you, stay still. An aggressive dog has a tight mouth, flattened ears and a direct stare. If you are threatened by a dog, remain calm, do not scream and avoid eye contact. If you say anything, speak calmly and firmly. Do not turn and run, try to stay still until the dog leaves, or back away slowly until the dog is out of sight or you have reached safety (e.g., vehicle). If attacked, retreat to vehicle or attempt to place something between you and the dog. If you fall or are knocked to the ground, curl into a ball with your hands over your head and neck and protect your face. If bitten, contact the occupational nurse at 1-866-893-2514. Report the incident to the local authorities.

10.8 Feral Pigs

There are 4 million feral swine in over 39 states, with populations in Texas, Florida and throughout the southeastern United States. They have also been noted in California, Oregon, Nebraska, Kansas, Michigan, and Ohio. Although some of the animals have a distinctive “wild boar” appearance, others may look no different than many breeds of domestic hogs.

Feral pigs or hogs have been known to attack human beings. Perhaps the greater risk, though, is that of contracting a disease from an infected hog. People can catch undulant fever from feral hogs infected with swine brucellosis.

Feral hogs have excellent senses of smell and hearing and normally avoid contact with humans, so making noise, and alerting them to your presence most of the time will help you avoid an encounter. There are occasions of hogs chasing hunters up trees, but these are rare, isolated instances. The vast majority of hogs flee from humans. However, should you find yourself nose-to-snout with an angry pig, the best defense is to climb the nearest tree. If the pig charges, sidestep quickly, taking care to avoid the swing of its tusks and promptly find a tree to scamper up.

10.9 Fire Ants

There are several types of fire ants in the United States that can cause painful bites and allergic reactions. Fire ants aggressively defend their nests by stinging several times after climbing on their victims. Large ant mounds are easily visible, but there can be smaller mounds or nests with little “worked” soil that can be stepped on inadvertently. They can also be under rocks, wood or other debris. Implement the following when fire ants are observed:

- Be aware of fire ants and take care not to stand on ant nests;
- Use insect repellents on clothing and footwear to temporarily discourage ants from climbing; and
- Tuck pants into socks.

If stung, get away from the area you are standing on, briskly brush off ants—wash affected area with soap. Call the occupational nurse.

10.10 Hantavirus

Hantavirus pulmonary syndrome (HPS) is a disease caused by a virus which can be transmitted from certain rodents to humans and is prevalent throughout the United States. Avoid disturbing rodent nests. Contact is most likely to occur when there is a current rodent infestation in things like control boxes, storage sheds, wellheads, remediation equipment, or trailers. Once excreted into the environment by the rodent, hantaviruses can survive in the environment and remain infectious for a period of 2-3 days. Ultraviolet rays in sunlight inactivate hantaviruses.

Nesting material and droppings must be removed if work is necessary in a rodent-infested area. PPE for removal shall include:

- Tyvek coveralls;
- Rubber boots or disposable shoe covers;
- Rubber, latex, or vinyl gloves;
- Respiratory protection such as a full face or half-mask air-purifying respirator with a high-efficiency particulate air (HEPA) filter; and
- Protective goggles if wearing a half-mask respirator.

Spray any urine, droppings, and nesting materials with either a bleach and water solution (1 parts bleach to 9 parts water) or a household disinfectant prepared according to the label instructions for dilution and disinfection time. Soak well and let stand for 15 minutes. Use a paper towel or rag to pick up the materials and dispose of them.

Mop floors after spraying them using bleach and water solution or a disinfectant. Dirt floors can be sprayed with either bleach and water solution or a disinfectant.

Personal protective gear shall be decontaminated upon removal at the end of the day. All potentially infective waste material (including respirator filters) from clean-up operations shall be double-bagged in plastic bags.

Symptoms of HPS

Symptoms develop between 14 and 31 days after exposure to infected rodents and include fatigue, fever, and muscle aches, especially the large muscle groups—thighs, hips, back and sometimes shoulders. About half of all HPS patients also experience headaches, dizziness, chills and/or abdominal pain. Four to 10 days after the initial phase of the illness, late symptoms of HPS may appear. These include coughing and shortness of breath. If you develop symptoms suggestive of HPS, call the occupational nurse at 1-866-893-2514.

10.11 Hazards during Hunting Seasons

Various times of the year can be particularly hazardous for personnel working in the field. The danger is highest for our teams doing cross-country surveys of pipelines and transmission lines, but everyone doing field work should be aware of the hunting seasons that are active where you are working.

Big game hunting can be very dangerous, but also be aware of water fowl seasons and hunting seasons for less common game in your area. Work in wetlands can bring us in close proximity to these types of hunters.

If possible consider postponing field surveys so they do not coincide with hunting seasons but if you must be in the field be as visible as possible at all times.

This site gives all the different hunting seasons by state:

www.huntinfo.org/

Implement the following if hunting may be a hazard:

- Do not wear kaki, brown or tan clothing, wear high visibility colors including hats and vests;
- Avoid wearing white or light colored scarves, gloves, handkerchiefs (a woman wearing white mittens hanging laundry was shot and killed as bad hunter shot at flash of white);

- When carrying white plans, field data sheets etc keep them in binder or backpack;
- Wear your safety vest at all times including standing by car/truck;
- Wear a safety hat/cap or put florescent markers on hard hats;
- Be alert particularly in early mornings and at end of day when most hunters are present;
- Avoid being in field altogether at dawn or dusk - start a little later in the morning and make sure you get out of the field earlier;
- Stop at local hardware or convenience market and pick up hunter safety gloves, caps, rolls of tape etc. All the stores carry them and they are cheap visual protection.
- Make your presence known, such as slamming car doors, honk horn, talk loudly when getting out to a field site; and
- Stop and survey your surroundings. Many hunters are up in tree stands.

10.12Leeches

Leeches are bloodsucking aquatic or terrestrial worms. They can crawl through or over your socks or brush onto you from shrubbery. They carry no disease and there is low risk of significant blood loss. Leech bites do not hurt since they release an anesthetic, but they can bleed profusely due to an anticoagulant they release to facilitate the flow of blood.

Possible Complications

- Some people suffer allergic reaction from leech bites and require urgent medical care. Symptoms include an ulcer infection, itchy rash, red blotches or an itchy rash over the body, swelling around the lips or eyes, feeling faint or dizzy, and difficulty breathing. If you experience any of these symptoms, seek medical attention immediately.

Prevention options

- The best protection against leeches is covering up and using tropical strength insect repellent on socks and clothing.
- Use anti leech socks and fit over outer garments which served as a barrier.
- Various reports suggest applying salt, dettol spray, bath soap, eucalyptus oil or lemon juice to your skin.
- Inspect your body after leaving leech-infested waters or area, removing them promptly.

First Aid

- Locate the head with a sucker attached to the wound. It will be the narrow end of leech's body.
- Use your fingernail or other flat, blunt object to break the seal of the oral sucker at which point the leech's jaws will detach. Repeat with the posterior end.
- Quickly flick the leech away before it bites you again and reattaches.
- Treat the wound with soap and water and antiseptic wipes; then bandage to stop bleeding.
- Do not just pull off the leech as this may cause a severe wound and the jaws may stay imbedded in the skin
- If the leech has attached to an orifice such ear, nose or mouth use salt or strong (drinkable) alcohol to cause it to release before it expands.
- Apply pressure to the area and a cold pack to reduce pain or swelling.
- The wound normally itches as it heals, but should not be scratched, as this may complicate healing and introduce other infections. Apply an antihistamine if necessary to reduce itching.

- If assisting a bitten person, use the usual protective universal precautions to protect against blood borne pathogens
- Call the occupational nurse.

10.13 Mosquito Bites

Due to the recent detection of the West Nile Virus in the southwestern United States it is recommended that preventative measures be taken to reduce the probability of being bitten by mosquitoes whenever possible. Mosquitoes are believed to be the primary source for exposure to the West Nile Virus as well as several other types of encephalitis. The following guidelines should be followed to reduce the risk of these concerns for working in areas where mosquitoes are prevalent:

- Stay indoors at dawn, dusk, and in the early evening;
- Wear long-sleeved shirts and long pants whenever you are outdoors;
- Spray clothing with repellents containing permethrin or N,N-diethyl-meta-toluamide (DEET) since mosquitoes may bite through thin clothing;
- Apply insect repellent sparingly to exposed skin. An effective repellent will contain 35 percent DEET. Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands; and
- Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product.

Vitamin B and "ultrasonic" devices are NOT effective in preventing mosquito bites.

Symptoms of Exposure to the West Nile Virus

Most infections are mild, and symptoms include fever, headache, and body aches, occasionally with skin rash and swollen lymph glands. More severe infection may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and, rarely, death.

The West Nile Virus incubation period is from 3 to 15 days.

Contact the project RHSM with questions, and immediately report any suspicious symptoms to your supervisor, PM, and contact the occupational nurse at 1-866-893-2514.

10.14 Poison Ivy, Poison Oak, and Poison Sumac

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Shrubs are usually 12 to 30 inches high, or can also be a tree-climbing vine, with triple leaflets and short, smooth hair underneath. Plants are red and dark green in spring and summer, with yellowing leaves anytime especially in dry areas. Leaves may achieve bright reds in fall, but plants lose its (yellowed, then brown) leaves in winter, leaving toxic stems. All parts of the plant remain toxic throughout the seasons. These plants contain urushiol a colorless or pale yellow oil that oozes from any cut or crushed part of the plant, including the roots, stems and leaves and causes allergic skin reactions when contacted. The oil is active year round.

Become familiar with the identity of these plants (see below). Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

Poison Ivy



Poison Sumac



Poison Oak



Contamination with poison ivy, sumac or oak can happen through several pathways, including:

- Direct skin contact with any part of the plant (even roots once above ground foliage has been removed).
- Contact with clothing that has been contaminated with the oil.
- Contact from removing shoes that have been contaminated (shoes are coated with urishol oil).
- Sitting in a vehicle that has become contaminated.
- Contact with any objects or tools that have become contaminated.
- Inhalation of particles generated by weed whacking, chipping, vegetation clearing.

If you must work on a site with poison ivy, sumac or oak the following precautions are necessary:

- Do not drive vehicles onto the site where it will come into contact with poison ivy, sumac or oak. Vehicles which need to work in the area, such as drill rigs or heavy equipment must be washed as soon as possible after leaving the site.
- All tools used in the poison ivy, sumac or oak area, including those used to cut back poison oak, surveying instruments used in the area, air monitoring equipment or other test apparatus must be decontaminated before they are placed back into the site vehicle. If on-site decontamination is not possible, use plastic to wrap any tools or equipment until they can be decontaminated.
- Personal protective equipment, including Tyvek coveralls, gloves, and boot covers must be worn. PPE must be placed into plastic bags and sealed if they are not disposed immediately into a trash receptacle.
- As soon as possible following the work, shower to remove any potential contamination. Any body part with suspected or actual exposure should be washed with Zanol, Tecnu or other product designed for removing urushiol. If you do not have Zanol or Tecnu wash with cold water. Do not take a bath, as the oils can form an invisible film on top of the water and contaminate your entire body upon exiting the bath.
- Tecnu may also be used to decontaminate equipment.
- Use IvyBlock or similar products to prevent poison oak, ivy and sumac contamination. Check with the closest CH2M HILL warehouse to see if these products are available. Follow all directions for application.
- If you do come into contact with one of these poisonous plants and a reaction develops, contact your supervisor and the occupational nurse 1-866-893-2514. Be aware that in some instances, there can be a delay between contact with poisonous plants and the symptoms. If you are working near poison ivy or other poisonous plants and feel a mild skin irritation, apply Zanol/Tecnu immediately and contact the occupational nurse.

10.15Scorpions

Scorpions usually hide during the day and are active at night. They may be hiding under rocks, wood, or anything else lying on the ground. Some species may also burrow into the ground. Most scorpions live in dry, desert areas; however, some species can be found in grasslands, forests, and inside caves.

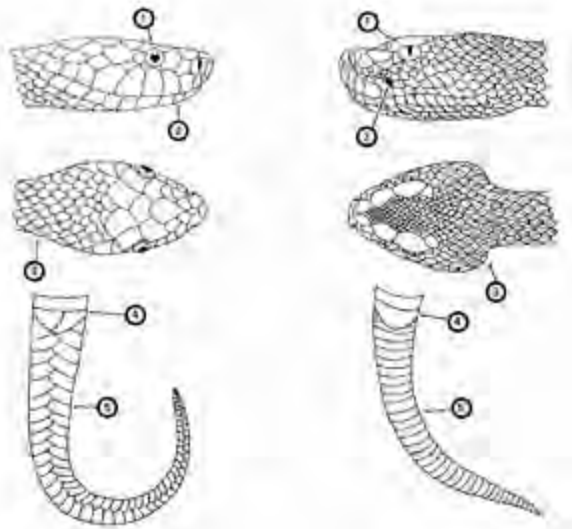
When entering an area that has the potential to contain scorpions, the following PPE is recommended: long pants, long sleeved shirts with collars, leather work gloves and leather work boots. Reaching into enclosures or recesses without prior visual inspection is not recommended. Thoroughly inspect each area before accessing. Shake out clothing, jackets, shoes or boots prior to putting them on.

If you are stung by a scorpion, call the occupational nurse 1-866-893-2514 and try to note the description of the scorpion. Cleanse the sting area and apply ice.

10.16Snakes

Snakes typically are found in underbrush and tall grassy areas. If you encounter a snake, stay calm and look around; there may be other snakes. Turn around and walk away on the same path you used to approach the area. If bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Call the occupational nurse at 1-866-893-2514 immediately. Do not apply ice, cut the wound, or apply a tourniquet. Try to identify the type of snake: note color, size, patterns, and markings. Below is a guide to identifying poisonous snakes from non-poisonous snakes.

Identification of Poisonous Snakes

Major Identification Features Non-venomous Snake	Major Identification Features Venomous Snake
<ol style="list-style-type: none"> 1. Round pupils 2. No sensing pit 3. Head slightly wider than neck 4. Divided anal plate 5. Double row of scales on the underside of the tail 	<ol style="list-style-type: none"> 1. Elliptical pupils 2. Sensing pit between eye and nostril 3. Head much wider than neck 4. Single anal plate 5. Single scales on the underside of the tail
	

10.17Spiders - Brown Recluse and Widow

The Brown Recluse spider can be found most anywhere in the United States. It varies in size in shape, but the distinguishing mark is the violin shape on its body. They are typically non-aggressive. Keep an eye out for irregular,

pattern-less webs that sometimes appear almost tubular built in a protected area such as in a crevice or between two rocks. The spider will retreat to this area of the web when threatened.

The Black Widow, Red Widow and the Brown Widow are all poisonous. Most have globose, shiny abdomens that are predominantly black with red markings (although some may be pale or have lateral stripes), with moderately long, slender legs. These spiders are nocturnal and build a three-dimensional tangled web, often with a conical tent of dense silk in a corner where the spider hides during the day.

