Woolsey Fire Cleanup Sampling and Analysis Plan

Santa Monica Mountains National Recreation Area

Paramount Ranch, Peter Strauss Ranch, Morrison Ranch, Rocky Oaks, Cooper Brown, Dragon Property, Miller Property, Arroyo Sequit, Circle X Ranch

Prepared by

Terraphase Engineering, Inc.

5/27/2020

Signatories:

[Federal Government Lead]	[Signature]	[Date Signed]
[Cleanup Lead]	[Signature]	[Date Signed]
[Legal Lead]	[Signature]	[Date Signed]
[Regional Coordinator]	[Signature]	[Date Signed]
[Contaminated Sites Program]	[Signature]	[Date Signed]
By signing above, the signatories verify that they understand and concur with the information, procedures, and recommendations presented herein.		

Table of Contents

List of Figures

List of Tables

List of Abbreviations and Acronyms

BGS	Below ground surface
BSA	Boy Scouts of America
BTV	Background Threshold Value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chain of Custody
COPC	Contaminant of Potential Concern
CrVI	Chromium (VI)
CSM	Site Conceptual Site Model
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
EPC	Exposure Point Concentration
FSP	Field Sampling Plan
GPS	Global Positioning System
HASP	Health and Safety Plan
IDQTF	Intergovernmental Data Quality Task Force
MDL	Method Detection Limit
NPS	National Park Service
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
PCB	Polychlorinated Biphenyl
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
SAP	Sampling and Analysis Plan
SAMO	Santa Monica Mountains National Recreation Area
SOP	Standard Operating Procedure
STLC	Soluble Threshold Level Concentration
TCLP	Toxicity Characteristic Leachate Procedure
TCRA	Time Critical Removal Action
TTLC	Total Threshold Limit Concentrations

UCLA	University of California at Los Angeles
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
WET	Waste Extraction Test

1 Introduction

This document serves as the Sampling and Analysis Plan (SAP) for the Woolsey Fire Time Critical Removal Action project in the Santa Monica Mountains National Recreation Area (SAMO) (the Site, Figure 1). A total of 31 structures were destroyed during the Woolsey Fire in November 2018 (Table 1). The structures were located in the nine project areas of the Site (i.e., Paramount Ranch, Peter Strauss Ranch, Rocky Oaks, Cooper/Brown, Arroyo Sequit, Circle X Ranch, Morrison Ranch, Miller Property, and the Dragon Property).

The purpose of this SAP is to:

- Detail the sampling and analytical methods that will be used to characterize the nature and extent of site-related chemicals of potential concern (COPC) in ash prior to performing response activities;
- Detail the sampling and analytical methods that will be used to characterize naturally occurring metals concentrations in soil in the vicinity of each of the nine project areas;
- Document the human health and ecological screening levels used to inform the laboratory reporting requirements to achieve the necessary data quality objectives (DQOs);
- Detail the sampling and analytical methods that will be used to characterize the nature and extent of site-related COPC in surface soil following the performance of response activities; and
- Establish the general data evaluation approach(es) that will be used to support Removal Action decision-making.

1.1 CERCLA and National Park Service (NPS) Authority

This SAP was generated in general accordance with the United States Environmental Protection Agency's (USEPA) *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA 2006), *Guidance for Quality Assurance Project Plans* (USEPA 2002), *EPA Requirements for Quality Assurance Project Plans* (USEPA 2001), and the Intergovernmental Data Quality Task Force's (IDQTF) *Uniform Federal Policy for Quality Assurance Project Plans* (IDQTF 2005). The National Park Service (NPS) is authorized under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC. Section 9601 et seq., to respond as the Lead Agency to a release or threatened release of hazardous substances and/or a release or threatened release of any pollutant or contaminant that may present an imminent and substantial danger to public health or welfare on NPS land.

> CERCLA's implementing regulations, codified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300, establishes the framework for responding to such releases and threatened releases. The NCP prescribes two similar processes for responding to releases: removal actions and remedial actions (see NCP Sections 300.400 through 300.440). In accordance with the NCP (40 CFR Part 300, Subpart §300.415), the following factors are used in considering the appropriateness of a removal action:

1. Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants
2. Actual or potential contamination of drinking water supplies or sensitive ecosystems
3. Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage containers, that may pose a threat of release
4. High levels of hazardous substances, pollutants, or contaminants in soil largely or near the surface that may migrate
5. Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released
6. Threat of fire or explosion
7. The availably of other appropriate federal or state response mechanisms to respond to the release
8. Other situations or factors that may pose threats to public health or welfare of the United States or the environment.

If environmental samples are to be collected under either process, a SAP is required (see NCP Sections 300.415 and 300.430).

The SAP includes the Field Sampling Plan (FSP) which describes the number, types, and locations of samples and the types of analyses that will be conducted on the samples. The SAP also describes the project's policy framework, organization, functional activities, data quality objectives (DQOs), and measures necessary to achieve the goals of the study.

In addition, the NPS has many regulations that apply to the release of hazardous substances on NPS land (see NPS 2015) including the NPS Organic Act of 1916 (16 USC Section 1, et seq., 36 CFR Part 1), which requires that the NPS manage parks in order to conserve the scenery, natural and historic objects, and wildlife and to provide for their enjoyment by such means as will leave them unimpaired for the enjoyment of future generations. Therefore, whether conditions at the Site pose unacceptable risks to the interaction of organisms and the environment is especially relevant to the NPS responsibility to protect park resources.

To the extent practicable, all work will be conducted in accordance with USEPA guidance, *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites* (USEPA 2008).

1.2 Purpose of Field Sampling

The purpose of the field sampling effort will be to adequately characterize the nature and extent of COPCs in ash at the nine impacted areas for waste disposal purposes and develop removal goals that can support the evaluation of post-cleanup soil sampling results to confirm completion of Removal Action. This will involve:

1. Characterizing the nature and extent of COPCs in ash, generated when structures in the nine areas were destroyed by fire to facilitate disposal of the ash material during response activities;

2. Characterizing the range of naturally occurring metals concentrations in soil in the vicinity of each of the nine project areas to support the development of removal goals; and
3. Characterizing the nature and extent of COPCs in surface soil, following the implementation of response activities, in order to confirm that conditions following cleanup are equal to or below the removal goals.

The sampling events will be conducted in 2019 and 2020. Data generated from these sampling events will be used in accordance with the provisions outlined in the DQOs detailed in Section 4.

The sampling that will be performed is summarized on Table 1 and is as follows:

- Up to 16 ash samples (total) in the vicinity of 28 burned and destroyed structures, located within eight of the nine project areas[1], will be collected and analyzed for Title 22 metals via USEPA Method 6010B/7471A, including one sample at each area (8 samples) that will be analyzed for chromium (VI) (CrVI) via USEPA Method 7196A, dioxins and furans via USEPA Method 8920, PCBs via USEPA Method 8082 and asbestos via USEPA Method 600;
- A total of 90 background soil samples from six selected areas (15 samples collected from each selected area, Figures 2, 3, 4, 5, 7 and 9), will be collected and analyzed for Title 22 metals via USEPA Method 6010B/7471A, including 20% of samples (3 samples per area) that will be analyzed for CrVI via USEPA Method 7196A; and,
- A total of 120 post-Removal Action soil samples in the vicinity of 28 burned and destroyed structures, located within nine project areas, will be collected and analyzed for Title 22 metals via USEPA Method 6010B/7471A, including 20% of samples per area that will be analyzed for CrVI via USEPA Method 7196A, and dioxins and furans via USEPA Method 8920.
- Locations of previous structures where limited or non-existent ash was observed will not be sampled for ash or soil.

[1] Ash is not present at Circle X Ranch and this area is not included for sampling.

2 Site Description and Conceptual Site Model

2.1 Site Description

The Site is located in the SAMO in Los Angeles and Ventura Counties, California and consists of 182,440 acres of land. The NPS controls 23,620 acres of the SAMO and the California State Park system controls 42,000 acres. The rest of the SAMO is controlled by local agency parks, university study reserves, and private property conservation easements.

2.1.1 Project Areas

In November of 2018, the Woolsey Fire destroyed 21,000 acres (88%) of NPS land within the Site, including 269 known archaeological sites, two cultural landscapes and 32 historical buildings. The nine project areas where structures were destroyed in the Fire and which are the subject of this sampling scope are shown on Figure 1. The locations of each of the nine project areas subject to this sampling scope are as follows:

1. **Paramount Ranch (see Figure 2)**
   - 2903 Cornell Rd
     Agoura Hills, CA 91301
   - 34.115508°, -118.756145°

2. **Peter Strauss Ranch (see Figure 3)**
   - 30000 Mulholland Hwy
     Agoura Hills, CA 91301
   - 34.113496°, -118.779316°

3. **Rocky Oaks (see Figure 4)**
   - 107 Kanan Dume Rd
     Malibu, CA 90265
   - 34.098123°, -118.813196°

4. **Cooper/Brown (see Figure 4)**
   - 31915 Mulholland Hwy
     Malibu, CA 90265
   - 34.097067°, -118.815981°

5. **Arroyo Sequit (see Figure 5)**
   - 34138 Mulholland Hwy
     Malibu, CA 90265
   - 34.086259°, -118.890645°

6. **Circle X Ranch (see Figure 6)**
   - 12896 Yerba Buena Rd
     Malibu, CA 90265
   - 34.109734°, -118.937229°

7. **Morrison Ranch (see Figure 7)**
   - Near Cheeseboro Canyon Rd at Cheeseboro Rd
     Agoura Hills, CA 91301
   - 34.154874°, -118.727014°

8. **Miller Property (see Figure 8)**
   - 2200 Latigo Canyon Rd
     Malibu, CA 90265
   - 34.074250°, -118.784160°

9. **Dragon Property (see Figure 9)**
   - Near Trancas Canyon Rd at Edison Rd
     Malibu, CA 90265
   - 34.050842°, -118.852780°

The following sections provide additional details for each area.

Paramount Ranch

Paramount Ranch is a 2,700-acre ranch located in Agoura Hills, California (34.115508°, -118.756145°). Paramount Ranch and features burned in the Woolsey Fire are shown on Figure 2. The land was

purchased by Paramount Studios in 1927 and, prior to the Fire, was used as a movie set where numerous television shows and movies had been filmed. Paramount Ranch was open to the public for tours of the property and private events and contains hiking trails. A total of ten structures were burned in the Fire including the freight building, private quarters 107, the mercantile building, the pavilion, the saloon, the horse barn, the jail, the restroom, the hotel, and the telegraph office (Figure 2). In 1956, the owner of Paramount Ranch built a road-racing track adjacent to Medea Creek. The track was 2 miles in length and featured 11 turns and a bridge and underpass in the northern section of the course. The racetrack bridge was the eleventh feature burned in the Fire. Details about structures destroyed are presented in Table 1.

Peter Strauss Ranch

Peter Strauss Ranch is a located in Agoura Hills, California (34.113496°, -118.779316°). Peter Strauss Ranch and the features burned in the Fire are shown on Figure 3. Peter Strauss Ranch was first owned by automobile manufacturer Henry Miller and used as a weekend retreat. In 1926, Miller built the stone ranch rouse, look-out tower, and aviary. The property was sold in the mid-1930s to developers Warren Shobert and Arthur Edison who turned the property into a recreational amusement park called Lake Enchanto. The property was sold to actor Peter Strauss in 1976, who turned the property into a private estate. The land was sold to the Santa Monica Mountains Conservancy in 1983 and later to the NPS in 1987. The ranch contains hiking trails, a swimming pool in the Lake Enchanto dam, and previously allowed access to the stone ranch house. The ranch house was burned in the Fire. Details about structures destroyed are presented in Table 1.

Rocky Oaks

Rocky Oaks is located in Malibu, California (34.098123°, -118.813196°). Rocky Oaks and the features burned in the Fire are shown on Figure 4. This area was originally part of the Rocky Oaks Ranch, established in the 1920s by Albert and Anna Bradenberger. The area is maintained by the NPS and contains hiking trails and a seasonal man-made pond. Features destroyed in the Fire include the Quarters 102 House, the Museum Building, a vault restroom and a chicken coup. Details about structures destroyed are presented in Table 1.

Cooper/Brown

Cooper/Brown is located directly adjacent to and west of the Rocky Oaks park unit in Malibu, California (34.097067°, -118.815981°). The Cooper/Brown area and features burned in the Fire are shown on Figure 4. The area contained the Bradenberger-Brown house, or the Cooper/Brown house, constructed by Albert and Anna Bradenberger in the 1940s. Details about structures destroyed are presented in Table 1.

Arroyo Sequit

Arroyo Sequit is located in Malibu, California (34.086259°, -118.890645°). the Arroyo Sequit area and features burned in the Fire are shown on Figure 5. It was purchased by Richard Mason and Mabel Kelch in the 1920s and sold to the State of California in 1985, following a large wildfire in the area. The NPS acquired the land in 1991. Arroyo Sequit contained a picnic area for visitor use and a wood frame ranch house used as a ranger residence. Features destroyed in the Woolsey Fire include the Quarters 113 house,

the survey office, the vault restroom and the pump house. Details about the structures destroyed are presented in Table 1.

Circle X Ranch

Circle X Ranch is located in Malibu, California (34.109734°, -118.937229°). Circle X Ranch and the features burned in the Woolsey Fire are shown on Figure 6. The site was a former Boy Scout Camp created by the Exchange Club of Los Angeles and the Boney Ridge Country Club in 1949. In 1951, the Boy Scouts of America (BSA) signed a 99-year lease with the Circle X Ranch foundation, and in 1979, the foundation deeded the land to the BSA. In 1987, the NPS bought the land from the BSA and the NPS has managed an on-site campground since 1989 as well as several hiking trails open to the public. Features destroyed in the Woolsey Fire include the basketball court and vault toilets A and B. Details about the structures destroyed are presented in Table 1.

Morrison Ranch

Morrison Ranch is located in Agoura Hills, California (34.154874°, -118.727014°). Morrison Ranch and the features burned in the Woolsey Fire is shown on Figure 7. The property was purchased by John W. Morrison in 1904 and was used as a cattle ranch. Morrison Ranch was acquired by the NPS in 1999. Features destroyed in the Woolsey Fire include the Morrison Ranch house, the chicken coup and the corral area. Details about structures destroyed are presented in Table 1.

Miller Property

The Miller Property is located in Malibu, California (34.074250°, -118.784160°). The Miller Property and features burned in the Woolsey Fire are shown on Figure 8. The property is a recent purchase of the NPS. The Miller Property, formerly a roofed area which covered recreational vehicles, was burned in the Woolsey Fire. Details about structures destroyed are presented in Table 1.

Dragon Property

The Dragon Property is a park unit located in Malibu, California (34.050842°, -118.852780°). The Dragon Property and features burned in the Woolsey Fire are shown on Figure 9. The property is a recent purchase of the NPS. The structures destroyed during the Woolsey Fire include an Air Stream trailer, a school bus called the Life Estate, and a pump house. Details about structures destroyed are presented in Table 1.

2.1.2 Waste Characteristics

The nine project areas did not represent areas which stored or generated hazardous waste prior to the fire, other than household hazardous waste. The descriptions of the former structures at each of the nine areas are presented in Table 1. Many of the structures destroyed in the Woolsey Fire were constructed of either wood or metal frames, some including metal siding, asphalt shingles and other building materials. Older structures may have been constructed using asbestos-containing materials. As a result, the potential presence of COPCs in ash/surface soil at the nine areas are attributable to burning of these building materials or to the building materials themselves.

2.1.3 Site Geology

The SAMO forms the western portion of the east-west trending Transverse Ranges of Southern California. The Transverse Ranges were rotated clockwise approximately 90°–110° and uplifted in the last 20 million years coinciding with the development of the San Andreas Fault. Sedimentary rocks include lithologies deposited in marine settings over 21 million years ago that were uplifted in an active tectonic setting. Igneous rocks include intrusive granitic varieties emplaced during the Cretaceous period as well as extrusive varieties which developed in marine environments and were subsequently uplifted. The most common metamorphic rocks in the area are slate from the Jurassic to early Cretaceous period that were metamorphosed while being sutured to the North American continental margin. The SAMO has been a tectonically active area throughout the Quaternary period where uplift and extensive folding and faulting has produced widespread occurrences of landslides (NPS 2016). In addition, many low-lying areas have accumulated alluvial deposits over time due to numerous ephemeral streams in the area.

2.1.4 Site Hydrology

The nine project areas are located in two major watersheds within the SAMO: the Malibu Creek Watershed and the Coastal Watersheds. The Malibu Creek Watershed drains to the Pacific Ocean via Malibu Creek. The Coastal Watersheds are a series of steep drainages on the southern section of the Site that drain to the Pacific Ocean. The rainy season ranges from approximately December to April and the dry season for the remainder of the year. Average yearly rainfall ranges from 12.5 to 15 inches along the coast and up to 24 inches inland, at higher elevations. Malibu, Solstice and Topanga Creeks are perennial streams that flow in the SAMO, and countless others are ephemeral streams that coincide with the rainy season. Several areas of the Site are located adjacent to aquatic features. The Peter Strauss Ranch area is located adjacent to an ephemeral drainage, formerly dammed to create Lake Enchanto. This drainage flows to Lake Malibu. Paramount Ranch is located adjacent to Madea Creek, which is upstream from Lake Malibu.

2.1.5 Local Climate

The SAMO has a Mediterranean-type climate. This climate type is characterized by cool, wet winters and hot, dry summers. Coastal area temperatures are moderated in the summer by fog which occurs along the coast in the southern part of the SAMO. December through March are the coolest months and July through October are the hottest months in the SAMO. The average mean temperature in January ranges from 50-65 degrees F; summers are a little warmer with an average mean temperature in July that ranges from 65-76 degrees F. Both winter and summer temperature extremes are moderated by the moist ocean air with generally high nighttime humidity and frequent fog. Diurnal temperature differences are small with cool days and warm nights. Strong winds blowing from the east, known as Santa Ana winds, occur in the later summer and fall months and increase the chances for forest fires.

2.1.6 Ecological Setting and Sensitive Environments

The Santa Monica Mountains are part of the east-west trending Transverse Ranges of Southern California. The range is characterized by steep, rugged mountain slopes and canyons with elevations ranging from sea level to more than 3,000 feet. The Santa Monica Mountains are adjacent to 46 miles of California coastline with sandy beaches and rocky tide pools and lagoons.

The mountains are home to over 1,000 plant species making up 26 distinct natural communities, from freshwater aquatic habitats and two of the last salt marshes on the Pacific Coast, to oak woodlands, valley oak savannas, coastal sage, and chaparral. Over 45 mammal species are found in the Santa Monica Mountains, including bobcats, coyotes, and mountain lions. Nearly 400 species of birds have been observed and another 35 species of reptiles and amphibians can also be found in the mountains. The rare, threatened and endangered plant and animal species (NPS 2005) are listed below:

Plants:

- Braunton's milk-vetch
- Coastal dunes milk-vetch
- Salt march birds-beak
- Conejo dudleya
- Agoura Hills dudleya
- Blochman's dudleya
- Many-stemmed dudleya
- Marcescent dudleya
- Santa Monica Mountains dudleya
- Verity's dudleya
- Lyon's Pentachaeta
- Conejo buckwheat
- Santa Susana tarplant
- Plummer's mariposa lily
- Dune larkspur
- Coulter's goldfields
- Parry's Spineflower
- California beargrass
- Mud nama
- Rayless ragwort
- Sonoran maiden fern
- Lewis's evening-primrose
- Vernal barley
- Red sand-verbena
- Plummer's baccharis
- Round-leaved boykinia
- Seaside calandrinia
- Island mountain-mahogany
- Southern mountain misery
- Western dichondra
- Suffretescent wallflower
- Santa Barbara bedstraw
- Southwestern spiny rush
- Fragrant pitcher sage
- Fish's milkwort
- Estuary seablite
- Malibu baccharis

Birds:

- Swainson's Hawk
- Peregrine Falcon
- Marbled Murrelet
- Bank Swallow
- Least Bell's Vireo
- Belding's Savannah Sparrow
- American White Pelican Birds
- Harlequin Duck
- Cooper's Hawk
- Northern Harrier
- Osprey
- Merlin
- Prairie Falcon

- Mountain Quail
- Long-billed Curlew
- Elegant Tern
- Long-eared Owl
- Burrowing Owl
- California Horned Lark
- San Diego (Coastal) Cactus Wren
- Loggerhead Shrike
- Tri-colored Blackbird
- Southern California Rufous-crowned Sparrow
- Yellow Warbler
- Western Snowy Plover
- Southwestern Willow Flycatcher
- California Condor
- Bald Eagle
- Brown Pelican
- California Gnatcatcher
- Light-footed Clapper Rail
- California Least Tern
- Least Bell's Vireo

Mammals:

- Spotted Bat
- Greater Western Mastiff Bat
- California Leaf-nosed Bat
- Occult Little Brown Bat
- Pacific Western Big-eared Bat
- Salt Marsh Ornate Shrew
- American Badger

Reptiles:

- Southwestern Pond Turtle
- San Diego Horned Lizard
- California Horned Lizard
- Coastal Western Whiptail
- Silvery Legless Lizard
- San Bernardino Ringneck Snake
- San Diego Mountain King Snake
- Coastal Rosy Boa
- Coast Patch-nosed Snake
- Two-striped Garter Snake

Amphibians:

- California Red-legged Frog
- Coast Range Newt

Fishes:

- Tidewater Goby
- Southern California Steelhead Trout

Invertebrates:

- Wright's Checkerspot Butterfly
- Callippe Silverspot Butterfly
- Clouded Tailed Copper Butterfly
- Salt Marsh Skipper

- Santa Monica Mountains Hairstreak
- Belkins Dune Tabanid Fly
- Santa Monica Shieldback Katydid
- Valley Oak Ant

Potential ecological receptor groups include terrestrial birds, mammals, reptiles, amphibians, and vegetation. These species are summarized in Tables 2 and 3.

2.1.7 Current and Future Property Use Scenarios

The nine areas impacted by the Fire have been predominantly used for recreational purposes. Currently, as a result of the Fire, access to these areas is limited. In the future, following restoration, use of these areas may involve recreational activities, routine work and maintenance activities by NPS staff, or use of these lands as residences for NPS staff. Adjacent to, or in close proximity to, these nine impacted areas are land that is (or could be) used for similar purposes (i.e., recreational and residential use).

2.1.8 Summary of Previous Investigations

No previous investigations have been conducted at the Site that are pertinent to this project.

2.1.9 Contaminants of Potential Concern

The COPCs for this investigation include metals, dioxins and furans, PCBs, and asbestos.

The COPCs were identified accounting for the byproducts that could be generated from burned building materials or from the building materials themselves. In some areas, the details provided for the construction materials of burned structures are limited or incomplete. Older structures were likely built with asbestos-containing materials. Many of the structures were also constructed with metal construction materials. PCBs could have been released from damaged building transformers or may have been present in building materials, such as in paint and caulk. No building -materials surveys have been conducted in the nine impacted areas.

2.1.10 Media of Potential Concern

The primary media of potential concern are ash and surface soil which may have been impacted by the potential release of COPCs to the environment as a result of buildings being burned in the Woolsey Fire. Due to the general hydrophobic nature of the COPCs, leaching to groundwater is not anticipated to be a complete pathway.

Secondary media of concern may be surface water and sediment in nearby streams or ephemeral drainages. Potentially contaminated ash or soil may have migrated to nearby drainages during winter 2018/2019. Though surface water and sediment are not primary media of concern in this investigation and no surface water or sediment sampling is planned, the spatial distribution of COPC concentrations in surface soil post removal will be evaluated. If it appears as though elevated concentrations of COPCs

could have been release to these streams/drainages then additional investigation and assessment would be considered.

2.2 Scenarios for Potential Human and Ecological Exposure

Current NPS land use within the SAMO is open space for public use. Land use outside of NPS-owned land in the SAMO is a complex mixture of open space, residential and some commercial and is governed by Los Angeles and Ventura County land use plans and various city plans within the SAMO.

2.2.1 Human Receptors and Exposure Pathways

With consideration for current and reasonably expected future land use at and in the vicinity of the nine project areas, the potentially exposed populations are as follows:

On-Site

- Park Residents
- Park Employees
- Park Visitors
- Maintenance Workers
- Construction Workers

Off-Site

- Park Residents
- Park Employees
- Park Visitors

The potential exposure pathways evaluated for each receptor are discussed below and are summarized in Table 4 and on Figure 10.

On-Site

Currently, as a result of the fire, the impacted areas are not being used for residential purposes, for use by park employees, or open to park visitors for recreational activities. However, park residents, park employees and park visitors could be exposed in the future to chemicals in ash or surface soil. Potential routes of exposure to ash/surface soil would be possible through incidental ingestion, dermal contact, and inhalation of airborne particulates.

Following removal activities and potential reconstruction, these areas may also require occasional maintenance activities to be completed. This could include various tasks such as excavations of limited extent and duration. Future potential exposure of maintenance workers to surface soil is assumed to include incidental ingestion, dermal contact, and inhalation of airborne particulates.

During reconstruction or future site redevelopment, exposures to surface soil during larger scale construction activities may be possible. Future potential exposure of construction workers to surface soil is assumed to include incidental ingestion, dermal contact, and inhalation of airborne particulates.

Off-Site

Off-site receptors include off-site park residents, off-site park employees, and off-site park visitors. These receptors could be exposed to on-site ash/surface soil via inhalation of airborne particulates migrating from on-site areas to off-site areas.

2.2.2 Ecological Receptors and Exposure Pathways

As discussed in Section 2.1.6, potentially exposed ecological receptor groups include terrestrial wildlife (i.e., birds, mammals, reptiles, amphibians) and terrestrial vegetation. The potential exposure routes for terrestrial wildlife include ingestion and direct contact with ash/surface soil and food web exposure.

The receptors and exposure pathways are summarized on Figure 11.

2.2.3 Key CSM Assumptions

- Site-related volatile organic chemicals (VOCs) are not expected to be present in ash or surface soil given the nature of the release (i.e., impacts and deposition as a result of fire). As a result, the exposure scenarios for which removal goals are anticipated to be developed do not include volatilization to indoor air or volatilization to outdoor air inhalation exposures.
- The general hydrophobic nature of the COPCs is such that impact to subsurface soil and leaching to groundwater is not anticipated. As a result, receptor exposure to COPCs is only assumed for ash/surface soil. The CSM may be modified following post-removal confirmation soil sampling, if detected concentrations exceed the RGs.
- Currently, it is assumed that sediment or surface water have not been impacted by COPCs as a result of the fires.

3 DQO Planning Team and Stakeholders

3.1 DQO Planning Team

The DQO Planning Team for this project includes:

- Stephen Mitchell, P.E., Operations/Environmental Programs Branch Chief, NPS
- J. Colter Chisum, P.E., Chief of Facilities Management, NPS, SAMO
- Patricia Billig, Environmental Protection Specialist, Pacific West Region, NPS
- Greg Nottingham, Environmental Protection Specialist, NPS
- Ryan Dewey, Vice President, Lead Builders, Inc.
- Darren Croteau, Principal Geologist, Terraphase
- Kevin Long, Principal Consultant, Terraphase
- Jonathan Marshak, Senior Staff Geologist, Terraphase

The DQO process is iterative, and team members may be added or changed during the project in order to address technical issues not initially identified.

3.2 Decision-Makers

The decision-makers have the ultimate authority for making final decisions based on the recommendations of the DQO Planning Team. The decision-makers for this project are:

- Stephen Mitchell, P.E. – Operations/Environmental Programs Branch Chief, NPS
- J. Colter Chisum, P.E., Chief of Facilities Management, NPS, SAMO

3.3 Stakeholders

Stakeholders are parties who may be affected by the results of the investigation and/or persons who may later use the data resulting from the investigation. The stakeholders for this project include the public who may use these areas for recreational purposes, local tribes (i.e., the Chumash and the Tongva)[2], local agency parks, university study reserves, and private property conservation easements with land in close proximity to the impacted areas.

[2] https://www.nps.gov/samo/learn/historyculture/nativeamericanindians.htm

4 Data Quality Objectives

The DQO process specifies anticipated project decisions, the data quality required to support those decisions, specific sample types and numbers needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified.

The DQO process consists of the following seven steps:

1. State the Problem
2. Identify the Goal of the Investigation
3. Identify the Information Inputs
4. Define the Boundaries of the Investigation.
5. Develop the Analytic Approach
6. Specify Performance or Acceptance Criteria
7. Develop the Plan for Obtaining Data

4.1 State the Problem(s)

Burned debris and ash resulting from the Woolsey Fire is present at each of the nine areas. It is unknown whether, and to what extent, the ash contains elevated levels of COPCs that could have an impact on disposal options for this material following removal. Also, COPCs present in the ash may have been released to surface soil as a result of the Fire. It is also unknown whether, and to what extent, these possible releases to the environment could have resulted in COPC concentrations in ash and surface soil that could present an unacceptable risk to human health or the environment. Determination of the existing and post-cleanup conditions are needed to support the complete cleanup of these areas.

4.2 Identify the Goal(s) of the Investigation

The goals of this investigation are as follows:

- Characterize the nature and extent of site-related COPCs in ash, prior to performing response actions, in order to facilitate proper off-site disposal of the ash/debris;
- Characterize the concentrations of naturally occurring metals concentrations in soil in the vicinity of each of the nine project areas to support development of removal goals; and,
- Characterize the nature and extent of site-related COPCs in surface soil, following the performance of response activities, to confirm that post-cleanup conditions meet the forthcoming proposed removal goals.

Based upon these goals, the principal investigation questions for this investigation are as follows:

1. What is the range of naturally occurring metals concentrations in surficial soil in vicinity of each project area?

2. What is the nature and extent of COPC concentrations in ash as a result of releases to the environment from the Fire?
3. What is the nature and extent of COPC concentration in surface soil, following the implementation of response activities, as a result of releases to the environment from the Fire?
4. Following the implementation of response activities, do site-related COPCs in surface soil pose an unacceptable risk to human or ecological receptors under current or reasonably expected future land use?

4.3 Identify Information Inputs

4.3.1 Previous Data Usability

No previously obtained laboratory analytical data are available.

4.3.2 Data to be Collected in the Current Investigation

There are two distinct sampling phases for this investigation.

Ash and Background Soil Sampling

Initially, samples of ash will be collected and analyzed from eight of the nine project areas to characterize the nature and extent of site-related COPC concentrations and facilitate disposal as hazardous or non-hazardous material during response activities. Ash is not present at Circle X Ranch and no ash sampling is proposed at this area. In parallel with this effort, soil samples will also be collected from areas expected to have been unimpacted by fire debris in order to determine the range of naturally occurring metal concentrations in soil. The background soil samples will also inform the development of removal goals.

Figures 2 to 9 show the nine project areas and the location of the burned structures. Ash samples will be collected at eight of the nine project areas according to Table 3 of the Statement of Work (NPS 2019). Table 1 provides a summary of ash samples that will be collected from each area. A minimum of two samples will be collected for each project area, based on communication with disposal facilities on sampling requirements. During a Site visit conducted with NPS on November 13, 2019, Terraphase noted that little to no ash is present in some of the areas, including the former restroom at Rocky Oaks (Figure 4), the former vault restroom at Arroyo Sequit (Figure 5), the former chicken coup and corral area at Morrison Ranch (Figure 7) and at the Dragon Site (Figure 9). According to the Statement of Work (NPS 2019), each of these features was designated for ash sampling. However, ash samples may not be collected at some of these areas due to the limited or non-existent ash. No ash samples are proposed for Circle X Ranch, per Table 3 of the Statement of Work (NPS 2019), due to limited or non-existent ash.

The number of samples proposed for collection during this phase of investigation is as follows:

- Up to 16 ash samples will be collected from the vicinity of 28 structures at the following eight areas (analyzed for metals, [including one sample per area (8 samples) that will be analyzed for hexavalent chromium [CrVI], dioxins and furans, PCBs, and asbestos): Paramount Ranch, Peter

Strauss Ranch, Rocky Oaks, Cooper Brown, Arroyo Sequit, Morrison Ranch, Miller Property and Dragon Property (Figures 2, 3, 4, 5, 7, 8 and 9). 2 samples will be collected from each area;

- 90 background soil samples will be collected from the following six areas (analyzed for metals, including 20% of samples (3 samples per area) that will be analyzed for CrVI): Arroyo Sequit, Dragon Property, Paramount Ranch, Peter Strauss Ranch, Rocky Oaks, Morrison Ranch (Figures 2, 3, 4, 5, 7 and 9). 15 samples will be collected from each area.

Post-Removal Action Soil Sampling

The second sampling phase will involve the collection of surface soil samples from beneath, and in the immediate vicinity of, the burned structures following the removal of debris and ash. The surface soil samples will also be analyzed for COPCs.

Figures 2 to 9 show the nine project areas and the location of the burned structures. Surface soil samples will be collected at the nine project areas according to Table 3 of the Statement of Work (NPS 2019). Table 1 provides a summary of surface soil samples that will be collected from each area. The number of surface soil samples was determined based on the square footage of the former structures. A minimum of two samples will be collected for each structure, and for structures larger than 800 ft^2, samples will be collected at an interval of one sample every 400 ft^2. No soil samples were designated for the Race Track Bridge at Paramount Ranch, the former pump house at Arroyo Sequit or the former restroom facilities located at Circle X Ranch, per Table 3 of the Statement of Work (NPS 2019), since ash is not present in these areas.

The number of samples proposed for collection during this phase of investigation is as follows:

- 120 surface soil samples will be collected from beneath the footprints of the former structures following debris removal (analyzed for metals, including 20% of samples per area that will be analyzed for CrVI, and dioxins and furans).

4.4 Define the Boundaries of the Investigation

4.4.1 Spatial Boundaries

The Site encompasses nine areas impacted by the Woolsey Fire (Figure 1). The boundary of this investigation is defined by the boundaries of these individual areas as shown on Figures 2 through 9. The vertical extent of COPCs in ash and soil is expected to be limited to surface soil (e.g., no greater than 1 ft below ground surface [bgs]). The project area boundaries are considered preliminary until ash and surface soil sampling results are obtained and the need for additional characterization, if any, is determined.

4.4.2 Temporal Boundaries

As discussed in Section 4.3.2, the investigation is currently planned to be completed during two discrete sampling events. The first phase will likely be conducted in December 2019. The second phase will commence when the debris and ash are removed from each of the project areas. Because the sampling involves the characterization of ash and soil, there are no seasonal aspects that would be expected to affect the sampling.

4.4.3 Sampling Areas

The sampling areas include the nine project areas (Paramount Ranch, Peter Strauss Ranch, Rocky Oaks, Cooper/Brown, Arroyo Sequit, Circle X Ranch[3], Morrison Ranch, Miller Property, and the Dragon Property) shown on Figure 1 and presented in more detail on Figures 2 through 9.

4.5 Develop the Analytic Approach

4.5.1 Decision or Estimation Parameters

Ash Sampling

Up to 16 ash samples will be collected from eight areas and analyzed for metals (including one sample per area (8 samples) that will be analyzed for CrVI), dioxins and furans, PCBs, and asbestos. The maximum detected concentrations identified in each area will conservatively be compared to the action levels as defined and discussed in Section 4.5.2.

Background Sampling

90 background soil samples will be collected from the six specific areas and analyzed for metals, including 20% of samples (3 samples per area) that will be analyzed for CrVI. The background soil samples will be used to calculate background threshold values (BTVs) for metals in soil for use in developing the removal goals. Specifically, the BTVs will be used in evaluating whether metals concentrations observed in ash/surface soil samples are indicative of naturally occurring levels or levels representative of impacts from the Fire.

Post Response Action Soil Sampling

Following the removal of debris and ash, 120 surface soil samples will be collected within original building footprints from the upper six inches and analyzed for metals (including 20% of samples per area that will be analyzed for CrVI), and dioxins and furans. Soil exposure point concentrations (EPC) will be calculated for each of the nine sites (i.e., Paramount Ranch, Peter Strauss Ranch, Rocky Oaks, Cooper Brown, Arroyo Sequit, Circle X Ranch, Morrison Ranch, Miller Property, Dragon Property) and compared to the removal goals. To streamline the post response action soil evaluation, highly conservative estimates of EPC (i.e., maximum detected concentrations) will be used in order to avoid unnecessary computations. Should the maximum detected concentration for a COPC detected at a given site exceed the removal goal, where possible[4], a more reasonable EPC (i.e., the 95% upper confidence limit [UCL] on the mean[5]) will be calculated.

