ENGINEERING EVALUATION/COST ANALYSIS

FORMER PRESCOTT SPORTSMEN'S CLUB SHOOTING RANGE
YAVAPAI COUNTY, ARIZONA

PRESCOTT NATIONAL FOREST
BRADSHAW RANGER DISTRICT

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE SOUTHWESTERN REGION

FEBRUARY 2016

Prepared By

HELIOTECH
A Joint Venture

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Matt Udell, Project Manager

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ACRONYMS AND ABBREVIATIONS

ºF	Degree Fahrenheit
µg/L	Microgram per liter
AAC	*Arizona Administrative Code*
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AGFD	Arizona Game and Fish Department
AOC	Area of contamination
AQD	Air Quality District
ARAR	Applicable or relevant and appropriate requirement
ASWQS	Arizona surface water quality standard
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	Below ground surface
BHHRA	Baseline human health risk assessment
BMP	Best management practices
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COPC	Chemical of potential concern
COPEC	Chemical of potential ecological concern
CWA	Clean Water Act
Eco-SSL	Ecological soil screening level
EE/CA	Engineering evaluation/cost analysis
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
Forest Service	U.S. Forest Service
GCL	Geosynthetic clay liner
GPS	Global positioning system
IEUBK	Integrated Exposure-Uptake Biokinetic Model
LDR	Land disposal restriction
LOAEL	Lowest observed adverse effects level

mg/kg	Milligram per kilogram
mg/L	Milligram per liter
NC	Not calculated
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Protection Act
NOAEL	No observed adverse effects level
NOV	Notice of violation
NPDES	National Pollutant Discharge Elimination System
NS	Not sampled
O&M	Operation and maintenance
OSHA	Occupational Safety and Health Administration
PRAG	Preliminary removal action goal
PRAO	Preliminary removal action objective
PSC	Prescott Sportsmen's Club
QA/QC	Quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RSI	Removal site investigation
RSL	Regional screening level
SCEM	Site conceptual exposure model
SGC	Southwest Ground-Water Consultants
SGCN	Species of Greatest Conservation Need
SLERA	Screening-level ecological risk assessment
SRL	Arizona Soil Remediation Level
TBC	To be considered
TCLP	Toxicity characteristic leaching procedure
TSD	Treatment, storage, and disposal
USC	*United States Code*
USFWS	U.S. Fish and Wildlife Service
XN	Experimental non-essential
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

The U.S. Forest Service (Forest Service) is exercising its authority as lead agency under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to undertake a response action at the former Prescott Sportsman's Club (PSC) Shooting Range located in Prescott, Yavapai County, Arizona. HelioTech, a joint venture of Helios Resources Ltd. and Tetra Tech Inc., is under contract to the Forest Service to prepare an engineering evaluation/cost analysis (EE/CA) for the non-time-critical removal of lead-impacted soils and sediment associated with historical operation of the former PSC Shooting Range.

The former PSC shooting range is located in the northwest suburbs of Prescott, Yavapai County, Arizona (Figure 1-1). The shooting range occupies an area of 24.88 acres and operated under a Special Use Permit from the Prescott National Forest. The shooting range began operations in 1957. A Special Use Permit was approved for range operations on June 25, 1957. The most recent special use permit was issued in 1985 and expired in 2014. Forest Service is no longer permitting shooting activities at the Site.

Previous investigations by Forest Service and other parties and the current removal site investigation (RSI) completed for the Site concluded that a non-time-critical removal action is warranted to reduce unacceptable risk to human and ecological receptors at and halt continued migration of lead-impacted soils and sediment from the Site. The project administrative record contains previous investigation reports for the Site and is maintained at the Forest Service Bradshaw Ranger District Office in Prescott, Arizona.

This EE/CA presents a detailed analysis of response action alternatives that Forest Service and appropriate regulatory agencies can use for decision-making. The EE/CA identifies, screens, and evaluates technologies that may be implemented to address on-site exposure to and off-site release of lead in soil and sediment at the Site. HelioTech prepared this EE/CA in accordance with the U.S. Environmental Protection Agency (EPA) "Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA" (EPA 1993) and "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA 2000).

Range operations left potentially hazardous levels of lead in soil which may have migrated into drainages downstream of the Site. Lead has been identified in stormwater runoff from the Site. Residences are located immediately east of the Site (Figure 2-1). Human health risks are most likely to be associated with direct soil contact by adjacent residents through incidental ingestion, dermal contact, or inhalation of windborne particulates. Exposure to contaminated storm water runoff was historically a concern; however, drainage basins have been constructed at the Site to capture lead-impacted sediment before reaching drainages. The impact to groundwater is unknown; however, groundwater is located in deep, confined aquifers and a pathway from ground surface is likely incomplete. Residents in the area are served by the City of Prescott.

Removal Site Investigation

As a part of the development of this EE/CA, HelioTech conducted a RSI in November 2015. The RSI assessed whether potentially hazardous concentrations of lead remaining from historical range operations threaten human health, ecological receptors, or water quality at the Site. The objectives of the RSI were to: 1) quantify the concentrations of lead that remain at the Site, 2) quantify the lateral and vertical extent of lead in soil and sediment at the Site, and 3) quantify the volume of soils and sediment at the Site, necessary to support risk screening and evaluation of removal action alternatives.

Primary sources of contamination evaluated at the former PSC shooting range included the firing lines, target lines, and berms on the 50 yard, 100 yard, and 200 yard ranges as well as the overall range backstop berm. Secondary sources of contamination evaluated included the four drainage basins that capture stormwater runoff and allow settling of solids from various parts of the range as well as the three ephemeral drainages at the Site (Figures 3-1 and 3-2).

HelioTech collected and analyzed 408 out of a planned 439 soil and sediment samples using a portable x-ray fluorescence (XRF) analyzer to define the lateral and vertical extent of lead contamination at each potential source area, and in drainage basins and drainage sediment. Thirty-one samples were attempted but not collected due to the presence of bedrock at depth. Sample locations are presented on Figure 3-1 (potential source areas) and Figure 3-2 (drainage basins and drainages) and field XRF data are provided in Appendix D.

Forty-two out of 45 split samples were submitted to a fixed laboratory for analysis of total lead to support correlation of XRF readings and provide quantitative for risk assessment. Three split samples for laboratory analysis were attempted but not collected due to the presence of bedrock. Field XRF data were correlated with fixed laboratory data at locations where split samples were collected. Correlation graphs and predicted lead values used to define the extent of contamination, and calculate volumes of soil and sediment requiring removal are presented in Appendix E.

Laboratory analytical results (Table 3-5) and correlated XRF lead values (Appendix E) indicate that lead in soil and drainage sediment exceeds the state of Arizona Department of Environmental Quality (ADEQ) soil remediation level (SRL) (ADEQ 2002) and ecological benchmarks in the following areas:

- The primary source areas posing a threat to human health and ecological receptors at the Site include Drainage Basins 1 and 4, firing lines, and 50 yard target lines; 50 yard berm, 100 yard berm, 200 yard berm, and backstop berm; and the upstream reach of Drainage 1.

The primary source areas posing a threat to human health and ecological receptors at the Site include:

- Lead in soils to at least 18 inches below ground surface (bgs) and possibly up to 48 inches into the faces of the 50 yard, 100 yard, 200 yard, and backstop berms (Figures 4-3 to 4-6)

- Lead in surface and near surface soils (0 to 6 inches bgs) in front of the firing lines (Figure 4-2).

- Lead in surface and near surface soils (up to 12 inches bgs) at the target lines immediately in front of each of the berms (Figures 4-1 and 4-2).

- Lead in surface and near surface soils (up to 12 inches bgs) in all or portions of drainage basins 1 and 4 (Figures 4-1 and 4-2).

- Lead in surface and near surface soils (0 to 6 inches bgs) in Drainage 1 (Figure 4-7).

The primary source areas posing a threat to surface water quality at the Site include:

- Lead in surface and near surface soils (0 to 6 inches bgs) in Drainage 1 poses a threat to surface water quality (Figure 4-7).

- Lead in surface and near surface soils (0 to 6 inches bgs) at all other source areas at the Site are contained by drainage basin berms. Removal of lead from other source areas and within drainage basins will mitigate any long-term threat associated with potential breaching of drainage basin berms.

Twenty split samples (soils and drainage sediment) were also collected for leachable lead analysis after the toxicity characteristic leaching procedure (TCLP). TCLP leachable lead from soils in the 50 yard, 100 yard, 200 yard, and backstop berms and Drainage Basin 1 were found to exceed Federal Resource Conservation and Recovery Act (RCRA) D list toxicity criteria indicating that the soils from the four berms and Drainage Basin 1 are RCRA hazardous waste and require treatment prior to disposal (Table 3-6).

Streamline Risk Assessment

Preliminary human health and ecological risk screening was conducted to identify environmental media, based on the completed pathways presented in the site conceptual exposure model (SCEM) (Figure 3-3), which may pose an unacceptable risk to human health or the environment. Potential risks to human health and ecological receptors were evaluated by comparison to screening criteria for soil and sediment.

Human health benchmarks were used to determine if lead is a chemical of potential concern (COPC) in soil and sediment at the Site. Lead was identified as a COPC by comparing concentrations in soil source areas and drainage sediment at the Site with the Arizona SRL (400 milligram per kilogram [mg/kg]) for a conservative residential receptor and EPA Regional Screening Level (RSL) (400 mg/kg) (EPA 2015) for a conservative residential receptor. Conservative residential benchmarks using a residential exposure scenario were selected because permanent residents live on private property east adjacent to the Site. In addition, the more conservative residential exposure scenario was also selected as it allows for unrestricted future use of the Site. Potential bioaccumulation in cattle and game animals, followed by human consumption, was considered as a potential exposure pathway. However, cattle have been historically excluded from the Site with range fencing, and any cattle or game animal bioaccumulation is expected to be very low based on the limited duration of grazing, limited grazing area, and range fencing at Site in comparison to overall grazing range. A baseline human health risk assessment (BHHRA) is beyond the scope of this project and is not necessary to justify an action given the magnitude by which lead concentrations exceed benchmarks.

Ecological benchmarks were used to determine if lead is a chemical of potential ecological concern (COPEC) in soil and sediment at the Site. Benchmarks used include EPA ecological soil screening levels (Eco-SSL) for avian and terrestrial receptors (EPA 2010b). The Eco-SSLs selected for lead at the Site are 46/56 mg/kg for dove and shrew, respectively. A screening-level ecological risk assessment (SLERA) is beyond the scope of this project and is not necessary to justify an action given the magnitude by which lead concentrations exceed benchmarks.

Based on comparison of investigation data to human health and ecological benchmarks and water quality criteria, the following findings have been developed for the Site.

- Lead was identified as a COPC for residential receptors. The concentrations of lead in solid matrix samples ranged from 9.4 to 39,744 mg/kg, which is 0.02 to 99.4 times the residential benchmarks. For comparison purposes, a low risk ranges from 1 to 10 times a benchmark and a moderate risk ranges from 10 to 100 times a benchmark.

- Lead in drainage sediment at and downstream of the Site ranged from 10.5 to 1,875 mg/kg, which is 0.03 to 4.7 times residential benchmarks; Drainage 1 was the only drainage reach that exceed the residential benchmarks.

- Lead was identified as a COPEC for ecological receptors. The concentrations of lead in solid matrix samples ranged from 0.17 to 864 times the conservative Eco-SSL benchmarks.

- Lead in drainage sediment at and downstream of the Site ranged from 0.19 to 40.8 times conservative Eco-SSL benchmarks; Drainage 1 was the only drainage reach that exceed the ecological benchmarks.

- Lead in sediment in drainages at and downstream of the shooting range contributes to total and dissolved lead in stormwater above the Arizona surface water quality standard (ASWQS) of 15 microgram per liter (ug/L). Construction of drainage basins in 2010 to capture lead impacted soils from the range before migration to the drainages has reduced total and dissolved lead in stormwater to below the ASWQS (two events); however, the sediment bed load in the Drainage 1 (no sediment drainage basin) will continue to contribute lead to stormwater.

An estimated 2,900 cubic yards (CY) of in-situ soil and sediment were found to require a removal action based on the promulgated Arizona SRL and non-promulgated EPA RSL, and 10 times the non-promulgated conservative Eco-SSL for avian and mammal receptors. For estimation purposes, the depth of contaminated soil in the berms was assumed to extend to a depth of 48 inches based on high velocity bullet penetration of 36 inches and allowing for successive placement of additional material and ballistic sand on the faces of berms over the long operational period of the firing range. Approximately 2,700 of the 2,900 CY of contaminated soil were identified as RCRA hazardous waste and require treatment prior to disposal (Table 4-2).

Preliminary Removal Action Objectives, Goals, and Alternatives Evaluated

Based on the results of the streamlined risk assessment and surface water quality threat assessment, four preliminary removal action objectives (PRAO) were developed for the Site:

- Minimize the potential for human and ecological exposure to lead in soil, drainage sediment, and windblown dust.
- Prevent continued migration of lead toward and within drainages and to off-site receptors.
- Minimize the potential for lead to migrate to shallow groundwater, if present.
- Reduce physical hazards posed by over steep shooting range berms.

Attaining these objectives is expected to result in mitigation of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) removal action factors—enhancing protection of human and ecological receptors at the Site and surrounding area.

Three removal action alternatives were developed to address these PRAOs and attain preliminary removal action goals (PRAG) identified in Table 6-1. These include a “no action” baseline alternative and two removal alternatives to mitigate the lead impacted soil and sediment at Site source areas and drainages.

The following removal action alternatives were evaluated and compared for effectiveness, implementability, and cost at the Site:

- Alternative 1: No Action.

- Alternative 2: Excavation, on-site treatment, and off-site disposal in a RCRA Class II facility; site regrading; and erosion control installation.

- Alternative 3: Excavation, off-site stabilization of lead, and off-site disposal in a RCRA Class I Treatment, Storage, and Disposal (TSD) facility; site regrading; and erosion control installation.

Preferred Removal Action Alternative

Alternative 2: excavation, on-site treatment, and off-site disposal in a RCRA Class II facility is the recommended removal action alternative at the Site for reducing the threat to human health and the environment associated with soil and sediment contamination, reducing the migration of lead to drainages and off-site receptors, minimizing the potential for lead to migrate to shallow groundwater, and controlling physical hazards. Alternative 2 is summarized below:

- Perform a treatability study on mixing lead contaminated soil with Portland cement to determine viability, optimal mixing volumes, and methods to ensure that TCLP limit for lead is not exceeded after soil treatment.
- Prepare a removal design that will provide construction drawings and define standards for the removal action.
- Prepare a bid package and construction management plan.
- Procure construction firm(s); negotiate transport, treatment, and disposal costs, and necessary insurance and bonding.
- Provide full-time construction management during the removal action, which will include full-time Contractor oversight, confirmation sampling and analysis, waste profiling, surveying, and preparing a construction report with As-Constructed drawings.
- Mobilize and demobilize necessary equipment to and from the Site once, including installing temporary erosion control measures.
- Prepare and secure a staging area for equipment storage and use during construction.
- Establish off-site water source for dust control and turn on electrical service.
- Complete site preparation including posting signs and reviewing hospital routes.
- Repair of site access road for heavy truck traffic and evaluate traffic control plan at the site entrance from N Granite Basin Road.
- Remove concrete debris from three firing line pads and in ground target stand supports and dispose at an off-site Class III facility (Figure 8-1).

- Close potential water well, if located south of the range.
- Establish dust monitoring locations between excavation areas and cement mixing areas and adjacent residences to confirm dust control measures are protective.
- Excavate approximately 2,900 CY of soil from source areas and sediment from Drainage 1 (Figures 4-1 to 4-7).
- Use XRF and laboratory split sampling to confirm limits of excavation at or below the PRAG.
- Segregate approximately 200 CY of soils and sediment above PRAGs but below TCLP limit.
- Segregate approximately 2,700 CY of soils above PRAGs and above TCLP limit.
- Screen approximately 2,700 CY of soil to remove medium and large bullets.
- Recycle screened bullets at no cost.
- Mix approximately 2,700 CY of soils containing lead above TCLP limit in windrows with 10% Portland cement and water for dust suppression.
- Profile waste for disposal and collect samples for TCLP analysis to confirm attainment of TCLP limit.
- Load Portland cement-treated soils into haul trucks and transport to the Northwest Landfill near Surprise, Arizona (RCRA Class II facility) for disposal.
- Load untreated soils (above PRAGs but below TCLP limit) into haul trucks and transport to the Northwest Landfill near Surprise, Arizona (RCRA Class II facility) for disposal.
- After waste removal, knockdown remainder of target berms and eastern berm.
- Backfill the removal areas with approximately 2,900 CY of clean excess berm material and add lime to increase the alkalinity of soil pore water and immobilize residual lead (Figure 8-1).
- Grade slopes to natural contours using approximately 1,000 CY of clean excess berm material (Figure 8-1).
- Install surface controls including a diversion berm along the east side of former backstop and 200 yard berms, a diversion berm along the east side of former 100 yard berm, a sediment detention basin, on Drainage 3, and rock spillways on existing Drainage Basins 2 and 3 (Figure 8-1).. Berms and basin will use approximately 1,000 CY of clean excess berm material.
- Revegetate the site using native seed mixture.
- Erect signs to notify site visitors of site restoration and revegetation efforts.

- Perform semi-annual site visits to monitor the integrity of and maintain the surface controls and revegetation efforts.

Both Alternative 2 and 3 are equally protective of human health and the environment through waste removal from the Site. Alternative 2 would comply with applicable or relevant and appropriate requirements (ARAR), provide long-term effectiveness and permanence, and greatly reduce the mobility of lead and risk of exposure to unhealthy levels of lead at the Site. Alternative 2 and 3 would both provide an equally high level of permanence as the waste would no longer remain on site. Alternative 3 would be slightly more protective over the short-term as the waste would be stabilized off-site and any potential concern with dust generation during on-site mixing of cement for lead stabilization would be eliminated. However, dust generation could easily be mitigated through application of water as an engineering control. Dust monitoring will be conducted for up to 1 month duration between the project area and east adjacent residences to ensure engineering controls are protective.

In order to comply with location-specific ARARs, contacts with appropriate agencies and tribes regarding cultural resources would be required. A cultural resource survey has not yet been conducted by Forest Service at the Site, specifically for the clean up efforts. The Forest Service did conduct archeological surveys in/near the Site under two previous heritage project efforts. One site was identified just outside of the Site's boundary, which should not be impacted by implementation of the proposed removal action. Forest Service will flag the area to avoid any potential disturbance prior to construction. A biological and botanical resource inventory report would be required to evaluate potential impacts on sensitive species. Coordination with U.S. Fish and Wildlife Service and Arizona Game and Fish Department (AGFD) would be required if any threatened or endangered species could be disturbed by excavation and truck movement to ensure minimizing of potential impacts.

Operation and maintenance (O&M) costs required to maintain the erosion controls over the short term until vegetation is re-established would be the same for both Alternatives 2 and 3. However, the very high cost of off-site stabilization and disposal in a RCRA Class I facility with Alterative 3 would limit the likelihood of funding due to budget constraints.

The removal action at the Site would require up to 2 months of construction. O&M would be carried out for a period of 5 years and would consist of applying soil to any eroded areas, reapplying hydroseed, repairing stormwater control berms, repairing drainage basin berms and spillways, and inspecting and replacing informational signs as necessary.

Alternative 2 could be implemented at the Site at an estimated present worth cost of $1,052,057. The net present value of annual O&M costs over the next 5 years is about 13 percent of the total present worth cost at the Site (Table 8-1). These construction costs are estimates expected to be within minus 30 to plus 50 percent of the actual project cost (based on year 2015 dollars). Changes in the cost elements are likely as new information and data are collected during treatability studies for on-site stabilization, engineering design, and construction pre-bid and walk-through meetings.

