CARSON RIVER MERCURY SUPERFUND SITE

OPERABLE UNIT 1
LONG TERM SAMPLING AND RESPONSE PLAN FOR RESIDENTIAL DEVELOPMENT

Nevada Division of Environmental Protection
in collaboration with
U.S. Environmental Protection Agency

NEVADA DIVISION OF
ENVIRONMENTAL
PROTECTION

Carson River Mercury Superfund Site
Operable Unit 1
Residential Long-Term Sampling and Response Plan

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Signature Page

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TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

APPENDICES

LIST OF ACRONYMS:

As	**Arsenic**
BCA	**Bureau of Corrective Actions, within NDEP**
BMRR	**Bureau of Mining Regulation and Reclamation, within NDEP**
bgs	**below ground surface**
CC&Rs	**Homeowner Association Covenants, Conditions & Restrictions**
CEM	**Nevada Certified Environmental Manager**
CERCLA	**Comprehensive Environmental Response, Compensation and Liability Act**
CFR	**Code of Federal Regulations**
CGP	**Construction General Permits**
CoC	**Contaminants of Concern (Mercury, Arsenic and Lead)**
CRMS	**Carson River Mercury Superfund Site**
CSM	**Conceptual Site Model**
DNM	**Durable Notification Mechanism**
EC	**Environmental Covenant**
EPA	**U.S. Environmental Protection Agency**
ESD	**Explanation of Significant Differences**
FEMA	**Federal Emergency Management Agency**
FPXRF	**Field Portable X-Ray Fluorescence**
LUCs	**Land Use Controls**
Pb	**Lead**
LTSMP	**Long-Term Soils Management Plan**
LTSRP	**Long-Term Sampling and Response Plan**
Hg	**Mercury**
DCNR	**Nevada Division of Conservation and Natural Resources**
NDEP	**Nevada Division of Environmental Protection**
NFA	**No Further Action**
NHL	**National Historic Landmark**
NHPA	**National Historic Preservation Act**
NPL	**National Priority List**
QA/QC	**Quality Assurance/Quality Control**
RA	**Risk Assessment**
RI	**Remedial Investigation**
ROD	**Record of Decision**
RSLs	**EPA Region 9 Regional Screening Levels**
SAP	**Sampling and Analysis Plan**
USGS	**U.S. Geological Survey**
OU1	**Operable Unit 1**
OU2	**Operable Unit 2**
VCHD	**Virginia City Historic District**

1.0 Purpose

In 1995, after extensive sampling and investigation, the U.S. Environmental Protection Agency (EPA) signed a Record of Decision (ROD) for the Carson River Mercury Superfund Site (CRMS) Operable Unit 1 (OU1). To address specific areas not investigated within the broad landscape that defines the CRMS, the remedy included "Implementation of institutional controls to ensure that any residential development in present open land use areas known or suspected to be impacted by mercury includes characterizing mercury levels in surface soils, and if necessary, addressing impacted soils. These institutional controls will be referred to as the Long-Term Sampling and Response Plan (LTSRP)" (EPA, March 1995). Although this definition is included in the ROD, this LTSRP is considered a soil management plan to characterize, manage, and control impacted soils on residential properties within the CRMS. This LTSRP includes a Sampling and Analysis Plan (SAP) guidance document (Appendix A) to guide and support the development of sampling and analysis plans for site characterization. The remedy was updated with an Explanation of Significant Differences (ESD) in 2013 (EPA, 2013). The update identified arsenic and lead, when co-located with mercury, as contaminants of concern (CoC). Their site-specific action levels are included in Table 1 of this LTSRP. The Nevada Department of Conservation and Natural Resources, Division of Environmental Protection (NDEP), Bureau of Corrective Actions (BCA), administers the LTSRP by agreement with EPA. In accordance with the ROD, the provisions of the LTSRP apply to residential construction/development/soil disturbance within portions of Carson, Storey, Lyon, Washoe, and Churchill Counties as described below.

2.0 Background

Historic mining activities in the Comstock region of northern Nevada in the 1800s used imported elemental mercury to extract gold and silver from ore through the amalgamation process. An estimated 7,500 tons (15,000,000 pounds) of elemental mercury was lost to the environment in the processing of Comstock ore (Grant H. Smith, 1943). In addition, the ore milling activity concentrated and discharged naturally occurring arsenic and lead. Interspersed in the mill tailings, the three CoCs (mercury, arsenic, and lead) subsequently migrated into soil and sediment via air and water erosion and then into a 130-mile stretch of the Carson River from Mexican Dam to the river's terminal points at Carson Lake, Stillwater Wildlife Refuge, and the Carson Sink. During the same era, mills around Big Washoe Lake, Little Washoe Lake, and Steamboat Creek dispersed mercury downstream. Episodic flooding, fluvial deposition, and irrigation practices spread the contamination from the mill sites throughout the river systems producing some areas with higher contaminant levels. Areas likely to have the highest levels of mercury, arsenic, and lead include former mill sites and associated drainage pathways down gradient of mill sites, the Carson River channel, and areas within the 100-year floodplain.

The U.S. Geological Survey (USGS) reported high levels of mercury in sediment and water of the Carson River in the early 1970s. Subsequent studies documented the presence of mercury and methylmercury in sediments, soil, water, and wildlife. Elevated methylmercury levels in fish prompted the Nevada State Health Division to issue health advisories recommending no consumption of any fish from the Carson River (from Mexican Dam to the Lahontan Dam) and from all waters of the Lahontan Valley, and no consumption of white bass from Big and Little Washoe Lakes. In 1990, the contamination prompted the EPA to designate the area the "Carson River Mercury Superfund Site" and list the area on the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Superfund") National Priorities List (NPL).

For management purposes, EPA divided the site into two Operable Units: OU1 and OU2. OU1 includes mercury-contaminated soil at former mill sites, the “source areas”, near Carson City, Virginia City, Dayton, and the Washoe Valley and Pleasant Valley historic mill locations, and the 100-year flood plain from the New Empire Mill site to the eastern edge of the Six-Mile Canyon alluvial fan. OU2 includes mercury contamination in sediment, fish, and wildlife in the 130-mile stretch of the Carson River from Mexican Dam to the terminal ends, the mercury-contaminated soil and sediment in waterways adjacent to the mill sites, and the 100-year flood plain from the eastern edge of the Six-Mile Canyon alluvial fan to the terminal ends (including historic pre-Lahontan Dam channels). Big Washoe Lake, Little Washoe Lake, and Steamboat Creek are part of the CRMS due to the release of mercury during the Comstock mining era, but have not yet been studied for final remedy (Map 1).

3.0 Remedy Protectiveness and Enforcement

The investigation conducted by EPA in the 1990s to characterize OU1 of the CRMS identified mercury, arsenic, and lead as CoC. Using data gathered during the investigation, EPA evaluated the cancer and non-cancer health risks from exposure to the three metals by various exposure pathways in the Human Health Risk Assessment (HHRA) and Remedial Investigation (RI) OU1 report (Hogan and Smucker, EPA 1994). For OU1, exposure through incidental soil ingestion is the pathway of potential concern for the CoC. Cancer and non-cancer health risks were estimated using toxicity information and CRMS concentration data for each metal. The HHRA concluded that cancer risks from exposures to the contaminants of concern in OU1 were not significant. However, the non-cancer health risks for children under the age of six, living on or adjacent to contaminated areas where they could potentially ingest mercury or arsenic in soil, were determined to be at levels considered potentially adverse (EPA, 1994). The CRMS OU1 ROD and subsequent LTSRP protective remedy is the reduction of residential CoC exposure through land use controls (LUCs). LUCs may consist of non-engineered instruments, such as administrative and legal controls or engineered and physical barriers, such as clean soil or pavement caps over contaminated soils or physical markers to identify the limits of remediation.

The ROD does not require NDEP to enforce the implementation of the LTSRP. Rather, NDEP will notify EPA of non-compliant parties and EPA will have the discretion of using their CERCLA, Sections 104 and 106 authorities to enforce compliance with the LTSRP (EPA, 1995). NDEP believes that the LTSRP and sampling program will be effectively implemented through public outreach, mapping, database tracking, county and real estate industry outreach.

4.0 Applicability

The CRMS OU1 boundaries are defined by the location of CoC potentially exceeding action levels. The investigative boundary map depicting areas where the contaminants have the highest likelihood of detection is presented on the NDEP BCA CRMS website and in the Map 2 series. The NDEP BCA Superfund Branch can provide property owners a more detailed review of a specific property with respect to the investigative boundaries.

By narrative description, a property is within the boundaries of OU1, and subject to the requirements of this LTSRP, if located within or near the following:

1. Millsites/Tailings Piles: The historic millsites and all associated features (i.e., tailings piles, tailings ponds, flumes, etc.) which are recognized as the original point sources of mercury in the Carson River drainage, Washoe Valley, and Pleasant Valley;
2. Tributaries: The tributaries which drain the Virginia Mountain Range into the Carson River basin (i.e. Six-Mile Canyon, Gold Canyon, etc.);
3. Alluvial Fan: The alluvial fan below the mouth of Six-Mile Canyon;
4. Floodplain: The Carson River 100 year floodplain beginning above New Empire Mill Site and extending to the eastern edge of the Alluvial Fan (as described above); and
5. The geographic description of 1 through 4 above and has not already undergone sampling and/or cleanup.

This LTSRP is applicable to residential construction/development activities within OU1 that disturb more than three cubic yards of soil or sediment, or any amount of historic tailings material. Three cubic yards of contaminated soil is defined in Nevada regulation as a trigger that requires regulatory notification (NAC 445A.347). The activities may include: individual property development, minor and major property subdivision construction activities, swimming pool excavation/installation, grading, home additions, and utility ditching/trenching.

5.0 Site Action Levels

To reduce the risk of mercury, arsenic and lead exposure to children under the age of six living within OU1 of the CRMS, NDEP BCA and EPA established Site Action Levels for each of the contaminants of concern (Table 1: Carson River Mercury Site Action Levels for Residential Soils). The action level for mercury (>80 mg/kg) is based on site-specific data modeled in the HHRA for OU-1 (it includes background levels, the typical species of mercury encountered in soil on the site, and non-cancer health risks for children under the age of six). The action level for arsenic (>32 mg/kg) is based on statistical evaluation of site-specific sample data and taking into account background levels typically found in OU-1. Note: soil samples collected adjacent to and nearby the mineralized zone of the geologic formation containing the Comstock Lode found background concentrations of arsenic in the range of 90 to 120 mg/kg, but these hot spots are significantly limited in their extent and distance from the parent rock. The action level for lead (>400 mg/kg) is based on the EPA Region 9 Regional Screening Level (RSL).

Table 1: Carson River Mercury Site Action Levels for Residential Soils

Contaminant	**Action Levels in milligrams per kilogram (mg/kg)**
Mercury (Hg)	80 mg/kg
Arsenic (As)	32 mg/kg
Lead (Pb)	400 mg/kg

To ensure children under the age of six are not exposed to contaminants of concern at levels above those shown in Table 1, the top two feet of soil located on residential property or properties that may be developed into residential property must not exceed the action levels. If characterization sampling confirms exceedances, a remediation plan should be developed and carried out.

While all three contaminants of concern occurred in Comstock ore at natural background levels, large quantities of mercury were introduced in the milling process. Using data from studies of the Carson River basin, NDEP BCA concluded that concentrations of mercury in soil exceeding 1.0 mg/kg are most likely associated with the historic milling process and are above natural background conditions (NDEP BCA, 2012). Therefore, 1.0 mg/kg mercury in soils and tailings is the threshold level EPA and NDEP BCA will reference to determine the presence of CRMS-contaminated materials. Additionally, mercury remains the sentinel compound for CRMS-related contamination. Therefore, the presence of elevated levels of arsenic and lead at a particular location, in the absence of mercury above the natural background level, may not require the same level of management provided by the LTSRP unless located in a high priority Investigation Area with proximity to mill sites or tailings.

6.0 Investigation Areas

LTSRP requirements vary within OU1 dependent on the probability that CoC are present above the CRMS Action Levels for Residential Soils (Table 1). The Investigation Areas are characterized as follows:

- **Investigation Area 1 (IA-1):** Includes the areas lying **outside the buffer zones** of the other three Investigation Areas in the Carson River drainage basin beginning in the area of the historic settlement of New Empire in Carson City, NV, downstream to the existing or historic terminal points of the river at Carson Lake, Carson Sink, Indian Lakes, and the Stillwater National Wildlife Refuge. It is least probable that CRMS CoCs will be located in these areas. It is unlikely any sampling will be needed for areas developed within IA-1; however, sampling may be recommended based on professional judgment of the NDEP BCA technical staff. For example, if the property is near a contamination source area where historic activities could potentially have caused impacts beyond the typical boundaries as identified by the conceptual site model (CSM).
- **Investigation Area 2 (IA-2):** Defined as a buffer lying 100 feet perpendicular to the Investigation Area 3 boundary. For Comstock-era mill sites and isolated tailings piles, this translates to the area between 350 feet and 450 feet from the center point of the historic feature. For the 100-year FEMA floodplain and areas of irrigation, this is the area beginning at the limit of the flood plain boundary or irrigated land extending out 100 feet.
- **Investigation Area 3 (IA-3):** Defined as a buffer lying 100 feet perpendicular to the IA-4 boundary for Comstock-era mills or isolated tailings piles. For Comstock-era mill sites and isolated tailings piles, this is the area between 250 feet and 350 feet from the center point of the historic feature. It is also defined as the limits of the FEMA 100-year floodplain or past or current flood irrigation practices. A tributary of the Carson River must have a Comstock-era mill site or tailings pile located along it to be mapped in IA-3 and only the portion of the tributary downstream of the historic feature is included. If a tributary does not have the FEMA 100-year flood plain defined, then IA-3 is defined as the area 100 feet perpendicular to the IA-4 boundary of that tributary.
- **Investigation Area 4 (IA-4):** Defined as the area within a 250-foot radius from the center point of a Comstock-era mill or tailings pile. The geographic centers around these historic features were established in a multi-step process: 1. The centerline of the current channel of the Carson River is enclosed in a polygon 100-feet wide (50 feet either side); 2. Tributaries to the Carson River, where Comstock-era mills and tailings piles were located and that do not have FEMA 100-year floodplains defined, are enclosed in a polygon 50-feet wide (25 feet either side) from the approximate center of the tributary channel; and 3. Irrigation canals are enclosed in a polygon 20-feet wide (10 feet either side) from the approximate center of the canal.

In order to be protective of human health, the properties located within Investigation Areas 2 – 4 must undergo soil characterization sampling per the guidance provided in the SAP (Appendix A) for residential development. The density of sampling is dependent on the probability that a property is contaminated. After remediation, verification sampling must be conducted to confirm remediation was effective in mitigating the CoC exposure pathway.

7.0 LTSRP Process

It is incumbent upon the property owner to comply with the sampling provisions of the LTSRP. Failure to conduct characterization sampling and proper remediation can result in the spreading of site contaminants throughout the property. This may result in NDEP BCA requiring the property owner to conduct more extensive sampling and remediation of the contaminants.

Subject to funding availability and a signed access agreement, EPA and NDEP BCA will offer to sample single-family homeowner properties and, if requested by the property owner, remediate single-family homeowner property using public funds. As a condition of remediating these properties, where the selected remedy will leave potentially CoC impacted soil below a protective clean soil barrier, EPA will require the homeowner to incorporate LUCs in the form of an Environmental Covenant (EC) to protect the integrity of the remedy. In accordance with Nevada Revised Statute 445D, Environmental Covenants (Uniform Act) (Attachment B), an EC is a servitude arising under an environmental response project that imposes activity and use limitations. For the CRMS, LUCs may include fences, subsurface barrier tape, and signs. The EC should provide clear documentation for perpetual real estate interests when real estate transfers from one owner to another. Although ECs are voluntary in Nevada, an EC for a property within the CRMS that contains a protective barrier provides the future property owner with information about the property's top two feet of soil, assuring the CoC concentrations are below the CRMS action levels. Single-family homeowners who are not willing to record an EC on their property will not receive publicly funded remedial actions.

By comparison, owners of large, multi-parcel residentially zoned property in the CRMS boundary who plan to develop the property for profit and speculation construction are responsible for the planning, sampling and potential remedial activities required to characterize potentially contaminated soils that may pose a risk to human health. The LTSRP and LUCs provide a means for landowner/developers to address potential contamination issues up front to avoid potential liability issues under CERCLA before soil disturbance. LUCs are an integral part of any response action where contaminated soil remains on the property after a cleanup has been completed.

NDEP BCA and EPA developed the LTSRP guidelines as part of the remedy for OU1 in accordance with the ROD. The guidelines are administered through NDEP BCA. Notification of new development within the CRMS Investigation Areas will occur in several ways. NDEP's Bureau of Water Pollution Control (BWPC) will notify NDEP BCA after receiving a proposal for property development over 1 acre and requiring a storm water discharge permit. NDEP BCA will then contact the developer and present the LTSRP guidelines. For smaller developments and/or single-family homes, NDEP BCA will continue to work with the county planning departments, real estate, mortgage, and title companies to develop property owner notification mechanisms for proposed developments. When notified about developments within the CRMS Investigation Areas, NDEP BCA will discuss the LTSRP guidelines with the developer/property owner.

The LTSRP Process is shown in Figure 1. Details of the requirements for the sampling efforts are contained in the SAP (Appendix A).

Figure 1: LTSRP Process Flowchart

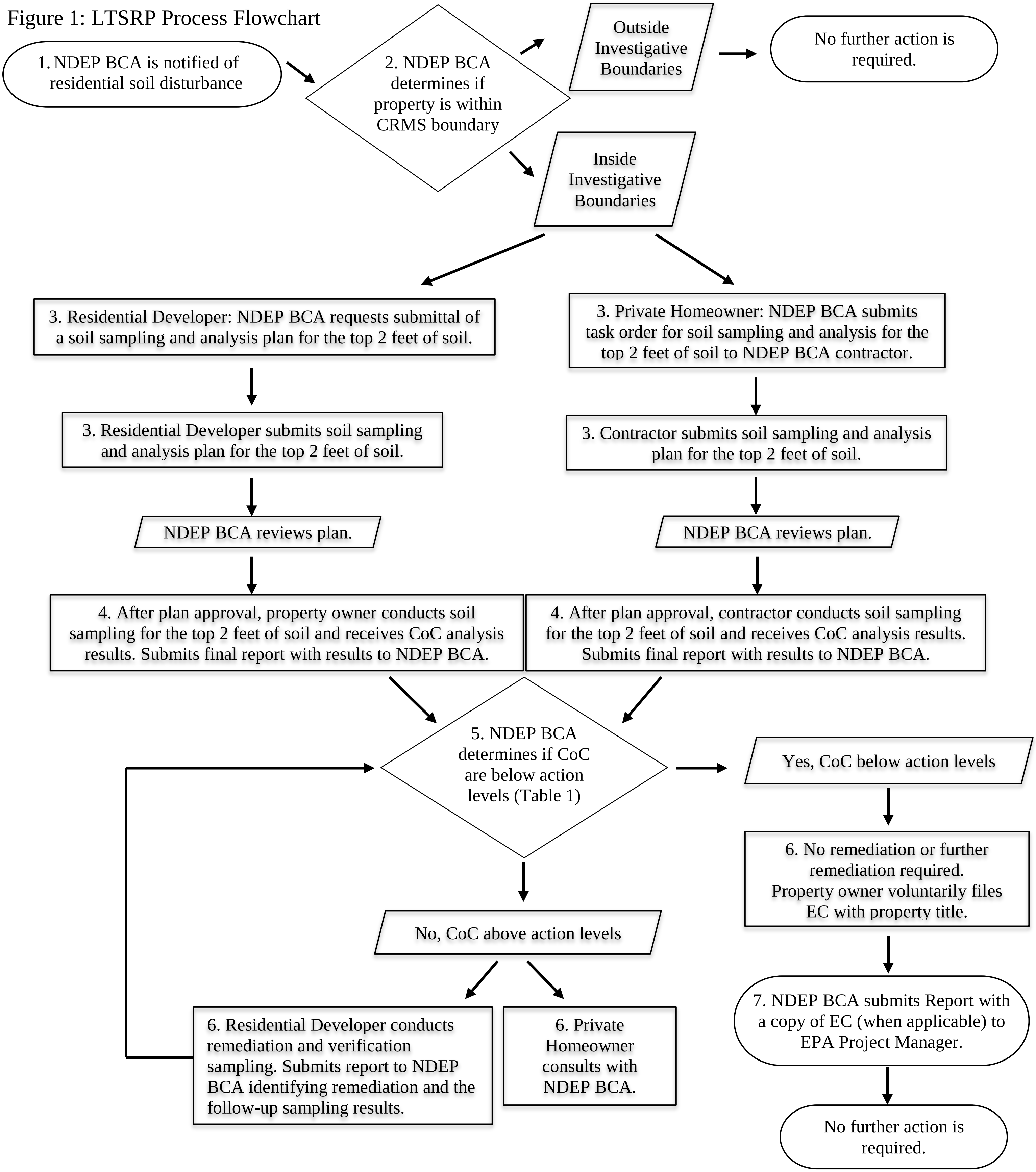

Figure 1: LTSRP Process Flowchart Narrative:

1. NDEP BCA is notified of residential soil disturbance activity (7.1 Notification to NDEP BCA) Notification is through:
    a. The Bureau of Water Pollution Control through the stormwater permit application;
    b. County planning or building office for an individual residence; and/or
    c. Property owner.
2. NDEP BCA determines if property is within the CRMS boundary:
    a. Outside investigative boundaries: No further action is required.
    b. Within investigative boundaries: continue with LTSRP process.
3. Residential Developer: NDEP BCA requests submittal of a sampling and analysis plan for the top two feet of soil following the LTSRP SAP (Appendix A).
    a. Property owner submits sampling and analysis plan for the top two feet of soil.
    b. This is a collaborative process between NDEP BCA and the property owner and/or developer to determine if the submitted plan meets NDEP BCA criteria and identify any deficiencies in the submitted plan.
    c. NDEP BCA approves the plan before any soil disturbance begins.
3. Private Homeowner: NDEP BCA submits task order for sampling and analysis for the top two feet of soil to NDEP BCA contractor following the LTSRP SAP (Appendix A).
    a. NDEP BCA contractor submits property-specific sampling and analysis plan for the top two feet of soil.
    b. This is a collaborative process between NDEP BCA, the property owner, and the NDEP BCA contractor. The sampling and analysis plan is site specific for the area and type of soil disturbance.
    c. NDEP BCA reviews and approves the plan before any soil disturbance begins.
4. After plan approval, soil sampling is conducted for the top two feet of soil in accordance with the approved plan. NDEP BCA receives CoC analysis results and final report.
5. NDEP BCA reviews results and determines if CoC are below action levels or if remediation is required.
6. CoCs are above the action levels (Table 1). Conduct remediation, verification sampling and placement of a visible marker, such as plastic construction fence, used to define the bottom extent of characterization. Any future excavation below this original grade shall require additional characterization and potential for response actions (i.e., soil management).
    a. Residential Developer: Conduct remediation and verification sampling. Submits report to NDEP BCA identifying remediation and follow-up sampling results. Return to Step 5 in the LTSRP Process Flowchart and refer to 7.3 Property Cleanup and Verification.
    b. Private Homeowner: Consults with NDEP BCA to evaluate the data and undertake remedial action, based on the owner's willingness to provide access and sign an EC, and the availability of funding and priority.
7. CoCs are below the CRMS Action Levels for Residential Soil (Table 1) and NDEP BCA concurs with the submitted results (7.4 LTSRP Process Completion). No further remediation is required. Property owner is encouraged to file an Environmental Covenant stating the top two feet has CoCs less than the action levels and potential CoC above action levels remain below two feet.
8. NDEP BCA submits a copy of the final Report with a copy of the EC to the EPA Project Manager.