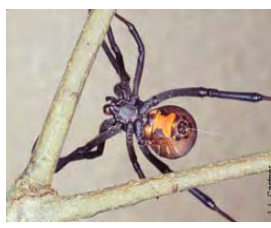
Hazard Controls

- Inspect or shake out any clothing, shoes, towels, or equipment before use.
- Wear protective clothing such as a long-sleeved shirt and long pants, hat, gloves, and boots when handling stacked or undisturbed piles of materials.
- Minimize the empty spaces between stacked materials.
- Remove and reduce debris and rubble from around the outdoor work areas.
- Trim or eliminate tall grasses from around outdoor work areas.
- Store apparel and outdoor equipment in tightly closed plastic bags.
- Keep your tetanus boosters up-to-date (every 10 years). Spider bites can become infected with tetanus spores.

If you think you have been bit by a poisonous spider, immediately call the occupational nurse at 1-866-893-2514 and follow the guidance below:

- Remain calm. Too much excitement or movement will increase the flow of venom into the blood;
- Apply a cool, wet cloth to the bite or cover the bite with a cloth and apply an ice bag to the bite;
- Elevate the bitten area, if possible;
- Do not apply a tourniquet, do not try to remove venom; and
- Try to positively identify the spider to confirm its type. If the spider has been killed, collect it in a plastic bag or jar for identification purposes. Do not try to capture a live spider—especially if you think it is a poisonous spider.

Black Widow Red Widow Brown Widow Brown Recluse



10.18 Ticks

Every year employees are exposed to tick bites at work and at home putting them at risk of illness. Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch (6.4 mm) in size.

In some geographic areas exposure is not easily avoided. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into boots; spray only outside of clothing with permethrin or permamone and spray skin with only DEET; and check yourself frequently for ticks.

Where site conditions (vegetation above knee height, tick endemic area) or when tasks (having to sit or kneel in vegetation) diminish the effectiveness of the other controls mentioned above, bug-out suits (check with your local or regional warehouse) or Tyvek shall be used. Bug-out suits are more breathable than Tyvek.

Take precautions to avoid exposure by including pre-planning measures for biological hazards prior to starting field work. Avoid habitats where possible, reduce the abundance through habitat disruption or application of acaricide. If these controls aren't feasible, contact your local or regional warehouse for preventative equipment such as repellants, protective clothing and tick removal kits. Use the buddy system and perform tick inspections prior to entering the field vehicle. If ticks were not planned to be encountered and are observed, do not continue field work until these controls can be implemented.

See Tick Fact Sheet attached to project safety plan for further precautions and controls to implement when ticks are present. If bitten by a tick, follow the removal procedures found in the tick fact sheet, and call the occupational nurse at 1-866-893-2514.

Be aware of the symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme disease is a rash that might appear that looks like a bull's eye with a small welt in the center. RMSF is a rash of red spots under the skin 3 to 10 days after the tick bite. In both RMSF and Lyme disease, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, again contact the occupational nurse at 1-866-893-2514.

Be sure to complete an Incident Report (either use the Hours and Incident Tracking System [HITS] system on the VO) if you do come in contact with a tick.

11. Personal Protective Equipment

(Reference CH2M HILL- SOP HSE-117, *Personal Protective Equipment*)

11.1 Required Personal Protective Equipment

PPE must be worn by employees when actual or potential hazards exist and engineering controls or administrative practices cannot adequately control those hazards.

A PPE assessment has been conducted by the RHSM based on project tasks (see PPE specifications below). Verification and certification of assigned PPE by task is completed by the RHSM in each project safety plan. Below are items that need to be followed when using any form of PPE:

- Employees must be trained to properly wear and maintain the PPE; if you are unsure of how to use or maintain your PPE, ask your RHSM for guidance.
- Employees must be trained in the limitations of the PPE; if you are unsure, ask your RHSM for guidance.
- In work areas where actual or potential hazards are present at any time, PPE must be worn by employees working or walking through the area;
- Areas requiring PPE should be posted or employees must be informed of the requirements in an equivalent manner;
- PPE must be inspected prior to use and after any occurrence to identify any deterioration or damage;
- PPE must be maintained in a clean and reliable condition;
- Damaged PPE shall not be used and must either be repaired or discarded; and
- PPE shall not be modified, tampered with, or repaired beyond routine maintenance.

Each project safety plan will outline PPE to be used according to task based on project-specific hazard assessment.

11.2 Respiratory Protection

(Reference CH2M HILL SOP HSE-121, *Respiratory Protection*)

Implement the following when using respiratory protection:

- Respirator users must have completed appropriate respirator training within the past 12 months. Level C training is required for air-purifying respirators (APR) use and Level B training is required for supplied-air respirators (SAR) and self-contained breathing apparatus (SCBA) use. Specific training is required for the use of powered air-purifying respirators (PAPR);
- Respirator users must complete the respirator medical monitoring protocol and been approved for the specific type of respirator to be used;
- Tight-fitting facepiece respirator (negative or positive pressure) users must have passed an appropriate fit test within past 12 months;
- Respirator use shall be limited to those activities identified in the safety plan. If site conditions change that alters the effectiveness of the specified respiratory protection, the RHSM shall be notified to amend the written plan;
- Tight-fitting facepiece respirator users shall be clean-shaven and shall perform a user seal check before each use;
- Canisters/cartridges shall be replaced according to the change-out schedule specified in the safety plan. Respirator users shall notify the SC or RHSM of any detection of vapor or gas breakthrough. The SC shall report any breakthrough events to the RHSM for schedule upgrade;

- Respirators in regular use shall be inspected before each use and during cleaning;
- Respirators in regular use shall be cleaned and disinfected as often as necessary to ensure they are maintained in a clean and sanitary condition;
- Respirators shall be properly stored to protect against contamination and deformation;
- Field repair of respirators shall be limited to routine maintenance. Defective respirators shall be removed from service;
- When breathing air is supplied by cylinder or compressor, the SC or RHSM shall verify the air meets Grade D air specifications; and
- The SC or designee shall complete the Self-Assessment Checklist – Respiratory Protection included in the SOP and/or in the safety plan to verify compliance with CH2M HILL's respiratory protection program.

12. Worker Training and Qualification

12.1 CH2M HILL Worker Training

(Reference CH2M HILL SOP HSE-110, *Training*)

12.1.1 Hazardous Waste Operations Training

All employees engaging in hazardous waste operations or emergency response shall receive appropriate training as required by 29 CFR 1910.120 and 29 CFR 1926.65. At a minimum, the training shall have consisted of instruction in the topics outlined in 29 CFR 1910.120 and 29 CFR 1926.65. Personnel who have not met these training requirements shall not be allowed to engage in hazardous waste operations or emergency response activities.

12.1.1.1 Initial Training

General site workers engaged in hazardous waste operations shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations, unless otherwise noted in the above-referenced standards.

Employees who may be exposed to health hazards or hazardous substances at treatment, storage, and disposal (TSD) operations shall receive a minimum of 24 hours of initial training to enable the employee to perform their assigned duties and functions in a safe and healthful manner.

Employees engaged in emergency response operations shall be trained to the level of required competence in accordance with 29 CFR 1910.120.

12.1.1.2 Three-Day Actual Field Experience

General site workers for hazardous waste operations shall have received three days of actual experience (on-the-job training) under the direct supervision of a trained, qualified supervisor and shall be documented. If the field experience has not already been received and documented at a similar site, this supervised experience shall be accomplished and documented at the beginning of the assignment of the project.

12.1.1.3 Refresher Training

General site workers and TSD workers shall receive 8-hours of refresher training annually (within the previous 12-month period) to maintain qualifications for fieldwork. Employees engaged in emergency response operations shall receive annual refresher training of sufficient content and duration to maintain their competencies or shall demonstrate competency in those areas at least annually.

12.1.1.4 Eight-Hour Supervisory Training

On site management or supervisors who will be directly responsible for, or supervise employees engaged in hazardous waste site operations, will have received at least 8 hours of additional specialized training on managing such operations. Employees designated as Safety Coordinator – Hazardous Waste are considered 8-hour HAZWOPER Site Safety Supervisor trained.

12.1.2 First Aid/Cardiopulmonary Resuscitation

First aid and CPR training consistent with the requirements of a nationally recognized organization such as the American Red Cross Association or National Safety Council shall be administered by a certified trainer. A minimum of two personnel per active field operation will have first aid and CPR training. Bloodborne pathogen training located on CH2M HILL's Virtual Office is also required for those designated as first aid/CPR trained.

12.1.3 Safety Coordinator Training

SCs are trained to implement the HSE program on CH2M HILL field projects. A qualified SC is required to be identified in the project safety plan for CH2M HILL field projects. SCs must also meet the requirements of the worker category appropriate to the type of field project (construction or hazardous waste). In addition, the SCs shall have completed additional safety training required by the specific work activity on the project that qualifies them to implement the HSE program (for example, fall protection, excavation).

12.1.4 Site-Specific Training

Site-specific training will be addressed in the project safety plan. Prior to commencement of field activities, all field personnel assigned to a project will have completed site-specific training that will address the contents of applicable project safety plans, including the activities, procedures, monitoring, and equipment used in the site operations. Site-specific training will also include site and facility layout, potential hazards, risks associated with identified emergency response actions, and available emergency services. This training allows field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safety and work operations for their particular activity.

13. Medical Surveillance and Qualification

(Reference CH2M HILL SOP HSE-113, *Medical Surveillance*)

All site workers participating in hazardous waste operations or emergency response (HAZWOPER) will maintain an adequate medical surveillance program in accordance with 29 CFR 1910.120 or 29 CFR 1926.65 and other applicable OSHA standards. Documentation of employee medical qualification (e.g., physician's written opinion) will be maintained in the project files and made available for inspection.

13.1 Hazardous Waste Operations and Emergency Response

CH2M HILL personnel expected to participate in on site HAZWOPER tasks are required to have a current medical qualification for performing this work. Medical qualification shall consist of a qualified physician's written opinion regarding fitness for duty at a hazardous waste site, including any recommended limitations on the employee's assigned work. The physician's written opinion shall state whether the employee has any detected medical conditions that would place the employee at increased risk of material impairment of the employee's health from work in hazardous waste operations or emergency response, or from respirator use.

13.2 Respirator User Qualification

Personnel required to wear respirators must have a current medical qualification to wear respirators. Medical qualification shall consist of a qualified physician's written opinion regarding the employee's ability to safely wear a respirator in accordance with 29 CFR 1910.134.

13.3 Hearing Conservation

Personnel working in hazardous waste operations or operations that fall under 29 CFR 1910.95 and exposed to noise levels in excess of the 85dBA time-weighted average shall be included in a hearing conservation program that includes annual audiometric testing.

14. Site-Control Plan

14.1 Site-Control Procedures

(Reference CH2M HILL SOP HSE-218, *Hazardous Waste Operations*)

Site control is established to prevent the spread of contamination throughout the site and to ensure that only authorized individuals are permitted into potentially hazardous areas.

The SC will implement site control procedures including the following bulleted items.

- Establish support, contamination reduction, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Establish onsite communication consisting of the following:
 - Line-of-sight and hand signals;
 - Air horn; and
 - Two-way radio or cellular telephone if available.
- Establish offsite communication.
- Establish and maintain the “buddy system.”

14.2 Remediation Work Area Zones

(Reference CH2M HILL SOP HSE-218 Hazardous Waste Operations)

A three-zone approach will be used to control areas where site contaminants exist. Access will be allowed only after verification of appropriate training and medical qualification. The three-zone approach shall include an EZ, Contamination Reduction Zone (CRZ) and a Support Zone (SZ). The three-zone approach is not required for construction work performed outside contaminated areas where control of site contamination is not a concern.

Specific work control zones shall be established as necessary during task planning. Site work zones should be modified in the field as necessary, based on such factors as equipment used, air monitoring results, environmental conditions, or alteration of work plans. The following guidelines shall be used for establishing and revising these preliminary zone designations.

14.2.1 Support Zone

The SZ is an uncontaminated area (trailers, offices, field vehicles, etc.) that will serve as the field support area for most operations. The SZ provides field team communications and staging for emergency response. Appropriate sanitary facilities and safety and emergency response equipment will be located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. The only exception will be appropriately packaged and decontaminated materials, or personnel with medical emergencies that cannot be decontaminated.

14.2.2 Contamination Reduction Zone

The CRZ is established between the EZ and the SZ, upwind of the contaminated area where possible. The CRZ provides an area for decontamination of personnel, portable handheld equipment and tools, and heavy equipment. In addition, the CRZ serves as access for heavy equipment and emergency support services.

14.2.3 Exclusion Zone

The EZ is where activities take place that may involve exposure to site contaminants and/or hazardous materials or conditions. This zone shall be demarcated to prevent unauthorized entry. More than one EZ may be established if there are different levels of protection to be employed or different hazards that exist in the same work area. The EZ shall be large enough to allow adequate space for the activity to be completed, including field personnel and equipment, as well as necessary emergency equipment.

The EZ shall be demarcated with some form of physical barrier or signage. The physical barrier or signage shall be placed so that they are visible to personnel approaching or working in the area. Barriers and boundary markers shall be removed when no longer needed.

14.2.4 Other Controlled Areas

Other work areas may need to be controlled due to the presence of an uncontrolled hazard, to warn workers of requirements, or to prevent unauthorized entry. Examples include general construction work areas, open excavations, high noise areas, vehicle access areas, and similar activities or limited access locations. These areas shall be clearly demarcated with physical barriers (fencing, cones, reinforced caution tape or rope) as necessary and posted with appropriate signage.

15. Decontamination

(Reference CH2M HILL SOP HSE-218, *Hazardous Waste Operations*)

Decontamination areas will be established for work in potentially contaminated areas to prevent the spread of contamination. Decontamination areas should be located upwind of the exclusion zone where possible and should consider any adjacent or nearby projects and personnel. The SC must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SC. The SC must ensure that procedures are established for disposing of materials generated on the site.

No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SC should establish areas for eating, drinking, and smoking.

15.1 Contamination Prevention

Preventing or avoiding contamination of personnel, tools, and equipment will be considered in planning work activities at all field locations. Good contamination prevention and avoidance practices will assist in preventing worker exposure and result in a more efficient decontamination process. Procedures for contamination prevention and avoidance include the following:

- Do not walk through areas of obvious or known contamination;
- Do not directly handle or touch contaminated materials;
- Make sure there are no cuts or tears in PPE;
- Fasten all closures in suits and cover them with duct tape, if appropriate;
- Take particular care to protect any skin injuries;
- Stay upwind of airborne contamination, where possible;
- Do not eat or drink in contaminated work areas;
- Do not carry food, beverages, tobacco, or flame-producing equipment into contaminated work areas;
- Minimize the number of personnel and amount of equipment in contaminated areas to that necessary for accomplishing the work;
- Choose tools and equipment with nonporous exterior surfaces that can be easily cleaned and decontaminated;
- Cover monitoring and sampling equipment with clear plastic, leaving openings for the sampling ports, as necessary; and
- Minimize the amount of tools and equipment necessary in contaminated areas.