4.5.2 Action Levels

Action levels for materials to be disposed of off-site, including ash and debris, and building materials, will be based on the acceptance criteria of the disposal facility. The ultimate disposal facility may change

[3] The sampling that is planned for this area does not include ash samples since ash was not identified in the area following the Fire. Sampling that is anticipated in this area is not associated with concerns related to releases of COPCs to the environment.
[4] At least eight sampling locations available for the area
[5] For lead, the arithmetic mean concentration will be calculated

during project construction as there are parameters outside of project control that may dictate the ability to dispose of material at a given site (i.e., landfill capacity). To support a determination as to whether ash may be disposed as non-hazardous or hazardous waste, the metals, dioxin and furan (2,3,7,8-tetrachloro dibenzo dioxin [TCDD] only) and total PCB analytical results for the ash samples will be compared to the Total Threshold Limit Concentrations (TTLC, Table 5) which are used for California hazardous waste determination[26]. If a constituent is detected at a concentration greater than 10 times the Soluble Threshold Level Concentration (STLC, 10 times rule)[7] (Table 5), then a Waste Extraction Test (WET) will be performed on exceeding samples, and the extract analyzed for the exceeding constituent. If a constituent is detected at a concentration greater than 20 times the federal Toxicity Characteristic Leachate Procedure (TCLP, 20 times rule) (Table 5), a TCLP analysis will be performed on exceeding samples, and the extract analyzed for exceeding metals. Any sample results which exceed the TCLP criteria will be considered hazardous. In California, the "10 times" rule (for STLC) and the "20 times" rule for TCLP is accepted universally by waste disposal facilities as a tool to compare soil concentrations to and evaluate the need for additional leachability testing. If a soil sample exceeds the 10 times or 20 times rule, the STLC or TCLP tests will be performed on the samples that exceed the rule. Additional information on leaching tests can be found in the California Code of Regulations, Appendix II(c)(1) and (3), Chapter 11, Title 22.

Action levels (i.e., removal goals) to evaluate the post-cleanup confirmation soil sampling will be established based on estimated human health and ecological exposure scenarios and the results of the background soil sampling. The methods, supporting information, and assumptions that will be used to calculate the removal goals will be presented as an attachment to the Time Critical Removal Action Memorandum.

For this SAP, a comparison of the laboratory analytical limits to risk-based screening levels potentially applicable for this project is presented on Table 6.

4.6 Performance or Acceptance Criteria

The purpose of this step is to establish the criteria needed to maximize the ability of the investigation to obtain the data needed to answer the principal investigation questions accurately and with confidence.

4.6.1 Quality Assurance/Quality Control

Quality assurance and quality control checks of field and laboratory data are used to assess data quality and to identify sampling or measurement procedures that need correction. Quality control samples can be used to assess the representativeness of field data and assess the effectiveness of field decontamination processes.

This section of the SAP defines measurement quality objectives (MQOs) for the data assessment parameters: precision, accuracy, sensitivity, completeness, comparability, and representativeness. This section identifies field and laboratory QC samples that will be collected and analyzed. Table 6 presents the acceptance criteria for the data assessment parameters. These acceptance criteria are determined by

[2] California Code of Regulations, Title 22, Chapter 11, Article 3
[7] http://ccelearn.csus.edu/wasteclass/mod6/mod6_06.html

the laboratory based on their internal records of QC sample results for each analytical method. Table 6 also presents a comparison of laboratory method detection limits (MDLs) and reporting limits (RLs). The analytical laboratory is providing industry standard MDLs and RLs that, in most cases are below generic screening levels. Exceptions are the metals antimony and arsenic, mercury, and thallium. However, the metals analysis will be supplemented by a site-specific background metals evaluation to determine naturally occurring metals concentrations. Sections 4.6.3 and 7.2 provide descriptions of procedures used to reconcile analytical data with project data assessment parameters.

Data Quality Parameters

This section presents six data quality parameters: precision, accuracy, sensitivity, completeness, comparability, and representativeness. The quantitative quality criteria/indicators for the project data assessment parameters (precision and accuracy) have been determined for this project and are presented in Table 7, along with the analytical quantitation limits required to meet the project goals (i.e., sensitivity requirements [Table 6]). At project completion, data will be reconciled with stated objectives by the calculation of precision, accuracy, and completeness, as well as statements regarding sensitivity, comparability, and representativeness. These six data quality parameters are described in the following subsections.

Precision

Precision is defined as the degree of agreement between or among independent, similar, or repeated measures. Precision is expressed in terms of sampling and analytical variability. For this investigation, analytical variability will be measured as the relative percent difference (RPD) or coefficient of variation between analytical laboratory duplicates (which will be analyzed for samples in which metals analysis is performed), the matrix spike (MS) and matrix spike duplicate (MSD) analyses (which will be analyzed for all analyte types), and field samples and field duplicates collected from the same location.

Precision will be calculated as the RPD as follows:

$$RPD = \frac{|S - D|}{\frac{(S + D)}{2}} \times 100$$

where:

S = Analyte concentration in a sample or matrix spike
D = Analyte concentration in a sample or matrix spike duplicate

The resultant RPD will be compared to criteria established for each analyte established in Table 6, and deviations from these criteria will be reported. If the established laboratory acceptance criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. If field acceptance criteria are not met, potential implications of this non-conformance will be evaluated and described in the written report.

Accuracy

Accuracy is a measure of the difference between the analytical results for a parameter and the true value of the parameter due to systematic errors. Potential sources of systematic errors include sample collection, physical/chemical instability of samples, interference effects, calibration of the measurement system, and artificial contamination.

Accuracy will be measured as the percent recoveries of the matrix spike (MS) and matrix spike duplicate (MSD), and the laboratory control samples (LCS). In cases where bias is determined from spiked samples, accuracy will be expressed as the percent recovery. The closer these values are to 100, the more accurate the data. Surrogate recovery will be calculated as follows:

$$Recovery = \left(\frac{MC}{SC}\right) \times 100$$

where:

SC = Spiked Concentration
MC = Measured Concentration

Matrix spike percent recovery will be calculated as follows:

$$Recovery = \left(\frac{MC - USC}{SC}\right) \times 100$$

where:

SC = Spiked Concentration
MC = Measured Concentration
USC = Unspiked Concentration

Percent recoveries will be compared to criteria established for each analyte in Table 6. During data review and validation, and deviations from these criteria will be reported. If the objective criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions.

Sensitivity

Analytical methods selected for use in this project should be able to provide useable data for decision-making purposes. For the purposes of this investigation, the analytical methods should provide accurate results that can be used in the human health and ecological risk assessment. Laboratory analytical results will be reported to the MDLs. All detections above the MDL but below the SQL will be reporting as "J" values and the J-qualified concentrations considered in evaluations as detectable levels.

Completeness

Completeness is a measure of the number of valid measurements obtained in relation to the total number of measurements planned. The closer the numbers are, the more complete the measurement process.

Completeness is expressed as the percentage of planned measurements that are valid. A sufficient volume of sample material is collected to complete the required analyses, so that samples represent all possible contaminant situations under investigation, as well as background and control areas. Completeness is influenced by environmental conditions, potential for change with respect to time and location, equipment maintenance, data records, sampling location, sample volume, QC samples, and sample representativeness. Target completeness for this project requires successful collection and generation of valid results for 95% of the samples planned for collection as part of this project.

Comparability

Comparability is a measure of the confidence with which one set of data can be compared to another data set. Comparability is increased by eliminating the number of variables during a sampling and analysis exercise. Variability is reduced by documenting and following standardized field and analytical practices, recognized as industry standards and/or regulations. Standardized field practices (including documentation, decontamination, and other QA/QC procedures) are described below and in the Field Sampling Plan (Section 5). Adherence to these field practices will be maintained throughout the sampling process; adherence will be checked by the field audit process (see Section 7.1.1). Any deviations from field practices based on unexpected field conditions or obstacles will be justified in field documentation.

Laboratory sample processing and analytical procedures will follow SOPs included in this SAP. Analytical data will be reported in the standard units and measurements used for the applicable regulatory threshold against which the sample is being compared. In addition, analytical data will be presented in a standardized, comparable format.

Representativeness

Representativeness is a measure of how accurately a sample result can be reproduced. For this investigation, duplicate samples will be collected to evaluate laboratory analytical methods. For field sample collection, the sampling plan was designed to ensure that they are representative of the sampling areas identified (see Section 5 for further discussion of field methods). The sampling method for ash of two 5-point composite samples per area is adequate enough to determine the chemical nature of the ash for disposal purposes, per communication with the disposal facilities. For post-removal soil samples, one field duplicate sample will be collected for every 20 samples collected, or at least one field duplicate per area. In this way, the amount of field duplicates will be proportional to the samples size of the area, with each area receiving a measure of representativeness. Representativeness may also be affected by sample treatment that occurs after sample collection. Therefore, strict sample chain-of-custody will be employed, post sampling.

Laboratory Quality Assurance/Quality Control

The selected analytical laboratory for this project is Enthalpy Analytical Laboratory ("the Laboratory") located in Orange, California. The laboratory has Standard Operating Procedures (SOPs) that will be followed in the processing and analysis of soil and ash samples collected in this investigation. These SOPs are consistent with the EPA analytical method standards and are included in Appendix A.

A variety of different standard quality control samples will be analyzed in the soil and ash samples, as outlined in the SOPs available in Appendix A. The results from the analysis of the QC samples will be compared to the laboratory QA/QC method requirements outlined in the SOPs. Samples which fall outside the range of acceptable control limits may be subjected to reanalysis, as defined by each method in the laboratory SOPs. The following laboratory QC measurements will be analyzed for this investigation:

- **Surrogate Analysis –** The laboratory will use surrogate compounds, or compounds that are not expected to be found in the sample but exhibit similar characteristics during analytical measurements, to evaluate the accuracy of an analytical measurement.
- **Method Blanks-** Blank samples will be analyzed by the laboratory for the same parameters as the associated field sample to check for laboratory contamination and instrument bias.
- **Laboratory Control Samples-** These samples are blank samples that are spiked with a controlled amount of the target analyte list and the results reveal the performance of the laboratory instruments.
- **Matrix Spikes and Matrix Spike Duplicates-** For these samples, known concentration of analytes are added to aliquots of the field sample. At the end of the entire analytical procedure, the recovery of the added analytes is calculated and expressed as a percent recovery to measure method accuracy.

Field Quality Assurance/Quality Control

Up to two equipment rinsate blank samples will be collected during each sampling event by pouring distilled water over sample collection tools into sampling containers. The equipment rinsate blank sample will be analyzed for the following analyses:

- Title 22 metals using USEPA Method 6010B/7471A, and
- Dioxins and furans using USEPA Method 8920.

Results of these analyses will be used to assess the adequacy of decontamination procedures of sampling equipment in the field and evaluate the potential for cross-contamination between samples.

Field duplicate samples will be collected for post-removal soil samples to evaluate the reproducibility of laboratory analytical data. One field duplicate sample will be collected for every 20 samples collected, or at least one field duplicate per area. Samples will be analyzed for metals, and dioxins and furans.

Decontamination Procedures

All reusable tools that come into contact with sampling media will be decontaminated immediately following the collection of each sample. Tools will be cleared of loose media using a disposable paper towel and cleaned thoroughly with an Alconox or Liquinox spray solution between each sample collection.

Instrument/Equipment Testing, Inspection, and Maintenance

An iPad will be used for a variety of tasks in the field sampling effort to efficiently and accurately collect field data. The iPad application “Metamoji Note” will facilitate collecting daily field notes with the with

photos and detailed diagrams. The daily field notes can then be sent electronically to the project manager or members of the project team. The iPad application "Device Magic" will streamline the sample documentation process by transforming tabular data that can be easily recorded during the sample collection process into a chain of custody (COC) form. The iPad application "Collector" will be used to collect sample location coordinates in the field and update to the Terraphase ArcGIS Online database. This application allows for real-time updating of sample locations as well as other spatial features and will help facilitate the production of figures for subsequent reports. The Collector application will be used in conjunction with the Trimble R1 global positioning system (GPS) unit which enhances the satellite signal of the iPad to provide increased accuracy of field data.

Instrument/Equipment Calibration and Frequency

No field equipment will regular calibration during the course of this investigation.

Inspection/Acceptance of Supplies and Consumables

A list of field supplies and consumables required to complete this investigation, including both field supplies and sampling materials, will be generated prior to mobilizing to the field. The field staff will inspect these materials as well as ensure that all laboratory provided supplies are accounted for before the field work commences.

The table below describes the data quality indicators and corresponding laboratory QC analyses described above.

Table 7 Data Quality Indicators

DQIs	Matrix	Parameter	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC for Field (F), Laboratory (L), or Both (F&L)
Precision	Soil, Ash	All	RPD for spiked analytes within established lab control limits.	MS/MSD pair	L
Accuracy	Soil, Ash	All	Spike recovery for spiked analytes within established lab control limits.	MS, MSD, LCS	L
Accuracy	Soil, Ash	All	Surrogate recovery within established lab control limits	All field samples and laboratory QC samples	L

DQIs	Matrix	Parameter	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC for Field (F), Laboratory (L), or Both (F&L)
Accuracy	Deionized Water	All	No target compounds ≥ the MDL	Equipment rinsate blanks	F
Precision	Soil, Ash	All	LCS/LCSD and MS/MSD <30%	LCS/LCSD, MS,MSD	L
Precision	Soil, Ash	All	RPD <30% (except at <5x MDL, where a difference of <2x MDL is acceptable)	Field duplicate samples	F
Representativeness	Soil, Ash	All	Appropriate sample design and field methods. field duplicate samples	Data validation and usability	F
Completeness	Soil, Ash	All	95% Complete	Number of valid samples compared to field sampling plan	F
Comparability	Soil, Ash	All	Appropriate sample design, field methods, and laboratory analytical methods	Data validation and usability	F & L

4.6.2 Decision Error Limits and Uncertainty Evaluation

For ash sampling data, decisions will be made based on comparisons between the maximum detected concentrations per area and the disposal criteria discussed in Section 4.5.2. For the post-cleanup soil sampling data, decisions will be made through a comparison of chemical-specific EPCs (see Section 4.5.1) and the removal goals.

4.6.3 Data Validation and Usability

After each field sampling event has been implemented and the sample analytical results are received, the data will undergo verification and validation to assess data quality. Environmental data verification and validation ensures that samples collected and methods used in this investigation are supported by the data.

Prior to the analysis of samples, the field staff will ensure that all samples specified in the field sampling plan are collected, accounted for on the chain-of-custody documentation and the at the chain-of-custody indicates the proper laboratory analytical methods.

Terraphase will review the quality assurance procedures and assess the quality of the laboratory analytical data by evaluating the accuracy, precision, and completeness of the data. Data quality will be completed using the USEPA's Contract Laboratory Program National Functional Guidelines for Organic Data Review (National Functional Guidelines) (USEPA 2017) and Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA 2004).

4.7 Plan for Obtaining the Data

In order to address the investigation questions identified in Section 4.2, the following tasks will be completed:

- Up to 16 samples of ash will be collected from eight of the nine project areas. The samples will be analyzed for metals (including one sample per area (8 samples) that will be analyzed for CrVI), PCBs, dioxins and furans, and asbestos.
- Background soil samples will be collected at six of the nine project areas (Figures 2, 3, 4, 5, 7 and 9). 15 samples will be collected from each of the six areas and analyzed for metals (including 20% of samples (3 samples per area) that will be analyzed for CrVI).
- Following the removal of debris and ash from the project areas, surface soil will be sampled. 120 samples will be collected and analyzed for metals (including 20% of samples per area that will be analyzed for CrVI), and dioxins and furans.

5 Field Sampling Plan

This Field Sampling Plan (FSP) documents the field activities, standard operating procedures (SOPs) and other methods involved in collecting field samples.

Field staff members will be deployed for two separate field sampling phases. The first phase of work will involve collecting ash samples from 32 burned structures at the nine project areas. During the first phase of work, 15 background soil samples will also be collected from six of the nine project areas. The first phase of sampling is anticipated to take four days, given the widespread area being characterized, and the limited access of roads to these areas. The second phase of sampling will commence after the building debris and ash has been characterized and the structures have been removed.

Additional details regarding the ash and soil sampling procedures are described in sections below.

5.1 Ash Sampling

Ash samples will be collected from the burned building materials of the structures of the Site detailed on Figure 2 through Figure 9 and Table 1.

5.1.1 Ash Sampling Locations

Ash samples will be collected from within the building footprint of structures shown in Figures 2 through Figure 9 and on Table 1. Samples will be collected from locations where ash is present within the building footprint and field staff will attempt to collect all samples presented on Table 1 within the former building footprints, but will prioritize sample collection in areas where ash is present, since ash may not be present in all areas, as described in Section 4.3.2.

5.1.2 Ash Sampling Protocol

A minimum of two samples will be collected for each project area. Samples will be comprised of a five-point field-composited sample of ash material within an approximate five-foot radius of the sampling location. Samples will be either hand collected or collected with a stainless-steel trowel, placed into a laboratory-supplied glass sample jar and placed on ice.

5.1.3 Ash Sampling Health and Safety

The Health and Safety Plan (HASP) (Appendix B) contains the site-specific health and safety protocols.

5.1.4 Ash Field Measurements

Sampling coordinates will be collected upon the completion of the sample with the ArcGIS Collector application and uploaded to the project database.

5.1.5 Ash Analytical Measurements/Methods

Ash samples will be submitted to the laboratory for the following analyses:

- Metals via USEPA Method 6010B/7471A, including one sample per area (8 samples) that will be analyzed for CrVI via USEPA Method 7196A;
- Dioxins and furans via USEPA Method 8920;
- PCBs via USEPA Method 8082; and,
- Asbestos via USEPA Method 600.

5.2 Background Soil Sampling

Background soil samples will be collected during the first phase of sampling simultaneously with ash sampling. At each of the six specific project areas where background sampling is to be performed (i.e., Paramount Ranch, Peter Strauss Ranch, Rocky Oaks, Arroyo Sequit, Morrison Ranch and the Dragon Property; Figures 2, 3, 4, 5, 7 and 9). 15 soil samples from the upper six inches of soil will be collected.

5.2.1 Background Soil Sampling Locations

Soil samples will be collected from the six project areas where background soil sampling is to be performed. Samples will be collected in the upper six inches of soil (Figures 2 through 9 and Table 1). Samples will be collected from locations within the Site area boundary that are unaffected by fire and debris. Background soil sampling locations will be selected prior to field sampling and with the direction and input of the NPS.

5.2.2 Background Soil Sampling Protocol

A total of 90 discrete background soil samples will be collected, at a frequency of 15 samples at each of the six project areas where background sampling is to be performed. Samples will be collected using a stainless-steel trowel, placed into a glass sample jar and placed on ice. Equipment which comes in contact with soil will be decontaminated between samples.

5.2.3 Background Soil Sampling Health and Safety

The Health and Safety Plan (HASP) (Appendix B) contains the site-specific health and safety protocols.

5.2.4 Background Soil Field Measurements

The background soil sampling locations will be recorded based on the input of the NPS and likely after the initial visit to the nine project areas. The background soil sample locations will be presented in the Time Critical Removal Action Completion Report.

5.2.5 Background Soil Sample Analytical Measurements/Methods

Background soil samples will be submitted to the laboratory for the following analyses:

- Metals by USEPA Method 6010B/7471A, including 20% of samples (3 samples per area) that will be analyzed for CrVI via USEPA Method 7196A

5.3 Post-Removal Soil Sampling

Following the removal of ash and debris, soil samples will be collected. Soil samples will be collected from all nine project areas.

5.3.1 Post-Removal Soil Sampling Locations

Soil samples will be collected from the nine project areas, from the upper six inches of soil. Samples will be collected from within the footprints of former structures detailed in Figure 2 through Figure 9. Field staff will collect samples an evenly spaced range of locations within the building footprint.

5.3.2 Post-Removal Soil Sampling Protocol

Consistent with the methods proposed for sampling of ash, 5-point composite post-removal soil samples with approximately equal volumes for each point, will be collected at a frequency of at least two samples per every former structure up to 400 ft^2. For former structures larger than 800 ft^2, up to 10-point composite samples will be collected. Samples will be collected from the upper six inches of soil beneath the ash and debris that has been removed. Samples will be collected with a stainless-steel trowel, placed into a glass sample jar and placed on ice.

5.3.3 Post-Removal Soil Sampling Health and Safety

The Health and Safety Plan (HASP) (Appendix B) contains the site-specific health and safety protocols.

5.3.4 Post-Removal Soil Field Measurements

Post-removal soil sample locations will be recorded upon the completion of the sampling with the ArcGIS Collector application and uploaded to the project database.

5.3.5 Post-Removal Soil Analytical Measurements/Methods

Post-removal soil samples will be submitted to the laboratory for the following analyses:

- Metals by USEPA Method 6010B/7471A, including 20% of samples per area that will be analyzed for CrVI via USEPA Method 7196A
- Dioxins and Furans by USEPA Method 8920

5.4 Sample Handling

5.4.1 Sample Designation

Sample identification (ID) nomenclature will consist of the following elements:

- Building Code (refer to Table 1)
- Media Sampled
  - A = Ash
  - BS = Background Soil
  - RS = Post-Removal Soil
- Sample Number, indicated by an increasing numeral
- Samples of ash and post-removal soil that are duplicate samples will be denoted with a "D"

For example, sample "PR07-A-01" indicates the first ash sample collected from the Jail Building at Paramount Ranch.

Equipment blank samples will be denoted with "EB" followed by the collection date in the form "DDMMYY".

5.4.2 Sample Labeling

All samples will be labeled at the time of collection. Sample labels will include: the sample ID, date of sample collection, and the time of sample collection.

5.4.3 Sample Handling and Chain of Custody

During sampling activities, the sample IDs, dates of sample collections, sample matrices, and sample preservatives (if applicable) and the analyses requested for the samples on a laboratory-provided COC will be documented. The COC will be used to track the possession of the samples from the point of collection to the analytical laboratory. The laboratory will send a courier to retrieve the samples from the previous day, at which time the field staff will sign and designate the time and date that the samples were retrieved. Samples will be kept preserved on ice from the moment they were collected to when they are received by the laboratory.

5.4.4 Documentation and Records

The primary record of field sampling activities will be recorded on a daily field log. The field log will contain information about the timing activities occurring at the site, making note of weather throughout the day, any events of note which occur, or any personnel which come on site. Notes will be taken on an iPad each day and include photos, sketches and diagrams. Sample location points will be recorded using a GPS unit in the Arc GIS collector application and uploaded to the Terraphase database.

5.5 Investigative-Derived Waste Handling

Paper towels and a limited quantity of rinsate from sampling equipment decontamination will be generated as part of the field sampling. The limited quantity of rinsate generated is assumed to be absorbed by the paper towels and the paper towels will be disposed of as municipal waste. Liquid investigation-derived waste is not anticipated to be disposed of.

5.6 Health and Safety

See the HASP (Appendix B) for the site-specific health and safety procedures.

6 Data Management

The types of data produced in this investigation will consist of field data and laboratory data. Field data will consist primarily of field notes and photos. Field notes and photos will be kept in the possession of Terraphase Engineering servers for the duration of this project. Field data points will be recorded using the ArcGIS collector application and will be stored on Terraphase's ArcGIS online database for the future creation of Figures related to this project. Also, tight integration with GIS and other three or four dimensional data visualization software allows for easy mapping of sample results and visualization of trends or patterns.

Laboratory data will be transmitted by the analytical laboratory in two forms: as a PDF laboratory report and as a Microsoft Excel-formatted electronic data deliverable (EDD). Terraphase utilizes ESdat Data Management Software and EQuIS as our primary analytical database tools. Using these tools, importation of standardized lab EDDs into a centralized and standardized relational database is assisted by various data checking tools that enforce data integrity and perform data verification to ensure consistent and reliable data reporting. In addition to analytical data, ESdat integrates other site data for a more holistic data management approach, making reporting and analysis more efficient. These tools will facilitate the ability to efficiently generate figures and tables that can display the data associated with this investigation in a wide array of representations.

7 Assessment and Oversight

7.1 Assessment and Corrective Actions

The primary field personnel responsible for implementing QA/QC procedures outlined in the SAP will be Senior Staff Geologist Jonathan Marshak. Principal Geologist Darren Croteau and Principal Consultant Kevin Long will provide oversight of these procedures and assist in their successful implementation.

The laboratory project manager for the analytical laboratory (Enthalpy Analytical) will be Patty Mata who will oversee adherence to the QA/QC procedures and requirements of the laboratory analyses.

7.1.1 Field Audit and Response Actions

A field self-audit of the adherence of field procedures described in the SAP will occur during the course of the field investigation. The audit will focus on ensuring the following procedures are being followed:

- The decontamination of field sampling equipment is occurring between every sample collected at the Site,
- Chain of custody record is complete and free of errors before and after handing off to laboratory representative,
- Field notes contain complete record of daily field activities including any notable events that occur on Site.

Any deviations from the field procedures outlined in the SAP will be documented and rationale provided.

7.1.2 Laboratory Audit and Response Actions

The laboratory SOPs included in Appendix A outline the different types of audits and quality assessments that the laboratory will conduct. The laboratory project manager will note any discrepancies in the laboratory QA/QC procedures and record them on the case narrative of the laboratory report. Terraphase will check that data presented in the laboratory report PDF matches data from the EDD during the course of the data validation process. Any discrepancies will be noted to the laboratory project manager and request for reissuance of EDD and laboratory report will be made.

Additionally, for composite samples, the laboratory will homogenize the sample before creating a subsample for analysis.

7.2 Quality Assessment Reporting

7.2.1 Data Verification and Validation

A summary of the findings of the data verification and data validation processes outlined in Section 4.6.3 will be included in the final written Time Critical Removal Action Report.

7.3 Data Usability

Data usability will be determined by the data quality indicators described in Section 4.6.1 and following completion of data validation.

8 Investigation Outputs

Following completion of the investigation activities described in this SAP, receipt of final laboratory analytical data, and completion of Removal Action activities at the nine areas, a Time Critical Removal Action Completion Report will be prepared. The report will describe the sampling activities performed, results of ash and soil samples, presentation of the methodologies and results used to develop the removal goals, comparison of confirmation soil sample results to the removal goals, and conclusions.

The report will also include tabulated data, figures, and photographs of the nine project areas prior to and following removal activities.

9 References

Intergovernmental Data Quality Task Force (IDQTF). 2005. *Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs*. EPA/505/B-04/900A; DoD DTIC ADA 427785.

National Park Service (NPS). 2005. *Final Environmental Impact Statement for a Fire Management Plan, Santa Monica Mountains National Recreation Area,* September.

NPS. 2015. *NPS-Specific CERCLA ARARs and TBCs*. February 3.

NPS. 2016. *Geologic Resources Inventory Report, Santa Monica Mountains National Recreation Area*. National Resource Report NPS/NRSS/GRD/NRR-2016/1297. September.

NPS. 2018. *NPS Protocol for the Selection and Use of Ecological Screening Values for Non-Radiological Analytes*. Revision 3. November.

NPS. 2019. *Statement of Work, Woolsey Fire Time Critical Response Action, Santa Monica National Recreation Area*.

United States Environmental Protection Agency (USEPA). 1992. *Guide to Management of Investigative-Derived Wastes*. Publication: 9345.3-03FS. January.

USEPA. 1996a. *Soil Screening Guidance: Technical Background Document*. Office of Solid Waste and Emergency Response. May.

USEPA. 1996b. *Soil Screening Guidance: User's Guide*. Office of Solid Waste and Emergency Response. July.

USEPA. 2001. *EPA Requirements for Quality Assurance Project Plans*. EPA/240/B-01/003. March.

USEPA. 2002. *Guidance for Quality Assurance Project Plans*. EPA/240/R-02/009. December.

USEPA. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process*. February.

USEPA. 2008. *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites*. EPA/540/R-08/002. April.

USEPA. 2017. *National Functional Guidelines for Organic Superfund Methods Data Review*. EPA-540-R-2017-002. January.

USEPA. 2017. *National Functional Guidelines for Inorganic Superfund Methods Data Review*. EPA-540-R-2017-001. January.

USEPA. 2019. *Regional Screening Levels (RSLs)*. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables. May.

US Geological Survey (USGS). 2002. *Techniques of Water-Resources Investigations of the United States Geological Survey: Statistical Methods in Water Resources*. Book 4, Hydrologic Analysis and Interpretation. September.

USGS. 2008. *Techniques of Water-Resources Investigations: National Field Manual for the Collection of Water-Quality Data*.

Figures

Legend

- Woolsey Fire Site
- Woolsey Fire Boundary
- Santa Monica Mountains National Recreation Area Boundary

0 12,500 25,000 Feet

1 inch = 12,500 feet

N

SAFETY FIRST

terraphase engineering

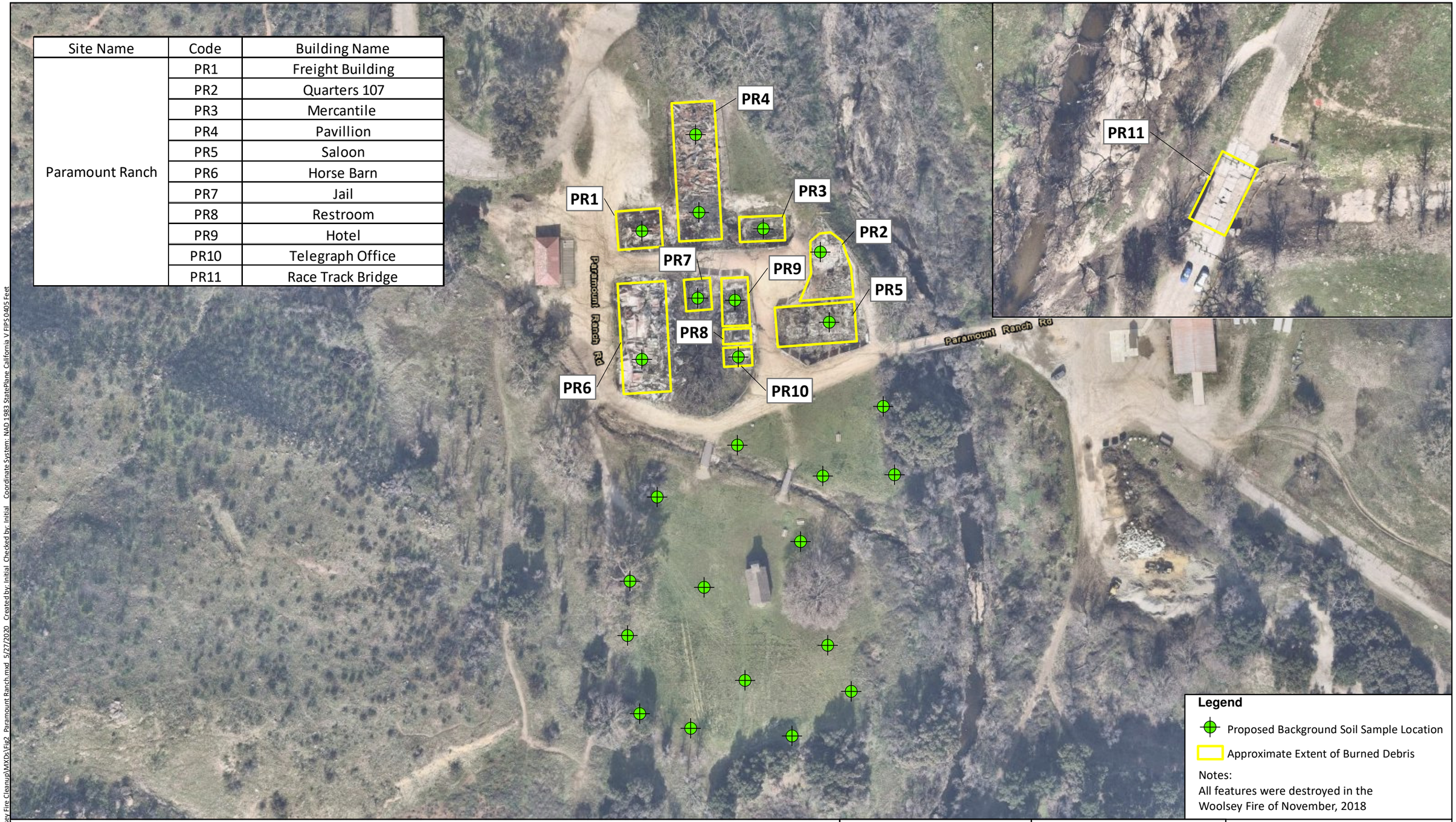
CLIENT:	Lead Builders Inc.
PROJECT:	Woolsey Fire Cleanup
PROJECT NUMBER:	S073.001.001

Woolsey Fire Site Location Map

FIGURE 1

File: K:\GIS\Prj\S073.001 Woolsey Fire Cleanup\MXDs\Fig1_Fire Site Location Map.mxd 10/15/2019 Created by: Initial Checked by: Initial Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Site Name	Code	Building Name
Paramount Ranch	PR1	Freight Building
	PR2	Quarters 107
	PR3	Mercantile
	PR4	Pavillion
	PR5	Saloon
	PR6	Horse Barn
	PR7	Jail
	PR8	Restroom
	PR9	Hotel
	PR10	Telegraph Office
	PR11	Race Track Bridge



Legend

- Proposed Background Soil Sample Location
- Approximate Extent of Burned Debris

Notes:
All features were destroyed in the Woolsey Fire of November, 2018

Imagery Source: February 19, 2019

0 100 200 Feet

1 inch = 100 feet

N

SAFETY FIRST

terraphase engineering

CLIENT:	Lead Builders Inc.
PROJECT:	Woolsey Fire Cleanup
PROJECT NUMBER:	S073.001.001

Paramount Ranch Location Map

FIGURE 2

File: N:\GIS\Prj\S073.001 Woolsey Fire Cleanup\MXDs\Fig2_Paramount Ranch.mxd 5/27/2020 Created by: Initial Checked by: Initial Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Site Name	Code	Building Name
Peter Strauss Ranch	PS1	Peter Strauss Ranch House

Legend

Proposed Background Soil Sample Location

Approximate Extent of Burned Debris

Notes:
All features were destroyed in the Woolsey Fire of November, 2018

Imagery Source: June 12, 2019

0 75 150 Feet

1 inch = 75 feet

N

SAFETY FIRST

terraphase engineering

CLIENT:	Lead Builders Inc.
PROJECT:	Woolsey Fire Cleanup
PROJECT NUMBER:	S073.001.001

Peter Strauss Ranch Location Map

FIGURE 3

File: K:\GIS\Prj\S073.001 Woolsey Fire Cleanup\MXDs\Fig3 Peter Strauss Ranch.mxd 11/14/2019 Created by: Initial Checked by: Initial Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Site Name	Code	Building Name
Rocky Oaks	RO1	Quarters 102
	RO2	Museum Building
	RO3	Vault Restroom
	RO4	Chicken Coup
Cooper Brown	CB1	Cooper Brown House

Legend

Proposed Background Soil Sample Location

Approximate Extent of Burned Debris

Notes:
All features were destroyed in the Woolsey Fire of November, 2018

Imagery Source: February 19, 2019

0 100 200 Feet

1 inch = 100 feet

N

SAFETY FIRST

terraphase engineering

CLIENT: Lead Builders Inc.

PROJECT: Woolsey Fire Cleanup

PROJECT NUMBER: S073.001.001

Rocky Oaks and Cooper Brown House Location Map

FIGURE 4

Site Name	Code	Building Name
Arroyo Sequit	AS1	Quarters 113
	AS2	Survey Office
	AS3	Vault Restroom
	AS4	Pump House

Legend

Proposed Background Soil Sample Location

Approximate Extent of Burned Debris

Notes:
All features were destroyed in the Woolsey Fire of November, 2018

Source Aerial: March 13, 2019

0 100 200 Feet

1 inch = 100 feet

N

SAFETY FIRST

terraphase engineering

CLIENT:	Lead Builders Inc.
PROJECT:	Woolsey Fire Cleanup
PROJECT NUMBER:	S073.001.001

Arroyo Sequit Site Map

FIGURE 5

File: K:\GIS\Prj\S073.001 Woolsey Fire Cleanup\MXDs\Fig5 Arroyo Sequit.mxd 11/14/2019 Created by: Initial Checked by: Initial Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Site Name	Code	Building Name
Circle X Ranch	CX1	Basketball Court
	CX2	Vault Restroom A
	CX3	Vault Restroom B

Legend

Approximate Extent of Burned Debris

Notes:
All features were destroyed in the Woolsey Fire of November, 2018

Source Aerial: June 30, 2019

0 100 200 Feet

1 inch = 100 feet

N

SAFETY FIRST

terraphase engineering

CLIENT: Lead Builders Inc.