Note: EPA can request to co-review project SAPs with NDEP BCA. Additionally, NDEP BCA and EPA may conduct on-site audits to assure the property owner follows the LTSRP process and their approved SAP.

7.1 Notification to NDEP BCA

All property owners engaging in residential construction, development, or improvement of a property within the CRMS Investigation Areas disturbing more than three cubic yards of soil or sediment, or any amount of tailings material, are required to notify NDEP BCA of the project prior to soil disturbance activities. In addition, NDEP BCA has requested county planning departments notify NDEP BCA of new single home construction or other surface disturbance totaling less than one acre. When a permit application is submitted for Construction General Permits (CGP) under the Phase II Storm Water Rule to the NDEP Bureau of Water Pollution Control (BWPC), NDEP BCA is notified if the construction includes sites with five (5) or more homes or one (1) or more acres. The BWPC CGP also applies to projects disturbing less than one (1) acre, but which are part of a larger common plan for development or sale that will ultimately disturb one (1) or more acres.

7.2 Soil Characterization Sampling

Once NDEP BCA receives notification of a soil disturbing activity, they will determine the applicability of the LTSRP, identify the appropriate investigative boundary(ies) for the property, and notify the property owner, in writing, of the applicability.

If the property's purpose is of a for-profit or multi-tenant residential complex, NDEP BCA will direct the owner to develop an appropriate site-specific soil characterization sampling and analysis plan. The sampling and analysis plan will identify sample locations and sampling frequencies that have been determined to be adequate in each type of investigative boundary in which soil disturbance will occur. The SAP (Appendix A) provides guidance on how to design an acceptable sampling and analysis plan to meet CRMS requirements. NDEP BCA has template sampling and analysis plans for each investigative boundary available on its website. No surface grading or soil disturbance is to occur before soil characterization has been conducted and the results reviewed by NDEP BCA.

Once soil characterization is completed and the report is reviewed by NDEP BCA, a determination will be made whether the property needs further evaluation, remediation, or whether the construction/development project can proceed without further application of the LTSRP and a no further action determination has been made. In either case, NDEP BCA will issue a letter to the property owner with the determination.

NDEP BCA and EPA are concerned that the provisions of this LTSRP may put an undue burden on individual landowners; therefore, homeowners making improvements to their own residences and individual property owners who are building single-family dwellings for the purpose of their primary residence will begin a separate, joint-agency sponsored process of soil investigation and potential remediation on their property. As an alternative for the process described above, individual property owners with property located within a CRMS investigative boundary that have not already undergone sampling for the CoC and do not have an EC recorded on the property, can contact NDEP BCA and request that a CoC screening be conducted. NDEP BCA will arrange a site visit to conduct the soil screening. Based on the results of soil screening, the property owner, in consultation with NDEP BCA, can determine if more sampling is warranted and/or if remediation is recommended. NDEP BCA and EPA sponsored remediation activities will be evaluated based on the availability of public funding. These services are intended to assist homeowners, and do not apply to residential developers or residences built for profit and speculation.

7.3 Property Action Level and Verification

For property planned for profit or speculative development where contamination is above action levels (Table 1), the property owner must submit a remediation plan to NDEP BCA for approval. In the case of individual property owners, NDEP BCA will work with the owner to develop an appropriate remediation plan. There are generally two remediation methods for reducing soil exposure risk when CRMS contaminants of concern levels exceed an action level:

1. Excavating contaminated soils for appropriate disposal, and
2. Capping contaminated soils with two feet of clean fill.

For the first remediation method, the preferred disposal option is off-site disposal at an approved facility. The only on-site disposal option, which will be reviewable on a case-by-case basis and is not available for highly contaminated soils, involves using impacted soil material for road base under public subdivision roads. NDEP BCA will request this material be placed in specific areas and not spread throughout the subdivision. A map depicting the specific location of this material will be required upon the submittal of the soil management plan.

For the second remediation method, the top two feet of finish grade soils cannot exceed the applicable action level standards for the contaminants of concern. More than two feet of clean fill may be required in areas where future land use will result in exposure to soils at depths greater than two feet below ground surface.

In areas where future erosion, fluvial transport, and/or deposition could reasonably be anticipated to cause contaminant of concern levels to exceed the action levels at previously clean or remediated areas, additional LUCs will be evaluated for limiting recontamination.

In each of these remediation methods, it is not acceptable to mix site soils and/or imported borrow material to reduce contaminant levels to below the action levels. This creates a larger volume of impacted material and spreads the impacted material over a larger area.

Once remediation is completed, the property owner must conduct verification sampling to ensure effective remediation. A sample plan, consistent with Appendix A, must be submitted for NDEP BCA review and approval. If characterization sampling and remediation were properly conducted, finish grade soils will have lower levels of contamination; therefore, NDEP BCA may approve a lower sampling density for verification. Verification samples will not be required if the top two feet of finish grade are removed and replaced with clean fill.

7.4 LTSRP Process Completion

LTSRP process completion occurs after NDEP BCA reviews the soil sampling final report (either initial or after remediation) and determines if exposure by incidental soil ingestion is still a concern. If the pathway of concern is not applicable or if the pathway of concern has been remediated, NDEP BCA will issue a no further action letter to the property owner. Since this LTSRP addresses the top two feet of soil, there remains a potential for contamination below two feet in depth. As a result, the property owner is encouraged (required, in the case of a single family residence receiving publicly funded remediation) to file an EC with the property title stating the nature of the sampling, results, and if remediation was completed (see Attachment A: Environmental Covenant).

After the top two feet of soil are reported below action levels and an EC is filed on the property, the property owner must notify NDEP BCA in the future when: 1. disturbing greater than three (3) cubic yards to any depth below the top two (2) feet of clean material and/or 2. leaving that area exposed for a period exceeding one (1) month. If NDEP BCA determines the subsequent disturbance of property soil below the top two feet warrant mitigation and verification sampling, NDEP BCA will assist the property owner or hired designee in developing a sampling and analysis plan for review and approval by NDEP BCA consistent with Appendix A. If NDEP BCA determines that an action level is exceeded, then the property cleanup and verification methods described in Section 7.3 apply. After final grading, the top two feet must ultimately demonstrate no exceedances of the action level (Table 1). If the analytical results demonstrate that mercury, arsenic, and lead levels are less than the action levels, then no remediation is required and NDEP BCA will issue a no further action letter.

NDEP BCA will submit a copy of the Final Report and a copy of the Environmental Covenant (if applicable) to the EPA Region 9 Project Manager.

EPA can request to co-review project SAPs with NDEP BCA throughout the LTSRP process. Additionally, NDEP BCA and EPA may conduct on-site audits to assure the property owner follows the LTSRP process and the SAP.

8.0 Removal of Property from the CRMS Investigative Areas

NDEP BCA reviews sampling and analysis plans for removal of a property from the CRMS Investigative Areas on a case-by-case basis. The property owner must verify the CoC are not present within the top eight feet of the soil surface, depth to rock, etc. through sampling for the CoC. Verifying the soil within the property boundary is below the action levels to a depth of eight feet provides NDEP BCA with a level of certainty that mercury, arsenic, and lead are not a human health risk on that property and can be excluded from the ROD requirements. NDEP BCA may determine that the EC is eligible for removal once verification samples demonstrate the CoCs are below acceptable levels.

9.0 Compliance with the National Historic Preservation Act

As the designated Federal lead agency for Superfund activities related to the CRMS, EPA is responsible for ensuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), 54 U.S.C. § 306108, and its implementing regulations, 36 C.F.R. §800. Any work funded by the EPA to identify, characterize, and, if necessary, remediate properties associated with the CRMS will be referred to as an “Undertaking” as defined in 36 C.F.R. §800.16[y].

A Programmatic Agreement between the Nevada State Historic Preservation Office and EPA Region 9 is under development.

10.0 References

Boerngen, Josephine G., and Shacklette, Hansford T. Chemical Analyses of Soils and Other Surficial Materials of the Conterminous United States,1981, Denver, Colorado, U.S. Geological Survey Open-File Report 81-197

Environmental Protection Agency, 1995, EPA Record of Decision, Carson River Mercury Site, EPA Site ID: NVD980813646, OU 01, Dayton, NV

Environmental Protection Agency, August 2003, Superfund Lead-Contaminated Residential Sites Handbook, OSWER 9285.7-50

Environmental Protection Agency, September 2013, Explanation of Significant Differences for the Carson River Site Operable Unit 1 Record of Decision. EPA Site ID: NVD980813646

Environmental Protection Agency, August 1989, CERCLA Compliance with Other Laws Manual Part II: Clean Air Act and Other Environmental Statutes and State Requirements, Interim Final, OSWER 9234.1-02

Environmental Protection Agency, August 1994, Memorandum: OSWER Directive: Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, EPA OSWER Directive #9355.4-12.

FEMA Flood Map. [computer map]. 1:25000. FEMA Flood Map Service Center, 2016. Using ArcGIS [GIS software]. Version 8.3.

Hogan, Sean, and Smucker, Stanford, Environmental Protection Agency Region 9, December 1994, Revised Draft Human Health Risk Assessment and Remedial Investigation Report, Carson River Mercury Site

Nevada Division of Environmental Protection, Bureau of Corrective Actions, Mary A. Siders, Ph.D., June 29, 2012, Evaluation of Metals Data from Tidball et al. (1991): Arsenic, Lead and Mercury, Unpublished

Smith, Grant H., 1943, The History of the Comstock Lode, Geology and Mining Series, No. 37, Vol. 37, 1943

Tidball, R.R., Briggs, P.H., Stewart, K.C., Vaughn, R.B., and Welsch, E.P., 1991Analytical Data for Soil and Well Core Samples from the Carson River Basin, Lyon and Churchill Counties, Nevada, U.S. Geological Survey Open-File Report 91-584A

United States Army Corps of Engineers, September 2003, Five-Year Review Report for Carson River Mercury Site, Cities of Dayton and Silver City, Lyon County, Nevada. Seattle District, Seattle, WA.

United States Army Corps of Engineers, September 2008, Second Five-Year Review Report for Carson River Mercury Site, Cities of Dayton and Silver City, Lyon County, Nevada. Seattle District, Seattle, WA.

United States Army Corps of Engineers, September 2013, Third Five-Year Review Report for Carson River Mercury Site, Cities of Dayton and Silver City, Lyon County, Nevada. Seattle District, Seattle, WA.

ATTACHMENT A:
ENVIRONMENTAL COVENANT

APNs:

After Recording, Return to:

Attn:

The undersigned hereby affirms that this document, including any exhibits, submitted for recording does not contain the social security number of any person or persons. (Per NRS 239B.030)

GRANT OF PERPETUAL ENVIRONMENTAL COVENANT
(Nevada Revised Statutes Chapter 445D)

THIS GRANT OF PERPETUAL ENVIRONMENTAL COVENANT (this "**Covenant**"), is made by Branch Banking and Trust Company, a North Carolina banking corporation ("**Grantor**") in favor of the State of Nevada, acting through its Department of Conservation and Natural Resources, Division of Environmental Protection, ("**Holder**" or **"NDEP"**) and is effective this ___ day of __________, 2013.

RECITALS:

A. Grantor is the owner in fee simple of that certain real property located in ________ County, Nevada, more properly described in **Exhibit "A"** attached hereto and incorporated herein by this reference (all of such property, and any portion or parcel thereof, is referenced herein as the "**Property"**);

B. Nevada Revised Statues (NRS) Chapter 445D, titled *Environmental Covenants (Uniform Act)* (hereafter **"the Act"**), sets forth the procedure for executing and recording an environmental covenant to provide notice to the public of activity and use limitations with respect to real property that is the subject of an environmental response project;

C. The Property is subject to an "environmental response project" as that term is defined in NRS 445D.070 and is the subject of enforcement and remedial action pursuant to Title 40 of the Nevada Revised Statutes and the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9601, *et. seq.* (commonly known as "**CERCLA**");

D. Specifically, the Property is located within the Carson River Mercury Site (the "**Site**"), which was placed on CERCLA's National Priority List in 1990 as a result of historic mining activities that resulted in the discharge of mercury into the Carson River's drainage basin, as more fully described below;

E. Because of the Property's location within the Site, Grantor desires to subject the Property to certain covenants and restrictions in accordance with the Act, which covenants and restrictions shall run with the Property, and any portion thereof or interest therein, and shall bind all parties having any right, title, or interest in or to the Property in perpetuity; and

F. The Holder is an agency of the State of Nevada and is qualified to hold and enforce this Covenant pursuant to NRS 445D.120(1).

NOW, THEREFORE, pursuant to the provisions of the Act, Grantor hereby grants, and Holder hereby accepts, this Covenant, with the intent that this Covenant burden the Property in perpetuity and that the Property shall be held, used, and conveyed subject to, and in compliance with, the following provisions:

ENVIRONMENTAL COVENANT

I. Recitals. The foregoing Recitals are true and correct and are incorporated herein by this reference.

II. Grant of Environmental Covenant. Pursuant to the Act, Grantor hereby executes this Covenant as an "environmental covenant" with the intent that this Covenant burden the Property, and bind Grantor and any future record owner and, if any, any other person or entity otherwise legally authorized to make decisions regarding the transfer of the Property or placement of encumbrances on the Property, or any parcel thereof, other than by exercise of eminent domain, (an "**Owner**"), in perpetuity. Grantor grants this Covenant to Holder with the intent that Holder may exercise any or all of the remedies of a "holder" under NRS 445D.200, including, without limitation, the right to file suit to obtain an injunction against actual or threatened violations of this Covenant. Holder hereby accepts its appointment as the "Holder" of this Covenant.

III. Notification of Potential Risks. One of the purposes of this Covenant is to notify the public, including future owners and occupants of the Property, that the Property is located within the Site. Nearby mining activities in the 1800s resulted in the discharge of, among other substances, mercury, arsenic, and lead, which are now known to be hazardous substances, into the drainage basin for the Carson River. Residual mercury, arsenic, and lead have been identified in the Carson River drainage basin, and this drainage basin (the Site, as defined above), which includes the Property, was added to the National Priority List in 1990. Concentrated sampling on a parcel-by-parcel basis was conducted to determine the potential for mercury, arsenic, and lead to exist on the Property above screening/action levels. Sampling was confined to the top two (2) feet of soil, as required by the NDEP. The United States Environmental Protection Agency ("**EPA**") has established health-based exposure limits for mercury and lead in residential areas within the Site, such as the Property, of 80 mg/kg total mercury in soils and 400 mg/kg total lead in soils, respectively. A non-mineralized background level of 32 mg/kg has been established for total arsenic in soils. While sampling results did not indicate the presence of mercury, arsenic, or lead in excess of regulatory standards for the Site, this Covenant serves as public notice that concentrations of these substances above regulatory action levels may be present at depths below the top two (2) feet of soil. Sample results for each parcel comprising the Property and a detailed general reference document related to the Site are available through the Superfund Branch of NDEP's Bureau of Corrective Actions ("**NDEP BCA**"), and also (as of the date of this Covenant) on NDEP's website.

IV. Activity and Use Limitations on the Property. The NDEP BCA-approved soil sampling program to confirm the absence of mercury contamination has been completed to a depth of two (2) feet below final grade. The two (2) foot clean soil cover is considered the protective remedy on the Property and must be maintained. Owner therefore shall, submit to, and obtain approval from the NDEP BCA for, a soils management plan prior to removing more than three cubic yards of the clean soil cover to any depth below existing grade and leaving that area exposed for a period exceeding one (1) month. Prior to disturbing any soils at a depth below two (2) feet of the current grade of the Property, including, without limitation, disturbances caused by grading, digging, or related construction activities, Owner shall first notify the NDEP BCA. If the NDEP BCA determines that Owner's proposed disturbance warrants sampling, then Owner will be required to develop a work plan for review and approval by NDEP BCA prior to performing the soil sampling, and issue a summary report to the NDEP BCA containing all pertinent analytical results. Depending on the analytical results of the sampling, the NDEP BCA may then require additional remediation of the contaminated soils prior to permitting Owner to proceed with Owner's proposed disturbance. For the purpose of clarity, in no event may Owner disturb any soils at a depth below two (2) feet of the current grade of the Property without first providing written notification to the NDEP BCA and obtaining the NDEP BCA's written permission to proceed.

V. Notice to Lessees: Owner agrees to incorporate either in full or by reference the restrictions in this Covenant in any leases, licenses, or other instruments granting a right to occupy the Property.

VI. Modifications to this Covenant. This Covenant runs with the Property and is perpetual in nature unless it is modified or terminated pursuant to this Section 5, or pursuant to the provisions of the Act, respectively. Owner may request that Holder and NDEP (if NDEP is no longer the Holder of this Covenant at the time of the request) approve a modification or termination of this Covenant; provided, however, that any such modification or termination shall be made in Holder's and NDEP's (if NDEP is no longer the Holder of this Covenant at the time of the request) sole and absolute discretion. As a condition precedent to any modification of this Covenant, Owner must: (1) provide a written proposal to NDEP detailing the modifications to (or termination of) this Covenant proposed by Owner; (2) submit a soil sampling plan to NDEP for review; and (3) upon NDEP's approval of a soil sampling plan, collect and analyze soil samples and provide the results to NDEP for review. If requested by NDEP, Owner shall provide additional information, including, without limitation, additional soil sampling results, to NDEP for review. If NDEP (and Holder, if NDEP is no longer the Holder of this Covenant) determines, in its sole and absolute discretion, that Owner's proposal will maintain an equal or greater level of protection of human health and the environment, NDEP (and Holder, if NDEP is no longer the Holder of this Covenant) may approve such proposal. Notwithstanding anything to the contrary contained in this Covenant, this Covenant may not be terminated or modified accept through a written instrument signed by NDEP (and Holder, if NDEP is no longer the Holder of this Covenant) and recorded in the Official Records of Churchill County, Nevada.

VII. Inspections. Subject to providing reasonable prior notice to Owner, Holder shall have the right to enter upon the Property at any reasonable time for the purpose of determining Owner's compliance with this Covenant, and, if necessary, for performing any remediation made necessary by Owner's non-compliance with this Covenant. Notwithstanding the foregoing, nothing in this Covenant shall be deemed to limit or otherwise impair any rights that NDEP may have independent of this Covenant to enter upon and inspect the Property.

VIII. Successors and Assigns. The provisions of this Covenant shall be binding upon the successors and assigns of Grantor and Holder, and this Covenant shall constitute a burden upon the Property, and shall bind all persons hereafter acquiring or owning any interest in the Property regardless of however such interest may be obtained. NDEP may assign its interest as Holder of this Covenant to any person, entity, or agency qualified to act as a "holder" pursuant to NRS 445D.120(1); provided, however, that no such assignment shall divest NDEP of its right to enforce this Covenant pursuant to NRS 445D.200, or to amend or terminate this Covenant (or prevent any such amendment or termination) pursuant to NRS 445D.180 or 445D.190, respectively.

IX. Notice to Lessees, Tenants, and Occupants. Owner shall attach this Covenant as an exhibit to any lease, license, or rental agreement for the Property, and Owner shall inform all temporary occupants of the Property of the restrictions set forth in this Covenant.

X. Holder Accepts No Liability. Holder is an agency of the State of Nevada; NDEP, acting in its capacity as the Holder of this Covenant, does not accept any liability under NRS 445D.120(3) by accepting the grant of this Covenant.

XI. Administrative Record. The administrative record of the environmental response project referenced in this Covenant is located at:

Nevada Department of Conservation and Natural Resources
Division of Environmental Protection
Bureau of Corrective Actions
901 South Stewart Street, Suite 4001
Carson City, NV 89701-5249

XII. Notices. Owner acknowledges that Holder may use the address of the Property to provide notices to Owner. Any document or notice that Owner desires to provide, or is required to provide, to Holder shall be sent to:

Nevada Division of Environmental Protection
Bureau of Corrective Actions
901 S. Stewart Street; Suite 4001
Carson City, Nevada 89701-5249

Or to any other address that Holder may in the future direct Owner to send notices to.