1.0 INTRODUCTION

HelioTech, a joint venture of Helios Resources Ltd. and Tetra Tech Inc., prepared this combined engineering evaluation/cost analysis (EE/CA) for the U.S. Forest Service (Forest Service) under Forest Service Regional Contract AG-9A40-C-14-0036 and associated delivery order AG-8371-D-15-0063. The Site evaluated was the former Prescott Sportsman's Club (PSC) Shooting Range located in Prescott, Yavapai County, Arizona. Previous investigations by Forest Service and other parties and the current removal site investigation (RSI) completed for the Site concluded that a non-time-critical removal action is warranted to reduce unacceptable risk to human and ecological receptors at and halt continued migration of lead impacted soils from the Site.

The former PSC shooting range is located in the northwest suburbs of Prescott, Yavapai County, Arizona (see Figure 1-1). The shooting range occupies an area of 24.88 acres and operated under a Special Use Permit from the Prescott National Forest. The shooting range began operations in 1957. A Special Use Permit was approved for range operations on June 25, 1957. The most recent special use permit was issued in 1985 and expired in 2014. Forest Service is no longer permitting shooting activities at the Site.

Range operations left potentially hazardous levels of lead in soil that may have migrated into drainages downstream of the Site. Lead has been identified in stormwater runoff from the Site. Residences are located immediately east of the Site. Human health risks are most likely to be associated with direct soil contact by adjacent residents through incidental ingestion, dermal contact, or inhalation of windborne particulates. Exposure to contaminated storm water runoff was historically a concern; however, drainage basins have been constructed at the Site to capture lead-impacted sediment before reaching drainages. The impact to groundwater is unknown; however, groundwater is located in deep, confined aquifers and a pathway from ground surface is likely incomplete. Residents in the area are served by the City of Prescott.

This EE/CA presents a detailed analysis of removal action alternatives that the Forest Service and appropriate regulatory agencies can use for decision-making. This EE/CA identifies, screens, and evaluates technologies that may be implemented to address on-site exposure to and off-site release of lead in soil and sediment at the Site. Each removal action alternative evaluated in this report, other than Alternative 1 (No Action) is intended to be the final action at the Site and will remove the sources of lead contamination and reduce risk to humans and the environment.

This EE/CA also presents background information, findings from previous and current site investigations, risk screening results, an evaluation of applicable or relevant and appropriate requirements (ARAR), preliminary removal action objectives (PRAO), and preliminary removal action goals (PRAG) necessary to develop and screen removal action alternatives.

This EE/CA is organized into ten sections:

- Section 2.0 briefly describes the location, site history, soils and geology, hydrogeology and hydrology, climate, vegetation, and wildlife, significant cultural and archeological features, and land use and population.
- Section 3.0 summarizes findings from previous investigations, identifies data gaps, presents findings of the current site investigations, and presents a site conceptual exposure model (SCEM).
- Section 4.0 describes the human health and ecological risk screening methodology, present risk screening results for the Site, and recommends the need for removal action based on risk findings.
- Section 5.0 presents the state and federal chemical-, location-, and action-specific ARARs that may be pertinent to a removal action at the Site.
- Section 6.0 describes the PRAOs and PRAGs for the Site.
- Section 7.0 discusses general response actions, technologies, and process options; screens technologies; and develops removal action alternatives applicable to the Site.
- Section 8.0 presents a detailed analysis of removal action alternatives for the Site using effectiveness, implementability, and cost as criteria.
- Section 9.0 comparatively assesses removal action alternatives for consistency with the effectiveness, implementability, and cost criteria; summarizes findings of the assessment; and presents a recommended removal action alternative for the Site.
- Section 10.0 lists sources referenced to prepare this EE/CA.

Figures and tables appear after the text of the report. Appendices appear after figures and tables.

2.0 SITE LOCATION AND BACKGROUND

This section describes the location and access to the Site; presents background information about the Site and physical characteristics of the Site; presents a summary of previous investigations; and presents a SCEM for releases from the Site.

2.1 PROJECT LOCATION AND ACCESS

The former PSC shooting range is located in the northwest suburbs of Prescott, Arizona (see Figure 1-1). The Site is located within the southeast one-quarter of Section 13 and the northeast one-quarter of Section 24, Township 14 North and Range 3 West, of the Gila and Salt River Base and Meridian. The approximate location of the center of the range is North 34° 35' 3.85" and West 112° 31' 16.9". The Site address is 2751 N. Granite Basin Rd. Prescott, Arizona 86305. The Site is located north of Iron Springs Road and east of Prescott National Forest Road 374. Access to the Site is provided by Forest Road 374A that begins on the east side of Forest Road 374 at a point approximately 700 feet north of Iron Springs Road. The road extends approximately 1,600 feet northeast to the range parking area.

2.2 BACKGROUND

The shooting range extends northward from three shooting stations. Firing is divided into three ranges of different lengths. The west shooting station is on the 50 yard pistol range and the east shooting station is on the 100 yard rimfire small caliber range. The center shooting station is on the 200 yard large caliber range. Each range has an impact berm constructed of soil. A constructed soil backstop berm is located downrange of the 200 yard target berm and the mountain rises behind the backstop berm. The shooting stations were on three separate canopy covered concrete slabs; only the easternmost canopy and slabs remain. A graded, gravel surfaced parking area is located to the south of the shooting stations.

Range usage varies annually, typically hosting 1,500 to 3,000 visitors. Support structures (sheds, kiosk, propane tanks, and pit toilet) and a mobile home for the range master were previously located on the south end of the Site; however, all of these features have been removed. Metered power is located adjacent to the former mobile home site. Water service to the Site is provided by hauling water to a storage tank located to the south of the shooting stations. Wastewater generated at the Site is treated in a septic tank drain field system. Site features are shown in Figures 3-1 and 3-2.

2.2.1 Soils

The Soil Survey of Yavapai County shows that soils on the property are of the Barkerville Series. This series consists of well-drained soils that are shallow to very shallow over weathered granitic bedrock (NRCS 2015). The Barkerville Cobbly Sandy Loam is the specific soil type identified at

the Site. This soil is classified as silty sand or sandy silt in the Unified Soil Classification System. The Soil Survey indicates that the soil contains 10 to 25 percent non-plastic fines and has a pH range of 6.1 to 7.3. The soil is rated as having moderately rapid permeability. Cobbly, sandy loam soils are typically low in reactive and corrosive behavior.

2.2.2 Hydrogeology and Hydrology

Groundwater, if present at the Site, is limited in quantity. Arizona Department of Water Resources (ADWR), Hydrologic Map Series, Report No. 9, 1982, indicates that the property is located in an area of granitic bedrock. Water bearing units are not depicted beneath the Site. The map indicates that water, if present, may occur in weathered or fractured bedrock, joint systems or thin veneers of sediments overlying consolidated rocks. Regional groundwater is located in deep, confined aquifers.

A survey of water wells located within ½ mile of the Site using the ADWR Well Registry (ADWR 2015) was completed. A well map and tabular summary of registry findings are presented in Appendix A. A well (B14003024ABD) is shown on the ADWR Well Registry Map (Appendix A) registered to a private individual, just south of the Site, on Forest Service land. Well B14003024ABD is completed to a depth of 250 feet with a depth to water of 200 feet. The private well may be inaccurately located on Forest Service land or may have previously been used to support range operations. The closest downgradient well (B14002019BBA) is located approximately ½ mile east of the Site (Appendix A). Ephemeral Willow Creek and tributary serve as hydraulic boundaries for migration of any potential shallow groundwater to the east or south. Well B14002019BBA is completed to a depth of 205 feet with a depth to potable water of 40 feet. Groundwater is located in deep, confined aquifers and a pathway from ground surface is likely incomplete. Residents in the area are served by the City of Prescott.

The Site elevation varies from 5,520 to 5,580 feet above mean sea level with multiple steep berms and backstops as well as retention berms on drainage basins. The Site generally slopes down from west to east. Ponding and running streams are generally only present on the Site in response to snow melt in winter and thunderstorms during the monsoon season.

Four drainage basins and five drainages were observed on the Site. The drainage basins were constructed in 2010 to reduce entrainment of lead impacted soil in stormwater runoff. Drainage Basin 1, if overtopped, discharges to Drainage 1. Drainages 1 and 5 discharge into Drainage 2. Drainage Basins 2 and 3, if overtopped, discharge to Drainage 2. Drainage 4 is internal to the Site and discharges into a Drainage Basin 4. Drainage Basin 4 if over topped discharges to Drainage Basin 3 and Drainage 2. Stormwater flows exit the property via Drainages 2 and 3 into the residential subdivision to the east. These channels are tributaries to Willow Creek, which is located approximately one-half mile east and downstream from the Site. The drainage basins and channels are shown in Figure 4-2.

2.2.3 Climate, Vegetation, and Wildlife

The City of Prescott is located at a relatively high elevation of 5,400 feet and exhibits a Mediterranean climate with mild to cool winters and warm to hot summers. Average annual precipitation for 1981–2010 is 17.75 inches. The largest portion of precipitation falls during the July–September monsoon season. Snowfall is typically light and snow cover usually melts away quickly; the 1981–2011 average seasonal total is 12.8 inches. Average daytime temperatures remain above 50 °F the entire year, but diurnal temperature variation is large throughout the year, averaging nearly 30 °F annually. On average, temperatures reach 90 °F on 36 days annually, though 100 °F+ readings are uncommon and do not occur every year. The average window for freezing temperatures is October 21 thru May 1.

The south and east portions of the Site are populated with the Pinyon-Juniper vegetation community, while the northwest portion of the Site is populated by the Interior Chaparral vegetation community. Natural vegetation outside of the range operational area, approximately 20 of 25 acres, is predominantly undisturbed. The range operational area, approximately 4 acres, is cleared of vegetation.

The predominantly undisturbed character of the Site provides wildlife habitat consistent with the adjoining Prescott National Forest. Wildlife in the Prescott National Forest includes Rocky Mountain mule deer, javelina, and black bear. Smaller animals include fox, raccoon, badger, Abert's squirrel, gray squirrel, cottontail, and jack rabbit. Birds in the area include dove, quail, songbirds, and cavity nesters.

Table 2-1 identifies amphibian, bird, fish, mammal, and reptile species known to occur within a 3 kilometer radius of the Site based on an on-line review of the Species of Greatest Conservation Need (SGCN) mapping tool (http://www.azgfd.gov/hgis/) (AGFD 2015). The Site is within the historic geographic range for the black-footed ferret; however, no suitable habitat occurs in or near the project area. The Site is within Recovery Zone 2 for the experimental non-essential population of the Mexican gray wolf, at this time; however, no wolves are known to occur on the Prescott National Forest. The Gila chub (federal-listed endangered) is located in in drainages further up in the Granite Basin and is not present in ephemeral drainages at the Site. The Yellow-billed Cuckoo (federal-listed threatened) territory does not overlap the Site. The Mexican spotted owl has not been observed at the Site and the surrounding and Site habitat are not suitable. No Forest Service sensitive species are known to occur within or near the project area. There would not be any trend towards listing for any sensitive species.

No threatened or endangered plant or wildlife species were identified at the Site. No riparian areas of high, medium, or low value were identified at the Site.

2.3 SIGNIFICANT HISTORICAL AND ARCHEOLOGICAL FEATURES

No structures or features of historical significance or archeological features were observed at the Site. Shooting range berms and backstops were constructed in 1957 on previously undeveloped Forest Service land. Firing line covers and temporary storage sheds were constructed over the years. A cultural resource survey has not yet been conducted by Forest Service at the Site, specifically for the clean up efforts. The Forest Service did conduct surveys in/near the Site under two previous heritage project efforts. One site was identified just outside of the Site's boundary, which should not be impacted by implementation of the proposed removal action. Forest Service will flag the area to avoid any potential disturbance prior to construction.

2.4 LAND USE AND POPULATION

The adjoining property to the south, west, and north of the Site is undeveloped Forest Service land, while the adjoining property to the east is developed with single-family residences (Figure 2-1). The Site is located in the rural northwestern outskirts of the City of Prescott, Arizona with a population of approximately 40,000 (2014 estimate). The Site operated as a recreational shooting range, under a Special Use Permit for approximately 57 years. The permit expired in 2014 and Forest Service elected not to renew the permit due to proximity of immediately east adjacent residences. Forest Service will continue to use the property for unspecified recreational uses; however, due to the proximity of the adjacent residences, site use is likely to include local hiking over the long term and is fenced and signed over the short term until potential exposure to lead is addressed.

3.0 SITE INVESTIGATION SUMMARY

Forest Service and Southwest Ground-Water Consultants (SGC) completed previous investigations at the Site between 1999 and 2010. Arizona Department of Environmental Quality (ADEQ), PSC, and Forest Service conducted Stormwater sampling between 2007 and 2012. As a part of the development of this EE/CA, HelioTech conducted an RSI in 2015. The RSI assessed whether potentially hazardous levels of lead that remain from past shooting range operations threaten human health, ecological receptors, or water quality at the Site. The objectives of the RSI were to:

- Quantify the concentrations of lead that remain in soils (berms, backstops, target lines, firing line) and sediment (basins and channels) at the Site,
- Quantify the lateral and vertical extent of lead in solids associated with features at the Site, and
- Quantify the volume of lead waste in solids associated with features at the Site necessary to support risk screening and evaluation of removal action alternatives.

The following sections summarize the results of the previous investigations, identify data gaps, present the results of the current RSI to address the data gaps, and provides a SCEM developed for the Site based on current understanding of site conditions.

3.1 PREVIOUS ENVIRONMENTAL INVESTIGATIONS

Previous investigations of potential releases of lead to Site soils and sediment include a June 23, 1999 sampling event conducted by Prescott Coconino Kaibab Forest Hazmat Coordinator, Mr. Alan Anderson (USFS 1999), an April 2002 sampling event conducted by SGC (2003), and summer of 2010 construction sampling events conducted by SGC (2010b). Previous investigation results are provided in Table 3-1. Site features are shown on Figure 3-1; however, sampling locations from previous investigation were not adequately documented to present on a figure.

ADEQ conducted stormwater sampling and soil sampling on Drainage 2 and Drainage 3 at locations downstream from the Site on September 22, 2007. ADEQ issued a Notice of Violation (NOV) to PSC on July 16, 2008 based on the concentration of lead in stormwater runoff in drainage channels within the east adjacent residential area exceeding the Arizona Surface Water Quality Standard (ASWQS) (SGC 2010a). Subsequent to that NOV, PSC constructed drainage basins to capture lead impacted soils and reduce contribution to stormwater in area drainages (SGC 2010b). PSC also installed stormwater samplers and conducted sampling during precipitation events in 2010. PSC and Forest Service conducted multiple follow-up stormwater sampling events in 2011 and 2012. Previous stormwater sampling results are provided in Table 3-2. Site drainage features are shown on Figure 3-2; however, sampling locations from previous investigation were not adequately documented to present on a figure.

Summary of 1999 Forest Service Investigation:

- Seventeen soil and sediment samples were collected from depth ranging from 0 to 2 inches below ground surface (bgs).
- All samples were field sieved to remove particles larger than 1 mm.
- All samples were analyzed for total lead by U.S. Environmental Protection Agency (EPA) Method 6010B at McKenzie Laboratories.
- Lead was identified at concentrations ranging from 5 to 20 milligram per kilogram (mg/kg) in background soils and sediment.
- Lead was identified at concentrations ranging from 150 to 1,300 mg/kg in firing line soils.
- Lead was identified at concentrations ranging from 370 to 10,000 mg/kg in berm and backstop soils.
- Lead was identified at a concentration of 40 mg/kg in Drainage 2 sediment at the eastern fence line.
- The Arizona residential soil remediation level for lead is 400 mg/kg.

Summary of 2002 SGC (2003) Investigation:

- Six soil and sediment samples were collected.
- No information is available regarding sample depths.
- No information is available regarding field sieving to remove lead bullet fragments.
- All samples were analyzed for total lead by EPA Method 6010B.
- No information is available regarding the name of fixed laboratory.
- Lead was identified at concentrations ranging from 370 to 10,000 mg/kg in berm and backstop soils.
- Lead was identified at concentrations ranging from of 21 to 26 mg/kg in Drainage 2 sediment downstream of the Site.

Summary of 2010 SGC (2010b) Construction Sampling Event:

- Four composite soil samples were collected from segregated backfill and excavated drainage basin sediment.
- No information is available regarding field sieving to remove lead bullet fragments
- All samples were analyzed for total lead by EPA Method 6010B at Xenco Laboratories.
- Lead was identified at concentrations ranging from of 14 to 38 mg/kg in backfill soils.
- Lead was identified at concentrations ranging from of 10 to 11 mg/kg in drainage basin sediment stockpiles.

Summary of Multiple Stormwater Sampling Events:

- The concentration of lead in downstream stormwater samples ranged from 5.4 to 640 microgram per liter (ug/L) prior to construction of the range drainage basins.

- The concentration of lead in downstream stormwater samples after construction of the range drainage basins was below laboratory reporting limit of 2 ug/L.
- The ASWQS for lead in surface water is 15 ug/L.

Previous Investigation Summary.

Lead in soils in range berms and backstops and at range firing lines exceeds the Arizona residential Soil Remediation Level (SRL) (ADEQ 2002) of 400 mg/kg by a factor of 10 to 60 in sieved samples. Lead in soils also exceeds EPA ecological soil screening levels (Eco-SSL) of 46/56 mg/kg for avian (dove) and terrestrial (shrew) receptors. Lead is the primary chemical of potential concern (COPC) and chemical of potential ecological concern (COPEC).

Lead in sediment in drainages at and downstream of the range, while not exceeding the Arizona residential SRL, does exceed the EPA Eco-SSLs and contributes to total and dissolved lead in stormwater above the ASWQS of 15 ug/L. Construction of drainage basins in 2010 to capture lead impacted soils from the range before migration to the drainages has reduced total and dissolved lead in stormwater to below the ASWQS (two events); however, the sediment bed load in the drainages will continue to contribute lead to stormwater.

Stormwater discharges from the Site via Drainage Channels 2 and 3, both of which are tributaries to Willow Creek located approximately one-half mile downstream of the Site. Willow Creek is tributary to Granite Creek. The Granite Creek Headwaters, specifically Willow Creek, is listed on Arizona's 2004 303(d) List of Impaired Waters. The pollutant or parameter of concern on this stream reach is dissolved oxygen. The stream reach number for Willow Creek is AZ 15060202-059A.

The occurrence of groundwater and the potential impact by site-related lead was not evaluated. However, groundwater is located in deep, confined aquifers and a pathway from ground surface is likely incomplete. Residents in the area are served by the City of Prescott.

3.2 DATA GAPS AND REQUIREMENTS

HelioTech identified the following data gaps after review of the previous investigation findings:

- The potential threat from background and Site-related lead in berm and backstop soils, firing line and target line soils, drainage basin soils, and drainage channel sediment to human health and ecological receptors has not been adequately documented.

- The extent of lead in berm and backstop soils, firing line and target line soils, drainage basin soils, and drainage channel sediment posing a threat to human health or ecological receptors has not been adequately delineated.

- The downstream extent of lead migration from the Site has not been adequately documented.

- The volume of lead-impacted soils and sediment at and downstream of the Site has not been sufficiently documented to evaluate removal action alternative costs.

- The migration of lead-impacted sediment from Forest Service land on to east adjacent private land has not been adequately documented. No sampling will occur on private property absent the owner's consent or unless such sampling is otherwise in accordance with Forest Service's legal authority. At this time, no sampling is planned.

Previous investigation data and a September 2015 site reconnaissance with Forest Service were used to select additional sampling locations and analytes necessary to address these data gaps before preparation of this EE/CA report. The sampling rationale and approach, sampling methodology, analytical methods, and quality control procedures for the 2015 RSI are provided in the Final Engineering Evaluation/Cost Analysis Work Plan, Field Sampling Plan, and Health and Safety Plan (HelioTech 2015).