PROJECT: Woolsey Fire Cleanup

PROJECT NUMBER: S073.001.001

Circle X Ranch Map

FIGURE 6

File: K:\GIS\Prj\S073.001 Woolsey Fire Cleanup\MXDs\Fig6 Circle X Ranch.mxd 11/14/2019 Created by: Initial Checked by: Initial Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Site Name	Code	Building Name
Morrison Ranch	MR1	Morrison Ranch House
	MR2	Chicken Coup
	MR3	Corral Area

Legend

Proposed Background Soil Sample Location

Approximate Extent of Burned Debris

Notes:
All features were destroyed in the Woolsey Fire of November, 2018

Imagery Source: February 19, 2019

0 50 100 Feet

1 inch = 50 feet

N

SAFETY FIRST

terraphase engineering

CLIENT:	Lead Builders Inc.
PROJECT:	Woolsey Fire Cleanup
PROJECT NUMBER:	S073.001.001

Morrison Ranch Location Map

FIGURE 7

File: K:\GIS\Pri\S073.001 Woolsey Fire Cleanup\MXDs\Fig7 Morrison Ranch.mxd 11/14/2019 Created by: Initial Checked by: Initial Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Site Name	Code	Building Name
Miller Property	MP1	Miller Property

Legend

Approximate Extent of Burned Debris

Notes:
All features were destroyed in the Woolsey Fire of November, 2018

Source Imagery: March 13, 2019

0 50 100 Feet

1 inch = 50 feet

N

SAFETY FIRST

terraphase engineering

CLIENT:	Lead Builders Inc.
PROJECT:	Woolsey Fire Cleanup
PROJECT NUMBER:	S073.001.001

Miller Property Location Map

FIGURE 8

File: K:\GIS\Pr\S073.001 Woolsey Fire Cleanup\MXDs\Fig8_Miller.mxd 11/14/2019 Created by: Initial Checked by: Initial Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Site Name	Code	Building Name
	DP1	Air Stream Trailer
Dragon Property	DP2	Life Estate
	DP3	Pump House

Source Imagery: March 13, 2019

0 50 100 Feet

1 inch = 50 feet

N

SAFETY FIRST

terraphase engineering

CLIENT: Lead Builders Inc.

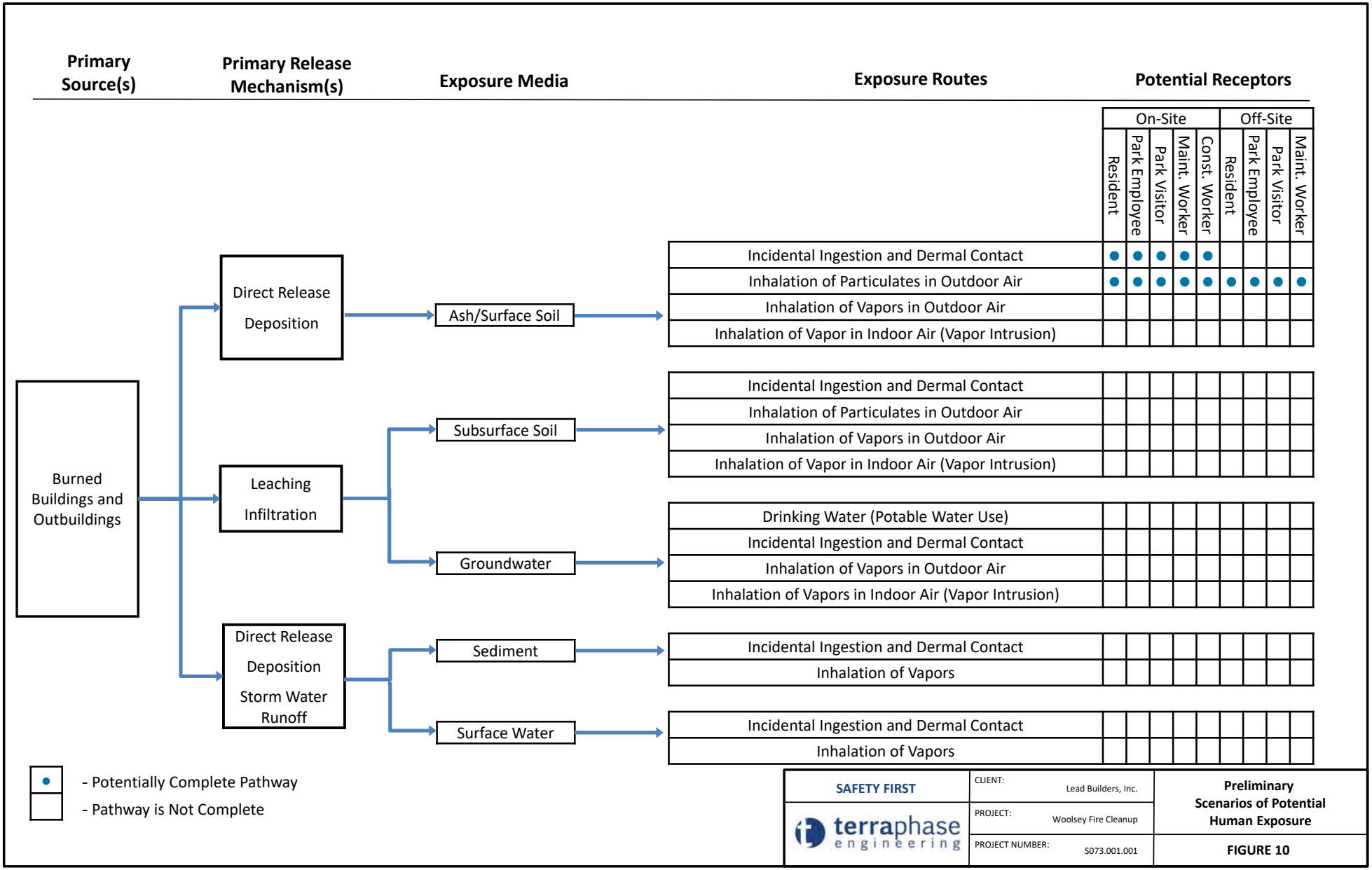
PROJECT: Woolsey Fire Cleanup

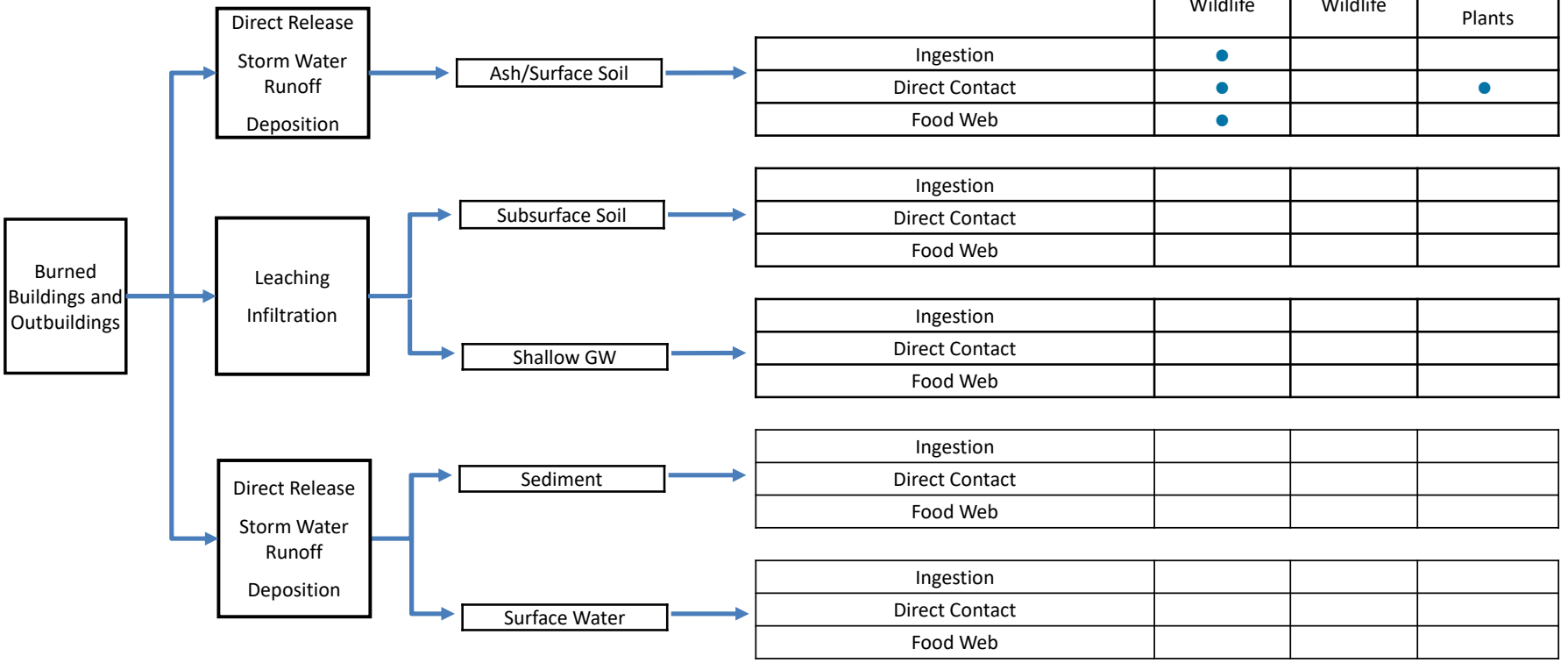
PROJECT NUMBER: S073.001.001

Dragon Site Location Map

FIGURE 9

File: K:\GIS\Prj\S073.001 Woolsey Fire Cleanup\MXDs\Fig9_Dragon.mxd 11/14/2019 Created by: initial Checked by: initial Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet


Primary Source(s)
Primary Release Mechanism(s)
Exposure Media
Exposure Routes
Potential Receptors
On-Site
Off-Site
Resident
Park Employee
Park Visitor
Maint. Worker
Const. Worker
Resident
Park Employee
Park Visitor
Maint. Worker
Burned Buildings and Outbuildings
Direct Release Deposition
Leaching Infiltration
Direct Release Deposition Storm Water Runoff
Ash/Surface Soil
Subsurface Soil
Groundwater
Sediment
Surface Water
Incidental Ingestion and Dermal Contact
Inhalation of Particulates in Outdoor Air
Inhalation of Vapors in Outdoor Air
Inhalation of Vapor in Indoor Air (Vapor Intrusion)
Drinking Water (Potable Water Use)
Inhalation of Vapors
- Potentially Complete Pathway
- Pathway is Not Complete
SAFETY FIRST
terraphase engineering
CLIENT: Lead Builders, Inc.
PROJECT: Woolsey Fire Cleanup
PROJECT NUMBER: S073.001.001
Preliminary Scenarios of Potential Human Exposure
FIGURE 10



- Potentially Complete Pathway
- Pathway is Not Complete

SAFETY FIRST	CLIENT: Lead Builders, Inc.	Preliminary Scenarios of Potential Ecological Exposure
terraphase engineering	PROJECT: Woolsey Fire Cleanup	
	PROJECT NUMBER: S073.001.001	FIGURE 11

Tables

Table 1
Site Area Locations, Structure Descriptions and Sample Analyses
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Site Name	Code[1]	Building Name	Previous Use	Previous Structure Size (ft^2)	Ash Samples[2, 3]	Background Soil Samples[4]	Soil Post Cleanup Soil Samples[5]	NPS Description[6]
Paramount Ranch	PR1	Freight Building	Film Set	3,600	2	15	7	Historic wood and corrugated metal sided building with corrugated metal gable roof
	PR2	Quarters 107	Residence	9,984			17	Non-historic two-story residential building with a movie set façade
	PR3	Mercantile	Film Set	2,584			5	Non-historic two-story movie set
	PR4	Pavilion	Event Space	5,472			10	Historic wooden frame structure with metal gable roof and south end dressed as a movie set façade
	PR5	Saloon	Film Set	1,760			4	Historic two-story movie set with façade on all sides and non-historic interior modifications
	PR6	Horse Barn	Space	6,720			12	Historic wood and corrugated metal sided, roofed structure with non-historic interior conversion to sound stage
	PR7	Jail	Film Set	130			2	Non-historic wooden building with movie set façade and interior jail cell
	PR8	Restroom	Restroom	1,150			3	Non-historic public restroom facilities built behind Hotel movie set façade
	PR9	Hotel	Film Set	2,288			5	Non-historic movie set façade with no actual building
	PR10	Telegraph Office	Film Set	100			2	Non-historic movie set façade with storage building added later
	PR11	Race Track Bridge	Bridge	1,500			0	Historic concrete abutments and non-historic metal bridge at center of historic figure-eight racetrack
Peter Strauss Ranch	PS1	Peter Strauss Ranch House	Lease Event	1,628	2	15	4	One-story wooden country cottage on concrete foundation with wrap-around porch and historic and non-historic renovations
Rocky Oaks	RO1	Quarters 102	Residence	1,876	2	15	4	NPS single-family, one-story housing unit
	RO2	Museum Building	Museum Collections	2,064			4	NPS museum storage and archives facility located in Bally secure modular building
	RO3	Vault Restroom	Restroom	273			1	Non-historic public vault toilet
	RO4	Chicken Coup	Coup	144			2	Plywood three-side building with chain-link fenced enclosure
Cooper Brown	CB1	Cooper Brown House	Dorm and Quarters	6,075	2	-	12	One-story Spanish Mission Revival style residence and outbuildings renovated and converted into research facility
Arroyo Sequit	AS1	Quarters 113	Residence	1,271	2	15	3	Historic ranch house converted into park housing
	AS2	Survey Office	Office	1,225			3	Probably historic wooden frame structure with swinging bay doors and loft used as barn or farm equipment garage
	AS3	Vault Restroom	Restroom	247			1	Non-historic public vault toilet
	AS4	Pump House	Pump House	81			0	Non-historic shed with plumbing fixtures and water pump used to supply water for irrigation
Circle X Ranch	CX1	Basketball Court	Basketball Court	-	0[7]	-	2	Outdoor asphalt paving with non-historic basketball hoops
	CX2	Vault Restroom A	Restroom	135			0	Non-historic public toilet facility associated with group campground
	CX3	Vault Restroom B	Restroom	135			0	Non-historic public toilet facility associated with group campground
Morrison Ranch	MR1	Morrison Ranch House	Historic Exhibit	1,452	2	15	3	One-story wooden ranch house with no foundation
	MR2	Chicken Coup	Coup	289			2	Historic wood frame building
	MR3	Corral Area	-	560			2	Galvanized metal movable tube fencing (non-historic) associated with historic wood loading chute and corral fence segments
Miller Property	MP1	Miller Property	-	1,880	2	-	4	Roofed area covering three recreational vehicles and plywood shed
Dragon Property	DP1	Air Stream Trailer	-	507	2	15	2	Two house trailers
	DP2	Life Estate	-	600			2	Old school bus with miscellaneous debris
	DP3	Pump House	-	875			2	Pump house of uncertain construction

Notes:
ft^2 = square feet
NPS = National Park Service
USEPA = United States Environmental Protection Agency
- = no data available or samples collected
1. Refer to Figure 2-9 for structure locations.
2. The number of ash samples is based on communication with disposal facilities on sampling requirements.
3. Ash samples will be analyzed for Title 22 metals using USEPA Method 6010B/7471A (including one sample per area that will be analyzed for hexavalent chromium using USEPA Method 7196A), dioxins and furans using USEPA Method 8920, PCBs using USEPA Method 8082 and asbestos using USEPA Method 600.
4. Background soil samples will be analyzed for Title 22 metals using USEPA Method 6010B/7471A, including 20% of samples that will be analyzed for hexavalent chromium using 7196A.
5. Post-Cleanup soil samples will be analyzed for Title 22 metals using USEPA Method 6010B/7471A (including 20% of samples per area that will be analyzed for hexavalent chromium using USEPA Method 7196A) and dioxins and furans using USEPA Method 8920
6. Building descriptions provided by the NPS. *Description of buildings and structures destroyed in the 2018 Woolsey Fire, Santa Monica Mountains National Recreation Area.* Revised July 7, 2019.
7. Ash is not present at Circle X Ranch and will not be sampled.