15.2 Personnel and Equipment Decontamination

Personnel exiting an EZ must ensure that they are not spreading potential contamination into clean areas or increasing their potential for ingesting or inhaling potential contaminants. Personal decontamination may range from removing outer gloves as exiting the EZ, to proceeding through an outer layer doffing station including a boot and glove wash and rinse, washing equipment, etc. Equipment that has come into contact with contaminated media must also be cleaned/decontaminated when it is brought out of the EZ.

15.3 Decontamination During Medical Emergencies

Standard personnel decontamination practices will be followed whenever possible. For emergency life saving first aid and/or medical treatment, normal decontamination procedures may need to be abbreviated or omitted. In this situation, site personnel shall accompany contaminated victims to advise emergency response personnel on potential contamination present and proper decontamination procedures.

Outer garments may be removed if they do not cause delays, interfere with treatment, or aggravate the problem. Protective clothing can be cut away. If the outer garments cannot be safely removed, a plastic barrier between the individual and clean surfaces should be used to help prevent contaminating the inside of ambulances or medical personnel. Outer garments can then be removed at the medical facility.

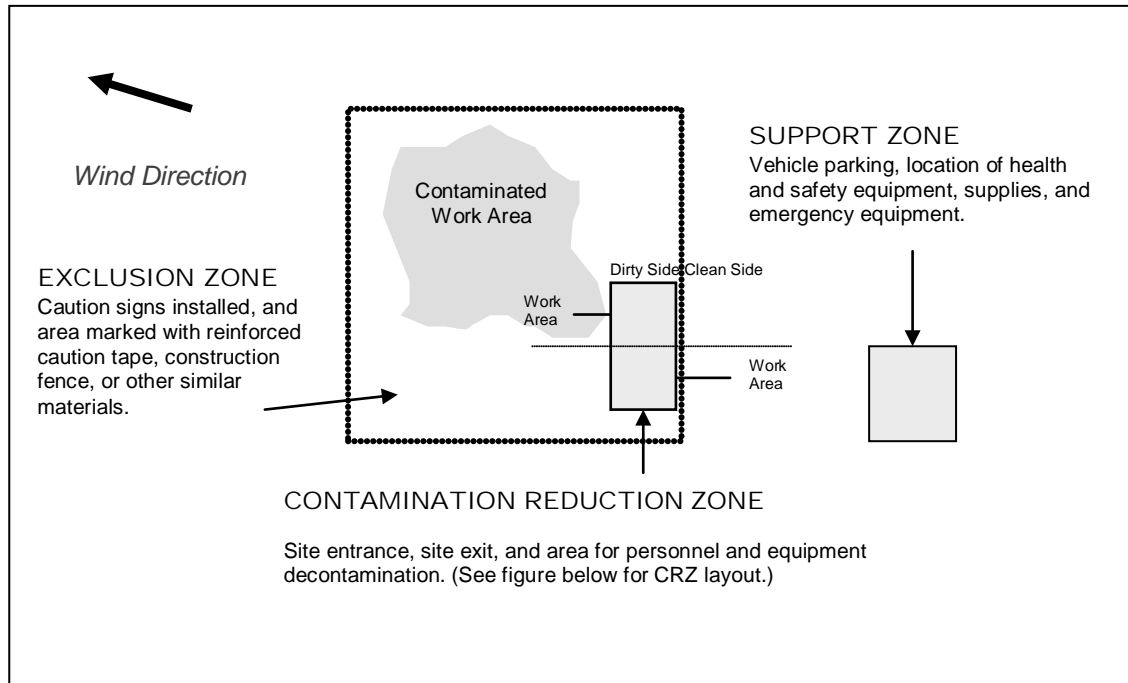
15.4 Waste Collection and Disposal

All contaminated material generated through the personnel and equipment decontamination processes (e.g., contaminated disposable items, gross debris, liquids, sludges) will be properly containerized and labeled, stored at a secure location, and disposed in accordance with the project plans.

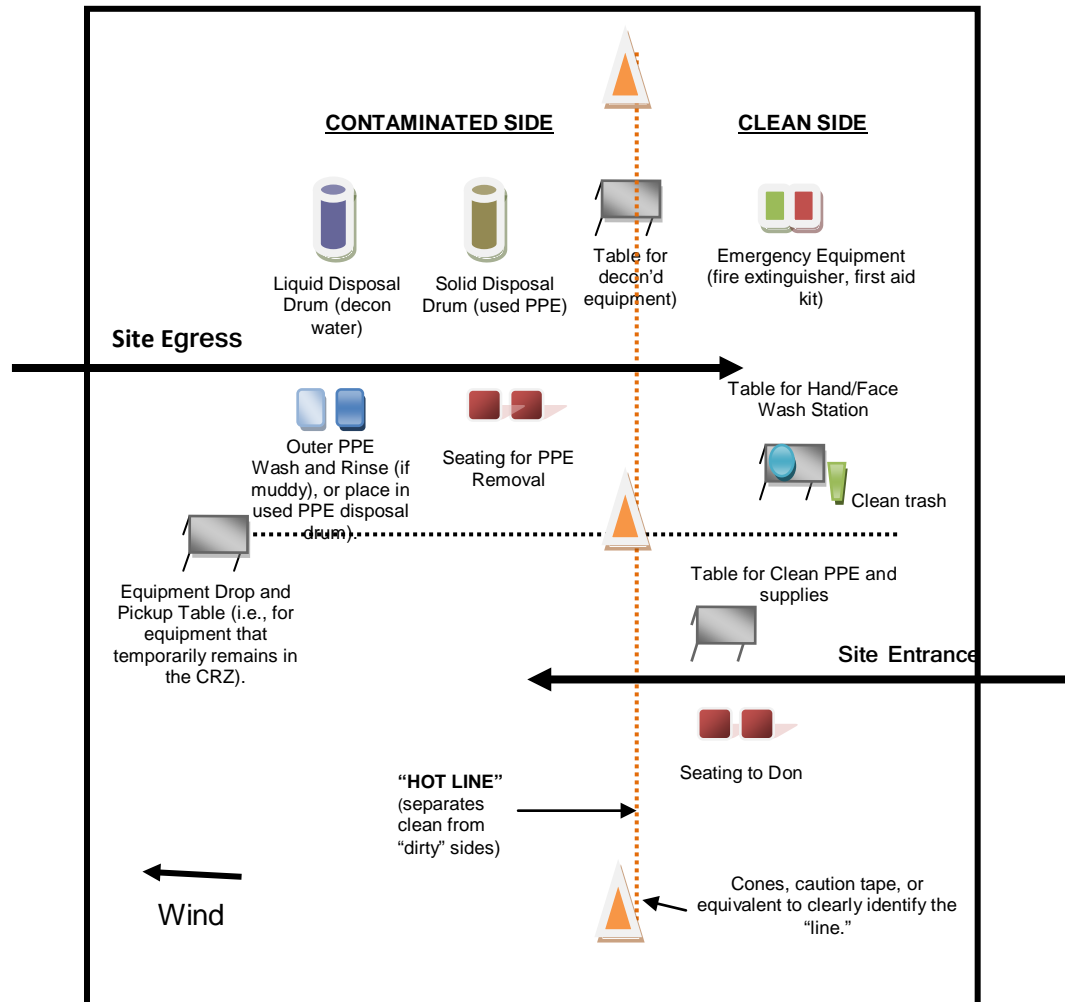
15.5 Diagram of Personnel-Decontamination Line

The following figure illustrates a conceptual establishment of work zones, including the decontamination line. Work zones are to be modified by the SC to accommodate task-specific requirements.

Work Area - Set up appropriately based on wind direction



Typical Contamination Reduction Zone



16. Emergency Preparedness

(Reference CH2M HILL SOP HSE-106, *Emergency Planning*)

16.1 Pre-Emergency Planning

The Emergency Response Coordinator (ERC), typically the SC or designee, performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with CH2M HILL onsite parties, the facility, and local emergency-service providers as appropriate. Pre-Emergency Planning activities performed by the ERC include:

- Review the facility emergency and contingency plans where applicable;
- Determine what onsite communication equipment is available (two-way radio, air horn);
- Determine what offsite communication equipment is needed (nearest telephone, cell phone);
- Confirm and post the “Emergency Contacts” page and route to the hospital located in this section in project trailer(s) and keep a copy in field vehicles along with evacuation routes and assembly areas. Communicate the information to onsite personnel and keep it updated;
- Field Trailers: Post “Exit” signs above exit doors, and post “Fire Extinguisher” signs above locations of extinguishers. Keep areas near exits and extinguishers clear;
- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures;
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies;
- Inventory and check site emergency equipment, supplies, and potable water;
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases;
- Rehearse the emergency response plan before site activities begin. This may include a “tabletop” exercise or an actual drill depending on the nature and complexity of the project. Drills should take place periodically but no less than once a year;
- Brief new workers on the emergency response plan; and
- The ERC will evaluate emergency response actions and initiate appropriate follow-up actions.

16.2 Incident Response

In fires, explosions, or chemical releases, actions to be taken include the following:

- Notify appropriate response personnel;
- Shut down CH2M HILL operations and evacuate the immediate work area;
- Account for personnel at the designated assembly area(s);
- Assess the need for site evacuation, and evacuate the site as warranted;
- Implement HSE-111, Incident Notification, Reporting and Investigation; and
- Notify and submit reports to clients as required in contract.

Small fires or spills posing minimal safety or health hazards may be controlled with onsite spill kits or fire extinguishers without evacuating the site. When in doubt evacuate. Follow the incident reporting procedures in the “Incident Notification, Reporting, and Investigation” section of these Guidelines.

16.3 Emergency Medical Treatment

Emergency medical treatment is needed when there is a life-threatening injury (such as severe bleeding, loss of consciousness, breathing or heart has stopped). When in doubt if an injury is life-threatening or not, treat it as needing emergency medical treatment.

- Notify 911 or other appropriate emergency response authorities as listed in the “Emergency Contacts” page located in this section.
- The ERC will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury, perform decontamination (if applicable) where feasible; lifesaving and first aid or medical treatment takes priority.
- Initiate first aid and CPR where feasible.
- Notify supervisor and if the injured person is a CH2M HILL employee, the supervisor will call the occupational nurse at 1-866-893-2514 and make other notifications as required by HSE SOP-111, *Incident Notification, Reporting and Investigation*.
- Make certain that the injured person is accompanied to the emergency room.
- Follow the Serious Incident Reporting process in HSE SOP-111, Incident Notification, Reporting and Investigation, and complete incident report using the HITS system on the VO or if not feasible, use the hard copy forms provided as an attachment to the project safety plan.
- Notify and submit reports to client as required in contract.

16.4 Evacuation

- Evacuation routes, assembly areas, and severe weather shelters (and alternative routes and assembly areas) are to be specified on the site map.
- Evacuation route(s) and assembly area(s) will be designated by the ERC or designee before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The ERC and a “buddy” will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The ERC will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s).
- The ERC will follow the incident reporting procedures in the “Incident Notification, Reporting and Investigation” section of these Guidelines.

16.5 Evacuation Signals

Signal	Meaning
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

16.6 Inclement Weather

Sudden inclement weather can rapidly encroach upon field personnel. Preparedness and caution are the best defenses. Field crew members performing work outdoors should carry clothing appropriate for inclement weather. Personnel are to take heed of the weather forecast for the day and pay attention for signs of changing weather that indicate an impending storm. Signs include towering thunderheads, darkening skies, or a sudden increase in wind. If stormy weather ensues, field personnel should discontinue work and seek shelter until the storm has passed.

Protective measures during a lightning storm include seeking shelter; avoiding projecting above the surrounding landscape (don't stand on a hilltop—seek low areas); staying away from open water, metal equipment, railroad tracks, wire fences, and metal pipes; and positioning people several yards apart. Some other general precautions include:

- Know where to go and how long it will take to get there. If possible, take refuge in a large building or vehicle. Do not go into a shed in an open area;
- The inclination to see trees as enormous umbrellas is the most frequent and most deadly mistake. Do not go under a large tree that is standing alone. Likewise, avoid poles, antennae, and towers;
- If the area is wide open, go to a valley or ravine, but be aware of flash flooding;
- If you are caught in a level open area during an electrical storm and you feel your hair stand on end, drop to your knees, bend forward and put your hands on your knees or crouch. The idea is to make yourself less vulnerable by being as low to the ground as possible and taking up as little ground space as possible. Lying down is dangerous, since the wet earth can conduct electricity. Do not touch the ground with your hands; and
- Do not use telephones during electrical storms, except in the case of emergency.

Remember that lightning may strike several miles from the parent cloud, so work should be stopped and restarted accordingly. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap.

High winds can cause unsafe conditions, and activities should be halted until wind dies down. High winds can also knock over trees, so walking through forested areas during high-wind situations should be avoided. If winds increase, seek shelter or evacuate the area. Proper body protection should be worn in case the winds hit suddenly, because body temperature can decrease rapidly.

16.6.1 Tornado Safety

Recognizing imminent tornado signs include seeing an unusually dark sky, possibly with some green or yellow clouds. You may hear a roaring or rumbling sound like a train, or a whistling sound like a jet. Large hail may also be falling. You may be able to see funnels, or they may be hidden by rain or hail.

Listen to your radio for tornado warnings during bad thunderstorms. If a tornado warning is issued, don't panic. Instead, listen and look. Quickly but calmly follow directions for getting to shelter.

Take cover. Indoors you should go down into the basement and crouch down under the stairs, away from windows. Do not take an elevator. If you can't get to a basement, go into a closet or bathroom and pull a mattress over you or sit underneath a sturdy piece of furniture on the ground floor near the center of the building. Pull your knees up under you and protect your head with your hands.

A bad place to be in a tornado is in a building with a large freestanding roof such as a gymnasium, arena, auditorium, church or shopping mall. If you are caught in such a building, take cover under something sturdy.

More than half of tornado deaths occur in mobile homes. If a tornado threatens, get out and go to a building with a good foundation, or lay down in a ditch away from vehicles and other objects.

If you are driving, get to a shelter, lie down in a ditch or seek cover up under the girders of an overpass or bridge. Stay as close to the ground as you can. Protect your head and duck flying debris.

Stay away from metal and electrical equipment because lightning accompanies tornadoes.

If you have time before the tornado strikes, secure objects such as garbage cans and lawn furniture which can injure people. While most tornado damage is a result of the violent winds, most injuries and deaths actually result from flying debris.