3.3 CURRENT REMOVAL SITE INVESTIGATION

HelioTech and Southwest Hazard Control (excavation subcontractor) conducted a RSI from November 9 through 13, 2015. A detailed map of the Site was developed and additional samples were collected at the Site for on- and off-site lead analysis to 1) support a streamlined risk evaluation, 2) to determine the lateral and vertical extent and volume of lead-contaminated soils and sediment, 3) to evaluate potential threat to water quality, and 4) to determine waste disposal requirements. Field investigation activities included:

1) Excavation of 14 trenches to a depth of 24 inches in the faces of the 50 yard, 100 yard, 200 yard berms and the overall range backstop. Visual inspection of depth of bullet penetration. Collection of samples from 0-6, 6-12, and 12-18 inches below grade from five vertical transects along trench wall.

2) Excavation of 4 trenches to a depth of 24 inches immediately in downrange of each firing line. Collection of samples from 0-6, 6-12, and 12-18 inches below grade from five vertical transects along trench wall.

3) Excavation of potholes to a depth of 24 inches around perimeters of firing lines, along target lines, below the faces of the 50 yard, 100 yard, 200 yard berms and the overall range backstop, beyond the range backstop, and background location. Collection of samples from 0-6, 6-12, and 12-18 inches below grade from a vertical transect on the pothole side wall.

4) Excavation of potholes to a depth of 24 inches in drainage basins and hand augering of inaccessible drainage channel sample locations. Collection of samples from 0-6, 6-12, and 12-18 inches below grade from a vertical transect on the pothole side wall or within auger boring.

5) Sieving of soil and drainage samples using a ¼-inch sieve for all samples and #10 sieve where moist clay was absent, and field screening of soil and sediment using an x-ray fluorescence (XRF) analyzer to evaluate the lateral and vertical extent of lead above screening criteria in samples collected from above features.

6) Preparation and submittal of split samples to a fixed laboratory for confirmation of XRF analyzer lead readings and to provide quantitative data for risk assessment.

7) Preparation and submittal of split samples to a fixed laboratory for evaluation of the leachable fraction of lead using the toxicity characteristic leaching procedure (TCLP) to classify waste for evaluation of potential on-site treatment and off-site stabilization and disposal options and costs.

8) Global positioning system (GPS) mapping of any newly identified site features, including drainage and erosion features, and sample locations. GPS data were used to enhance existing site maps and estimate lead waste volumes associated with each site feature.

Field photographs and sample and feature coordinates are provided in Appendices B and C, respectively.

A summary of the RSI findings for the Site is presented below in Section 3.3.1 and data validation findings are presented in Section 3.3.2.

3.3.1 RSI Findings

HelioTech collected and analyzed 408 out of a planned 439 soil and sediment samples using a portable XRF analyzer to define the lateral and vertical extent of lead contamination at each potential source area, and in drainage basins and drainage sediment (Table 3-3). Thirty-one samples were attempted but not collected due to the presence of bedrock at depth (Table 3-4). Sample locations are presented on Figure 3-1 (potential source areas) and Figure 3-2 (drainage basins and drainages) and field XRF data are provided in Appendix D.

- Primary sources evaluated included firing lines, target lines, 50 yard berm, 100 yard berm, 200 yard berm, and backstop (Figure 3-1).

- Potential secondary sources evaluated included Drainage Basins 1, 2, 3, and 4, as well as Drainages 1, 2, 3, 4, and 5 that potentially received runoff containing lead-contaminated soil (Figure 3-2).

- Previous investigations evaluated stormwater runoff and water standing in each drainage basin; therefore, surface water samples were not collected during this investigation.

Forty-two out of 45 split samples were submitted to a fixed laboratory for analysis of total lead to support correlation of XRF readings and provide quantitative for risk assessment (Table 3-3). Three split samples for laboratory analysis were attempted but not collected due to the presence of bedrock (Table 3-4). Field XRF data were correlated with fixed laboratory data at locations where split samples were collected. Correlation involved splitting the dataset into a low range (range floor and drainages) and a high range (berms and backstops) due to the very high concentrations of lead detected. The low range subset is generally within the linear range of the XRF analyzer, while the high range subset is outside of the linear range of the XRF analyzer. Conservative correlations were developed to ensure that predicted lead values used for risk assessment and removal volume calculations were slight overestimates of actual lead concentrations. Correlation graphs and predicted lead values used to define the extent of contamination, and calculate volumes of soil and sediment requiring removal are presented in Appendix E.

Laboratory analytical results (Table 3-5) and predicted lead values (Appendix E) indicate that lead in soil and drainage sediment exceeds the state of Arizona SRL, human health, and ecological benchmarks in the following areas:

- The primary source areas posing a threat to human health and ecological receptors at the Site include Drainage Basins 1 and 4, firing lines, and 50 yard target lines (Figures 4-1 and 4-2); 50 yard berm, 100 yard berm, 200 yard berm, and backstop berm (Figures 4-3 through 4-6); and the upstream reach of Drainage 1 (Figure 4-7).

Lead was detected at more than one order of magnitude above conservative human health and ecological benchmarks at the preceding primary and secondary source areas and is the primary COPC and COPEC at the Site. Lead was also detected above the Arizona SRL at the preceding primary and secondary source areas; therefore, soils and sediment at the locations are also considered a hazardous material.

Twenty split samples (soils and drainage sediment) were collected for leachable lead analysis after TCLP extraction. TCLP leachable lead from soils in the 50 yard, 100 yard, 200 yard, and backstop berms and Drainage Basin 1 were found to exceed Federal Resource Conservation and Recovery Act (RCRA) D list toxicity criteria indicating that the soils from the four berms and Drainage Basin 1 are RCRA hazardous waste and require treatment prior to disposal (Table 3-6).

A detailed discussion of risk screening approach, results of the streamlined risk evaluation (Appendix G), extent of lead contaminated soils and drainage sediment above human health and ecological benchmarks, and volume of lead contaminated soils and drainage sediment requiring a response action is presented in Section 4.

3.3.2 Data Validation Findings

Data validation was performed in accordance with EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 2010a). A cursory review of the analytical report and the quality assurance and quality control (QA/QC) information was conducted on 100 percent of the chemical data. An additional, full review of the analytical reports, the QA/QC information, and the associated raw data was not conducted. The cursory review evaluated the effect of the most critical QA/QC information, such as holding times, calibration requirements, and spiking accuracy, on the data.

Data validation specifications require that various data qualifiers be assigned when a deficiency is detected or when a result is less than its detection limit. If no qualifier is assigned to a result that has been validated, the data user is assured that no technical deficiencies were identified during validation.

The overall assessment of the data is summarized below:

- All holding times and calibration criteria were met.
- No total and leachable lead data were rejected.
- Matrix spike recoveries were low relative to the sample amount (high sample lead concentration). No qualification was required.
- Relative percent difference for serial dilutions were outside control limits, in each case returning a higher value than expected. Therefore, no lead values were underestimated. No qualification was required.

The laboratory data report is provided for reference in Appendix F.

3.4 SITE CONCEPTUAL EXPOSURE MODEL

HelioTech has developed a SCEM for the Site (Figure 3-3) based on the previous investigation and current RSI data and site reconnaissance. The SCEM addresses sources, release mechanisms, pathways, and exposure routes. The four primary sources of lead contamination are the following:

- Soil Berms and Backstop
- Soil from Firing Lines and Target Lines
- Soil in Drainage Basins
- Drainage Channel Sediment

Five primary mechanisms for release of lead to the environment are identified in the SCEM. One or more of the primary release mechanisms may operate on any of the potential primary sources

to mobilize lead to the environment. Primary release mechanisms that may be operating on individual primary sources at the Site include the following:

- Storm Water Runoff. Lead can be released and transported away from any of the primary sources by storm water runoff.

- Dissolution. Lead can be entrained in sediment and released from any of the primary sources while inundated with surface water, or may dissolve into the water column.

- Slope Failure. Steep earthen berms may degrade and fail from either wind erosion or storm water runoff, and increase the rate at which lead are released.

- Wind Erosion. Lead in dust may be transported and released from any of the primary sources by wind erosion.

- Infiltration. During seasonal monsoons, surface water may leach lead from primary sources.

In addition, the SCEM identifies the following three secondary sources of lead: Secondary sources are media that are not currently contaminated but are a risk to become contaminated by primary sources due to environmental conditions.

- Surface Water. Surface water may be affected by primary release through storm water runoff, dissolution, or particles and dust.

- Airborne Particles and Dust. Particulate-bound lead from the exposed ground surfaces on the berms, backstop, target and firing lines, drainage basins, and the channel sediment can be released by migration of airborne particles and dust during the dry season.

- Groundwater. Depth to bedrock is shallow (surface to approximately 2 to 6 feet bgs). Perched water was noted at the 50 yard firing line and in Drainage Basin 2 and appears to be related to slow infiltration rather than shallow groundwater as adjacent trenches and potholes were dry. Water bearing units have not been identified beneath the Site. Regional groundwater is located in deep, confined aquifers and a pathway from ground surface is likely incomplete. Residents in the area are served by the City of Prescott.

Secondary release mechanisms operating on the secondary sources listed above include:

- Deposition. Ambient air and seasonal runoff can transport lead—these exposure pathways do not require a secondary release mechanism. Lead could be deposited as wind-blown dust or bound to particulates in deposited sediment.

- Wind. Wind can move airborne particles to the ambient air, which can be a reservoir for lead and an exposure pathway not requiring a secondary release mechanism. Lead could be bound to and travel with wind-blown dust and particulates.

Based on an evaluation of potential primary sources, release mechanisms, and environmental data, three direct exposure media for potential receptors have been identified. Potential receptors may be exposed to lead via inhalation, ingestion, and dermal contact with storm water, soil/sediment, or air.

- Surface Water. Exposure routes for site visitors and adjacent residents and terrestrial receptors include ingestion of and dermal contact with lead in stormwater runoff from the Site and in drainage basins during and immediately after storms. Due to the hot, dry climate at the Site, surface water is rarely present. Furthermore, the drainage area around the Site is not a source for drinking water, and substantial ingestion is unlikely. Ingestion or dermal contact with surface water discharged from the Sites, while not likely, is considered a completed pathway.

- Soil/Sediment. Exposure routes for site visitors and adjacent residents and terrestrial fauna include ingestion of and dermal contact with lead in soil/sediment at the Site and in drainage channels downstream of the Site. Based on the documented levels of lead in soil and sediment samples, potential ingestion and dermal contact by area receptors is considered high and a completed pathway.

- Ambient Air. Inhalation of ambient air is also a potentially completed pathway for potentially downwind residents, site visitors, and terrestrial receptors. Lead in suspended dust particles are a potential concern, especially as wind speeds increase. Based on the documented levels of lead in soil and sediment samples, potential for dust inhalation and ingestion or dermal contact with settled dust by area receptors is considered high and a completed pathway.

4.0 PRELIMINARY RISK SCREENING

Preliminary human health and ecological risk screening was conducted to identify environmental media, based on the completed pathways presented in the SCEM (Figure 3-3), which may pose an unacceptable risk to human health or the environment. The main objective of the risk screening is to help focus removal activities on media of greatest potential risk to human or ecological receptors. Potential risks to human health and ecological receptors were evaluated by comparison to screening criteria for soil and sediment. Concentrations of lead in soil and sediment were compared to both site-specific background data and risk-based screening criteria (Table 4-1). This risk screening was prepared based on RSI data reported in this EE/CA. Stormwater data collected by Forest Service and PSC before and after construction of sediment drainage basins was also considered in evaluating the surface water pathway.

Risk screening approach and results are provided in Section 4.1 for human health, and in Section 4.2 for ecological receptors. Potential threats to water quality from discharge of storm water runoff and lead-contaminated soil to ephemeral drainages are evaluated in Section 4.3. Based on the findings of the human health and ecological risk screening and threats to water quality, justification for removal action is presented in Section 4.4.

4.1 HUMAN HEALTH RISK SCREENING

Lead was identified as a COPC by comparing concentrations in soil source areas and drainage sediment at the Site with human health risk-based screening criteria. Solid matrix screening criteria used for this comparison include Arizona SRL (ADEQ 2002) for a conservative residential receptor and EPA Regional Screening Level (RSL) (EPA 2015) for a conservative residential receptor.

Conservative residential benchmarks using a residential exposure scenario were selected because permanent residents live on private property east adjacent to the Site. In addition, the more conservative residential exposure scenario was also selected as it allows for unrestricted future use of the Site. The residential scenario is based on soil ingestion, soil inhalation, and potable water ingestion routes of exposure. Residential exposure assumes residents are exposed 24 hours/day and 350 days/year. The EPA RSL is based on evaluation lead exposure using blood-lead modeling for a typical child resident, such as the Integrated Exposure-Uptake Biokinetic Model (IEUBK).

The relative magnitude of risk was calculated for each sample location by calculating a ratio of chemical detected with applicable benchmarks. Table 4-1 presents the conservative residential risk-based screening criteria for human receptors and site background concentration. Figures 4-1 through 4-7 present the results of the investigation and identify those areas where lead concentration exceed residential benchmarks. A numerical risk screening table is provided in Appendix G, Table G-1. A baseline human health risk assessment (BHHRA) is beyond the

scope of this project and is not necessary to justify an action given the magnitude by which lead concentrations exceed benchmarks.

Based on comparison of investigation data to benchmarks, exposure assessments and risk screening findings were developed for the Site in the following subsections.

4.1.1 Human Health Risk Screening Findings

Lead was identified as a COPC for residential receptors. The concentrations of lead in solid matrix samples in the flat areas of the Site ranged from 0.02 to 15.2 times residential benchmarks (Figures 4-1 and 4-2), while lead concentrations in the berms and backstop ranged from 0.08 to 99.4 time the residential benchmarks (Figures 4-3 and 4-6). Most of the lead contamination in the flat areas of the Site was limited to the upper 6 inches of soil, while the depth of lead contamination in the berms extended beyond the 18 inch sampling depth.

Lead in drainage sediment at and downstream of the Site ranged from 0.03 to 4.7 times residential benchmarks; Drainage 1 was the only drainage reach that exceed the residential benchmarks (Figure 4-7). Lead contamination in Drainage 1 was limited to the upper 6 inches of sediment.

For comparison purposes, a low risk ranges from 1 to 10 times a benchmark and a moderate risk ranges from 10 to 100 times a benchmark. The primary source areas posing a threat to human receptors at the Site include all of Drainage Basin 1, small areas of Drainage Basin 4, the firing lines and 50 yard target lines for each range (Figures 4-1 and 4-2); the 50 yard berm, 100 yard berm, 200 yard berm, and backstop berm (Figures 4-3 through 4-6); and the upstream reach of Drainage 1 (Figure 4-7).

Table 4-2 identifies the location, depth, and volume of soils and sediment by source area potentially warranting a removal action based on the promulgated Arizona SRL and non-promulgated EPA RSL. An estimated 2,900 cubic yards (CY) of in-situ soil and sediment were found to exceed the Arizona SRL. Approximately 2,700 of the 2,900 CY of contaminated soil was identified as RCRA hazardous waste and requires treatment prior to disposal (Table 4-2). For estimation purposes, the depth of contaminated soil in the berms was assumed to extend to a depth of 48 inches based on high velocity bullet penetration of 36 inches and allowing for successive placement of additional material and ballistic sand on the faces of berms over the long operational period of the firing range.

4.1.2 Human Health Exposure Assessment

The Site is located on Forest Service land immediately adjacent to a residential area (Figure 2-1). The area is currently under a closure order and signed to exclude trespass. Adjacent residents were observed to walk through the Site during evening walks. Windblown dust from soils and migration of contaminated sediment may be a concern for east adjacent residents as well as site

visitors. Lead in sediment located in Drainage Basin 1 and Drainage 1 as well as past elevated lead concentrations in stormwater indicate contaminated soils are being actively transported from a portion of the Site. The five berms and backstops at the Site are also over steep and pose a physical hazard for site visitors and Forest Service employees.

Potential bioaccumulation in cattle and game animals, followed by human consumption, was considered as a potential exposure pathway. However, cattle have been historically excluded from the Site with range fencing, and any cattle or game animal bioaccumulation is expected to be very low based on the limited duration of grazing, limited grazing area, and range fencing at Site in comparison to overall grazing range.

Surface water was not encountered during investigation activities. Surface water is present only during or immediately after seasonal rain events. Surface water is not expected to be used as a source of drinking water. Further, stormwater sampling conducted after construction of detention basins indicated that lead concentrations were below the ASWQS. Therefore, risk screening was not completed for surface water.

Depth to bedrock is shallow (surface to approximately 2 to 6 feet bgs). Perched water was noted at the 50 yard firing line and in Drainage Basin 2 and appear to be related to slow infiltration of stormwater rather than shallow groundwater, as adjacent trenches and potholes were dry. Water bearing units have not been identified beneath the Site. Regional groundwater is located in deep, confined aquifers and a pathway from ground surface is likely incomplete. Residents in the area are served by the City of Prescott. Therefore, risk screening was not completed for ground water.

4.2 ECOLOGICAL RISK SCREENING

Lead was identified as a COPEC by comparing concentrations soil source areas and drainage sediment at the Site with ecological risk-based screening criteria. Solid matrix screening criteria used for this comparison were EPA Eco-SSLs (EPA 2010b). The Eco-SSL for a chemical varies based on receptor selected and whether a no observed adverse effect levels (NOAEL) or lowest observed adverse effect levels (LOAEL) was used to develop the benchmark. Doves and hawks were identified as likely avian receptors, while shrews and voles as likely terrestrial mammal receptors. Surface water is present only during or immediately after seasonal rain events. Aquatic receptors and benthic invertebrates were not observed; therefore, only benchmarks for avian and terrestrial receptors were considered.

The relative magnitude of risk was calculated for each sample location by calculating a ratio of chemical detected with applicable benchmarks. Table 4-1 presents the conservative non-promulgated Eco-SSLs for dove and shrew (most conservative) based on NOAEL and site background concentration. A numerical risk screening table is provided in Appendix G, Table G-2. Figures 4-1 through 4-7 present the results of the investigation and identify those areas where lead concentration exceed 10 times the ecological benchmarks as risk managers typically set cleanup goals at a value of 10 times the Eco-SSL to account for the NOAEL threshold in Eco-

SSL development. A screening-level ecological risk assessment (SLERA) is beyond the scope of this project and is not necessary to justify an action given the magnitude by which chemical concentrations exceed benchmarks.

Based on comparison of investigation data to ecological benchmarks, ecological exposure assessments and risk screening findings were developed for the Site in the following subsections.

4.2.1 Ecological Risk Screening Findings

Lead was identified as a COPEC for ecological receptors. The concentrations of lead in solid matrix samples in the flat areas ranged from 0.17 to 133 times conservative Eco-SSL benchmarks, while lead concentrations in the berms and backstop ranged from 0.57 to 864 times the ecological benchmarks. Most of the lead contamination in the flat areas of the Site was limited to the upper 6 inches of soil, while the depth of lead contamination in the berms extended beyond the 18 inch sampling depth.

Lead in drainage sediment at and downstream of the Site ranged from 0.19 to 40.8 times conservative Eco-SSL benchmarks; Drainage 1 was the only drainage reach that exceed the ecological benchmarks. Lead contamination in Drainage 1 was limited to the upper 6 inches of sediment.

The primary source areas posing a threat to ecological receptors (10 times the conservative Eco-SSL) at the Site include all of Drainage Basin 1, small areas of Drainage Basin 4, the firing lines and 50 yard target lines for each range (Figures 4-1 and 4-2); the 50 yard berm, 100 yard berm, 200 yard berm, and backstop berm (Figures 4-3 through 4-6); and the upstream reach of Drainage 1 (Figure 4-7).

Table 4-2 identifies the location, depth, and volume of soils and sediment by source area potentially warranting a removal action based on 10 times the conservative Eco-SSLs. An estimated 2,900 CY of in-situ soil and sediment were found to exceed 10 times the ecological benchmark. Approximately 2,700 of the 2,900 CY of contaminated soil were identified as RCRA hazardous waste and requires treatment prior to disposal (Table 4-2). For estimation purposes, the depth of contaminated soil in the berms was assumed to extend to a depth of 48 inches based on high velocity bullet penetration of 36 inches and allowing for successive placement of additional material and ballistic sand on the faces of berms over the long operational period of the firing range.