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Agavaceae	Agave americana ssp. americana	Nonnative
Agavaceae	Hesperoyucca whipplei	Native
Agavaceae	Nolina cismontana	Native
Agavaceae	Yucca schidigera	Native
Aizoaceae	Aptenia cordifolia	Nonnative
Aizoaceae	Carpobrotus chilensis	Nonnative
Aizoaceae	Carpobrotus edulis	Nonnative
Aizoaceae	Galenia pubescens	Nonnative
Aizoaceae	Malephora crocea	Nonnative
Aizoaceae	Mesembryanthemum crystallinum	Nonnative
Aizoaceae	Mesembryanthemum nodiflorum	Nonnative
Aizoaceae	Tetragonia tetragonioides	Nonnative
Alismataceae	Alisma triviale	Native
Alismataceae	Echinodorus berteroi	Native
Amaranthaceae	Amaranthus albus	Nonnative
Amaranthaceae	Amaranthus blitoides	Native
Amaranthaceae	Amaranthus californicus	Native
Amaranthaceae	Amaranthus deflexus	Nonnative
Amaranthaceae	Amaranthus powellii	Native
Amaranthaceae	Amaranthus retroflexus	Nonnative
Anacardiaceae	Malosma laurina	Native
Anacardiaceae	Rhus aromatica	Native
Anacardiaceae	Rhus integrifolia	Native
Anacardiaceae	Rhus ovata	Native
Anacardiaceae	Schinus molle	Nonnative
Anacardiaceae	Schinus terebinthifolius	Nonnative
Anacardiaceae	Toxicodendron diversilobum	Native
Apiaceae	Angelica tomentosa	Native
Apiaceae	Anthriscus caucalis	Nonnative
Apiaceae	Apiastrum angustifolium	Native
Apiaceae	Apium graveolens	Nonnative
Apiaceae	Berula erecta	Native
Apiaceae	Bowlesia incana	Native
Apiaceae	Conium maculatum	Nonnative
Apiaceae	Cyclospermum leptophyllum	Nonnative
Apiaceae	Daucus carota	Nonnative
Apiaceae	Daucus pusillus	Native
Apiaceae	Foeniculum vulgare	Nonnative
Apiaceae	Hydrocotyle moschata	Nonnative
Apiaceae	Hydrocotyle ranunculoides	Native
Apiaceae	Hydrocotyle umbellata	Native
Apiaceae	Hydrocotyle verticillata	Native
Apiaceae	Lomatium dasycarpum ssp. dasycarpum	Native
Apiaceae	Lomatium lucidum	Native
Apiaceae	Lomatium utriculatum	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Apiaceae	Osmorhiza brachypoda	Native
Apiaceae	Sanicula arguta	Native
Apiaceae	Sanicula bipinnata	Native
Apiaceae	Sanicula crassicaulis	Native
Apiaceae	Sanicula tuberosa	Native
Apiaceae	Scandix pecten-veneris	Nonnative
Apiaceae	Tauschia arguta	Native
Apiaceae	Tauschia hartwegii	Native
Apiaceae	Torilis arvensis	Nonnative
Apiaceae	Torilis nodosa	Nonnative
Apiaceae	Yabea microcarpa	Native
Apocynaceae	Apocynum cannabinum	Native
Apocynaceae	Araujia sericifera	Nonnative
Apocynaceae	Asclepias californica	Native
Apocynaceae	Asclepias eriocarpa	Native
Apocynaceae	Asclepias fascicularis	Native
Apocynaceae	Nerium oleander	Nonnative
Apocynaceae	Vinca major	Nonnative
Araliaceae	Hedera helix	Nonnative
Arecaceae	Phoenix canariensis	Nonnative
Arecaceae	Washingtonia filifera	Nonnative
Arecaceae	Washingtonia robusta	Nonnative
Asclepiadaceae	Funastrum cynanchoides var. hartwegii	Native
Asphodelaceae	Asphodelus fistulosus	Nonnative
Aspleniaceae	Asplenium vespertinum	Native
Asteraceae	Achillea millefolium	Native
Asteraceae	Achyrachaena mollis	Native
Asteraceae	Acourtia microcephala	Native
Asteraceae	Acroptilon repens	Nonnative
Asteraceae	Ageratina adenophora	Nonnative
Asteraceae	Agoseris grandiflora var. grandiflora	Native
Asteraceae	Agoseris heterophylla var. heterophylla	Native
Asteraceae	Amblyopappus pusillus	Native
Asteraceae	Ambrosia acanthicarpa	Native
Asteraceae	Ambrosia artemisiifolia	Nonnative
Asteraceae	Ambrosia chamissonis	Native
Asteraceae	Ambrosia confertiflora	Native
Asteraceae	Ambrosia psilostachya	Native
Asteraceae	Anaphalis margaritacea	Native
Asteraceae	Ancistrocarphus filagineus	Native
Asteraceae	Anthemis cotula	Nonnative
Asteraceae	Artemisia biennis	Nonnative
Asteraceae	Artemisia californica	Native
Asteraceae	Artemisia douglasiana	Native
Asteraceae	Artemisia dracunculus	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Asteraceae	Artemisia tridentata ssp. parishii	Native
Asteraceae	Baccharis glutinosa	Native
Asteraceae	Baccharis malibuensis	Native
Asteraceae	Baccharis pilularis var. consanguinea	Native
Asteraceae	Baccharis plummerae ssp. plummerae	Native
Asteraceae	Baccharis salicifolia	Native
Asteraceae	Baccharis sergiloides	Native
Asteraceae	Bahiopsis laciniata	Native
Asteraceae	Baileya multiradiata	Native
Asteraceae	Bellis perennis	Nonnative
Asteraceae	Bidens frondosa	Native
Asteraceae	Bidens laevis	Native
Asteraceae	Bidens pilosa	Nonnative
Asteraceae	Brickellia californica	Native
Asteraceae	Brickellia nevinii	Native
Asteraceae	Carduus pycnocephalus	Nonnative
Asteraceae	Carduus tenuiflorus	Nonnative
Asteraceae	Carthamus lanatus	Nonnative
Asteraceae	Centaurea calcitrapa	Nonnative
Asteraceae	Centaurea melitensis	Nonnative
Asteraceae	Centaurea solstitialis	Nonnative
Asteraceae	Centromadia pungens	Native
Asteraceae	Centromadia pungens ssp. laevis	Native
Asteraceae	Centromadia pungens ssp. pungens	Native
Asteraceae	Chaenactis artemisiifolia	Native
Asteraceae	Chaenactis glabriuscula	Native
Asteraceae	Chaenactis glabriuscula var. glabriuscula	Native
Asteraceae	Chaenactis glabriuscula var. lanosa	Native
Asteraceae	Chondrilla juncea	Nonnative
Asteraceae	Chrysothamnus nauseosus ssp. mohavensis	Native
Asteraceae	Cichorium intybus	Nonnative
Asteraceae	Cirsium occidentale	Native
Asteraceae	Cirsium occidentale var. californicum	Native
Asteraceae	Cirsium occidentale var. occidentale	Native
Asteraceae	Cirsium vulgare	Nonnative
Asteraceae	Cnicus benedictus	Nonnative
Asteraceae	Corethrogyne filaginifolia	Native
Asteraceae	Cotula australis	Nonnative
Asteraceae	Cotula coronopifolia	Nonnative
Asteraceae	Crepis capillaris	Nonnative
Asteraceae	Cynara cardunculus	Nonnative
Asteraceae	Cynara scolymus	Nonnative
Asteraceae	Deinandra fasciculata	Native
Asteraceae	Deinandra minthornii	Native
Asteraceae	Deinandra sp.	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Asteraceae	Delairea odorata	Nonnative
Asteraceae	Dimorphotheca sinuata	Nonnative
Asteraceae	Eclipta prostrata	Native
Asteraceae	Encelia californica	Native
Asteraceae	Encelia farinosa	Native
Asteraceae	Erechtites minima	Nonnative
Asteraceae	Ericameria arborescens	Native
Asteraceae	Ericameria ericoides	Native
Asteraceae	Ericameria linearifolia	Native
Asteraceae	Ericameria palmeri var. pachylepis	Native
Asteraceae	Ericameria parishii var. parishii	Native
Asteraceae	Ericameria pinifolia	Native
Asteraceae	Erigeron bonariensis	Nonnative
Asteraceae	Erigeron canadensis	Native
Asteraceae	Erigeron foliosus var. foliosus	Native
Asteraceae	Eriophyllum confertiflorum var. confertiflorum	Native
Asteraceae	Eriophyllum multicaule	Native
Asteraceae	Euthamia occidentalis	Native
Asteraceae	Galinsoga parviflora var. parviflora	Nonnative
Asteraceae	Gazania linearis	Nonnative
Asteraceae	Glebionis coronarium	Nonnative
Asteraceae	Gnaphalium palustre	Native
Asteraceae	Grindelia camporum	Native
Asteraceae	Grindelia hirsutula	Native
Asteraceae	Gutierrezia divergence	Native
Asteraceae	Gutierrezia sarothrae	Native
Asteraceae	Hazardia squarrosa var. grindelioides	Native
Asteraceae	Hedypnois cretica	Nonnative
Asteraceae	Helenium puberulum	Native
Asteraceae	Helianthus annuus	Native
Asteraceae	Helianthus californicus	Native
Asteraceae	Helianthus gracilentus	Native
Asteraceae	Heliomeris hispida	Nonnative
Asteraceae	Helminthotheca echioides	Nonnative
Asteraceae	Hemizonia congesta	Native
Asteraceae	Hemizonia congesta ssp. congesta	Native
Asteraceae	Hemizonia congesta ssp. luzulifolia	Native
Asteraceae	Heterotheca grandiflora	Native
Asteraceae	Heterotheca sessiliflora	Native
Asteraceae	Heterotheca sessiliflora ssp. echioides	Native
Asteraceae	Heterotheca sessiliflora ssp. fastigiata	Native
Asteraceae	Heterotheca sessiliflora ssp. sessiflora	Native
Asteraceae	Heterotheca villosa	Native
Asteraceae	Hieracium argutum	Native
Asteraceae	Hypochaeris glabra	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Asteraceae	Hypochaeris radicata	Nonnative
Asteraceae	Isocoma menziesii	Native
Asteraceae	Isocoma menziesii var. menziesii	Native
Asteraceae	Isocoma menziesii var. sedoides	Native
Asteraceae	Isocoma menziesii var. vernonioides	Native
Asteraceae	Iva axillaris ssp. robustior	Native
Asteraceae	Jaumea carnosa	Native
Asteraceae	Lactuca serriola	Nonnative
Asteraceae	Lactuca virosa	Nonnative
Asteraceae	Laennecia coulteri	Native
Asteraceae	Lagophylla ramosissima ssp. ramosissima	Native
Asteraceae	Lasthenia californica	Native
Asteraceae	Lasthenia coronaria	Native
Asteraceae	Lasthenia glabrata ssp. coulteri	Native
Asteraceae	Lasthenia gracilis	Native
Asteraceae	Layia hieraciodes	Native
Asteraceae	Layia platyglossa	Native
Asteraceae	Lepidospartum squamatum	Native
Asteraceae	Leptosyne bigelovii	Native
Asteraceae	Leptosyne californica	Native
Asteraceae	Leptosyne calliopsidea	Native
Asteraceae	Leptosyne gigantea	Native
Asteraceae	Lessingia glandulifera	Native
Asteraceae	Logfia filaginoides	Native
Asteraceae	Logfia gallica	Nonnative
Asteraceae	Madia elegans	Native
Asteraceae	Madia elegans ssp. densiflora	Native
Asteraceae	Madia elegans ssp. elegans	Native
Asteraceae	Madia exigua	Native
Asteraceae	Madia gracilis	Native
Asteraceae	Madia sativa	Native
Asteraceae	Malacothrix clevelandii	Native
Asteraceae	Malacothrix coulteri	Native
Asteraceae	Malacothrix saxatilis var. tenuifolia	Native
Asteraceae	Matricaria matricarioides	Nonnative
Asteraceae	Micropus californicus var. californicus	Native
Asteraceae	Microseris douglasii	Native
Asteraceae	Microseris douglasii ssp. douglasii	Native
Asteraceae	Microseris douglasii ssp. platycarpha	Native
Asteraceae	Microseris douglasii ssp. tenella	Native
Asteraceae	Microseris elegans	Native
Asteraceae	Microseris sp.	Native
Asteraceae	Monolopia lanceolata	Native
Asteraceae	Osteospermum ecklonis	Nonnative
Asteraceae	Osteospermum fructicosum	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Asteraceae	Packera breweri	Native
Asteraceae	Pentachaeta lyonii	Native
Asteraceae	Perityle emoryi	Native
Asteraceae	Pluchea odorata	Native
Asteraceae	Pseudognaphalium beneolens	Native
Asteraceae	Pseudognaphalium bioletti	Native
Asteraceae	Pseudognaphalium californicum	Native
Asteraceae	Pseudognaphalium canescens	Native
Asteraceae	Pseudognaphalium leucocephalum	Native
Asteraceae	Pseudognaphalium luteoalbum	Nonnative
Asteraceae	Pseudognaphalium microcephalum	Native
Asteraceae	Pseudognaphalium ramosissimum	Native
Asteraceae	Pseudognaphalium stramineum	Native
Asteraceae	Psilocarphus brevissimus var. brevissimus	Native
Asteraceae	Psilocarphus tenellus var. tenellus	Native
Asteraceae	Rafinesquia californica	Native
Asteraceae	Senecio aphanactis	Native
Asteraceae	Senecio flaccidus var. douglasii	Native
Asteraceae	Senecio quadridentatus	Nonnative
Asteraceae	Senecio vulgaris	Nonnative
Asteraceae	Silybum marianum	Nonnative
Asteraceae	Solidago californica	Native
Asteraceae	Solidago confinis	Native
Asteraceae	Solidago gigantea	Native
Asteraceae	Solidago sp.	Native
Asteraceae	Soliva sessilis	Nonnative
Asteraceae	Sonchus asper ssp. asper	Nonnative
Asteraceae	Sonchus oleraceus	Nonnative
Asteraceae	Sonchus sp.	Nonnative
Asteraceae	Stebbinsoseris heterocarpa	Native
Asteraceae	Stephanomeria cichoriacea	Native
Asteraceae	Stephanomeria diegensis	Native
Asteraceae	Stephanomeria exigua ssp. coronaria	Native
Asteraceae	Stephanomeria sp.	Native
Asteraceae	Stephanomeria virgata ssp. virgata	Native
Asteraceae	Stylocline gnaphaloides	Native
Asteraceae	Symphyotrichum lanceolatum var. hesperium	Native
Asteraceae	Symphyotrichum subulatum	Native
Asteraceae	Symphyotrichum subulatum var. parviflorum	Native
Asteraceae	Tanacetum parthenium	Nonnative
Asteraceae	Taraxacum officinale	Nonnative
Asteraceae	Tetradymia comosa	Native
Asteraceae	Tragopogon porrifolius	Nonnative
Asteraceae	Uropappus lindleyi	Native
Asteraceae	Urospermum picroides	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Asteraceae	Venegasia carpesioides	Native
Asteraceae	Verbesina encelioides ssp. exauriculata	Nonnative
Asteraceae	Xanthium spinosum	Native
Asteraceae	Xanthium strumarium	Native
Azollaceae	Azolla filiculoides	Native
Bataceae	Batis maritima	Native
Berberidaceae	Berberis nevinii	Native
Berberidaceae	Berberis pinnata ssp. pinnata	Native
Betulaceae	Alnus rhombifolia	Native
Bignoniaceae	Catalpa sp.	Nonnative
Blechnaceae	Woodwardia fimbriata	Native
Boraginaceae	Amsinckia intermedia	Native
Boraginaceae	Amsinckia menziesii	Native
Boraginaceae	Cryptantha clevelandii	Native
Boraginaceae	Cryptantha intermedia	Native
Boraginaceae	Cryptantha micromeres	Native
Boraginaceae	Cryptantha microstachys	Native
Boraginaceae	Cryptantha muricata	Native
Boraginaceae	Cryptantha sp.	Native
Boraginaceae	Heliotropium curassavicum	Native
Boraginaceae	Pectocarya linearis ssp. ferocula	Native
Boraginaceae	Pectocarya penicillata	Native
Boraginaceae	Plagiobothrys acanthocarpus	Native
Boraginaceae	Plagiobothrys canescens	Native
Boraginaceae	Plagiobothrys collinus	Native
Boraginaceae	Plagiobothrys collinus var. californicus	Native
Boraginaceae	Plagiobothrys collinus var. fulvescens	Native
Boraginaceae	Plagiobothrys collinus var. gracilis	Native
Boraginaceae	Plagiobothrys nothofulvus	Native
Boraginaceae	Plagiobothrys sp.	Native
Boraginaceae	Plagiobothrys tenellus	Native
Brassicaceae	Athysanus pusillus	Native
Brassicaceae	Barbarea orthoceras	Native
Brassicaceae	Boechera sparsifolia	Native
Brassicaceae	Brassica napus	Nonnative
Brassicaceae	Brassica nigra	Nonnative
Brassicaceae	Brassica rapa	Nonnative
Brassicaceae	Brassica tournefortii	Nonnative
Brassicaceae	Cakile edentula	Nonnative
Brassicaceae	Cakile maritima	Nonnative
Brassicaceae	Camelina microcarpa	Nonnative
Brassicaceae	Capsella bursa-pastoris	Nonnative
Brassicaceae	Cardamine californica var. californica	Native
Brassicaceae	Cardamine oligosperma	Nonnative
Brassicaceae	Caulanthus heterophyllus	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Brassicaceae	Caulanthus heterophyllus var. heterophyllus	Native
Brassicaceae	Caulanthus heterophyllus var. pseudosimulans	Native
Brassicaceae	Caulanthus lasiophyllus	Native
Brassicaceae	Descurainia pinnata	Native
Brassicaceae	Descurainia pinnata ssp. halictorum	Native
Brassicaceae	Descurainia pinnata ssp. menziesii	Native
Brassicaceae	Descurainia sophia	Nonnative
Brassicaceae	Diplotaxis tenuifolia	Nonnative
Brassicaceae	Descurainia pinnata ssp. brachycarpa	Native
Brassicaceae	Dithyrea maritima	Native
Brassicaceae	Draba cuneifolia var. integrifolia	Native
Brassicaceae	Erysimum capitatum var. capitatum	Native
Brassicaceae	Erysimum insulare ssp. suffrutescens	Native
Brassicaceae	Hirschfeldia incana	Nonnative
Brassicaceae	Lepidium didymum	Nonnative
Brassicaceae	Lepidium draba	Nonnative
Brassicaceae	Lepidium lasiocarpum var. lasiocarpum	Native
Brassicaceae	Lepidium latifolium	Nonnative
Brassicaceae	Lepidium latipes var. latipes	Native
Brassicaceae	Lepidium nitidum var. nitidum	Native
Brassicaceae	Lepidium oblongum var. oblongum	Nonnative
Brassicaceae	Lepidium perfoliatum	Nonnative
Brassicaceae	Lepidium strictum	Native
Brassicaceae	Lepidium virginicum var. pubescens	Native
Brassicaceae	Lobularia maritima	Nonnative
Brassicaceae	Nasturtium officinale	Nonnative
Brassicaceae	Raphanus raphanistrum	Nonnative
Brassicaceae	Raphanus sativus	Nonnative
Brassicaceae	Rorippa curvisiliqua	Native
Brassicaceae	Sinapis arvensis	Nonnative
Brassicaceae	Sisymbrium altissimum	Nonnative
Brassicaceae	Sisymbrium irio	Nonnative
Brassicaceae	Sisymbrium officinale	Nonnative
Brassicaceae	Sisymbrium orientale	Nonnative
Brassicaceae	Stanleya pinnata var. pinnata	Native
Brassicaceae	Thysanocarpus conchuliferus	Native
Brassicaceae	Thysanocarpus curvipes	Native
Brassicaceae	Thysanocarpus laciniatus	Native
Brassicaceae	Thysanocarpus sp.	Native
Brassicaceae	Tropidocarpum gracile	Native
Brassicaceae	Turritis glabra	Native
Buddlejaceae	Buddleja saligna	Nonnative
Cactaceae	Cylindropuntia prolifera	Native
Cactaceae	Opuntia basilaris var. basilaris	Native
Cactaceae	Opuntia ficus-indica	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Cactaceae	Opuntia littoralis	Native
Cactaceae	Opuntia oricola	Native
Cactaceae	Opuntia phaeacantha	Native
Cactaceae	Opuntia X occidentalis	Native
Callitrichaceae	Callitriche marginata	Native
Campanulaceae	Githopsis diffusa ssp. diffusa	Native
Campanulaceae	Heterocodon rariflorum	Native
Campanulaceae	Lobelia dunnii var. serrata	Native
Campanulaceae	Nemacladus ramosissimus	Native
Campanulaceae	Triodanis biflora	Native
Cannabaceae	Cannabis sativa	Nonnative
Capparaceae	Peritoma arborea var. arborea	Native
Caprifoliaceae	Lonicera hispidula	Native
Caprifoliaceae	Lonicera subspicata var. denudata	Native
Caprifoliaceae	Sambucus nigra ssp. cerulea	Native
Caprifoliaceae	Symphoricarpos mollis	Native
Caryophyllaceae	Cardionema ramosissimum	Native
Caryophyllaceae	Cerastium glomeratum	Nonnative
Caryophyllaceae	Gypsophila elegans	Nonnative
Caryophyllaceae	Herniaria hirsuta ssp. cinerea	Nonnative
Caryophyllaceae	Loeflingia squarrosa	Native
Caryophyllaceae	Minuartia douglasii	Native
Caryophyllaceae	Petrorhagia dubia	Nonnative
Caryophyllaceae	Polycarpon depressum	Native
Caryophyllaceae	Polycarpon tetraphyllum ssp. tetraphyllum	Nonnative
Caryophyllaceae	Sagina decumbens ssp. occidentalis	Native
Caryophyllaceae	Silene antirrhina	Native
Caryophyllaceae	Silene coniflora	Native
Caryophyllaceae	Silene gallica	Nonnative
Caryophyllaceae	Silene laciniata ssp. major	Native
Caryophyllaceae	Silene sp.	Unknown
Caryophyllaceae	Silene verecunda ssp. platyota	Native
Caryophyllaceae	Spergula arvensis	Nonnative
Caryophyllaceae	Spergularia bocconei	Native
Caryophyllaceae	Spergularia macrotheca	Native
Caryophyllaceae	Spergularia macrotheca var. leucantha	Native
Caryophyllaceae	Spergularia macrotheca var. macrotheca	Native
Caryophyllaceae	Spergularia marina	Native
Caryophyllaceae	Spergularia villosa	Nonnative
Caryophyllaceae	Stellaria media	Nonnative
Caryophyllaceae	Stellaria nitens	Native
Chenopodiaceae	Aphanisma blitoides	Native
Chenopodiaceae	Arthrocnemum subterminale	Native
Chenopodiaceae	Atriplex amnicola	Nonnative
Chenopodiaceae	Atriplex canescens	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Chenopodiaceae	Atriplex canescens var. canescens	Native
Chenopodiaceae	Atriplex canescens var. linearis	Native
Chenopodiaceae	Atriplex coulteri	Native
Chenopodiaceae	Atriplex dioica	Native
Chenopodiaceae	Atriplex lentiformis	Native
Chenopodiaceae	Atriplex leucophylla	Native
Chenopodiaceae	Atriplex polycarpa	Native
Chenopodiaceae	Atriplex prostrata	Nonnative
Chenopodiaceae	Atriplex rosea	Nonnative
Chenopodiaceae	Atriplex semibaccata	Nonnative
Chenopodiaceae	Atriplex serenana	Native
Chenopodiaceae	Atriplex suberecta	Nonnative
Chenopodiaceae	Atriplex watsonii	Native
Chenopodiaceae	Bassia hyssopifolia	Nonnative
Chenopodiaceae	Beta vulgaris ssp. maritima	Nonnative
Chenopodiaceae	Chenopodium album	Nonnative
Chenopodiaceae	Chenopodium berlandieri	Native
Chenopodiaceae	Chenopodium californicum	Native
Chenopodiaceae	Chenopodium macrospermum	Nonnative
Chenopodiaceae	Chenopodium murale	Nonnative
Chenopodiaceae	Chenopodium rubrum	Native
Chenopodiaceae	Chenopodium strictum var. glaucophyllum	Nonnative
Chenopodiaceae	Dysphania ambrosioides	Nonnative
Chenopodiaceae	Dysphania multifida	Nonnative
Chenopodiaceae	Dysphania pumilio	Nonnative
Chenopodiaceae	Extriplex californica	Native
Chenopodiaceae	Kochia scoparia	Nonnative
Chenopodiaceae	Salicornia bigelovii	Native
Chenopodiaceae	Salicornia maritima	Native
Chenopodiaceae	Salicornia pacifica	Native
Chenopodiaceae	Salsola australis	Nonnative
Chenopodiaceae	Salsola sp.	Nonnative
Chenopodiaceae	Suaeda calceoliformis	Native
Chenopodiaceae	Suaeda esteroa	Native
Chenopodiaceae	Suaeda nigra	Native
Chenopodiaceae	Suaeda taxifolia	Native
Cistaceae	Cistus sp.	Nonnative
Cistaceae	Helianthemum scoparium	Native
Cistaceae	Cistus ladanifer	Nonnative
Convolvulaceae	Calystegia collina ssp. venusta	Native
Convolvulaceae	Calystegia macrostegia	Native
Convolvulaceae	Calystegia macrostegia ssp. cyclostegia	Native
Convolvulaceae	Calystegia macrostegia ssp. intermedia	Native
Convolvulaceae	Calystegia macrostegia ssp. macrostegia	Native
Convolvulaceae	Calystegia purpurata ssp. purpurata	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Convolvulaceae	Calystegia soldanella	Native
Convolvulaceae	Convolvulus arvensis	Nonnative
Convolvulaceae	Convolvulus simulans	Native
Convolvulaceae	Cressa truxillensis	Native
Convolvulaceae	Cuscuta californica	Native
Convolvulaceae	Cuscuta californica var. breviflora	Native
Convolvulaceae	Cuscuta californica var. papillosa	Native
Convolvulaceae	Cuscuta pentagona	Native
Convolvulaceae	Cuscuta salina var. major	Native
Convolvulaceae	Cuscuta sp.	Native
Convolvulaceae	Cuscuta subinclusa	Native
Convolvulaceae	Dichondra occidentalis	Native
Convolvulaceae	Ipomoea purpurea	Nonnative
Cornaceae	Cornus glabrata	Native
Crassulaceae	Aeonium arboreum	Native
Crassulaceae	Crassula connata	Native
Crassulaceae	Dudleya blochmaniae ssp. blochmaniae	Native
Crassulaceae	Dudleya caespitosa	Native
Crassulaceae	Dudleya cymosa	Native
Crassulaceae	Dudleya cymosa ssp. agourensis	Native
Crassulaceae	Dudleya cymosa ssp. marcescens	Native
Crassulaceae	Dudleya cymosa ssp. ovatifolia	Native
Crassulaceae	Dudleya lanceolata	Native
Crassulaceae	Dudleya multicaulis	Native
Crassulaceae	Dudleya palmeri	Native
Crassulaceae	Dudleya parva	Native
Crassulaceae	Dudleya pulverulenta ssp. pulverulenta	Native
Crassulaceae	Dudleya verityi	Native
Crassulaceae	Sedum spathulifolium	Native
Cucurbitaceae	Cucurbita foetidissima	Native
Cucurbitaceae	Marah fabaceus	Native
Cucurbitaceae	Marah macrocarpus var. macrocarpus	Native
Cupressaceae	Calocedrus decurrens	Nonnative
Cupressaceae	Calocedrus sp.	Nonnative
Cupressaceae	Juniperus californica	Native
Cyperaceae	Bolboschoenus maritimus ssp. paludosus	Native
Cyperaceae	Carex barbarae	Native
Cyperaceae	Carex globosa	Native
Cyperaceae	Carex multicostata	Native
Cyperaceae	Carex praegracilis	Native
Cyperaceae	Carex senta	Native
Cyperaceae	Carex spissa	Native
Cyperaceae	Carex triquetra	Native
Cyperaceae	Cyperus acuminatus	Native
Cyperaceae	Cyperus difformis	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Cyperaceae	Cyperus eragrostis	Native
Cyperaceae	Cyperus erythrorhizos	Native
Cyperaceae	Cyperus esculentus	Native
Cyperaceae	Cyperus involucratus	Nonnative
Cyperaceae	Cyperus niger	Native
Cyperaceae	Cyperus odoratus	Native
Cyperaceae	Cyperus rotundus	Nonnative
Cyperaceae	Eleocharis macrostachya	Native
Cyperaceae	Eleocharis montevidensis	Native
Cyperaceae	Eleocharis parishii	Native
Cyperaceae	Eleocharis radicans	Native
Cyperaceae	Eleocharis rostellata	Native
Cyperaceae	Isolepis cernua	Native
Cyperaceae	Schoenoplectus acutus var. occidentalis	Native
Cyperaceae	Schoenoplectus californicus	Native
Cyperaceae	Scirpus americanus	Native
Cyperaceae	Scirpus californicus	Native
Cyperaceae	Scirpus maritimus	Native
Cyperaceae	Scirpus microcarpus	Native
Cyperaceae	Scirpus pungens	Native
Cyperaceae	Scirpus robustus	Native
Datiscaceae	Datisca glomerata	Native
Dennstaedtiaceae	Pteridium aquilinum var. pubescens	Native
Dryopteridaceae	Dryopteris arguta	Native
Elatinaceae	Elatine californica	Native
Equisetaceae	Equisetum arvense	Native
Equisetaceae	Equisetum hyemale ssp. affine	Native
Equisetaceae	Equisetum laevigatum	Native
Equisetaceae	Equisetum telmateia ssp. braunii	Native
Equisetaceae	Equisetum X ferrissii	Native
Ericaceae	Arbutus menziesii	Nonnative
Ericaceae	Arctostaphylos glandulosa	Native
Ericaceae	Arctostaphylos glandulosa ssp. glandulosa	Native
Ericaceae	Arctostaphylos glandulosa ssp. mollis	Native
Ericaceae	Arctostaphylos glauca	Native
Ericaceae	Comarostaphylis diversifolia ssp. planifolia	Native
Euphorbiaceae	Chamaesyce albomarginata	Native
Euphorbiaceae	Chamaesyce maculata	Nonnative
Euphorbiaceae	Chamaesyce melanadenia	Native
Euphorbiaceae	Chamaesyce polycarpa	Native
Euphorbiaceae	Chamaesyce serpens	Nonnative
Euphorbiaceae	Chamaesyce serpyllifolia	Native
Euphorbiaceae	Chamaesyce sp.	Native
Euphorbiaceae	Croton californicus	Native
Euphorbiaceae	Croton setigerus	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Euphorbiaceae	Euphorbia crenulata	Native
Euphorbiaceae	Euphorbia esula	Nonnative
Euphorbiaceae	Euphorbia lathyris	Nonnative
Euphorbiaceae	Euphorbia peplus	Nonnative
Euphorbiaceae	Euphorbia spathulata	Native
Euphorbiaceae	Euphorbia terracina	Nonnative
Euphorbiaceae	Ricinus communis	Nonnative
Euphorbiaceae	Stillingia linearifolia	Native
Fabaceae	Acacia cyclops	Nonnative
Fabaceae	Acacia dealbata	Nonnative
Fabaceae	Acacia longifolia	Nonnative
Fabaceae	Acacia redolens	Nonnative
Fabaceae	Acacia retinodes	Nonnative
Fabaceae	Acacia saligna	Nonnative
Fabaceae	Acacia sp.	Nonnative
Fabaceae	Acmispon americanus var. americanus	Native
Fabaceae	Acmispon argophyllus var. argophyllus	Native
Fabaceae	Acmispon glaber	Native
Fabaceae	Acmispon grandiflorus var. grandiflorus	Native
Fabaceae	Acmispon maritimus var. maritima	Native
Fabaceae	Acmispon micranthus	Native
Fabaceae	Acmispon sp.	Native
Fabaceae	Acmispon strigosus	Native
Fabaceae	Acmispon wrangelianus	Native
Fabaceae	Albizia lophantha	Nonnative
Fabaceae	Amorpha californica var. californica	Native
Fabaceae	Astragalus brauntonii	Native
Fabaceae	Astragalus didymocarpus var. didymocarpus	Native
Fabaceae	Astragalus gambelianus	Native
Fabaceae	Astragalus pycnostachyus var. lanosissimus	Native
Fabaceae	Astragalus sp.	Native
Fabaceae	Astragalus tener var. titi	Native
Fabaceae	Astragalus trichopodus	Native
Fabaceae	Astragalus trichopodus var. lonchus	Native
Fabaceae	Astragalus trichopodus var. phoxus	Native
Fabaceae	Astragalus trichopodus var. trichopodus	Native
Fabaceae	Bituminaria bituminosa	Nonnative
Fabaceae	Caesalpinia gilliesii	Nonnative
Fabaceae	Ceratonia siliqua	Nonnative
Fabaceae	Cercis occidentalis	Nonnative
Fabaceae	Dipogon lignosus	Nonnative
Fabaceae	Genista monspessulana	Nonnative
Fabaceae	Glycyrrhiza lepidota	Native
Fabaceae	Hoita macrostachya	Native
Fabaceae	Lathyrus latifolius	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Fabaceae	Lathyrus odoratus	Nonnative
Fabaceae	Lathyrus vestitus var. vestitus	Native
Fabaceae	Lotus corniculatus	Nonnative
Fabaceae	Lotus micranthus	Native
Fabaceae	Lotus oblongifolius var. oblongifolius	Native
Fabaceae	Lupinus albifrons	Native
Fabaceae	Lupinus arboreus	Native
Fabaceae	Lupinus bicolor	Native
Fabaceae	Lupinus chamissonis	Native
Fabaceae	Lupinus concinnus	Native
Fabaceae	Lupinus excubitus	Native
Fabaceae	Lupinus formosus var. formosus	Native
Fabaceae	Lupinus hirsutissimus	Native
Fabaceae	Lupinus latifolius	Native
Fabaceae	Lupinus latifolius var. latifolius	Native
Fabaceae	Lupinus latifolius var. parishii	Native
Fabaceae	Lupinus longifolius	Native
Fabaceae	Lupinus microcarpus var. microcarpus	Native
Fabaceae	Lupinus nanus	Native
Fabaceae	Lupinus sp.	Native
Fabaceae	Lupinus sparsiflorus	Native
Fabaceae	Lupinus succulentus	Native
Fabaceae	Lupinus truncatus	Native
Fabaceae	Medicago lupulina	Nonnative
Fabaceae	Medicago polymorpha	Nonnative
Fabaceae	Medicago sativa	Nonnative
Fabaceae	Melilotus albus	Nonnative
Fabaceae	Melilotus indicus	Nonnative
Fabaceae	Melilotus officinalis	Nonnative
Fabaceae	Melilotus sp.	Nonnative
Fabaceae	Parkinsonia aculeata	Nonnative
Fabaceae	Pickeringia montana var. montana	Native
Fabaceae	Robinia pseudoacacia	Nonnative
Fabaceae	Rupertia physodes	Native
Fabaceae	Spartium junceum	Nonnative
Fabaceae	Trifolium albopurpureum	Native
Fabaceae	Trifolium ciliolatum	Native
Fabaceae	Trifolium depauperatum var. truncatum	Native
Fabaceae	Trifolium fucatum	Native
Fabaceae	Trifolium gracilentum	Native
Fabaceae	Trifolium gracilentum var. gracilentum	Native
Fabaceae	Trifolium gracilentum var. palmeri	Native
Fabaceae	Trifolium hirtum	Nonnative
Fabaceae	Trifolium incarnatum	Nonnative
Fabaceae	Trifolium microcephalum	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Fabaceae	Trifolium obtusiflorum	Native
Fabaceae	Trifolium pratense	Nonnative
Fabaceae	Trifolium repens	Nonnative
Fabaceae	Trifolium sp.	Unknown
Fabaceae	Trifolium variegatum	Native
Fabaceae	Trifolium willdenovii	Native
Fabaceae	Vicia americana ssp. americana	Native
Fabaceae	Vicia benghalensis	Nonnative
Fabaceae	Vicia hassei	Native
Fabaceae	Vicia ludoviciana ssp. ludoviciana	Native
Fabaceae	Vicia sativa	Nonnative
Fabaceae	Vicia sativa ssp. nigra	Nonnative
Fabaceae	Vicia sativa ssp. sativa	Nonnative
Fabaceae	Vicia villosa	Nonnative
Fabaceae	Vicia villosa ssp. varia	Nonnative
Fabaceae	Vicia villosa ssp. villosa	Nonnative
Fagaceae	Quercus agrifolia var. agrifolia	Native
Fagaceae	Quercus berberidifolia	Native
Fagaceae	Quercus chrysolepsis	Native
Fagaceae	Quercus douglasii	Native
Fagaceae	Quercus dumosa	Native
Fagaceae	Quercus lobata	Native
Fagaceae	Quercus wislizeni var. frutescens	Native
Frankeniaceae	Frankenia salina	Native
Garryaceae	Garrya veatchii	Native
Gentianaceae	Zeltnera exaltata	Native
Gentianaceae	Zeltnera venusta	Native
Geraniaceae	California macrophylla	Native
Geraniaceae	Erodium botrys	Nonnative
Geraniaceae	Erodium brachycarpum	Nonnative
Geraniaceae	Erodium cicutarium	Nonnative
Geraniaceae	Erodium moschatum	Nonnative
Geraniaceae	Geranium bicknellii	Native
Geraniaceae	Geranium carolinianum	Native
Geraniaceae	Geranium dissectum	Nonnative
Geraniaceae	Geranium molle	Nonnative
Geraniaceae	Geranium rotundifolium	Nonnative
Geraniaceae	Geranium sp.	Unknown
Grossulariaceae	Ribes aureum var. gracillimum	Native
Grossulariaceae	Ribes californicum var. hesperium	Native
Grossulariaceae	Ribes indecorum	Native
Grossulariaceae	Ribes malvaceum	Native
Grossulariaceae	Ribes malvaceum var. malvaceum	Native
Grossulariaceae	Ribes malvaceum var. viridifolium	Native
Grossulariaceae	Ribes speciosum	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Hyacinthaceae	Chlorogalum pomeridianum var. pomeridianum	Native
Hydrocharitaceae	Najas flexilis	Native
Hydrocharitaceae	Najas guadalupensis	Native
Hydrophyllaceae	Emmenanthe penduliflora var. penduliflora	Native
Hydrophyllaceae	Eriodictyon crassifolium	Native
Hydrophyllaceae	Eriodictyon crassifolium var. crassifolium	Native
Hydrophyllaceae	Eriodictyon crassifolium var. nigrescens	Native
Hydrophyllaceae	Eriodictyon trichocalyx var. trichocalyx	Native
Hydrophyllaceae	Eucrypta chrysanthemifolia	Native
Hydrophyllaceae	Eucrypta chrysanthemifolia var. chrysanthemifolia	Native
Hydrophyllaceae	Nemophila menziesii var. integrifolia	Native
Hydrophyllaceae	Nemophila pedunculata	Native
Hydrophyllaceae	Phacelia brachyloba	Native
Hydrophyllaceae	Phacelia cicutaria	Native
Hydrophyllaceae	Phacelia cicutaria var. hispida	Native
Hydrophyllaceae	Phacelia cicutaria var. hubbyi	Native
Hydrophyllaceae	Phacelia distans	Native
Hydrophyllaceae	Phacelia douglasii	Native
Hydrophyllaceae	Phacelia egena	Native
Hydrophyllaceae	Phacelia grandiflora	Native
Hydrophyllaceae	Phacelia imbricata ssp. imbricata	Native
Hydrophyllaceae	Phacelia longipes	Native
Hydrophyllaceae	Phacelia minor	Native
Hydrophyllaceae	Phacelia parryi	Native
Hydrophyllaceae	Phacelia ramosissima	Native
Hydrophyllaceae	Phacelia ramosissima var. austrolitoralis	Native
Hydrophyllaceae	Phacelia ramosissima var. latifolia	Native
Hydrophyllaceae	Phacelia sp.	Native
Hydrophyllaceae	Phacelia tanacetifolia	Native
Hydrophyllaceae	Phacelia viscida	Native
Hydrophyllaceae	Pholistoma auritum var. auritum	Native
Hydrophyllaceae	Pholistoma racemosum	Native
Hydrophyllaceae	Wigandia urens	Nonnative
Iridaceae	Chasmanthe floribunda	Nonnative
Iridaceae	Iris pseudacorus	Nonnative
Iridaceae	Sisyrinchium bellum	Native
Juglandaceae	Juglans californica var. californica	Native
Juncaceae	Juncus acutus ssp. leopoldii	Native
Juncaceae	Juncus balticus	Native
Juncaceae	Juncus bufonius	Native
Juncaceae	Juncus bufonius var. bufonius	Native
Juncaceae	Juncus bufonius var. congestus	Native
Juncaceae	Juncus effusus var. pacificus	Native
Juncaceae	Juncus macrophyllus	Native
Juncaceae	Juncus mexicanus	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Juncaceae	Juncus patens	Native
Juncaceae	Juncus phaeocephalus	Native
Juncaceae	Juncus phaeocephalus var. paniculatus	Native
Juncaceae	Juncus phaeocephalus var. phaeocephalus	Native
Juncaceae	Juncus rugulosus	Native
Juncaceae	Juncus sp.	Native
Juncaceae	Juncus textilis	Native
Juncaceae	Juncus torreyi	Native
Juncaceae	Juncus xiphioides	Native
Juncaginaceae	Triglochin concinna var. cocinna	Native
Juncaginaceae	Triglochin maritima	Native
Lamiaceae	Lamium amplexicaule	Nonnative
Lamiaceae	Lepechinia fragrans	Native
Lamiaceae	Marrubium vulgare	Nonnative
Lamiaceae	Mentha arvensis	Native
Lamiaceae	Mentha x piperita	Nonnative
Lamiaceae	Mentha pulegium	Nonnative
Lamiaceae	Mentha spicata	Nonnative
Lamiaceae	Monardella hypoleuca ssp. hypoleuca	Native
Lamiaceae	Monardella lanceolata	Native
Lamiaceae	Prunella vulgaris	Native
Lamiaceae	Rosmarinus officinalis	Nonnative
Lamiaceae	Salvia apiana	Native
Lamiaceae	Salvia columbariae	Native
Lamiaceae	Salvia leucophylla	Native
Lamiaceae	Salvia mellifera	Native
Lamiaceae	Salvia sp.	Native
Lamiaceae	Salvia spathacea	Native
Lamiaceae	Satureja douglasii	Native
Lamiaceae	Scutellaria siphocampyloides	Native
Lamiaceae	Scutellaria tuberosa	Native
Lamiaceae	Stachys ajugoides var. rigida	Native
Lamiaceae	Stachys albens	Native
Lamiaceae	Stachys bullata	Native
Lamiaceae	Trichostema lanatum	Native
Lamiaceae	Trichostema lanceolatum	Native
Lauraceae	Umbellularia californica var. californica	Native
Lemnaceae	Lemna gibba	Native
Lemnaceae	Lemna minor	Native
Lemnaceae	Lemna trisulca	Native
Lemnaceae	Lemna turionifera	Native
Lemnaceae	Lemna valdiviana	Native
Lemnaceae	Wolffiella lingulata	Native
Lennoaceae	Pholisma arenarium	Native
Liliaceae	Allium fimbriatum var. fimbriatum	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Liliaceae	Allium haematochiton	Native
Liliaceae	Allium neapolitanum	Nonnative
Liliaceae	Allium peninsulare var. peninsulare	Native
Liliaceae	Allium praecox	Native
Liliaceae	Asparagus asparagoides	Nonnative
Liliaceae	Brodiaea jolonensis	Native
Liliaceae	Calochortus albus	Native
Liliaceae	Calochortus catalinae	Native
Liliaceae	Calochortus clavatus var. gracilis	Native
Liliaceae	Calochortus clavatus var. pallidus	Native
Liliaceae	Calochortus plummerae	Native
Liliaceae	Calochortus sp.	Native
Liliaceae	Calochortus splendens	Native
Liliaceae	Calochortus venustus	Native
Liliaceae	Calochortus weedii var. intermedius	Native
Liliaceae	Calochortus weedii var. weedii	Native
Liliaceae	Dichelostemma capitatum ssp. capitatum	Native
Liliaceae	Fritillaria biflora	Native
Liliaceae	Lilium humboldtii ssp. ocellatum	Native
Liliaceae	Muilla maritima	Native
Linaceae	Hesperolinon micranthum	Native
Linaceae	Linum grandiflorum	Native
Loasaceae	Mentzelia laevicaulis	Native
Loasaceae	Mentzelia micrantha	Native
Lythraceae	Ammannia coccinea	Native
Lythraceae	Lythrum californicum	Native
Lythraceae	Lythrum hyssopifolia	Nonnative
Lythraceae	Rotala ramosior	Native
Malvaceae	Lavatera assurgentiflora	Native
Malvaceae	Malacothamnus fasciculatus	Native
Malvaceae	Malva arborea	Nonnative
Malvaceae	Malva nicaeensis	Nonnative
Malvaceae	Malva parviflora	Nonnative
Malvaceae	Malva pseudolavatera	Nonnative
Malvaceae	Malvella leprosa	Native
Malvaceae	Modiola caroliniana	Nonnative
Malvaceae	Sidalcea malviflora	Native
Malvaceae	Sidalcea malviflora ssp. malviflora	Native
Malvaceae	Sidalcea malviflora ssp. sparsifolia	Native
Martyniaceae	Proboscidea louisianica	Nonnative
Melanthiaceae	Toxicoscordion fremontii	Native
Montiaceae	Calandrinia breweri	Native
Montiaceae	Calandrinia ciliata	Native
Montiaceae	Calyptridium monandrum	Native
Montiaceae	Cistanthe maritima	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Moraceae	Ficus carica	Nonnative
Myoporaceae	Myoporum laetum	Nonnative
Myricaceae	Myrica californica	Native
Myrsinaceae	Anagallis arvensis	Nonnative
Myrtaceae	Eucalyptus camaldulensis	Nonnative
Myrtaceae	Eucalyptus cladocalyx	Nonnative
Myrtaceae	Eucalyptus globulus	Nonnative
Nyctaginaceae	Abronia maritima	Native
Nyctaginaceae	Abronia umbellata ssp. umbellata	Native
Nyctaginaceae	Mirabilis laevis var. crassifolius	Native
Nymphaeaceae	Nuphar lutea ssp. polysepala	Nonnative
Nymphaeaceae	Nymphaea mexicana	Nonnative
Oleaceae	Fraxinus dipetala	Native
Oleaceae	Fraxinus uhdei	Nonnative
Oleaceae	Fraxinus velutina	Native
Oleaceae	Olea europaea	Nonnative
Onagraceae	Camissonia boothii ssp. decorticans	Native
Onagraceae	Camissonia cheiranthifolia ssp. suffruticosa	Native
Onagraceae	Camissonia hirtella	Native
Onagraceae	Camissonia ignota	Native
Onagraceae	Camissonia intermedia	Native
Onagraceae	Camissonia lewisii	Native
Onagraceae	Camissonia strigulosa	Native
Onagraceae	Camissoniopsis bistorta	Native
Onagraceae	Camissoniopsis micrantha	Native
Onagraceae	Camissoniopsis sp.	Native
Onagraceae	Clarkia amoena ssp. whitneyi	Native
Onagraceae	Clarkia bottae	Native
Onagraceae	Clarkia cylindrica ssp. cylindrica	Native
Onagraceae	Clarkia epilobioides	Native
Onagraceae	Clarkia purpurea ssp. quadrivulnera	Native
Onagraceae	Clarkia sp.	Native
Onagraceae	Clarkia unguiculata	Native
Onagraceae	Epilobium brachycarpum	Native
Onagraceae	Epilobium canum	Native
Onagraceae	Epilobium canum ssp. angustifolium	Native
Onagraceae	Epilobium canum ssp. canum	Native
Onagraceae	Epilobium canum ssp. latifolium	Native
Onagraceae	Epilobium ciliatum ssp. ciliatum	Native
Onagraceae	Eulobus californica	Native
Onagraceae	Ludwigia palustris	Native
Onagraceae	Ludwigia peploides ssp. peploides	Native
Onagraceae	Oenothera biennis	Nonnative
Onagraceae	Oenothera californica ssp. californica	Native
Onagraceae	Oenothera elata ssp. hirsutissima	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Onagraceae	Oenothera rosea	Nonnative
Onagraceae	Oenothera sinuosa	Nonnative
Onagraceae	Oenothera sp.	Unknown
Onagraceae	Oenothera speciosa	Nonnative
Onagraceae	Oenothera suffrutescens	Native
Onagraceae	Oenothera villosa ssp. strigosa	Native
Orchidaceae	Epipactis gigantea	Native
Orchidaceae	Piperia elegans	Native
Orchidaceae	Piperia elongata	Native
Orchidaceae	Piperia sp.	Native
Orchidaceae	Piperia unalascensis	Native
Orobanchaceae	Orobanche bulbosa	Native
Orobanchaceae	Orobanche californica ssp. grandis	Native
Orobanchaceae	Orobanche fasciculata	Native
Orobanchaceae	Orobanche uniflora	Native
Orobanchaceae	Orobanche vallicola	Native
Oxalidaceae	Oxalis articulata ssp. rubra	Nonnative
Oxalidaceae	Oxalis californica	Native
Oxalidaceae	Oxalis corniculata	Nonnative
Oxalidaceae	Oxalis pes-caprae	Nonnative
Paeoniaceae	Paeonia californica	Native
Papaveraceae	Argemone munita	Native
Papaveraceae	Dendromecon rigida	Native
Papaveraceae	Ehrendorferia ochroleuca	Native
Papaveraceae	Eschscholzia caespitosa	Native
Papaveraceae	Eschscholzia californica	Native
Papaveraceae	Meconella denticulata	Native
Papaveraceae	Papaver californicum	Native
Papaveraceae	Papaver heteorphyllum	Native
Papaveraceae	Platystemon californicus	Native
Papaveraceae	Romneya coulteri	Native
Papaveraceae	Romneya trichocalyx	Native
Passifloraceae	Passiflora sp.	Nonnative
Pittosporaceae	Pittosporum undulatum	Nonnative
Plantaginaceae	Antirrhinum coulterianum	Native
Plantaginaceae	Antirrhinum kelloggii	Native
Plantaginaceae	Antirrhinum multiflorum	Native
Plantaginaceae	Antirrhinum nuttallianum	Native
Plantaginaceae	Antirrhinum sp.	Native
Plantaginaceae	Plantago coronopus	Nonnative
Plantaginaceae	Plantago erecta	Native
Plantaginaceae	Plantago lanceolata	Nonnative
Plantaginaceae	Plantago major	Nonnative
Platanaceae	Platanus racemosa	Native
Plumbaginaceae	Limonium californicum	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Plumbaginaceae	Limonium perezii	Nonnative
Plumbaginaceae	Limonium sinuatum	Nonnative
Poaceae	Achnatherum brachychaetum	Native
Poaceae	Achnatherum diegoense	Native
Poaceae	Aegilops cylindrica	Nonnative
Poaceae	Agrostis exarata	Native
Poaceae	Agrostis gigantea	Nonnative
Poaceae	Agrostis pallens	Native
Poaceae	Agrostis stolonifera	Nonnative
Poaceae	Aira caryophyllea	Nonnative
Poaceae	Alopecurus saccatus	Native
Poaceae	Ammophila arenaria ssp. arenaria	Nonnative
Poaceae	Andropogon glomeratus var. scabriglumis	Native
Poaceae	Aristida adscensionis	Native
Poaceae	Aristida purpurea var. parishii	Native
Poaceae	Arundo donax	Nonnative
Poaceae	Avena barbata	Nonnative
Poaceae	Avena fatua	Nonnative
Poaceae	Avena sativa	Nonnative
Poaceae	Avena sp.	Nonnative
Poaceae	Bothriochloa barbinodis	Native
Poaceae	Brachypodium distachyon	Nonnative
Poaceae	Briza minor	Nonnative
Poaceae	Bromus arenarius	Nonnative
Poaceae	Bromus arizonicus	Native
Poaceae	Bromus berteroanus	Nonnative
Poaceae	Bromus carinatus var. carinatus	Native
Poaceae	Bromus catharticus var. catharticus	Nonnative
Poaceae	Bromus diandrus	Nonnative
Poaceae	Bromus hordeaceus	Nonnative
Poaceae	Bromus madritensis	Nonnative
Poaceae	Bromus madritensis ssp. madritensis	Nonnative
Poaceae	Bromus madritensis ssp. rubens	Nonnative
Poaceae	Bromus pseudolaevipes	Native
Poaceae	Bromus sp.	Unknown
Poaceae	Bromus sterilis	Nonnative
Poaceae	Bromus tectorum	Nonnative
Poaceae	Chloris gayana	Nonnative
Poaceae	Chloris virgata	Nonnative
Poaceae	Cortaderia jubata	Nonnative
Poaceae	Cortaderia selloana	Nonnative
Poaceae	Crypsis alopecuroides	Nonnative
Poaceae	Crypsis schoenoides	Nonnative
Poaceae	Crypsis vaginiflora	Nonnative
Poaceae	Cynodon dactylon	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Poaceae	Cynosurus echinatus	Nonnative
Poaceae	Dactylis glomerata	Nonnative
Poaceae	Dactyloctenium aegyptium	Nonnative
Poaceae	Digitaria ciliaris	Nonnative
Poaceae	Digitaria ischaemum	Nonnative
Poaceae	Digitaria sanguinalis	Nonnative
Poaceae	Distichlis spicata	Native
Poaceae	Echinochloa colona	Nonnative
Poaceae	Echinochloa crus-galli	Nonnative
Poaceae	Ehrharta calycina	Nonnative
Poaceae	Ehrharta erecta	Nonnative
Poaceae	Elymus caput-medusae	Nonnative
Poaceae	Elymus condensatus	Native
Poaceae	Elymus glaucus ssp. glaucus	Native
Poaceae	Elymus multisetus	Native
Poaceae	Elymus stebbinsii	Native
Poaceae	Elymus triticoides	Native
Poaceae	Elytrigia elongata	Nonnative
Poaceae	Eragrostis barrelieri	Nonnative
Poaceae	Eragrostis cilianensis	Nonnative
Poaceae	Eragrostis hypnoides	Native
Poaceae	Eragrostis mexicana ssp. virescens	Native
Poaceae	Festuca arundinacea	Nonnative
Poaceae	Festuca bromoides	Nonnative
Poaceae	Festuca elmeri	Native
Poaceae	Festuca microstachys	Native
Poaceae	Festuca multiflora	Native
Poaceae	Festuca myuros	Nonnative
Poaceae	Festuca octoflora	Native
Poaceae	Festuca perennis	Nonnative
Poaceae	Festuca pratensis	Nonnative
Poaceae	Festuca rubra	Native
Poaceae	Festuca sp.	Unknown
Poaceae	Gastridium phleoides	Nonnative
Poaceae	Gastridium ventricosum	Nonnative
Poaceae	Hordeum brachyantherum ssp. californicum	Native
Poaceae	Hordeum depressum	Native
Poaceae	Hordeum intercedens	Native
Poaceae	Hordeum marinum ssp. gussoneanum	Nonnative
Poaceae	Hordeum murinum	Nonnative
Poaceae	Hordeum murinum ssp. glaucum	Nonnative
Poaceae	Hordeum murinum ssp. leporinum	Nonnative
Poaceae	Hordeum vulgare	Nonnative
Poaceae	Koeleria macrantha	Native
Poaceae	Lamarckia aurea	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Poaceae	Leptochloa fascicularis	Native
Poaceae	Leptochloa fusca ssp. fascicularis	Native
Poaceae	Leptochloa uninervia	Native
Poaceae	Lolium rigidum ssp. lepturoides	Nonnative
Poaceae	Lolium temulentum	Nonnative
Poaceae	Melica californica	Native
Poaceae	Melica frutescens	Native
Poaceae	Melica imperfecta	Native
Poaceae	Monanthochloe littoralis	Native
Poaceae	Muhlenbergia asperifolia	Native
Poaceae	Muhlenbergia microsperma	Native
Poaceae	Muhlenbergia rigens	Native
Poaceae	Panicum capillare	Native
Poaceae	Panicum miliaceum	Nonnative
Poaceae	Parapholis incurva	Nonnative
Poaceae	Paspalum dilatatum	Nonnative
Poaceae	Paspalum distichum	Native
Poaceae	Paspalum vaginatum	Nonnative
Poaceae	Pennisetum clandestinum	Nonnative
Poaceae	Pennisetum setaceum	Nonnative
Poaceae	Pennisetum villosum	Nonnative
Poaceae	Phalaris aquatica	Nonnative
Poaceae	Phalaris canariensis	Nonnative
Poaceae	Phalaris caroliniana	Nonnative
Poaceae	Phalaris minor	Nonnative
Poaceae	Phalaris paradoxa	Nonnative
Poaceae	Phleum pratense	Nonnative
Poaceae	Phragmites australis	Native
Poaceae	Poa annua	Nonnative
Poaceae	Poa bulbosa	Nonnative
Poaceae	Poa howellii	Native
Poaceae	Poa palustris	Nonnative
Poaceae	Poa pratensis ssp. pratensis	Nonnative
Poaceae	Poa secunda ssp. secunda	Native
Poaceae	Polypogon imberbis	Nonnative
Poaceae	Polypogon interruptus	Nonnative
Poaceae	Polypogon monspeliensis	Nonnative
Poaceae	Polypogon viridis	Nonnative
Poaceae	Puccinellia distans	Native
Poaceae	Schismus arabicus	Nonnative
Poaceae	Schismus barbatus	Nonnative
Poaceae	Setaria adhaerens	Nonnative
Poaceae	Setaria parviflora	Native
Poaceae	Setaria pumilla	Nonnative
Poaceae	Sorghum halepense	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Poaceae	Spartina foliosa	Native
Poaceae	Sporobolus indicus	Nonnative
Poaceae	Stenotaphrum secundatum	Nonnative
Poaceae	Stipa cernua	Native
Poaceae	Stipa coronata	Native
Poaceae	Stipa lepida	Native
Poaceae	Stipa miliacea	Nonnative
Poaceae	Stipa pulchra	Native
Poaceae	Stipa sp.	Native
Poaceae	Triticum aestivum	Nonnative
Polemoniaceae	Allophyllum divaricatum	Native
Polemoniaceae	Allophyllum glutinosum	Native
Polemoniaceae	Eriastrum densifolium	Native
Polemoniaceae	Eriastrum densifolium ssp. densifolium	Native
Polemoniaceae	Eriastrum densifolium ssp. elongatum	Native
Polemoniaceae	Eriastrum filifolium	Native
Polemoniaceae	Eriastrum sapphirinum	Native
Polemoniaceae	Gilia angelensis	Native
Polemoniaceae	Gilia capitata ssp. abrotanifolia	Native
Polemoniaceae	Gilia clivorum	Native
Polemoniaceae	Leptodactylon californicum	Native
Polemoniaceae	Leptodactylon californicum ssp. californicum	Native
Polemoniaceae	Leptodactylon californicum ssp. glandulosum	Native
Polemoniaceae	Leptosiphon ciliatus	Native
Polemoniaceae	Linanthus dianthiflorus	Native
Polemoniaceae	Linanthus liniflorus	Native
Polemoniaceae	Linanthus parviflorus	Native
Polemoniaceae	Linanthus pygmaeus ssp. continentalis	Native
Polemoniaceae	Loeseliastrum schottii	Native
Polemoniaceae	Microsteris gracilis	Native
Polemoniaceae	Navarretia atractyloides	Native
Polemoniaceae	Navarretia hamata ssp. leptantha	Native
Polemoniaceae	Navarretia mellita	Native
Polemoniaceae	Navarretia mitracarpa	Native
Polemoniaceae	Navarretia ojaiensis	Native
Polemoniaceae	Navarretia pubescens	Native
Polemoniaceae	Saltugilia australis	Native
Polemoniaceae	Saltugilia splendens ssp. splendens	Native
Polygalaceae	Polygala cornuta var. fishiae	Native
Polygonaceae	Chorizanthe parryi	Native
Polygonaceae	Chorizanthe parryi var. fernandina	Native
Polygonaceae	Chorizanthe parryi var. parryi	Native
Polygonaceae	Chorizanthe staticoides	Native
Polygonaceae	Chorizanthe wheeleri	Native
Polygonaceae	Emex spinosa	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Polygonaceae	Eriogonum angulosum	Native
Polygonaceae	Eriogonum cinereum	Native
Polygonaceae	Eriogonum cithariforme var. agninum	Native
Polygonaceae	Eriogonum crocatum	Native
Polygonaceae	Eriogonum elongatum var. elongatum	Native
Polygonaceae	Eriogonum fasciculatum	Native
Polygonaceae	Eriogonum fasciculatum var. fasciculatum	Native
Polygonaceae	Eriogonum fasciculatum var. foliolosum	Native
Polygonaceae	Eriogonum giganteum	Native
Polygonaceae	Eriogonum gracile var. gracile	Native
Polygonaceae	Eriogonum parvifolium	Native
Polygonaceae	Eriogonum roseum	Native
Polygonaceae	Eriogonum wrightii var. membranaceum	Native
Polygonaceae	Lastarriaea coriacea	Native
Polygonaceae	Mucronea californica	Native
Polygonaceae	Oxytheca trilobata	Native
Polygonaceae	Persicaria amphibia	Native
Polygonaceae	Persicaria hydropiperoides	Native
Polygonaceae	Persicaria lapathifolia	Native
Polygonaceae	Persicaria punctata	Native
Polygonaceae	Polygonum argyrocoleon	Nonnative
Polygonaceae	Polygonum aviculare	Nonnative
Polygonaceae	Polygonum ramosissimum	Nonnative
Polygonaceae	Pterostegia drymarioides	Native
Polygonaceae	Rumex acetosella	Nonnative
Polygonaceae	Rumex conglomeratus	Nonnative
Polygonaceae	Rumex crassus	Native
Polygonaceae	Rumex crispus	Nonnative
Polygonaceae	Rumex fueginus	Native
Polygonaceae	Rumex kerneri	Nonnative
Polygonaceae	Rumex salicifolius	Native
Polygonaceae	Rumex stenophyllus	Nonnative
Polygonaceae	Rumex violascens	Native
Polypodiaceae	Polypodium californicum	Native
Portulaceae	Claytonia exigua ssp. exigua	Native
Portulaceae	Claytonia parviflora	Native
Portulaceae	Claytonia parviflora ssp. parviflora	Native
Portulaceae	Claytonia parviflora ssp. viridis	Native
Portulaceae	Claytonia perfoliata	Native
Portulaceae	Claytonia perfoliata ssp. mexicana	Native
Portulaceae	Claytonia perfoliata ssp. perfoliata	Native
Portulaceae	Claytonia sp.	Native
Portulaceae	Lewisia rediviva	Native
Portulaceae	Montia fontana	Native
Portulaceae	Portulaca oleracea	Nonnative