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IN WITNESS WHEREOF, Grantor hereby burdens the Property with this Grant of Perpetual Environmental Covenant effective as of the date written above.

____
Name: ________________________________
Title: ________________________________

Holder hereby accepts its appointment as the "Holder" of this Covenant effective this ___ day of ______________________________, 20__.

STATE OF NEVADA;
Acting By and Through Its
NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL PROTECTION,

____
Name: ________________________________
Title: ________________________________

[notary page follows]

STATE OF NEVADA)
)
County of __________)

This instrument was acknowledged before me on _________________, 20__, by _______________________ as ____________________ of _______________________.

____
(Signature of Notarial Officer)

STATE OF NEVADA)
)
County of __________)

This instrument was acknowledged before me on _________________, 20__, by _______________________ as ____________________ of _______________________.

____
(Signature of Notarial Officer)

ATTACHMENT B:
NEVADA ENVIRONMENTAL COVENANTS (UNIFORM ACT) NRS 445D

GENERAL PROVISIONS

NRS 445D.010 Short title. This chapter may be cited as the Uniform Environmental Covenants Act.

(Added to NRS by 2005, 1362)

NRS 445D.020 Definitions. As used in this chapter, unless the context otherwise requires, the words and terms defined in NRS 445D.030 to 445D.110, inclusive, have the meanings ascribed to them in those sections.

(Added to NRS by 2005, 1362)

NRS 445D.030 "Activity and use limitations" defined. "Activity and use limitations" means restrictions or obligations created under this chapter with respect to real property.

(Added to NRS by 2005, 1362)

NRS 445D.040 "Agency" defined. "Agency" means:

1. The State Department of Conservation and Natural Resources;
2. The Division of Environmental Protection of the State Department of Conservation and Natural Resources; or
3. The United States Environmental Protection Agency.

(Added to NRS by 2005, 1362)

NRS 445D.050 "Common-interest community" defined. "Common-interest community" means a condominium, cooperative or other real property with respect to which a person, by virtue of the person's ownership of a parcel of real property, is obligated to pay property taxes or insurance premiums, or for maintenance or improvement of other real property described in a recorded covenant that creates the common-interest community.

(Added to NRS by 2005, 1362)

NRS 445D.060 "Environmental covenant" defined. "Environmental covenant" means a servitude arising under an environmental response project that imposes activity and use limitations.

(Added to NRS by 2005, 1362)

NRS 445D.070 "Environmental response project" defined. "Environmental response project" means a plan or work performed for environmental remediation of real property and conducted:

1. Under a federal or state program governing environmental remediation of real property;
2. Incident to closure of a solid or hazardous waste management unit, if the closure is conducted with approval of an agency; or
3. Under a state voluntary cleanup program authorized by the laws of this State.

(Added to NRS by 2005, 1362)

NRS 445D.080 "Holder" defined. "Holder" means the grantee of an environmental covenant as specified in subsection 1 of NRS 445D.120.

(Added to NRS by 2005, 1362)

NRS 445D.090 "Person" defined. "Person" means any natural person, corporation, business trust, estate, trust, partnership, limited-liability company, association, joint venture, public corporation, government, governmental subdivision, agency or instrumentality, or any other legal or commercial entity.

(Added to NRS by 2005, 1362)

NRS 445D.100 "Record" defined. "Record," used as a noun, means information which is inscribed on a tangible medium or which is stored in an electronic or other medium and is retrievable in perceivable form.

(Added to NRS by 2005, 1363)

NRS 445D.110 "State" defined. "State" means the State of Nevada.

(Added to NRS by 2005, 1363)

ENVIRONMENTAL COVENANTS

NRS 445D.120 Nature of rights; subordination of interests.

1. Any person, including a person who owns an interest in the real property, the agency or a municipality or other unit of local government, may be a holder. An environmental covenant may identify more than one holder. The interest of a holder is an interest in real property.
2. A right of an agency under this chapter or under an environmental covenant, other than a right as a holder, is not an interest in real property.
3. An agency is bound by any obligation it assumes in an environmental covenant, but an agency does not assume obligations merely by signing an environmental covenant. Any other person who signs an environmental covenant is bound by the obligations the person assumes in the covenant, but signing the covenant does not change obligations, rights or protections granted or imposed under law other than this chapter except as otherwise provided in the covenant.

4. The following rules apply to interests in real property in existence at the time an environmental covenant is created or amended:

(a) An interest that has priority under any other law is not affected by an environmental covenant unless the person who owns the interest subordinates that interest to the covenant.

(b) This chapter does not require a person who owns a prior interest to subordinate that interest to an environmental covenant or to agree to be bound by the covenant.

(c) A subordination agreement may be contained in an environmental covenant covering real property or in a separate record. If the environmental covenant covers commonly owned property in a common-interest community, the record may be signed by any person authorized by the executive board of the unit-owners' association.

(d) An agreement by a person to subordinate a prior interest to an environmental covenant affects the priority of that person's interest, but does not by itself impose any affirmative obligation on the person with respect to the environmental covenant.

(Added to NRS by 2005, 1363)

NRS 445D.130 Contents.

1. An environmental covenant must:

(a) State that the instrument is an environmental covenant executed pursuant to this chapter;

(b) Contain a legally sufficient description of the real property subject to the covenant;

(c) Describe the activity and use limitations on the real property;

(d) Identify every holder;

(e) Be signed by the agency, every holder and, unless waived by the agency, every owner of the fee simple of the real property subject to the covenant; and

(f) Identify the name and location of any administrative record for the environmental response project reflected in the environmental covenant.

2. In addition to the information required by subsection 1, an environmental covenant may contain other information, restrictions and requirements agreed to by the persons who signed it, including:

(a) Any requirements for notice following transfer of a specified interest in, or concerning proposed changes in use of, applications for building permits for, or proposals for any site work affecting the contamination on, the property subject to the covenant;

(b) Any requirements for periodic reporting describing compliance with the covenant;

(c) Any rights of access to the property granted in connection with implementation or enforcement of the covenant;

(d) A brief narrative description of the contamination and remedy, including the contaminants of concern, pathways of exposure, limits on exposure, and location and extent of the contamination;

(e) Any limitation on amendment or termination of the covenant in addition to those contained in NRS 445D.180 and 445D.190; and

(f) Any rights of the holder in addition to its right to enforce the covenant pursuant to NRS 445D.200.

3. In addition to other conditions for its approval of an environmental covenant, the agency may require those persons specified by the agency who have interests in the real property to sign the covenant.

(Added to NRS by 2005, 1363)

NRS 445D.140 Validity; effect on other instruments.

1. An environmental covenant that complies with this chapter runs with the land.

2. An environmental covenant that is otherwise effective is valid and enforceable even if:

(a) It is not appurtenant to an interest in real property;

(b) It can be or has been assigned to a person other than the original holder;

(c) It is not of a character that has been recognized traditionally at common law;

(d) It imposes a negative burden;

(e) It imposes an affirmative obligation on a person having an interest in the real property or on the holder;

(f) The benefit or burden does not touch or concern real property;

(g) There is no privity of estate or contract;

(h) The holder dies, ceases to exist, resigns or is replaced; or

(i) The owner of an interest subject to the environmental covenant and the holder are the same person.

3. An instrument that creates restrictions or obligations with respect to real property that would qualify as activity and use limitations, except for the fact that the instrument was recorded before October 1, 2005, is not invalid or unenforceable because of any of the limitations on enforcement of interests described in subsection 2 or because it was identified as an easement, servitude, deed restriction or other interest. This chapter does not apply in any other respect to such an instrument.

4. This chapter does not invalidate or render unenforceable any interest, whether designated as an environmental covenant or other interest, that is otherwise enforceable under the laws of this State.

(Added to NRS by 2005, 1364)

NRS 445D.150 Relationship to other land-use law. This chapter does not authorize a use of real property that is otherwise prohibited by zoning, by law other than this chapter regulating use of real property or by a recorded instrument that has priority over the environmental covenant. An environmental covenant may prohibit or restrict uses of real property which are authorized by zoning or by law other than this chapter.

(Added to NRS by 2005, 1364)

NRS 445D.160 Notice.

1. A copy of an environmental covenant must be provided by the persons and in the manner required by the agency to:

(a) Each person who signed the covenant;

(b) Each person holding a recorded interest in the real property subject to the covenant;

(c) Each person in possession of the real property subject to the covenant;

(d) Each municipality or other unit of local government in which real property subject to the covenant is located and any local planning commission whose territorial jurisdiction includes or is immediately adjacent to the real property subject to the covenant; and

(e) Any other person the agency requires.

2. The validity of a covenant is not affected by failure to provide a copy of the covenant as required under this section.

(Added to NRS by 2005, 1365)

NRS 445D.170 Recording.

1. An environmental covenant and any amendment or termination of the covenant must be recorded in every county in which any portion of the real property subject to the covenant is located. For purposes of indexing, a holder must be treated as a grantee.

2. Except as otherwise provided in subsection 3 of NRS 445D.180, an environmental covenant is subject to the laws of this State governing recording and priority of interests in real property.

(Added to NRS by 2005, 1365)

NRS 445D.180 Duration; amendment by court action.

1. An environmental covenant is perpetual unless it is:

(a) By its terms limited to a specific duration or terminated by the occurrence of a specific event;

(b) Terminated by consent pursuant to NRS 445D.190;

(c) Terminated pursuant to subsection 2;

(d) Terminated by foreclosure of an interest that has priority over the environmental covenant; or

(e) Terminated or modified in an eminent domain proceeding, but only if:

(1) The agency that signed the covenant is a party to the proceeding;

(2) All persons identified in subsections 1 and 2 of NRS 445D.190 are given notice of the pendency of the proceeding; and

(3) The court determines, after hearing, that the termination or modification will not adversely affect human health or the environment.

2. If the agency that signed an environmental covenant has determined that the intended benefits of the covenant can no longer be realized, a court, under the doctrine of changed circumstances, in an action in which all persons identified in subsections 1 and 2 of NRS 445D.190 have been given notice, may terminate the covenant or reduce its burden on the real property subject to the covenant. The agency's determination or its failure to make a determination upon request is subject to judicial review pursuant to NRS 233B.130.

3. Except as otherwise provided in subsections 1 and 2, an environmental covenant may not be extinguished, limited or impaired through issuance of a tax deed, foreclosure of a tax lien or application of the doctrine of adverse possession, prescription, abandonment, waiver, lack of enforcement or acquiescence, or a similar doctrine.

4. An environmental covenant may not be extinguished, limited or impaired by application of any laws of this State relating to marketable title or dormant mineral interests.

(Added to NRS by 2005, 1365)

NRS 445D.190 Amendment or termination by consent.

1. An environmental covenant may be amended or terminated by consent only if the amendment or termination is signed by:

(a) The agency;

(b) Unless waived by the agency, the current owner of the fee simple of the real property subject to the covenant;

(c) Each person who originally signed the covenant, unless the person waived in a signed record the right to consent or a court finds that the person no longer exists or cannot be located or identified with the exercise of reasonable diligence; and

(d) Except as otherwise provided in paragraph (b) of subsection 4, the holder.

2. If an interest in real property is subject to an environmental covenant, the interest is not affected by an amendment of the covenant unless the current owner of the interest consents to the amendment or has waived in a signed record the right to consent to amendments.

3. Except for an assignment undertaken pursuant to a governmental reorganization, the assignment of an environmental covenant to a new holder is an amendment.

4. Except as otherwise provided in an environmental covenant:

(a) A holder may not assign its interest without the consent of the other parties; and

(b) A holder may be removed and replaced by agreement of the other parties specified in subsection 1.

5. A court of competent jurisdiction may fill a vacancy in the position of holder.

(Added to NRS by 2005, 1366)

MISCELLANEOUS PROVISIONS

NRS 445D.200 Enforcement.

1. A civil action for injunctive or other equitable relief for the violation of an environmental covenant may be maintained by:

(a) A party to the covenant;

(b) The agency or, if it is not the agency, the State Department of Conservation and Natural Resources or the Division of Environmental Protection of that Department;

(c) Any person to whom the covenant expressly grants power to enforce;

(d) A person whose interest in the real property or whose collateral or liability may be affected by the alleged violation of the covenant; or

(e) A municipality or other unit of local government in which the real property subject to the covenant is located.

2. This chapter does not limit the regulatory authority of the agency, or the State Environmental Commission, the State Department of Conservation and Natural Resources or the Division of Environmental Protection of that Department, under law other than this chapter with respect to an environmental response project.

3. A person is not responsible for or subject to liability for environmental remediation solely because it has the right to enforce an environmental covenant.

(Added to NRS by 2005, 1366)

NRS 445D.210 Uniformity of application and construction. In applying and construing this chapter, consideration must be given to the need to promote uniformity of the law with respect to its subject matter among states that enact it.

(Added to NRS by 2005, 1366)

NRS 445D.220 Relation to Electronic Signatures in Global and National Commerce Act. This chapter modifies, limits or supersedes the federal Electronic Signatures in Global and National Commerce Act, 15 U.S.C. §§ 7001 et seq., but does not modify, limit or supersede section 101 of that Act, 15 U.S.C. § 7001(a), or authorize electronic delivery of any of the notices described in section 103 of that Act, 15 U.S.C. § 7003(b).

(Added to NRS by 2005, 1366)

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APPENDIX A
SAMPLING AND ANALYSIS PLAN

CARSON RIVER MERCURY SUPERFUND SITE

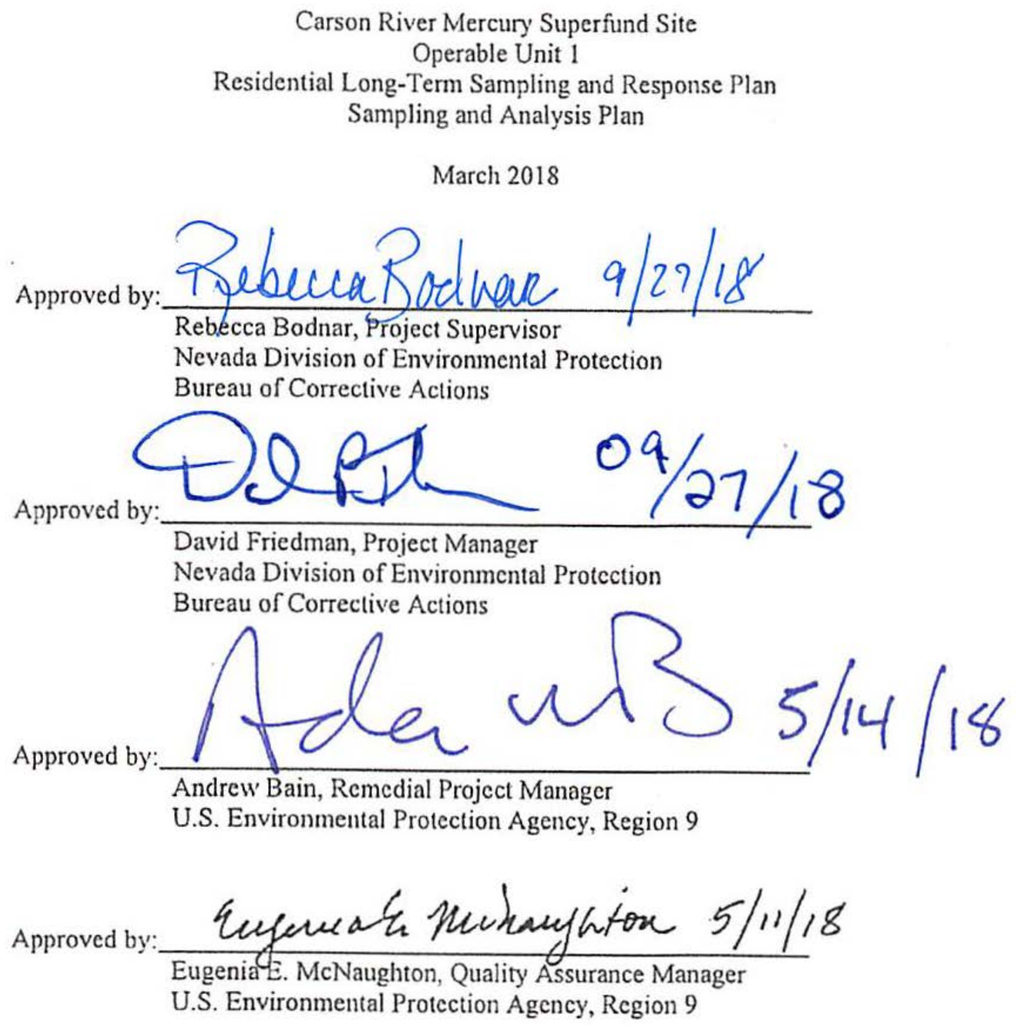
OPERABLE UNIT 1
LONG-TERM
SAMPLING AND RESPONSE PLAN

Prepared by:
Nevada Division of Environmental Protection
901 South Stewart Street
Carson City, Nevada

Prepared for:
Environmental Protection Agency
75 Hawthorne Street
San Francisco, California

Carson River Mercury Superfund Site
Operable Unit 1
Residential Long-Term Sampling and Response Plan
Sampling and Analysis Plan

September 2018



Carson River Mercury Superfund Site
Operable Unit 1
Residential Long-Term Sampling and Response Plan
Sampling and Analysis Plan

March 2018

Approved by: Rebecca Bodnar 9/27/18
Rebecca Bodnar, Project Supervisor
Nevada Division of Environmental Protection
Bureau of Corrective Actions

Approved by: 09/27/18
David Friedman, Project Manager
Nevada Division of Environmental Protection
Bureau of Corrective Actions

Approved by: 5/14/18
Andrew Bain, Remedial Project Manager
U.S. Environmental Protection Agency, Region 9

Approved by: Eugenia E. McNaughton 5/11/18
Eugenia E. McNaughton, Quality Assurance Manager
U.S. Environmental Protection Agency, Region 9

TABLE OF CONTENTS

Tables

Figures

Maps

1.0 Introduction

This document serves as an appendix to the *Carson River Mercury Site Long-Term Sampling and Response Plan for Residential Development* (NDEP BCA, 2018). This Sampling and Analysis Plan (SAP) addresses data collection and the quality process for soil sampling activities conducted at residential premises within the Carson River Mercury Superfund Site (CRMS) Operable Unit 1 (OU-1), under the Comprehensive Environmental Response, Cleanup and Liability Act (CERCLA). The Human Health Risk Assessment (HHRA) for OU-1 determined that the complete pathway for the mercury contamination impacting the site to potentially affect human health is through the incidental ingestion of soil in the yards of children under the age of 6 years old (Hogan and Smucker, EPA, December 1994). However, the CRMS Record of Decision (ROD) (EPA, March 1995) recognized that while the Remedial Investigation (RI) did identify several specific areas where removal actions remediated the properties of homes where mercury contamination was a potential threat, the RI could not sample and characterize the full extent of contamination over a geographic area as extensive as the CRMS. Thus, part of the proposed remedy is to develop a plan, termed the LTSRP, that creates a framework to conduct additional soil sampling at sites of new residential development that were not sampled and characterized in the OU-1 RI. This document details the procedure for addressing impacted soils within the CRMS boundaries.

1.1 Background

The Nevada Division of Environmental Protection Bureau of Corrective Actions (NDEP BCA) prepared this SAP for the U.S. Environmental Protection Agency (EPA) Region 9. It is Appendix A of the LTSRP and intentionally does not contain certain sections fully developed in the parent document. The document follows format defined by the EPA Region 9 guidance document Sampling and Analysis Plan, Guidance and Template Version 4, General Projects, May 2014. This SAP is guidance to aid in writing a site-specific SAP where residential development is planned or already exists on the CRMS. As discussed further in Section 4.0 Request for Analysis, end users of this document can select to conduct their site-specific investigation using field-based portable x-ray fluorescence spectroscopy (FPXRF) analysis in conjunction with limited laboratory-based analysis using approved EPA methods. The purpose of the laboratory-based analysis in conjunction with the FPXRF study is to assess the performance of the FPXRF instrument. Some samples are also required for necessary quality assurance/quality control (QA/QC) assessment of both FPXRF and fixed laboratory instruments. As an alternative to the field-based approach, the site investigator can decide to collect all samples for laboratory-based analysis with the requisite QA/QC samples.

The purpose of this SAP is to supplement the LTSRP by providing guidance to design and implement a residential near-surface soil sampling program that meets the regulatory agencies' expectations for the required work. This document provides the information needed to appropriately determine a site-specific SAP's comprehensiveness and defensibility.

As stated above, the CRMS involves contamination impacting the environment on a regional level. This is largely due to the release of mercury directly into the Carson River system in the original period of Comstock era mining. Over time, the contamination was distributed throughout the length of the river downstream from its point of discharge. The mercury was deposited in the river's floodplain and irrigation channels as contaminated sediments moving out of the river channel as overbank deposits and diverting to cropland for agricultural irrigation (Ecology and Environment, May 1991). Due to the geographic extent, the site was not completely characterized in the RI/FS but will be addressed incrementally as new residential lots are developed or as new soil disturbance occurs on existing residential lots not previously characterized.

1.2 Project Organization

The following is a list of project personnel and their responsibilities.

EPA is the primary decision-maker and will direct the project and specify project tasks. Additional duties include coordination of communication with the EPA quality assurance (QA) office and the State of Nevada and conducting unannounced field audits.

EPA Region 9 QA Officer – The EPA Region 9 QA Officer is responsible for the review of this SAP and any proposed revisions to this SAP after it is finalized. Her reviews will ensure that this plan is written in accordance with EPA QA Office guidelines.

EPA Region 9 Grant Project Officer – The EPA Region 9 Grant Project Officer oversees and manages Region 9 grant projects.

NDEP BCA Project Supervisor – The NDEP Bureau of Corrective Actions (BCA) project supervisor is responsible for overseeing all BCA cleanup authorities and reviewing data quality and sufficiency for these authorities.

NDEP BCA Project Manager – The NDEP BCA Project Manager (PM) is responsible for implementing the SAP, coordination of project tasks, project management, project reporting and conducting unannounced field audits.