17. Inspections

17.1 Management Health, Safety, Security, and Environment Inspections

The Management Inspection Checklist is intended to facilitate PM leadership, provide an opportunity for PM's to mentor field staff on HSE and identify any big picture actions that need to be addressed. Observations that would improve global HSE program should also be included on the form. This Checklist does NOT take the place of a formal HSE audit. The PM shall:

- Complete one checklist per month during field work when visiting the site. The PM may delegate completion to the task lead, field team leader, or construction manager if the project is short duration and a visit is not planned for.
- Complete applicable sections of the checklist (can be typed or hand-written). Address issues with the field team, taking the opportunity to mentor staff by identifying the "root cause" of observation (e.g., why are SBOs not being completed, had this hazard been noted by any other team members?).
- Send completed form to Project Delivery Manager, Sector HSE Lead, and RHSM for tracking and review. Original should be kept in the project files.

17.2 Project Activity Self-Assessment Checklists

In addition to the hazard controls specified in this document, Project Activity Self-Assessment Checklists are contained as an attachment to the project safety plan. The Project-Activity Self-Assessment Checklists are based upon minimum regulatory compliance and some site-specific requirements may be more stringent. The objective of the self-assessment process is to identify gaps in project safety performance, and prompt for corrective actions in addressing these gaps. The self-assessment checklists, including documented corrective actions, shall be made part of the permanent project records and maintained by the SC.

The self-assessment checklists will also be used by the SC in evaluating the subcontractors and any client contractors' compliance on site.

17.3 Safe Behavior Observations

Safe Behavior Observations (SBOs) are a tool to be used by supervisors to provide positive reinforcement for work practices performed correctly, while also identifying and eliminating deviations from safe work procedures that could result in a loss.

The SC or designee shall perform at least one SBO each week for any field work performed by subcontractors or when there are at least two CH2M HILL personnel performing field work.

The SC or designee shall complete the SBO form (attached to the project safety plan) for the task/operation being observed and submit them weekly.

For ES Federal Sector projects please email completed forms to: [CH2M HILL ES FED Safe Behavior Observation](#)

For ES Commercial Sector projects please email completed forms to: [CH2M HILL ES COM Safe Behavior Observation](#)

For CNR ES staff please email completed forms to: cnressafe@ch2m.com

For International ES projects please e-mail completed forms to: ESINTLSafeBehaviorObservation@ch2m.com

18. Incident Notification, Reporting, and Investigation

(Reference CH2M HILL SOP HSE-111, *Incident Notification, Reporting and Investigation*)

18.1 General Information

This section applies to the following:

- All injuries involving employees, third parties, or members of the public;
- Damage to property or equipment;
- Interruptions to work or public service (hitting a utility);
- Incidents which attract negative media coverage;
- Near misses;
- Spills, leaks, or regulatory violations; and
- Motor vehicle accidents.

Documentation, including incident reports, investigation, analysis and corrective measure taken, shall be kept by the SC and maintained onsite for the duration of the project.

18.2 Section Definitions

Incident: An incident is an event that causes or could have caused undesired consequences. An incident may be caused by natural forces, employees, subcontractors, or third parties in any location associated with CH2M HILL operations, including offices, warehouses, project sites, private property, or public spaces. Incidents include:

- Injury or illness to a CH2M HILL employee or subcontractor employee, or member of the public;
 - Property damage;
 - Spill or release;
 - Environmental requirement or permit violation;
 - A “near-miss”; or
 - Other (e.g., fire, explosion, bomb threat, workplace violence, threats)
- Accident:** an incident involving actual loss through injury, damage to assets, or environmental harm.

Near Miss: A near-miss occurs when an intervening factor prevented an injury or illness, property damage, spill or release, permit violation or other event from occurring. Examples of near-miss situations include: a hard hat or other personal protective equipment (PPE) prevented an injury; secondary containment or emergency shutoff prevented a spill; or an alert co-worker prevented an incident.

Serious Incident

A Serious Incident must be immediately reported to senior management includes:

- Work related death, or life threatening injury or illness of a CH2M HILL employee;
- subcontractor, or member of the public;
- Kidnap/missing person;
- Acts or threats of terrorism;

- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than \$ 500,000 in damage; or
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

18.3 Reporting Requirements

All employees and subcontractors' employees shall immediately report any incident (including "near misses," as defined in the section above) in which they are involved or witness to their supervisor.

The CH2M HILL or Subcontractor supervisor, upon receiving an incident report, shall inform his immediate superior and the CH2M HILL SC.

The SC shall immediately report the following information to the RHSM and PM by phone and e-mail:

- Project Name and Site Manager;
- Date and time of incident;
- Description of incident;
- Extent of known injuries or damage;
- Level of medical attention; and
- Preliminary root cause/corrective actions

If the incident was an environmental permit issue (potential permit non-compliance, other situation that result in a notice of violation) or a spill or release, contact the Project EM immediately so evaluation of reportable quantity requirements and whether agency reporting is required.

The CH2M HILL team shall comply with all applicable statutory incident reporting requirements such as those to OSHA, the police, or state or Federal environmental agency.

Be aware that many OSHA-designated states require reporting to the area OSHA office if one person is admitted to the hospital (e.g., California and Washington); whereas Federal OSHA requires it if three or more are admitted.

18.4 Drug and Alcohol Testing for CH2M HILL Employees

As required by CH2M HILL Policy 810, U.S. Employees are subject to post-incident and reasonable suspicion drug and alcohol testing. The Employee must submit to drug and alcohol testing if the supervisor has a reasonable suspicion, and when any of the following occur:

- Work-related injury requiring off-site medical attention;
- Incident resulting in property damage over USD\$500 as determined by the Employee's supervisor;
- Incident considered to be a serious near-miss injury that occurs in the field or in the office as determined by the supervisor;
- Other circumstances as dictated by Employee Relations; or
- An Employee contributes to any of the above.

Except in emergencies, the employee must remain available for testing. Failure to remain available will be considered as a refusal to submit to the testing, which will result in disciplinary action. Following the test, if there is no reasonable suspicion, the Employee returns to work. The employee will not be allowed to operate any company vehicle or company equipment, or work in any designated areas, pending the result of the drug and/or alcohol test.

Employees who are required to submit to reasonable suspicion testing are prohibited from transporting themselves to or from the collection site. The supervisor will arrange for transportation; the employee will be transported by a CH2M HILL staff member. The employee must remain under the direct observation of the supervisor until turned

over to the transporter. The employee will not be allowed to eat or drink unless instructed by the collector as this may hinder or decrease the company's ability to obtain a valid sample once the drug and/or alcohol test is administered.

After returning from the collection site, the employee must make arrangements to be transported home or to his/her residence. Supervisors must contact local authorities if an employee insists on driving a vehicle. Pending receipt of the drug and alcohol test results, the employee may not return to work.

18.5 Drug and Alcohol Testing for Subcontractors

The drug and alcohol testing requirements stated above apply to subcontractors when required by the subcontract.

18.6 HITS System and Incident Report Form

CH2M HILL maintains a HITS entry and/or Incident Report Form (IRF) for all work-related injuries and illnesses sustained by its employees in accordance with recordkeeping and insurance requirements. A HITS entry and/or IRF will also be maintained for other incidents (property damage, fire or explosion, spill, release, potential violation, and near misses) as part of our loss prevention and risk reduction initiative.

The SC shall complete an entry into the Hours and Incident Tracking System (HITS) database system located on CH2M HILL's Virtual Office (or if VO not available, use the hard copy Incident Report Form and Root Cause Analysis Form and forward it to the RHSM) within 24 hours and finalize those forms within 3 calendar days.

18.7 Injury Management/Return-to-Work (for U.S./Puerto Rico based CH2M HILL Staff Only)

(Reference CH2M HILL, SOP HSSE-124, Injury Management/Return-to-Work)

18.7.1 Background

The Injury Management Program has been established to provide orderly, effective and timely medical treatment and return-to-work transition for an employee who sustains a work-related injury or illness. It also provides guidance and assistance with obtaining appropriate treatment to aid recovery, keep supervisors informed of employee status, and to quickly report and investigate work-related injury/illnesses to prevent recurrence.

To implement the Injury Management/Return-to-Work Program successfully, supervisors and/or SC should:

- Ensure employees are informed of the Injury Management/Return-to-Work Program;
- Become familiar with the Notification Process (detailed below); and
- Post the Injury Management/Return-to-Work Notification Poster.

18.7.2 The Injury Management/Return-to-Work Notification Process:

- Employee informs their supervisor.
- Employee calls the Injury Management Program toll free number 1-866-893-2514 immediately and speaks with the Occupational Injury Nurse. This number is operable 24 hours per day, 7 days a week. **Employees are encouraged to enter this phone number into their cell phones prior to starting field work.**
- Supervisor ensures employee immediately calls the Injury Management Program number. Supervisor makes the call with the injured worker or for the injured worker, if needed.
- Nurse assists employee with obtaining appropriate medical treatment, as necessary schedules clinic visit for employee (calls ahead, and assists with any necessary follow up treatment). The supervisor or SC accompanies the employee if a clinic visit is necessary to ensure that employees receive appropriate and timely care.
- Supervisor or SC completes the HITS entry or Incident Report Form immediately (within 24 hours) and forwards it to the Project Manager and RHSM.

- Nurse notifies appropriate CH2M HILL staff by e-mail (supervisor, Health & Safety, Human Resources, Workers' Compensation).
- Nurse communicates and coordinates with and for employee on treatment through recovery.
- Supervisor ensures suitable duties are identified and available for injured or ill workers who are determined to be medically fit to return to work on transitional duty (temporary and progressive).
- Supervisor ensures medical limitations prescribed (if any) by physician are followed until the worker is released to full duty.

18.8 Serious Incident Reporting Requirements

(Reference CH2M HILL SOP HSE-111, *Incident Reporting, Notification and Investigation*)

The serious incident reporting requirements ensures timely notification and allows for positive control over flow of information so that the incident is handled effectively, efficiently, and in conjunction with appropriate corporate entities. This standard notification process integrates Health, Safety, Security and Environment and Firm Wide Security Operations requirements for the consistent reporting of and managing of serious events throughout our operations.

18.8.1 Serious Incident Determination

The following are general criteria for determining whether an incident on CH2M HILL owned or managed facilities or program sites is considered serious and must be immediately reported up to Group President level through the reporting/notification process:

- Work related death, or life threatening injury or illness of a CH2M HILL employee, subcontractor, or member of the public;
- Kidnap or missing person;
- Acts or threats of terrorism;
- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than \$ 500,000 in damage; or
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

18.8.2 Serious Incident Reporting

If an incident meets the "Serious Incident" criteria, the Project Manager is to immediately contact the Crisis Manager at 720-286-4911, then follow the standard incident reporting procedure.

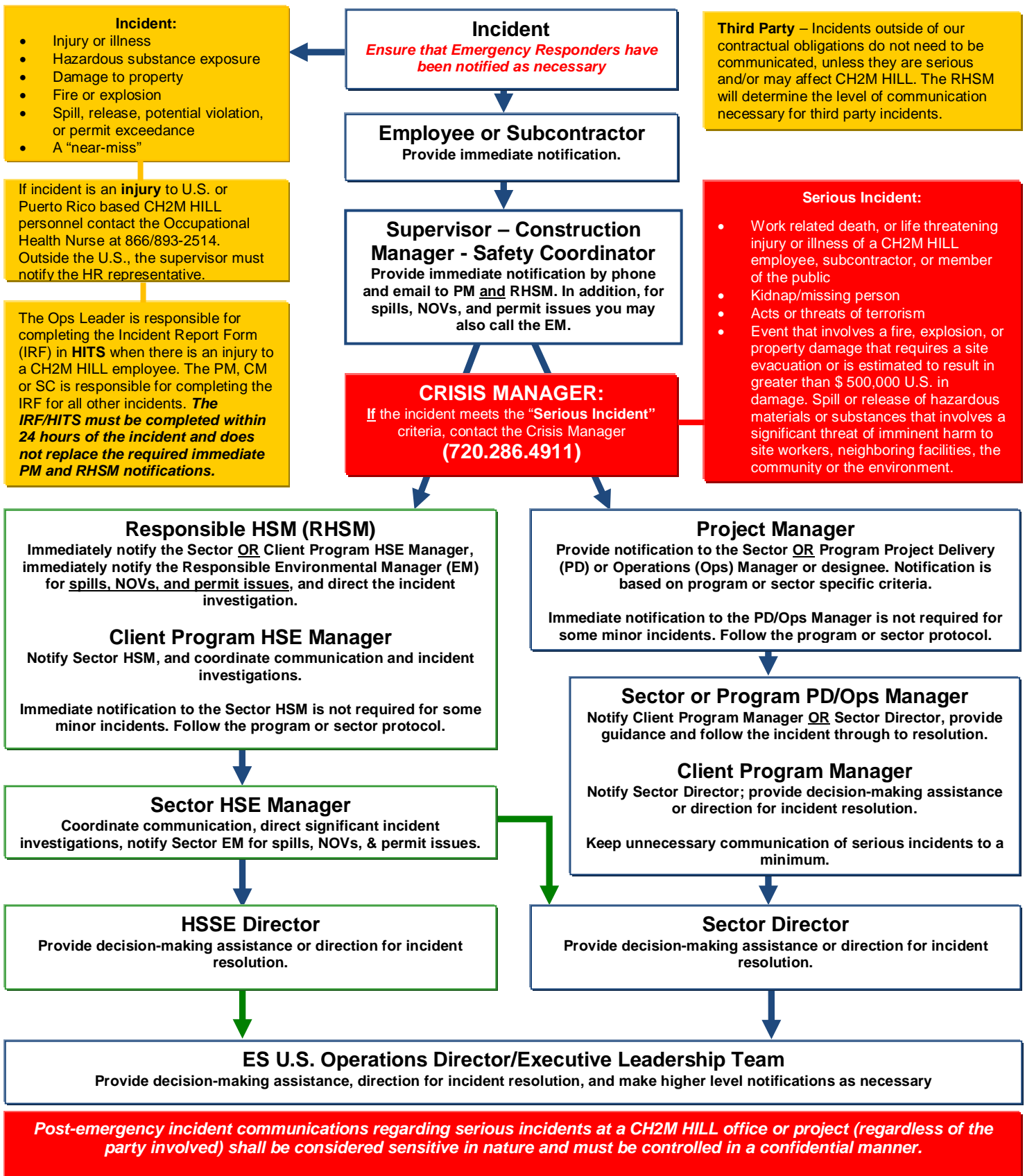
For all serious incidents this standard reporting process is implemented immediately so as to ultimately achieve notification to the Business Group President within 2 hours of incident onset or discovery, and notification to appropriate corporate Crisis Management Support Team.