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Potamogetonaceae	Potamogeton crispus	Nonnative
Potamogetonaceae	Potamogeton nodosus	Native
Potamogetonaceae	Ruppia cirrhosa	Native
Potamogetonaceae	Ruppia maritima	Native
Potamogetonaceae	Stuckenia pectinata	Native
Primulaceae	Dodecatheon clevelandii	Native
Primulaceae	Dodecatheon clevelandii ssp. clevelandii	Native
Primulaceae	Dodecatheon clevelandii ssp. sanctarum	Native
Primulaceae	Samolus parviflorus	Native
Pteridaceae	Adiantum capillus-veneris	Native
Pteridaceae	Adiantum jordanii	Native
Pteridaceae	Aspidotis californica	Native
Pteridaceae	Myrioteris cooperae	Native
Pteridaceae	Myrioteris covillei	Native
Pteridaceae	Myrioteris newberryi	Native
Pteridaceae	Notholaena californica ssp. leucophylla	Native
Pteridaceae	Pellaea andromedifolia	Native
Pteridaceae	Pellaea mucronata var. mucronata	Native
Pteridaceae	Pentagramma triangularis ssp. triangularis	Native
Ranunculaceae	Clematis lasiantha	Native
Ranunculaceae	Clematis ligusticifolia	Native
Ranunculaceae	Delphinium cardinale	Native
Ranunculaceae	Delphinium parryi	Native
Ranunculaceae	Delphinium parryi ssp. blochmaniae	Native
Ranunculaceae	Delphinium parryi ssp. maritimum	Native
Ranunculaceae	Delphinium parryi ssp. parryi	Native
Ranunculaceae	Delphinium patens ssp. hepaticoideum	Native
Ranunculaceae	Ranunculus aquatilis	Native
Ranunculaceae	Ranunculus californicus	Native
Ranunculaceae	Ranunculus cymbalaria	Native
Ranunculaceae	Ranunculus hebecarpus	Native
Ranunculaceae	Ranunculus repens	Nonnative
Ranunculaceae	Thalictrum fendleri	Native
Ranunculaceae	Thalictrum fendleri var. fendleri	Native
Ranunculaceae	Thalictrum fendleri var. polycarpum	Native
Resedaceae	Oligomeris linifolia	Nonnative
Rhamnaceae	Ceanothus crassifolius	Native
Rhamnaceae	Ceanothus cuneatus var. cuneatus	Native
Rhamnaceae	Ceanothus leucodermis	Native
Rhamnaceae	Ceanothus megacarpus var. megacarpus	Native
Rhamnaceae	Ceanothus oliganthus	Native
Rhamnaceae	Ceanothus oliganthus var. oliganthus	Native
Rhamnaceae	Ceanothus oliganthus var. sorediatus	Native
Rhamnaceae	Ceanothus spinosus	Native
Rhamnaceae	Frangula californica	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Rhamnaceae	Frangula californica ssp. californica	Native
Rhamnaceae	Frangula californica ssp. tomentella	Native
Rhamnaceae	Rhamnus crocea	Native
Rhamnaceae	Rhamnus ilicifolia	Native
Rosaceae	Adenostoma fasciculatum var. fasciculatum	Native
Rosaceae	Adenostoma sparsifolium	Native
Rosaceae	Aphanes arvensis	Nonnative
Rosaceae	Aphanes occidentalis	Native
Rosaceae	Cercocarpus betuloides	Native
Rosaceae	Cercocarpus betuloides var. betuloides	Native
Rosaceae	Cercocarpus betuloides var. blancheae	Native
Rosaceae	Chamaebatia australis	Native
Rosaceae	Heteromeles arbutifolia	Native
Rosaceae	Holodiscus discolor	Native
Rosaceae	Horkelia cuneata ssp. cuneata	Native
Rosaceae	Potentilla anserina ssp. pacifica	Native
Rosaceae	Potentilla egedii ssp. grandis	Native
Rosaceae	Potentilla glandulosa ssp. glandulosa	Native
Rosaceae	Prunus caroliniana	Nonnative
Rosaceae	Prunus ilicifolia	Native
Rosaceae	Prunus ilicifolia ssp. ilicifolia	Native
Rosaceae	Prunus ilicifolia ssp. lyonii	Native
Rosaceae	Pyracantha angustifolia	Nonnative
Rosaceae	Rosa californica	Native
Rosaceae	Rubus armeniacus	Nonnative
Rosaceae	Rubus ursinus	Native
Rosaceae	Sanguisorba minor ssp. muricata	Nonnative
Rubiaceae	Galium andrewsii ssp. intermedium	Native
Rubiaceae	Galium angustifolium	Native
Rubiaceae	Galium angustifolium ssp. angustifolium	Native
Rubiaceae	Galium angustifolium ssp. foliosum	Native
Rubiaceae	Galium aparine	Native
Rubiaceae	Galium californicum ssp. flaccidum	Native
Rubiaceae	Galium cliftonsmithii	Native
Rubiaceae	Galium nuttallii ssp. nuttallii	Native
Rubiaceae	Galium parisiense	Nonnative
Rubiaceae	Sherardia arvensis	Nonnative
Rutaceae	Ruta chalapensis	Nonnative
Salicaceae	Populus fremontii ssp. fremontii	Native
Salicaceae	Populus nigra	Nonnative
Salicaceae	Populus sp.	Nonnative
Salicaceae	Populus trichocarpa	Native
Salicaceae	Salix exigua var. hindsiana	Native
Salicaceae	Salix gooddingii	Native
Salicaceae	Salix laevigata	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Salicaceae	Salix lasiandra var. lasiandra	Native
Salicaceae	Salix lasiolepis	Native
Sapindaceae	Acer macrophyllum	Native
Sapindaceae	Acer negundo	Nonnative
Saururaceae	Anemopsis californica	Native
Saxifragaceae	Boykinia occidentalis	Native
Saxifragaceae	Boykinia rotundifolia	Native
Saxifragaceae	Lithophragma affine	Native
Saxifragaceae	Lithophragma cymbalaria	Native
Saxifragaceae	Lithophragma heterophyllum	Native
Saxifragaceae	Saxifraga californica	Native
Scrophulariaceae	Castilleja affinis ssp. affinis	Native
Scrophulariaceae	Castilleja applegatei ssp. martinii	Native
Scrophulariaceae	Castilleja densiflora ssp. densiflora	Native
Scrophulariaceae	Castilleja exserta ssp. exserta	Native
Scrophulariaceae	Castilleja foliolosa	Native
Scrophulariaceae	Castilleja minor ssp. spiralis	Native
Scrophulariaceae	Collinsia heterophylla	Native
Scrophulariaceae	Collinsia parryi	Native
Scrophulariaceae	Cordylanthus maritimus ssp. maritimus	Native
Scrophulariaceae	Cordylanthus molle ssp. hispidus	Native
Scrophulariaceae	Cordylanthus rigidus	Native
Scrophulariaceae	Cordylanthus rigidus ssp. rigidus	Native
Scrophulariaceae	Cordylanthus rigidus ssp. setigerus	Native
Scrophulariaceae	Diplacus aurantiacus	Native
Scrophulariaceae	Diplacus bigelovii	Native
Scrophulariaceae	Diplacus brevipes	Native
Scrophulariaceae	Erythranthe androsacea	Native
Scrophulariaceae	Erythranthe cardinalis	Native
Scrophulariaceae	Erythranthe floribunda	Native
Scrophulariaceae	Erythranthe guttata	Native
Scrophulariaceae	Galvezia speciosa	Nonnative
Scrophulariaceae	Keckiella cordifolia	Native
Scrophulariaceae	Kickxia elatine	Nonnative
Scrophulariaceae	Linaria pinifolia	Nonnative
Scrophulariaceae	Mimetanthe pilosa	Native
Scrophulariaceae	Mimulus sp.	Native
Scrophulariaceae	Nuttallanthus canadensis	Native
Scrophulariaceae	Nuttallanthus texana	Native
Scrophulariaceae	Pedicularis densiflora	Native
Scrophulariaceae	Penstemon centranthifolius	Native
Scrophulariaceae	Penstemon heterophyllus var. australis	Native
Scrophulariaceae	Penstemon spectabilis var. subviscosus	Native
Scrophulariaceae	Penstemon X parishii	Native
Scrophulariaceae	Scrophularia californica	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Scrophulariaceae	Scrophularia californica ssp. californica	Native
Scrophulariaceae	Scrophularia californica ssp. floribunda	Native
Scrophulariaceae	Verbascum blattaria	Nonnative
Scrophulariaceae	Verbascum thapsus	Nonnative
Scrophulariaceae	Verbascum virgatum	Nonnative
Scrophulariaceae	Veronica anagallis-aquatica	Nonnative
Scrophulariaceae	Veronica arvensis	Nonnative
Scrophulariaceae	Veronica peregrina ssp. xalapensis	Native
Scrophulariaceae	Veronica persica	Nonnative
Selaginellaceae	Selaginella bigelovii	Native
Simaroubaceae	Ailanthus altissima	Nonnative
Solanaceae	Datura inoxia	Native
Solanaceae	Datura stramonium	Nonnative
Solanaceae	Datura wrightii	Native
Solanaceae	Lycium californicum	Native
Solanaceae	Lycopersicon esculentum	Nonnative
Solanaceae	Nicotiana acuminata var. multiflora	Nonnative
Solanaceae	Nicotiana clevelandii	Native
Solanaceae	Nicotiana glauca	Nonnative
Solanaceae	Nicotiana quadrivalvis	Native
Solanaceae	Petunia parviflora	Native
Solanaceae	Salpichroa origanifolia	Nonnative
Solanaceae	Solanum americanum	Native
Solanaceae	Solanum aviculare	Nonnative
Solanaceae	Solanum douglasii	Native
Solanaceae	Solanum elaeagnifolium	Nonnative
Solanaceae	Solanum physalifolium	Nonnative
Solanaceae	Solanum rostratum	Nonnative
Solanaceae	Solanum umbelliferum	Native
Solanaceae	Solanum xanti	Native
Sterculiaceae	Fremontodendron californicum	Native
Tamaricaceae	Tamarix gallica	Nonnative
Tamaricaceae	Tamarix parviflora	Nonnative
Tamaricaceae	Tamarix ramosissima	Nonnative
Thelypteridaceae	Thelypteris puberula var. sonorensis	Native
Themidaceae	Bloomeria crocea var. crocea	Native
Themidaceae	Brodiaea terrestris ssp. kernensis	Native
Tropaeolaceae	Tropaeolum majus	Nonnative
Typhaceae	Typha angustifolia	Nonnative
Typhaceae	Typha domingensis	Native
Typhaceae	Typha latifolia	Native
Ulmaceae	Ulmus parvifloria	Nonnative
Urticaceae	Hesperocnide tenella	Native
Urticaceae	Parietaria hespera	Native
Urticaceae	Parietaria hespera var. californica	Native

Table 2
Ecological Plant Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Family Name	Scientific Name	Nativity
Urticaceae	Parietaria hespera var. hespera	Native
Urticaceae	Soleirolia soleirolii	Nonnative
Urticaceae	Urtica dioica ssp. holosericea	Native
Urticaceae	Urtica urens	Nonnative
Valerianaceae	Centranthus ruber	Nonnative
Valerianaceae	Plectritis ciliosa ssp. insignis	Native
Verbenaceae	Phyla lanceolata	Native
Verbenaceae	Phyla nodiflora	Native
Verbenaceae	Phyla nodiflora var. incisa	Native
Verbenaceae	Phyla nodiflora var. nodiflora	Native
Verbenaceae	Phyla nodiflora var. rosea	Nonnative
Verbenaceae	Verbena bracteata	Native
Verbenaceae	Verbena lasiostachys	Native
Verbenaceae	Verbena lasiostachys var. lasiostachys	Native
Verbenaceae	Verbena lasiostachys var. scabrida	Native
Verbenaceae	Verbena menthifolia	Native
Verbenaceae	Verbena pulchella	Nonnative
Verbenaceae	Verbena scabra	Native
Violaceae	Viola pedunculata	Native
Viscaceae	Phoradendron serotinum ssp. macrophyllum	Native
Viscaceae	Phoradendron villosum	Native
Vitaceae	Parthenocissus inserta	Native
Vitaceae	Vitis girdiana	Native
Zannichelliaceae	Zannichellia palustris	Native
Zosteraceae	Phyllospadix scouleri	Native
Zosteraceae	Phyllospadix torreyi	Native
Zosteraceae	Zostera marina	Native
Zygophyllaceae	Tribulus terrestris	Nonnative