NDEP BCA QA Coordinator – The NDEP BCA QA Coordinator is responsible for the review of project objectives, review of this SAP, and coordinating plan-related activities with the EPA. Their coordination activities will be independent of direct data generation activities over which they have oversight.

Principal Data Users – Data generated during the implementation of this SAP will be utilized by the EPA RPM and the NDEP BCA PM to make decisions regarding soil screening and response actions at the site, if necessary.

Analytical Laboratory Support – All analysis of contaminants of concern (COC) must be performed by a Nevada certified laboratory. Contact the Nevada Certified Laboratory Program for a list of certified analytical laboratories in Nevada.

1.3 Distribution List

Copies of this SAP were distributed to the following persons and organizations:

- Andrew Bain (or appropriate contact), U.S. EPA Region 9 RPM
- Eugenia E. McNaughton (or appropriate contact), EPA Region 9 QA Officer
- Nevada Division of Environmental Protection (NDEP)
- Affected Property Owners/Residents (if requested) and/or their environmental representatives/Certified Environmental Managers (CEM)

1.4 Statement of the Specific Problem

Significant mining activity in the Comstock began in approximately 1851 and employed imported elemental mercury in the ore refining process. An estimated 7,500 tons (15,000,000 pounds) of elemental mercury was lost to the environment in the processing of Comstock ore (Grant H. Smith, 1943) directly to the Carson River system. Intrinsic to the ore body are elevated amounts of arsenic and lead. Normally not found at a cautionary level, these historic milling activities concentrated and discharged arsenic and lead. Mercury, arsenic and lead in the mill tailings were transported into soil and sediment via air and water erosion impacting a 130-mile stretch of the Carson River from the historic New Empire Mill (just east of Carson City) to its termination points at Carson Lake, Stillwater Wildlife Refuge, and the Carson Sink (EPA, January 2017). Additionally, due to the impact of the contamination on wildlife, the reach of river from the historic New Empire Mill to the Mexican Dam, is also part of the CRMS. Thus, mercury, arsenic and lead are the contaminants of concern (CoC). Based on previous sampling and investigation data, site-specific action levels are established for mercury, arsenic and lead in surface soils and sediment within OU-1. The CRMS Residential LTSRP employs these action levels and identifies the requirements necessary to assure CoC levels in residential soils are below these action levels. The CRMS action levels established in the Explanation of Significant Differences (ESD) for mercury, arsenic, and lead are 80 milligrams per kilogram (mg/kg), 32 mg/kg and 400 mg/kg, respectively (EPA Region 9, September 2013).

The LTSRP requires sampling to ensure the top two (2) feet of soil at residential properties is at or below the CoC action levels. If sampling shows soil within the top two (2) feet has CoCs at concentrations greater than the action levels, removal or capping is required to create clean material from finish grade to two (2) feet below finish grade. Investigation below the top two (2) feet of finish grade is strongly encouraged to determine if elevated levels of CoCs exist below the two (2) feet depth to inform potential future excavation activities. The LTSRP applies to all residential properties, including residential subdivisions within portions of Carson City, Storey, Lyon, Washoe, and Churchill Counties.

The ESD document identifies the conditions when the presence of arsenic and lead at elevated concentrations is attributed to the CRMS: when found above the screening levels and in the presence of mercury above the screening level. Using USGS and CRMS studies of concentrations of elements in the soil of the Carson River basin, NDEP BCA concluded that concentrations of mercury in soil exceeding 1.0 mg/kg are most likely associated with the historic milling process and are above natural background conditions (Mary Siders, NDEP BCA, June 2012). Because such large quantities of mercury were introduced into the native ore in the milling process, it serves as the sentinel compound for Comstock-related contamination.

2.0 Project Objectives

The following sections present the project objectives regarding project tasks and sampling, project action levels, data quality indicators (DQIs), data quality objectives (DQOs), the schedule of sampling activities, and special training requirements/certifications.

2.1 Project Tasks and Sampling Objectives

The purpose of the CRMS LTSRP is to reduce the exposure risk to levels of mercury, arsenic, and lead at concentrations that could affect human health. The first step is the sampling and chemical analyses of soil samples collected in yards of residences where no such data or insufficient data exists. This SAP documents the procedural and analytical requirements required to 1) conduct the near-surface soil sampling at residential properties; 2) determine mercury, arsenic and lead concentrations in the soil samples; and 3) determine the need for potential remedial action(s).

This LTSRP focuses on residential construction/development/soil disturbance in the CRMS OU-1. As prescribed in the LTSRP and summarized in Section 4.1 of this SAP, procedures are in place to notify NDEP BCA of a project prior to soil disturbance activities by residential developers and individual property owners. The LTSRP calls for residential soil characterization sampling. If determined from the analytical data that soil concentrations are above the site-specific action levels, a remedy might be required and additional sampling will be used to determine if the remedy has adequately controlled the risk as defined in the OU-1 ROD.

The LTSRP provides for a NDEP BCA-lead investigation when a resident is building a new home for their use or are performing renovations or additions with significant excavation required at an existing home. Development and new construction of residential dwellings for profit and speculation construction requires the property owner or developer be responsible for the planning and sampling activities required to characterize the soil as defined in this plan.

Two types of sampling plans detailed in Section 3.0. The first is for large multi-parcel subdivisions planned to occupy multiple acres. Pre-construction and earth disturbance planning with NDEP BCA (and either directly or indirectly EPA) is necessary to determine if a preliminary site characterization of the soil is appropriate. The planning will consider the area of investigation boundaries (defined below) that will be potentially disturbed; geologic, topographic and hydrologic features in the proposed project; and any special circumstances located within the proposed subdivision that are of significant interest based on the probability that contamination is associated with them. Working with the property developer and their consultants, the objective is to focus sampling efforts to identify “hot spots” of contamination and refine the area of investigation boundaries identified within the proposed limits of the project prior to other site activity. This effort will limit the unintentional spread of contamination during construction earthwork tasks and potentially minimize the density of verification sampling of the finished residential lots.

The second sample program defined in this SAP applies to single residential parcels with a smaller footprint of soil disturbance activities associated with the construction. In general, this program is used for:

- the construction of a new home, renovation, or addition to an existing home requiring ≥3 cu. yds. of soil disturbance,
- new construction of multiple homes limited to just a few acres and when there is no need to build new infrastructure or significant new underground utility lines; and
- for verification sampling of individual parcels of large subdivisions or if a remedial action was required on any size project.

The objective of this sampling program is to characterize the entire area of disturbance for CoCs and not bias the characterization toward discovering areas of greater or less contamination.

2.2 Contaminant Action Levels

The EPA Region 9 ESD document and the LTSRP for the CRMS establishes action levels for mercury, arsenic, and lead. The action level for mercury (80 mg/kg) is based on site-specific data modeled in the Human Health Risk Assessment for OU-1 (it includes background levels, the typical species of mercury encountered in soil on the site, and non-cancer health risks for children under the age of six). The action level for arsenic (32 mg/kg) is based on statistical evaluation of site-specific sample data and taking into account background levels typically found in OU-1. It should be noted that soil samples collected adjacent to and nearby the mineralized zone of the geologic formation containing the Comstock Lode found background concentrations of arsenic in the range of 90 to 120 mg/kg, but these hot spots are significantly limited in their extent and distance from the parent rock. The action level for lead (400 mg/kg) is based on the EPA Region 9 Regional Screening Level (RSL). Background levels for lead in soil are much lower than this concentration. The site-specific action levels are shown in Table 3-1 below.

2.3 Data Quality Indicators (DQIs)

Data processing, verification, and validation are the quality management tools used to determine if project data meet the plan's Data Quality Objectives (DQO) (Section 2.4) defined in this SAP. During data processing, verification, and validation, project data is evaluated for completeness, correctness, and compliance against the method and procedural requirements of the project. Contracted sampling and analytical services must consider these data quality considerations in the contract terms of service negotiated with the provider. Verified data is validated against performance measures and DQOs. Data quality indicators (DQIs) are also known as PARCCS Parameters and are defined as: precision, accuracy (bias), representativeness, completeness, comparability, and sensitivity (method detection limits).

- **Precision** is the degree of mutual agreement between or among independent measurements of a similar property (usually reported as standard deviation (SD) or relative percent difference) and relates to the analysis of duplicate laboratory or field samples. The measurement quality objectives (MQOs) for precision and accuracy for the analyses of the specific CoCs are summarized in Table 2-1.
- **Accuracy (bias)** is the degree of agreement of a measurement with a known or true value and is determined by comparing the reported laboratory value for a sample to a known or true concentration (i.e. matrix spikes, surrogate spikes, laboratory control samples and performance samples). The measurement quality objectives (MQOs) for accuracy for the analyses of the specific COCs are summarized in Table 2-1.
- **Representativeness** is the expression of the degree to which data accurately and precisely represent a characteristic of an environmental condition or population and

relates to the method of collecting samples and determining sampling locations. Representativeness is a qualitative parameter that will be satisfied using two different sampling strategies described in Section 4. Preliminary pre-construction investigations conducted at large sub-division developments are biased toward detecting CoCs by using professional judgment and knowledge of site history to focus sampling on the area most likely to be contaminated. Single lot and verification sampling conducted in residential yards use a more random approach as developed in the EPA's "Superfund Lead-Contaminated Residential Sites Handbook", August 2003.

- **Completeness** is expressed as the percent of valid usable data obtained compared to the amount that was expected. Data collection may be inhibited by geologic conditions and/or underground utilities, etc. The project goal is to obtain at least 90% of the soil samples outlined in this SAP.
- **Comparability** is the degree to which data from one study can be compared with data from other similar studies, reference values (such as background), and screening values. Field procedures to promote comparability of collected samples are discussed in this SAP. Laboratories used for analytical testing of soil samples collected for compliance with the LTSRP are certified by the State of Nevada for standard analyses using EPA-approved methods as defined in Table 3-1.
- **Sensitivity** is defined by the laboratory detection limits and are generally expressed in terms of method detection limits (MDLs) or reporting limits (RLs). The laboratory reporting limit for each analyte is summarized in Table 3-1. An example of the manufacturer's detection limits for an FPXRF have been included in this SAP as Table 2-3. The reporting limits are well below the action levels and are adequate for this investigation.

Table 2-1
Data Quality Indicators

Data Quality Indicator	Data Collection Task	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Precision	Field Screening by FPXRF	≤ 35% RPD to laboratory analysis	Split sample for laboratory analysis	S
	Laboratory Analysis Method 6010	≤ 20% As & Pb	MS/MSD, LCS	A
	Laboratory Analysis Method 7471	≤ 20% Hg	MS/MSD, LCS	A
Accuracy	Field Screening by FPXRF	65 – 135% As, Pb, Hg	Standard Reference Material	S
	Laboratory Analysis Method 6010	80 – 120% As & Pb	% Recovery for MS/ MSD	A
	Laboratory Analysis Method 7471	80 – 120 % Hg	% Recovery for MS/ MSD	A

Table 2-1
Data Quality Indicators

Data Quality Indicator	**Data Collection Task**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Representativeness	Residential yard characterization	Sample design based on "*Superfund Lead-Contaminated Residential Sites Handbook*", August 2003	Qualitative Parameter	S & A
	Large Sub-division preliminary pre-construction characterization	Biased sample locations to identify highest CoCs based on CSM and Areas of Investigation	Qualitative Parameter	S & A
Completeness	Field Screening by FPXRF	≤ 90%	Samples Collected/ Samples planned	S
	Laboratory Analysis Method 6010	≤ 95%	Usable Lab Data/ Lab Samples Submitted	A
	Laboratory Analysis Method 7471	≤ 95%	Usable Lab Data/ Lab Samples Submitted	A
Comparability	Field Screening by FPXRF	Adherence to SAP	Qualitative Parameter	S & A
	Laboratory Analysis Method 6010	NV Certified Lab Requirements		S & A
	Laboratory Analysis Method 7471	NV Certified Lab Requirements		S & A
Sensitivity	Field Screening by FPXRF	Manufacturer's Specifications	Site-Specific Action Level: Hg = 80 mg/kg As = 32 mg/kg Pb = 400 mg/kg	S
	Laboratory Analysis Method 6010	MDL As = 10 mg/kg; Pb = 10 mg/kg		A
	Laboratory Analysis Method 7471	MDL Hg = 0.1 mg/kg		A

2.4 Data Quality Objectives (DQOs)

The DQO process as set forth by U.S. EPA guidelines (Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4, U.S. EPA 2006) is followed to establish the DQOs for this project. This seven-step DQO process uses a common-sense approach to ensure the level of documentation and rigor of effort in planning is commensurate with the intended use of the information and available resources. The systematic planning approach includes well-established management and scientific elements resulting in a project's logical development, efficient use of scarce resources, transparency of intent and direction, soundness of project conclusions, and proper documentation to allow determination of appropriate level of peer review.

DQOs for the soil sampling required by the LTSRP are established in this SAP. These DQOs should be used for all work implemented to comply with the LTSRP unless special conditions exist in a proposed investigation indicating these are not the best suited for the study needs. The DQO process is an iterative process allowing for the input of new information and data as previous work and data collection efforts allow. If a property-owner believes revision to these DQOs is appropriate, they will propose the request to NDEP BCA along with sufficient demonstration that such revision is merited.

Table 2-2 summarizes the DQO process. Two types of sampling are identified dependent on the study conducted. For preliminary site investigation where proposed large residential development, such as a new subdivision, a biased sampling design is proposed to identify contaminated ground surface areas based on existing data and the Conceptual Site Model (CSM). For single-family residential yards or the development of a few homes and extensive soil disturbance is not necessary and areas with a high probability of contamination will not be disturbed, a defined grid-like sampling design that characterizes the entire yard is to be employed. The DQO also provides for analytical data collected in the field by FPXRF technology verified by atomic adsorption or equally accurate laboratory-based analyses on a ratio of 1:5 laboratory samples to field screen samples.

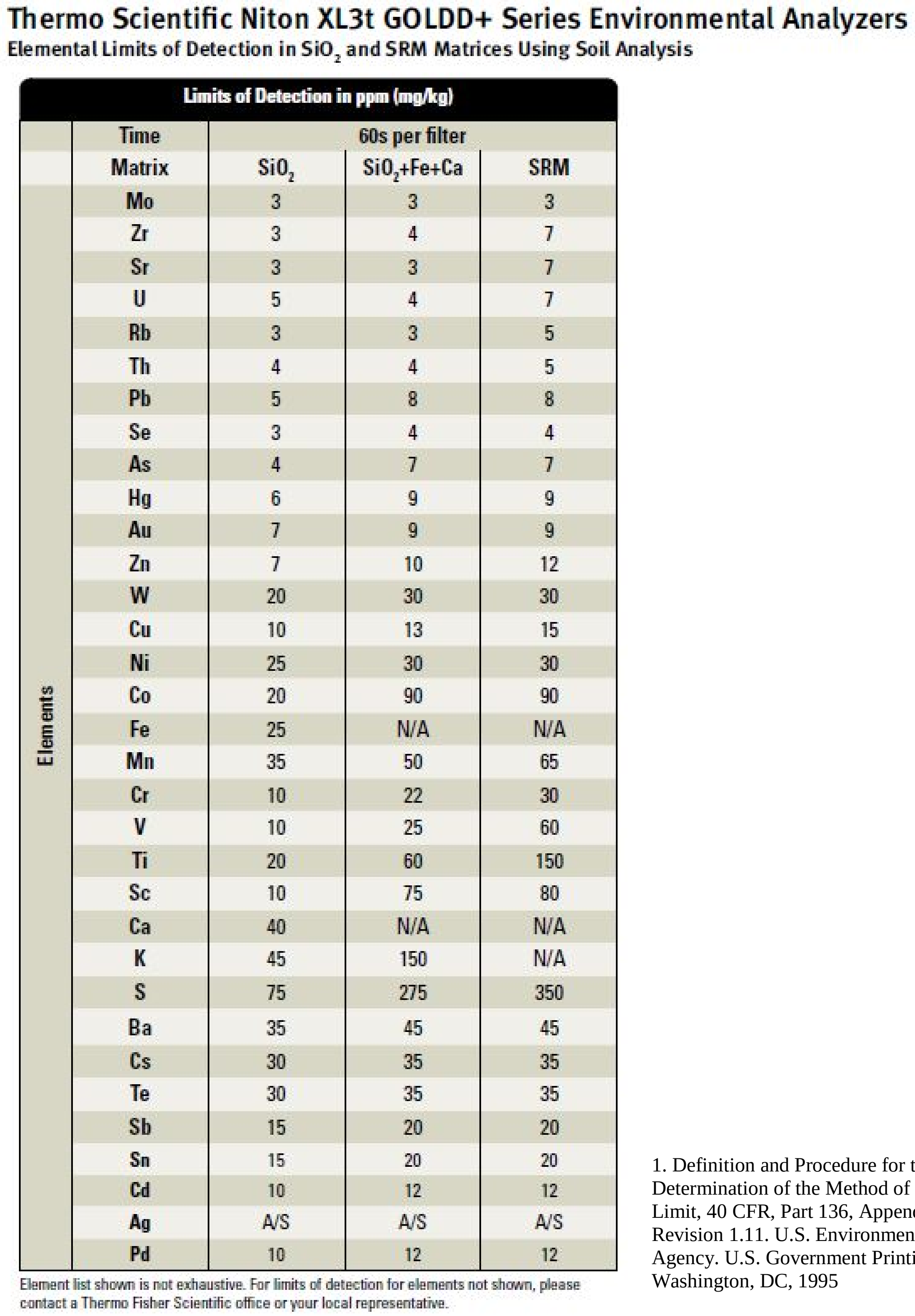
TABLE 2-2

Data Quality Objective Steps Summary for the CRMS OU-1 Long Term Sampling and Analysis Plan

Appendix A Sampling and Analysis Plan, Long Term Sampling and Analysis Plan, Carson River Mercury Superfund Site, Carson City, Nevada