ESBG U.S. Operations

Incident Reporting Flow Diagram

Direct Reporting Responsibility

Informational Reporting



18.9 Incident Root Cause Analysis

The accident analysis is essential if all causes of the incident are to be identified for the correct remedial actions to be taken to prevent the same and similar type of incident from recurring. Root Cause Analysis (RCA) shall be completed for all recordable injuries, property damage incidents in excess of \$5,000.00 (U.S.), environmental permit violations, spills and releases which are required to be reported to regulatory agencies, and any other incident, including near misses where they RHSM or PM determines an RCA is appropriate. The RHSM/REM is responsible for ensuring it is completed and results entered in the incident report form in HITS. RCA's must be completed using a Team that includes, at least the RHSM or designee, the involved party(ies), a responsible operations representative (e.g., PM, construction manager, crew supervisor, etc.) and an independent management representative not associated with the incident.

The Root Cause Analysis Form must be completed for all Loss Incidents and Near Loss Incidents. This form must be submitted to the investigation team for review.

For minor losses or near losses, the information may be gathered by the supervisor or other personnel immediately following the loss. Based on the complexity of the situation, this information may be all that is necessary to enable the investigation team to analyze the loss, determine the root cause, and develop recommendations. More complex situations may require the investigation team to revisit the loss site or re-interview key witnesses to obtain answers to questions that may arise during the investigation process.

Photographs or videotapes of the scene and damaged equipment should be taken from all sides and from various distances. This point is especially important when the investigation team will not be able to review the loss scene.

The investigation team must follow the Root Cause Analysis Flow Chart (see Attachment 4 of the SOP) to assist in identifying the root cause(s) of a loss. Any loss may have one or more root causes and contributing factors. The root cause is the primary or immediate cause of the incident, while a contributing factor is a condition or event that contributes to the incident happening, but is not the primary cause of the incident. Root causes and contributing factors that relate to the person involved in the loss, his or her peers, or the supervisor should be referred to as "personal factors." Causes that pertain to the system within which the loss or injury occurred should be referred to as "job factors."

Personal factors include:

- Lack of skill or knowledge;
- Correct way takes more time and/or requires more effort;
- Short-cutting standard procedures is positively reinforced or tolerated; or
- Person thinks there is no personal benefit to always doing the job according to standards.

Job Factors include:

- Lack of or inadequate operational procedures or work standards;
- Inadequate communication of expectations regarding procedures or standards; or
- Inadequate tools or equipment.

The root cause(s) could be any one or a combination of these seven possibilities or some other uncontrollable factor. In the vast majority of losses, the root cause is very much related to one or more of these seven factors. Uncontrollable factors should be used rarely and only after a thorough review eliminates all seven other factors.

18.9.1 Corrective Actions

Include all corrective actions taken or those that should be taken to prevent recurrence of the incident. Include the specific actions to be taken, the employer and personnel responsible for implementing the actions, and a timeframe for completion. Be sure the corrective actions address the causes.

Once the investigation report has been completed, the PM shall hold a review meeting to discuss the incident and provide recommendations. The responsible supervisors shall be assigned to carry out the recommendations, and shall inform the SC upon successful implementation of all recommended actions.

- Evaluation and follow-up of the IRF will be completed by the type of incident by the RHSM, EM, or FWSO.
- Incident investigations must be initiated and completed as soon as possible but no later than 72 hours after the incident.

19. Records and Reports

An organized project filing system is essential for good documentation and recordkeeping. There are many benefits to an organized filing system:

- Other CH2M HILL employees can easily and quickly find documents;
- Records are readily available for review;
- Records may be needed during OSHA investigations, audits, or other legal matters;
- Records may be needed on short notice in case of an accident, illness or other emergency; and
- Systematic recordkeeping aids in overall project organization.

The project filing system shall be established at the beginning of the project and maintained throughout all phases of construction and archived in accordance with CH2M HILL's Records Retention Policy. The information contained in the filing system shall be updated regularly and/or as specified in this document. The PM and SC are responsible for collecting documentation, including subcontractor documentation, and maintaining a complete and organized filing system.

Below are examples of records that must be maintained as the project progresses:

- Exposure records includes air monitoring data (including calibration records), SDSs, exposure modeling results;
- Physical hazard exposure records include noise, ionizing radiation, non-ionizing radiation, vibration, and lasers exposure assessments and measurements;
- Respiratory fit test records;
- Training records;
- Incident reports, investigations and associated back-up information such as agency notifications, calculations, and corrective actions taken;
- Federal or state agency inspection records;
- Other Records:
 - Ergonomic evaluations;
 - HSE audits and assessments;
 - Project-specific HSE plans;
 - Confined space entry permits;
 - Equipment inspections;
 - Equipment maintenance;
 - Emergency equipment inspection records;
 - SBOs;
 - Self-assessment checklists
- The RHSM shall coordinate with the PM or designee to ensure that final project-specific HSE records described in this section, including negative exposure determinations, are maintained with the project files in accordance with the CH2M HILL records retention schedule, or forwarded to the Medical Surveillance Program Administrator, as appropriate. Records retention requirements are detailed in the Recordkeeping and Access to Records SOP, HSE-119.

CH2M HILL Employee Sign-Off

I hereby acknowledge that I have received, read, understand, and will comply with these Guidelines.

Name (printed): _____

Signature: _____

Date: _____

Make a photo copy or scan and send this completed sign-off page to your CH2M HILL Safety Program Assistant (SPA).

Subcontractor Sign-Off

SUBCONTRACTOR SIGNOFF FORM

ESBG HSSE GUIDELINES

The CH2M HILL project employees and subcontractors listed below have been provided with these Guidelines, have read and understood them, and agree to abide by its provisions.

This sign-off sheet shall be maintained with the project safety plan.

Project Name:

Project Number:

EMPLOYEE NAME (Please print)	EMPLOYEE SIGNATURE	COMPANY	DATE

Fact Sheets
Vehicle Accident Guidance
Working Alone

2011 Vehicle Accident Guidance – ESBG

Remember that if you are **renting** a non-CH2M HILL owned vehicle (short-term rental) in the U.S., you should carry the [insurance card](#) from the state where your driver's license is issued.

If you operate a **fleet vehicle**, carry the [insurance card](#) where the vehicle is registered.

For ALL Vehicles if you are in an accident:

1. If you are injured, call 911 for emergency medical treatment or 1-866-893-2514 to contact the CH2M HILL Occupational Nurse/Physician for minor injuries. If you feel you have not been injured, contact the RHSM for guidance on whether calling the CH2M HILL Occupational Nurse/Physician is applicable.
2. **Call the Police**--For any vehicle accident/damage, it is recommended that the local police (or site security/emergency services if working on a client site that provides such services) be called to determine if a report needs to be filed. In some instances, a report may not be required (during accident alerts, or in public parking lots). Document that the authorities were called and follow up with any guidance they give you. State requirements vary. If a report is filed, obtain a copy.
3. Notify Supervisor, (and PM/RHSM if working on a project site)
4. Complete a HITS report on the VO.

Additional Steps

To report an auto accident, and before a claim can be taken by telephonic reporting, have available your name (the company name alone is no longer accepted, a driver's name must be provided even for fender benders), location of accident and your office address if different than the accident location, business group and project number. A claim cannot be taken without your name, address, business group and your project number. By location the state where the accident occurred, and which office you are aligned to, i.e., accident occurs in Idaho, but you are out of the Denver office. Advise the claim recorder the accident occurred in ID, but that your office location is Denver. This will assist the claim intake person in identifying location coding for the claims.

Auto accidents involve two different sections of an Auto policy:

- 1) Liability to others due to Bodily Injury and Property Damage
- 2) Physical Damage - Comprehensive and Collision - damage to the vehicle CH employee is driving

CH2M Hill has Liability coverage for any auto - our policy will respond on either a primary or excess basis.

Refer to the table below for additional notifications to make based on the type of accident experienced and type of vehicle being used.



Liability - Bodily Injury or Property Damage to Others

Scenario	Which Coverage Responds	What to do if in an accident
CH2M Hill fleet, pool or project vehicle - long term lease - lower 48	CH2M Hill - Primary	Contact Broadspire (1-800-753-6737); Jennifer Rindahl/DEN (720-286-2449); Linda George/DEN (720-286-2057)
CH2M Hill fleet, pool or project vehicle - long term lease - Alaska (North Slope)	CH2M Hill - Primary	Contact Jennifer Rindahl/DEN (720-286-2449)
Client vehicle driven by CH2M Hill employee	Client's auto policy unless client has made CH2M Hill responsible for vehicle	Contact Broadspire (1-800-753-6737); Contact Jennifer Rindahl/DEN (720-286-2449); contact client;
Short term lease (30 days or less)	Rental car company if rented through Enterprise, Budget or Hertz; CH2M Hill excess	Contact Broadspire (1-800-753-6737); Contact local branch of rental car company where vehicle leased (ERAC includes 24 hour roadside assistance) and Jennifer Rindahl/DEN (720-286-2449)
Short term lease (30 days or less)	CH2M Hill - Primary if rented through company other than our national agreements; \$100,000 deductible	Contact Broadspire (1-800-753-6737); Contact rental car company and Jennifer Rindahl/DEN (720-286-2449)
Personal vehicle used on business	Employee's personal auto policy; CH2M Hill on an excess basis	Contact personal auto insurance company; contact Jennifer Rindahl/DEN (720-286-2449)

Physical Damage - damage to vehicle CH employee was driving

Scenario	Which Coverage Responds	What to do if in an accident
CH2M Hill fleet, pool or project vehicle - long term lease - lower 48	CH2M Hill ONLY if vehicle is scheduled on policy - \$5,000 deductible	Contact Broadspire (1-800-753-6737); Jennifer Rindahl/DEN (720-286-2449); Linda George/DEN (720-286-2057)
CH2M Hill fleet, pool or project vehicle - long term lease - Alaska (North Slope)	CH2M Hill Equipment Schedule if scheduled on policy	Contact Jennifer Rindahl/DEN (720-286-2449)
CH2M Hill fleet, pool or project vehicle - long term lease	ARI if physical damage coverage purchased - \$500 deductible	Contact Jennifer Rindahl/DEN 720.286.2449; call ARI at 1-800-221-1645 give them Client Code and ARI fleet vehicle number; and notify Linda George/DEN - Fleet Coordinator - 720-286-2057
Client vehicle CH2M Hill Employee is driving	Client's auto policy unless client has made CH2M Hill contractually responsible for vehicle	Contact Jennifer Rindahl/DEN (720-286-2449); contact client; contact Broadspire (1-800-753-6737)
Short term lease (30 days or less) using corporate VISA	VISA if corporate credit card used and vehicle is not a pickup, truck, cargo van or used off-road	Contact VISA - 1-800-847-2911 or http://www.visa.com/eclaim
Short term lease (30 days or less) through Enterprise (ERAC) and vehicle is used off-road and physical damage coverage included when vehicle leased	ERAC up to \$3,000 in damage; CH2M Hill's coverage is excess	Notify Rental Car Company; contact Jennifer Rindahl/DEN (720-286-2449) if damage over \$5,000
Short term lease (30 days or less) did not use corporate VISA	CH2M Hill - \$5,000 deductible (project responsibility)	Contact Broadspire (1-800-753-6737); Contact Jennifer Rindahl/DEN 720-286-2449; contact VISA - 1-800-847-2911 or http://www.visa.com/eclaim
Personal vehicle used on business	CH will reimburse the amount of the deductible carried on the employee's policy up to \$500 whichever is less	Contact Jennifer Rindahl/DEN (720-286-2449); contact client; contact Broadspire (1-800-753-6737)

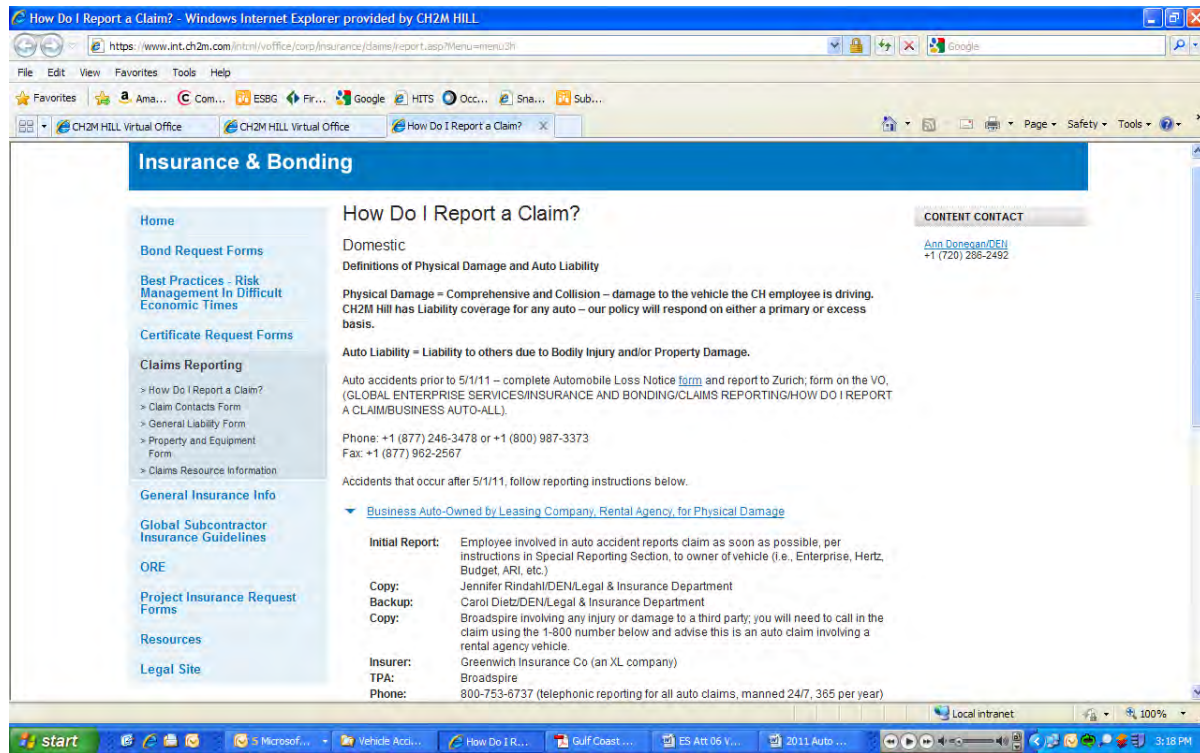


Details for reporting a claim on the CH2M Hill VO are accessed by going to the VO home page and clicking:

GLOBAL ENTERPRISE SERVICES/INSURANCE & BONDING/CLAIMS REPORTING

HOW DO I REPORT A CLAIM TAB or access the following URL:

<https://www.int.ch2m.com/intrnl/voffice/corp/insurance/claims/report.asp?Menu=menu3h>



For Personally Owned Vehicles (POVs):

CH2M HILL does not provide auto insurance for POVs, it is responsibility of the owner. If you are in a vehicle accident conducting company business, contact the police as above, supervisor, and 911 or CH2M HILL's occupational nurse/physician as stated above. Complete a HITS report. Contact Jennifer Rindahl/DEN for assistance for meeting personal insurance deductibles (up to \$500) with proof of insurance and deductible.