Notes:
var. = variety
ssp. = sub-species
sp. = species

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Accipiter cooperii	Cooper's Hawk	Bird	Present
Accipiter striatus	Sharp-shinned Hawk	Bird	Present
Aquila chrysaetos	Golden Eagle	Bird	Present
Buteo albonotatus	Zone-tailed Hawk	Bird	Present
Buteo jamaicensis	Red-tailed Hawk	Bird	Present
Buteo lagopus	Rough-legged Hawk	Bird	Present
Buteo lineatus	Red-shouldered Hawk	Bird	Present
Buteo platypterus	Broad-winged Hawk	Bird	Present
Buteo regalis	Ferruginous Hawk	Bird	Present
Buteo swainsoni	Swainson's Hawk	Bird	Present
Circus hudsonius	Northern Harrier	Bird	Present
Elanus leucurus	White-tailed Kite	Bird	Present
Haliaeetus leucocephalus	Bald Eagle	Bird	Present
Cathartes aura	Turkey Vulture	Bird	Present
Pandion haliaetus	Osprey	Bird	Present
Aix sponsa	Wood Duck	Bird	Present
Anas acuta	Northern Pintail	Bird	Present
Anas crecca	Green-winged Teal	Bird	Present
Anas platyrhynchos	Mallard	Bird	Present
Anser albifrons	Greater White-fronted Goose	Bird	Present
Anser caerulescens	Snow Goose	Bird	Present
Anser canagicus	Emperor Goose	Bird	Present
Anser rossii	Ross's Goose	Bird	Present
Aythya affinis	Lesser Scaup	Bird	Present
Aythya americana	Redhead	Bird	Present
Aythya collaris	Ring-necked Duck	Bird	Present
Aythya fuligula	Tufted Duck	Bird	Present
Aythya marila	Greater Scaup	Bird	Present
Aythya valisineria	Canvasback	Bird	Present
Branta bernicla	Brant	Bird	Present
Branta canadensis	Canada Goose	Bird	Present
Bucephala albeola	Bufflehead	Bird	Present
Bucephala clangula	Common Goldeneye	Bird	Present
Clangula hyemalis	Long-tailed Duck	Bird	Present
Histrionicus histrionicus	Harlequin Duck	Bird	Present
Lophodytes cucullatus	Hooded Merganser	Bird	Present
Mareca americana	American Wigeon	Bird	Present
Mareca penelope	Eurasian Wigeon	Bird	Present
Mareca strepera	Gadwall	Bird	Present
Melanitta americana	Black Scoter	Bird	Present
Melanitta fusca	White-winged Scoter	Bird	Present
Melanitta perspicillata	Surf Scoter	Bird	Present
Mergus merganser	Common Merganser	Bird	Present
Mergus serrator	Red-breasted Merganser	Bird	Present
Oxyura jamaicensis	Ruddy Duck	Bird	Present
Somateria spectabilis	King Eider	Bird	Present
Spatula clypeata	Northern Shoveler	Bird	Present
Spatula cyanoptera	Cinnamon Teal	Bird	Present
Spatula discors	Blue-winged Teal	Bird	Present
Aeronautes saxatalis	White-throated Swift	Bird	Present
Chaetura vauxi	Vaux's Swift	Bird	Present
Cypseloides niger	Black Swift	Bird	Present
Archilochus alexandri	Black-chinned Hummingbird	Bird	Present
Calypte anna	Anna's Hummingbird	Bird	Present
Calypte costae	Costa's Hummingbird	Bird	Present
Selasphorus calliope	Calliope Hummingbird	Bird	Present
Selasphorus rufus	Rufous Hummingbird	Bird	Present
Selasphorus sasin	Allen's Hummingbird	Bird	Present
Chordeiles acutipennis	Lesser Nighthawk	Bird	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Phalaenoptilus nuttallii	Common Poorwill	Bird	Present
Brachyramphus marmoratus	Marbled Murrelet	Bird	Present
Cepphus columba	Pigeon Guillemot	Bird	Present
Cerorhinca monocerata	Rhinoceros Auklet	Bird	Present
Ptychoramphus aleuticus	Cassin's Auklet	Bird	Present
Synthliboramphus antiquus	Ancient Murrelet	Bird	Present
Synthliboramphus craveri	Craveri's Murrelet	Bird	Present
Synthliboramphus scrippsi	Scripps's Murrelet	Bird	Present
Uria aalge	Common Murre	Bird	Present
Charadrius montanus	Mountain Plover	Bird	Present
Charadrius nivosus nivosus	Western Snowy Plover	Bird	Present
Charadrius semipalmatus	Semipalmated Plover	Bird	Present
Charadrius vociferus	Killdeer	Bird	Present
Charadrius wilsonia	Wilson's Plover	Bird	Present
Pluvialis dominica	American Golden-Plover	Bird	Present
Pluvialis fulva	Pacific Golden-Plover	Bird	Present
Pluvialis squatarola	Black-bellied Plover	Bird	Present
Haematopus bachmani	Black Oystercatcher	Bird	Present
Chlidonias niger	Black Tern	Bird	Present
Chroicocephalus philadelphia	Bonaparte's Gull	Bird	Present
Hydroprogne caspia	Caspian Tern	Bird	Present
Larus argentatus	Herring Gull	Bird	Present
Larus californicus	California Gull	Bird	Present
Larus canus	Mew Gull	Bird	Present
Larus crassirostris	Black-tailed Gull	Bird	Present
Larus delawarensis	Ring-billed Gull	Bird	Present
Larus fuscus	Lesser Black-backed Gull	Bird	Present
Larus glaucescens	Glaucous-winged Gull	Bird	Present
Larus glaucoides thayeri	Thayer's Gull	Bird	Present
Larus heermanni	Heermann's Gull	Bird	Present
Larus hyperboreus	Glaucous Gull	Bird	Present
Larus occidentalis	Western Gull	Bird	Present
Leucophaeus atricilla	Laughing Gull	Bird	Present
Leucophaeus pipixcan	Franklin's Gull	Bird	Present
Rissa tridactyla	Black-legged Kittiwake	Bird	Present
Rynchops niger	Black Skimmer	Bird	Present
Sterna forsteri	Forster's Tern	Bird	Present
Sterna hirundo	Common Tern	Bird	Present
Sterna paradisaea	Arctic Tern	Bird	Present
Sternula antillarum browni	California Least Tern	Bird	Present
Thalasseus elegans	Elegant Tern	Bird	Present
Thalasseus maximus	Royal Tern	Bird	Present
Thalasseus sandvicensis	Sandwich Tern	Bird	Present
Xema sabini	Sabine's Gull	Bird	Present
Himantopus mexicanus	Black-necked Stilt	Bird	Present
Recurvirostra americana	American Avocet	Bird	Present
Actitis macularius	Spotted Sandpiper	Bird	Present
Arenaria interpres	Ruddy Turnstone	Bird	Present
Arenaria melanocephala	Black Turnstone	Bird	Present
Bartramia longicauda	Upland Sandpiper	Bird	Present
Calidris alba	Sanderling	Bird	Present
Calidris alpina	Dunlin	Bird	Present
Calidris bairdii	Baird's Sandpiper	Bird	Present
Calidris canutus	Red Knot	Bird	Present
Calidris ferruginea	Curlew Sandpiper	Bird	Present
Calidris himantopus	Stilt Sandpiper	Bird	Present
Calidris mauri	Western Sandpiper	Bird	Present
Calidris melanotos	Pectoral Sandpiper	Bird	Present
Calidris minutilla	Least Sandpiper	Bird	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Calidris pugnax	Ruff	Bird	Present
Calidris pusilla	Semipalmated Sandpiper	Bird	Present
Calidris virgata	Surfbird	Bird	Present
Catoptrophorus semipalmatus	Willet	Bird	Present
Gallinago delicata	Wilson's Snipe	Bird	Present
Heteroscelus incanus	Wandering Tattler	Bird	Present
Limnodromus griseus	Short-billed Dowitcher	Bird	Present
Limnodromus scolopaceus	Long-billed Dowitcher	Bird	Present
Limosa fedoa	Marbled Godwit	Bird	Present
Limosa haemastica	Hudsonian Godwit	Bird	Present
Limosa lapponica	Bar-tailed Godwit	Bird	Present
Numenius americanus	Long-billed Curlew	Bird	Present
Numenius phaeopus	Whimbrel	Bird	Present
Phalaropus fulicarius	Red Phalarope	Bird	Present
Phalaropus lobatus	Red-necked Phalarope	Bird	Present
Phalaropus tricolor	Wilson's Phalarope	Bird	Present
Tringa flavipes	Lesser Yellowlegs	Bird	Present
Tringa melanoleuca	Greater Yellowlegs	Bird	Present
Tringa solitaria	Solitary Sandpiper	Bird	Present
Stercorarius maccormicki	South Polar Skua	Bird	Present
Stercorarius parasiticus	Parasitic Jaeger	Bird	Present
Stercorarius pomarinus	Pomarine Jaeger	Bird	Present
Columba livia	Rock Pigeon	Bird	Present
Columbina passerina	Common Ground-Dove	Bird	Present
Patagioenas fasciata	Band-tailed Pigeon	Bird	Present
Streptopelia chinensis	Spotted Dove	Bird	Present
Streptopelia decaocto	Eurasian Collared-Dove	Bird	Present
Zenaida asiatica	White-winged Dove	Bird	Present
Zenaida macroura	Mourning Dove	Bird	Present
Megaceryle alcyon	Belted Kingfisher	Bird	Present
Coccyzus americanus	Yellow-billed Cuckoo	Bird	Present
Geococcyx californianus	Greater Roadrunner	Bird	Present
Caracara cheriway	Crested Caracara	Bird	Present
Falco columbarius	Merlin	Bird	Present
Falco mexicanus	Prairie Falcon	Bird	Present
Falco peregrinus	Peregrine Falcon	Bird	Present
Falco sparverius	American Kestrel	Bird	Present
Callipepla californica	California Quail	Bird	Present
Oreortyx pictus	Mountain Quail	Bird	Present
Pavo cristatus	Indian Peafowl	Bird	Present
Gavia adamsii	Yellow-billed Loon	Bird	Present
Gavia arctica	Arctic Loon	Bird	Present
Gavia immer	Common Loon	Bird	Present
Gavia pacifica	Pacific Loon	Bird	Present
Gavia stellata	Red-throated Loon	Bird	Present
Antigone canadensis	Sandhill Crane	Bird	Present
Fulica americana	American Coot	Bird	Present
Gallinula galeata	Common Gallinule	Bird	Present
Porzana carolina	Sora	Bird	Present
Rallus limicola	Virginia Rail	Bird	Present
Rallus obsoletus	Ridgway's Rail	Bird	Present
Psaltriparus minimus	Bushtit	Bird	Present
Eremophila alpestris actia	California Horned Lark	Bird	Present
Bombycilla cedrorum	Cedar Waxwing	Bird	Present
Passerina amoena	Lazuli Bunting	Bird	Present
Passerina caerulea	Blue Grosbeak	Bird	Present
Passerina cyanea	Indigo Bunting	Bird	Present
Pheucticus ludovicianus	Rose-breasted Grosbeak	Bird	Present
Pheucticus melanocephalus	Black-headed Grosbeak	Bird	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Piranga ludoviciana	Western Tanager	Bird	Present
Piranga olivacea	Scarlet Tanager	Bird	Probably Present (Adj., Hist.)
Piranga rubra	Summer Tanager	Bird	Present
Spiza americana	Dickcissel	Bird	Present
Certhia americana	Brown Creeper	Bird	Present
Cinclus mexicanus	American Dipper	Bird	Present
Aphelocoma californica	California Scrub-Jay	Bird	Present
Corvus brachyrhynchos	American Crow	Bird	Present
Corvus corax	Common Raven	Bird	Present
Cyanocitta stelleri	Steller's Jay	Bird	Present
Nucifraga columbiana	Clark's Nutcracker	Bird	Present
Aimophila ruficeps	Rufous-crowned Sparrow	Bird	Present
Ammodramus nelsoni	Nelson's Sparrow	Bird	Probably Present (Adj., Hist.)
Ammodramus savannarum	Grasshopper Sparrow	Bird	Present
Amphispiza bilineata	Black-throated Sparrow	Bird	Present
Artemisiospiza belli	Bell's Sparrow	Bird	Present
Calamospiza melanocorys	Lark Bunting	Bird	Present
Chondestes grammacus	Lark Sparrow	Bird	Present
Junco hyemalis	Dark-eyed Junco	Bird	Present
Melospiza georgiana	Swamp Sparrow	Bird	Present
Melospiza lincolnii	Lincoln's Sparrow	Bird	Present
Melospiza melodia	Song Sparrow	Bird	Present
Melozone crissalis	California Towhee	Bird	Present
Passerculus sandwichensis beldingi	Belding's Savannah Sparrow	Bird	Present
Passerculus sandwichensis nevadensis	Savannah Sparrow (nevadensis)	Bird	Present
Passerculus sandwichensis rostratus	Large-billed Savannah Sparrow	Bird	Present
Passerella iliaca	Fox Sparrow	Bird	Present
Pipilo chlorurus	Green-tailed Towhee	Bird	Present
Pipilo maculatus	Spotted Towhee	Bird	Present
Pooecetes gramineus	Vesper Sparrow	Bird	Present
Spizella atrogularis	Black-chinned Sparrow	Bird	Present
Spizella breweri	Brewer's Sparrow	Bird	Present
Spizella pallida	Clay-colored Sparrow	Bird	Present
Spizella passerina	Chipping Sparrow	Bird	Present
Zonotrichia albicollis	White-throated Sparrow	Bird	Present
Zonotrichia atricapilla	Golden-crowned Sparrow	Bird	Present
Zonotrichia leucophrys	White-crowned Sparrow	Bird	Present
Zonotrichia querula	Harris's Sparrow	Bird	Present
Lonchura punctulata	Scaly-breasted Munia	Bird	Present
Haemorhous cassinii	Cassin's Finch	Bird	Present
Haemorhous mexicanus	House Finch	Bird	Present
Haemorhous purpureus	Purple Finch	Bird	Present
Loxia curvirostra	Red Crossbill	Bird	Present
Spinus lawrencei	Lawrence's Goldfinch	Bird	Present
Spinus pinus	Pine Siskin	Bird	Present
Spinus psaltria	Lesser Goldfinch	Bird	Present
Spinus tristis	American Goldfinch	Bird	Present
Hirundo rustica	Barn Swallow	Bird	Present
Petrochelidon pyrrhonota	Cliff Swallow	Bird	Present
Progne subis	Purple Martin	Bird	Present
Riparia riparia	Bank Swallow	Bird	Present
Stelgidopteryx serripennis	Northern Rough-winged Swallow	Bird	Present
Tachycineta bicolor	Tree Swallow	Bird	Present
Tachycineta thalassina	Violet-green Swallow	Bird	Present
Agelaius phoeniceus	Red-winged Blackbird	Bird	Present
Agelaius tricolor	Tricolored Blackbird	Bird	Present
Dolichonyx oryzivorus	Bobolink	Bird	Present
Euphagus carolinus	Rusty Blackbird	Bird	Present
Euphagus cyanocephalus	Brewer's Blackbird	Bird	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Icterus bullockii	Bullock's Oriole	Bird	Present
Icterus cucullatus	Hooded Oriole	Bird	Present
Icterus galbula	Baltimore Oriole	Bird	Present
Icterus parisorum	Scott's Oriole	Bird	Present
Molothrus ater	Brown-headed Cowbird	Bird	Present
Quiscalus mexicanus	Great-tailed Grackle	Bird	Present
Sturnella neglecta	Western Meadowlark	Bird	Present
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	Bird	Present
Lanius ludovicianus	Loggerhead Shrike	Bird	Present
Mimus polyglottos	Northern Mockingbird	Bird	Present
Oreoscoptes montanus	Sage Thrasher	Bird	Present
Toxostoma redivivum	California Thrasher	Bird	Present
Toxostoma rufum	Brown Thrasher	Bird	Present
Anthus rubescens	American Pipit	Bird	Present
Motacilla tschutschensis	Eastern Yellow Wagtail	Bird	Present
Oenanthe oenanthe	Northern Wheatear	Bird	Present
Baeolophus inornatus	Oak Titmouse	Bird	Present
Poecile gambeli	Mountain Chickadee	Bird	Present
Cardellina canadensis	Canada Warbler	Bird	Probably Present (Adj., Hist.)
Cardellina pusilla	Wilson's Warbler	Bird	Present
Geothlypis tolmiei	Macgillivray's Warbler	Bird	Present
Geothlypis trichas	Common Yellowthroat	Bird	Present
Helmitheros vermivorum	Worm-eating Warbler	Bird	Probably Present (Adj., Hist.)
Icteria virens	Yellow-breasted Chat	Bird	Present
Mniotilta varia	Black-and-white Warbler	Bird	Present
Myioborus pictus	Painted Redstart	Bird	Present
Oporornis agilis	Connecticut Warbler	Bird	Probably Present (Adj., Hist.)
Oreothlypis celata	Orange-crowned Warbler	Bird	Present
Oreothlypis luciae	Lucy's Warbler	Bird	Present
Oreothlypis peregrina	Tennessee Warbler	Bird	Present
Oreothlypis ruficapilla	Nashville Warbler	Bird	Present
Oreothlypis virginiae	Virginia's Warbler	Bird	Present
Parkesia noveboracensis	Northern Waterthrush	Bird	Present
Protonotaria citrea	Prothonotary Warbler	Bird	Probably Present (Adj., Hist.)
Setophaga americana	Northern Parula	Bird	Present
Setophaga caerulescens	Black-throated Blue Warbler	Bird	Present
Setophaga castanea	Bay-breasted Warbler	Bird	Present
Setophaga coronata	Yellow-rumped Warbler	Bird	Present
Setophaga discolor	Prairie Warbler	Bird	Present
Setophaga dominica	Yellow-throated Warbler	Bird	Present
Setophaga fusca	Blackburnian Warbler	Bird	Present
Setophaga magnolia	Magnolia Warbler	Bird	Present
Setophaga nigrescens	Black-throated Gray Warbler	Bird	Present
Setophaga occidentalis	Hermit Warbler	Bird	Present
Setophaga palmarum	Palm Warbler	Bird	Present
Setophaga pensylvanica	Chestnut-sided Warbler	Bird	Present
Setophaga petechia	Yellow Warbler	Bird	Present
Setophaga ruticilla	American Redstart	Bird	Present
Setophaga striata	Blackpoll Warbler	Bird	Present
Setophaga townsendi	Townsend's Warbler	Bird	Present
Setophaga virens	Black-throated Green Warbler	Bird	Probably Present (Adj., Hist.)
Passer domesticus	House Sparrow	Bird	Present
Euplectes franciscanus	Northern Red Bishop	Bird	Present
Polioptila caerulea	Blue-gray Gnatcatcher	Bird	Present
Polioptila californica	California Gnatcatcher	Bird	Present
Phainopepla nitens	Phainopepla	Bird	Present
Pycnonotus jocosus	Red-whiskered Bulbul	Bird	Present
Regulus calendula	Ruby-crowned Kinglet	Bird	Present
Regulus satrapa	Golden-crowned Kinglet	Bird	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Sitta canadensis	Red-breasted Nuthatch	Bird	Present
Sitta carolinensis	White-breasted Nuthatch	Bird	Present
Sitta pygmaea	Pygmy Nuthatch	Bird	Present
Sturnus vulgaris	European Starling	Bird	Present
Chamaea fasciata	Wrentit	Bird	Present
Campylorhynchus brunneicapillus couesi	Northern Cactus Wren	Bird	Present
Catherpes mexicanus	Canyon Wren	Bird	Present
Cistothorus palustris	Marsh Wren	Bird	Present
Salpinctes obsoletus	Rock Wren	Bird	Present
Thryomanes bewickii	Bewick's Wren	Bird	Present
Troglodytes aedon	House Wren	Bird	Present
Troglodytes pacificus	Pacific Wren	Bird	Present
Catharus guttatus	Hermit Thrush	Bird	Present
Catharus ustulatus	Swainson's Thrush	Bird	Present
Ixoreus naevius	Varied Thrush	Bird	Present
Myadestes townsendi	Townsend's Solitaire	Bird	Present
Sialia currucoides	Mountain Bluebird	Bird	Present
Sialia mexicana	Western Bluebird	Bird	Present
Turdus migratorius	American Robin	Bird	Present
Contopus cooperi	Olive-sided Flycatcher	Bird	Present
Contopus pertinax	Greater Pewee	Bird	Present
Contopus sordidulus	Western Wood-Pewee	Bird	Present
Empidonax difficilis	Pacific-slope Flycatcher	Bird	Present
Empidonax hammondii	Hammond's Flycatcher	Bird	Present
Empidonax minimus	Least Flycatcher	Bird	Present
Empidonax oberholseri	Dusky Flycatcher	Bird	Present
Empidonax traillii	Willow Flycatcher	Bird	Present
Empidonax wrightii	Gray Flycatcher	Bird	Present
Myiarchus cinerascens	Ash-throated Flycatcher	Bird	Present
Myiarchus crinitus	Great Crested Flycatcher	Bird	Present
Myiarchus tuberculifer	Dusky-capped Flycatcher	Bird	Present
Pyrocephalus rubinus	Vermilion Flycatcher	Bird	Present
Sayornis nigricans	Black Phoebe	Bird	Present
Sayornis phoebe	Eastern Phoebe	Bird	Present
Sayornis saya	Say's Phoebe	Bird	Present
Tyrannus forficatus	Scissor-tailed Flycatcher	Bird	Present
Tyrannus melancholicus	Tropical Kingbird	Bird	Present
Tyrannus tyrannus	Eastern Kingbird	Bird	Present
Tyrannus verticalis	Western Kingbird	Bird	Present
Tyrannus vociferans	Cassin's Kingbird	Bird	Present
Vireo bellii pusillus	Least Bell's Vireo	Bird	Present
Vireo cassinii	Cassin's Vireo	Bird	Present
Vireo flavoviridis	Yellow-green Vireo	Bird	Present
Vireo gilvus	Warbling Vireo	Bird	Present
Vireo huttoni	Hutton's Vireo	Bird	Present
Vireo olivaceus	Red-eyed Vireo	Bird	Present
Vireo philadelphicus	Philadelphia Vireo	Bird	Present
Vireo plumbeus	Plumbeous Vireo	Bird	Present
Ardea alba	Great Egret	Bird	Present
Ardea herodias	Great Blue Heron	Bird	Present
Botaurus lentiginosus	American Bittern	Bird	Present
Bubulcus ibis	Cattle Egret	Bird	Present
Butorides virescens	Green Heron	Bird	Present
Egretta caerulea	Little Blue Heron	Bird	Present
Egretta rufescens	Reddish Egret	Bird	Present
Egretta thula	Snowy Egret	Bird	Present
Egretta tricolor	Tricolored Heron	Bird	Present
Ixobrychus exilis	Least Bittern	Bird	Present
Nyctanassa violacea	Yellow-crowned Night-Heron	Bird	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Nycticorax nycticorax	Black-crowned Night-Heron	Bird	Present
Pelecanus erythrorhynchos	American White Pelican	Bird	Present
Pelecanus occidentalis	Brown Pelican	Bird	Present
Plegadis chihi	White-faced Ibis	Bird	Present
Colaptes auratus	Northern Flicker	Bird	Present
Melanerpes formicivorus	Acorn Woodpecker	Bird	Present
Melanerpes lewis	Lewis's Woodpecker	Bird	Present
Picoides nuttallii	Nuttall's Woodpecker	Bird	Present
Picoides pubescens	Downy Woodpecker	Bird	Present
Picoides villosus	Hairy Woodpecker	Bird	Present
Sphyrapicus nuchalis	Red-naped Sapsucker	Bird	Present
Sphyrapicus ruber	Red-breasted Sapsucker	Bird	Present
Sphyrapicus thyroideus	Williamson's Sapsucker	Bird	Present
Sphyrapicus varius	Yellow-bellied Sapsucker	Bird	Present
Aechmophorus clarkii	Clark's Grebe	Bird	Present
Aechmophorus occidentalis	Western Grebe	Bird	Present
Podiceps auritus	Horned Grebe	Bird	Present
Podiceps grisegena	Red-necked Grebe	Bird	Present
Podiceps nigricollis	Eared Grebe	Bird	Present
Podilymbus podiceps	Pied-billed Grebe	Bird	Present
Oceanodroma homochroa	Ashy Storm-Petrel	Bird	Present
Oceanodroma melania	Black Storm-Petrel	Bird	Present
Oceanodroma microsoma	Least Storm-Petrel	Bird	Present
Ardenna creatopus	Pink-footed Shearwater	Bird	Present
Ardenna grisea	Sooty Shearwater	Bird	Present
Ardenna tenuirostris	Short-tailed Shearwater	Bird	Present
Fulmarus glacialis	Northern Fulmar	Bird	Present
Pterodroma inexpectata	Mottled Petrel	Bird	Present
Puffinus opisthomelas	Black-vented Shearwater	Bird	Present
Amazona oratrix	Yellow-headed Parrot	Bird	Present
Amazona viridigenalis	Red-crowned Parrot	Bird	Present
Aratinga nenday	Nanday Parakeet	Bird	Present
Brotogeris chiriri	Yellow-chevroned Parakeet	Bird	Present
Psittacara mitratus	Mitred Parakeet	Bird	Present
Psittacula krameri	Rose-ringed Parakeet	Bird	Present
Asio flammeus	Short-eared Owl	Bird	Probably Present
Asio otus	Long-eared Owl	Bird	Present
Athene cunicularia	Burrowing Owl	Bird	Present
Bubo virginianus	Great Horned Owl	Bird	Present
Megascops kennicottii	Western Screech-Owl	Bird	Present
Tyto alba	Barn Owl	Bird	Present
Fregata magnificens	Magnificent Frigatebird	Bird	Present
Phalacrocorax auritus	Double-crested Cormorant	Bird	Present
Phalacrocorax pelagicus	Pelagic Cormorant	Bird	Present
Phalacrocorax penicillatus	Brandt's Cormorant	Bird	Present
Sula dactylatra	Masked Booby	Bird	Present
Aneides lugubris	Arboreal Salamander	Reptile/Amphibian	Present
Anniella stebbinsi	Legless Lizard	Reptile/Amphibian	Present
Aspidoscelis tigris	Tiger Whiptail	Reptile/Amphibian	Present
Batrachoseps major	Garden Slender Salamander	Reptile/Amphibian	Present
Batrachoseps nigriventris	Black-bellied Slender Salamander	Reptile/Amphibian	Present
Batrachoseps pacificus	Pacific Slender Salamander	Reptile/Amphibian	Present
Batrachoseps species	Unknown Batrachoseps species	Reptile/Amphibian	Present
Bufo boreas	California Toad	Reptile/Amphibian	Present
Coluber constrictor	Western Yellowbelly Racer	Reptile/Amphibian	Present
Coluber flagellum	Red Racer	Reptile/Amphibian	Present
Coluber lateralis	Western Yellowbelly Racer	Reptile/Amphibian	Present
Crotalus oreganus	Southern Pacific Rattlesnake	Reptile/Amphibian	Present
Diadophis punctatus	San Bernardino Ringneck Snake	Reptile/Amphibian	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Elgaria multicarinata	Southern Alligator Lizard	Reptile/Amphibian	Present
Ensatina eschscholtzii	Monterey Ensatina	Reptile/Amphibian	Present
Hypsiglena ochrorhyncha	San Diego Night Snake	Reptile/Amphibian	Present
Lampropeltis californiae	California Kingsnake	Reptile/Amphibian	Present
Lampropeltis multifasciata	Coast Mountain Kingsnake	Reptile/Amphibian	Present
Leptotyphlops humilis	Southwestern Blind Snake	Reptile/Amphibian	Present
Lithobates catesbeianus	Bullfrog	Reptile/Amphibian	Present
Phrynosoma blainvillii	California Horned Lizard	Reptile/Amphibian	Present
Pituophis catenifer	San Diego Gopher Snake	Reptile/Amphibian	Present
Plestiodon skiltonianus	Western Skink	Reptile/Amphibian	Present
Pseudacris cadaverina	California Treefrog	Reptile/Amphibian	Present
Pseudacris hyppchondriaca	Baja California Treefrog	Reptile/Amphibian	Present
Rana aurora	California Red-legged Frog	Reptile/Amphibian	Present
Salvadora hexalepis	Coast Patchnose Snake	Reptile/Amphibian	Present
Sceloporus occidentalis	Great Basin Fence Lizard	Reptile/Amphibian	Present
Spea hammondii	Western Spadefoot	Reptile/Amphibian	Present
Tantilla planiceps	Western Blackhead Snake	Reptile/Amphibian	Present
Taricha torosa	California Newt	Reptile/Amphibian	Present
Thamnophis hammondii	Two-striped Garter Snake	Reptile/Amphibian	Present
Thamnophis sirtalis	California Red-sided Garter Snake	Reptile/Amphibian	Present
Trimorphodon lyrophanes	California Lyre Snake	Reptile/Amphibian	Present
Uta stansburiana	Side-blotched Lizard	Reptile/Amphibian	Present
Didelphis virginiana	Virginia Opossum	Mammal	Present
Notiosorex crawfordi	Desert Shrew	Mammal	Present
Sorex ornatus	Ornate Shrew	Mammal	Present
Scapanus latimanus	Broad-footed Mole	Mammal	Present
Macrotus californicus	California Leaf-nosed Bat	Mammal	Present
Antrozous pallidus	Pallid Bat	Mammal	Present
Eptesicus fuscus	Big Brown Bat	Mammal	Present
Euderma maculatum	Spotted Bat	Mammal	Present
Lasionycteris noctivagans	Silver-haired Bat	Mammal	Present
Lasiurus borealis	Red Bat	Mammal	Present
Lasiurus cinereus	Hoary Bat	Mammal	Present
Myotis californicus	California Myotis	Mammal	Present
Myotis evotis	Long-eared Myotis	Mammal	Present
Myotis leibii	Small-footed Myotis	Mammal	Present
Myotis thysanodes	Fringed Myotis	Mammal	Present
Myotis volans	Long-legged Myotis	Mammal	Present
Myotis yumanensis	Yuma Myotis	Mammal	Present
Pipistrellus hesperus	Western Pipistrelle	Mammal	Present
Plecotus townsendii townsendii	Townsend's Big-eared Bat	Mammal	Present
Eumops perotis	Western Mastiff Bat	Mammal	Present
Nyctinomops femorosaccus	Pocketed Free-tailed Bat	Mammal	Present
Tadarida brasiliensis	Mexican Free-tailed Bat	Mammal	Present
Procyon lotor	Raccoon	Mammal	Present
Bassariscus astutus	Ringtail	Mammal	Present
Mephitis mephitis	Striped Skunk	Mammal	Present
Spilogale putorius	Spotted Skunk	Mammal	Present
Mustela frenata	Long-tailed Weasel	Mammal	Present
Taxidea taxus	Badger	Mammal	Present
Canis latrans	Coyote	Mammal	Present
Urocyon cinereoargenteus	Gray Fox	Mammal	Present
Vulpes vulpes	Red Fox	Mammal	Present
Lynx rufus	Bobcat	Mammal	Present
Puma concolor	Mountain Lion	Mammal	Present
Otospermophilus beecheyi	California Ground Squirrel	Mammal	Present
Sciurus griseus	Western Gray Squirrel	Mammal	Present
Sciurus niger	Fox Squirrel	Mammal	Present
Tamias merriami	Merriam's Chipmunk	Mammal	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Thomomys bottae	Botta's Pocket Gopher	Mammal	Present
Dipodomys agilis	Pacific Kangaroo Rat	Mammal	Present
Chaetodipus californicus	California Pocket Mouse	Mammal	Present
Microtus californicus	California Vole	Mammal	Present
Neotoma fuscipes	Dusky-footed Woodrat	Mammal	Present
Neotoma lepida	Desert Woodrat	Mammal	Present
Peromyscus boylii	Brush Mouse	Mammal	Present
Peromyscus californicus	California Mouse	Mammal	Present
Peromyscus eremicus	Cactus Mouse	Mammal	Present
Peromyscus maniculatus	Deer Mouse	Mammal	Present
Peromyscus truei	Pinon Mouse	Mammal	Present
Reithrodontomys megalotis	Western Harvest Mouse	Mammal	Present
Mus musculus	House Mouse	Mammal	Present
Rattus norvegicus	Norway Rat	Mammal	Present
Rattus rattus	Black Rat	Mammal	Present
Lepus californicus	Black-tailed Jack Rabbit	Mammal	Present
Sylvilagus audubonii	Desert Cottontail	Mammal	Present
Sylvilagus bachmani	Brush Rabbit	Mammal	Present
Odocoileus hemionus	Mule Deer	Mammal	Present
Abedus indentatus	Toe Biter	Invertebrate	Present
Ablabesmyia spp.	Ablabesmyia Spp.	Invertebrate	Present
Acmaeodera spp.	Acmaeodera Spp.	Invertebrate	Present
Acrididae	Grasshopper (Acrididae)	Invertebrate	Present
Acrotrichus spp.	Acrotrichus Spp.	Invertebrate	Present
Adela	Adela	Invertebrate	Present
Adelpha bredowii californicus	California Sister (A. B. Californicus)	Invertebrate	Present
Aegialia	Aegialia	Invertebrate	Present
Aeshna spp.	Darner (Aeshna Spp.)	Invertebrate	Present
Agabus spp.	Diving Beetle (Agabus Spp.)	Invertebrate	Present
Agapostemon spp.	Metallic Sweat Bee (Agapostemon Spp.)	Invertebrate	Present
Agelenidae	Grass Spider	Invertebrate	Present
Agromyzidae	Leafminer Fly (Agromyzidae)	Invertebrate	Present
Aleochara sulcicollis	Beetle (A. Sulcicollis)	Invertebrate	Present
Aleyrodidae	Whitefly (Aleyrodidae)	Invertebrate	Present
Aloms	Aloms	Invertebrate	Present
Alticinae	Alticinae	Invertebrate	Present
Amartus spp.	Beetle (Amartus Spp.)	Invertebrate	Present
Ameletidae	Ameletidae	Invertebrate	Present
Ammophila spp.	Ammophila Spp.	Invertebrate	Present
Amphipoda	Amphipod	Invertebrate	Present
Anaspis collaris	Beetle (A. Collaris)	Invertebrate	Present
Anchomenus funebris	Anchomenus Funebris	Invertebrate	Present
Andrena spp.	Adrenine Bee (Andrena Spp.)	Invertebrate	Present
Anihomyiidae	Anihomyiidae	Invertebrate	Present
Anobiidae	Pantry Beetle (Anobiidae)	Invertebrate	Present
Anopheles spp.	Anopheles Spp.	Invertebrate	Present
Anthaxia spp.	Metallic Wood-Boring Beetle (Anthaxia Spp.)	Invertebrate	Present
Anthicidae	Antlike Flower Beetle (Anthicidae)	Invertebrate	Present
Anthicus spp.	Antlike Flower Beetle (Anthicus Spp.)	Invertebrate	Present
Anthidium spp.	Leaf-Cutting Bee (Anthidium Spp.)	Invertebrate	Present
Anthocharis sara	Sara'S Orangetip	Invertebrate	Present
Anthocoridae	Minute Pirate Bug (Anthocoridae)	Invertebrate	Present
Anthrenus lepidus	Carpet Beetle (A. Lepidus)	Invertebrate	Present
Aphididae	Aphid (Aphididae)	Invertebrate	Present
Apidae	True Bee (Apidae)	Invertebrate	Present
Apiomerus spp.	Assassin Bug (Apiomerus Spp.)	Invertebrate	Present
Apis mellifera	Honey Bee	Invertebrate	Present
Apocellus spp.	Rove Beetle (Apocellus Spp.)	Invertebrate	Present
Apocrita	Parasitic Wasp (Apocrita)	Invertebrate	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Apoidea	Bee (Apoidea)	Invertebrate	Present
Apsena rufipes	Apsena Rufipes	Invertebrate	Present
Aquarius remigis	Aquarius Remigis	Invertebrate	Present
Aquarius spp.	Water Strider (Aquarius Spp.)	Invertebrate	Present
Arachnida	Arachnid (Arachnida)	Invertebrate	Present
Araneae	Spider (Araneae)	Invertebrate	Present
Araneus spp.	(Araneus Spp.)	Invertebrate	Present
Archiearis spp.	Orange Underwing (Archiearis Spp.)	Invertebrate	Present
Archilestes californicus	California Spreadwing	Invertebrate	Present
Arctiidae	Tiger Moth (Arctiidae)	Invertebrate	Present
Argia spp.	Damselfly (Argia Spp.)	Invertebrate	Present
Arhyssus spp.	Plant Bug (Arhyssus Spp.)	Invertebrate	Present
Arrenurus spp.	Arachnid (Arrenurus Spp.)	Invertebrate	Present
Ashmeadiella spp.	Leaf-Cutting Bee (Ashmeadiella Spp.)	Invertebrate	Present
Asilidae	Robber Fly (Asilidae)	Invertebrate	Present
Astenus	Astenus Sp.	Invertebrate	Present
Ataenius spp.	Scarab Beetle (Ataenius Spp.)	Invertebrate	Present
Athericidae	Athericidae	Invertebrate	Present
Attelabidae	Attelabidae	Invertebrate	Present
Autographa californica	Alfalfa Looper	Invertebrate	Present
Baetidae	Mayfly (Baetidae)	Invertebrate	Present
Baetis spp.	Mayfly (Baetis Spp.)	Invertebrate	Present
banded moth	Banded Moth	Invertebrate	Present
Banded snout moth	Banded Snout Moth	Invertebrate	Present
banded underwing	Banded Underwing	Invertebrate	Present
Berosus spp.	Berosus Spp.	Invertebrate	Present
Bethylidae	Bethylidae	Invertebrate	Present
bicid beetle	Bicid Beetle	Invertebrate	Present
Blapstinus spp.	Darkling Beetle (Blapstinus Spp.)	Invertebrate	Present
Blattodea	Cockroaches	Invertebrate	Present
Bledius fenyesi	Rove Beetle (B. Fenyesi)	Invertebrate	Present
bloody ladybird beetle	Bloody Ladybird Beetle	Invertebrate	Present
Bombus californicus	California Bumble Bee	Invertebrate	Present
Bombus spp.	Bumble Bee (Bombus Spp.)	Invertebrate	Present
Bombus vosnesenskii	Vonesenski'S Bumble Bee	Invertebrate	Present
Bombyliidae	Bee Fly (Bombyliidae)	Invertebrate	Present
Bombylius major	Bee Fly (B. Major)	Invertebrate	Present
Bombylius spp.	Bee Fly (Bombylius Spp.)	Invertebrate	Present
Bothriocyrtum californicum	California Trapdoor Spider	Invertebrate	Present
Brachinus spp.	Bombardier Beetle (Brachinus Spp.)	Invertebrate	Present
Brachycera	Picture Wing Fly (Brachycera)	Invertebrate	Present
Braconidae	Brachonid Wasp (Braconidae)	Invertebrate	Present
Brephidium exilis	Pygmy Blue	Invertebrate	Present
bronze moth	Bronze Moth	Invertebrate	Present
Brothylus spp.	Brothylus Spp.	Invertebrate	Present
Brown snout moth	Brown Snout Moth	Invertebrate	Present
Bruchidae	Seed Bettle (Bruchidae)	Invertebrate	Present
Buenoa spp.	Backswimmer (Buenoa Spp.)	Invertebrate	Present
Buprestidae	Metallic Wood-Boring Beetle (Buprestidae)	Invertebrate	Present
butter moth	Butter Moth	Invertebrate	Present
Caelifera	Short-Horned Grasshopper (Caelifera)	Invertebrate	Present
Caenis spp.	Mayfly (Caenis Spp.)	Invertebrate	Present
Cafius spp.	Rove Beetle (Cafius Spp.)	Invertebrate	Present
Calathus ruficollis	Rufous Ground Beetle	Invertebrate	Present
Callibaetis spp.	Mayfly (Callibaetis Spp.)	Invertebrate	Present
Calliphoridae	Blow Fly (Calliphoridae)	Invertebrate	Present
Calosoma spp.	Ground Beetle (Calosoma Spp.)	Invertebrate	Present
Camponotus anthrax	Camponatus Anthrax	Invertebrate	Present
Camponotus clarithorax	Carpenter Ant (C. Clarithorax)	Invertebrate	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Camponotus dumetorum	Camponatus Dumetorum	Invertebrate	Present
Camponotus semitestaceus	Carpenter Ant (C. Semitestaceus)	Invertebrate	Present
Canaceidae	Surf Fly (Canaceidae)	Invertebrate	Present
Canatharidae	Soldier Beetle (Canatharidae)	Invertebrate	Present
Cantharidae	Cantharidae	Invertebrate	Present
Carabidae	Ground Beetle (Carabidae)	Invertebrate	Present
Cardiocondyla mauritanica	Cardiocondyla Mauritanica	Invertebrate	Present
Carpophilus spp.	Beetle (Carpophilus Spp.)	Invertebrate	Present
Catocala spp.	Underwing (Catocala Spp.)	Invertebrate	Present
Cecidomyiidae	Gall Gnat (Cecidomyiidae)	Invertebrate	Present
Centrodera oculata	Long-Horned Beetle (C. Oculata)	Invertebrate	Present
Centrodera spurca	Long-Horned Beetle (C. Spurca)	Invertebrate	Present
Cerambycidae	Long-Horned Beetle (Cerambycidae)	Invertebrate	Present
Ceraphronidae	Ceraphronid Wasp (Ceraphronidae)	Invertebrate	Present
Ceratina spp.	Bumble Bee (Ceratina Spp.)	Invertebrate	Present
Ceratopogonidae	Punkie (Ceratopogonidae)	Invertebrate	Present
Ceratopsyche spp.	Caddisfly (Ceratopsyche Spp.)	Invertebrate	Present
Cerceris spp.	Cerceris Spp.	Invertebrate	Present
Cercyon fimbriatus	Water Scavenger Beetle (C. Fimbriatus)	Invertebrate	Present
Chaetarthria spp.	Water Scavenger Beetle (Chaetarthria Spp.)	Invertebrate	Present
Chalcididae	Chalcidid Wasp (Chalcididae)	Invertebrate	Present
Chamaemyiidae	Chamaemyiidae	Invertebrate	Present
Chilopoda	Centipede, Millipede (Chilopoda)	Invertebrate	Present
Chironomidae	Water Midge (Chironomidae)	Invertebrate	Present
Chironomus spp.	Chironomus Spp.	Invertebrate	Present
Chlaenius spp.	False Bombardier (Chlaenius Spp.)	Invertebrate	Present
Chlorochroa spp.	Chlorochroa Spp.	Invertebrate	Present
Chloropidae	Chloropid Fly (Chloropidae)	Invertebrate	Present
Chrysididae	Cuckoo Wasp (Chrysididae)	Invertebrate	Present
Chrysobothris spp.	Chrysobothris Spp.	Invertebrate	Present
Chrysochus spp.	Chrysochus Spp.	Invertebrate	Present
Chrysomelidae	Leaf Beetle (Chrysomelidae)	Invertebrate	Present
Chrysoperla spp.	Chrysoperla Spp.	Invertebrate	Present
Chrysopidae	Lacewing (Chrysopidae)	Invertebrate	Present
Chyromyidae	Chiromyid Fly (Chyromyidae)	Invertebrate	Present
Cicadellidae	Leafhopper (Cicadellidae)	Invertebrate	Present
Cicadidae	Cicada (Cicadidae)	Invertebrate	Present
Cixiidae	Cixid Planthopper (Cixiidae)	Invertebrate	Present
Cleptes spp.	Cleptes Spp.	Invertebrate	Present
Cleridae	Checkered Beetle (Cleridae)	Invertebrate	Present
Clostera spp.	Clostera Spp.	Invertebrate	Present
Coccinella novemnotata	Nine-Spot Ladybird Beetle	Invertebrate	Present
Coccinella septempunctata	Seven-Spott Ladybird Beetle	Invertebrate	Present
Coccinellidae	Ladybird Beetle (Coccinellidae)	Invertebrate	Present
Coelocnemis californica	Eleodes Giant	Invertebrate	Present
Coelus ciliatus	Ciliate Dune Beetle	Invertebrate	Present
Coenagrionidae	Dancer (Coenagrionidae)	Invertebrate	Present
Coenonympha californica	California Ringlet (C. Californica)	Invertebrate	Present
Coenonympha tullia californica	California Ringlet	Invertebrate	Present
Coleoptera	Beetle (Coleoptera)	Invertebrate	Present
Coliadinae	Sulphur Butterfly (Coliadinae)	Invertebrate	Present
Colias eurytheme	Orange Sulphur	Invertebrate	Present
Colias harfordii	Harford'S Sulphur	Invertebrate	Present
Colias philodice	Clouded Sulphur	Invertebrate	Present
Coniontis	Coniontis Sp.	Invertebrate	Present
Coniopterygidae	Dusty-Wing (Coniopterygidae)	Invertebrate	Present
Coniopteryx spp.	Coniopteryx Spp.	Invertebrate	Present
Conopidae	Thick-Headed Fly (Conopidae)Conopidae	Invertebrate	Present
Copidita quadrimaculata	False Blister Beetle (C. Quadrimaculata)	Invertebrate	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Cordulegaster spp.	Cordulegaster Spp.	Invertebrate	Present
Corisella spp.	Water Boatman (Corisella Spp.)	Invertebrate	Present
Corixidae	Water Boatmen	Invertebrate	Present
Corydalidae	Dobsonfly (Corydalidae)	Invertebrate	Present
Cotinus mutabilis	Green Fruit Beetle	Invertebrate	Present
Crabro spp.	Crabro Spp.	Invertebrate	Present
Crabronidae	Sphecoid Wasp (Crabronidae)	Invertebrate	Present
Crematogaster californica	Crematogaster Californica	Invertebrate	Present
Crematogaster marioni	Ant (C. Marioni)	Invertebrate	Present
Cryptophagus spp.	Silken Fungus Beetle (Cryptophagus Spp.)	Invertebrate	Present
Cryptorhopalum spp.	Dermestid Beetle (Cryptorhopalum Spp.)	Invertebrate	Present
Ctenuchidae	Ctenuchid Moth (Ctenuchidae)	Invertebrate	Present
Culicidae	Mosquito (Culicidae)	Invertebrate	Present
Culicinae	Culicinae	Invertebrate	Present
Cultellunguis	Cultellunguis Sp.	Invertebrate	Present
Curculionidae	Weevil (Curculionidae)	Invertebrate	Present
Cyanoptax hartwegii	Cyanoptax Hartwegii	Invertebrate	Present
Cyclopoida	Copepod (Cyclopoida)	Invertebrate	Present
Cyclosa spp.	Cyclosa Spp.	Invertebrate	Present
Cymatodera spp.	Checkered Beetle (Cymatodera Spp.)	Invertebrate	Present
Cymbiodyta spp.	Water Scavenger Beetle (Cymbiodyta Spp.)	Invertebrate	Present
Cynipidae	Gall Wasp (Cynipidae)	Invertebrate	Present
Danaus gilippus	Queen	Invertebrate	Present
Danaus plexippus	Monarch	Invertebrate	Present
Danepteryx spp.	Danepteryx Spp.	Invertebrate	Present
dark noctuid	Dark Noctuid	Invertebrate	Present
Dasytinae	Solf-Winged Flower Beetle (Dasytinae)	Invertebrate	Present
Decarthron spp.	Rove Beetle (Decarthron Spp.)	Invertebrate	Present
Dermaptera	Earwig (Dermaptera)	Invertebrate	Present
Dermestes spp.	Dermestid Beetle (Dermestes Spp.)	Invertebrate	Present
Dermestidae	Dermistid Beetle	Invertebrate	Present
Diachus auratus	Leaf Beetle (D. Auratus)	Invertebrate	Present
Diadasia spp.	Bee (Diadasia Spp.)	Invertebrate	Present
Diapriidae	Diapriid (Diapriidae)	Invertebrate	Present
Dicheirus spp.	Ground Beetle (Dicheirus Spp.)	Invertebrate	Present
Dichelonyx spp.	May Beetle, June Bug (Dichelonyx Spp.)	Invertebrate	Present
Dictynidae	Dictynidae	Invertebrate	Present
Diptera	Gnat, Midge, Fly (Diptera)	Invertebrate	Present
Dixa spp.	Dixa Spp.	Invertebrate	Present
Dolichopodidae	Longlegged Fly (Dolichopodidae)	Invertebrate	Present
Dolophiloides spp.	Dolophiloides Spp.	Invertebrate	Present
Dorymyrmex insanus	Dorymyrmex Insanus	Invertebrate	Present
Dorytomus spp.	Weevil (Dorytomus Spp.)	Invertebrate	Present
Dryinidae	Dryinidae	Invertebrate	Present
Dugesia spp.	Dugesia Spp.	Invertebrate	Present
Dytiscidae	Diving Beetle (Dytiscidae)	Invertebrate	Present
Elaphropus spp.	Ground Beetle (Elaphropus Spp.)	Invertebrate	Present
Elasmopus rapax	Amphipod (E. Rapax)	Invertebrate	Present
Elateridae	Click Beetle	Invertebrate	Present
Eleodes spp.	Stink Beetle (Eleodes Spp.)	Invertebrate	Present
Elmidae spp.	Riffle Beetle (Elmidae)	Invertebrate	Present
emerald geometer	Emerald Geometer	Invertebrate	Present
Emphyastes fucicola	Weevil (E. Fucicola)	Invertebrate	Present
Empididae	Dance Fly (Empididae)	Invertebrate	Present
Enallagma spp.	Bluet (Enallagma Spp.)	Invertebrate	Present
Encyrtidae	Encyrtid Wasp (Encyrtidae Spp.)	Invertebrate	Present
Enochrus spp.	Water Scavenger Beetle (Enochrus Spp.)	Invertebrate	Present
Enoclerus spp.	Enoclerus Spp.	Invertebrate	Present
Entomobryidae	Springtail (Entomobryidae)	Invertebrate	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Epantius obscurus	Darkling Beetle (E. Obscurus)	Invertebrate	Present
Ephydridae	Shore Fly (Ephydridae)	Invertebrate	Present
Epicauta spp.	Blister Beetle (Epicauta Spp.)	Invertebrate	Present
Eremobatidae	Sun Spider (Eremobatidae)	Invertebrate	Present
Erynnis spp.	Erynnis Spp.	Invertebrate	Present
Eschatocrepis spp.	Eschatocrepis Spp.	Invertebrate	Present
Eulophidae	Eulophid Wasp (Eulophidae)	Invertebrate	Present
Eumeninae	Eumeninae	Invertebrate	Present
Eupeodes spp.	Eupeodes Spp.	Invertebrate	Present
Euphilotes battoides bernardino	Bernardino Square-Spotted Blue	Invertebrate	Present
Euphilotes enoptes	Dotted Blue	Invertebrate	Present
Euphydryas chalcedona	Variable Checkerspot Butterfly	Invertebrate	Present
Eurytomidae	Jointworm (Eurytomidae)	Invertebrate	Present
Euspilotus scissus	Hister Beetle (E. Scissus)	Invertebrate	Present
Everes amyntula	Western Tailed Blue	Invertebrate	Present
Exomalopsis spp.	Bumble Bee (Exomalopsis Spp.)	Invertebrate	Present
Fallceon quilleri	Mayfly (F. Quilleri)	Invertebrate	Present
feathered moth	Feathered Moth	Invertebrate	Present
Figitidae	Gall Wasp (Figitidae)	Invertebrate	Present
Filiarisia spp.	Filiarisia Spp.	Invertebrate	Present
flower-loving longhorn beetle	Flower-Loving Longhorn Beetle	Invertebrate	Present
Forficula auricularia	European Earwig	Invertebrate	Present
Formica moki	Formica Moki	Invertebrate	Present
Formicidae	Ant (Formicidae)	Invertebrate	Present
Frostia	Frostia	Invertebrate	Present
Fucellia costalis	Beach Fly (F. Costalis)	Invertebrate	Present
Fuchsina spp.	(Fuchsina Spp.)	Invertebrate	Present
Fulgoridae	Fulgorid Planthopper (Fulgoridae)	Invertebrate	Present
Gammaridea	Gammarid Amphipod (Gammaridea)	Invertebrate	Present
Gasteruptiidae	Gasteruptiid (Gasteruptiidae)	Invertebrate	Present
Gelechiidae	Gelechiid Moth (Gelechiidae)	Invertebrate	Present
Geocoris spp.	True Bug (Geocoris Spp.)	Invertebrate	Present
Geometridae	Measuring Worm Moth (Geometridae)	Invertebrate	Present
Gerridae	Water Strider (Gerridae)	Invertebrate	Present
Gerris remigis	Gerris Remigis	Invertebrate	Present
giant water strider	Giant Water Strider	Invertebrate	Present
Gnaphosidae	Ground Spider (Gnaphosidae)	Invertebrate	Present
golden geometer	Golden Geometer	Invertebrate	Present
Grammoptera spp.	Long-Horned Beetle (Grammoptera Spp.)	Invertebrate	Present
Graptocorixa spp.	Water Boatman (Graptocorixa Spp.)	Invertebrate	Present
gray geometer	Gray Geometer	Invertebrate	Present
gray noctuid	Gray Noctuid	Invertebrate	Present
green folgorid	Green Folgorid	Invertebrate	Present
green leaf bug	Green Leaf Bug	Invertebrate	Present
Gretchena deludana	Arrowhead Moth	Invertebrate	Present
Gryllidae	Cricket	Invertebrate	Present
Gryllus spp.	Gryllus Spp.	Invertebrate	Present
Gyrinidae	Whirligig Beetle (Gyrinidae)	Invertebrate	Present
Halictus farinosus	Sweat Bee (H. Farinosus)	Invertebrate	Present
Halictus tripartitus	Sweat Bee (H. Tripartitus)	Invertebrate	Present
Haliplidae	Crawling Water Beetle (Haliplidae)	Invertebrate	Present
Harmonia axyridis	Ladybird Beetle (H. Axyridis)	Invertebrate	Present
Harpalini	Harpalini	Invertebrate	Present
Heleomyzidae	Heleomyzid Fly (Heleomyzidae)	Invertebrate	Present
Hemerobius spp.	Hemerobius Spp.	Invertebrate	Present
Hemiopsida robusta	California Beetle	Invertebrate	Present
Hesperapis spp.	Melittid Bee (Hesperapis Spp.)	Invertebrate	Present
Hesperiidae	Skipper (Hesperiidae)	Invertebrate	Present
Heterocampa manteo	Oakleaf Moth	Invertebrate	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Heterocampa spp.	Heterocampa Spp.	Invertebrate	Present
Hippodamia convergens	Convergent Lady Beetle	Invertebrate	Present
humpbacked moth	Humpbacked Moth	Invertebrate	Present
Hyalella spp.	Amphipod (Hyalella Spp.)	Invertebrate	Present
Hydraena spp.	Minute Moss Beetle (Hydraena Spp.)	Invertebrate	Present
Hydropsyche spp.	Caddisfly (Hydropsyche Spp.)	Invertebrate	Present
Hydropsychidae	Caddisfly (Hydropsychidae)	Invertebrate	Present
Hydroptila spp.	Caddisfly (Hydroptila Spp.)	Invertebrate	Present
Hylaeus spp.	Bee (Hylaeus Spp.)	Invertebrate	Present
Hyles lineata	White-Lines Sphinx	Invertebrate	Present
Hymenoptera	Wasps And Bees (Hymenoptera)	Invertebrate	Present
Hypocaccus spp.	Hister Beetle (Hypocaccus Spp.)	Invertebrate	Present
Ichneumonidae	Ichneumon Wasp (Ichneumonidae)	Invertebrate	Present
Idiostatus aequalis	Chaparral Shield-Backed Katydid	Invertebrate	Present
Incurvariidae	Incurvariid/Fairy Moth (Incurvariidae)	Invertebrate	Present
Isomira	Isomira	Invertebrate	Present
Isoperla spp.	Isoperla Spp.	Invertebrate	Present
Isopoda	Isopod (Isopoda)	Invertebrate	Present
Isoptera	Termite	Invertebrate	Present
Issidae	Issid Planthopper (Issidae)	Invertebrate	Present
Ixodidae	Hard Tick	Invertebrate	Present
Laceobius spp.	Laceobius Spp.	Invertebrate	Present
Lasioglossum spp.	Sweat Bee (Lasioglossum Spp.)	Invertebrate	Present
Lauxaniidae	Beachfly (Lauxaniidae)	Invertebrate	Present
Lebiini	Lebiini	Invertebrate	Present
Lepidocnemeplatia sericea	Darkling Beetle (L. Sericea)	Invertebrate	Present
Lepidoptera	Moth, Butterfly (Lepidoptera)	Invertebrate	Present
Lepidostoma spp.	Caddisfly (Lepidostoma Spp.)	Invertebrate	Present
Leptophlebiidae	Leptophlebiidae	Invertebrate	Present
Leptotes marina	Marine Blue	Invertebrate	Present
Lestes spp.	Lestes Spp.	Invertebrate	Present
Libellula saturata	Big Red Skimmer	Invertebrate	Present
Libellulidae	Skimmer (Libellulidae)	Invertebrate	Present
Limacidae	Common Slug (Limacidae)	Invertebrate	Present
Limenitis bredownii	California Sister	Invertebrate	Present
Limenitis lorquini	Lorquin'S Admiral	Invertebrate	Present
Limnephilidae	Caddisfly (Limnephilidae)	Invertebrate	Present
Limonia humidicola	Cranefly (L. Humidicola)	Invertebrate	Present
Linepithema humile	Linepithema Humile	Invertebrate	Present
Linyphiidae	Spider (Linyphiidae)	Invertebrate	Present
Liometophum occidentale	Velvety Tree Ant	Invertebrate	Present
Loedelia	Loedelia	Invertebrate	Present
Lonchaeidae	Lancefly (Lonchaeidae)	Invertebrate	Present
Lordithan	Lordithan	Invertebrate	Present
Loricaster rotundus	Fringe-Winged Beetle (L. Rotundus)	Invertebrate	Present
Lycaena arota	Tailed Copper	Invertebrate	Present
Lycaena gorgon	Gorgon Copper	Invertebrate	Present
Lycaenidae	Blue, Copper, Hairstreak	Invertebrate	Present
Lycosida spp.	Lycosida	Invertebrate	Present
Lycosidae	Wolf Spider	Invertebrate	Present
Lygaeidae	Seed Bug (Lygaeidae)	Invertebrate	Present
Lygaeus kalmii	Small Milkweed Bug	Invertebrate	Present
Lygus spp.	Plant Bug (Lygus Spp.)	Invertebrate	Present
Lymantriidae	Tussock Moth (Lymantriidae)	Invertebrate	Present
Machilidae	Jumping Bristletail (Machilidae)	Invertebrate	Present
Macrovelia hornii	Macrovelia Hornii	Invertebrate	Present
Malachius	Malachius	Invertebrate	Present
Malacosoma spp.	Malacosoma	Invertebrate	Present
Male scale	Male Scale	Invertebrate	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Malenka spp.	Malenka Spp.	Invertebrate	Present
Medon spp.	Rove Beetle (Medon Spp.)	Invertebrate	Present
Megachildae	Megachilid Bee	Invertebrate	Present
Megachile rotundata	Alfalfa Leafcutting Bee	Invertebrate	Present
Megaspilidae	Megaspilidae	Invertebrate	Present
Melissodes spp.	Bumble Bee (Melissodes Spp.)	Invertebrate	Present
Melyridae	Solf-Winged Flower Beetle (Melyridae)	Invertebrate	Present
Membracidae	Treehopper (Membracidae)	Invertebrate	Present
Mesovelia mulsanti	Mesovelia Mulsanti	Invertebrate	Present
Metophthalmus	Metophthalmus	Invertebrate	Present
Micrasema spp.	Caddisfly (Micrasema Spp.)	Invertebrate	Present
Microcoryphia	Bristletail (Microcoryphia)	Invertebrate	Present
Microcylloepus similis	Microcylloepus Similis	Invertebrate	Present
Microvelia spp.	Water Strider (Microvelia Spp.)	Invertebrate	Present
Miridae	Plant Bug (Miridae)	Invertebrate	Present
mite	Mite	Invertebrate	Present
Mordella albosuturalis	Tumbling Flower Beetle (M. Albosuturalis)	Invertebrate	Present
Mordella hubbsi	Tumbling Flower Beetle (M. Hubbsi)	Invertebrate	Present
Mordellidae	Tumbling Flower Beetle (Mordellidae)	Invertebrate	Present
Mordellistena spp.	Tumbling Flower Beetle (Mordellistena Spp.)	Invertebrate	Present
Muscidae	Muscid Fly (Muscidae)	Invertebrate	Present
Mutillidae	Velvet-Ant (Mutillidae)	Invertebrate	Present
Mycetophilidae	Mycetophilidae	Invertebrate	Present
Myllaena spp.	Rove Beetle (Myllaena Spp.)	Invertebrate	Present
Mymaridae	Fairyfly (Mymaridae)	Invertebrate	Present
Mythicomyiidae	Mythicomyiidae	Invertebrate	Present
Nabis spp.	Nabis Spp.	Invertebrate	Present
Neivamyrmex nigrescens	Neivamyrmex Nigrescens	Invertebrate	Present
Neivamyrmex spp.	Ant (Neivamyrmex Spp.)	Invertebrate	Present
Nemognatha spp.	Blister Beetle (Nemognatha Spp.)	Invertebrate	Present
Neobisnius	Neobisnius	Invertebrate	Present
Neohermes spp.	Neohermes Spp.	Invertebrate	Present
Nephrotoma suturalis	Cranefly (N. Suturalis)	Invertebrate	Present
Nepticulidae	Leaf Miners, Nepticulid Moth (Nepticulidae)	Invertebrate	Present
Neuroptera	Nerve-Winged Insects (Neuroptera)	Invertebrate	Present
Noctuidae	Owelt Moth (Noctuidae)	Invertebrate	Present
Notodontidae	Notodontid Moth (Notodontidae)	Invertebrate	Present
Notonecta hoffmanni	Backswimmer (N. Hoffmanni)	Invertebrate	Present
Notonecta spp.	Notonecta Spp.	Invertebrate	Present
Notoxus spp.	Antlike Flower Beetle (Notoxus Spp.)	Invertebrate	Present
Nyctoporis carinata	Nyctoporis Carinata	Invertebrate	Present
Nymphalinae	Checkerspot Butterfly (Nymphalinae)	Invertebrate	Present
Nymphalis antiopa	Mourning Cloak	Invertebrate	Present
Nymphalis spp.	(Nymphalis Spp.)	Invertebrate	Present
Nyssius raphanus	False Chinch Bug	Invertebrate	Present
Ochthebius spp.	Minute Moss Beetle (Ochthebius Spp.)	Invertebrate	Present
Odonata	Dragonfly (Odonata)	Invertebrate	Present
Odontoceridae	Odontoceridae	Invertebrate	Present
Oecophoridae	Oecophorid Moth (Oecophoridae)	Invertebrate	Present
Oedemeridae	False Blister Beetle (Oedemeridae)	Invertebrate	Present
Oligochaeta	Earthworm (Oligochaeta)	Invertebrate	Present
Olios schistus	Giant Crab Spider	Invertebrate	Present
opaque moth	Opaque Moth	Invertebrate	Present
Ophion spp.	Short-Tailed Ichneumon Wasp (Ophion Spp.)	Invertebrate	Present
Opiliones	Daddy Long-Leg (Opiliones)	Invertebrate	Present
Orchestia spp.	Amphipod (Orchestia Spp.)	Invertebrate	Present
Orchestoidea californiana	Amphipod (O. Californiana)	Invertebrate	Present
Ormyridae	Armyrid (Ormyridae)	Invertebrate	Present
Orthoceri	Primitive Weevil	Invertebrate	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Osmia spp.	Leaf Cutting Bee (Osmia Spp.)	Invertebrate	Present
Osphya lutea	Darkling Beetle (O. Lutea)	Invertebrate	Present
Otobius megnini	Spinose Ear Tick	Invertebrate	Present
Oxytelinae	Rove Beetle (Oxytelinae)	Invertebrate	Present
Ozyptila	Ozyptila	Invertebrate	Present
Pacificanthia consors	Soldier Beetle (P. Consors)	Invertebrate	Present
Paltothemis lineatipes	Red Rock Skimmer	Invertebrate	Present
Panurginus spp.	Panurgine Bees (Panurginus Spp.)	Invertebrate	Present
Papilio eurymedon	Pale Swallowtail	Invertebrate	Present
Papilio rutulus	Western Tiger Swallowtail	Invertebrate	Present
Papilio zelicaon	Anise Swallowtail	Invertebrate	Present
Papilionoidea	True Butterfly (Papilionoidea)	Invertebrate	Present
Paradonus pectoralis	Tiny-Spotted Click Beetle	Invertebrate	Present
Paraleptophlebia spp.	Mayfly (Paraleptophlebia Spp.)	Invertebrate	Present
Parcoblatta americana	Western Wood Cockroach	Invertebrate	Present
Pedilinae	Pedilidae Beetle	Invertebrate	Present
Pedilus spp.	Pedilus	Invertebrate	Present
Peltodytes spp.	Peltodytes Spp.	Invertebrate	Present
Pemphredonidae	Pemphredonidae	Invertebrate	Present
Pentaria nubila	Pentaria Nubila	Invertebrate	Present
Pentatomidae	Stink Bug	Invertebrate	Present
pepper moth	Pepper Moth	Invertebrate	Present
Pepsis chrysothymus	Tarantula Wasp (P. Chrysothymus)	Invertebrate	Present
Pericoma spp.	Pericoma Spp.	Invertebrate	Present
Phaleria spp.	Darkling Beetle (Phaleria Spp.)	Invertebrate	Present
Phausis spp.	Podabrus	Invertebrate	Present
Pheidole californica	Pheidole Californica	Invertebrate	Present
Pheidole hyatti	Pheidole Hyatti	Invertebrate	Present
Philonthina	Philonthina	Invertebrate	Present
Phoracantha semipunctata	Eucalyptus Long-Horned Borer	Invertebrate	Present
Phoridae	Phorid/Humpback Fly (Phoridae)	Invertebrate	Present
Phyllobaenus	Phyllobaenus	Invertebrate	Present
Phyllodesma cordonix	Phyllodesma Cordonix	Invertebrate	Present
Physella spp.	Physa (Physella Spp.)	Invertebrate	Present
Pieris protodice	Common White	Invertebrate	Present
Pieris rapae	European Cabbage Butterfly	Invertebrate	Present
Pipunculidae	Pipunculidae	Invertebrate	Present
Platygastridae	Platygastrid (Platygastridae)	Invertebrate	Present
Platylyra californica	Chaparral Katydid	Invertebrate	Present
Platypezidae	Platypezidae	Invertebrate	Present
Platystethus spp.	Rove Beetle (Platystethus Spp.)	Invertebrate	Present
Plebejus acmon	Acmon Blue	Invertebrate	Present
Pogonomyrmex subnitidus	Pogonomyrmex Subnitidus	Invertebrate	Present
Polistes fuscatus aurifer	Golden Paper Wasp	Invertebrate	Present
Polycentropodidae	Polycentropodidae	Invertebrate	Present
Pompilidae	Spider Wasp (Pompilidae)	Invertebrate	Present
Pontia protodice	Checkered White	Invertebrate	Present
Potamopyrgus antipodarum	New Zealand Mudsnail	Invertebrate	Present
Prenolepis imparis	Prenolepis Imparis	Invertebrate	Present
Procambarus clarkii	Crayfish	Invertebrate	Present
Proctotrupidae	Proctotrupidae	Invertebrate	Present
Protosmia rubifloris	Leaf Cutting Bee (P. Rubifloris)	Invertebrate	Present
Pryalidae	Pryalidae	Invertebrate	Present
Pseudomasaris vespoides	Pseudomasarime Wasp	Invertebrate	Present
Pseudomyrmex apache	Pseudomyrmex Apache	Invertebrate	Present
Pseudoscorpionida	Pseudoscorpionida	Invertebrate	Present
Psocoptera	Psocid (Psocoptera)	Invertebrate	Present
Psychodidae	Moth Fly	Invertebrate	Present
Psyllidae	Jumping Plant Lice	Invertebrate	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Psyllobora vigintimaeculata	Ladybird Beetle (P. Vigintimaeculata)	Invertebrate	Present
Pteromalidae	Pteromalidae	Invertebrate	Present
Pterophoridae	Plume Moth (Pterophoridae)	Invertebrate	Present
Pterostichus adstrictus	Ground Beetle (P. Adstrictus)	Invertebrate	Present
Pterostichus lama	Pterostichus Lama	Invertebrate	Present
Pterostichus spp.	Ground Beetle (Pterostichus Spp.)	Invertebrate	Present
Ptilinus spp.	Anobiid Beetle (Ptilinus Spp.)	Invertebrate	Present
Ptinidae	Spider Beetle (Ptinidae)	Invertebrate	Present
Pyralidae	Pyralid Moth (Pyralidae)	Invertebrate	Present
Pyralis farinalis	Meal Moth	Invertebrate	Present
Pyropyga spp.	Glow Worm (Pyropyga Spp.)	Invertebrate	Present
Red soldier beetle	Red Soldier Beetle	Invertebrate	Present
Rheotanytarsus spp.	Rheotanytaurus Spp.	Invertebrate	Present
Rhyacophila spp.	Caddisfly (Rhyacophila Spp.)	Invertebrate	Present
Saldidae	Shore Bug (Saldidae)	Invertebrate	Present
salt and pepper moth	Salt And Pepper Moth	Invertebrate	Present
Salticidae	Jumping Spider	Invertebrate	Present
Sanfillipodytes spp.	Sanfillipodytes Sp.	Invertebrate	Present
Sarcophagidae	Flesh Fly (Sarcophagidae)	Invertebrate	Present
Satyrium auretorum	Gold-Hunter'S Hairstreak	Invertebrate	Present
Satyrium auretorum spadix	Gold-Hunter'S Hairstreak (S. A. Spadix)	Invertebrate	Present
Satyrium californica	California Hairstreak	Invertebrate	Present
Satyrium saepium	Hedgerow Hairstreak	Invertebrate	Present
Saxinis spp.	Leaf Beetle (Saxinis Spp.)	Invertebrate	Present
Scaphinotus spp.	Ground Beetle (Scaphinotus Spp.)	Invertebrate	Present
Scarabaeidae	Scarab Beetle (Scarabaeidae)	Invertebrate	Present
Scelionidae	Scelionid Wasp (Scelionidae)	Invertebrate	Present
Sceliphron caementarium	Black And Yellow Mud Dauber	Invertebrate	Present
Schistocera nitens	Gray Bird Grasshopper	Invertebrate	Present
Sciaridae	Root Gnat	Invertebrate	Present
Sciomyzidae	Sciomyzidae	Invertebrate	Present
Scirtidae	Scirtidae Beetle	Invertebrate	Present
Scolopendra polymorpha	Multicolored Centipede	Invertebrate	Present
Scolops	Scolops	Invertebrate	Present
Scolytinae	Weevil (Scolytinae)	Invertebrate	Present
Scyphophorus yuccae	Yucca Weevil	Invertebrate	Present
Sepedopophilus castaneus	Sepedopophilus Castaneus	Invertebrate	Present
Serica spp.	Serica	Invertebrate	Present
Sialis spp.	Alderfly (Sialis Spp.)	Invertebrate	Present
Simuliidae	Black Fly (Simuliidae)	Invertebrate	Present
Simulium spp.	Fly (Simulium Spp.)	Invertebrate	Present
Solenopsis xyloni	Southern Fire Ant	Invertebrate	Present
Solfugidae	Solfugidae	Invertebrate	Present
Speyeria callippe comstocki	Comstock'S Callippe Fritillary	Invertebrate	Present
Sphaeriidae	Sphaeriidae	Invertebrate	Present
Sphaeroceridae	Sphaeroceridae	Invertebrate	Present
Sphecidae	Sphecid Wasp	Invertebrate	Present
Spilochalcis spp.	Spilochalcis Spp.	Invertebrate	Present
Stenopelmatus spp.	Jerusalem Cricket (Stenopelmatus Spp.)	Invertebrate	Present
Stenus spp.	Rove Beetle (Stenus Spp.)	Invertebrate	Present
Stereopalpus spp.	Antlike Flower Beetle (Stereopalpus Spp.)	Invertebrate	Present
Stictotarsus spp.	Predaceous Diving Beetle (Stictotarsus Spp.)	Invertebrate	Present
Stratiomyidae	Soldier Fly (Stratiomyidae)	Invertebrate	Present
straw colored incher	Straw Colored Incher	Invertebrate	Present
Strymon melinus	Common Hairstreak, Brown Hairstreak	Invertebrate	Present
Sylvilagus spp.	Cottontail (Sylvilagus Spp.)	Invertebrate	Present
Synhalonia spp.	(Synhalonia Spp.)	Invertebrate	Present
Syrphidae	Flower Fly (Syrphidae)	Invertebrate	Present
Tachinidae	Tachinid Fly (Tachinidae)	Invertebrate	Present