4.2.2 Ecological Exposure Assessment

The Site is located in the rural suburbs of the City of Prescott, which has encroached upon the Prescott National Forest (Figure 2-1). No threatened or endangered plant or wildlife species were identified at the Site. No Forest Service sensitive species are known to occur within or near the project area. There would not be any trend towards listing for any sensitive species.

Fauna may be exposed directly to lead on-site, through consumption of fauna prey, or through consumption of flora in soils and drainage sediment. Windblown dust from soils and drainage sediment may be a concern for fauna that utilize downwind flora as a food source. Lead in sediment located in Drainage Basin 1 and Drainage 1 as well as past elevated lead concentrations in stormwater indicate contaminated soils are being actively transported from a portion of the Site and could impact off-site fauna. Surface water was not encountered during investigation activities. Surface water is present only during or immediately after seasonal rain events. Surface water is not expected to be used as a source of drinking water for fauna. Further, stormwater sampling conducted after construction of detention basins indicated that lead concentrations were below the ASWQS. Therefore, risk screening was not completed for aquatic receptors. No riparian areas of high, medium, or low value were identified at the Site.

4.3 THREAT TO WATER QUALITY

ADEQ conducted stormwater sampling in Drainage 2 and Drainage 3 at locations downstream from the Site within the east adjacent residential area on September 22, 2007. Drainage 1, a tributary to Drainage 2, was not sampled. The concentration of total lead in downstream stormwater samples ranged from 20 to 67 ug/L above the ASWQS of 15 ug/L (Table 3-2). Dissolved lead did not exceed the ASWQS. A surface water sample collected during a high intensity storm identified total lead at 640 ug/L and dissolved lead at 24.3 ug/L. Surface water in Willow Creek, located approximately one-half mile downstream of the Site (Figure 2-1), contained total lead at concentrations ranging from 1.1 to 1.4 ug/L and dissolved lead at 0.3 ug/L.

ADEQ issued a NOV to PSC on July 16, 2008. Subsequent to that NOV, PSC constructed drainage basins to capture lead impacted soils and reduce contribution to stormwater in area drainages (SGC 2010b). The concentrations of total and dissolved lead in Drainage 2 downstream from the Site after construction of the range drainage basins were below laboratory reporting limit of 2 ug/L (Table 3-2). Surface water samples collected within the constructed drainage basins contained total lead at concentrations from 29 to 100 ug/L, and dissolved lead at concentrations from <1 to 23 ug/L.

Lead in sediment in drainages at and downstream of the shooting range contributes to total and dissolved lead in stormwater above the ASWQS of 15 ug/L. Construction of drainage basins in 2010 to capture lead impacted soils from the range before migration to the drainages has reduced total and dissolved lead in stormwater to below the ASWQS (two events); however, the sediment bed load in the Drainage 1 (no sediment drainage basin) will continue to contribute lead to stormwater.

Regional groundwater is located in deep, confined aquifers and a pathway from ground surface is likely incomplete. Residents in the area are served by the City of Prescott.

4.4 BASIS FOR REMOVAL ACTION

The on-site soil and sediment, air transport, and storm water SCEM pathways appear to be complete for human and ecological receptors based on the analytical results, field observations, and apparent terrestrial wildlife uses of the Site and residential use of east adjacent properties (Figures 2-1 and 3-3). The concentration of lead in soil and Drainage 1 sediment samples exceed conservative human health developed by EPA and the state of Arizona and ecological screening benchmarks compiled by EPA (Table 4-1). Human health benchmarks are based on a 1 in one million excess cancer risk or a hazard index of 1.0, while ecological benchmarks are based on a NOAEL to an ecological receptor.

Concentrations of lead in soils and sediment represent a low to moderate risk to human receptors at the Site, under a conservative residential scenario selected based on close proximity to east adjacent residences (Appendix G, Table G-1). Concentrations of lead in soils and sediment represent a moderate to high risk to ecological receptors at the Site based on conservative EPA Eco-SSLs (Appendix G, Table G-2). Low risk is defined as 1 to 10 times screening criteria, moderate risk is defined as 10 to 100 times screening criteria, high risk as 100 to 1,000 times screening criteria, and extremely high risk as greater than 1,000 times screening criteria. Risk managers consider a removal action as appropriate when risk exceeds the upper end of the moderate risk range.

A removal action is warranted at the Site based on moderate or higher risk to both human and ecological receptors. An estimated 2,900 cubic yards (CY) of in-situ soil and Drainage 1 sediment warrant a removal action based on a risk of at least 1 times the Arizona SRL (a promulgated value) and at least 10 times both Eco-SSL ecological benchmarks (non-promulgated values). Approximately 2,700 CY of the 2,900 CY of contaminated soil were identified as RCRA hazardous waste and require treatment prior to disposal (Table 4-2).

Potential impacts to human and ecological receptors posed by exposure to risk-driving lead from lead in soil and sediment at the Site are available in Agency for Toxic Substances and Disease Registry (ATSDR) prepared toxicological profiles at www.atsdr.cdc.gov/toxprofiles/index.asp.

Potential Physical Hazards. Over steep berms may create unsafe conditions for publicly accessed land. Berms could fail due to over steep slopes, causing a site visitor or Forest Service employee to fall or become buried by loose material that unexpectedly sloughs off because of natural or human-triggered erosion. The access road is gated; however, only range fencing limits access to the perimeter of the Site.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Removal Action Criteria. The documented potential risks to humans and ecological receptors and physical hazards described above indicate attainment of the following NCP removal action factors specified at 40 *Code of Federal Regulations* (CFR) § 300.415(b)(2):

- Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants;
- High levels of hazardous substances, pollutants, or contaminants in soils largely at or near the surface that may migrate;
- Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released; and
- Other situations or factors that may pose threats to public health or welfare or the environment

Based on these four NCP factors, a removal action is warranted at the Site to:

1) Minimize human and ecological exposure to lead in soil and Drainage 1 sediment;

2) Minimize human and ecological exposure to lead in wind-borne dust;

3) Minimize entrainment of lead in drainage basins and drainages during storm water runoff to protect surface water quality;

4) Minimize potential migration of lead to shallow groundwater; and

5) Minimize threats posed by physical hazards posed by over steep berms.

5.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section identifies and evaluates potential federal and State of Arizona ARARs, and sets forth Forest Service's determinations regarding potential ARARs for response action alternatives retained for detailed analysis in this EE/CA. Section 5.1 summarizes the definitions and concepts pertinent to ARAR determinations. The three categories of ARARs—chemical-, location- and action-specific— are described in Sections 5.3, 5.4, and 5.5, respectively. Classification of waste is discussion in Section 5.2 prior to identification of chemical-specific ARARs. Section 5.6 identifies other issues related to evaluation of potential alternatives, including National Environmental Policy Act (NEPA) and property ownership issues.

Forest Service has primary responsibility for identifying federal and state ARARs at the Site. The following section discusses Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and NCP requirements for identification of federal and state ARARs for the Site.

5.1 SUMMARY OF CERCLA AND NCP REQUIREMENTS

Section 121(d) of the CERCLA of 1980 (42 *United States Code* [USC] §9621[d]), as amended, states that removal actions on CERCLA sites must attain (or the decision document must justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the law or regulation directly address the circumstances at the Site. An applicable federal requirement is an ARAR. An applicable state requirement is an ARAR, only if it is more stringent than federal ARARs.

If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed response action and are well suited to the conditions of the Site (EPA 1988a). A requirement must be determined both relevant and appropriate to be considered an ARAR.

The criteria for determining relevance and appropriateness, as listed in 40 CFR §300.400(g)(2), are:

- Purpose of the requirement and the purpose of the CERCLA action

- Medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site
- Substances regulated by the requirement and the substances found at the CERCLA site
- The actions or activities regulated by the requirement and the removal action contemplated at the CERCLA site
- Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site
- Type of place regulated and the type of place affected by the release or CERCLA action
- Type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action
- Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site.

A requirement may be "applicable" or "relevant and appropriate," but not both. Identification of ARARs is done on a site-specific basis and involves a two-part analysis: first, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is nevertheless both relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (EPA 1988b).

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be:

- A state law or regulation
- An environmental or facility siting law or regulation
- Promulgated (of general applicability and legally enforceable)
- Substantive (not procedural or administrative)
- More stringent than the federal requirement
- Identified in a timely manner
- Consistently applied

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs in this analysis are considered ARARs. Permits are considered procedural or administrative requirements. Provisions of generally relevant

federal and state statutes and regulations determined to be procedural or non-environmental, including permit requirements, are not considered ARARs.

Nonpromulgated advisories or guidance issued by federal or state governments are not legally binding and do not have the status of ARARs. Such requirements may however be useful and are "to be considered" (TBC). TBC requirements complement ARARs but do not override them. TBC requirements are useful for guiding decisions regarding cleanup levels or methodologies when regulatory standards are not available.

Additional general information regarding ARARs may be found in EPA's "CERCLA Compliance with Other Laws Manual" (EPA 1989). Specific ARARs issues are also discussed in the March 8, 1990, *Federal Register* notice publishing the final rule for the National Contingency Plan (see 55 *Federal Register* 8666, et seq.)

Forest Service has developed three categories of ARARs to assist in the identification of ARARs. The three categories are: (1) chemical-specific, (2) location-specific, (3) and action-specific ARARs. EPA guidance recognizes that some requirements do not fall neatly into this classification. These categories are described in the following sections.

5.2 HAZARDOUS WASTE CLASSIFICATION

The lead contaminated soil and sediment from the Site must be evaluated to determine if they are RCRA hazardous wastes.

Federal RCRA hazardous waste determination is necessary to determine whether a waste is subject to RCRA requirements at *Arizona Administrative Code* (AAC) Title 18, Chapter 8, Article 2, §261 and 262. The first step in the RCRA hazardous waste characterization process is to evaluate contaminated media at the Site and determine whether the contaminant constitutes a "listed" RCRA waste. Forest Service has determined that the wastes at the Site are not RCRA F, K, P, or U code wastes. These wastes are specific to an industry or process.

The second step in the RCRA hazardous waste characterization process is to evaluate potential hazardous characteristics of the waste. The evaluation of characteristic waste is described in EPA guidance as follows (EPA 1988a).

> Under certain circumstances, although no historical information exists about the waste, it may be possible to identify the waste as RCRA characteristic waste. This is important in the event that (1) removal alternatives under consideration at the Site involve on-site treatment, storage, or disposal, in which case RCRA may be triggered as discussed in this section; or (2) a removal alternative involves off-site shipment. Since the generator (in this case, the agency or responsible party conducting the Superfund action) is responsible for determining whether the wastes exhibit any of these characteristics (defined in 40 CFR §261.21–261.24), testing may be required. The lead agency must use best

professional judgment to determine, on a site-specific basis, if testing for hazardous characteristics is necessary.

Hazardous waste characteristics, as defined in 40 CFR §261.21–261.24, are commonly referred to as ignitability, corrosivity, reactivity, and toxicity. Arizona environmental health standards for the management of hazardous waste set forth in AAC Title 18, Chapter 8, Article 2, §262 adopted the federal RCRA program except where noted.

A waste is considered hazardous if the contaminants in the water or soil TCLP extract is equal to or exceeds the TCLP limits. TCLP testing is required only if total contaminant concentrations in soil equals or exceeds 20 times the TCLP limits because TCLP uses a 20-to-1 dilution for the extract (EPA 1988a). The TCLP extract concentration for lead exceeds the TCLP limit of 5 milligrams per liter (mg/L) in the berms and backstop at the Site. Therefore, a portion of the soil at the Site is a RCRA hazardous waste by toxicity characteristic.

5.3 CHEMICAL-SPECIFIC ARARS AND TBCS

Chemical-specific ARARs are generally health- or risk-based numerical values or methodologies applied to site-specific conditions that result in the establishment of a cleanup level. The primary sources of contamination at the Site are:

- Storm water in drainages
- Soils and drainage sediment
- Solids deposited from windblown dust

Potential ARARs for solid media and surface water are evaluated below. Surface water is discussed for completeness but is not a concern because it is not present at the Site; however, lead mobilized with drainage sediment may degrade water quality during stormwater runoff events. Groundwater is not the focus of the removal action because groundwater is very deep below the ground surface at the Site and a pathway from ground surface is likely incomplete. Residents in the area are served by the City of Prescott.

5.3.1 Soil ARARs

There are no potential chemical-specific ARARs for soil. However, there are potential chemical-specific ARARs for soil for the alternatives that generate waste. Two of the removal alternatives that Forest Service is evaluating involve excavating soil, on- or off-site treatment, and disposing of it off-site. Excavation and disposal constitute generation of waste. The key threshold question for soil ARARs is whether the soil exceeding screening criteria would be classified as hazardous waste. The soil may be classified as a federal hazardous waste as defined by RCRA and the state-authorized program, or as non-RCRA, state regulated hazardous waste. If the soil is determined to be hazardous waste, the appropriate requirements apply.

The applicability of RCRA requirements depends on whether the soil is a RCRA hazardous waste; whether the soil was initially treated, stored, or disposed of after the effective date of the particular RCRA requirement; and whether the activity at the Site constitutes treatment, storage, or disposal as defined by RCRA. However, RCRA requirements may be relevant and appropriate even if they are not applicable. Examples include activities that are similar to the definition of RCRA treatment, storage, or disposal for waste that is similar to RCRA hazardous waste.

As discussed in Section 5.2, the determination of whether a waste is an RCRA hazardous waste can be made by comparing the site waste to the definition of RCRA hazardous waste. The RCRA requirements at 40 CFR §262.11 and AAC Title 18, Chapter 8, Article 2, §261, are potential ARARs because they define RCRA hazardous waste. These requirements are potential ARARs for soil and waste.

State RCRA requirements included within the EPA-authorized RCRA program for Arizona are considered potential federal ARARs and are discussed above. When state regulations are broader in scope than their federal counterparts, they are considered potential state ARARs. State requirements such as the non-RCRA, state-regulated hazardous waste requirements may be potential state ARARs because they are not within the scope of the federal ARARs (57 CFR §60848). The AAC Title 18, Chapter 7, Article 2, §264 requirements that are part of the state-approved RCRA program would be potential state ARARs for non-RCRA, state-regulated hazardous wastes.

The waste characteristics need to be compared to the definition of non-RCRA, state-regulated hazardous waste. The non-RCRA, state-regulated waste definition requirements at AAC Title 18, Chapter 7, Article 2, §201 through 206 are potential state ARARs for determining whether other RCRA requirements are potential state ARARs. The Site waste may be compared to these thresholds to determine whether it meets the characteristics for a non-RCRA, state-regulated hazardous waste. AAC Title 18, Chapter 7, Article 2, §205 (including Appendix A) lists pre-determined SRLs. Forest Service has identified these requirements as potential ARARs because one of the alternatives evaluates permanent off-site disposal of non-RCRA, state-regulated hazardous waste.

EPA has also developed RSLs and Eco-SSLs to identify chemical that may require site cleanup to protect human health and ecological receptors; both RSLs and Eco-SSLs are TBC. The EPA RSL for residential receptors and the Arizona SRL used to define state-regulated hazardous waste are the same numerical value. The Eco-SSLs are based on NOAELs for specific ecological receptors and are very conservative.

The action removal alternatives will result in the generation of waste for off-site disposal. If Forest Service determines that this waste is RCRA hazardous waste, Forest Service will comply with all applicable requirements (40 CFR §264.18 and AAC Title 18, Chapter 8, Article 2, §264) for proper off-site disposal, such as packaging, manifesting, and land disposal restrictions (LDR)

(40 CFR §268). Forest Service has identified these requirements as potential ARARs because the action removal alternatives evaluates treatment and permanent off-site disposal of RCRA hazardous waste.

As long as the excavated material remains inside the area of contamination (AOC), it is not considered newly generated waste and will not be subject to RCRA generator, treatment, or other waste management requirements. If excavated material is moved outside the area of contamination, the substantive RCRA requirements associated with managing hazardous waste (including RCRA LDRs) will be applicable. Excavation, consolidation outside of the AOC, and permanent on-site disposal would trigger RCRA requirements.

5.3.2 Surface Water ARARs

The Clean Water Act (40 CFR §131) and Section 304 establish permit requirements and water quality criteria for in-stream chemical levels for the protection of human health and ecological receptors. AAC Title 18, Chapter 11, Article 1 implements the Clean Water Act in the state of Arizona. AAC Title 18, Chapter 11, Article 1, §104 and 105 establish designated uses for bodies of water, §107 the state of Arizona anti-degradation policy, §108 narrative water quality standards, and §109-112 numeric water quality standards. ADEQ issued a NOV for the Site in 2008 due to the concentration of lead in storm water runoff in Drainages 2 and 3 downstream of the Site exceeding ASWQS numeric standard and triggering the anti-degradation policy.

Surface water at the Site is present only during seasonal rainstorms and would not be a consistent source of drinking water. Surface water is normally present less than 2 weeks per year during, and only immediately after seasonal storms. Therefore, the designated use would by aquatic and wildlife (ephemeral). AAC Title 18, Chapter 11, Article 1 may be an ARAR for ephemeral surface water when being degraded by lead in drainage sediment migrating from the Site.

Numerical surface water standards (ASWQS) will not be considered during development of removal action goals because degradation of surface water is the result of contaminated soil and sediment, which are the focus of the removal action. However, removal action goals developed for soil and sediment will be low enough to ensure that residual levels of lead, if entrained in runoff, will not exceed the ASWQS.

5.4 LOCATION-SPECIFIC ARARS AND TBCS

Location-specific ARARs are restrictions on the concentrations of hazardous substances or the conduct of activities solely because they are in specific locations. Special locations include national parks, wilderness areas, historic and cultural resources, sensitive species and ecosystems, and floodplains. The Wilderness Act, Protection and Enhancement of the Cultural Environment, Archeological and Historic Preservation Acts, Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act, Fish and Wildlife Coordination Act, Federal Endangered Species Act, Migratory Bird Treaty Act, Responsibilities

of Federal Agencies to Protect Migratory Birds, and Floodplain Management are potential ARARs and are summarized below.

5.4.1 Wilderness Act

The Wilderness Act, 16 USC §1131, established a National Wilderness Preservation System composed of federally owned areas designated by Congress as "wilderness areas." Wilderness areas are administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness. The Site is not located in a wilderness area.

5.4.2 Protection and Enhancement of the Cultural Environment

Executive Order No. 11593, signed in 1971, assigns responsibilities to federal agencies to protect and enhance the cultural environment of the nation. These responsibilities include: (a) locating, inventorying, and nominating all sites, buildings, districts, and objects under their jurisdiction or control that appear to qualify for listing on the National Register of Historic Places; (b) initiating measures to assure that where as a result of Federal action a property listed on the National Register of Historic Places is to be substantially altered or demolished, timely steps be taken to make or have made records, including measured drawings, photographs and maps, of the property, and that copy of such records then be deposited in the Library of Congress as part of the Historic American Buildings Survey or Historic American Engineering Record for future use and reference; and (c) initiating measures and procedures to provide for the maintenance, through preservation, rehabilitation, or restoration, of federally owned and registered sites at professional standards prescribed by the Secretary of the Interior. No structure or feature at the Site is listed in the National Register of Historic Places.

5.4.3 Archeological and Historic Preservation Acts

The *Archeological and Historic Preservation Act, 16 USC §469*, establishes procedures to provide for preservation of historical and archeological data that might be destroyed through alteration of terrain because of a federal construction project or a federally licensed activity or program. The *National Historic Preservation Act of 1966, 16 USC §470*, establishes procedures to preserve historic properties and to minimize harm to project or properties owned or controlled by a federal agency that are listed on or eligible for listing on the National Register of Historic Places. Under CERCLA, removal actions need to take into account the effects of removal activities on any historic properties included on or eligible for inclusion on the National Register of Historic Places. If any response action would cause irreparable loss or destruction of significant scientific, prehistoric, historical, or archeological data, it will be necessary to follow the procedures in the statute to provide for data recovery and preservation activities.