If using your POV for extended project use, notify the PM to make sure a rental car is not needed. Check your insurance policy for guidance on using the POV for business use.

Additional Resources:

[Claims Resource Manual](#)

**WORKING ALONE PROTOCOL
CALL – IN CONTACT FORM**

Date of site work: _____ Expected start time: _____

Name of CH2M HILL employee in the field: _____

Name of CH2M HILL employee responsible to receive contact: _____

Client Emergency Contact (if any): _____

CH2M HILL employee's contact numbers:

Radio # _____

Cell Phone # _____

Address and Location of work: _____

Directions/Map: _____

Planned Activity: _____

Specified Frequency and time for call in: _____

Time

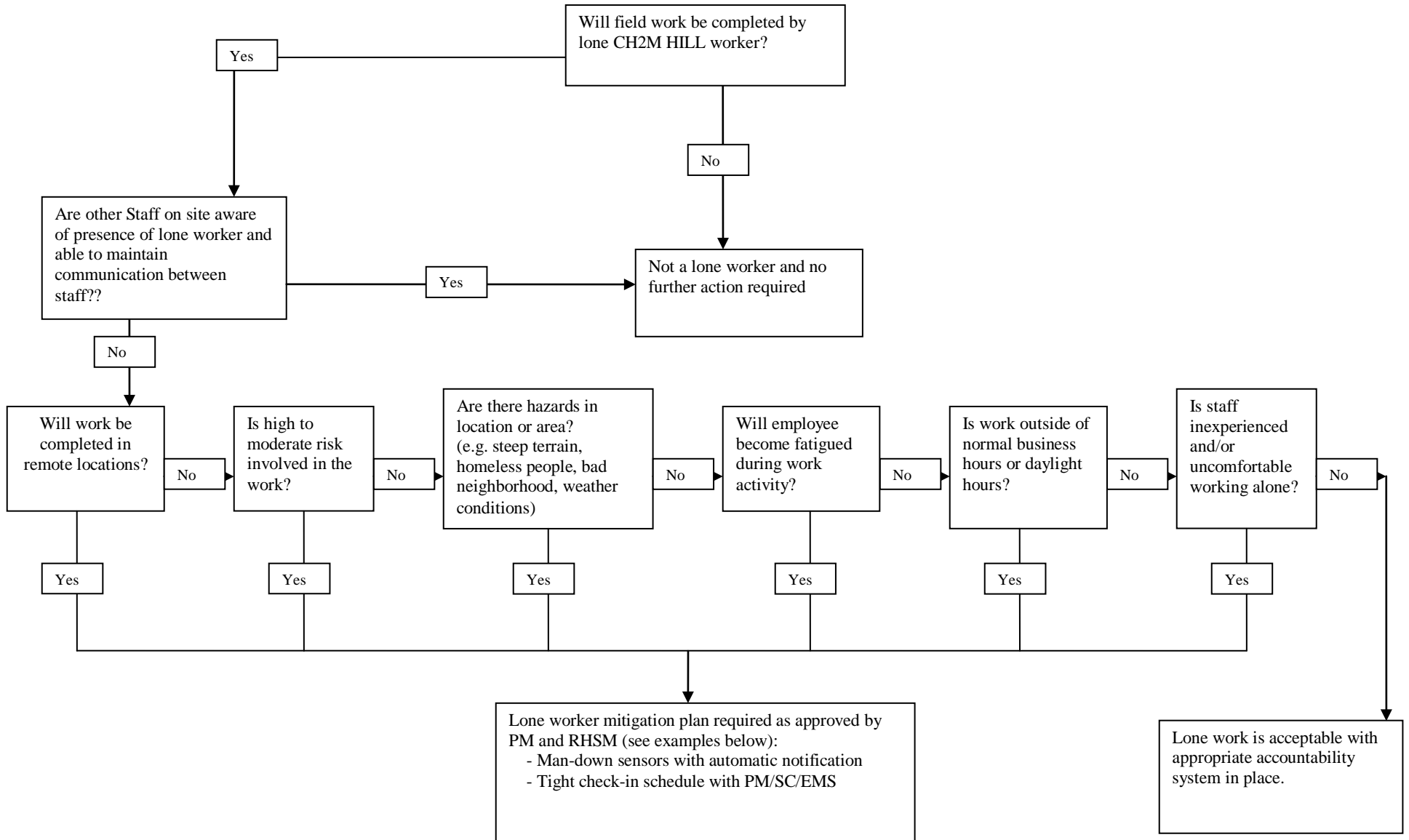
Verified

Location

If lone worker fails to call in at specified frequency/time:

- 1) Call worker's radio and cell to determine if an emergency exists.
- 2) If no reply, immediately call Client security/emergency service if there is one at the site.
- 3) If there is no client security call Emergency Services (911). Inform the dispatcher there is a lone worker that cannot be contacted and there may be an emergency on site. Provide the lone worker's name, their last known location, and your contact information.
- 4) After Emergency Services have been contacted, call the other emergency contacts, Project Manager, and Responsible Health and Safety Manager.

Lone Worker Protocol



CH2M HILL HEALTH AND SAFETY PLAN

Attachment 7

Observed Hazard Form

OBSERVED HAZARD FORM

Name/Company of Observer (*optional*):

Date reported:_____

Time reported:_____

Contractor/s performing unsafe act or creating unsafe condition:

1.

2.

Unsafe Act or Condition:

Location of Unsafe Act or Condition:

Name of CH2M HILL Representative:

Corrective Actions Taken:

Date:

Project Safety Committee Evaluation:

Date:

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 8

Stop Work Order Form

Stop Work Order

REPORT PREPARED BY:

Name:	Title:	Signature:	Date:

ISSUE OF NONPERFORMANCE:

Description:	Date of Nonperformance:

SUBCONTRACTOR SIGNATURE OF NOTIFICATION:

Name:	Title:	Signature:	Date:

** Corrective action is to be taken immediately. Note below the action taken, sign and return to CCI.* Work may not resume until authorization is granted by CH2M HILL Constructors, Inc. Representative,*

SUBCONTRACTOR'S CORRECTIVE ACTION

Description:	Date of Nonperformance:

SUBCONTRACTOR SIGNATURE OF CORRECTION

Name:	Title:	Signature:	Date:

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 9

Agency Inspection Target Zero Bulletin

TARGET ZERO Bulletin

Subject: HSSE Agency Inspections (OSHA, EPA, DOT, State Health Department)

Do you know what YOU would do if an agency inspector arrived at your site unannounced?

Recently, a State Occupational Safety and Health Administration (OSHA) inspector made an unannounced visit to one of our Federal project sites. OSHA, U.S. Environmental Protection Agency (EPA), and authorized state or local agencies have authority to inspect any facility that is subject to health, safety, and environmental legislation. Inspections may be announced or unannounced. This particular inspector indicated that the project was targeted for an inspection because the work was funded by the American Recovery and Reinvestment Act (ARRA).

Enterprise Standard Operating Procedure (SOP) HSE-201, *Agency Inspections and Communications*, describes the responsibilities, procedures, and requirements associated with inspections conducted by external regulatory agencies, as well as the methods for communicating information to key individuals. This Target Zero Bulletin is a brief summary of what to do in the event of an agency inspection at your site. Refer to the SOP for more specific guidance.

Notification of Inspections

- If the inspection is an announced regulatory agency inspection, the Project Manager (PM) should notify the Responsible Health and Safety Manager (RHSM) and Responsible Environmental Manager (REM) well in advance of the inspection.
- If an unannounced agency inspector visits one of our projects, Field personnel must immediately notify the project Emergency Response Coordinator (ERC). Typically the ERC is the Safety Coordinator (SC).
- The **ERC must immediately notify the RHSM/REM**, as appropriate, of unannounced inspections, or designate someone to call the RHSM/REM. The RHSM/REMs can provide guidance to the field staff and PM.

Inspector Credential Verification

- Upon arrival, the ERC must request the inspector to provide official credentials. Record the inspector's name and office phone number or obtain the inspector's business card.
- The inspector shall sign the visitors log and be given a site-specific health, safety, and environmental protection briefing.
- The inspector shall meet any site access requirements associated with security clearances, specialized training, and medical monitoring. The CH2M HILL representative shall verify that the inspector possesses these requirements; access will only be granted to those areas where appropriate access requirements are met. Some inspectors have the authority to gain access to any work area at any time, such as an inspector with a search warrant. In these cases, we can stop work operations as necessary to protect the safety of the inspector(s).

Opening Conference

- The CH2M HILL Project Manager, ERC, RHSM, or REM, and the inspector shall determine attendees for the opening conference. The RHSM (for OSHA and other worker health and safety inspections) or REM (for environmental inspections) shall join the opening conference via conference call.
- The inspector shall inform CH2M HILL of the purpose of the inspection and provide a copy of the complaint, if applicable.

-
- The inspector shall outline the scope of the inspection, including employee interviews conducted in private, physical inspection of the workplace and records, possible referrals, discrimination complaints, and the closing conference(s).

Requests for OSHA Logs

- An OSHA inspector may request to review the project OSHA Injury/Illness log, better known as the OSHA 300 Log. Contact your RHSM for assistance in obtaining the OSHA 300 Log.
- Field projects with a continuous duration of one year or longer are considered to be separate establishments and are required to maintain an OSHA 300 log specific to the project. The project OSHA 300 log should be maintained onsite and kept current.
- Recordable injuries and illnesses sustained on field projects less than one year in duration are maintained on the CH2M HILL office log where the injured employee is based.

The Inspection

- The scope of the inspection shall be limited to that indicated by the inspector in the opening conference. The inspector shall be escorted to relevant areas only. The ERC or other designated by the RHSM or REM must accompany the inspector during the inspection.
- Ensure that the inspection is limited to the scope that the inspector disclosed during the opening conference. The ERC should always take notes which identify: areas inspected, machinery or equipment and materials examined, employees or other persons interviewed, and photographs taken by the inspector.
- The inspector will observe safety, health, and environmental conditions and practices and document the inspection process. The inspector may also take photos and instrument readings, examine records, collect air samples, measure noise levels, survey existing engineering controls, and monitor employee exposure to toxic vapors, gases, and dusts.
- CH2M HILL should gather duplicate information (photographs, readings, samples) in the same manner and condition as the inspector. If the equipment needed to take duplicate samples is not onsite, ask the inspector if the sampling can wait until the equipment is available. If samples are taken, request a description of the tests that the agency intends to perform on the samples and request results as soon as they are available.
- Employees may be questioned during the inspection tour. The employee can refuse to speak to an inspector, can speak to the inspector with a company representative (including management) present, or can speak to the inspector privately. It is CH2M HILL policy that employees who wish to speak to the inspector are not discriminated against, intimidated, or otherwise mistreated for exercising their rights during compliance inspections.
- Copies of documents should not be provided to the inspector without the approval of the RHSM or REM or Legal Insurance Department (LID). **DO NOT** voluntarily release documents. Respond only to inspection team requests.
- During the course of the inspection, the inspector may point out violations. For each violation, the CH2M HILL representative should ask the inspector to discuss possible corrective action. Where possible, violations detected by the inspector should be corrected immediately and noted by the inspector as corrected.
- For those items which cannot be corrected immediately, an action plan shall be formulated for timely correction. In any instance, employees exposed to hazards shall be removed from the area.

Closing Conference

After the inspection, a closing conference is normally held as follows:

- The CH2M HILL PM, ERC, RHSM or REM shall be involved via conference call in the closing conference, at a minimum;
- The inspector shall describe the apparent violations found during the inspection and other pertinent issues as deemed necessary by the inspector. CH2M HILL shall be advised of their rights to participate in any subsequent conferences, meetings or discussions. Any unusual circumstances noted during the closing conference shall be documented by the ERC;
- The inspector shall discuss violations observed during the inspection and indicate for which violations a citation and a proposed penalty may be issued or recommended;

-
- The ERC shall request receipts for all samples and approved documents photocopied by the inspector, request a photocopy of the inspector's photograph log, and request a copy of the final inspection report; and
 - Any documentation from an agency inspection must be transmitted immediately to the RHSM or REM, and LID.

Unannounced regulatory agency inspections may happen at any time on our projects -

Get your RHSM/REM and PM involved immediately if an Inspector arrives

HS&E Self-Assessment Checklist—Biological Prevention Measures

CH2MHILL

HS&E Self-Assessment Checklist

Page 1 of 3

This checklist shall be used by Navy CLEAN personnel and shall be completed by each crew entering the work area at the frequency of one per day or otherwise specified in the project's Health and Safety Plan/Field Safety Instruction (HSP/FSI). The checklist should be completed prior to entry and at the end of the day to document that appropriate checks have been completed.

This checklist is to be used at locations where the possibility exists that contact with biological hazards is possible.

Site Safety Coordinator (SSC) will request any CH2M HILL subcontractor to take necessary precautions in eliminating the exposure to biological hazards, but shall not direct the means and methods.