Table 3
Ecological Terrestrial Species
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Scientific Name	Common Name	Group	Occurrence
Tachyporus	Tachyporus	Invertebrate	Present
Taenionema spp.	Stonefly (Taenionema Spp.)	Invertebrate	Present
Tapinoma sessile	Odorous House Ant	Invertebrate	Present
Temnothorax andrei	Temnothorax Andrei	Invertebrate	Present
Tenebrionidae	Darkling Beetle (Tenebrionidae)	Invertebrate	Present
Tephritidae	True Fruit Fly (Tephritidae)	Invertebrate	Present
Tetragnatha spp.	Tetragnatha Spp.	Invertebrate	Present
Tetragnathidae	Longjawed Orbweaver (Tetragnathidae)	Invertebrate	Present
Tettigoniidae	Katydid (Tettigoniidae)	Invertebrate	Present
Theclinae	Hairstreak (Theclinae)	Invertebrate	Present
Therevidae	Stilleto Fly (Therevidae)	Invertebrate	Present
Theridiidae	Comb-Footed Spider	Invertebrate	Present
Thomisidae	Crab Spider (Thomisidae)	Invertebrate	Present
Thysanoptera	Thirp	Invertebrate	Present
Tibellus	Tibellus	Invertebrate	Present
Tineidae	Tineid Moth	Invertebrate	Present
Tingidae	Lace Bug	Invertebrate	Present
Tiphiidae	Tiphiid Wasp (Tiphiidae)	Invertebrate	Present
Tipula millardi	Crane Fly (T. Millardi)	Invertebrate	Present
Tipula spp.	Crane Fly (Tipula Spp.)	Invertebrate	Present
Tipulidae	Crane Fly (Tipulidae)	Invertebrate	Present
Tortricidae	Tortricidae	Invertebrate	Present
Torymus spp.	Torymus Spp.	Invertebrate	Present
Trachusa gummifera	Leaf-Cutting Bee	Invertebrate	Present
Trachymela sloanei	Leaf Beetle (T. Sloanei)	Invertebrate	Present
Trechus spp.	Ground Beetle (Trechusspp.)	Invertebrate	Present
Trepobates spp.	Water Strider (Trepobates Spp.)	Invertebrate	Present
Trichocorixa reticulata	Water Boatman (T. Reticilata)	Invertebrate	Present
Trichodes ornatus	Trichodes Ornatus	Invertebrate	Present
Trichoplusia ni	Cabbage Looper	Invertebrate	Present
Trichoptera	Caddisfly (Trichoptera)	Invertebrate	Present
Triepeolus spp.	Bee (Triepeolus Spp.)	Invertebrate	Present
Trimerotropis spp.	Trimerotropis Spp.	Invertebrate	Present
Trimiera pilipes	Trimiera Pilipes	Invertebrate	Present
Triodoclytus lanifer	Triodoclytus Lanifer	Invertebrate	Present
Trogossitidae	Trogossitidae	Invertebrate	Present
Vanessa atalanta	Red Admiral	Invertebrate	Present
Vanessa cardui	Painted Lady	Invertebrate	Present
Vespidae	Paper Wasp	Invertebrate	Present
Vespula pensylvanica	Yellow Jacket	Invertebrate	Present
Vespula spp.	Vespula Spp.	Invertebrate	Present
Villa spp.	Villa Spp.	Invertebrate	Present
White-black Cheeker	White-Black Cheeker	Invertebrate	Present
Wormaldia spp.	Finger-Net Caddisfly (Wormaldia Spp.)	Invertebrate	Present
Xylocopa spp.	Carpenter Bee (Xylocopa)	Invertebrate	Present
Xylocopa tabaniformis	Mountain Carpenter Bee	Invertebrate	Present
Xylotrechus spp.	Long-Horned Beetle (Xylotrechus Spp.)	Invertebrate	Present
Zarhipis integripennis	Western Banded Glow-Worm	Invertebrate	Present
Zopheridae	Ironclad Beetle (Zopheridae)	Invertebrate	Present
Zygoptera	Damselfly (Zygoptera)	Invertebrate	Present

Notes:
var. = variety
ssp. = sub-species
sp. = species
adj. = species present in adjacent areas
hist. = species was present in recent historical record

Table 4

Conceptual Site Model - Scenarios for Potential Human Exposure

Woolsey Fire Time Critical Response Action

Santa Monica National Recreation Area

Receptor Population	Exposure Medium	Exposure Route	Potential Current Exposure?	Potential Future Exposure?	Comments
On-Site					
Residents	ash and surface soil	incidental ingestion of and dermal contact with ash and surface soil	No	Yes	As a result of the fire, these areas are not currently being used for residential purposes, or in use by park employees, or open to park visitors. In the future, exposure to chemicals in ash or surface soil through incidental ingestion, dermal contact, and inhalation of particulates is possible. No site-related volatile chemicals are expected to be present in ash or soil. Also, currently there is no evidence to suggest that groundwater has been impacted from leaching of site-related chemicals in ash or soil or that sediment/surface water in these areas has been impacted.
		inhalation of airborne particulates (wind erosion) in outdoor air	No	Yes	
Park Employee	ash and surface soil	incidental ingestion of and dermal contact with ash and surface soil	No	Yes	
		inhalation of airborne particulates (wind erosion) in outdoor air	No	Yes	
Park Visitor	ash and surface soil	incidental ingestion of and dermal contact with ash and surface soil	No	Yes	
		inhalation of airborne particulates (wind erosion) in outdoor air	No	Yes	
Maintenance Workers	ash and surface soil	incidental ingestion of and dermal contact with ash and soil; inhalation of ash/soil-derived airborne particulates in work-space air	No	Yes	Following reconstruction, these areas may require occasional maintenance activities to be completed. This could include various tasks including excavations of limited extent and duration.
Construction Workers	ash and surface soil	incidental ingestion of and dermal contact with ash and soil; inhalation of ash/soil-derived airborne particulates in work-space air	No	Yes	During reconstruction or future site redevelopment, exposures to ash or soil during larger scale construction activities may be possible.
Off-Site					
Residents	on-site ash and surface soil	inhalation of airborne particulates (wind erosion) in outdoor air	Yes	Yes	Potential airborne exposure to particulates migrating from uncovered on-site areas to off-site areas is possible.
Park Employee	on-site ash and surface soil	inhalation of airborne particulates (wind erosion) in outdoor air	Yes	Yes	
Park Visitor	on-site ash and surface soil	inhalation of airborne particulates (wind erosion) in outdoor air	Yes	Yes	

Table 5
Hazardous Waste Characterization Criteria
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

	TTLC	**STLC**	**TCLP**
	mg/kg	mg/L	mg/L
Metals			
Antimony	500	15	-
Arsenic	500	5	5
Barium	10,000	100	100
Beryllium	75	0.75	-
Cadmium	100	1	1
Chromium	2,500	5	5
Cobalt	8,000	80	-
Copper	2,500	25	-
Lead	1,000	5	5
Mercury	20	0.2	0.2
Molybdenum	3,500	350	-
Nickel	2,000	20	-
Selenium	100	1	1
Silver	500	5	5
Thallium	700	7	-
Vanadium	2,400	24	-
Zinc	5,000	250	-
Dioxin (2,3,7,8-TCDD)	--	0.001	0.01

Notes:
TTLC = total threshold limit concentration
STLC = soluble threshold limit concentration
TCLP = toxicity characteristic leachate procedure
mg/kg = milligrams per kilogram
mg/L = milligrams per liter

Table 6
Chemicals, Reference Limits, and Laboratory Accuracy and Precision Objectives for Ash and Soil Samples
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Analyte	CAS Number	Laboratory Methods	Laboratory RL (mg/kg)	Laboratory MDL (mg/kg)	Residential Soil Screening Levels (mg/kg)	Soil Ecological Screening Values (mg/kg)	Laboratory LCS Limit Low (%)	Laboratory LCS Limit High (%)	LCS RPD Limit (%)	MS Recovery Limits Low (%)	MS Recovery Limits High (%)	MS RPD Limit (%)
Metals (mg/kg)												
Antimony	7440-36-0	SW-846 6010B	3	0.37	3.1	0.248	80	120	20	75	125	20
Arsenic	7440-38-2	SW-846 6010B	3	0.2	0.041	0.25	80	120	20	75	125	20
Barium	7440-39-3	SW-846 6010B	1	0.23	1500	17.2	80	120	20	75	125	20
Beryllium	7440-41-7	SW-846 6010B	0.5	0.17	1.6	2.42	80	120	20	75	125	20
Cadmium	7440-43-9	SW-846 6010B	0.5	0.21	7.1	0.27	80	120	20	75	125	20
Chromium	7440-47-3	SW-846 6010B	1	0.13	0.3	0.34	80	120	20	75	125	20
Cobalt	7440-48-4	SW-846 6010B	0.5	0.19	2.3	13	80	120	20	75	125	20
Copper	7440-50-8	SW-846 6010B	1	0.31	310	14	80	120	20	75	125	20
Lead	7439-92-1	SW-846 6010B	1	0.32	80	0.94	80	120	20	75	125	20
Mercury	7439-97-6	SW-846 7471A	0.14	0.039	0.1	0.013	80	120	20	80	120	20
Molybdenum	7439-98-7	SW-846 6010B	1	0.13	39	0.52	80	120	20	80	120	20
Nickel	7440-02-0	SW-846 6010B	1.5	0.2	82	10	80	120	20	75	125	20
Selenium	7782-49-2	SW-846 6010B	3	0.72	39	0.331	80	120	20	75	125	20
Silver	7440-22-4	SW-846 6010B	0.5	0.13	39	2	80	120	20	75	125	20
Thallium	7440-28-0	SW-846 6010B	5	0.2	0.078	0.027	80	120	20	75	125	20
Vanadium	7440-62-2	SW-846 6010B	0.5	0.061	39	0.714	80	120	20	75	125	20
Zinc	7440-66-6	SW-846 6010B	5	0.28	2300	6.6	80	120	20	75	125	20
Dibenzofurans and Dioxins (µg/kg)												
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	SW-846 8290	0.005	0.00042	--	--	80	120	20	70	130	30
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	SW-846 8290	0.005	0.000414	--	--	80	120	20	70	130	30
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	SW-846 8290	0.005	0.000645	--	--	80	120	20	70	130	30
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	SW-846 8290	0.005	0.000543	--	--	80	120	20	70	130	30
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	SW-846 8290	0.005	0.000363	--	--	80	120	20	70	130	30
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	SW-846 8290	0.005	0.000498	--	--	80	120	20	70	130	30
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	SW-846 8290	0.005	0.000507	--	--	80	120	20	70	130	30
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	SW-846 8290	0.005	0.000357	--	--	80	120	20	70	130	30
2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	SW-846 8290	0.001	0.000184	--	--	80	120	20	70	130	30
Octachlorodibenzofuran	39001-02-0	SW-846 8290	0.01	0.00171	--	--	80	120	20	70	130	30
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	35822-46-9	SW-846 8290	0.005	0.000764	--	--	80	120	20	70	130	30
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	39227-28-6	SW-846 8290	0.005	0.000639	--	--	80	120	20	70	130	30
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	57653-85-7	SW-846 8290	0.005	0.000546	--	--	80	120	20	70	130	30
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	19408-74-3	SW-846 8290	0.005	0.000645	--	--	80	120	20	70	130	30
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	40321-76-4	SW-846 8290	0.005	0.00063	--	--	80	120	20	70	130	30
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	SW-846 8290	0.001	0.000239	0.005	0.0003	80	120	20	70	130	30
Octachlorodibenzo-p-dioxin	3268-87-9	SW-846 8290	0.01	0.00129	--	--	80	120	20	70	130	30

Table 6
Chemicals, Reference Limits, and Laboratory Accuracy and Precision Objectives for Ash and Soil Samples
Woolsey Fire Cleanup Sampling and Analysis Plan
Santa Monica Mountains National Recreation Area, California

Notes:
-- = Not Applicable or Not Available
mg/kg = milligrams/kilogram
RL = Reporting Limit
LCS = Laboratory Control Sample
MS = Matrix Spike
RPD = Relative Percent Difference

The residential human health screening levels for soil were compiled from the following hierarchy of sources:
1. CalEPA DTSC, Human and Ecological Risk Office (HERO) Human Health Risk Assessment (HHRA), Note Number 3: DTSC-modified Screening Levels (DTSC-SLs)
2. USEPA Regional Screening Levels (RSLs) for Residential Exposure to Soil

The residential human health screening levels for soil are based upon a target cancer risk (TCRL) of 10^{-6} and target noncancer hazard quotient (THQ) of 0.1.
The ecological soil screening values (ESVs) are those recommended by the National Park Service (NPS) for the selection of chemicals of potential ecological concern (COPEC).
They are based upon the minimum of the soil ESVs for terrestrial plants and soil invertebrates from NPS-approved sources.
The screening levels for Chromium (total) are the screening levels provided by the agency for Chromium VI, unless otherwise noted.

Appendix A – Laboratory Standard Operating Procedures

ENTHALPY ANALYTICAL

931 W. Barkley Ave
Orange, CA 92868

STANDARD OPERATING PROCEDURE

VOLATILE ORGANIC COMPOUNDS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

METHOD 8260B

SOP Number: B-0014
Prepared By: Dat Phan
Effective Date: ~~10/10/2017~~ 10/27/17 GS 10/27/17

Revision: 1.0
Supersedes: January 2015

Department Manager Approval: _____ Date: 10/26/17
Brian Built

Technical Director Approval: _____ Date: 10/25/2017
Hongling Cao

QA Director Approval: _____ Date: 10/17/17
Clifford Baldridge

I SCOPE AND APPLICATION:

1. Method 8260B is applicable to nearly all types of samples including ground and surface water, sludge, soils and sediments and various hazardous waste samples.

The following compounds can be determined by this method:

Compound	CAS No.
Acetone	67-64-1
Acetonitrile	75-05-8
Acrolein (Propenal)	107-02-8
Acrylonitrile	107-13-1
Allylalcohol	107-18-6
Allylchloride	107-05-1
Benzene	71-43-2
Benzyl chloride	100-44-7
Bis (2-chloroethyl) sulfide	505-60-2
Bromoacetone	598-31-2
Bromobenzene	108-86-1
Bromochloromethane	74-97-5
Bromodichloromethane	75-27-4
4-Bromofluorobenzene	460-00-4
Bromoform	75-25-2
Bromomethane	74-83-9
n-Butanol	71-36-3
2-Butanone (MEK)	78-93-3
t-Butyl alcohol	75-65-0
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chloroacetonitrile	107-14-2
Chloral hydrate	302-17-0
Chlorobenzene	108-90-7
Chlorodibromomethane	124-48-1
Chloroethane	75-00-3
2-Chloroethanol	107-07-3
2-Chloroethyl vinyl ether	110-75-8
Chloroform	67-66-3
Chloromethane	74-87-3
Chloroprene	126-99-8
3-Chloropropionitrile	542-76-7
Crotonaldehyde	4170-30-3
1,2-Dibromo-3-chloropropane	96-12-8
1,2-Dibromoethane	106-93-4
Dibromomethane	74-95-3
1,2-Dichlorobenzene	95-50-1
1,3-Dichlorobenzene	541-73-1
1,4-Dichlorobenzene	106-46-7
cis-1,4-Dichloro-2-butene	1476-57-6
trans-1,4-Dichloro-2-butene	110-57-6
Dichlorodifluromethane	75-71-8

1,1-Dichloroethane	75-34-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethene	75-35-4
trans-1,2-Dichloroethene	156-60-5
1,2-Dichloropropane	78-87-5
1,3-Dichloropropane	142-28-9
cis-1,3-Dichloropropene	10061-01-5
trans-1,3-Dichloropropene	10061-02-6
1,2,3,4-Diepoxybutane	1464-53-5
Diethyl ether	60-29-7
1,4-Dioxane	123-91-1
Epichlorohydrin	106-89-8
Ethanol	64-17-5
Ethyl acetate	141-78-6
Ethylbenzene	100-41-4
Ethylene oxide	75-21-8
Ethyl methacrylate	97-63-2
Hexachlorobutadiene	87-68-3
Hexachloroethane	67-72-1
2-Hexanone	591-78-6
2-Hydroxypropionitrile	78-97-7
Iodomethane	74-88-4
Isobutyl alcohol	78-83-1
Isopropylbenzene	98-82-8
4-Isopropyltoluene	99-87-6
Malononitrile	109-77-3
Methacrylonitrile	126-98-7
Methanol	67-56-1
Methylene chloride	75-09-2
Methyl methacrylate	80-62-6
4-Methyl-2-pentanone (MIBK)	108-10-1
Napthalene	91-20-3
Nitrobenzene	98-95-3
2-Nitropropane	79-46-9
N-Nitroso-di-butylamine	924-16-3
Paraldehyde	123-63-7
Pentachloroethane	76-01-7
2-Pentanone	107-87-9
2-Picoline	109-06-8
1-Propanol	71-23-8
2-Propanol	67-63-0
Propargyl alcohol	107-19-7
β-Propiolactone	57-57-8
Propionitrile (ethyl cyanide)	107-12-0
n-Propylamine	107-10-8
Pyridine	110-86-1
Styrene	110-86-1
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethene	127-18-4
Toluene	108-88-3

o-Toluidine	95-53-4
1,2,4-Trichlorobenzene	120-82-1
1,1,1-Trichloroethane	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloroethene	79-01-6
Trichlorofluoromethane	75-69-4
1,2,3-Trichloropropane	96-18-4
Vinyl acetate	108-05-4
Vinyl chloride	75-01-4
o-Xylene	95-47-6
m-Xylene	108-38-3
p-Xylene	106-42-3

2. Most volatile organic compounds with boiling points below 200 °C and that are insoluble or slightly soluble in water can be analyzed by this method. Volatile water-soluble compounds can be included in this method but the quantitation limits will be approximately 10 times higher because of poor purging efficiency.(low-molecular-weight halogenated hydrocarbons, aromatics, ketones, nitrites, acetates, ethers, and sulfides).

3. This method is restricted to use by, or under supervision of analysts experienced in the use of purge-and-trap systems and GC/MS, and skilled in the interpretation of mass spectra and their use as a quantitative tool.

II SUMMARY OF METHOD:

1. Volatile compounds are introduced into the GC by the purge-and-trap method or by direct injection (in limited application).

1.1 Purge-and-Trap (Water): Helium gas is bubbled through a 5mL or 10mL sample contained in a 40ml VOA vial at 40 C. The volatile organics are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a purge trap column where the volatile organics are trapped. After purging is completed, the purge trap column is heated and back-flushed with helium gas to desorb the volatile organics onto a gas chromatographic column. The gas chromatograph is temperature-programmed to separate the volatile organics which are then detected with a mass spectrometer.

1.2 Low-level Soil (<1mg/Kg): Helium gas is bubble through a mixture of 5mL reagent water and 5.0g of sample contained in a 40ml VOA vial at 40 C. The volatile organics are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a purge trap column where the volatile organics are trapped. After purging is completed, the purge trap column is heated and back-flushed with helium gas to desorb the volatile organics into a gas chromatographic column. The gas chromatograph is temperature-programmed to separate the volatile organics which are then detected with a mass spectrometer.

1.3 Medium-level Soil (>1 mg/Kg): A measured amount of soil is extracted with methanol. An aliquot of the extract is diluted to 5mL with reagent water. Helium gas is bubbled through this solution in a 40ml VOA vial at 40 C. The volatile organics are effectively transferred from the aqueous phase to the vapor phase. The vapor is swept

through a purge trap column where the volatile organics are trapped. After purging is completed, the purge trap column is heated and back-flushed with helium gas to desorb the volatile organics onto a gas chromatographic column. The gas chromatograph is temperature-programmed to separate the volatile organics which are then detected with a mass spectrometer.

III DETECTION LIMIT:

1. See LIMS for the current reporting limits and MDLs.

IV DEFINITIONS:

1. Special terms are defined the first time they appear in the text.

V INTERFERENCES:

1. Method interferences may be caused by impurities in the purge gas, impurities in the reagent water used by the Archon, organic compounds out-gassing from the plumbing ahead of the trap, and solvent vapors in the laboratory. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory method and instrument blanks. The use of non-Polytetrafluoroethylene (PTFE) tubing, non-PTFE thread sealants, or flow controllers with rubber components in the purging devices should avoided.

2. Samples can be contaminated by diffusion of volatile organics (particularly fluorocarbons and methylene chloride) through the septum seal into the sample during storage and handling.

3. Contamination by carryover can occur whenever high level and low-level samples are sequentially analyzed. To reduce carryover the sampling syringe must be rinsed with reagent water between sample analyses. The trap and other parts of the system are subjected to contamination; therefore, frequent bake-out and purging of the entire system may be required.

4. The laboratory where volatile analysis is performed should be free of organic solvents.

VI SAFETY:

1. Each laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of chemicals specified in this method. A reference file of Material Safety Data Sheets (MSDS) should be made available to all personnel involved in the chemical analysis. Refer to Associated Labs safety manual.

VII. Equipment and Supplies:

1. Gas chromatograph / mass spectrometer / data system

   1.1 Archon Purge and Trap Autosampler

   1.2 Tekmar 3000/3100 or Eclipse 4560

   1.3 Varian CP 3800/3900 Gas Chromatograph

   1.4 Varian Saturn 2000/2100 Mass Spectrometer

   1.5 Saturn GC-MS Workstation Version 6.9

   1.6 Computer.

2. Syringes - 5mL, gas-tight with shut-off valve. Micro-volume syringes – 5ul,10uL and larger.

3. Vials and Caps – 40ml VOA vials and caps for the Archon Purge & Trap Autosampler.

4. Volumetric Flask, Class A - 10mL and 100mL.

5. pH Paper - wide range.