Under the *Historic Sites, Buildings, and Antiquities Act, 16 USC §461*, Forest Service is charged with conducting a survey of historic and archeological sites to obtain, document, and secure historical and archaeological facts, features, objects, and structures for determining those that possess exceptional value for commemorating or illustrating the history of the United States.

No structure or feature at the Site is listed in the National Register of Historic Places. In addition, the Site was developed in the late 1950's on unimproved Forest Service land and no permanent structures remain at the Site.

5.4.4 Archaeological Resources Protection Act

The *Archaeological Resources Protection Act of 1979, 16 USC §470-1*, prohibits activities within area where action may cause irreparable harm, loss, or destruction of significant artifacts. The Act regulates alteration of terrain because of a federal construction project or federally licensed activity or program where action may cause irreparable harm, loss, or destruction of significant artifacts. An archaeological survey of previously undisturbed land is required prior to construction. Data recovery and preservation would be required if significant archaeological or historical data were found.

Under the *Historic Sites, Buildings, and Antiquities Act, 16 USC §461*, Forest Service is charged with conducting a survey of historic and archeological sites to obtain, document, and secure historical and archaeological facts, features, objects, and structures for determining those that possess exceptional value for commemorating or illustrating the history of the United States.

No structure or feature at the Site is listed in the National Register of Historic Places. In addition, the Site was developed in the late 1950's on unimproved Forest Service land and no permanent structures remain at the Site. Archeological features (ground stones and flake stones) are located west of the Site and outside of the project area. Forest Service will flag the area to avoid any potential disturbance prior to construction.

5.4.5 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act, 25 USC §3001, establishes the ownership of cultural items excavated or discovered on federal or tribal land. The act states that Native American remains and associated funerary objects belong to lineal descendants, or if the descendants cannot be identified, then to the tribe on whose lands the remains were found or the tribe having the closest relationship to them.

The act requires federal agencies to prepare an inventory of remains and funerary objects and a summary of sacred objects, cultural patrimony objects, and unassociated funerary objects. If federal agencies anticipate activities on federal lands that might have an effect on American Indian burials—or if burials are discovered during such activities—they must consult with

potential lineal descendants or American Indian tribal officials as part of their compliance responsibilities.

For planned excavations, consultation must occur during the planning phase of the project. For inadvertent discoveries, the regulations delineate a set of short deadlines for initiating and completing consultation. Prior to removal action planning, Forest Service should ensure potential Indian burials are located and documented by consulting with local tribal officials.

5.4.6 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act, 16 USC §661, was enacted to protect fish and wildlife when federal actions result in the control or structural modification of a nature stream or body of water. The statute requires federal agencies to take into consideration the effect that water-related projects would have upon fish and wildlife and then take action to prevent loss or damage to these resources. Any response actions taken with ephemeral Drainage 1 will reduce migration or remove lead impacted sediment, improving the resource. In addition, if any material is removed from ephemeral Drainage 1, engineering controls and best management practices (BMP) will be used to stabilize the drainage and control stormwater runoff into the drainage.

5.4.7 Federal Endangered Species Act

No federal threatened or endangered plant or wildlife species were observed on or near the Site. Therefore, the federal Endangered Species Act is not currently an ARAR.

5.4.8 Migratory Bird Treaty Act

The Migratory Bird Treaty Act, 16 USC §701, establishes federal responsibility for the protection of international migratory bird resources. It prohibits at any time, using any means or manner, the pursuit, hunting, capturing, killing or attempting to take, capture, or kill any migratory bird. No migratory birds have been identified at the Site.

The four acres of the range operational portion of the project area does not provide any migratory bird habitat due to the nature of the use of the site and high level of disturbance associated with the use as well as the lack of vegetation on that area. Restoring this small portion of the Site may displace some birds in the surrounding vegetation during the actual restoration activities in the short term. The long-term result would be improved habitat for migratory birds.

5.4.9 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act, 16 USC §668, was originally enacted in 1940 as the Bald Eagle Protection Act to protect bald eagles and later amended to include golden eagles. It prohibits the taking or possession of and commerce in bald and golden eagles, parts, feathers,

nests, or eggs with limited exceptions. The definition of take includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb. Bald eagles may not be taken for any purpose unless a permit is issued prior to the taking.

There are no known nests or roosts for either bald or golden eagles on or near the project site. There are no records of eagles using the area for foraging. There would not be any take of eagles with this project.

5.4.10 Responsibilities of Federal Agencies to Protect Migratory Birds

Executive Order 13186, signed in 2001, assigns responsibilities to federal agencies to protect migratory birds, including preventing or abating the pollution or detrimental alteration of the environment for the benefit of migratory birds, as practicable; ensuring that environmental analyses of federal actions required by the NEPA or other established environmental review processes evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern; and providing notice to the U.S. Fish and Wildlife Service (USFWS) in advance of conducting an action that is intended to take migratory birds. No migratory birds have been identified at the Site.

5.4.11 Floodplain Management

Under 40 CFR §6.302(b), federal agencies are required to evaluate the potential effects of actions they may take in a floodplain to avoid, to the extent possible, adverse effects associated with direct and indirect development of a floodplain. While the Site is not located within the 100-year floodplain, lead has migrated from the Site into ephemeral Drainage 1 sediment and are subject to a response action. Therefore, Forest Service has identified the substantive provisions of the following federal requirements as potential ARARs:

- Executive Order No. 11988
- 40 CFR §6.302(b) and 40 CFR §6, Appendix A §6(a)(1), (a)(3), and (a)(5)

Pursuant to §6(a)(5), Forest Service has determined that Alternatives 2 and 3 will not harm the floodplain but instead, with the controlled migration or removal of contaminated sediment from Drainage 1, will improve and preserve the downstream drainages and floodplains.

5.5 ACTION-SPECIFIC ARARS AND TBCS

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances. These requirements are triggered by the particular removal activities selected. This section summarizes the action-specific ARARs for the alternatives selected for further evaluation. A more detailed discussion of the action-specific ARARs as they apply to the removal action alternatives is included in Section 8.0, as part of the detailed analysis of the alternatives.

For alternatives that involve the excavation, treatment, and disposal of contaminated media, the following regulations were evaluated as potential ARARs: ADEQ Air Quality Division Regulations, Clean Water Act (CWA), National Pollutant Discharge Elimination System (NPDES) Permit Requirements, Characterization and Temporary Storage of Waste, and Off-Site Disposal of Waste.

5.5.1 ADEQ Air Quality Division Regulations

ADEQ Air Quality Division is charged with implementation of the Clean Air Act. Yavapai County does not have an air quality control agency. AAC Title 18, Chapter 2, Article 6, §604 to 607 and 614 include standards for visible emissions, nuisances, and fugitive dust—specifically, standards for discharges of particulate matter from sources other than combustion sources, and prohibition of discharges of air contaminants causing nuisances. A dust control plan, requiring air monitoring, must be submitted to the AQD for construction activities that disturb more than 1 acre of land surface. AAC Title 18, Chapter 2, Article 8, §801, 802, and 804 would also apply if diesel powered equipment is brought on-site and for dust suppression on roadways.

5.5.2 Clean Water Act

The CWA contains permit requirements for discharges to waters of the United States. For those response actions that would involve discharges to surface water, the substantive requirements of 40 CFR §122 are potential ARARs. None of the response actions involves a discharge to surface water; therefore, only stormwater discharges related to construction activity would be ARAR.

5.5.3 NPDES Permit Requirements

Any on-site discharge of stormwater runoff associated with construction of the proposed action must meet the substantive requirements of the AZPDES Stormwater Construction General Permit (CGP) 2013, issued by the ADEQ pursuant to its delegated authority under the CWA. In addition, the substantive requirements of the AZDPES Multi-Sector General Permit 2011 may be potential ARARs because an inactive shooting range is considered an industrial activity for purposes of the permit.

5.5.4 Characterization and Temporary Storage of Waste

Forest Service may temporarily store the excavated waste in staging piles prior to off-site disposal. The following are potential ARARs for storing waste:

- 40 CFR §264.554 sets forth siting standards, design criteria, and relief from LDRs for temporary storage (less than 2 years) of remediation waste on contiguous property. Physical operations such as mixing, sizing, and blending, intended to prepare wastes for subsequent management or treatment are allowed to occur in temporary units regardless of whether the operations technically meet the RCRA definition of

treatment. The standards and design criteria must facilitate a reliable, effective, and protective remedy; prevent or minimize releases of hazardous wastes and hazardous constituents into the environment; and minimize or adequately control cross-media transfer as necessary to protect human health and the environment. The facility must not operate for more than 2 years except when granted an operating term extension.

Prior to off-site disposal of the excavated waste, Forest Service will determine if the soil is RCRA hazardous waste. Potential federal and state ARARs for characterizing waste are addressed in Section 5.2.

Forest Service has identified the substantive provisions of the following potential federal and state ARARs for accurately characterizing and transporting waste for proper off-site disposal:

- The requirements to accurately characterize and manage wastes under 40 CFR §264.18 and AAC Title 18, Chapter 8, Article 2, §264

- The transportation requirements for hazardous wastes under 49 CFR Subchapter C, 10 CFR §71, 10 CFR §20.2006, and AAC R18-8-§263

The discharge requirements for nonhazardous solid waste are also addressed under AAC Title 18, Chapter 8, Article 2, §264.

5.5.5 Off-Site Disposal of Waste

Off-site disposal of lead waste would require compliance with Arizona and Federal transportation requirements and compliance with relevant disposal criteria. In particular, RCRA LDRs, require that lead waste with a TCLP level greater than 5 mg/L must be pretreated to reduce the leachability of lead prior to off-site disposal. In addition, Arizona regulations consider any solid material containing greater than 400 mg/kg lead to be hazardous. Thus, material that contains more than 400 mg/kg lead should be managed as an Arizona hazardous waste for off-site disposal purposes.

5.6 OTHER ISSUES

Other issues that could affect potential removal actions at the Site include NEPA and property ownership, which are briefly discussed below.

5.6.1 National Environmental Policy Act

The NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. Potential environmental impacts are presented in the implementability discussion of each removal action alternative in Section 8.

To meet NEPA requirements, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS). EPA reviews and comments on EIS reports prepared by other federal agencies, maintains a national filing system for all EISs, and assures that its own actions comply with NEPA.

5.6.2 Property Ownership

The property is owned by U.S. Government and is operated by Forest Service. The Site was operated by the PSC as a recreational shooting range, under a Special Use Permit from the Forest Service for approximately 57 years. The Special Use Permit expired in 2014 and Forest Service elected not to renew the permit due to proximity of immediately east adjacent residences.

6.0 REMOVAL ACTION OBJECTIVES AND GOALS

The goal of the EE/CA process at the Site is to develop and select a remedy in accordance with CERCLA criteria. These criteria require that a remedy be protective of human health and the environment and comply with ARARs (Section 5.0). PRAOs and PRAGs have been developed for the Site in consideration of the CERCLA criteria. The PRAOs and PRAGs identified in this EE/CA are typical of those used for removal actions at shooting ranges. They will be refined and updated as additional information becomes available. The final objectives and goals for the removal action will be identified in the action memorandum following stakeholder input.

6.1 PRELIMINARY REMOVAL ACTION OBJECTIVES

PRAOs are intended to remove the site conditions that trigger NCP criteria for a removal action. These NCP criteria are:

- **Actual or potential exposure to on-site and nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants.** Concentrations of lead in soils and Drainage 1 sediment exceed screening criteria and represent a low to moderate risk to human receptors under a residential exposure scenario and a moderate to high risk to terrestrial ecological receptors. Humans are primarily exposed to lead in wind-transported dust or when they disturb on-site lead-contaminated materials and Drainage 1 sediment. Ecological receptors are exposed to lead through contact with on-site lead-contaminated materials and Drainage 1 sediment.

- **High levels of hazardous substances, pollutants, or contaminants in solids largely at or near the surface that may migrate.** Field and laboratory analysis of soil and drainage sediment samples from the Site showed the soil and Drainage 1 sediment contain elevated levels of lead. Disturbance of the Site soils and Drainage 1 sediment primarily due to wind and storm water runoff could transport lead-containing dust and fine sediment off-site into the breathing zone of adjacent residents, site visitors, and Forest Service employees. Mobile lead in drainage basins and Drainage 1 sediment could also threaten ephemeral surface water quality.

- **Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or to be released.** Wind and dust storms could carry lead-contaminated dust away from the source areas and dry drainages toward east adjacent residences and other Forest Service lands, depending on wind direction and strength. Stormwater runoff during a large precipitation event could cause high flows within normally dry Drainage 1, thereby mobilizing lead-bearing sediment further down the drainages toward east adjacent residences and Willow Creek further downstream.

- **Actual or potential contamination of drinking water supplies or sensitive ecosystems.** Contamination of drinking water supplies is not a concern at the Site due to a lack of flowing or stored water and because groundwater in area wells is from confined aquifers, which are very deep below the ground surface based on a survey of areas wells. However, potential migration of lead to shallow groundwater should be considered. Adjacent residents, site visitors, and terrestrial fauna could be exposed to harmful levels of lead by consuming ephemeral surface water during storm water runoff events. Terrestrial fauna could also be exposed to harmful levels of lead by consuming site and drainage vegetation as a source of moisture.

- **Other situations or factors that may pose threats to public health or welfare of the environment.** Over steep berms at the Site could pose a fall risk to site visitors and Forest Service employees.

Based on these NCP removal action factors, the following PRAOs for the Site are:

- Minimize the potential for human and ecological exposure to lead in soil, drainage sediment, and windblown dust.
- Prevent continued migration of lead toward and within drainages and to off-site receptors.
- Minimize the potential for lead to migrate to shallow groundwater, if present.
- Reduce physical hazards posed by over steep shooting range berms.

Attaining these objectives is expected to result in mitigation of the NCP removal action factors, thus enhancing protection of human and ecological receptors at the Site and surrounding areas.

6.2 PRELIMINARY REMOVAL ACTION GOALS

The PRAGs for this removal action are to reduce the concentration of lead in and/or limit potential human and ecological exposure to lead-contaminated materials and Drainage 1 sediment, reduce the amount of lead in soils and drainage sediment available for transport, reduce the mobility of lead to shallow groundwater, and limit access to or remove physical hazards.

In meeting these qualitative goals, long-term risk reduction for human and ecological receptors may be attained. A BHHRA and SLERA for the Site have not been prepared and are not necessary given the several orders of magnitude by which lead concentrations exceed human health and ecological benchmarks; therefore, risk screening criteria presented in Section 4.0 have been used to identify long-term risk reduction goals at the Site. Table 6-1 presents numerical PRAGs for solid materials for the Site. Containment or removal of the lead-contaminated soils and Drainage 1 sediment at the Site is consistent with attaining long-term risk reduction goals.

7.0 IDENTIFICATION AND SCREENING OF RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS

Selection of the appropriate removal action alternatives for the Site depends on the: (1) scope of proposed removal action, (2) nature and types of source materials, (3) volume and location of the source material, (4) mobility of sediment from source areas, (5) concentration of lead in the source materials, (6) effectiveness of potentially applicable technology and process options, and (7) property ownership.

The selection process for the removal action alternative involves five steps:

1. Identification of general response actions, technologies, and process options.
2. Initial technology screening and alternative development.
3. Detailed analysis of alternatives.
4. Assessment of implementability of the alternatives identified.
5. Comparative assessment of alternatives.

Section 7.1 identifies general response actions, technologies, and process options. Section 7.2 describes results of the initial technology screening and alternative development process. Section 8.0 presents a detailed analysis of the alternatives. Section 9.0 presents a comparative assessment of alternatives and the recommended cleanup strategy for the Site.

7.1 IDENTIFICATION OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS

The first step in the removal action alternative selection process is identifying general response actions that may satisfy the PRAOs. General response actions are then progressively refined into technology types and process options. The process options are then screened in Section 7.2, and the retained technologies and process options are combined into removal action alternatives. The initial screening eliminates from further consideration infeasible process options and retains potentially feasible process options.

Primary and secondary sources of lead contamination identified at the Site that will be addressed by this removal action include: (1) soil from faces of 50 yard, 100 yard, and 200 yard berms and backstop; (2) soil from all firing lines and 45 yard, 50 yard, and 100 yard target lines; (3) soil in Drainage Basins 1, 2, and 4; and (4) sediment in Drainage Channel 1. General response actions, technologies, and process options potentially capable of meeting the PRAOs for these sources of lead contamination in solid media are identified in Table 7-1 and described in the text below.

7.1.1 No Action

Under the no action option, no removal action would occur at the Site. The no action response is a stand-alone response used as a baseline against which other removal actions are compared. The no action alternative will be retained through the detailed analysis of alternatives.

7.1.2 Institutional Controls

Institutional controls would not reduce lead migration from the Site, but could be used to protect human health and the environment by precluding future access to or development of, affected areas when an action is taken. In addition, these restrictions may be used to protect an implemented action. Potentially applicable institutional controls consist of land use and access restrictions.

Land use restrictions, comprised of zoning, deed restrictions, or environment control easements, would limit potential future uses of the land that could result in unacceptable risks due to human exposure to lead contamination or loss of action integrity.

Zoning. Zoning would be implemented to control present and future land uses on or around waste and source areas consistent with the potential hazards present, the nature of removal action implemented, and future land-use patterns. The objective of zoning would be to prevent public or private misuse of waste and source areas that could jeopardize the effectiveness of removal action or pose an unacceptable potential for human exposure to the contaminants present in the waste and source areas. Forest Service currently manages land on which the Site is located and can limit the types of land uses at the Site. PRAGs are based on unrestricted use of the property; therefore, no zoning limitations are required.

Deed Restrictions. Restrictions would be used to prevent the transfer of property without notification of limitations on the use of the property or requirements related to preservation and protection of the effectiveness of the implemented removal action alternative. Both elements are intended to limit the potential for human exposure to waste and source area contamination. Forest Service currently manages the land on which the Site is located. No transfer of land is anticipated. PRAGs are based on unrestricted use of the property; therefore, no deed restrictions are required.

Environmental Control Easements. Environmental control easements are an enforceable easement mechanism for imposing restrictions on the use of the Site and requiring performance of operations and maintenance activities that may help protect public health, safety, and welfare, and the environment. The easement mechanism is intended for use at sites that contain or may contain hazardous wastes or substances that may threaten public health, safety, or welfare, or the environment if certain uses are permitted on these sites or if certain activities are not performed on these sites. Protection of public health, safety, or welfare, or the environment may be enhanced by application and enforcement of certain restrictions on the future use of the Site or

requirements for performance of certain activities. Forest Service currently manages the land on which the Site is located and can limit the types of land uses at the Site. PRAGs are based on unrestricted use of the property; therefore, no easements are required.

Access Restrictions. Access restrictions typically include physical barriers, such as fencing, that could prevent both human and wildlife access to the Site to preclude exposure to waste and physical hazards, and to protect the integrity of the action. Fencing can be installed around the perimeter of waste and source areas to prevent human and animal access to the areas. Posted warnings would identify the potential hazards present at the waste and source areas to deter trespass and misuse.

Institutional controls could be implemented as a stand-alone action, or in combination with other alternatives. A local government or a cognizant state or federal agency, in this case Forest Service, would likely enforce institutional controls that are developed as part of a removal action alternative. Therefore, these entities must be involved in developing and eventually implementing any institutional controls.

This type of action does not achieve a specific cleanup goal. Considering the contaminant concentrations present and potential migration from the Site, institutional controls alone are not considered adequate to mitigate potential human health and ecological impacts. However, institutional controls will be considered in conjunction with other controls to protect the selected remedy. PRAGs are based on unrestricted use of the property; therefore, no institutional controls are required. Access restrictions will be retained to protect the Site during restoration.