Project Name: _____ Project No.: _____
Location: _____ PM: _____
Auditor: _____ Title: _____ Date: _____

- Check "Yes" if an assessment item is complete or correct.
- Check "No" if an item is incomplete or deficient. Section 2 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

	<u>SECTION 1 – PRE-ENTRY</u>	<u>Yes</u>	<u>No</u>	<u>N/A</u>	<u>N/O</u>
SITE HAZARD EVALUATION					
1. Inform field members of hazards (types, symptoms)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Can work be completed without entering the work zone		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Have controls been implemented where possible (clearing vegetation, spraying)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Has an inspection been made to identify nests, hives or areas where insects may concentrate		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Will working at different time will reduce exposure		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SENSATIVITIES					
6. Does any staff have existing reactions to stings or bites		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. If yes to #6, is special required and medication available on site (epi-pen)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Has anyone with an existing condition briefed other team members about symptoms and first aid which may be required		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EMERGENCY RESPONSE					
9. Are first aid kits, along with tick removal kits, readily available to all staff		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Does each member of the field staff have ability to communicate (phone, radios, and visual)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Are emergency contacts available (base emergency, local police, or local EMT)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. If working in remote areas, is transport readily available (less than 5 minutes)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Have you planned an emergency exit from the site in the event of a swarm		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<u>SECTION 2 - PPE</u>		<u>Yes</u>	<u>No</u>	<u>N/A</u>	<u>N/O</u>
SELECTION OF PPE					
14. Will weather (heat, rain, ice) impact the safety of workers wearing protective suits		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Will visibility be limited to unacceptable levels if a hood is worn		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. Will the use of equipment be difficult if a suit is worn		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Will heavy vegetation be encountered that could rip or damage a suit		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Will a Bug-Out suit or Tyvek suit be used by staff (if not, please give additional rationale in writing in Section 4)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TYPE OF PPE USED OTHER THAN BUG-OUT OR TYVEK SUIT					
19. Is staff wearing light-colored clothes		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. Is staff wearing long sleeve shirts		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21. Are pant legs tucked into socks		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22. Are shirts tucked into pants		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23. Has tape been placed around sock/pant leg line and around waist		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. Have hand and wrist areas been sealed		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25. Are hats being worn		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26. Have clothes been pre treated with Permethrin		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27. Has team member inspected coworker's suits or clothing to ensure no spaces exist for insects to penetrate		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<u>SECTION 3 – CHECKS AND DECONTAMINATION</u>		<u>Yes</u>	<u>No</u>	<u>N/A</u>	<u>N/O</u>
DAILY CHECKS (TO BE COMPLETED DURING AND AT END OF DAY)					
28. Were tick/insect checks performed during the day (if not, please provide reason in Section 4)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29. Was one unclothed tick check completed		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30. Were ticks found on the outerwear (if yes, please note the number in Section 4)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31. Were ticks found inside the Bug-Out, Tyvek, or personal clothing		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32. Were suits turned inside out and inspected prior to putting away		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33. Were showers taken by field staff immediately upon arrive from the field		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34. Were clothing placed in a garbage bag and sealed to prevent any insects from spreading		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
35. If ticks were found embedding in skin, were they properly removed and saved		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
36. Have vehicles been inspected for ticks on a daily basis and before the vehicle is turned in		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
REPORTING					
37. If a tick was found on your skin, could you tell where it entered so that it could be addressed		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
38. If a tick was found embedded, did you contact the PM, complete a HITS form and contact the Occupational Physician at 1-866-893-2514		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
39. Did you contact field staff on the project to provide potential corrective measures		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
40. Did you follow the IM/RTW procedure to ensure you received the proper medical attention (if not, provide an explanation in Section 4)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SECTION 4

Complete this section for all items where further information was requested in the previous sections.

[illegible]

Auditor: _____ Project Manager: _____

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: (1) CH2M HILL employees are exposed to hand and power tool hazards and/or (2) CH2M HILL provides oversight of subcontractor personnel who are exposed to hand and power tool hazards.

SC may consult with subcontractors when completing this checklist, but shall not direct the means and methods of hand and power tool use nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazard until corrected.

Project Name: _____ Project No.: _____
Location: _____ PM: _____
Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

- ☐ Evaluate CH2M HILL employee exposure to hand and power tool hazards.
☐ Evaluate a CH2M HILL subcontractor's compliance with hand and power tool requirements.
Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-210.

SECTION 1**Yes No N/A N/O****SAFE WORK PRACTICES (5.1)**

- | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. All tools operated according to manufacturer's instructions and design limitations. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. All hand and power tools maintained in a safe condition and inspected and tested before use. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Defective tools are tagged and removed from service until repaired. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. PPE is selected and used according to tool-specific hazards anticipated. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Power tools are not carried or lowered by their cord or hose. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Tools are disconnected from energy sources when not in use, servicing, cleaning, etc. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Safety guards remain installed or are promptly replaced after repair. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Tools are stored properly. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. Cordless tools and recharging units both conform to electrical standards and specifications. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. Tools used in explosive environments are rated for such use. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. Knife or blade hand tools are used with the proper precautions. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. Consider controls to avoid muscular skeletal, repetitive motion, and cumulative trauma stressors. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

SECTION 2
Yes No N/A N/O
GENERAL (5.2.2)

- | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|
| 13. PPE is selected and used according to tool-specific hazards anticipated. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. Tools are tested daily to assure safety devices are operating properly. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 15. Damaged tools are removed from service until repaired. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 16. Power operated tools designed to accommodate guards have guards installed. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 17. Rotating or moving parts on tools are properly guarded. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 18. Machines designed for fixed locations are secured or anchored. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 19. Floor and bench-mounted grinders are provided with properly positioned work rests. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 20. Guards are provided at point of operation, nip points, rotating parts, etc. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 21. Fluid used in hydraulic-powered tools is approved fire-resistant fluid. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

ELECTRIC-POWERED TOOLS (5.2.3)

- | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|
| 22. Electric tools are approved double insulated or grounded and used according to SOP HSE-206. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 23. Electric cords are not used for hoisting or lowering tools. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 24. Electric tools are used in damp/ wet locations are approved for such locations or GFCI installed. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 25. Hand-held tools are equipped with appropriate on/off controls appropriate for the tool. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 26. Portable, power-driven circular saws are equipped with proper guards. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

ABRASIVE WHEEL TOOLS (5.2.4)

- | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|
| 27. All employees using abrasive wheel tools are wearing eye protection. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 28. All grinding machines are supplied with sufficient power to maintain spindle speed. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 29. Abrasive wheels are closely inspected and ring-tested before use. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 30. Grinding wheels are properly installed. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 31. Cup-type wheels for external grinding are protected by the proper guard or flanges. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 32. Portable abrasive wheels used for internal grinding are protected by safety flanges. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 33. Safety flanges are used only with wheels designed to fit the flanges. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 34. Safety guards on abrasive wheel tools are mounted properly and of sufficient strength. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

PNEUMATIC-POWERED TOOLS (5.2.5)

- | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|
| 35. Tools are secured to hoses or whip by positive means to prevent disconnection. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 36. Safety clips or retainers are installed to prevent attachments being expelled. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 37. Safety devices are installed on automatic fastener feed tools as required. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 38. Compressed air is not used for cleaning unless reduced to < 30 psi, with PPE, and guarded. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 39. Manufacturer's safe operating pressure for hoses, pipes, valves, etc. are not exceeded. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 40. Hoses are not used for hoisting or lowering tools. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 41. All hoses >1/2-inch diameter have safety device at source to reduce pressure upon hose failure. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 42. Airless spray guns have required safety devices installed. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 43. Blast cleaning nozzles are equipped with operating valves, which are held open manually. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 44. Supports are provided for mounting nozzles when not in use. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 45. Air receiver drains, handholes, and manholes are easily accessible. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 46. Air receivers are equipped with drainpipes and valves for removal of accumulated oil and water. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 47. Air receivers are completely drained at required intervals. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 48. Air receivers are equipped with indicating pressure gauges. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 49. Safety, indicating, and controlling devices are installed as required. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 50. Safety valves are tested frequently and at regular intervals to assure good operating condition. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

HSE Self-Assessment Checklist—HAND AND POWER TOOLS

SECTION 2 (continued)

Page 3 of 4

	<u>Yes</u>	<u>No</u>	<u>N/A</u>	<u>N/O</u>
LIQUID FUEL-POWERED TOOLS (5.2.6)				
51. Liquid fuel-powered tools are stopped when refueling, servicing, or maintaining.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
52. Liquid fuels are stored, handled, and transported in accordance with SOP HSE-403	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
53. Liquid fuel-powered tools are used in confined spaces in accordance with SOP HSE-203.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
54. Safe operating pressures of hoses, valves, pipes, filters, and other fittings are not exceeded.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
POWDER-ACTUATED TOOLS (5.2.7)				
55. Only trained employee operates powder-actuated tools.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
56. Powder-actuated tools are not loaded until just prior to intended firing time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
57. Tools are not pointed at any employee at any time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
58. Hands are kept clear of open barrel end.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
59. Loaded tools are not left unattended.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
60. Fasteners are not driven into very hard or brittle materials.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
61. Fasteners are not driven into easily penetrated materials unless suitable backing is provided.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
62. Fasteners are not driven into spalled areas.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
63. Powder-actuated tools are not used in an explosive or flammable atmosphere.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
64. All tools are used with correct shields, guards, or attachments recommended by manufacturer.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
JACKING TOOLS (5.2.8)				
65. Rated capacities are legibly marked on jacks and not exceeded.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
66. Jacks have a positive stop to prevent over-travel.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
67. The base of jacks are blocked or cribbed to provide a firm foundation, when required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
68. Wood blocks are place between the cap and load to prevent slippage, when required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
69. After load is raised, it is cribbed, blocked, or otherwise secured immediately.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
70. Antifreeze is used when hydraulic jacks are exposed to freezing temperatures.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
71. All jacks are properly lubricated.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
72. Jacks are inspected as required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
73. Repair or replacement parts are examined for possible defects.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
74. Jacks not working properly are removed from service and repaired or replaced.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HAND TOOLS (5.2.9)				
75. Wrenches are not used when jaws are sprung to the point of slippage.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
76. Impact tools are kept free of mushroomed heads.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
77. Wooden handles of tools are kept free of splinters or cracks and are tightly fitted in tool.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CHAIN SAWS (5.2.10)				
78. Chainsaw equipped with spark arrestor and fully functioning chain brake	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
79. Chainsaw operator's manual readily available	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
80. Fully stocked first aid kit and multipurpose fire extinguisher available	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
81. Appropriate personal protective equipment available and worn	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
82. Clothing free of loose edges that could become entangled in the saw	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
83. Chainsaw handles kept dry, clean, and free of oil or fuel mixture	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
84. Chainsaws held firmly with both hands and used right-handed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
85. Operator standing to the left of the saw out of the plane of the chain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
86. Saw used between the waist and mid-chest level	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
87. Full throttle maintained while cutting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
88. Operator aware of position of guide bar tip, does not contact tip with anything being cut	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
89. Bumper spikes maintained as close to the object as possible	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
90. Operator aware of what is in the saw's downward path after the cut	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
91. No attempt to made to cut material that is larger than the guide bar of the saw	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
92. Cuts avoided that will cause chain to jam	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
93. Non-metallic wedges used to prevent compression cuts from jamming the blade	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
94. Bystanders and helpers kept at a safe distance from operation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
95. Chainsaw not operated when fatigued	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
96. Fire extinguisher present when operating the chainsaw in forest or brushy areas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

[illegible]

Auditor: _____ Project Manager: _____

CH2MHILL

HS&E Self-Assessment Checklist: PPERSONAL PROTECTIVE EQUIPMENT

Page 1 of 3

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where CH2M HILL employees are required to wear PPE or are required to perform oversight of a subcontractor using PPE or both.

CH2M HILL staff shall not direct the means and methods of subcontractor use of PPE nor direct the details of corrective actions. The subcontractor must determine how to correct deficiencies and CH2M HILL staff must carefully rely on their expertise. Conditions considered to be imminently dangerous (possibility of serious injury or death) must be corrected immediately or all exposed personnel must be removed from the hazard until corrected.

Project Name: _____	Project No.: _____																								
Location: _____ PM: _____																									
Auditor: _____ Title: _____ Date: _____																									
This specific checklist has been completed to (check only one of the boxes below):																									
<input type="checkbox"/> Evaluate CH2M HILL compliance with its PPE program (SOP HSE-117) <input type="checkbox"/> Evaluate a CH2M HILL subcontractor's compliance with its PPE program Subcontractor's Name: _____																									
Check the appropriate box, as follows:																									
<ul style="list-style-type: none"> • Check "Yes" if an assessment item is complete or correct. • Check "No" if an item is incomplete or deficient. Section 2 must be completed for all items checked "No." • Check "N/A" if an item is not applicable. • Check "N/O" if an item is applicable but was not observed during the assessment. 																									
Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-121.																									
SECTION 1 GENERAL 1. Required PPE listed in HSP FSI or AHA. 2. PPE available for use by employees. 3. PPE cleaning supplies available for use. 4. PPE stored appropriately to prevent deformation or distortion. 5. PPE written certification has been completed.	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Yes</th> <th style="text-align: left;">No</th> <th style="text-align: left;">N/A</th> <th style="text-align: left;">N/O</th> </tr> </thead> <tbody> <tr><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr> <tr><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr> <tr><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr> <tr><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr> <tr><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr> </tbody> </table>	Yes	No	N/A	N/O	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																						
EYEWEAR (Glasses/Goggles/Face Shields) 6 Eyewear cleaning supplies available. 7 Safety glasses in good condition and lenses free of scratches. 8 Goggles adjustment strap not cracked or frayed, not deformed, or lenses not scratched. 9. Face shields in good condition, including adjustment band, and free of scratches or chips.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr> <tr><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr> <tr><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr> <tr><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr> </tbody> </table>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>								
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CH2MHILL

HS&E Self-Assessment Checklist: PERSONAL PROTECTIVE EQUIPMENT

Page 2 of 3

SECTION 1 (Continued)	Yes	No	N/A	N/O
HEAD PROTECTION				
10. Hard hat bill and suspension attached as allowed by manufacturer.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Shell is pliable, free of dents, cracks, nicks, or any damage due to impact.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Suspension maintained at 1.25 inches from inside of shell.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Suspension free of cuts or fraying, torn headband, adjustment strap workable.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Electrical hard hat matched to hazard classification.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Dated to determine whether within manufacturer's allowable 5-year use time period.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HAND PROTECTION				
16. Available in sizes matched to employee.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Gloves free of rips tears, abrasions, or holes.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Matched to manufacturer's specification for chemicals used onsite.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Electrical gloves matched to hazard and periodically inspected for insulating rating.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. Maintained in a clean and sanitary condition, decontaminated or disposed properly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
BODY PROTECTION				
21. Available in sizes matched to employee.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22. Maintained in a clean and sanitary condition, decontaminated or disposed properly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23. Vapor-tight fully encapsulated suits tested at required periodic intervals.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. Flame-resistant clothing matched to electrical hazard and arc flash rating.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25. Welding gear matched to degree of hazard and free of cuts, tears or burn holes.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26. Flotation gear available for work near or on water and in good condition.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HOT AND COLD BODY PROTECTION				
27. Cooling gear available based on degree of heat stress hazard.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28. Cooling gear in operable, clean, and sanitary condition.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29. Cold-weather gear provided based on needs assessment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30. Cold-weather gear available in sizes to match employees.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31. Cold-weather gear is in free of tears, rips, or holes and in maintained in a clean condition.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TRAINING				
32. Initial PPE training completed by employees.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33. Training conducted when new types or styles of PPE are issued.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34. PPE selection, use, and maintenance reviewed at daily safety briefings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Complete this section for all items checked “No” in Section 1. Deficient items must be corrected in a timely manner.

[illegible]

Auditor: _____ Project Manager: _____

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's written safety plan.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to drilling hazards, 2) CH2M HILL staff are providing support function related to drilling activities, and/or 3) CH2M HILL oversight of a drilling subcontractor is required.

Safety Coordinator may consult with drilling subcontractors when completing this checklist, but shall not direct the means and methods of drilling operations nor direct the details of corrective actions. Drilling subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately, or all exposed personnel shall be removed from the hazard until corrected.