Problem Statement	Decision Statements	Inputs to the Decision	Study Boundaries	Decision Rules	Tolerable Limits on Decision Rules	Optimization of the Sampling Design
Extensive gold and silver mining of the Comstock Lode from approximately 1850 – 1900 relied on an ore refining process using elemental mercury to amalgamate the gold and silver. An estimated 7,500 tons of mercury was lost to the environment during this period through direct release to the Carson River, a tributary, or unrecovered in spent mill tailings discarded at the end of the process. The released mercury has impacted an approximate 130-mile stretch of the Carson River from the historic Mexican Mill Dam in Carson City to its terminal points in the Carson Sink, Carson Lake, and the Stillwater Wildlife Refuge. Mercury has also impacted the locations of the historic mill sites and tailings piles, the 100-year floodplain of the Carson River along an 80 mile section, and flood -irrigated agricultural lands. The CRMS is divided into operable units. Operable Unit 1 is the source areas where mercury contamination might be found. Investigation of the mercury contamination has also shown co-located concentrated arsenic and lead, both occurring naturally in the mined ore, due to the mining activities and are at levels that may be a risk to human health. Risk assessment of site data for OU-1 identified a potential complete pathway for mercury through the incidental ingestion of soil in residential yards by children 6 years old or younger. A site-specific action level is established for total mercury at a concentration of 80 mg/kg in soil. An action level for arsenic in soil is established at 32 mg/kg and lead in soil at 400 mg/kg, when they are detected with elevated mercury concentrations. Based on the complete pathway scenario, the OU-1 Record of Decision (ROD) determined that the upper two feet of soil in a residential yard must be below the mercury concentration 80 mg/kg to be protective of human health.	1. In accordance with the ROD, be protective of human health by assuring soil within the top two feet of ground surface on residential properties has concentrations of total mercury less than 80 mg/kg, total arsenic less than 32 mg/kg, and total lead less than 400 mg/kg. 2. If soil exceeds the required action level(s), remediation of the properties should occur that either removes soil with CoCs above the action level(s) and replaces with non-contaminated soil or place a minimum two feet cap of non-contaminated soil over the contaminated soil. 3. In the case of all residential properties that do not have definitive soil concentrations identified to a depth of at least 8 feet below finish grade, append an institutional control, preferably an environmental covenant, to the property in order to maintain awareness and the need for regulatory notification should future work involve excavation of 3 cu. yds. or more of soil to a depth below the limits of existing contaminant characterization (below the two foot cap).	1. Perform a soil sampling program over an area of proposed soil disturbance where there is a residential building or proposed construction of a residential building. The sampling program must meet the sampling program requirements of the SAP and be approved by NDEP BCA. 2. If analyzing soils with an FPXRF, a minimum of 20% of samples are split and analyzed in the laboratory by the appropriate EPA method defined in the SAP. Concentrations of mercury in the soil in the range of the action level may not give consistent results. Check the FPXRF against a NIST Reference Standard that contains lead, arsenic, and mercury at a certification or reference level. It is acceptable to check the FPXRF against more than one reference standard to meet this criteria. The DQI for accuracy defines the performance standard to be met by these reference standard checks. Sample analyses also require additional QA/QC samples as defined in the SAP. 3. Review the analytical results to determine if action levels are exceeded. Perform necessary QA/QC review to determine the acceptability of the analytical data collected. 4. If data is acceptable and CoC concentrations do not exceed action levels, provide letter of "*No Further Action*" to the property owner along with a proposal for an Environmental Covenant. If data is acceptable and CoC concentrations exceed action levels, plan to implement acceptable remedial action. 5. If data is not acceptable based on QA/QC review, determine steps necessary to take corrective action and perform re-analysis and/or re-sampling as necessary.	There are two types of site characterizations proposed in this SAP and the boundaries will vary with each. 1. Proposed development of residential subdivisions should contact NDEP BCA prior to performing any soil disturbance activity to determine if a preliminary pre-construction soil characterization is necessary. If a preliminary pre-construction soil study is needed, the study boundary will initially be the entire acreage of the subdivision including infrastructure, public right-of-ways, and public space or anywhere where soil disturbance activity will occur. The purpose and focus of the pre-construction study is to identify and define the limits of potential "hot spots" or CoC action level exceedance and plan actions that will limit the spread or exacerbation of contamination around the subdivision and CRMS during earthwork and construction activities. Following new home construction or final grading on vacant lots, verification will be performed to confirm that each residential parcel meets the LTSRP soil requirements. In this phase of subdivision development, study area boundaries will be reduced to each individual parcel zoned for residential development. 2. Existing residential properties requesting soil characterization of their yard, existing residential properties where renovation or addition will disturb >3 cu.yds of soil, or new residential construction of one or several buildings where extensive infrastructure and earthwork will not be required will have the study area boundaries limited to the extent of their parcel boundaries.	1. If the characterization study data indicate that mercury concentrations are less than the action level of 80 mg/kg, the study data will be added to the CRMS geodatabase noting the depth limit of the characterization. 2. If the characterization study data indicate that mercury concentrations exceed 80 mg/kg, arsenic and lead concentrations will be assessed and an appropriate remedial action will be requested. The study data will also be entered into the CRMS geodatabase 3. If the characterization study data exceeded action levels and a remedy was implemented, verification sampling will be performed to confirm the effectiveness of the remedy. 4. All data must meet QA/QC review criteria in order to be acceptable for decision making.	Data quality, as determined through the data quality indicators of the precision, accuracy, representativeness, completeness, and comparability of the data, are specified in Table 3-1 of the SAP. The SAP specifies all quality assurance and quality control objectives for sample measurements. The analytical quality objectives are set to obtain data of known precision and accuracy and to reduce the occurrence of Type I errors (false positive detections) and Type II errors (false negative detections). This is accomplished through the use of EPA analytical methods that will provide reporting limits below the applicable site-specific action level objectives. Based on the control limit requirements in EPA's *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 1994c), using the criterion of 35 percent to assess duplicate soil samples is considered to have acceptable precision. The limit of 35 percent for split/duplicate comparison samples between FPXRF and laboratory analysis will be used during the project to determine the effectiveness of the FPXRF instrument. The control limits were set for method-required QA/QC activities based on the requirements of the CLP program and allow for sufficiently accurate and precise data. The results of sample analyses will be validated in accordance with EPA required procedures.	Random, biased, grid, and transect sampling designs may be utilized during this investigation. Four Areas of Investigation have been defined by NDEP BCA based on the qualitative probabilistic determination that a property will have CoCs above action levels based on historic use and location of the property. These areas will be used to determine the necessary sample density as defined in the SAP. Preliminary pre-construction characterization on a property can be used to defend a lower final sampling density then prescribed for an Area of Investigation in the SAP. In preliminary pre-construction characterization studies, the Area of Investigation boundaries will be used to bias sample locations in an effort to find "hot-spots" and CoC action level exceedances. The sample design will be determined in discussions between the property owner and/or designated representative and the regulatory agencies. Residential yards will be sampled similar to the guidance for lead soil verification sampling found in "*Superfund Lead-Contaminated Residential Sites Handbook*", August 2003. Residential properties in Area of Investigation 1 boundaries will only require sampling in special circumstances. Residential properties in Area of Investigation 2 boundaries will require the collection of five-point composite samples from the yard divided into two halves. Four samples are to be analyzed with two samples from the 0" to 6" soil depth from both halves and two samples from the 6" to 24" soil depth from both halves. Residential properties in Areas of Investigation 3 and 4 boundaries will require the collection of 5-point composite samples from the yards divided roughly into quadrants representing the front yard, back yard and yard on both sides of the house. Eight samples will be analyzed with four samples from the 0" to 6" soil depth from each quadrant of the yard and four samples from the 6" to 24" depth from each quadrant of the yard. Split confirmation samples for laboratory analyses will be collected at a frequency of 1 sample for each 5 sample locations (analyzed by an FPXRF instrument) or 1 sample per residential lot, whichever is greater, to verify the quality of FPXRF data. Sample locations will be clearly defined and documented using a global positioning system and GIS. Field sampling techniques will be in accordance with the NDEP BCA-approved site-specific SAP and consistent with Section 5.0 such that they will be compliant with EPA requirements, industry standard practices, and they will be reproducible.

Table 2-3 Example Detection Limits[1] of FPXRF Analyzer



Thermo Scientific Niton XL3t GOLDD+ Series Environmental Analyzers

Elemental Limits of Detection in SiO_2 and SRM Matrices Using Soil Analysis

Limits of Detection in ppm (mg/kg)

	Time	60s per filter		
	Matrix	SiO_2	SiO_2+Fe+Ca	SRM
Elements	Mo	3	3	3
	Zr	3	4	7
	Sr	3	3	7
	U	5	4	7
	Rb	3	3	5
	Th	4	4	5
	Pb	5	8	8
	Se	3	4	4
	As	4	7	7
	Hg	6	9	9
	Au	7	9	9
	Zn	7	10	12
	W	20	30	30
	Cu	10	13	15
	Ni	25	30	30
	Co	20	90	90
	Fe	25	N/A	N/A
	Mn	35	50	65
	Cr	10	22	30
	V	10	25	60
	Ti	20	60	150
	Sc	10	75	80
	Ca	40	N/A	N/A
	K	45	150	N/A
	S	75	275	350
	Ba	35	45	45
	Cs	30	35	35
	Te	30	35	35
	Sb	15	20	20
	Sn	15	20	20
	Cd	10	12	12
	Ag	A/S	A/S	A/S
	Pd	10	12	12

Element list shown is not exhaustive. For limits of detection for elements not shown, please contact a Thermo Fisher Scientific office or your local representative.

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1. Definition and Procedure for the Determination of the Method of Detection Limit, 40 CFR, Part 136, Appendix B. Revision 1.11. U.S. Environmental Protection Agency. U.S. Government Printing Office: Washington, DC, 1995

3.0 Sampling Rationale and Design

NDEP BCA and EPA identified the need for two distinct sampling designs for the work accomplished under the OU-1 Residential LTSRP after reviewing available site information, the EPA residential lead guidance, and the Residential LTSRP objectives. As discussed in the Residential LTSRP, the original CRMS site boundaries were considered an "investigative boundary" and included the Carson River drainage basin from Carson City, NV to its terminal points in Churchill County, NV. NDEP BCA utilized the CSM of the CRMS and what is known about the fate and transport of the CoCs on the site to focus the boundaries to a more realistic representation of the CRMS site. To support the revision of the CRMS site map, EPA committed significant resources to a Level I archaeological survey identifying historic Comstock-era mill and tailings piles in the field and initiating an ESD to the OU-1 ROD. This resulted in formally adopting the new site definition and adapting the boundaries identified by NDEP BCA as the new estimates of the CRMS on all new maps and public outreach materials. NDEP BCA identified four geographic areas of prime importance to the CRMS and based on the CSM, these four areas have varying probabilities of contamination. These four Areas of Investigation have become the foundation for the residential soil sampling program mandated by the OU-1 ROD. Summarized briefly:

- **Investigation Area 1 (IA-1):** Includes the areas lying **outside the buffer zones** of the other three Investigation Areas in the Carson River drainage basin beginning in the area of the historic settlement of New Empire in Carson City, NV, downstream to the existing or historic terminal points of the river at Carson Lake, Carson Sink, Indian Lakes, and the Stillwater National Wildlife Refuge. It is least probable that CRMS CoC will be located in these areas. It is unlikely any sampling will be requested on areas developed within IA-1; however, sampling may be requested in special circumstances, especially near and around the source areas of the contamination where historic activities could potentially have caused impacts beyond the typical boundaries as identified by the conceptual site model (CSM).

- **Investigation Area 2 (IA-2):** Defined as a buffer lying 100 feet perpendicular to the Investigation Area 3 boundary. For Comstock-era mill sites and isolated tailings piles, this translates to the area between 350 feet and 450 feet from the center point of the historic feature. For the 100-year FEMA floodplain and areas of irrigation, this is the area beginning at the limit of the flood plain boundary or irrigated land extending out 100 feet.

- **Investigation Area 3 (IA-3):** Defined as a buffer lying 100 feet perpendicular to the Investigation Area 4 boundary for Comstock-era mills or isolated tailings piles. For Comstock-era mill sites and isolated tailings piles, this is the area between 250 feet and 350 feet from the center point of the historic feature. It is also defined as the limits of the FEMA 100-year floodplain or past or current flood irrigation practices. A tributary of the Carson River must have a Comstock-era mill site or tailings pile located along it to be mapped in IA-3 and only the portion of the tributary downstream of the historic feature is included. If a tributary does not have the FEMA 100-year flood plain defined, then IA-3 is defined as the area 100 feet perpendicular to the Investigation Area 4 boundary of that tributary.

- **Investigation Area 4 (IA-4):** Defined as the area within a 250-foot radius from the center point of a Comstock-era mill or tailings pile. The geographic centers around these historic features were established in a multi-step process described below. The centerline of the current channel of the Carson River is enclosed in a polygon 100-feet wide (50 feet either side). Tributaries to the Carson River, where Comstock-era mills and tailings piles were located and that do not have FEMA 100-year floodplains defined, are enclosed in a polygon 50-feet wide (25 feet either side) from the approximate center of the tributary channel. Irrigation canals are enclosed in a polygon 20-feet wide (10 feet either side) from the approximate center of the canal.

3.1 Notification to NDEP BCA

The LTSRP defines the scope of a project requiring NDEP BCA notification as any activity associated with residential construction, development, or improvement activities, for a property within the CRMS OU-1 physical boundary, disturbing more than three cubic yards of soil or sediment, or any amount of tailings material. Three cubic yards of contaminated soil is defined in Nevada regulation as a trigger that requires regulatory notification (NAC 445A.347). Property owners must notify NDEP BCA of the project prior to soil disturbance activities. These activities may include, but are not limited to: individual property development, minor and major property subdivision construction activities, swimming pool excavation/installation, grading, home additions and utility ditching/trenching. In accordance with the LTSRP, NDEP BCA is notified of new home construction or soil disturbance on a residential parcel through notification from county building departments or by the NDEP Bureau of Water Pollution Control (BWPC) following application for a construction general permit under the Phase II storm water rule. For smaller projects, local permit authorities will notify NDEP BCA of any soil disturbance requiring a local jurisdiction permit but not meeting storm water general construction requirements.

3.2 Large Project Preliminary Pre-Construction Sampling

Early collaboration with NDEP BCA in planning and sample design of large residential subdivision projects is the best method for compliance with the OU-1 ROD requirements. Information acquired in a well-planned sampling program prior to any grubbing or soil disturbance activities on site greatly improves the confidence in the overall site characterization study and has significant benefit to the developer in reducing the sampling effort for the verification sampling on each of the residential subdivided parcels. Further, if contamination is detected on site at elevated levels, CoC mitigation can be completed prior to soil disturbance activities and reduce potential problems caused when soil with elevated contamination is moved around the site and into residential lots.

3.2.1 Preliminary Pre-Construction Scoping and Planning

Optimally, a developer will contact NDEP BCA to discuss development plans early in the subdivision planning process to identify and characterize potential areas of contamination. This information is valuable in the layout and site plan of the proposed development. If area(s) of contamination greater than site action levels are identified in the proposed subdivision, a number of mitigation alternatives are considered including:

- development as non-residential space;
- removal of the contaminated material to an off-site repository; and/or
- excavation of the contaminated material for use as sub-grade for planned roadways or under some other low permeable cover like a paved parking lot or a community recreation center.

NDEP BCA encourages landowners and developers to contact NDEP BCA to schedule a scoping meeting. At the meeting, the tract of land proposed for development is overlayed with the CRMS Investigation Area boundaries. A preliminary pre-construction characterization study is discussed including target locations and possible sample densities (i.e., number of samples across an area of interest). The latter two topics are generally determined using the Investigation Area for guidance.

The expected outcomes from advance scoping meetings include: CRMS information and background including the legal authorities held by EPA and NDEP BCA and how a landowner and/or developer can minimize and limit their liabilities under CERCLA; understanding by the regulatory agencies what the proposed project goals and plans include and upcoming staffing needs for review time; and an outline and timeframe for both parties on a potential sampling program, its elements and scope. Such planning is a tremendous benefit for moving a project forward with less delays and missteps.

3.2.2 Preliminary Preconstruction Sample Design

The stated purpose of the preliminary preconstruction sampling program is to identify potentially contaminated areas located on a large tract of land slated for residential development. The first step in this process is overlaying the boundaries of the area to be developed on the CRMS map; then identifying the Investigation Area boundaries along with all existing soil and sediment analytical data for the CRMS.

With the information available on the CRMS maps, it can quickly be determined if Investigation Areas with a higher probability of contamination are located with boundaries of the proposed subdivision, identify what those Investigation Areas are, and identify if they will be subject to potential soil disturbance. The need to perform a preliminary preconstruction sampling program can be assessed and discussion about the sample design necessary to appropriately characterize an Investigation Area can begin.

Investigation Area 1

As stated previously, Investigation Area 1 will generally not need sampling. In the case of a proposed subdivision, the site will be reviewed for the potential of contamination being transported within the Investigation Area 1 boundary based on the proximity of historic mills and tailings piles, the relation of topographic and hydrologic features between Investigation Area 3 and 4 boundaries and the Area 1 boundary of interest. Factors such as being lateral to and downslope or down gradient from Investigation Area 3 or 4 boundary may require some sample collection. For example, if it appears historic fill was placed in the Investigation Area 1 boundary and is in the vicinity of historic mills and tailings piles, sampling may be required. In the Carson River valley, it is sometimes difficult to tell if land was farmed or ranched and historic flood irrigation was practiced. In such a case, it may be appropriate to collect samples in an Investigation Area 1 boundary.

Investigation Area 2

This Investigation Area boundary defines a buffer of uncertainty associated with historic flood events and possible variation in the course of the historic stream channel. Proposed subdivisions that include Investigation Area 2 boundaries are likely to include the Carson River or an impacted tributary to the Carson River. Although historic sampling has shown there is not significant contamination associated with this area, some sampling may be required. As drainage channels are linear in their landform, conducting sampling linearly along the length of the drainage on both sides of the channel is prescribed. Sampling can be less dense as contamination is historically not likely. The spacing distance is determined as part of the preliminary preconstruction sample program process.

Investigation Area 3

Investigation Area 3 defines several different types of geographic areas. First, it is a buffer around a potential contamination source like a mill site or tailings pile. These two source areas are typically defined as polygons on the order of 10s to 100s of square feet; however, due to the nature of the historic mills, some sites are acres in size. Second, it is the definition of a regional feature: the FEMA 100-year flood plain of the Carson River and the tributaries of Gold Canyon and Six-Mile Canyon and the Six-Mile Canyon alluvial fan that have a FEMA 100-year flood plain defined. Finally, it defines land west of the Six-Mile Canyon alluvial fan border where Operable Unit 2 begins that is or has historically been subject to flood irrigation and is out of the Carson River 100-year floodplain.

Consideration for the sample design used in Investigation Area 3 is designed around the particular feature or features that define it. For example, in the Dayton Valley where the Carson River floodplain is broad, the sample design will likely incorporate a type of grid system. In the tributaries of Six-Mile Canyon and Gold Canyon where the canyon walls are high and steep and soils tend to be thin, a linear spacing on both sides of the stream channel might best-fit the study needs. For buffers around source areas, a grid system might best characterize the area. The actual spacing and density of samples will be determined in the planning process.

Depth of samples collected in Investigation will also be dependent on the particular feature defined as Investigation Area 3. Some Investigation Area 3 locations in the tributaries have very thin soils. Other areas in the Six-Mile Canyon alluvial fan and the Carson River valley have very deep soils. During the OU-1 RI/FS it was discovered that where the valley soil is highly permeable and/or the historic tailings were buried quite deep, elemental mercury migrated to significant depth (11+ feet near the Birdsall Mill and Kustel & Winters Mill). Therefore, where soil and unconsolidated material is deep enough, sampling is recommended to a depth of 8 feet to sufficiently characterize the site and avoid liability.

Investigation Area 4

Investigation Area 4 represents the Comstock-era mills and tailings piles where the Washoe Process was employed and are historically high in CoCs. They represent the source areas for the contamination and will be of high interest for investigation, especially if future residential structures are planned on the land they occupied. The sample design will likely employ a grid system and sampling density will be requested at its highest compared to other Investigation Area sites. It is important to determine what the distribution of contamination and range of concentrations are to minimize the chance of spreading the contamination across the site. Early planning and collaboration with NDEP BCA is recommended to mitigate contamination. Depth of samples should continue through the thickness of unconsolidated material or at least 10 feet below planned finish grade.

3.3 Single Lot or Verification Sampling

The purpose of sampling at existing or new homes, homes with planned renovation or additions that will potentially disturb 3 cubic yards or more of soil, and new lots in subdivisions is to verify the soil is below CRMS contamination action levels. In the case of a renovation or addition to an existing house, the sampling is conducted prior to any soil disturbance to the planned depth of excavation. This ensures that any potential contamination is not exacerbated or spread during the construction activities. If contamination is found prior to new construction, some mitigation might be required and verification sampling will be done to assure the top two feet of the finished grade is below action levels. For new home construction, particularly for lots developed in a new subdivision, this will be a verification process to assure the top two feet of the finished grade meets the health protection requirements established by the contamination action levels.

The sampling design conducted in the yards are based on the “Superfund Lead-Contaminated Residential Sites Handbook”, U.S. EPA Lead Sites Workgroup, August 2003 (Residential Lead Sites Handbook). Although the sampling design in the Handbook has relevance to the CRMS, it is also important to note that several factors considered in the Handbook have limited or no relevance on the CRMS. Most notable are considerations given to potential lead sources from lead-based paint which is not a target contaminant in these investigations. The Residential Lead Sites Handbook suggests decision units should be areas of approximately 0.25 acres in size and within each decision unit, a five-point composite sample is collected. For representative sampling within the CRMS, the actual sample design acceptable for a single-family lot will vary depending on the Investigation Area(s) the yard occupies, the size of the yard, and the configuration of the yard in relation to the residential structure and any other significant building structures on the property. The sampling program for verification of new subdivision lots can also be varied on the regulatory agency’s discretion based on the findings and any mitigation taken as a result of the preliminary preconstruction sampling program.

3.3.1 Single Lot or Verification Sampling Scoping and Planning

Notification to NDEP BCA:

1. The county building department will notify NDEP BCA through the permitting process prior to new home construction or renovation or addition to an existing home if greater than 3 cubic yards of soil is potentially disturbed during the renovation or addition construction. Once notified of the building plans, NDEP BCA will contact the construction permittee to discuss the project and possible need for soil sampling.

2. Private homeowners of existing homes or individuals purchasing any vacant lot for development of their own residence will be contacted by NDEP BCA. They are welcome to contact NDEP BCA at any time to discuss the potential of finding contamination on their property and the possibility of characterizing the lot prior to purchase or prior to the start of new construction.

3. Contractors or developers building a new home with the intent of selling the property commercially are obligated to contact NDEP BCA.

Planning and scoping the characterization of single residential lots is generally much less complex as the area of the property is usually less than one acre and unlikely to consist of more than one Investigation Area type. The soil sampling, if determined to be necessary, can usually be limited to a single sampling event in the yard of the home following completion of the new construction. If the site is located in an Investigation Area 3 or 4 boundary, pre-construction soil characterization is encouraged to identify if contamination above action levels exists on the property. If contaminants are above action levels, how to proceed without exacerbating and/or spreading the contamination is discussed; assuring that final grade will meet the requirement that the top 2 feet of soil (at a minimum) on the surface of the yard are below site action levels. Again, for existing homeowners and those building or having a new home built for themselves, NDEP BCA will provide the necessary resources to conduct the soil sampling.

3.3.2 Single Lot or Verification Sampling Design

As stated above, the sample designs suggested for residential parcels in this SAP are based on sample designs described in the Residential Lead Sites Handbook. The sample program designs suggested in the Residential Lead Sites Handbook includes sample designs for yards ≤ 5,000 sq. ft. (appx. 0.1 acre) and > 5,000 sq. ft. It further recognizes sample designs for small residential parcels ≤ 5,000 sq. ft. with "substantial" side yards and with no substantial side yards. A decision unit will be approximately 0.1 acres unless the property is 1 acre. In a case of a large lot ≥ 1 acre, the decision units will be 0.25 acres. Therefore, if any segment of a yard (front, back, and/or side) is > 0.33 acres on a residential property that is ≥ 1 acre, the yard segment should be subdivided into decision unit areas of equal size with each subdivision ≤ 0.25 acres in size. On lots ≤ 1 acre size, it will be acceptable to count each yard segment as its own decision unit without further subdivision.

Investigation Area 1

Investigation Area 1 will generally not need sampling. NDEP BCA will review all available historic information for the property location to verify there are not any exceptional factors that would lead to making investigation of the soil relevant and if none are found, the property owner will be notified that no characterization is necessary prior to or following construction activity.

Investigation Area 2

A minimum of two five-point composite samples per lot are required. Refer to Figures 3-1 through 3-3 for suggested schematic designs. Each of the two samples will be composited from five discrete sample locations from the zero to six inch (0-6") depth range and from the six to twenty-four inch (6-24") depth range (see Diagram 1). Composites should consist of aliquots collected from the same depth interval. This sampling is conducted to two feet below final grade or the depth of any planned soil disturbance area.

Investigation Area 3

For houses located in or being built on a lot designated in Investigation Area 3 and located within the buffer drawn 100 feet from a mill site or tailing pile, NDEP BCA will recommend soil sampling prior to any soil disturbance. This aids in identifying areas containing contamination near or above action levels and allows planning to avoid disturbing the contaminated material or allows managing the contaminated material selectively if it is disturbed. This effort leads to verification sampling in the yard at final grade with no additional concerns or issues. Properties identified as Investigation Area 3 because they are in the 100-year flood plain or a field subjected to flood irrigation should not require this preliminary characterization.