7.1.3 Engineering Controls

Engineering controls are used primarily to reduce the mobility of, and exposure to, contaminants. These goals are accomplished by creating a barrier that prevents direct exposure and transport of waste from the contaminated sources to the surrounding media. Engineering controls do not reduce the volume or toxicity of the hazardous material. Typical engineering controls for solid media include surface controls, containment, and on-site and off-site disposal. These engineering controls are discussed in the following subsections.

7.1.3.1 Surface Controls

Surface control measures are used primarily to reduce contaminant mobility and limit direct exposure. Surface controls would be appropriate in more remote areas where direct human contact is not a primary concern (human receptors are not living or working directly on or near the Site). Surface control process options include consolidation, grading, revegetation, erosion controls, and soil binders. These process options are usually integrated with other technologies to various degrees based on site characteristics.

Consolidation. Consolidation involves grouping similar waste types in a common area for subsequent management or treatment. Excavation during consolidation is accomplished with standard earthmoving equipment including scrapers, bulldozers, excavators, loaders, and trucks. Consolidation is especially applicable when multiple waste sources are present at a site and one or more of the sources require removal from particularly sensitive areas (that is, flood plain, over steep slope, slide area, erosive area, or heavy traffic area). Also applicable when containing or treating one large combined waste source in a particular location, rather than several smaller waste sources dispersed throughout an area.

Grading. Grading is the general term for techniques used to reshape the ground surface to reduce slopes, manage surface water infiltration and runoff, restore eroded areas, and aid in erosion control. The spreading and compaction steps used in grading are routine construction practices. The equipment and methods used in grading are similar for all surfaces, but vary slightly depending on the waste location and the surrounding terrain. Equipment may include bulldozers, scrapers, graders, and compactors. Periodic maintenance and regrading may be necessary to eliminate depressions, rills, and gullies formed because of settlement, subsidence, or erosion.

Revegetation. Revegetation involves adding soil amendments to the waste surface to provide nutrients, organic material, and neutralizing agents, and improve the water storage capacity of the contaminated media, as necessary. Revegetation can provide an erosion-resistant cover that protects the ground surface from surface water and wind erosion and reduces net infiltration through the contaminated medium by increasing evapotranspiration processes. Revegetation can also reduce the potential for direct contact. Revegetation would not likely be successful at the Site due to limited annual rainfall and poor soils.

Erosion control and protection. Erosion control and protection includes using erosion-resistant materials, such as mulch, natural or synthetic fabric mats, gabions, velocity breaks, and riprap to reduce the erosion potential at the surface of the contaminated medium. The erosion-resistant materials are placed in areas susceptible to surface water erosion (concentrated flow or overland flow) or wind erosion. Proper erosion protection design requires knowledge of drainage area characteristics, wind patterns, average slopes, soil texture, vegetation types and abundance, and wind and precipitation data. Sediment detention basins can be constructed in drainage ditches and in small streams to capture migrating soil before it leaves the Site or to a capture soil already released from the Site.

Soil Binder. Application of a chemical soil binder involves adding proprietary soil amendments to the waste surface to bond the individual soil particles together and form a flexible "crust" that strengthens the surface of the soil resulting in enhanced stability to reduce dust and prevent further erosion. A soil binder provides an erosion-resistant cover that protects the ground surface from rainfall and wind erosion. In general, soil binder is applied using standard spray-on technologies and can then be left or worked into the soil with tilling equipment.

7.1.3.2 Containment

A containment approach leaves waste materials in place and uses an earthen cover or engineered cap to reduce or eliminate mobility of, and exposure to, the contaminated medium. Containment source control measures can be used to reduce wind erosion, divert surface water from the contaminated medium, and minimize infiltration (and subsequent formation of leachate) of surface water/precipitation into the underlying contaminated medium. Infiltration can be reduced or prevented by physical barriers (geomembranes or geosynthetic clay liners [GCL]) or by increasing ET processes. Covering or capping wastes during containment reduces or eliminates contaminant mobility and the potential health risk that may be associated with exposure to the contaminated media.

Cover or cap design may vary in complexity from a simple earthen cover to a multilayered cap designed to meet substantive state and Federal requirements. Factors to consider in cover or cap design include physical conditions of the contaminated media, topography, slope stability, chemical leachability, site hydrogeology, precipitation, depth to groundwater, groundwater quality, groundwater use, and applicable groundwater standards. Stringent cover or cap performance standards may not always be appropriate, particularly in instances where the toxicity of the contaminated medium is relatively low, where the cover or cap is intended to be temporary, where precipitation is very low, or where the waste is not leached by infiltrating rain water. Specific cover or cap design should also consider the desired future land use. Containment would not be feasible due to berm configurations at the Site. Other feasible process options can provide equal or greater protectiveness.

7.1.3.3 On-Site Disposal

Permanent, on-site disposal is used as a source control measure and is similar to containment. The objectives of on-site disposal are the same as for containment, except that disposal includes excavation and consolidation of waste into a single, usually smaller area, and would involve installing physical barriers (geomembranes or GCLs) beneath and above the waste. These added barriers would be needed to provide additional protection of groundwater from potential leachate contamination.

On-site disposal options may be applied to treated or untreated contaminated materials. As materials are excavated and moved during this process, treatment may become a cost-effective option. The design configuration of an on-site repository would depend on the toxicity and type of material requiring disposal. The design could range in complexity from an earthen cover to a RCRA permitted facility. For this Site, stabilization would be required as a pretreatment step along with use of physical barriers to control lead leaching and migration to groundwater.

Factors to consider in design include physical condition of the contaminated media, topography, slope stability, chemical leachability, site hydrogeology, precipitation, depth to groundwater, current groundwater quality, area groundwater use, and applicable groundwater standards.

Stringent cover or cap performance standards may not always be appropriate, particularly in instances where the toxicity of the contaminated medium is relatively low, where precipitation is very low, or where the waste is not leached by infiltrating rainwater. Desired land use following cover or cap construction should also be considered in cover or cap design. On-site disposal may not be administratively feasible on Forest Service lands, unless used as an interim action, due to long-term operation and maintenance (O&M) requirements. Other feasible process options can provide equal or greater protectiveness.

Potential on-site lead stabilization, consolidation, and on-site disposal with a GCL is considered to be an overly complex for the volume of materials at the Site and will not be retained for further consideration as a process option or in combination with other technologies. Other feasible process options can provide equal or greater protectiveness.

7.1.3.4 Off-Site Disposal

Off-site disposal involves placing excavated lead-contaminated material in an engineered waste repository at a RCRA-permitted Class I, II, or III facility. Hazardous materials would require disposal in a permitted Class 1 or Class 2 facility, depending on level of hazard and chemical leachability. Conversely, less mobile and less toxic materials could be disposed of outside the site in a permitted solid waste landfill (Class III) in compliance with other applicable laws. Off-site disposal may require treatment of contaminated material when lead concentrations exceeds land ban concentrations or TCLP criteria. Treatment requirements may include lead stabilization through a chemical additive. This technology will be retained for further consideration.

7.1.4 Excavation and Treatment

Excavation and treatment incorporates removal of contaminated soils and drainage sediment and subsequent treatment through processes that chemically, physically, or thermally reduces contaminant toxicity and volume. Treatment processes have the primary objective of either (1) concentrating chemicals for additional treatment or recovery of valuable constituents, or (2) reducing the toxicity of the chemicals. Excavation can occur using conventional earth moving equipment and accepted procedures for handling hazardous materials.

7.1.4.1 Physical and Chemical Treatments

Physical treatment processes use physical characteristics to concentrate constituents into a relatively small volume for disposal or further treatment. Chemical treatment processes act through the addition of a chemical reagent that removes or fixates the contaminants. The net result of chemical treatment processes is a reduction of toxicity and mobility of contaminants in the solid media. Chemical treatment processes often work in conjunction with physical processes to wash the contaminated media with water, acids, bases, or surfactant.

Soil Washing/Acid Extraction. Acid extraction applies an acidic solution to the contaminated medium in a heap, vat, or agitated vessel. Depending on temperature, pressure, and acid concentration, varying quantities of the metal constituents present in the contaminated medium would solubilize. Ordinarily, a broader range of contaminants is acid soluble at ambient conditions using acid extraction than would be removed by soil washing; however, sulfide compounds may be acid soluble only under extreme conditions of temperature and pressure. Dissolved contaminants are subsequently precipitated for additional treatment and off-site disposal. Chemical washing/extraction are not considered feasible options because of the relatively small volume of waste, infrastructure requirements, and long treatment duration required to reduce high concentrations of lead to PRAGs. Other feasible process options can provide equal or greater protectiveness.

Fixation/Stabilization. Fixation and stabilization technologies treat materials by physically encapsulating them in an inert matrix (stabilization) and chemically altering them to reduce the mobility and toxicity of their constituents (fixation). These technologies generally involve mixing materials with binding agents under prescribed conditions to form a stable matrix. Fixation and stabilization are established technologies for treating inorganic contaminants. The technologies incorporate a reagent or combination of reagents to facilitate a chemical and physical reduction of the mobility of contaminants in the solid media. Lime/fly ash-based treatment processes and pozzolan/cement-based treatment processes are potentially applicable fixation and stabilization technologies. Stabilized material must still be disposed of in an off-site facility. Stabilization is considered feasible for this Site and will be retained for further consideration.

Reprocessing. Reprocessing involves excavating and transporting materials to an existing RCRA permitted facility for processing and economic recovery of lead. Applicability of this option depends on the willingness of an existing permitted facility to accept and process the material and dispose of the waste. Although reprocessing at permitted facilities has been conducted in the past, permit limitations, CERCLA liability, and process constraints all limit the feasibility of this process option. Reprocessing is not considered feasible for this Site due to the low value of recoverable lead in the majority of the material and the high cost of reprocessing. Other feasible process options can provide equal protectiveness.

7.1.4.2 Thermal Treatment

Under thermal treatment technologies, heat is applied to the contaminated medium to volatilize and oxidize metals and render them amenable to additional processing. Potentially applicable moderate-temperature thermal processes, which volatilize metals and form metallic oxide particulates, include the fluidized bed reactor, the rotary kiln, and the multi-hearth kiln.

Thermal treatment technologies can be applied to a wet or dry contaminated medium; however, the effectiveness may vary somewhat with variable moisture content and particle size. Crushing may be necessary as a pretreatment step, especially for large and variable particle sizes.

Moderate-temperature thermal processes should be considered only as pretreatment for other treatment options. This process concentrates the contaminants into a highly mobile (and potentially more toxic) form. High-temperature thermal processes immobilize most metal contaminants into a vitrified slag that would require proper disposal. The volatile metals would be removed or concentrated into particulate metal oxides, which would likely require disposal as hazardous waste. Thermal treatment costs are extremely high compared to other potentially applicable mitigation technologies.

Excavation and subsequent thermal treatment are not considered feasible options because infrastructure is not available to deliver high-voltage electricity to the Site, treated waste and byproducts would still require on- or off-site disposal, and the large volume of waste makes treatment cost prohibitive. Other feasible process options can provide equal or greater protectiveness.

7.1.5 In-Situ Treatment

In-situ treatment involves treating the contaminated medium where it is currently located. In-situ technologies reduce the mobility and toxicity of the contaminated medium and may reduce exposure to the contaminated materials; however, they allow a lesser degree of control, in general, than ex situ treatment options.

7.1.5.1 Physical and Chemical Treatments

Potentially applicable in-situ physical and chemical treatment technologies include soil stabilization and solidification.

In-situ stabilization and solidification are similar to conventional stabilization in that a solidifying agent (or combination of agents) induces a chemical or physical change in the mobility and/or toxicity of the contaminants. The in-situ process uses deep-mixing techniques to allow maximum contact of the solidifying agents with the contaminated medium.

In-situ physical and chemical treatment is not considered a feasible option because of limited demonstrated success in controlling leachate generation, and the vertical orientation of waste on the faces of berms and backstops would make the approach problematic. Other feasible process options can provide equal or greater protectiveness.

7.1.5.2 Thermal Treatment

In-situ vitrification is an innovative process used to melt contaminated solid media in situ to immobilize lead into a glass-like, inert, nonleachable solid matrix. Vitrification requires significant energy to generate sufficient current to force the solid medium to act as a continuous electrical conductor. This technology is seriously inhibited by high moisture content. Gases generated by the process must be collected and treated in an off-gas treatment system. In-situ

vitrification has been demonstrated only at the pilot scale, and treatment costs are extremely high compared to other treatment technologies.

In-situ thermal treatment is not considered a feasible option because infrastructure necessary to deliver high-voltage electricity to the Site is unavailable, and the small volume of waste makes the startup and treatment cost prohibitive. Other feasible process options can provide equal or greater protectiveness.

7.2 TECHNOLOGY SCREENING SUMMARY AND DEVELOPMENT OF REMOVAL ACTION ALTERNATIVES

The purpose of technology and process option screening, the second step in the removal action alternative development process, is to (1) evaluate identified technologies and process options based on the NCP criteria of effectiveness, implementability, and relative costs; and (2) eliminate technologies and process options to reduce the number of alternatives developed and carried forward for detailed analysis in Section 8.0. A technology or process option can be eliminated from further consideration if it does not meet the effectiveness or implementability criteria. In addition, a technology or process option can be eliminated if its cost is substantially higher than other technologies or process options, and at least one other technology or process option is retained that offers equal protectiveness. Summaries of the initial screening of technologies and process options for controlling the toxicity, mobility, and volume of lead in soils and drainage sediment are identified in Table 7-2.

The retained technologies and process options have been combined into the three removal action alternatives shown in Table 7-3. In accordance with guidance from the Forest Service, the three alternatives include no action plus two alternatives likely to be most feasible for the Site. All of these alternatives will be carried through to the detailed analysis in Section 8.0 because the number of alternatives is not unreasonably high and none could easily be eliminated through an additional screening step.

8.0 DETAILED ANALYSIS OF REMOVAL ACTION ALTERNATIVES

A detailed analysis is the third step in the EE/CA alternative selection process. The purpose of the detailed analysis is to evaluate removal action alternatives for their effectiveness, implementability, and cost in minimizing the potential for human and ecological exposure to lead in soil, sediment, and windblown dust; preventing the continued migration of lead in Drainage 1 to off-site receptors; minimizing the potential for lead to migrate to shallow groundwater, if present; and controlling physical hazards posed by over steep berms. The removal action alternatives retained after the technology and process option identification and screening processes performed in Section 7.0 are included in this detailed analysis. Three removal action alternatives are evaluated in this EE/CA.

As suggested in "Guidance on Conducting Non-Time Critical Removal Actions under CERCLA" (EPA 1993), retained removal action alternatives are evaluated individually against the following three broad criteria: effectiveness, implementability, and cost. The qualitative evaluation criteria are described in the following paragraphs.

Effectiveness Evaluation

The ability of the technology to protect human health and the environment is reviewed during an evaluation of the effectiveness of a removal action alternative (EPA 1993). Protection is achieved by reducing the toxicity, mobility, or volume of lead over a short-term and long-term period while complying with ARARs. Effectiveness relates to the potential of a technology to achieve the PRAOs, considering the chemical and physical characteristics of the source and the site conditions. Potential impacts to human health and the environment during the construction and implementation phase, as well as the reliability of the process with respect to the site conditions, are also considered. The evaluation considers effectiveness as poor, good, very good, and best.

Implementability Evaluation

The technical and administrative feasibility of constructing, operating, and maintaining the implemented technology is measured during an evaluation of the implementability of a removal action alternative (EPA 1993). Technical feasibility takes into account whether the technology applies to and can be properly constructed and operated at the Site. The evaluation considers long-term operation, maintenance, and monitoring of the technology implemented. Administrative feasibility considers regulatory approval and scheduling constraints, as well as the availability of disposal services, disposal locations, and the necessary construction expertise and equipment. This evaluation considers implementability as easy, moderate, moderately difficult, or difficult.

An alternative may not be implementable if a biological and botanical resource inventory report prepared by Forest Service concludes that the project could affect threatened or sensitive species or if one or more alternatives would negatively and significantly affect any archeological feature. However, given the high concentrations of lead present at the Site, any potential local impact from the project would likely be small in comparison to the overall reduction of risk to all ecological receptors.

Cost Evaluation

The types of costs assessed include the following:

- Capital costs, including both direct and indirect costs
- Annual O&M costs, including the monitoring cost to evaluate long-term effectiveness
- Net present worth of capital, O&M costs, and periodic costs.

In accordance with EPA guidance (EPA 1993, 2000), engineering costs are estimates within plus 50 to minus 30 percent of the actual project cost (based on year 2015 dollars). Cost estimates were prepared in accordance with EPA guidelines (EPA 2000) using engineer's estimates, R.S. Means 2015, and vendor quotes. Changes in the cost elements are likely as new information and data collected during the removal action design become available. The present worth of each removal action alternative provides the basis for the cost comparison. The present worth cost represents the amount of money that, if invested in the initial year of the removal action at a given interest rate (this EE/CA uses a 7 percent discount rate, the historical average), would provide the funds required to make future payments to cover all costs associated with the removal action over its planned life. Inflation and depreciation were not considered in preparing the present worth costs. Tables 8-1 and 8-2 contain detailed cost estimate spreadsheets for the Site under each alternative. Assumptions used in preparing the cost estimate spreadsheets are also provided in Appendix H for each alternative.

The final step of this analysis is to conduct a comparative analysis of the removal action alternatives. The comparative analysis presented in Section 9.0, discusses each alternative's relative strengths and weaknesses with respect to each of the criteria. Once completed, the findings of the comparative analysis are used to identify the preferred removal action alternative.

8.1 ALTERNATIVE 1: NO ACTION

Under the No Action alternative, no treatment or removal action would occur at the Site. Consequently, reducing the threat to human health and the environment associated soil and sediment contamination, potential human health, ecological, and water quality impacts associated with migration of lead to drainages and off-site receptors, minimizing the potential for lead to migrate to shallow groundwater, and controlling physical hazards remain unchanged. The No Action alternative is used as a baseline to compare the removal action alternatives. The No

Action alternative is applicable to all media at the Site. The No Action alternative will be retained through the detailed analysis of alternatives.

8.1.1 Effectiveness

The effectiveness of the No Action alternative is considered poor for achieving PRAOs. This alternative would not minimize potential exposure to or transport of lead from the Site or control physical hazards at the Site. This alternative would not reduce metal toxicity, mobility, or volume of contaminants and would no reduce risk to human health or the environment. Ingestion, dermal adsorption, and inhalation of lead would remain unchanged. Therefore, protection of human health and the environment would not be achieved under the No Action alternative.

A comprehensive list of federal and state ARARs is presented in Section 5.0. ARARs are divided into contaminant-specific, location-specific, and action-specific requirements. Under the No Action alternative, lead would not be treated, removed, or actively managed. Consequently, no location- or action-specific ARARs apply to the No Action alternative. Chemical-specific ARARs do not exist for soil that remains in place (not generated waste); however, ARARs do exist for protection of surface water and groundwater quality. Because lead would remain at the Site at concentrations not protective of surface water and groundwater quality, sources remain uncontrolled, and exposure pathways remain unchanged, the No Action alternative would not comply with ARARs.

No controls or long-term measures would be implemented to control lead at the Site under the No Action alternative; consequently, this alternative provides no long-term effectiveness. Therefore, the No Action alternative would not be effective at reducing risks to human and ecological receptors. The No Action alternative would provide no reduction in toxicity, mobility, or volume of lead at the Site. In the short term, the No Action alternative would not reduce the threat to the community or the environment than exists under the current site conditions.

8.1.2 Implementability

The No Action alternative would be readily implementable and administratively feasible. No permits would be required to implement this alternative. No services or materials would be needed to implement this No Action alternative.

8.1.3 Cost

No construction costs are associated with the No Action alternative.