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

- ☐ Evaluate CH2M HILL employee exposures to drilling hazards (complete Section 1).
☐ Evaluate CH2M HILL support functions related to drilling activities (complete Section 2)
☐ Evaluate a CH2M HILL subcontractor's compliance with drilling safety requirements (complete entire checklist).
 Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in SOP HSE-204.

SECTION 1 - SAFE WORK PRACTICES (4.1)

	Yes	No	N/A	N/O
1. Personnel cleared during rig startup	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Personnel clear of rotating parts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Personnel not positioned under hoisted loads	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Loose clothing and jewelry removed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Smoking is prohibited around drilling operation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Personnel wearing appropriate personal protective equipment (PPE), per written plan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Personnel instructed not to approach equipment that has become electrically energized	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SECTION 2 - SUPPORT FUNCTIONS (4.2)

FORMS/PERMITS (4.2.1)

8. Driller license/certification obtained	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Well development/abandonment notifications and logs submitted and in project files	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Water withdrawal permit obtained, where required	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Dig permit obtained, where required	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

UTILITY LOCATING (4.2.2)

12. Location of underground utilities and structures identified	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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SECTION 2 (Continued)				
	Yes	No	N/A	N/O
WASTE MANAGEMENT (4.2.3)				
13. Drill cuttings and purge water managed and disposed properly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DRILLING AT HAZARDOUS WASTE SITES (4.2.4)				
14. Waste disposed of according to project's written safety plan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Appropriate decontamination procedures being followed, per project's written safety plan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DRILLING AT MUNITIONS RESPONSE (4.2.5)				
16. MEC plan prepared and approved	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. MEC avoidance provided, routes and boundaries cleared and marked	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Initial pilot hole established by UXO technician with hand auger	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Personnel remain inside cleared areas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SECTION 3 - DRILLING SAFETY REQUIREMENTS (4.3)				
GENERAL (4.3.1)				
20. Only authorized personnel operating drill rigs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21. Daily safety briefing/meeting conducted with crew	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22. Daily inspection of drill rig and equipment conducted before use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DRILL RIG PLACEMENT (4.3.2)				
23. Location of underground utilities and structures identified	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. Safe clearance distance maintained from overhead power lines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25. Drilling pad established, when necessary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26. Drill rig leveled and stabilized	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27. Additional precautions taken when drilling in confined areas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DRILL RIG TRAVEL (4.3.3)				
28. Rig shut down and mast lowered and secured prior to rig movement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29. Tools and equipment secured prior to rig movement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30. Only personnel seated in cab are riding on rig during movement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31. Safe clearance distance maintained while traveling under overhead power lines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32. Backup alarm or spotter used when backing rig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DRILL RIG OPERATION (4.3.4)				
33. Kill switch clearly identified and operational	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34. All machine guards are in place	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
35. Rig ropes not wrapped around body parts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
36. Pressurized lines and hoses secured from whipping hazards	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
37. Drill operation stopped during inclement weather	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
38. Air monitoring conducted per written safety plan for hazardous atmospheres	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
39. Rig placed in neutral when operator not at controls	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DRILL RIG SITE CLOSURE (4.3.5)				
40. Ground openings/holes filled or barricaded	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
41. Equipment and tools properly stored	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
42. All vehicles locked and keys removed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DRILL RIG MAINTENANCE (4.3.6)				
28. Defective components repaired immediately	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29. Lockout/tagout procedures used prior to maintenance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30. Cathead in clean, sound condition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31. Drill rig ropes in clean, sound condition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32. Fall protection used for fall exposures of 6 feet (U.S.) 1.5 meters (Australia) or greater	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33. Rig in neutral and augers stopped rotating before cleaning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34. Good housekeeping maintained on and around rig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

[illegible]

Auditor: _____ Project Manager: _____

Attachment 2
Project Forms/Templates

Attachment 3

Fact Sheets

Attachment 4
Project Activity Self-Assessment Checklists

Attachment 5
CH2M HILL AHAs

EXHIBIT 1 TO FORM 408 HS - ACTIVITY HAZARD ANALYSIS FORM

Activity:	RADIATION SURVEY AND SOIL SAMPLING	Date:	10_18_13
		Project:	Ruby Mines
Description of the Services:	Perform gamma walkover surveys of open land areas using portable radiation detection equipment. Collection of surface soil samples using hand tools (hand trowel)	Site Supervisor:	See HSP
		Site Safety Officer:	See HSP

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	Potential Health and Safety Hazards (Analyze each principal step for potential hazards)	Hazard Controls (Develop specific controls for each potential hazard)
VEHICLE USAGE TO AND FROM SURVEY SITE	<ul style="list-style-type: none"> VEHICLE ACCIDENT/COLLISION RESULTING IN INJURY 	<ul style="list-style-type: none"> DRIVER MUST HAVE A VALID DRIVE'S LICENSE TO OPERATE A MOTOR VEHICLE ON SITE SEAT BELTS MUST BE WORN AT ALL TIMES WHILE OPERATING VEHICLE USE CAUTION WHEN DRIVING ON LOOSE GRAVEL, WHEN WET CONDITIONS EXIST OBEY ALL TRAFFIC SIGNS AND POSTINGS VISUALLY INSPECT VEHICLES PRIOR TO USE
ACTIVITIES IN VARIOUS OUTSIDE AREAS <ul style="list-style-type: none"> WALKING TO AND FROM JOB SITE. MOBILIZATION AND DEMOBILIZATION OF MATERIALS AND EQUIPMENT FOR SURVEYS. PERFORMING SURVEYS. 	<ul style="list-style-type: none"> TRIPPING/SLIPPING THAT MAY RESULT IN RELATED INJURY INSECTS/ANIMALS THAT MAY RESULT IN BITES, STINGS, INFECTION OR OTHER RELATED INJURY OR ILLNESS 	<ul style="list-style-type: none"> DETERMINE THE BEST ACCESS ROUTE BEFORE WALKING OR TRANSPORTING EQUIPMENT. CREATE A CLEAR PATH. MAINTAIN GOOD HOUSEKEEPING CONTINUALLY INSPECT THE WORK AREA FOR SLIP, TRIP AND FALL HAZARDS AND BE AWARE OF THE CHANGES IN SURFACE CONDITIONS THAT MAY OCCUR. EMINATE OR MARK HAZARD CONDITIONS. BE AWARE OF TRIPPING AND SLIPPING HAZARDS (CABLES, WIRES, PIPING, SHIPPED FLOORS, ETC.) BE AWARE OF SLIPPERY OR WET SURFACES ESPECIALLY IN WINTER USE STEEL TOE/HIGH TOP SAFETY BOOTS WITH RUBBERIZED SOLES IN GOOD CONDITION NOTIFY YOUR SUPERVISOR AND CO-WORKERS OF ANY KNOWN ALLERGIES TO INSECT BITES SUCH AS BEE OR WASP STINGS. BE AWARE OF AREAS WITH POTENTIAL BEE, WASP, YELLOW JACKETS, SPIDERS, ETC. USE WASP AND INSECT REPELLENT AS NECESSARY, ESPECIALLY DURING SUMMER MONTHS.

		<ul style="list-style-type: none"> • AVOID CONTACT WITH ANIMALS OR RODENTS (INCLUDING ANIMAL FECES). • IF BIRD OR RODENT DROPPINGS ARE PRESENT IN THE WORK AREA PROPER PPE SHALL BE WORN (INCLUDING RESPIRATORY PROTECTION) OR THE DROPPINGS SHALL BE REMOVED BY PERSONNEL WEARING APPROPRIATE PPE PRIOR TO WORK
	<ul style="list-style-type: none"> • SNAKES INCLUDING POTENTIALLY POISONOUS SNAKES WHICH MAY RESULT IN ADVERSE MEDICAL REACTION DUE TO SNAKE BITE 	<ul style="list-style-type: none"> • BE AWARE OF SNAKES IN AREAS WITH LOW VISIBILITY AND WHERE EQUIPMENT OR MATERIAL IS BEING MOVED. • IF BITTEN BY A SNAKE, CALL FOR HELP IMMEDIATELY. CONTACT THE PSS WITH DETAILED INFORMATION ABOUT YOUR LOCATION AND THE NATURE OF THE INJURY. • SOME POISONOUS PLANTS MAY EXIST IN THE OUTSIDE AREAS. • INDIVIDUALS WHO ARE SENSITIVE TO POISONOUS PLANTS SHOULD USE PREVENTATIVE CREAMS, EXTRA CLOTHING, AND SHOWER IMMEDIATELY UPON COMPLETION OF THEIR ACTIVITIES.
	<ul style="list-style-type: none"> • POISONOUS PLANTS RESULTING IN RASHES, ITCH, OR OTHER MEDICAL REACTION 	<ul style="list-style-type: none"> • HAZARDS SUCH AS STORED ITEMS MAY FALL WHEN DISTURBED. VISUALLY ASSESS THE AREA PRIOR TO PERFORMING WORK. • ALL PERSONNEL SHALL OBSERVE WEATHER CONDITIONS AND WARNINGS • SAFETY SHALL DETERMIN WHEN WORKERS NEED TO TAKE SHELTER AWAY FROM THE WORK SITE BY BEING ALERT TO CHANGING AND THREATENING WEATHER CONDITIOJNS SUCHA AS HEAVY RAIN, STRONG WINDS AND LIGHTNING. • TAKE COVER IN THE NEAREST PERMANENT STRUCTURE OR STORM SHELTER IF INSTRUCTED TO DO SO BY THE PSS.
	<ul style="list-style-type: none"> • CONCEALED, UNSTABLE HAZARDS RESULT IN OBJECTS FALLING CAUSING INJURY OR MAY CAUSE INDIVIDUAL TO BECOME TRAPPED. 	
	<ul style="list-style-type: none"> • INCLEMENT WEATHER WHICH MAY RESULT IN RELATED INJURY, E.G., INJURY FROM FLYING DEBRIS, LIGHTING STRIKE, ETC. 	<ul style="list-style-type: none"> • WEAR APPROPRIATE LIGHT WEIGHT CLOTHING DURING THE SUMMER MONTHS OR WHILE WORKING IN A HOT ENVIRONMENT. • DRINK PLENTY OF LIQUIDS (WATER) AT FREQUENT INTERVALS. • TAKE FREQUENT BREAKS IN A COOL AREA.

		<ul style="list-style-type: none"> • USE THE BUDDY SYSTEM TO WATCH FOR HEAT STRESS SIGNS AND SYMPTOMS. • SYMPTOMS OF HEAT STRESS SHALL BE STRESSED DAILY AND THE PLAN OF THE DAY MEETING. •
	<ul style="list-style-type: none"> • HEAT STRESS RELATED ILLNESS (HEAT CRAMPS, HEAT EXHAUSTION, HEAT STROKE) 	<ul style="list-style-type: none"> • USE THE BUDDY SYSTEM WHILE WORKING IN REMOTE OR DESERTED AREAS UNLESS AUTHORIZED BY YOUR SUPERVISOR. • ALWAYS MAINTAIN A MEANS OF COMMUNICATION (2-WAY RADIO, CELL PHONE) WITH SUPERVISION OR EMERGENCY SERVICES. • FOLLOW AREA POSTINGS FOR ENTRY AND PPE REQUIREMENTS.
	<ul style="list-style-type: none"> • LOSS OF COMMUNICATION WHILE WORKING IN REMOTE AREAS WHEREBY INDIVIDUAL IS UNABLE TO OBTAIN ASSISTANCE IF INJURED OR HAS NON-WORK RELATED INCIDENT 	<ul style="list-style-type: none"> • REFER TO RWP FOR REQUIREMENTS. • SAFETY GLASSES WITH SIDE SHIELDS SHOULD BE WORN AT ALL TIMES WHILE PERFORMING SURVEYS OR AS DIRECTED BY THE PSS.
	<ul style="list-style-type: none"> • CONTAMINATION EVENT RESULTING IN POTENTIAL EXPOSURE 	<ul style="list-style-type: none"> • BE AWARE OF SHARP EDGES AND CORNERS IN WORK AREA. • WEAR LEATHER GLOVES WHILE WORKING AROUND EQUIPMENT OR MATERIALS WITH SHARP EDGES OR CORNERS. • BE AWARE OF THE PRESENCE OF PROTRUDING OR JAGGED EDGES THAT MAY PRESENT SCRAPES OR CUTS
	<ul style="list-style-type: none"> • INJURY TO EYES FROM PARTICULATES OR DEBRIS 	<ul style="list-style-type: none"> • AVOID WALKING ON TOP OF ANY SPOIL AREAS WHERE SOIL/SAND IS LOOSE. USE EXTENSION POLES FOR INSTRUMENT PROBES TO AVOID THESE AREAS. • DETERMINE THE BEST ACCESS ROUTE BEFORE WALKING OR TRANSPORTING EQUIPMENT. CREATE A CLEAR PATH • CONTINUALLY INSPECT THE WORK AREA FOR SLIP, TRIP AND FALL HAZARDS AND BE AWARE OF CHANGES IN SURFACE CONDITIONS THAT MY OCCUR. • ELIMINATE OR MARK HAZARDOUS CONDITIONS
	<ul style="list-style-type: none"> • SHARP EDGES OR CORNERS CAUSING LACERATION OR OTHER POTENTIAL INJURY 	

	<ul style="list-style-type: none"> DEBRIS AND SCRAP PILES WHICH MAY PRESENT POTENTIAL FOR SCRAPES, LACERATIONS, TRIPPING, OR OTHER ASSOCIATED INJURIES 	<ul style="list-style-type: none"> WEAR PROPER PPE
	EXPOSURE TO RADIATION AND RADIOACTIVE MATERIAL	<ul style="list-style-type: none"> ALL WORKERS WHO MUST PERFORM WORK ON SITE SHALL HAVE AT LEAST A CURRENT RADIATION WORKER II TRAINING CERTIFICATE. SMOKING, CHEWING TOBACCO OR GUM, EATING, DRINKING, OR USE OF COSMETICS IS PROHIBITED IN RADIOLOGICAL AREAS. HOLD POINT: IF WORK IS TO BE CONDUCTED IN RADIOLOGICAL AREAS, FIXED CONTAMINATION AREAS, OR AS DETERMINED BY RADCON, REQUEST A NEW RWP TO ADDRESS THE HAZARD BEFORE CONTINUING WORK (OR EQUIVALENT). PERSONAL PROTECTIVE EQUIPMENT SHALL BE SPECIFIED IN THE RADIATION WORK PERMIT (RWP). RADIATION EXPOSURE MAYL BE MONITORED BY TLD. A RADIATION WORK PERMIT IS REQUIRED FOR OPERATIONS AS DETERMINED BY RADCON AND AREA POSTING. ALL PERSONNEL SHALL FOLLOW REQUIREMENTS OUTLINED IN THE RWP AND THE DIRECTIONS GIVEN BY RADCON PERSONNEL. PERSONNEL SHALL SIGN THE RWP PRIOR TO EACH ENTRY.