The Investigation Area 3 sample design will generally consist of four five-point composite samples per lot (see Diagram 1). Refer to Figures 3-1 through 3-3 for suggested schematic designs. Each of the four samples will be composited from five discrete sample locations from the zero to six inch (0-6") depth range and from the six to twenty-four inch (6-24") depth range. Composites consist of aliquots collected from the same depth interval. This sampling is conducted to two feet below final grade or the depth of any planned soil disturbance area.

If contamination above site action levels is detected in the soil within the top 2 feet of the final grade, remediation is performed in order to mitigate the contamination issue. An additional round of sampling using the five-point sample design as described is performed in the section of the yard following the mitigation to verify effectiveness.

Investigation Area 4

Properties located in Investigation Area 4 with existing homes to be renovated or slated for addition or to have new homes built on them should have preliminary soil investigation prior to any soil disturbance. This is the best way to assure that any contamination detected on the property will not be spread further on the property or released from the property. NDEP BCA will work with a property owner to develop a comprehensive and efficient sampling program that will not cause unnecessary delays or costs. NDEP BCA will provide the resources necessary to conduct the preliminary characterization sampling program for private home owners. If contamination is found, the regulatory agencies will work with the property owner to remediate the soil based on the availability of funds.

Verification sampling is necessary to confirm the final grade of the yard meets the CRMS requirements for two (2) feet of clean soil. The Investigation Area 4 sample design will be the same as the Investigation Area 3 verification sampling, consisting of four five-point composite samples per lot (refer to Diagram 1). Refer to Figures 3-1 through 3-3 for suggested schematic designs. Each of the four samples will be composited from five discrete sample locations from the zero to six inch (0-6”) depth range and from the six to twenty-four inch (6-24”) depth range. Composites should consist of aliquots collected from the same depth interval. This sampling is conducted to two feet below final grade or the depth of any planned soil disturbance area.

Figure 3-1
Small Residential Parcel- No Side Yards

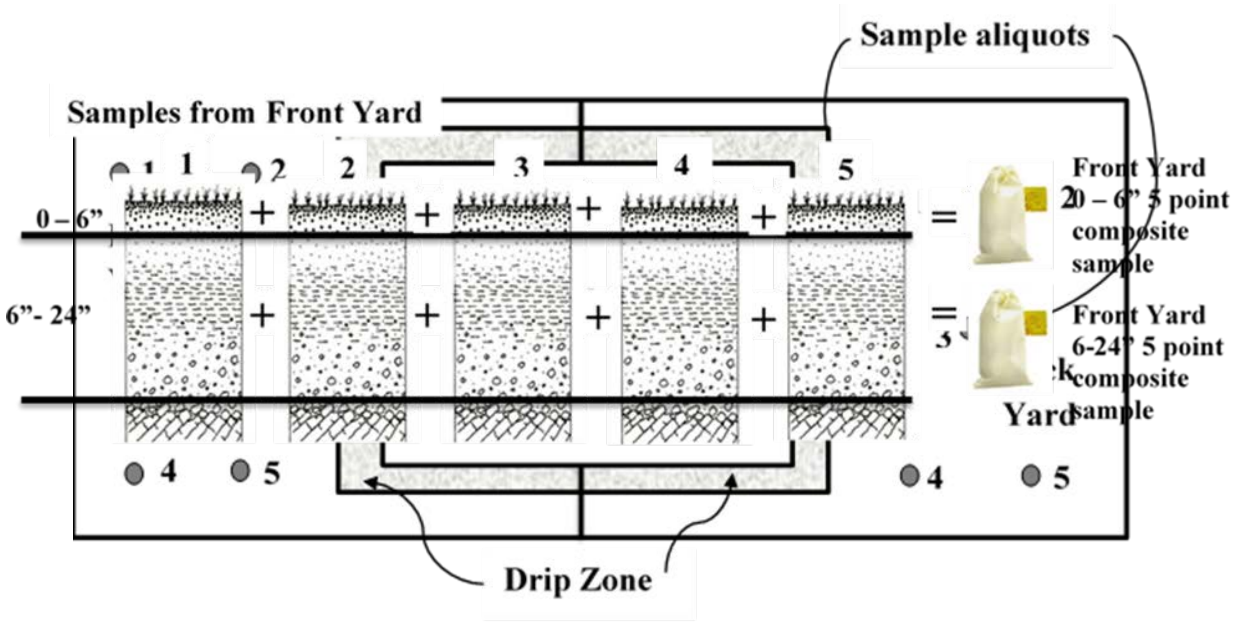


Diagram 1: Five Point Composite Sampling Example

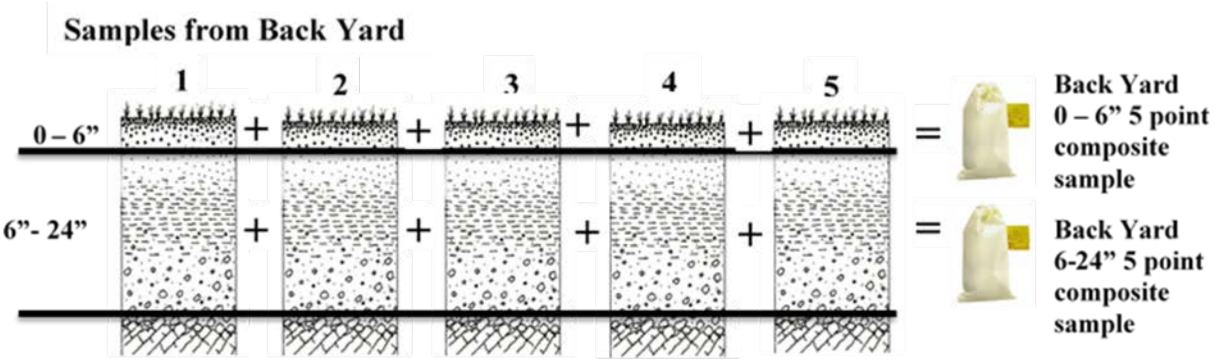


Figure 3-2
Small Residential Parcel- Side Yard

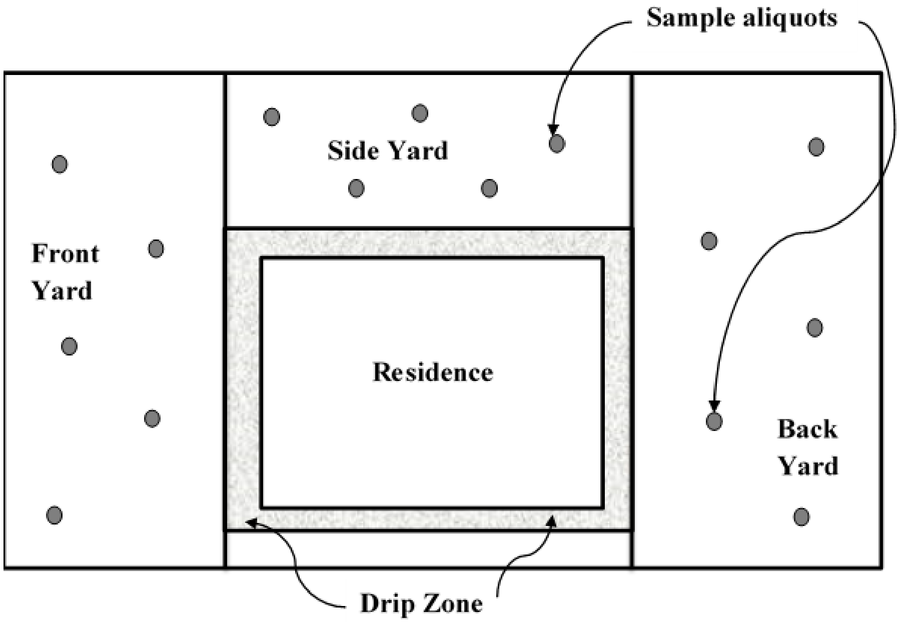
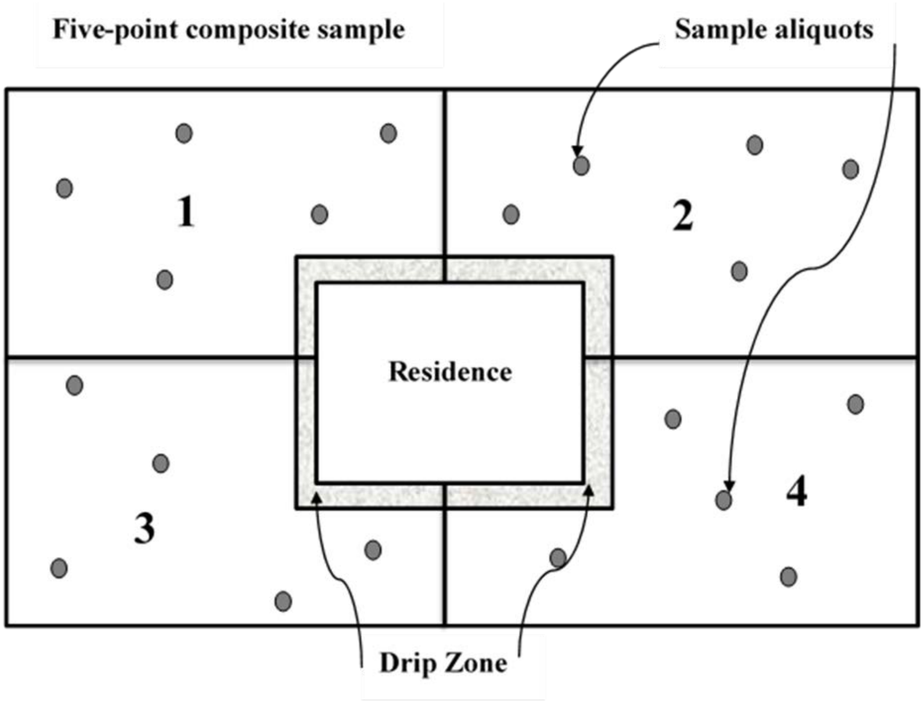


Figure 3-3
Large Residential Parcel > 1 acre



3.4 Sampling Program Reporting

The reporting requirements described below are followed after soil characterization sampling and verification sampling.

3.4.1 Preliminary Preconstruction Soil Characterization Report

The results of the soil characterization sampling are provided to NDEP BCA in a letter report describing the horizontal (five point location) and vertical (0-6" or 6-24") distribution of CoCs associated with the site and a plan for mitigating any soil with mercury, arsenic, and lead above the action levels. Grading activities commence after NDEP BCA reviews and approves the report.

3.4.2 Verification Soil Sampling Report

After analytical results for verification sampling are received by the property owner or his/her representative, a final sampling report is submitted to NDEP BCA in a timely manner prior to residential development or soil disturbance. The final sampling report includes a narrative discussion of the soil characterization and verification sampling events, analytical results from the sampling events, maps depicting sample locations, and copies of the analytical reports. NDEP BCA will notify the property owner or his/her representative of the determination if further sampling or remediation is required. Sampling locations and data must be submitted in both hardcopy and electronic format. GPS-derived coordinates for each sample location corresponding with the total mercury, arsenic, and lead levels encountered shall be submitted electronically to NDEP BCA . This will aid to more accurately refine the investigation boundaries of the CRMS OU-1 for future development.

4.0 Request for Analyses

At the property owner's discretion, samples may be analyzed in the field for mercury, arsenic, and lead using FPXRF technology or submitted to a Nevada-certified laboratory to be analyzed using U.S. EPA SW-846 Method 6010 for arsenic and lead and Method 7471 for mercury. If an FPXRF is used in the field, 1 in 5 or 20% of the sample locations analyzed will have a laboratory duplicate sample split from the same aliquot and submitted to a Nevada-certified laboratory for analysis by Method 6010 and 7471.

4.1 Field Analysis

Property owners or developers will be able to use FPXRF analysis to acquire the majority of their data to satisfy the soil characterization requirements on their residential property. Advantages to FPXRF analysis include that it is typically less expensive to acquire than fixed laboratory methods and it provides real-time data results allowing an investigator flexibility in collecting additional samples from offset locations or at greater depths if they appear merited. There are a number of issues significantly affecting the results obtained using the FPXRF analytical method and the QA/QC controls must be followed closely to assure data quality objectives are met in the study. The FPXRF instrument manufacturer's guidance will be used to conduct analysis with the exception of a site-specific calibration standard to determine possible matrix interference. Replicate samples will be collected for laboratory analysis by Method 6010 for arsenic and lead and Method 7471 for mercury and compared to the field results to determine the accuracy and matrix effects of the XRF method. USEPA Method 6200 provides discussion on many of the factors that may impact the quality of the FPXRF results including matrix interference with the analytes of interest, moisture content of the soil sample, meteorological conditions and other factors. To provide QC for the field analytical effort, the following measures from Method 6200 are utilized:

- The analytical precision of the XRF instrument will be determined by comparison to the laboratory analytical results of replicate samples. The relative percent difference between the field analyzed XRF result and the laboratory analytical result should be ≤ 35%.

- The sensitivity of the XRF instrument will be determined by acceptable method performance on a National Institute of Standards and Technology (NIST) standard reference material (SRM) within the appropriate calibration range for the contaminants of concern. NIST SRM 2709 San Joaquin Soil with certified values of 17.7 mg/kg arsenic and 18.9 mg/kg lead is an appropriate standard reference to check the method detection limit for these two CoCs. NIST SRM 2710 Montana Soil with certified value 32.6 mg/kg mercury is an appropriate standard reference to check the method detection limit for mercury. Because NIST does not have a SRM available that has mercury concentrations in the high ranges that might be found on the CRMS, NDEP BCA and EPA have collected and archived soil samples from the site that contain mercury concentrations in the elevated ranges that one might encounter in certain portions of the CRMS. These samples are considered by the agencies as a known value and may be available to the property owner or developer to calibrate their instrumentation if they are working in a portion of the site suspected to have elevated concentrations of mercury.

- Collect field duplicate samples from 20 percent of the sampling locations. Obtain duplicate samples by collecting a 50/50 split of a single unique sample volume in the field, in order to create two samples for field analysis.

- Analyze QC standard samples after every 20 unique site samples. QC standard samples are known concentration samples and are analyzed to evaluate the standard deviation between the known sample concentrations and field analysis concentrations to provide continued precision and accuracy of the XRF instrument results.

- Submit a minimum of 20 percent of site samples analyzed by XRF to a Nevada Certified laboratory for confirmation analysis of mercury, arsenic and lead concentrations.

4.2 Laboratory Analysis

A property owner or developer has the option to submit all samples collected as part of the site characterization study to a laboratory for analysis instead of performing analysis in the field using a FPXRF instrument. If a property owner uses an FPXRF to conduct analysis, then 20% of the locations sampled in the FPXRF study must also be randomly selected to have additional sample volume collected and submitted to a Nevada Certified laboratory for confirmatory analysis of the FPXRF results. All laboratory samples are submitted for analysis of arsenic and lead using US EPA SW-846 Method 6010 and analysis of mercury using Method 7471.

Additionally, the following quality control samples must be analyzed:

- At a frequency of 1 to 10 (10%) of total samples submitted for laboratory analysis, twice the volume of soil necessary for laboratory analysis will be collected at randomly selected locations and submitted for arsenic, lead and mercury analysis by the same method (blind duplicate). Submit samples to the laboratory using a unique identifier that will not relate the sample to the actual sample location where collected. These samples assess sample collection, handling, and processing error.

- When non-dedicated equipment is used to collect more than one soil sample and equipment is being decontaminated between samples, collect a rinsate blank sample at a minimum frequency of once per day (not including a field duplicate as above or a matrix spike and matrix spike duplicate samples) and submit to the laboratory for arsenic, lead, and mercury analysis to determine the effectiveness of the equipment decontamination process.

- At a frequency of 1 to 20 (5%) of total samples submitted for laboratory analysis, sufficient sample volume will be collected at a single sample location to submit a matrix spike/matrix spike duplicate for laboratory quality control purposes.

More information regarding these quality control samples can be found in Section 8.0 Quality Assurance/Quality Control of this SAP.

5.0 Field Methods and Procedures

The following sections describe field procedures and equipment anticipated by NDEP BCA to be frequently utilized during the site activities. At all times, NDEP BCA is available to answer questions and collaborate with the planning of a comprehensive, site specific, SAP.

Note: Samples collected as part of the LTSRP site characterization and confirmation sampling program described in this SAP are limited to soil samples with one exception. If non-dedicated sampling equipment is utilized for CRMS sampling, rinsate samples are collected to assess the effectiveness of the equipment decontamination process.

5.1 Sampling Equipment

There are a number of different technologies useful in performing an excavation or drilling a borehole into the earth. It is not the intent of this SAP to provide a comprehensive list of those methods and technologies. The intent is to provide a partial list of acceptable sampling tools and methods that may be used in an approved sampling program. The most important factor in deciding the sampling tools to be utilized is the planned depth of sampling. For samples collected between 0 to 2 feet below ground surface, hand tools will likely be satisfactory to reach the desired completion depth with a reasonable level of effort. Beyond a depth of 2 feet below ground surface, the sampler should consider a power tool, such as a power auger or drill rig. Beyond a depth of 5 feet below ground surface, a drill rig will almost certainly be necessary to reach the desired depth in a timely manner and to satisfactorily drive and withdraw the sampling tool.

The soil classifications vary significantly across the potential areas of interest in Operable Unit 1; therefore, soil conditions must be carefully considered when selecting the sampling tool used. Some tools work well in only fine-grained soils while other sampling tools are better adapted for coarser soils. Due to the nature of characterizing the CoC in the CRMS, an undisturbed or slightly disturbed soil sample is not critical to these studies. Tools like trowels and shovels, which only allow for the collection of a disturbed sample and are well-suited for collecting soil that consists of grain sizes larger than coarse sand to gravels are appropriate for sampling in these studies. Any description of the condition of the undisturbed strata can be logged from walls of the pit or hole created to collect the sample.

Note that grain sizes greater than medium sands or retained on U.S. Sieve Size #60 (approximately 250 microns ⌀) are not of significant interest when performing FPXRF analysis and these large soil grains can be selectively removed in the sampling process. The FPXRF samples are biased to remove the larger grain sizes, either by mechanical means using a sieve or by grossly estimating the grain size by eye and selecting the fine grain sizes purposefully with the sampling tool while removing the largest sands and gravels by hand. It is important to collect the laboratory duplicate samples in the same manner to maintain consistency.

When possible, use stainless steel sampling tools to reduce contamination potential due to corrosion of untreated and common steel. Decontaminate sampling tools not dedicated to the collection of one sample at one location in between uses in the manner described in Section 5.4.

<u>Sampling Tools:</u>

- **Spoon**- Best for near surface sampling and removing deeper soil from hand-dug holes reached at arm's length. Also valuable for mixing/homogenizing samples.
- **Trowel**- Best for near surface sampling and removing soil samples from deeper holes. Also used for sample mixing and homogenization. Because of its pointed tip and generally thicker gauge construction, it may be a better, more durable digging tool than a spoon.
- **Scoop-** Best for near surface sampling and removing deeper soil from deeper holes. Also used for sample mixing and homogenization. As with a trowel, a scoop might be preferable to a spoon for digging because of thicker gauge construction and better durability.
- **Tulip-Bulb Planter-** Similar in shape to a trier, but generally with a much larger diameter to length ratio, this device can be useful for removing a circular quantity of soil to a depth of up to approximately 1 foot. It has no trap and performs best in moist, fine-grained soil that is not too compact.
- **Trier-** A long hollow tube cut in half lengthwise with the bottom end open and a T-shaped handle at the top. The edges of the open tube and bottom are sharpened with a knife-like edge to aid in penetrating the soil and cutting a core by rotating the handle when the trier has reached the desired depth. It is best suited for soft soil and sediments.
- **Spade or Shovel-** Best for near surface sampling, especially if the plan bottom depth of the sample location is less than or equal to 2 feet. Used in conjunction with other sampling tools to quickly advance a sampling location down to the next deeper sampling elevation and then using a smaller more dexterous tool to collect the desired soil sample.
- **Hand Auger-** Somewhat similar to a trier, a soil sampling hand auger consists of a hollow tube with two auger-type curved blades on the bottom to aid in cutting the soil and driving the sampler deeper as it is twisted while applying downward force. The sampling tube is typically 2 feet in length and attached to several feet of rod with a T-shaped, chest high, handle at the top and the auger blades are on the ground. It is often designed with a screw-on handle that allows the addition of more rods to increase the sampler's length and permit deeper sampling. This sampler is better suited for denser or more rocky soils than a trier.
- **Split-Spoon Sampler-** This sampler is a tube split into two equal halves along the length and held together by a head and a hardened shoe. The drive head is attached to the upper end of the tube and serves as a point or attachment for the drill rod. The removable tapered nose piece or shoe attaches to the lower end of the tube, facilitating cutting. While the split-spoon sampler can be fabricated to be driven by hand, it is typically a sampler used with a motorized drill rig and often driven ahead of the drill string through hollow-stem augers.
- **Shelby or Thin-Wall Tube Sampler-** This sampler is designed to recover an undisturbed core of fine-grained cohesive soil. It also has application in sludge and fine-grained sediment sampling. It is typically designed to recover a 24-inch core of soil and the tube walls have a

tapered knife-like edge to aid in penetration of the soil. The top end of the tube is fabricated to allow attachment by a fitting to the drill string. Its primary purpose is the collection of soil for geotechnical testing or permeability tests where collection of an undisturbed sample replicating the in-situ conditions is significant. In order to assure an undisturbed condition, the sampler must be driven by a continuous force such as hydraulic direct-push system. Use of percussion drilling with this type sampler will not provide an undisturbed sample. Because the appropriate soil conditions for this type of sampler rarely occur in the CRMS and an undisturbed sample is not necessary, this type of sampler is not expected to be used in these site characterizations. There are other sampling tools and systems available. The primary considerations are the sampler's suitability for the soil conditions and the expected maximum depth of sampling. Samplers poorly suited for the conditions can result in loss of sample recovery, difficulty in use and low durability.