8.2 ALTERNATIVE 2: EXCAVATION, ON-SITE TREATMENT, AND OFF-SITE DISPOSAL IN A RCRA CLASS II FACILITY; SITE REGRADING AND EROSION CONTROL INSTALLATION

Under Alternative 2, the PRAOs of addressing lead-contaminated material from the former shooting range at the Site by reducing direct contact with lead-contaminated material and by reducing lead mobility would be accomplished through excavation, on-site treatment, transport, and off-site disposal, and surface controls. Excavation and off-site transport is used to remove lead-contaminated material from source areas and Drainage 1 at the Site. On-site treatment is used to remove or stabilize lead prior to permanent containment in an off-site permitted RCRA Class II facility. Surface controls are used primarily to reduce the mobility of any residual lead-containing materials from excavated source areas and drainages at the Site to the surrounding and downstream areas including the adjacent residential area. Access restrictions are used to protect the Site from illegal firearm discharge and protect the Site during restoration and revegetation. Ecological impacts would be addressed through removal of lead-contaminated material from the Site and Drainage 1. Water quality impacts would be reduced by removing the sources areas that could potentially leach lead to surface water and groundwater and limiting residual material migration to drainages. Surface water is ephemeral and groundwater is not used at the Site or adjacent residential neighborhood, so no change in exposure would occur. Exposure to natural levels of lead in soil and sediment will not be addressed as directed under CERCLA 104(a)(3)(A).

Excavation, on-site treatment, and off-site transport and disposal would involve excavating and removing lead-contaminated material from multiple source areas at the Site, treating the soils, transporting them to the Class II municipal landfill, filling and grading the excavation areas, and revegetating the entire site. On-site treatment and disposal would involve screening the soils to one-quarter inch to remove large intact bullets, then mixing 10% Portland cement by volume into the lead-contaminated soils and sediment to reduce TCLP leachable lead to below RCRA D list acceptance criteria followed by disposal in a permitted Class II facility. Surface controls would involve directing and capturing storm water within excavated source areas using berms and sediment detention basins, and revegetating the Site to reduce erosion. Access restrictions would involve maintaining existing barrier gate across the access road. Because the PRAO is unrestricted used, additional fencing will not be required. However, signage on existing gate and range fencing will be installed providing information about range closure, site restoration, and revegetation.

8.2.1 Removal Action Components

Implementation of Alternative 2 would involve the activities described below. Table 8-1 presents the Alternative 2 cost estimate for excavation, on-site treatment and off-site disposal, and surface controls. Assumptions used in preparing the cost estimate spreadsheets are also provided in Appendix H.

- Perform a treatability study on mixing lead contaminated soil with Portland cement to determine viability, optimal mixing volumes, and methods to ensure that TCLP limit for lead is not exceeded after soil treatment.
- Prepare a removal design that will provide construction drawings and define standards for the removal action.
- Prepare a bid package and construction management plan.
- Procure construction firm(s), negotiate transport, treatment, and disposal costs, and necessary insurance and bonding.
- Provide full-time construction management during the removal action, which will include full-time Contractor oversight, confirmation sampling and analysis, waste profiling, surveying, and preparing a construction report with As-Constructed drawings.
- Mobilize and demobilize necessary equipment to and from the Site once, including installing temporary erosion control measures.
- Prepare and secure a staging area for equipment storage and use during construction.
- Establish off-site water source for dust control and turn on electrical service.
- Complete site preparation including posting signs and reviewing hospital routes.
- Repair of the Site access road for heavy truck traffic and evaluate traffic control plan at the Site entrance from N Granite Basin Road.
- Remove concrete debris from three firing line pads and in ground target stand supports, and dispose at an off-site Class III facility (Figure 8-1).
- Close potential water well, if located south of the range.
- Establish dust monitoring locations between project area and east adjacent residences to confirm dust control measures are protective.
- Excavate approximately 2,900 CY of soil from source areas and sediment from Drainage 1 (Figures 4-1 to 4-7).
- Use XRF and laboratory split sampling to confirm limits of excavation at or below the PRAG.
- Segregate approximately 200 CY of soils and sediment above PRAGs but below TCLP limit.
- Segregate approximately 2,700 CY of soils above PRAGs and above TCLP limit.
- Screen approximately 2,700 CY of soil to remove medium and large bullets.
- Recycle screened bullets at no cost.
- Mix approximately 2,700 CY of soils containing lead above TCLP limit in windrows with 10% Portland cement and water for dust suppression.

- Profile waste for disposal and collect samples for TCLP analysis to confirm attainment of TCLP limit.
- Load Portland cement-treated soils into haul trucks and transport to the Northwest Landfill near Surprise, Arizona (RCRA Class II facility) for disposal.
- Load untreated soils (above PRAGs but below TCLP limit) into haul trucks and transport to the Northwest Landfill near Surprise, Arizona (RCRA Class II facility) for disposal.
- After waste removal, knockdown remainder of target berms and eastern berm.
- Backfill the removal areas with approximately 2,900 CY of clean excess berm material and add lime to increase the alkalinity of soil pore water and immobilize residual lead (Figure 8-1).
- Grade slopes to natural contours using approximately 1,000 CY of clean excess berm material (Figure 8-1).
- Install surface controls including a diversion berm along the east side of former backstop and 200 yard berms, a diversion berm along the east side of former 100 yard berm, a sediment detention basin, on Drainage 3, and rock spillways on existing Drainage Basins 2 and 3 (Figure 8-1). Berms and basin will use approximately 1,000 CY of clean excess berm material.
- Revegetate the Site using native seed mixture.
- Erect signs to notify site visitors of site restoration and revegetation efforts.
- Perform semi-annual site visits to monitor the integrity of and maintain the surface controls and revegetation efforts.

8.2.2 Effectiveness

The effectiveness of the Alternative 2 is considered equally best for achieving PRAOs. This alternative would eliminate potential human and ecological exposure to lead-contaminated material from the Site through excavation and on-site treatment and disposal in a Class II facility, and reducing erosion and transport of residual material to the nearby residential area. Permanence is achieved through leachable lead stabilization and disposal in an off-site RCRA Class II municipal landfill. Periodic inspections would be necessary to ensure surface controls and informational signs about site restoration and revegetation remain intact over the long term.

This alternative would not reduce the volume of contaminated material, although the toxicity of lead would be reduced through on-site treatment. Risk associated with ingestion, dermal adsorption, and inhalation of lead would be reduced primarily through waste excavation and on-site treatment and off-site disposal. The presence of lead-contaminated material would be eliminated and future activities at the Site would be unencumbered. Protection of ecological receptors would also occur through excavation and on-site treatment and off-site disposal of lead-

contaminated material from source areas as well as from drainages. Water quality impacts would be eliminated by waste excavation and on-site treatment and disposal, and by reducing residual material migration to drainages. Potential leaching of lead from sediment to surface water would be greatly reduced, as contaminated sediment would be removed from drainages. Potential leaching of lead to groundwater would be greatly reduced by mixing lime into soil during backfilling and grading. Addition of lime increases the alkalinity of soil pore water and immobilizes residual lead. Surface water is ephemeral and groundwater is not used at the Site, so no change in exposure would occur.

A comprehensive list of federal and state ARARs is presented in Section 5.0. ARARs are divided into contaminant-specific, location-specific, and action-specific requirements. Under Alternative 2, lead-contaminated material would be excavated, treated on-site, transported off-site, and disposed of off-site, all of which entails generation of a waste subject to federal and state RCRA regulation. No lead-contaminated material would remain on site at concentrations that threatens surface water or groundwater quality. Generated federal RCRA and state non-RCRA wastes would be transported off-site disposal in an engineered waste disposal unit. Therefore, the alternative would fully comply with chemical-specific ARARs.

Location- and action-specific ARARs would apply to implementation of Alternative 2. Stormwater generated during construction, though not anticipated, would be managed in accordance with the CWA. Stormwater BMPs would be employed during construction activities to reduce erosion and potential impact on future stormwater quality. Typical requirements for nuisance dust suppression and control apply for construction and earth moving associated with this alternative; these requirements would be met by applying water to roads that receive heavy vehicular traffic and to construction or excavation areas, if necessary. Occupational Safety and Health Administration (OSHA) requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase. Dust monitoring will be conducted for up to 1 month duration between the project area and east adjacent residences to ensure engineering controls are protective.

Because excavation and movement of soil outside of the AOC constitutes generation of waste, federal and state RCRA requirements would apply to this alternative. These requirements include waste characterization, waste generation, land disposal restriction for lead-impacted waste, and placement of waste in off-site disposal units. This alternative would comply with Federal and state RCRA ARARs.

Contacts with appropriate agencies and tribes regarding historical and cultural resources and potential cultural items, remains, and funerary objects would be required. In addition, a historical and cultural resources survey report prepared by Forest Service concluding that the project would not affect these resources would be required before design and construction. The Forest Service did conduct archeological surveys in/near the Site under two previous heritage project efforts. One site was identified just outside of the Site's boundary which should not be impacted by

implementation of the proposed removal action. Forest Service will flag the area to avoid any potential disturbance prior to construction.

No threatened or endangered species and no Forest Service sensitive species are known to occur within or near the project area. There would not be any trend towards listing for any sensitive species.

The construction phase for Alternative 2 would be accomplished within two months at the Site; therefore, impacts associated with construction would likely be short term and limited due to the remote nature of the Site. On-site workers would be adequately protected by using appropriate personal protective equipment and by following safe work practices. Short-term impacts to air quality in the surrounding environment may also occur during excavation, treatment involving mixing of Portland cement, and loading and hauling of lead-contaminated materials to the off-site RCRA Class II facility for disposal. Dust suppression will be used to mitigate any air quality concerns. Dust monitoring will be conducted for up to 1 month duration between the project area and east adjacent residences to ensure engineering controls are protective. Short-term risks of physical injury would exist for site workers during construction. Increased truck traffic required to transport construction materials to the Site and haul lead-contaminated materials off-site would have a short-term, but significant impact on local air quality and traffic safety.

8.2.3 Implementability

Alternative 2 is both technically and administratively feasible and could be implemented within two months. No permits would be required to implement this alternative. Excavation, on-site treatment, hauling, and off-site disposal at a RCRA Class II facility, constructing erosion controls, and posting of warning signs (as needed) require conventional construction practices; materials are readily available. Design methods, construction practices, and engineering requirements for excavation and installation of berms, ditches, culverts, and sediment detention basins are well documented and understood. Equipment, materials, and labor would be available through the local market.

Excavation, on-site treatment, hauling, and disposal at a RCRA Class II facility, and construction of erosion controls would require use of heavy equipment, including excavators, loaders, dozers, and haul trucks. Controlling fugitive dust emissions, dust monitoring, and controlling stormwater discharge (if generated) during excavation, hauling, and construction would be required. The duration of the construction would up to two months. No future additional alternatives would be required because lead-contaminated material would be removed from the Site.

Long-term monitoring and maintenance would be required, especially repair of erosional features and revegetation. Culverts should also be cleared and repaired as necessary. The access gate and informational signs would also be checked and repaired or replaced as necessary.

Based on available information, implementation of this removal action alternative in compliance with federal, state, and local requirements may require consideration of the following environmental factors:

Aesthetics – Tall berms and a backstop are located at the Site. Excavation of waste followed by complete knockdown of the remainder of these features would improve the existing scenery, as the most visible features of the former shooting range would be removed from the area. Returning the Site to natural land contours and upland habitat would improve the visual character of the area.

Biological Resources – Excavation and off-site disposal of lead-contaminated material could have an impact on flora in the excavation area. However, the berms and backstop are not vegetated and are not used as habitat. Installation of surface controls would have limited impact on flora and fauna as the construction area would be very small in comparison to the disturbance from historic shooting activity. In addition, revegetation will return the natural flora. No threatened or endangered species and no Forest Service sensitive species are known to occur within or near the project area. There would not be any trend towards listing for any sensitive species.

Historical and Cultural Resources – No historical features are located on the Site. A cultural resources survey would be prepared by Forest Service for the Site to identify any resources, to identify any resources that cannot be disturbed or that must be restored after construction, and to identify features that are not a resource requiring protection or mitigation. The Forest Service did conduct archeological surveys in/near the Site under two previous heritage project efforts. One site was identified just outside of the Site's boundary which should not be impacted by implementation of the proposed removal action. Forest Service will flag the area to avoid any potential disturbance prior to construction.

Hydrology and Water Quality – Excavation and off-site disposal of lead-contaminated soils and sediment, implementation of surface controls, and revegetation would reduce the amount of erodible material from the Site. Construction of surface controls would improve site drainage and reduce solids loading to drainages during storm water runoff, improving water quality. Maintenance of surface controls will ensure improved water quality over the long term. Mixing lime into soil during backfilling and grading will increase the alkalinity of soil pore water and immobilizes any residual lead that could migrate to groundwater. Surface water is ephemeral and groundwater is not used at the Site, so no change in exposure would occur.

Noise – Excavation, trucks hauling lead-contaminated materials, rock, gravel, and supplies, and surface control construction using heavy equipment would generate elevated noise levels and vibrations near the Site for a period of up to two months. Because homes are located in close proximity to the Site, some impact is expected.

Transportation – Lead-contaminated materials would be hauled off-site, on-site soils from knock down berms would be used for backfilling of excavations and grading, and bulk materials (gravel and rock) would be hauled on site for construction of surface controls. Haul trucks would haul the treated soil over Arizona Department of Transportation (ADOT) highways to the Northwest Landfill near Surprise, Arizona. Haul trucks would haul bulk materials (gravel and rock) over ADOT highways near Prescott, Arizona. All loads would be tarped during transport. In accordance with ADOT laws, loads would be limited to 20 tons. Since little traffic is present in proximity to the former Shooting Range, it is doubtful that traffic disruption would occur at a regular frequency. However, given the extremely large number of trucks hauling lead-contaminated material off-site to a RCRA Class II disposal facility, traffic signage and direction may be warranted at the intersection of the Forest Service access road and N Granite Basin Road.

8.2.4 Costs

The total present worth cost for Alternative 2 is estimated at $1,052,057. Table 8-1 presents a summary of the costs associated with implementing Alternative 2. The total present worth cost includes the present value of 5 years of annual maintenance and monitoring ($139,773) in addition to the capital costs ($912,284). Changes in the cost elements are likely as commodity prices change and new information and data are collected during the engineering design and construction pre-bid and walk-through meetings.

8.3 ALTERNATIVE 3: EXCAVATION, OFF-SITE STABILIZATION OF LEAD, AND OFF-SITE DISPOSAL AT A RCRA CLASS I TSD FACILITY; SITE REGRADING AND EROSION CONTROL INSTALLATION

Under Alternative 3, the PRAOs of addressing lead-contaminated material from the former shooting range at the Site by reducing direct contact with lead-contaminated material and by reducing lead mobility would be accomplished through excavation, off-site stabilization of lead and disposal, and surface controls. Excavation and off-site transport is used to remove lead-contaminated material from source areas and Drainage 1 at the Site. Off-site stabilization and disposal is used to remove or stabilize lead prior to permanent containment in an off-site permitted RCRA Class I Treatment, Storage, and Disposal (TSD) facility. Surface controls are used primarily to reduce the mobility of any residual lead-containing materials from excavated source areas and drainages at the Site to the surrounding and downstream areas, including the adjacent residential area. Access restrictions are used to protect the Site from illegal firearm discharge and protect the Site during restoration and revegetation. Ecological impacts would be addressed through removal of lead-contaminated material from the Site and Drainage 1. Water quality impacts would be reduced by removing the sources areas that could potentially leach lead to surface water and groundwater and limiting residual material migration to drainages. Surface water is ephemeral and groundwater is not used at the Site or adjacent residential neighborhood, so no change in exposure would occur. Exposure to natural levels of lead in soil and sediment will not be addressed as directed under CERCLA 104(a)(3)(A).

Excavation and off-site stabilization and disposal, and surface controls would involve excavating and removing lead-contaminated material from multiple source areas at the Site, filling and grading the excavation areas, and revegetating the Site. Off-site stabilization and disposal would involve chemical stabilization of TCLP leachable lead above RCRA D list acceptance criteria followed by disposal in a RCRA permitted Class I TSD facility. Surface controls would involve directing and capturing storm water within excavated source areas using berms and sediment detention basins, and revegetating the Site to reduce erosion. Access restrictions would involve maintaining existing barrier gate across the access road. Because the PRAO is unrestricted used, additional fencing will not be required. However, signage on existing gate and range fencing will be installed providing information about range closure, site restoration, and revegetation.

8.3.1 Removal Action Components

Implementation of Alternative 3 would involve the activities described below. Table 8-2 presents the Alternative 3 cost estimate for excavation, off-site stabilization and disposal, and surface controls. Assumptions used in preparing the cost estimate spreadsheet are also provided in Appendix H.

- Prepare a removal design that will provide construction drawings and define standards for the removal action.
- Prepare a bid package and construction management plan.
- Procure construction firm(s); negotiate transport, treatment, and disposal costs, and necessary insurance and bonding.
- Provide full-time construction management during the removal action, which will include full-time Contractor oversight, confirmation sampling and analysis, waste profiling, surveying, and preparing a construction report with As-Constructed drawings.
- Mobilize and demobilize necessary equipment to and from the site once.
- Prepare and secure a staging area for equipment storage and use during construction.
- Establish off-site water source for dust control and turn on electrical service.
- Complete site preparation including posting signs and reviewing hospital routes.
- Repair of the Site access road for heavy truck traffic and evaluate traffic control plan at the Site entrance from N Granite Basin Road.
- Remove concrete debris from three firing line pads and in ground target stand supports, and dispose at an off-site Class III facility (Figure 8-1).
- Close potential water well, if located south of the range.

- Establish dust monitoring locations between project area and east adjacent residences to confirm dust control measures are protective.
- Excavate approximately 2,900 CY of soil from source areas and sediment from Drainage 1 (Figures 4-1 to 4-7).
- Use XRF and laboratory split sampling to confirm limits of excavation at or below the PRAG.
- Segregate soils and sediment above PRAGs but below TCLP limit for disposal at a RCRA Class II facility.
- Segregate soils above PRAGs and above TCLP limit for disposal at a RCRA Class I TSD facility.
- Profile waste for disposal and collect samples for TCLP analysis to confirm attainment of TCLP limit.
- Load approximately 2,700 CY of soils above TCLP limit into haul trucks and transport to the Clean Harbors Grassy Mountain Facility in Utah (RCRA Class I TSD facility) for stabilization and disposal.
- Load approximately 200 CY of soils and sediment below TCLP limit but above PRAGs into haul trucks and transport the Northwest Landfill near Surprise, Arizona (RCRA Class II facility) for disposal.
- After waste removal, knockdown remainder of target berms and eastern berm.
- Backfill the removal areas with approximately 2,900 CY of clean excess berm material and add lime to increase the alkalinity of soil pore water and immobilize residual lead (Figure 8-1).
- Grade slopes to natural contours using approximately 1,000 CY of clean excess berm material (Figure 8-1).
- Install surface controls including a diversion berm along the east side of former backstop and 200 yard berms, a diversion berm along the east side of former 100 yard berm, a sediment detention basin, on Drainage 3, and rock spillways on existing Drainage Basins 2 and 3 (Figure 8-1). Berms and basin will use approximately 1,000 CY of clean excess berm material.
- Revegetate the Site using native seed mixture.
- Erect signs to notify site visitors of site restoration and revegetation efforts.
- Perform semi-annual site visits to monitor the integrity of and maintain the surface controls and revegetation efforts.

8.3.2 Effectiveness

The effectiveness of the Alternative 3 is considered equally best for achieving PRAOs. This alternative would eliminate potential human and ecological exposure to lead-contaminated material from the Site through excavation and off-site treatment and disposal in a Class I facility, and reducing erosion and transport of residual material into the nearby residential area. Permanence is achieved through leachable lead stabilization and disposal in an off-site RCRA Class I TSD facility. Periodic inspections would be necessary to ensure surface controls and informational signs about site restoration and revegetation remain intact over the long term.

This alternative would not reduce the volume of contaminated material, although the toxicity of lead would be reduced through off-site treatment. Risk associated with ingestion, dermal adsorption, and inhalation of lead would be reduced primarily through waste excavation and off-site treatment and disposal. The presence of lead-contaminated material would be eliminated and future activities at the Site would be unencumbered. Protection of ecological receptors would also occur through excavation and off-site treatment and disposal of lead-contaminated material from source areas as well as from drainages. Water quality impacts would be eliminated by waste excavation and off-site treatment and disposal, and by reducing residual material migration to drainages. Potential leaching of lead from sediment to surface water would be greatly reduced, as contaminated sediment would be removed from drainages. Potential leaching of lead to groundwater would be greatly reduced by mixing lime into soil during backfilling and grading. Addition of lime increases the alkalinity of soil pore water and immobilizes residual lead. Surface water is ephemeral and groundwater is not used at the Site, so no change in exposure would occur.

A comprehensive list of federal and state ARARs is presented in Section 5.0. ARARs are divided into contaminant-specific, location-specific, and action-specific requirements. Under Alternative 3, lead-contaminated material would be excavated, hauled, and stabilized off-site prior to off-site disposal, all of which entails generation of a waste subject to federal and state RCRA regulation. No lead-contaminated material would remain on site at concentrations that threatens surface water or groundwater quality. Generated federal RCRA and state non-RCRA wastes would be transported off-site for stabilization and disposal in an engineered waste disposal unit. Therefore, the alternative would fully comply with chemical-specific ARARs.

Location- and action-specific ARARs would apply to implementation of Alternative 3. Stormwater generated during construction, though not anticipated, would be managed in accordance with the CWA. Stormwater BMPs would be employed during construction activities to reduce erosion and potential impact on future stormwater quality. Typical requirements for nuisance dust suppression and control apply for construction and earth moving associated with this alternative; these requirements would be met by applying water to roads that receive heavy vehicular traffic and to construction or excavation areas, if necessary. OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase. Dust monitoring will be conducted for up to 2 weeks duration between the project area and east adjacent residences to ensure engineering controls are protective.

Because excavation and movement of soil outside of the AOC constitutes generation of waste, federal and state RCRA requirements would apply to this alternative. These requirements include waste characterization, waste generation, land disposal restriction for lead-impacted waste, and placement of waste in off-site disposal units. This alternative would comply with Federal and state RCRA ARARs.

Contacts with appropriate agencies and tribes regarding historical and cultural resources and potential cultural items, remains, and funerary objects would be required. In addition, a historical and cultural resources survey report prepared by Forest Service concluding that the project would not affect these resources would be required before design and construction. The Forest Service did conduct archeological surveys in/near the Site under two previous heritage project efforts. One site was identified just outside of the Site's boundary, which should not be impacted by implementation of the proposed removal action. Forest Service will flag the area to avoid any potential disturbance prior to construction.

No threatened or endangered species and no Forest Service sensitive species are known to occur within or near the project area. There would not be any trend towards listing for any sensitive species.

The construction phase for Alternative 3 would be accomplished within one month at the Site; therefore, impacts associated with construction would likely be short term and limited due to the remote nature of the Site. On-site workers would be adequately protected by using appropriate personal protective equipment and by following safe work practices. Short-term impacts to air quality in the surrounding environment may also occur during excavation, loading, and hauling of lead-contaminated materials to the off-site RCRA Class I TSD facility for stabilization and disposal. Dust suppression will be used to mitigate any air quality concerns. Short-term risks of physical injury would exist for site workers during construction. Dust monitoring will be conducted for up to 2 weeks duration between the project area and east adjacent residences to ensure engineering controls are protective. Increased truck traffic required to transport construction materials to the Site and haul lead-contaminated materials off-site would have a short-term, but significant impact on local air quality and traffic safety.

8.3.3 Implementability

Alternative 3 is both technically and administratively feasible and could be implemented within one month. No permits would be required to implement this alternative. Excavation, transportation, and off-site stabilization and disposal at a RCRA Class I TSD facility, constructing erosion controls, and posting of warning signs (as needed) require conventional construction practices; materials are readily available. Design methods, construction practices, and engineering requirements for excavation and installation of berms, ditches, culverts, and sediment detention basins are well documented and understood. Equipment, materials, and labor would be available through the local market.

Excavation, hauling, and off-site stabilization and disposal at a RCRA Class I TSD facility, and construction of erosion controls would require use of heavy equipment, including excavators, loaders, dozers, and haul trucks. Controlling fugitive dust emissions, dust monitoring, and controlling stormwater discharge (if generated) during excavation, hauling, and construction would be required. The duration of construction under this alternative is expected to be up to one month. No future additional alternatives would be required because lead-contaminated material would be removed from the Site.

Long-term monitoring and maintenance would be required, especially repair of erosional features and revegetation. Culverts should also be cleared and repaired as necessary. The access gate and informational signs would also be checked and repaired or replaced as necessary.

Based on available information, implementation of this removal action alternative in compliance with federal, state, and local requirements may require consideration of the following environmental factors:

Aesthetics –Tall berms and a backstop are located at the Site. Excavation of waste followed by complete knockdown of the remainder of these features would improve the existing scenery, as the most visible features of the former shooting range would be removed from the area. Returning the Site to natural land contours and upland habitat would improve the visual character of the area.

Biological Resources – Excavation and off-site disposal of lead-contaminated material could have an impact on flora and fauna in the excavation area. However, the berms and backstop are not vegetated and are not used as habitat. Installation of surface controls, would have limited impact on flora and fauna as the construction area would be very small in comparison to the disturbance from historic shooting activity. In addition, revegetation will expedite the return of natural flora. No threatened or endangered species and no Forest Service sensitive species are known to occur within or near the project area. There would not be any trend towards listing for any sensitive species.

Historical and Cultural Resources – No historical features are located on the Site. A cultural resources survey would be prepared for the Site by Forest Service to identify any resources, to identify any resources that cannot be disturbed or that must be restored after construction, and to identify features that are not a resource requiring protection or mitigation. The Forest Service did conduct archeological surveys in/near the Site under two previous heritage project efforts. One site was identified just outside of the Site's boundary, which should not be impacted by implementation of the proposed removal action. Forest Service will flag the area to avoid any potential disturbance prior to construction.

Hydrology and Water Quality – Excavation and off-site disposal of lead-contaminated soils and sediment, implementation of surface controls, and revegetation would reduce

the amount of erodible material from the Site. Construction of surface controls would improve site drainage and reduce solids loading to drainages during storm water runoff, improving water quality. Maintenance of surface controls will ensure improved water quality over the long term. Mixing lime into soil during backfilling and grading will increase the alkalinity of soil pore water and immobilizes any residual lead that could migrate to groundwater. Surface water is ephemeral and groundwater is not used at the Site, so no change in exposure would occur.

Noise – Excavation, trucks hauling contaminated materials, rock, gravel, and supplies, and surface control construction using heavy equipment would generate elevated noise levels and vibrations near the Site for a period of up to one month. Because homes are located in close proximity to the Site, some impact is expected.

Transportation –Lead-contaminated materials would be hauled off-site, on-site soils from knock down of berms would be used for backfilling of excavations and grading, and bulk materials (gravel and rock) would be hauled on site for construction of surface controls. Haul trucks would haul the treated soil over ADOT highways to the Clean Harbors Grassy Mountain Facility in Utah. Haul trucks would haul bulk materials (gravel and rock) over ADOT highways near Prescott, Arizona. All loads would be tarped during transport. In accordance with ADOT laws, loads would be limited to 20 tons. Since little traffic is present in proximity to the former Shooting Range, it is doubtful that traffic disruption would occur at a regular frequency. However, given the extremely large number of trucks hauling lead-contaminated material off-site to a RCRA Class I TSD facility traffic signage and direction may be warranted at the intersection of the Forest Service access road and N Granite Basin Road.

8.3.4 Costs

The total present worth cost for Alternative 3 is estimated at $1,980,412. Table 8-2 presents a summary of the costs associated with implementing Alternative 3 at the Site. The total present worth cost includes the present value of 5 years of annual maintenance and monitoring ($141,959) in addition to the capital costs ($1,838,453). Changes in the cost elements are likely as commodity prices change, and new information and data are collected during the engineering design and construction pre-bid and walk-through meetings.

9.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section compares the removal action alternatives retained for detailed analysis at Site to reduce the migration of lead to drainages and off-site receptors, reduce the threat to human health and the environment associated soil and sediment contamination, minimize the potential for lead to migrate to shallow groundwater, and control physical hazards at the Site. The comparison focuses on the effectiveness, implementability, and cost of each alternative. The following sections present the comparative analysis, a summary of the findings from the analysis, and the recommended removal action alternative based on the findings from the analysis.

9.1 COMPARATIVE ANALYSIS

The final step of an EE/CA is to conduct a comparative analysis of the removal action alternatives. This analysis will discuss each alternative's relative strengths and weaknesses with respect to each of the comparison criteria. Once completed, the analysis will be used to select the recommended removal action alternative for the Site. Public notices will be placed in the Prescott Daily Courier and on the Forest Service website announcing the availability of the Draft Final EE/CA report for public review and comment. The public comment period will be open for a period of 30 days unless a longer time is requested before the end of the 30 days. Written and oral comments received from the community during the public comment period on the EE/CA report and on the recommended removal action alternative for the Site will be addressed in the Technical Response to Comments included with the Action Memorandum. The preferred removal action alternative for the Site will be documented in the Final Action Memorandum.

This analysis compares the relative effectiveness, implementability, and cost of the removal action alternatives in reducing the threat to human health and the environment associated soil and sediment contamination, reducing the migration of lead to drainages and off-site receptors, minimizing the potential for lead to migrate to shallow groundwater, and controlling physical hazards at the Site. The effectiveness comparison considers the following criteria: (1) protectiveness of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, and volume; (5) short-term effectiveness of each alternative. The implementability comparison will include consideration of the following criteria: 1) ability to construct and operate, 2) ease of implementing more action if necessary, 3) availability of services and capacities, and 4) availability of equipment and materials to implement each alternative. The cost comparison will include consideration of the estimated total present worth cost of each alternative.

Each criterion is presented and compared for each removal action alternative in Table 9-1. Acceptance by supporting agencies and the community are additional criteria that will be addressed in the action memorandum after addressing state agency and the public comments on the EE/CA report and the recommended removal action alternative for the Site.

9.2 SUMMARY OF FINDINGS

Baseline conditions at the Site as represented by Alternative 1, the No Action alternative, allows the continued release of lead and does not pass the threshold criteria of protectiveness of human health and the environment or water quality. Table 9-1 provides a comparison of the alternatives by assessment criterion.

Effectiveness

Both Alternative 2 and Alternative 3 provide the highest degree of protection through removal of soil and sediment from the Site and off-site containment in a disposal facility. Both alternatives would reduce the potential for residual lead migration to groundwater through the addition of lime, which would fix lead to soil and precipitate any lead in soil pore water. Both alternatives would remove the over steep berms during site restoration, eliminating physical hazards. Both alternatives would allow unrestricted use of the Site.

Reliability and permanence for both Alternatives 2 and 3 is high and achieved through waste removal and off-site containment in a disposal facility. Periodic inspections and maintenance to ensure revegetation success, repair surface controls, and replace informational signs would ensure site restoration under both alternatives.

Alternatives 2 and 3 would not reduce the volume of contaminated material, although the toxicity of lead would be reduced through on- or off-site treatment and mobility reduced through off-site disposal. Both alternatives would also reduce mobility of lead in drainage through removal and potential leaching to shallow groundwater through lime addition during excavation backfill and site grading.

Alternatives 2 and 3 would comply with chemical-specific ARARs because lead-contaminated material would be excavated from source areas and Drainage 1, stabilized on- or off-site, and contained within an off-site Class I or II facility. Both alternatives would generate a waste because soil is moved outside of the AOC, triggering federal and state RCRA chemical- and action-specific ARARs.

In order to comply with location-specific ARARs, contacts with appropriate agencies and tribes regarding cultural resources would be required. In addition, a cultural resources survey report would also be required to evaluate potential impacts to these resources. The Forest Service did conduct archeological surveys in/near the Site under two previous heritage project efforts. One site was identified just outside of the Site's boundary, which should not be impacted by implementation of the proposed removal action. Forest Service will flag the area to avoid any potential disturbance prior to construction.

No threatened or endangered species and no Forest Service sensitive species are known to occur within or near the project area. There would not be any trend towards listing for any sensitive species.

Alternatives 2 and 3 are both considered to have short-term effectiveness because they could be implemented in one field season and the reduction in risk from removal of material and attainment of PRAOs would be immediate.

Implementability

Alternatives 2 and 3 are both technically and administratively feasible, require no permits, and could be implemented within one field season. Each of alternative requires conventional design methods, engineering requirements, and construction practices that are well documented and understood. Equipment, materials, and labor for all of the action alternatives would be available through the local market. Controlling fugitive dust emissions, dust monitoring, and controlling stormwater discharge (if generated) would be required for both alternatives. Both Alternatives 2 and 3 would improve site hydrology and water quality through construction of surface controls and would reduce sediment load leaving the Site.

No future action would be required under Alternatives 2 and 3 because lead-contaminated material would be removed from the Site. Long-term monitoring and maintenance of surface controls and access restrictions would be required under Alternatives 2 and 3, especially repair of erosional features and revegetation. Removal and disposal of sediment from drainage basins is not anticipated, as all lead-contaminated soil will be removed from the Site. The purpose of the drainage basins is to capture any eroding soil during the revegetation process.

Alternatives 2 and 3 would both improve both site aesthetics and viewscape through material excavation and off-site disposal. In addition, the remainder of the berms will be removed and the clean material used to backfill excavations and restore soil borrow area and slopes to natural contours. Alternatives 2 and 3 could both have a short-term impact on flora and fauna due to the excavation and truck movement throughout the Site and access road.

Site construction and material hauling would generate elevated noise levels and vibrations near the Site for period up to 2 months. Because homes are located east adjacent to the Site, some impact is expected and would be mitigated through schedule coordination with residents. Noise from truck traffic hauling materials on local roads may be a concern for rural suburb area; however, the traffic would be limited to the main thoroughfare and would avoid subdivisions.

Approximately 10 to 15 haul trucks would be routed daily over a 2 to 3 week period along the short unpaved Site access road and paved access roads through the City of Prescott. All loads would be tarped during transport. In accordance with ADOT laws, loads would be limited to 20 tons. Since little traffic is present in proximity to the former Shooting Range, it is doubtful that traffic disruption would occur at a regular frequency. However, given the large number of trucks

hauling lead-contaminated material off-site traffic signage and direction may be warranted at the intersection of the Forest Service access road and N Granite Basin Road.

Costs

Alternative 1 is the least expensive because no cost is incurred. Costs range from $1,052,057 for Alternative 2 to $1,980,412 for Alternative 3. Alternative 2 represents the best value for the Site and is equally effective as Alternative 3 and readily implementable.

These construction costs are estimates expected to be within minus 30 to plus 50 percent of the actual project cost (based on year 2015 dollars). Changes in the cost elements are likely as a result of new information and data collected during engineering design and construction pre-bid and walk-through meetings.

9.3 RECOMMENDED REMOVAL ALTERNATIVE

Alternative 2, excavation, on-site treatment, and off-site transport and disposal, is the recommended removal action alternative at the Site for reducing the threat to human health and the environment associated soil and sediment contamination, reducing the migration of lead to drainages and off-site receptors, minimizing the potential for lead to migrate to shallow groundwater, and controlling physical hazards. Alternative 2 is summarized below:

- Perform a treatability study on mixing lead contaminated soil with Portland cement to determine viability, optimal mixing volumes, and methods to ensure that TCLP limit for lead is not exceeded after soil treatment.
- Prepare a removal design that will provide construction drawings and define standards for the removal action.
- Prepare a bid package and construction management plan.
- Procure construction firm(s); negotiate transport, treatment, and disposal costs, and necessary insurance and bonding.
- Provide full-time construction management during the removal action, which will include full-time Contractor oversight, confirmation sampling and analysis, waste profiling, surveying, and preparing a construction report with As-Constructed drawings.
- Mobilize and demobilize necessary equipment to and from the Site once, including installing temporary erosion control measures.
- Prepare and secure a staging area for equipment storage and use during construction.
- Establish off-site water source for dust control and turn on electrical service.
- Complete site preparation including posting signs and reviewing hospital routes.

- Repair of the Site access road for heavy truck traffic and evaluate traffic control plan at the Site entrance from N Granite Basin Road.
- Remove concrete debris from three firing line pads and in ground target stand supports, and dispose at an off-site Class III facility (Figure 8-1).
- Close potential water well, if located south of the range.
- Establish dust monitoring locations between project area and east adjacent residences to confirm dust control measures are protective.
- Excavate approximately 2,900 CY of soil from source areas and sediment from Drainage 1 (Figures 4-1 to 4-7).
- Use XRF and laboratory split sampling to confirm limits of excavation at or below the PRAG.
- Segregate approximately 200 CY of soils and sediment above PRAGs but below TCLP limit.
- Segregate approximately 2,700 CY of soils above PRAGs and above TCLP limit.
- Screen approximately 2,700 CY of soil to remove medium and large bullets.
- Recycle screened bullets at no cost.
- Mix approximately 2,700 CY of soils containing lead above TCLP limit in windrows with 10% Portland cement and water for dust suppression.
- Profile waste for disposal and collect samples for TCLP analysis to confirm attainment of TCLP limit.
- Load Portland cement-treated soils into haul trucks and transport to the Northwest Landfill near Surprise, Arizona (RCRA Class II facility) for disposal.
- Load untreated soils (above PRAGs but below TCLP limit) into haul trucks and transport to the Northwest Landfill near Surprise, Arizona (RCRA Class II facility) for disposal.
- After waste removal, knockdown remainder of target berms and eastern berm.
- Backfill the removal areas with approximately 2,900 CY of clean excess berm material and add lime to increase the alkalinity of soil pore water and immobilize residual lead (Figure 8-1).
- Grade slopes to natural contours using approximately 1,000 CY of clean excess berm material (Figure 8-1).
- Install surface controls including a diversion berm along the east side of former backstop and 200 yard berms, a diversion berm along the east side of former 100 yard berm, a sediment detention basin, on Drainage 3, and rock spillways on existing Drainage Basins 2 and 3 (Figure 8-1). Berms and basin will use approximately 1,000 CY of clean excess berm material.

- Revegetate the Site using native seed mixture.
- Erect signs to notify site visitors of site restoration and revegetation efforts.
- Perform semi-annual site visits to monitor the integrity of and maintain the surface controls and revegetation efforts.

Both Alternative 2 and 3 are equally protective of human health and the environment through waste removal from the Site. Alternative 2 would comply with ARARs, provide long-term effectiveness and permanence, and greatly reduce the mobility of lead and risk of exposure to unhealthy levels of lead at the Site. Alternative 2 and 3 would both provide an equally high level of permanence as the waste would no longer remain on site. O&M costs required to maintain the removal action measures for Alternative 2 and 3 would be similar. However, the very high cost of off-site stabilization and disposal in a RCRA Class I facility with Alternative 3 would limit the likelihood of funding due to budget constraints.

The removal action at the Site would require up to 2 months of construction. O&M would be carried out for a period of 5 years and would consist of applying soil to any eroded areas, reapplying hydroseed, repairing stormwater control berms, repairing drainage basin berms and spillways, and inspecting and replacing informational signs as necessary.

Alternative 2 could be implemented at the Site at an estimated present worth cost of $1,052,057. The net present value of annual O&M costs over the next 5 years is about 13 percent of the total present worth cost at the Site. These construction costs are estimates expected to be within minus 30 to plus 50 percent of the actual project cost (based on year 2015 dollars). Changes in the cost elements are likely as new information and data are collected during engineering design and construction pre-bid and walk-through meetings.

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TABLES

FIGURES

APPENDICES