<u>Powered drilling and digging methods:</u>

As stated above, if the site characterization plan calls for limiting the sample depth to a maximum of 2 feet below the existing ground surface, it will likely be more economical and just as expeditious to sample the locations by muscle-powered methods. If the site characterization plan calls for numerous sample locations 5 feet below grade and deeper, some type of machine-driven method is likely advisable.

If a machine is used to advance the depth of the investigation, all parts in contact with the surface or sub-surface must be decontaminated as described in Section 5.4 between sample locations to prevent cross-contamination.

- **Power or Motorized Auger-** Most frequently associated with digging fence postholes, this is a motorized device that can rotate an auger flight into the ground. It is generally limited to a maximum depth of one, 4 to 5 feet length auger flight. The soil is removed from the advancing auger by being forced up along the screw-like turning blades of the auger and is deposited at the ground surface around the auger. It is best to sample by advancing the auger to a planned depth of interest, remove the power auger from the boring and driving a sampler through the depth interval desired.
- **Direct Push Drilling-** Direct push drilling has a number of advantages over more traditional drill methods in the field of environmental sampling. It operates using hydraulic force created by the drill rig to push a string of relatively small diameter drill rod into the ground. A conical-tip slightly larger than the drill rod can be used on the end of the drill string to aid in advancing the boring or a continuous soil core can be collected by using special hollow drill rod with a tool on the end that looks similar to a split-spoon sampler shoe. The drill rod is generally fitted with an inner sleeve that can be used to remove the recovered soil core with minimal disturbance of the sample. Advantages include the generation of less investigation-derived waste because there are little or no cuttings and the generally smaller size drill steel is easier to carry and decontaminate. Disadvantages include difficulty in advancing the drill string through well-compacted strata and strata containing large gravels, cobbles and boulders.
- **Truck- or Track-Mounted Rotary Drilling-** Rotary drilling methods are frequently used for environmental sampling investigations because they allow for relatively quick advancement of the drill string through a wide-range of varying geologic formations. They also adapt well to allowing a number of different borehole completions such as groundwater monitoring wells and inclinometers.

Most rotary drilling rigs will use hollow-stem augers fabricated in nominal 5-feet flights to advance the boring. When the sampling depth of interest is reached by the bottom of the hollow-stem auger string, the augers are disconnected from the drill rig beneath the rotary table and the table is moved off the drill string to give access to the open hollow-stem augers and the boring. A separate string of smaller diameter rod with a sampler attached is lowered into the hole by means of a cat-head and is generally driven by a 140-lb hammer free-falling through a vertical height of 30-inches, also known as the standard penetration test or SPT. The number of blows required to drive the sampler through 4 x 6-inch intervals are recorded with the total number of blows to drive the sampler through the second and third 6-inch intervals counted as the SPT value. Note the SPT value is only valid when using a nominal 2-inch diameter split-spoon sampler in cohesionless (i.e., non-plastic) soil.

- **Backhoe or Excavator-** Two types of heavy equipment used for the excavation of test pits are a backhoe and an excavator. A backhoe has a bucket that draws into towards itself and is attached to the tractor and the hydraulic power system by a two-piece articulated arm that are called the boom arm (connected to the tractor) and dipper arm (connected to the bucket). An excavator works the same way but is generally operated from a cab mounted on an undercarriage that allows it to rotate 360°. Both machines can rapidly excavate through unconsolidated material and are generally limited in depth by the depth to rock or the reach of the boom and dipper arms.

<u>Accessory Sampling Equipment and Supplies:</u>

Other equipment and supplies are required in order to process, analyze, store, ship and record the samples collected in the site characterization study. The following list is not comprehensive but is a general checklist recommended to satisfy the requirements identified in the SAP.

- **FPXRF Analyzer-** The field portable x-ray fluorescence analyzer instrument should be checked to assure it is in good working order. At least one spare rechargeable battery is recommended to have a back-up power supply in the field. The quality assurance program requires a standard reference material source is analyzed at the start of the day and re-analyzed every 20 samples to meet the target performance criteria based on the relative percent difference to the known standard. Periodic performance checks are recommended to assure the FPXRF continues to meet the SAP criteria and the battery strength is sufficient for it to operate satisfactorily. Discussion of additional quality assurance/quality control criteria are in Section 8.0.
- **Stainless-Steel 250 Micron Mesh Sieve (U.S. Sieve Size #60)-** A standard laboratory stainless-steel mesh sieve equal to 250 micron openings or U.S. Sieve Size #60 should be used to separate the soil sample into +250 micron fraction and -250 micron fraction. The +250 micron fraction can be returned to the sample location and the -250 micron fraction is retained for FPXRF analysis. In coarse-grained soil material, it is useful to have a larger size sieve on top of the #60 mesh sieve, such as a ¼-inch mesh size to break the soil fraction farther and reduce the load and quantity of sample on the #60 mesh sieve. A compatible bottom pan that fits the sieves is also available to conveniently catch the -250 micron sample fraction. Decontaminate the sieves between samples.
- **Stainless-Steel or Aluminum Bowls or Baking Pans-** Stainless-steel or aluminum bowls or baking pans are excellent containers to perform sample homogenization.
- **Laboratory Supplied Sample Containers-** Samples shipped to an approved-analytical laboratory should be placed in pre-cleaned sample containers provided by the laboratory.

This helps assure that the adequate sample size is collected for the analysis requested by filling the supplied container.

- **Shipping Labels-** Self-adhesive shipping labels should be used to label each sample container with, minimally, the sample location ID, the date and time the sample was collected, and the requested analysis.
- **Clear Plastic Zip-Lock Baggies-** Clear, plastic zip-lock baggies can be used to hold the sample while shooting with the FPXRF analyzer and also to store additional volume of sample while waiting for the analytical laboratory results or to test at a future date. Additionally, they can keep the sample containers dry while in the cooler and keep the melted ice from filling up the cooler and leaking during transport. They are also convenient for protecting the chain-of-custody paperwork while in the cooler.
- **Coolers-** Coolers chilled with ice or blue ice packets should be used to store the samples in the field once collected and also to ship them.
- **Ice-** Used for sample preservation as described above.
- **Polyethylene Sheeting-** Used to cover the ground surface where decontamination activities are occurring and to create a protective, removable layer between any working surface where the sample preparation and field analysis activities are performed.
- **Felt-Tipped Marking Pen-** Valuable for writing sample shipping labels.
- **Clear Plastic Shipping Tape-** Protects self-adhesive labels from moisture and seals the shipping coolers.
- **Distilled De-Ionized Water-** Used for collecting a rinsate sample from non-dedicated sampling devices in accordance with the SAP.
- **Potable Water-** Necessary for creating a non-phosphate soap wash and rinse of non-dedicated sampling devices and downhole equipment in the decontamination process.
- **Five-Gallon Garden Sprayer-** Used for rinsing the decontaminated sampling equipment with potable water.
- **Five-Gallon Pails or Wash Tubs-** Pails or wash tubs to contain non-phosphate soap wash water and rinsate for the non-dedicated sample equipment decontamination process.
- **Aluminum Foil-** Used for wrapping the decontaminated sampling equipment after it has air-dried and is transported between sampling locations or is stored for next use.
- **Chain-of-Custody Forms-** Chain-of-custody forms as required in Section 8 to accompany all samples shipped for chemical analysis to an Agency-approved laboratory.
- **Field Logbook-** To record all data and observations made in the field, exceptions made from the approved SAP and the site-specific site characterization plan, and other work details. A comprehensive list of logbook entry requirements are described in Section 8.0 of this SAP.
- **Health and Safety Equipment-** Necessary health and safety equipment as defined in the site-specific health and safety plan.
- **Global Positioning System (GPS) Device-** A GPS device of sufficient accuracy to locate the sample locations to within a meaningful resolution. For example, if the site characterization being performed is a pre-mass grading survey for a large subdivision that will involve the disturbance and development of hundreds of acres of ground surface, a GPS unit accurate to < 3.0 meters might be sufficient. If the site characterization being performed is to clear a residential yard for occupation that is < 0.5 acre and five point composite samples are being taken in the front and backyards, then the accuracy of each sample point location should be 1.0 meter or less.
- **Survey Stakes or Flags-** To mark sample locations.

- **Measuring Tape and Folding 6-Feet Rule-** For measuring distances accurately in the field and for measuring and accurately describing soil and strata characteristics.
- **Camera-** To provide a photographic record of key observations and conditions in the field.

5.2 Soil Sampling Procedures

As discussed above, a number of tools and techniques can be used to collect soil samples in a site characterization performed under the LTRSP. Regardless of the tool used to collect the sample, it should be pre-cleaned prior to its use in the field. Decontamination procedures for non-dedicated sampling tools that come in contact with soil or any potentially contaminated media are provided in Section 5.4 and are required between sample points. Performance and operational checks on analytical instruments and other data collection instruments used during sampling is addressed in Section 8.0.

5.2.1 Sample Locations

Determine sample locations based on the site-specific characterization plan. Mark locations prior to initiating the sampling activities to assure meeting the plan design objectives. Specifically, to meet plan objectives, field conditions must allow for the identified sample locations be accessible and that issues such as buried or overhead utilities, existing structures or other physical barriers to collecting the soil samples do not interfere with the sample design. The most effective way to identify and determine any existing issues is to have the property surveyed and marked by the appropriate underground utility location service and then to mark out the planned sample locations. Any offsets to the locations or elimination of sample points can then be done in a manner that least impacts the sample design plan's goals.

Provide measurements in a standardized coordinate system that is recognizable by the GIS and in such a way that they can be located on a map at a scale that is meaningful to the property size. Standard land survey techniques are likely the most accurate method to locate the sample point locations but may be prohibitively expensive. A GPS device is an acceptable method but the accuracy must be commensurate with the areal separation of the sample points. Each of the five points sampled in a portion of a residential yard need to be discernable from each other, so a high-resolution GPS device is recommended with accuracy < 1 meter to locate sample points in such close proximity.

5.2.2 Soil Logs

Field logs include the Unified Soil Classification System description of each strata encountered and the depth at which any change in stratum is noted. Describe other important details such as color, mineralogy, structural features, matrix and clast description, and other geologic or pedological characteristics observed by the field technician. For samples collected in a sampling device, describe soil in the device after it has been open. For samples collected from hand-dug holes or machine dug excavations, describe the soil from the hole or pit walls after any smearing from the digging equipment has been carefully cleared. Health and safety considerations are of primary importance in any sampling plan excavating test pits below 2 feet in depth and the site-specific investigation's health and safety plan will identify the safety procedures during pit entry. Pit walls can be logged from the ground surface if necessary with more detailed description of the soil acquired by using the shovel or excavator bucket to carefully remove individual stratum from the excavation wall to be analyzed closer by the field technician. Record field logs either in the field log book or enter on specialized log sheets.

5.3 Field Analytical Procedures

5.3.1 Sample Preparation and Homogenization

Samples should be dry prior to analysis. If the soil is moist or damp, allow it to air dry out of direct sunlight until the sample is less than 10% moisture content. The soil sample must be in a condition to allow the fine particles to pass through the fine sieve without a significant fraction adhering to the stainless steel mesh. In order to minimize the loss of any free mercury which might be in the sample, do not heat or dry the sample in direct sunlight.

The homogenization process must be done thoroughly and can be done in a stainless steel bowl, aluminum baking pan or plastic bag. If homogenized in a bowl or baking pan, the soil must be mixed by turning the material from the bottom of the container and poured back onto itself using a spoon or trowel. If the material tends to adhere or clump together it is too moist. It is hard to define the number of times or length of time to appropriately mix the sample in this way, but 25 times might be a good basis. Note that if you tend to pull the sample into a little stockpile while mixing, this tends to cause larger soil grains to fall towards the bottom and exterior of the pile. Bring the material together and spread it evenly on the bottom of the mixing container during the process. Spread the material evenly before containerizing the sample for analysis. If you chose to homogenize the sample in a plastic bag, be sure to flip the contents such that all material mixes. If you mix the bag by turning it right-side up and upside down repeatedly, the larger and heavier grains will tend to fall to the bottom of the bag first causing undesirable segregation. Mix the material by moving it in the bag horizontally and vertically.
When sufficiently dry, the sample is to be sieved through standard laboratory stainless-steel mesh sieve equal to 250 micron openings or U.S. Sieve Size #60. The sample passing though the sieve is retained and can be placed in a clear plastic zip-lock bag or plastic XRF sample cup with mylar film cover. Significantly less sample volume is required when using a plastic sample cup. The sample cup must be filled such that the mylar film fits over the top of the cup tightly without observable void space between the sample and mylar film. If a plastic bag is preferred, a clear polyethylene of standard thickness is to be used. It will be necessary to determine if the polyethylene is affecting test results by comparative analysis discussed in Section 8.1.

5.3.2 Sample Collection

Five point composite samples are to be composited and homogenized at similar depth intervals from all sample points (refer to diagram 1 below). In other words, the 0- to 6-inch depth interval should be collected, composited and homogenized from all five sample points first before proceeding to the 6- to 24-inch interval. This is to include processing the sample through the 250 micron sieve (#60 mesh size) and then homogenizing the sample.

Fill the FPXRF sample and then the laboratory-supplied containers making sure there is sufficient volume for all analyses and QA/QC duplicates that are necessary. Any field duplicate sample containers should be filled contemporaneously with the original sample container by alternating filling of each duplicate container until all are filled. Laboratory containers should be labeled quickly and stored in an iced cooler for preservation.

5.3.3 FPXRF Field Analysis

The FPXRF user must have basic understanding of the theory outlined in part below and be familiar with the operation of the specific instrument being used to obtain data of sufficient quality and reliability for the intended use of the findings; i.e., site screening or risk-based closure. All the instrument manufacturer’s directions should be followed and special attention should be made for any information or recommendations the manufacturer can provide on the instrument's performance in the detection of the CoCs.

5.3.3.1 Basic XRF Theory

In short, XRF analysis uses the phenomenon of x-ray emission produced at a characteristic energy or wavelength when electrons from the K, L or M shell of an atom are "excited" by a higher energy causing them to be ejected from their stable state with a higher energy outer shell electron falling to the lower energy shell to replace it. The transfer of the electron from the higher energy shell to the lower energy shell produces an x-ray emission as it loses energy at a specific wavelength and this release of energy is known as fluorescence. Detecting the wavelengths of the particular energies emitted during this phenomenon can be used to identify the elements present as it is specific to its atomic configuration. In addition to identifying atoms present in a sample that meet the above electron orbitals, the abundance of the various x-ray peaks detected can be used to determine the relative concentration of these elements in the sample. A FPXRF consists of an x-ray source that produces energies in the range necessary to cause the fluorescence phenomenon to occur, an x-ray detector that converts the x-ray energies detected into electronic signals and a computer processing unit that measures and converts the electronic signals into the data identifying the elements present and their concentrations.

The main variables that affect precision and accuracy for XRF analysis are:

1. Physical matrix effects (variations in the physical character of the sample);
2. Chemical matrix effects (absorption and enhancement phenomena);
3. Spectral interferences (peak overlaps); and
4. Moisture content, which causes an effect on precision and accuracy when above approximately 10 percent.

Section 8.1 provides detailed procedures to determine the FPXRF's performance. It will be necessary to complete the evaluation of the instrument **prior** to the collection of field data. The evaluation requires statistical comparison of analytical results collected from samples of known concentration and from samples collected from the site location.

5.3.3.2 Sample Analysis with the FPXRF

After the sample has been sieved to remove medium sand (>250 micons) and larger particles and properly homogenized as described in Section 5.3.1. above, sufficient volume of sample should be placed in a commercially available sample cup or other non-metal container for analyses using the FPXRF analyzer. Note that sample cups marketed for use in XRF analysis are designed to accept a transparent mylar or other plastic film over the top of the cup to secure the sample and prevent dust from settling on the sample potentially contaminating it. There should also be a thin clear plastic window covering the FPXRF window to prevent dust from contaminating this critical area. The window serves as the port where the excitation beam is emitted while simultaneously the fluorescent energy is received back from the sample for processing and analysis. Investigators may choose to use a zip-loc plastic bag to store the sample for analysis. This is acceptable, however; a clear plastic at the minimum functioning thickness should be used to prevent energy scatter in voids between the plastic films. Textured plastic bags should not be used at all as these only increase the air gap between the sample and the sensor.

Operating instructions provided by the instrument's manufacturer in the operation manual are to be followed. FPXRF analyzers typically have the option of operating the device in one of several modes to tailor the device to different end-users needs (i.e., detection of lead-based paint, composition of metal alloys, soil and mineral ore analysis, etc.). These modes often operate through the amplification of detected signals within certain excitation energy levels to improve the detection limits of particular elements of interest. The investigator operating the FPXRF needs to understand the purpose and effect of the modes or filters the selected instrument operates under and select the one most appropriate for the soil investigation. This will likely be for soil analysis, if such an option is available.

In general, these instruments are operated similar to a gun using a "*point and shoot*" technique. A deadman switch that initiates the emission of x-rays from the instrument is configured as a trigger and the x-ray emissions window is analogous to the muzzle. The emissions window is positioned firmly on the sample being measured with no gaps between the window and sample surface, this improves the transmission of the beam of exciting energy emitted from the device, recovery of the returning fluorescent energy to the device's detector and reduces potential scatter x-ray energy and therefore unintended exposure of radiation to the operator. The instrument will have a timer which will control the length of time the unit is emitting and detecting the x-rays with the trigger depressed. This time period is called the read, measurement or acquisition time of the analysis. While the data is generated, the instrument will be creating a spectrograph of the resulting data to determine the elements present and their relative concentrations. The longer the unit analyzes the sample, the lower the detection limit results achieved by the device for a given analyte. The instrument evaluation procedures presented in Section 8.1.1.3 will help determine the appropriate read or measurement time that is necessary for the investigation, but these times generally are between 40 to 60 seconds per sample analysis. It is likely that the spectrographs generated by the FPXRF will include a suite of metals beyond the site CoCs of mercury, arsenic and lead. It is not necessary for the investigation to report these findings in the investigation report. The complete results should be monitored by the investigator in the field; however, especially paying attention to the relative presence of arsenic and lead as these peaks could interfere with one another, in particular high lead concentrations masking the presence of arsenic.

FPXRF instruments on the market today have the ability to log and save each test result internally with sufficient memory to store hundreds or thousands of analytical data sets. In addition, most of these instruments provide the capability of associating important sample information such as sample identification, coordinate location, sample depth and/or elevation and will likely automatically date and time stamp the collection of the sample with the analytical results. It is not necessary that the sample data be completely identified in the field, so long as the investigator as enough information to accurately complete this information for each sample point later. The analytical data is viewable in the field on the device and can be downloaded from the device for review and statistical analysis later. The ability to acquire such immediate analytical information gives the site investigator the flexibility to modify the investigation's focus should unexpected levels of contaminants be detected.

5.4 Laboratory Analysis Samples

As stated in Section 4.2., it is necessary to collect duplicate samples at 1 of every 5 (20%) XRF sample locations to be submitted for inductively-coupled plasma/atom emission spectrometry by EPA Methods 6010 and 7471 to a qualified analytical laboratory. Some additional QA/QC samples are also necessary at frequencies as specified in Section 4.2 to determine MS/MSD interferences and as laboratory performance checks. Where these samples are collected, the laboratory supplied sample containers are to be filled contemporaneously with the collection of the FPXRF samples. The laboratory containers should be filled completely and stored in an iced cooler while in the field.

5.5 Field Decontamination Procedures

Decontamination is to be performed on all non-dedicated sample handling devices. The following sequential procedure is to be used:

- Gross contamination and soil is removed first by brushing or wiping the device to remove as much visible contamination as possible;
- A non-phosphate detergent and tap water wash using an appropriate brush to scrub off fine particles and any oils or grease;
- Thoroughly rinse the device using tap water;
- Rinse again with deionized/distilled water;
- Allow to air dry.

Stainless steel wire mesh sieves are to be decontaminated prior to preparation of each new sample, except where duplicate samples are being prepared. Of significant concern is the length of time the sieves will require to adequately air dry if water is used in the cleaning and rinsing process. These devices can be decontaminated with non-phosphate detergent and tap water and washed and rinsed with deionized/distilled water as described above. It is also acceptable to brush and wipe gross contamination and soil from these devices and then wash and rinse them using 70-100% isopropanol. This will decrease the time required to air dry the sieves making them ready for their next use more quickly.

6.0 Investigation-Derived Waste

The field activities and sampling and analysis tasks will generate several different waste streams of potentially contaminated wastes. These waste streams include:

- Used personal protective equipment (PPE);
- Disposable sampling equipment;
- Excess and/or post-processed sample material;
- Decontamination fluids.

Prior experience working and conducting sampling programs on the CRMS has demonstrated that PPE and disposable sampling equipment can be treated as non-hazardous waste and compliantly managed and disposed of as municipal solid waste in the majority of cases. However; the project manager of the sampling program should exercise professional judgement in determining if any waste characterization is necessary to make this determination. This decision should largely be determined by the site conditions and contamination levels encountered during sampling. Large sites under investigation might have “hot spots” of contamination where it makes sense to segregate wastes generated from sampling in those particular areas from the rest of the site to reduce the volume of potential hazardous waste generated.

It is compliant to return unused and excess volumes of sample back to the location from where they were gathered. It is anticipated in this SAP that much of the sample processing and analysis will be conducted in the field and on the site where the samples were collected; therefore, it should be convenient to discard of excess sample volume in this manner. It will also generally be compliant to discard the spent decontamination water and rinse water to the ground surface if the quantity is only several gallons and it will quickly infiltrate the soil where it is poured. This should only be done if the decontamination fluid and rinsate consists of non-phosphate detergent and water. These fluids are not to be poured in a gutter or on any impermeable pavement or surface will they will flow as storm water. Spent isopropanol wash and rinsate waste need to either be placed in a large pan or tub where it will evaporate or managed through compliant offsite disposal.

7.0 Sample Identification, Documentation and Shipment

7.1 Sample Identification

Each sample is to be assigned a unique identifier. This identifier is to be formatted such that it will indicate the location where the sample was collected down to the individual points of each composite sample. Specific sample identification is necessary to clearly identify each proposed sample in the SAP and its proposed location. It is also necessary to identify the field and laboratory analytical results. The final report as discussed in Section 3.4. will include a figure(s) that maps the actual sample location determined in the field.

A specific identification format is not mandated for these soil characterization studies, however; a suggested format for a system of unique sample identification includes:

- Sequential sample number that counts every sample planned under the sample program (e.g., S-1, S-2, S-3, …);
- Letter sequence that identifies each unique point combined in a composite sample (e.g., S-1A, S-1B, S-1C, …);
- Depth value to indicate the range or a segment of the range of depths from which the sample was collected (e.g., S-1A-0_6”, S-1B-0_6”, S-1C-0_6”, …)

Depending on the size of the planned sampling program and the project objectives (i.e., pre-site characterization or finished grade verification sampling), additional modifiers might be added to the sample ID to further differentiate each sample from other locations in a sampling program. Geographic-based information like a planned unit of a subdivision or an assessor’s parcel number or the date the sample was collected can be added to further refine a sample identification system if necessary. When determining the identification format to be used, keep in mind that the identification will need to be written on the sample container labels, chain of custody forms and other documentation. It should be as short and simple as possible while still being able to clearly and accurately identify each sample uniquely.

7.2 Sample Containers, Preservation and Holding Times

7.2.1 Sample Containers

All sample containers should be new and unused prior to arriving at the project site. Samples collected for laboratory analysis should be collected and shipped in new containers provided by the laboratory. Any containers used for holding the sample temporarily or processing of the sample while mixing and homogenizing or sieving to remove the coarse grain fraction are to be pre-cleaned using the decontamination procedure described in Section 6 and brought to the site wrapped or protected from contamination by dust or contact while in storage and transit. Samplers and other staff that might handle these containers as part of the preparation for fieldwork are to remember the target analytes are mercury, lead and arsenic and should avoid potential causes of cross-contamination such as atmospheric mercury through exposure to dust and precipitation.

7.2.2 Sample Preservation

Soil samples should be kept in a cool, dry place out of direct sunlight. Every effort should be made to collect sufficient sample volume and perform the required processing as soon as practical following the soil’s removal from the ground. Be aware that mercury can volatilize, so while it is necessary to thoroughly mix and homogenize each sample as described in Section 5.3.1., this should be done out of direct sunlight if possible and after the sample preparation is complete (i.e., homogenization and sieving if necessary), the sample should be placed in the appropriate shipping container as soon as possible. If samples must be stored prior to FPXRF analysis, they will be placed in an iced cooler until they can be analyzed. Samples being shipped to laboratory for analysis will also be stored in an iced cooler until the cooler can be prepared for shipping and transportation to the laboratory.

No preservatives other than protected cover and cooling will be necessary except for the rinsate blank quality control samples. These samples will be analyzed by the laboratory and collected when non-dedicated sampling devices are used. These samples are to be preserved using nitric acid and the sample bottle should be delivered from the laboratory spiked with nitric acid for this purpose. Most likely, it will be a 500 ml plastic bottle. Be careful not to overfill this bottle when pouring the deionized water over the sampling device as this will dilute the intended pH of the preserved rinsate sample. If the laboratory does not provide you with a spiked bottle, discuss with the selected laboratory what quantity of reagent grade nitric acid is to be added to the bottle and will be necessary to achieve the desired pH.

If final sample packaging and documentation is prepared at the end of the day prior to shipment, refresh the ice in the coolers to assure there is sufficient quantity to maintain the desired temperature for the expected length of the trip to the laboratory.

7.2.3 Sample Holding Times

Holding times for mercury by EPA Method 7471 are 28 days from date of collection. Holding times for lead and arsenic by EPA Method 6010 are 180 days from date of collection. It is important to note that holding times are valid only if the samples are kept in an appropriate climate-controlled environment during storage.

7.3 Sample Labeling, Packaging, and Shipping

7.3.1 Sample Labeling

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. Sample labels will be affixed to the sample containers and will contain the following information:

- Sample Identification Number;
- Date and time of collection;
- Site Name;
- Analytical parameter and method of preservation.

7.3.2 Sample Packaging and Storage

Samples will be stored as described above in an iced cooler or appropriately cooled container where they are shielded from excessive heat and direct sunlight while waiting for field analysis or final documentation and shipment to the selected laboratory. The samples will also remain under the sole control of site personnel and/or are secured in such a way that only approved site personnel can gain access to them. Storage of samples prior to analysis should be minimized and samples should be shipped the same day they were collected and prepared for analysis. If being analyzed by a laboratory, samples should be sent for immediate delivery to the laboratory at the end of the day when all of the planned samples have been collected and packaged for shipment. If samples cannot be analyzed or shipped on the same day they were collected, the sample's environment will be rigorously maintained to assure temperature and access control are adequate.

7.3.3 Shipping and Chain of Custody Forms

Chain-of-custody forms will be maintained for all samples to be removed offsite for analysis from the time the sample is collected until its final deposition. Every transfer of custody must be noted and a signature affixed. Corrections on sample paperwork will be made by drawing a single line through the mistake and initialing and dating the change. The correct information will be entered above, below, or after the mistake. When samples are not under the direct control of the individual responsible for them, they must be stored in a locked container sealed with a custody seal.

The chain-of-custody form must include the following:

- Sample identification numbers
- Identification of sample to be used for Matrix Spike/Matrix Spike Duplicate (MS/MSD) purposes
- Site name
- Sample date
- Number and volume of sample containers
- Required analyses
- Signature and name of samplers
- Signature(s) of any individual(s) with control over samples
- Airbill number
- Note(s) indicating special holding times and/or detection limits

The chain-of-custody form will be completed and sent with the samples for each laboratory and each shipment. Each sample cooler should contain a chain-of-custody form for all samples within the sample cooler.

8.0 Quality Assurance and Control (QA/QC)

The QA/QC requirements described below include requirements to be implemented for both the use of FPXRF and laboratory-based analyses. As noted earlier, comparison of field-based analytical results (i.e., FPXRF data) to laboratory-based analysis will serve as a necessary quality assurance element to allow decision-making level use of the FPXRF analytical data collected in the field. There are also requirements described below that represent quality assurance elements for the laboratory-generated data.

EPA requires that an approved quality assurance project plan be in place for any environmental data operations funded by EPA (EPA Requirements for Quality Assurance Project Plans: EPA QA/R5: March 2001). This applies to any site characterization study performed on the CRMS by NDEP BCA under the LTSRP. A quality assurance project plan is also required for any environmental data operations where NDEP BCA and/or EPA will be asked to use the data gathered to make a decision. The QA/QC program described in this SAP will be accepted for use in any site characterization studies performed under the LTSRP. Any deviations from the elements of this QA/QC program need to be clearly identified in the proposed SAP for consideration by EPA and NDEP BCA prior to beginning sampling activities.

8.1 FPXRF Quality Assurance Requirements

The analytical procedure described below is intended to determine the FPXRF analyzer’s performance in accurately detecting and measuring the concentrations of the contaminants of concern in general and to alert the user if site-specific conditions are effecting results due to one or more of the variables identified in Section 5.3.3. FPXRF Analysis. If the instrument performance is being adversely effected, the performance and calibration checks described below may help to make adjustments in the field. This quality assurance procedure is in addition to comparison to the laboratory-generated data, which is not likely to be available until the fieldwork is complete.

8.1.1 FPXRF Performance Evaluation and Calibration

The following procedure is adopted from EPA's Office of Research and Development's draft standard operating procedure (Personal Communication, Deana Crumbling, USEPA ORD, July 13, 2017) for assessing FPXRF instrument precision and bias. It should be used to evaluate the performance of a FRXRF prior to collecting field data. This evaluation is necessary in obtaining data that is scientifically and legally defensible. It is an important element in determining data usability in any investigation, but is especially important if the instrument is a rental or used only as a screening tool and its performance has not been similarly verified in the past. A record of the data and statistical analyses performed using this guidance are required to be submitted as an appendix or addendum to the investigation's findings report. The record is to include a copy of the certificate of analysis of the Standard Reference Materials™ (SRM) or certified reference materials used and any correction factors deemed necessary based on the performance of this calibration will be discussed in the site investigation findings report.

8.1.1.1 Standard Reference Materials

The term Standard Reference Material™ (SRM) refers to a certified reference material that is commercially available from the National Institute of Standards and Technology (NIST) and the term is a registered trademark used by that organization. A SRM™ issued by NIST meets the criteria of a certified reference material as defined by the International Organization for Standardization (ISO) and meets additional NIST-specific certification criteria. Each SRM™ is issued with a certificate or certificate of analysis reporting the results of its elemental constituent concentrations and provides information regarding the appropriate use(s) of the material. As stated by NIST, a SRM™ is prepared and used for three main purposes: (1) to help develop accurate methods of analysis; (2) to calibrate measurement systems used to facilitate exchange of goods, institute quality control, determine performance characteristics, or measure a property at the state-of-the-art limit; and (3) to ensure the long-term adequacy and integrity of measurement quality assurance programs (www.nist.gov/srm/about-nist-srms). A SRM™ is well-suited for the purposes required here to assess the accuracy and stability of the performance of the FPXRF used in the planned soil investigation and to determine the need for any instrument corrections, if necessary, based on the raw data values. A drawback to the use of these standards is their cost. If an investigator wants to use a certified reference material from a provider other than NIST, they will need to make such a request of NDEP BCA or EPA prior to starting the investigation and provide documentation regarding the validity and traceability of the proposed standard to determine its suitability as a SRM™ replacement.

The instrument performance evaluation requires a minimum three SRMs™ and one blank CRM. The blank sample typically used for this purpose is a certified "clean" sample of silica sand or pure silica. Silica is chosen because while it is possible to detect silicon and even lighter elements by XRF, FPXRF instruments are typically not designed to detect fluorescent emissions at these low energy levels. Manufacturers often include SRMs™ and blank samples with new FPXRF units in the purchase. If the FPXRF instrument is being rented from an equipment supply company for the LTSRP sampling program, discuss the need for SRMs™ as a condition of using the equipment supplier's service.

It is very important that the range of concentrations of the CoCs in the SRMs™ are similar to the range of concentrations expected to be encountered in the field. NIST doesn't currently offer an SRM™ containing mercury in appropriate range for some source areas (i.e. former mill site and tailings piles) and floodplain soils. EPA Region 9 has created some reference materials from soil samples collected on the CRMS containing mercury levels at concentrations expected to be encountered on certain parts of the site. Use of these site-specific CRMS reference materials can be arranged with NDEP BCA for the instrument performance evaluation and periodic performance checks conducted in the field. Note: Most of the previous LTSRP soil investigations conducted in the flood plain surrounding Dayton, NV, mercury concentrations have been in the range of background levels of 1 ppm. NDEP BCA and EPA will assist in determining if an area has history or likelihood of higher concentrations than the background level. Six Mile Canyon is the most likely area to have high mercury contamination levels. If higher mercury concentrations are encountered during the investigation and were not anticipated as part of the instrument's evaluation, it will be necessary to stop the investigation and contact NDEP BCA or EPA to access the site-specific reference material(s) with the appropriate mercury range(s) and perform an evaluation on the instrument before proceeding further with the investigation.

8.1.1.2 Handling of SRMs™

SRMs™ are vulnerable to contamination. Employ the similar standard laboratory procedures used in handling a reagent-grade chemical when handling the SRM™. Store the SRM™ in the sealed container it was delivered in, store in an area out of light, and maintain at a stable temperature avoiding high and low fluctuations. NIST SRMs™ are delivered in a clear glass jar not suitable for XRF analysis. Instead, use a plastic XRF sample cup with a mylar film window. Open the delivery container and remove a sufficient volume of the SRM™ to conduct the evaluation and calibration analyses. Minimize the length of time the lid of the jar is off to reduce contamination from dust particles settling in the sample. Use a clean plastic scoopula or similar plastic tool to transfer the SRM™ and avoid any environmental contamination. Fill the sample cup volume to the top until the mylar window covers it tightly without visible wrinkles in the film and observable air gaps between the surface of the SRM™ sample and mylar film. Fill the cup in incremental levels tapping the cup on a solid tabletop and along the sides to eliminate void space in the sample material that may result in settlement of the material and air gaps after the mylar film is in place. Discard excess material removed from the jar: Never return any excess SRM™ sample back into the original container. The CRMS high mercury reference materials available through NDEP BCA are prepared in XRF sample cups and are ready to use without further preparation.

8.1.1.3 Performance Check Procedure

The following procedure describes a method for assessing the FPXRF instrument's accuracy and bias by collecting data sets from the SRMs™, comparing the instrument's readings to the known concentrations, determining the relative standard deviation of the results, and performing linear regression analysis on the result of site CoCs from each of the three SRMs™ analyzed. This procedure is a modification of the procedure developed by Deana Crumbling for EPA ORD's SOPs (Personal Communication, Deana Crumbling, USEPA ORD, July 13, 2017). If the statistical analysis of the check procedure shows the FPXRF does not perform satisfactorily, the instrument will need to be adjusted by the manufacturer.

8.1.1.3.1 FPXRF Stability Check

The first step in checking instrument stability is determining if any contamination has entered the spectrometer by analyzing the blank sample. The primary concern is the positive detection of any CoCs in the blank analysis; however, the results for any detected elements reported by the analyzer should be considered and any unusual detection or variance in results noted. Repeat the blank sample analysis at least 10 times. If the FPXRF will be operating on internal battery power in the field, replicate this condition during the check by using the instrument on battery power only. An exposure time between 45 to 60 seconds should be adequate to achieve the stability check, the accuracy and bias check (see below procedure), and the site-specific detection limits. The analytical results for the blank sample should be consistent and non-detect for the CoCs. An FPXRF analyzer is capable of detecting and quantifying some light elements that may naturally occur in a silica sand blank. Review the analytical results to determine if unexpected elements are detected and if the positive results are the result of contamination in the blank, in the spectrometer, or as the result of some contamination on the FPXRF window or sample cup. The relative stability of the instrument readings will also be noted for consistency. If detections and/or non-detections of elements vary by significant values between tests, there is likely some problem with the instrument. Consult the instrument operation manual or contact the manufacturer to discuss any results that appear inconsistent with the blank and the tests.

8.1.1.3.2 Accuracy and Bias Check

The instrument accuracy and bias check consists of analyzing the three SRMs™ and/or the CRMS-specific CRM 25 to 30 times at an exposure of 45 to 60 seconds. The exposure setting is to remain consistent across all tests during the checks. As above, if the unit will be operated on the internal battery power in the field, replicate this condition in these checks. Download the data from the instrument to perform the necessary statistical analysis. Archive this data report for inclusion in the site investigation report. Calculate the relative standard deviation (RSD) for the CoCs from the all the test results of each SRM™. The RSD should be $\leq 20\%$. Perform linear regression analysis on the results of each CoC from all the SRMs. The coefficient of determination (R-squared or r^2) value should be ≥ 0.9 for decision-level quantitative data. Provide all statistical analyses and plots of the performance check data in the final investigations report.

8.2 Laboratory Quality Assurance Requirements

8.2.1 Equipment Blank Samples

Collect equipment rinsate blanks on a daily basis when soil samples are collected using non-detect sampling equipment to evaluate field sampling and decontamination procedures.

8.2.2 Assessment of Sample Variability

Collect split duplicate soil samples at selected sample locations. These locations will be chosen in the field based on field observations and will be collected at a rate of 1 for every 20 field samples.

8.2.3 Laboratory Quality Control Samples

A laboratory QC sample or matrix spike/matrix spike duplicate (MS/MSD) will be randomly selected by the laboratories and documented within the laboratory data reports. A minimum of one laboratory QC sample per 20 unique samples (or one per delivery group) will be analyzed. Laboratory QC samples, including laboratory MS/MSD and field duplicate samples, will be selected randomly.

8.3 Analytical and Data Package Requirements

All samples are required to be analyzed in accordance with U.S. EPA Methods listed in Table 2-1. The laboratory is required to supply documentation to demonstrate that their data meet the requirements specified in the method. A preliminary data summary will be required 30 working days after submission of samples for analysis. A full validation data package will be required five weeks after submission of samples. The laboratory will also provide all data electronically in a text file.

The following deliverables are required. Note that the following data requirements are included to specify and emphasize general documentation requirements and are not intended to supersede or change requirements of each method.

- A copy of the chain-of-custody, sample log-in records, and a case narrative describing the analyses and methods used.
- Analytical data (results) for up to three significant figures for all samples, method blanks, MS/MSD, Laboratory Control Samples (LCS), duplicates, Performance Evaluation (PE) samples, and field QC samples.
- QC summary sheets/forms that summarize the following:
- MS/MSD/LCS recovery summary
- Method/preparation blank summary
- Initial and continuing calibration summary (including retention time windows)
- Sample holding time and analytical sequence (i.e., extraction and analysis)
- Calibration curves and correlation coefficients
- Duplicate summary
- Detection limit information
- Analyst bench records describing dilution, sample weight, percent moisture (solids), sample size, sample extraction and cleanup, final extract volumes, and amount injected.
- Standard preparation logs, including certificates of analysis for stock standards.
- Detailed explanation of the quantitation and identification procedure used for specific analyses, giving examples of calculations from the raw data.
- The final deliverable report will consist of sequentially numbered pages.

8.4 Data Validation

Data validation of all data will be performed by the investigator or investigator’s representative in accordance with the U.S. EPA Region 9 Superfund Data Evaluation/Validation Guidance (EPA R9QA/006.1), December 2001 (EPA 2001b). Standard data QA/QC review requirements are the Tier 2 validation of 100 percent of the data (EPA 2001b).

If during or after the evaluation of the project’s analytical data it is found that the data contains excess QA/QC problems or if the data does not meet the DQI goals, then the independent reviewer may determine that additional data evaluation is necessary. Additional evaluation may include for Tier 3 evaluation (EPA 2001b).

To meet evaluation and project requirements, the following criteria will be evaluated during a Tier 2 evaluation:

- Data package completeness
- Laboratory QA/QC summaries
- Holding times
- Blank contamination
- Matrix related recoveries
- Field duplicates
- Random data checks
- Preservation and holding times
- Initial and continuing calibration
- Blank analyses
- Interference check samples
- Laboratory control samples

- Duplicate sample analysis
- Matrix spike sample analyses
- Sample serial dilution
- Field duplicate/replicate
- Overall assessment of data.

An analytical data evaluation Tier 2 review report and narrative summary of the evaluation will be included with final investigation report. Classify the report data as one of the following:

- acceptable for use without qualifications
- acceptable for use with qualifications
- unacceptable for use

Attach the data with applicable qualifications to the report. The analytical data evaluation Tier 1A review report will not compare data to specific project quality objectives, which include target analytes, sensitivity, analytical accuracy, analytical and sampling precision, and analytical completeness.
Thoroughly examine unacceptable data to determine whether corrective action could mitigate data usability.

8.5 Field Variances

As conditions in the field may vary, implementation of minor modifications to the approved plan may become necessary. When modifications are significant and potentially impact investigation DQOs, the site investigator will notify the NDEP BCA contact of the potential modification and obtain a verbal approval before implementing the modification. All minor and major modifications to the original plan will be recorded in site records and documented in the final report.

9.0 References

Deana Crumbling, Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation, July 13, 2017, Washington, D.C., Personal Communication

Ecology and Environment, Inc., May 20, 1991, Conceptual Site Model (Task 1.5), Carson River Mercury Site, Remedial Investigation/Feasibility Study

Environmental Protection Agency, 1994, Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (1994c)

Environmental Protection Agency, March 30, 1995, EPA Record of Decision, Carson River Mercury Site, EPA ID: NVD980813646, OU 01, Dayton, NV

Environmental Protection Agency, March 2001, Requirements for Quality Assurance Project Plans, EPA QA/R5

Environmental Protection Agency, August 2003, Superfund Lead-Contaminated Residential Sites Handbook, OSWER 9285.7-50

Environmental Protection Agency, 2006, Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4

Environmental Protection Agency, February 2007, Method 6200, Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment

Environmental Protection Agency, 2015, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Methods 6010 and 7471, SW-846, Third Edition, Updates I-V

Environmental Protection Agency Region 9, December 2001, Superfund Data Evaluation/Validation Guidance (EPA R9QA/006.1)

Environmental Protection Agency Region 9, September 2013, Explanation of Significant Differences, Carson River Mercury Site, Washoe, Carson City, Storey, Lyon, and Churchill Counties, Nevada, NVD980813646

Environmental Protection Agency Region 9, May 2014, Sampling and Analysis Plan, Guidance and Template Version 4, General Projects, R9QA/009.1

Environmental Protection Agency Region 9, January 2017, Carson River Mercury Site OU-2 Screening Level Ecological Risk Assessment

Grant H. Smith, 1943, The History of the Comstock Lode, Geology and Mining Series, No. 37, Vol. 37

Mary A. Siders, Ph.D., Nevada Division of Environmental Protection, Bureau of Corrective Actions, June 29, 2012, Evaluation of Metals Data from Tidball et al. (1991): Arsenic, Lead and Mercury, Unpublished

Nevada Division of Environmental Protection, Bureau of Corrective Actions, 2018, Residential Long Term Sampling and Response Plan

National Institute of Standards and Technology, Standard Reference Materials, About NIST SRMS, www.nist.gov/srm/about-nist-srms

Sean Hogan, EPA Project Manager and Stanford Smucker, Ph.D., EPA Toxicologist, EPA Region 9, December 1994, Revised Draft Human Health Risk Assessment and Remedial Investigation Report, Carson River Mercury Site

Tidball, R.R., Briggs, P.H., Stewart, K.C., Vaughn, R.B., and Welsch, E.P., 1991, Analytical Data for Soil and Well Core Samples from the Carson River Basin, Lyon and Churchill Counties, Nevada, U.S. Geological Survey Open-File Report 91-584A