6. Balances
   6.1 Analytical, capable of accurately weighing ±0.0001 g

   6.2 Top-loading balance capable of weighing 100 g ±0.01 g.

VIII REAGENTS AND STANDARDS:

1. Reagents:

   1.1 Organic free reagent water - defined as water in which interference is not observed at the method detection limit of the analytes of interest. Quality also refers to SOP J-0004 – Reagent Water Monitoring.

   1.2 Methanol - purge and trap quality or equivalent.

2. Standards:

2.1 Stock Standard Solutions: Stock standard solutions of various compounds of interests are purchased at a concentration of 2000ug/ml. Certificates are on file showing the concentration and purity of each of the compounds of interest.

2.2 Working Standards:

   2.2.1 Matrix Spiking Solution: Prepare a second source spiking solution in methanol that contains at least 51 compounds of interest (See attachment 2 for detail). This is

prepared by adding 250ul of the stock standard solutions (2000ug/ml) into a 10ml volumetric flask to give us a final concentration of 50ug/ml. 5uL of this solution is added to the 5mL of water sample or 5.0grams of soil sample to give a final concentration of 50ug/L for water and 50ug/Kg for soil. This standard is good for six months if it can be verified by a second source. All other targeted 8260 compounds shall be included in the spike mixture and monitored over a two year period.

2.2.2 Standards for Archon Auto sampler: Prepare an internal standard and surrogate solution in methanol by adding 1 ml of the stock standard internal standard / surrogate solution (2,500ug/ml) into a 10ml volumetric flask and diluting up to volume. This gives a final concentration for the internal standard / surrogate solution to be 250ug/ml. The auto-sampler adds 1ul of this solution along with 5 ml of water to each 5ml of water sample or 5.0 grams of soil sample. The final concentration for the internal standard / surrogate solution in the water or soil sample is 50ug/L.

2.2.3 Instrument Performance Check Solution [4-Bromofluorobenzene (BFB)]: The BFB Tune is checked at the beginning of each 12-hour period by running a sample spiked with 50ng of BFB (10ug/L). This BFB check solution should only be used on the day of preparation.

2.2.4 Calibration standard: Prepare a primary source solution in methanol that contains all of the compounds of interest. This is prepared by adding 250 ul of the stock standard solutions (2000ug/ml) into a 10 ml volumetric flask to give a final concentration of 50ug/ml. A secondary standard is prepared by diluting 1ml of the primary standard to 10ml to produce a 5ug/ml standard. This standard is good for six months if it can be verified by a second source standard

3. Storage of Standard Solutions

3.1 Store the stock standards between -10 °C to -20 °C, and protect the standards from light.

3.2 Store the working standards in Teflon-sealed screw-cap bottles with minimal head-space at -10 °C to -20 °C, and protect these standards from light.

3.3 Volatile organic standards must be stored in their own separate freezer and separated from other standards.

4. Documentation of Standards:

4.1. The date when standards was received and opened is recorded in the standard book.

4.2. When standards are prepared, the following information is recorded in the Standard Preparation Notebook: Standard source and lot number, identity of compound or compounds, date prepared, expiration date, and initials of the preparer. A code number is assigned to each standard for traceability.

Refer to SOP J-0011 for detail.

IX SAMPLE COLLECTION, PRESERVATION, & STORAGE:

1. Aqueous samples:

   1.1. No residual Chlorine: Cool to 4 °C, adjust pH to <2 with H_2SO_4, HCL or solid $NaHSO_4$.

   1.2. Residual Chlorine Present: 25mg Ascorbic acid /40 ml. Cool to 4 °C, adjust pH to <2 with H_2SO_4, HCL, or solid $NaHSO_4$.

2. Solid Samples (e.g. solids, sediments, sludge) store at 4 °C.

3. Holding Time: 14 days for preserved aqueous and solid samples.

X CALIBRATION:

1. Refer to Procedure section for details on calibration

XI PROCEDURE:

1. Instrument Conditions:

   1.1 Archon Autosampler:
   Water added: 5 ml
   Purge Chamber Temperature: 40 C
   Purge time: 11 min
   Purge flow: 40 ml/min

   1.2 Purge and Trap Device

   Tekmar 3000 and Velocity parameters:

   Purge Trap K: VOCARB 3000
   Standby temperature: < 35 C
   Purge flow: 40mL/min
   Purge time: 11 min
   Desorb preheat temperature: 245 C
   Desorb time: 4 min
   Bake temperature: 260 C
   Bake time: 20 min

   Eclipse 4560 parameters:

   Purge Trap: OI Analytical #10
   Standby temperature: <35 C
   Purge flow: 40mL/min
   Purge time: 11 min
   Desorb preheat temperature: 180 C
   Desorb temperature: 190 C

Sparger mount: 60 C
Desorb time: 1 min
Bake temperature: 220 C
Bake time: 24 min

1.3 Gas Chromatograph

For instrument MS #3, #6:
Initial column temperature hold: 30 C for 10 min
Temperature program: 30 EC to 160 C at 8 C/min, then hold for 5 min, then 160 C to 230 C at 8 C/min.
Final Column temperature hold: 230 C for 1 min
Injector temperature: 150 C
Transfer line temperature: 130 C
GC column: RTX 624 60m x 0.25mm x 1.4um micro bore capillary

For instrument MS#5, #8, #4:
Initial column temperature hold: 35 C for 8 min
Temperature program: 40 C to 120 C at 8 C/min, then hold for 5ml, then 120 C to 230C at 8C/min
Final column temperature: 230 C for 2min
Injector temperature: 150C
Transfer line temperature: 130C
GC column: RTX 624 60m x 0.25mm x 1.4um micro bore capillary

1.4 Mass Spectrometer (Ion Trap Conditions):
Temperature: 150 C
Emission Current: 10 uA
RF Storage level: 32 u
Scan rate: 0.7sec/scan
Filament / multiplier delay: 5 min
Mass range: 35 u - 260 u

2. GC/MS Performance Test:

2.1 GC/MS Performance Test: At the beginning of each 12-hour period, a sample containing 50 nanograms of Bromofluorobenzene (BFB) must be analyzed.
2.1.1 Add 2.5 ul of 20 ug/L BFB into 40 ml vial contained 10 ml of water.
2.1.2 Analyze

2.2 The mass spectrum of BFB must meet the following criteria:

BFB Mass - Intensity Specifications
(4-Bromofluorobenzene)

Mass	Intensity Required (relative abundance)
50	15 to 40 % of mass 95
75	30 to 60 % of mass 95
95	base peak, 100 % relative abundance
96	5 to 9 % of mass 95
173	less than 2 % of mass

174	greater than 50 % of mass 95
175	5 to 9 % of mass 174
176	greater than 95 % but less than 101 % of mass 174
177	5 to 9 % of mass 176

Analyses must not begin until these criteria are met.

3. GC-MS Calibration:

3.1 An initial 8 point calibration (1.0, 5.0, 20, 50, 100, 150, 200 and 250 ug/L) analysis is run to demonstrate the linear working range of the instrument. Using the Saturn GC/MS workstation software (version 6.3), go into the Method Editor using the Compound Table Field, make sure that the # of calibration levels is set to 8, select the curve fit type to be Linear, the origin point to be Force, and the regression weighting to be 1/nx2. This calibration selection allows for the largest and best dynamic linear range of our initial calibration curve. Points cannot be deleted form the curve, but if one point is bad it can be rerun and added to the curve. The calibration curve is prepared by adding the following amounts of standard to 5ml of acidified water.

1.0ppb	1ul of the 5ppm std.
5.0ppb	5ul of the 5ppm std.
20ppb	1ul of the 100ppm std
50ppb	2.5ul of the 100ppm std
100ppb	5ul of the 100ppm std
150ppb	7.5ul of the 100ppm std
200ppb	10ul of the 100ppm std
250ppb	12.5ul of the 100ppm std

3.2 The RSD (relative standard deviation) for all the target analytes should be less than 15%. The RSD (relative standard deviation) for all the Calibration Check Compounds (CCCs) should be less than 30%. The mean of the RSD values for all analytes in the calibration must be less than or equal to 15%. If the RSD of any of the target compounds is greater than 15%, then set the linearity through the origin to “Ignore”.

3.3 A System Performance Check Compounds or SPCCs should be verified before this calibration curve is used. Five SPCCs compounds are checked for a minimum average response factor. These compounds are chloromethane; 1,1-dichloroethane, bromoform; 1,1,2,2-tetrachloroethane; and chlorobenzene. These compounds are used to check compound instability and to check for degradation caused by contaminated lines or active sites in the system. The minimum mean Response Factors (RF) for the volatile SPCCs are as follows:

Chloromethane	0.10
1,1-Dichloroethane	0.10
Bromoform	0.10
Chlorobenzene	0.30
1,1,2,2-Tetrachloroethane	0.30

3.4 GC-MS Initial Calibration Verification (ICV):

3.4.1 The initial calibration curve for each compound of interest must be checked and verified once every 12 hours. This is accomplished by analyzing a calibration standard that is at a concentration near the midpoint. Each of the SPCC compounds is checked to see that the minimum RF is met for each of the SPCC compounds listed above.

3.42 Next, Calibration check compounds (CCCs) are used to check the validity of the initial calibration. If the percent difference (RPD) or drift for each CCC is less than or equal to 20%, the initial calibration is assumed to be valid. The CCC's are:

1,1-Dichloroethene	Toluene	
Chloroform	Ethylbenzene	
1,2-Dichloropropane		Vinyl chloride

3.4.3 The internal standard responses and retention times in the check calibration standard must be evaluated immediately after or during data acquisition. If the retention time for any internal standard changes by more than 30 seconds from that in the midpoint standard level of the most recent initial calibration sequence, the chromatographic system must be inspected for malfunctions and corrections must be made. If the EICP area for any of the internal standards changes by a factor of two (-50% to + 100 %) from that in the midpoint standard level of the most recent initial calibration sequence, the mass spectrometer must be inspected for malfunctions and corrections must be made. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is necessary.

4. Sample Analysis:

4.1 Samples are analyzed only after the GC/MS has met the instrument performance checks, initial calibration, and continuing calibration requirements. The same instrument conditions are used for the sample analysis.

4.2 Aqueous samples are run according to EPA method 5030B.

4.2.1 Allow samples to reach ambient temperature.

4.2.2 Open water sample bottle and carefully place a 5ml syringe into the voa vial. Inject 5ml sample into a 40 ml VOA vial and place into the Archon Purge & Trap Autosampler. Check the sample for preservative and record the findings on the prep sheet. The syringe must then be rinsed three times or more in clean water.

4.23 Dilutions are made by using a gas tight syringe to inject the appropriate amount of the sample into 5ml of water in a VOA vial.

4.3 Compositing Aqueous Samples Prior to GC/MS Analysis**:**

4.3.1 Add 5ml or equal larger amounts of each sample (up to 5 samples are allowed) to a 25ml glass syringe. Special precautions must be made to maintain

zero head-pace in the syringe.

4.3.2 The samples must be cooled at 4 °C during this step to minimize volatilization losses.

4.3.3 Mix well and draw out a 5ml aliquot for analysis.

4.4 Low Level Soil/Sediment Samples (<1 mg/Kg):

4.4.1 Soil samples are run according to EPA method 5035.

4.4.2 It must be determined whether a soil/sediment sample should be analyzed by the low or medium method. The sample must be analyzed at the correct level. One approach to determine whether the low level or medium level method must be followed is:

4.4.2.1 Assume the sample is low level and analyze a 5.0 g sample.

4.4.2.2 Weigh 5.0 g of sample into a 40 ml VOA vial and add 5 ml of organic-free reagent water.

4.4.2.3 The sample is then placed into the Archon Purge & Trap system and purged directly in the Archon system using the soil mode at 40 C.

4.4.2.4 Analyze blanks, standards and QC samples under the same conditions as the samples.

4.4.2.5 If the on column concentration of any compound exceeds the initial calibration range from the analysis of 5.0g sample, a smaller sample size must be analyzed. However, the smallest sample size permitted is 0.5g. If smaller than 0.5g sample size is needed to prevent the on column concentration from exceeding the initial calibration range, the medium level method must be used.

4.4.3 The sample (for volatile organics) is defined as the entire contents of the sample container. Do not discard any supernatant liquids. Mix the contents of the sample container with a narrow metal spatula.

4.5 High Level Soil/Sediment Samples (> 1mg/Kg):

4.5.1 The high level soil / sediment method is based on extracting the soil / sediment sample with methanol. Weigh out 5.0g of the soil into a 40 ml VOA vial, then add either 5ml or 10ml of Purge & Trap Grade methanol. Place on a vortex mixer and allow to mix for 1 to 2 minutes. Allow the soil to settle in the vial and remove 100ul or less of the methanol extract and add it to a 40ml VOA vial that already contains 5ml of organic-free water. The sample is then placed into the Archon Purge & Trap auto sampler and analyzed using the soil mode.

4.5.2 The sample (for volatile organics) is defined as the entire contents of the sample container. Do not discard any supernatant liquids. Mix the contents of the sample container with a narrow metal spatula. Weigh 5.0g (wet weight) into a

tared 40mL vial. Use a top loading balance. Note and record the actual weight to the nearest 0.1 g.

4.5.3 Quickly add either 5ml or 10ml of methanol. Cap the vial and vortex for 2 minutes.

4.5.4 NOTE: The steps in Sample Analysis Section 4.5 must be performed rapidly to avoid loss of volatile organics. These steps must be performed in a laboratory free of solvent fumes.

4.5.5 The following table can be used to determine the volume of methanol extract to add to the 5mL of reagent water for analysis:

Estimated Concentrated Range (ug/Kg)	Take this Volume of Methanol Extract in ul
500 - 10,000	100
1,000 - 20,000	50
5,000 - 100,000	10
25,000 - 500,000	100 of 1/50 dilution

4.5.6 Calculate appropriate dilution factor for concentrations exceeding those in the table. If the concentration is over 25,000ug/Kg dilute an aliquot of the methanol extract and then take 100uL or less for analysis.

4.5.7 The volume of methanol added to the 5mL of water being purged should be kept constant. Therefore, add to the 5mL of water in the VOA vial the volume of methanol that is necessary to maintain a volume of 100uL in the vial.

4.5.8 Inject the sample into the prepared vial containing 5ml of water and any additional Methanol needed to make 100ul and quickly seal the vial and place into the Archon Purge & Trap Autosampler.

4.5.9 A methanol blank should also be analyzed with the samples any time high level soils are analyzed. This is done by adding 100 ul of the purge and trap methanol to 5 ml of water in a 40 ml VOA vial and then placing it into the Archon Purge & Trap Autosampler.

5. Qualitative Analysis:

5.1 The qualitative identification of compounds determined by this method is based on retention time, and on comparison of the sample mass spectrum, after background correction, with characteristic ions in a reference mass spectrum. The reference mass spectrum must be generated by the laboratory using the conditions of this method. The characteristic ions from the reference mass spectrum are defined to be the three ions of greatest relative intensity, or any ions over 30% relative intensity if less than three such ions occur in the reference spectrum. Compounds should be identified as present when the criteria below are met.

5.1.1 The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other. Selection of a peak by a data system target chromatographic peak containing ions specific for the target compound at a

compound-specific retention time will be accepted as meeting this criterion.

5.1.2 The RRT of the sample component is within ±0.06 RRT units of the RRT of the standard component.

5.1.3 The relative intensities of the characteristic ions agree within 30 % of the relative intensities of these ions in the reference spectrum. (Example: For an ion with an abundance of 50 % in the reference spectrum, the corresponding abundance in a sample spectrum can range between 20 % and 80 %).

5.1.4 Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 25 % of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

5.1.5 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component (i.e., broadened peak with shoulder (s) or a valley between two or more maxima), appropriate selection of analyte spectra and background spectra is important. Examination of extracted ion current profiles of appropriate ions can aid in the selection of spectra, and in qualitative identification of compounds. When analytes co-elute (i.e., only one chromatographic peak is apparent), the identification criteria can be met, but each analyte spectrum will contain extraneous ions contributed by the co-eluting compound.

5.2 For samples containing components not associated with calibration standards, a library search may be made for the purpose of tentative identification. Guidelines for making tentative identification are:

5.2.1 Relative intensities of major ions in the reference spectrum (ions >10% of the most abundant ion) should be present in the sample spectrum.

5.2.2 The relative intensities of the major ions should agree within ± 20%. (Example: For an ion with an abundance of 50 % in the standard spectrum, the corresponding sample ion abundance must be between 30 to 70 %).

5.2.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

5.2.4 Ions present in the sample spectrum buy not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.

5.2.5 Ions present in the reference spectrum but not in sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting peaks. Data system library reduction programs can sometimes create these discrepancies.

5.2.6 Computer generated library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Only after visual comparison of sample with the nearest library searches will the mass spectral interpretation specialist assign a tentative identification.

6. Quantitative Analysis:

6.1 When a compound has been identified, the quantitation of that compound will be based on the integrated abundance from the EICP (Extracted Ion Current Profile) of the primary characteristic ion. Quantitation will take place using the internal standard technique. The internal standard used shall be the one nearest the retention time of that of a given analyte.

6.2 Calculate the concentration of each identified analyte in the sample. For water, the concentration is calculated in ug/L. For soil/sediment/sludge (on a weight basis), the concentration will be in ug/Kg. The calculations are preformed by the Varian software. Refer to SW846 for an explanation of the calculations.

XII QUALITY CONTROL (Including data assessment and acceptance criteria for QC measures & corrective actions and contingencies for unacceptable data):

1. Method Blanks and a Continuing Calibration Verification (CCV) is to be analyzed at the beginning of every 12-hour window. The method blank is analyzed at the beginning of the 12 hour window. LCS and MS/MSD are to be analyzed at least every 20 samples or less of the same matrix.

1.1. Method Blanks:

1.1.1 The concentration of each target compound found in the blank must be less than the detection limit of that compound.

1.1.2 If the blank exceeds the above limits, investigate the source of contamination and appropriate corrective measures must be taken and documented before further analysis proceeds. Re-analyze the blank.

1.1.3 All samples, including LCS, MS/MSD, associated with a blank that fails the limits, will require re-analysis.

1.2 Laboratory Control Samples (LCS):

1.2.1 The Initial Calibration Verification Analysis can serve as an aqueous LCS. The ICV Standard must be from a second source.

1.2.2 All the 51 LCS compounds listed in the Attachment 2 shall be monitored and the acceptance criteria are listed in Attachment 2.

1.2.3 If the percent recovery for the LCS are outside the limits, terminate the analysis, reanalyze the LCS before the current batch is end. If the LCS is still not

pass the criteria, correct the problem and re-analyze all samples associated with that LCS. (This includes allowable marginal exceedance (ME). Three analytes are allowed in ME of LCS control limit if 51 analytes are spiked.)

1.3 Matrix Spike/Matrix Spike Duplicate**:**

1.3.1 Matrix Spike Recovery and Relative Percent Difference Limits are provided in the table below:

Compound	% Recovery	RPD
1,1-Dichloroethane	59-172	22
Trichloroethene	66-142	21
MTBE	62-137	24
Benzene	62-137	24
Toluene	59-139	21
Chlorobenzene	60-133	21

1.3.2 Any MS/MSD that does not meet the acceptance limits must be reanalyzed. If still outside the limit and the LCS recoveries are acceptable, there is possibly matrix interference.

1.4 Surrogates**:**

1.4.1 Surrogate recovery limits are provided in the following table:

Surrogate Compound	Percent Recovery Limits
Bromofluorobenzene	70-145
Dibromofluoromethane	70-145
Toluene-d8	70-145
1,2-Dichloroethane-d4	70-145

1.4.2 If recovery is not within limits, the following procedures are required.

1.4.2.1 Check to be sure that there are no errors in the calculations, surrogate solutions or internal standards. If errors are found recalculate the data accordingly.

1.4.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and re-analyze the sample.

1.4.2.3 If no problem is found re-analyze the sample.

1.4.2.4 If, upon re-analysis, the recovery is again not within limits, flag the data.

1.5. Internal Standards

1.5.1. If the EICP area for any of the internal standards in the calibration verification standard changes by a factor of two (-50% to + 100%) from that in the mid-point standard level of the most recent initial

calibration sequence, the mass spectrometer must be inspected for malfunctions and corrections must be made, as appropriate. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

1.6. Lab-to-lab Transportation Blanks

Due to the physical set-up of the laboratories; samples are received and stored in the main building, then transported to the Annex building for analysis; the lab-to-lab transportation blank must be analyzed every day.

1.6.1 Dedicate one cooler as a lab-to-lab transportation container.

1.6.2 Fill two 40 mL VOA vials with DI water, cap the vials and place the vials in the transportation cooler every morning. Sample control should generate a lab sample number for transportation blank and label the vials.

1.6.3 Record all the samples being transported in the day to the lab-to-lab transportation samples log book. Samples of the same ticket number should be kept together in one zip-lock bag. Samples of different tickets should be kept in separate zip-lock bags.

1.6.4 Remove the lab-to-lab transportation blank vials from the transportation cooler on the last trip of the day and analyze the vials immediately, one by GC and one by GC-MS instruments.

1.6.5 The concentration of each target compound found in the blank must be less than the detection limit of that compound.

1.6.6 If the blank exceeds the detection limits, investigate the source of contamination and appropriate corrective measures must be taken and documented. Notify the clients if samples associated with this transportation blank also have the same hits.

XIII METHOD PERFORMANCE:

1. Method performance is monitored on a continuous basis through the use of Lab Control Samples, Method Blanks, Matrix Spikes, and Sample Duplicates.

XIV POLLUTION PREVENTION:

1. The EPA has established guidelines of environmental management techniques to institute pollution prevention in the workplace. Whenever feasible, laboratory personnel use pollution prevention techniques to address their waste generation and minimize pollution resulting from any laboratory activity.

XV WASTE MANAGEMENT:

1. Hazardous wastes generated are properly disposed of in accordance to existing federal and state regulations. Details refer to SOP - Laboratory Hazardous Waste Disposal (J 0010).

XVI REFERENCES:

1. SW-846, 3rd Edition, Method 8260B.

2. CLP/SOW for Organic Analysis, and Analytical Method for Volatiles.

XVII. REVISION HISTORY

Revisions: Revised from August 2004, added detection limits DLR and MDL summary.

5/10/2005: Revised from February 2005 by adding reference SOP to Waste Management and Reagents.

12/14/2005: Revised sections for BFB tuning to specify 50 ng of BFB for 12 hour tune.

8/2/07: Revised from the version of July 2007, added new concentrator Eclipse 4560 parameters and GC temperature program for MS#5 at section VII and IX.

7/2/09: Revised from the version of June 2008 by updating the instrumentation and QA control limits.

11/10/2011: Revised from the version of July 2011 by updating the Section III Detection Limits

9/11/2012: Revised by updating the BFB solution, LCS solution preparation and criteria LCS.

May 2017: Revised contents of section III
Edit equipment in VII, 1.2
Remove MS #7 from XI, 1.3
Add procedures for BFB in XI, 2.1.1 and 2.1.2
Edits to section XI, 3.2 and 3.3
Added XII, 1.5

ENTHALPY ANALYTICAL

931 W. Barkley Ave.
Orange, CA 92868

STANDARD OPERATING PROCEDURE

CALIFORNIA STLC WASTE EXTRACTION TEST (WET)

California Code of Regulations, Title 22, Article 5, Appendix II

SOP Number:	F-0006		
Prepared By:	Clifford Baldridge/Kedy Nguyen	Revision:	2
Effective Date:	12/21/2018	Supersedes:	1.0

Approved By:	Signature:	Date:
Hongling Cao Technical Director	Hongling Cao	12/18/18
Clifford Baldridge QA Director		12/18/18
Reapproved By:	Signature:	Date:

1.0 IDENTIFICATION OF THE TEST METHOD

1.1. The procedure described in this SOP is the California STLC Waste Extraction Test (WET) from 22 CCR Appendix II

2.0 APPLICABLE MATRIX OR MATRICES

2.1. This procedure is applicable to solids, liquids, and multi phasic samples.

3.0 DETECTION LIMIT

3.1. Detection limits are available in LIMS for the analytical methods by which the prepare leachate from this procedure will be analyzed.

4.0 SCOPE AND APPLICATION

4.1. The Waste Extraction Test (WET) is used to determine the amount of extractable substances in a waste or other material.

5.0 SUMMARY

5.1. A sample is leached for 48 hours in a citric acid/sodium hydroxide solution at a pH of 5 ± 0.1. The resulting leachate is filtered and analyzed by an appropriate analytical method.

6.0 DEFINITIONS

6.1. Leachate: Any liquid that, in the course of passing through matter, extracts soluble or suspended solids, or any other component of the material through which it has passed. A liquid that has dissolved environmentally harmful substances that may then enter the environment. (Extract is sometimes used to describe the fluid resulting from this procedure, however, the term leachate is preferred to avoid confusion when discussing Semi-Volatile extraction procedures.)

6.2. Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is to be carried through the complete sample preparation and analytical procedure. It is used to assess contamination resulting from the analytical process. A minimum of one method blank must be included with each set of 20 or fewer samples.

6.3. Laboratory Control Sample (LCS)**:** An aliquot of laboratory reagent blank to which known quantities of the method analytes are added in the laboratory. The LCS is to be carried through the complete sample preparation and analytical procedure and is used to evaluate ongoing laboratory performance and analyte recovery in a clean matrix. A minimum of one LCS must be included with each batch of up to 20 samples.

6.4. Matrix Spike (MS): An aliquot of environmental sample to which known quantities of the method analytes are added in the laboratory. The addition occurs prior to sample preparation and analysis. The spiking volume should be limited to 5% or less of the sample volume. The MS is to be carried through the complete sample preparation and analytical procedure and is used to determine whether the sample matrix contributes any bias to the analytical results. A minimum of one MS may be included with each set of 20 or fewer samples.

The background concentration of the analytes in the sample matrix must be determined in a separate aliquot of sample and the measured value in the MS corrected for the background concentration. Through this, the recovery of the spiked analytes can be determined and matrix bias, if any, can be observed.

6.5. Matrix Spike Duplicate (MSD): A duplicate of the Matrix Spike used to determine the precision and bias of a method in a given sample matrix. A minimum of one MSD may be included with each set of 20 or fewer samples.

6.6. Duplicate (DUP): A randomly-selected or client-assigned sample that is processed through the entire sample preparation and analytical procedure twice. Analysis of the sample duplicate can indicate precision associated with the laboratory procedures by removing variations contributed by sample collection, preservation, and storage procedures. For clients who require a duplicate to be analyzed, a minimum of one DUP must be included with each set of 20 or fewer samples.

7.0 INTERFERENCES

7.1. See the appropriate analytical method for applicable interferences.

8.0 SAFETY

8.1. Assume all samples contain hazardous and/or potentially toxic materials; lab coat, gloves and safety glasses should be worn at all times while handling samples.

9.0 EQUIPMENT AND SUPPLIES

9.1. Top loading balance

9.2. 1 L Volumetric Flask, class A

9.3. ZHE extraction vessel (for extraction of volatile analytes)

9.4. Plastic or Glass extraction vessels (use only glass for Semi-volatile analytes)

9.5. A rotator or shaker table

9.6. 0.45 µm membrane filter

9.7. Nitrogen Manifold (for N_2 purging)

9.8. UHP Nitrogen

9.9. Disposable 5 or 10mL pipettes (for N_2 purging)

10.0 REAGENTS AND STANDARDS

10.1. Reagent Water

10.2. Citric Acid, Analytical Grade

10.3. Sodium Hydroxide, pellets, Analytical Grade

10.4. Sodium Hydroxide, 10 N: Fill a 1 L volumetric flask to 500 mL with reagent water and dissolve 400 g of sodium hydroxide. Volume up to 1 L with reagent water.

10.5. Sodium Hydroxide, 4.0 N: Fill a 1 L volumetric flask to 500 mL with reagent water and dissolve 160g of sodium hydroxide. Volume up to 1 L with reagent water.

10.6. STLC Fluid: Dissolve 38.424 g of Citric acid in a 1 L volumetric flask that contains 750 mL reagent water. Titrate with 4 N or 10 N Sodium Hydroxide to achieve a pH to 5.0 ± 0.1. Bring the volume to 1 L and check the pH again. Adjust as necessary with NaOH to achieve a pH of 5.0 ± 0.1.

11.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

11.1. See the appropriate analytical method for proper sample containers and follow thermal preservation procedures. Do not use chemical preservation.

12.0 QUALITY CONTROL

12.1. Method Blank (MB): Each batch of up to 20 leached samples must have one method blank. The MB result must be below the reporting limit of the relevant analytical method.

12.2. Laboratory Control Spike (LCS): Each batch of up to 20 samples must have an LCS. The spike is added to an aliquot of the blank extraction fluid after the leaching has been performed. See the relevant analytical method for the LCS acceptance criteria.

12.3. Matrix Spike (MS) and Matrix Spike Duplicate (MSD): When possible, based on sample amount provided, batches of leached samples may contain an MS and an MSD. The spikes are to be added after the leaching procedure is completed.

13.0 CALIBRATION AND STANDARDIZATION

13.1. Balances are calibrated annually by an outside vendor and the calibrations are checked each day of use with reference weights.

13.2. See the appropriate analytical SOP for specifics on calibrations and standardizations.

14.0 PROCEDURE

14.1. Types of waste:

14.1.1. **Type 1**: If the waste or other material is a millable solid, the sample shall be passed directly, or shall be milled to pass, through a No. 10 Sieve (2mm). The solids will be leached according to the procedure beginning in section 14.2.

14.1.2. **Type 2**: If the waste or other material is a filterable mixture of liquid and solids in which the solids constitute 0.5% by weight or greater of the sample, the liquid and solid shall be separated by filtration through a 0.45 µm membrane filter. The solids will be leached according to the procedure beginning in section 14.3

14.1.3. **Type 3**: If the waste or other material is a nonfilterable and nonmillable sludge, slurry, or oily, tarry or resinous material, it shall be leached as received according to the procedure beginning in section 14.2.

14.1.4. **Type 4**: If the waste or other material is a liquid containing less than 0.5% by weight of undissolved solids, the liquid itself is considered the leachate and shall not be subjected to the WET procedure. The liquid shall be filtered through a 0.45 µm membrane filter and the solids discarded. The liquid portion of the sample will proceed with the analytical method requested for analysis.

14.2. Preparation of Type 1 and Type 3 samples:

14.2.1. Weigh 50 g of sample and add the sample to an appropriate extraction vessel. A smaller aliquot of sample may be used provided that the final sample to STLC fluid ration remains 1:10

14.2.2. Add 500 mL, or less, of STLC fluid and seal the container. If less than 50 g of sample was used in step 14.2.1, use a volume of STLC fluid that will keep the sample to fluid ratio 1:10.

NOTE: If hexavalent chromium is requested, DI water is used to leach the sample.

14.2.3. Vigorously purge the sample and fluid mixture for 15 minutes with nitrogen gas to remove any atmospheric oxygen.

NOTE: If the sample is being leached for volatile compounds, perform the purge with nitrogen gas before the sample is added to the fluid.

14.2.4. Place the container into a rotary extractor or on a shaker table for 48 ± 2 hours.

14.2.5. After 48 ± 2 hours, the leachate fluid and solids must be separated. This may be accomplished by pressure filtration or vacuum filtration through a 0.45 µm membrane filter. The leachate may be centrifuged prior to filtration to aid in filtration speed.

14.2.6. Treatment of Filtered Extract:

14.2.6.1. For Metals Analysis (except hexavalent chromium): Transfer the filtered leachate into a clean polyethylene bottle and acidify to 5% HNO_3 by volume (10mL of leachate requires 0.5 mL of HNO_3. 25 mL of leachate requires 1.25 mL of HNO_3). Store at room temperature.

14.2.6.2. For Organic Compounds: Transfer the filtered leachate into a clean glass bottle. The end of the 48-hour leaching procedure is considered the collection time of the leachate for the purpose of calculating the hold time. The leachate must be analyzed, or prepared for analysis within the analytical method's hold time.

14.2.6.3. For Fluoride: Transfer the filtered leachate into a clean polyethylene bottle. The leachate is now ready for analysis. The end of the 48-hour leaching procedure is considered the collection time of the leachate for the purpose of calculating the hold time.

14.2.6.4. Hexavalent Chromium: Transfer the filtered leachate into a clean polyethylene bottle. The leachate is now ready for analysis. The end of the 48-hour leaching procedure is considered the collection time of the leachate for the purpose of calculating the hold time.

14.3. Preparation of Type 2 samples:

14.3.1. The mass of solids in the sample will first need to be determined.

14.3.1.1. Weigh a 0.45 µm membrane filter and record the weight.

14.3.1.2. Place the filter into a vacuum filtration apparatus and begin filtering a known volume of sample. Thoroughly mix the sample and use vacuum filtration to separate the solids from the liquid. Apply vacuum until no liquid drips from the sample for a period of 1 minute.

14.3.1.3. Transfer the filtrate to a clean container.

14.3.1.4. Weigh the filter containing the solids. Calculate the % solids

$$\% \text{ Solids} = \frac{Wight\ of\ filter\ caontaining\ solids - weight\ of\ blank\ filter}{volume\ of\ sample\ filtered}$$

14.3.1.5. If the % solids is greater than 0.5%, then the solids must be leached.

14.3.1.6. Determine the volume of STLC fluid to use by multiplying the weight of the solids by 10.

14.3.1.7. Add the filter paper containing the solids into an extraction vessel and add the STLC fluid.

NOTE: If hexavalent chromium is requested, DI water is used to leach the sample.

14.3.1.8. Vigorously purge the sample and fluid mixture for 15 minutes with nitrogen gas to remove any atmospheric oxygen.

NOTE: If the sample is being leached for volatile compounds, perform the purge with nitrogen gas before the sample is added to the fluid.

14.3.1.9. Place the vessel into a rotary extractor or on a shaker table for 48 ± 2 hours.

14.3.1.10. After 48 ± 2 hours, the leachate fluid and solids must be separated. This may be accomplished by pressure filtration or vacuum filtration through a 0.45 µm membrane filter. The leachate may be centrifuged prior to filtration to aid in filtration speed.

14.3.1.11. Combine the initial filtrate from step 14.3.1.3 and the filtered leachate from step 14.3.1.10 into the same container.

14.3.1.12. Proceed as directed in section 14.2.6

15.0 CALCULATIONS

15.1. See the appropriate analytical method for calculations.

16.0 METHOD PERFORMANCE

16.1. Method performance is monitored during the analysis of every batch with the analysis of Method Blanks, Laboratory Control Spikes, Matrix Spikes, and Matrix Spike Duplicates.

17.0 POLLUTION PREVENTION

17.1. Prepare only sufficient standard and reagent volume that can be used within the expiration date, to reduce the volume of waste generated by the laboratory and to reduce production costs.

18.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QUALITY CONTROL MEASURES

18.1. See the appropriate analytical method.

19.0 CORRECTIVE ACTIONS FOR OUT-OF-CONTROL DATA

19.1. See the appropriate analytical method.

20.0 CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1. If samples cannot be reanalyzed after a QC failure, an NCD must be filed, the data flagged as unacceptable, and the PM must notify the client of the failure and its potential impact on the results.

21.0 WASTE MANAGEMENT

21.1. Hazardous wastes generated are properly disposed of in accordance to existing federal and state regulations.

22.0 REFERENCES

22.1. California Code of Regulations, Title 22, Article 5, Appendix II

23.0 ATTACHMENTS

23.1. None

24.0 DOCUMENT REVISION HISTORY

Date	Description of Revision
December 2018	• Added LCS to the definitions section • Revised MS and MSD definitions to state that these QC may be included • Section 9.0 Equipment and Supplies o Added top loading balance o Added Nitrogen Manifold • Section 10.4: Added 10 N NaOH • Section 10.6: Added option to use 10 N NaOH • Section 12.2: Added LCS • Sections 14.2.1 and 14.2.2: Added option to use less than 50 g of sample •
September 2017	• Revised the SOP format. • Updated the procedures section to make it more clear and concise.

ENTHALPY ANALYTICAL

931 W. Barkley Ave.
Orange, CA 92868

STANDARD OPERATING PROCEDURE

TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP)

EPA Method 1311

SOP Number: F-0007
Prepared By: Clifford Baldridge
Effective Date: 1/22/2018

Revision: 2
Supersedes: 1.1

Approved By:	Signature:	Date:
Hongling Cao Technical Director	Hongling Cao	1/19/2018
Clifford Baldridge QA Director		1/19/18
Reapproved By:	Signature:	Date:

1.0 IDENTIFICATION OF THE TEST METHOD

1.1. The extraction method covered by this SOP is EPA Method 1311, Toxicity Characteristic Leaching Procedure.

2.0 APPLICABLE MATRIX OR MATRICES

2.1. Applicable matrices are liquids, solids, and multiphasic wastes.

3.0 DETECTION LIMIT

3.1. Detection limits are not applicable to this method. See the appropriate analytical methods for their detection limits.

4.0 SCOPE AND APPLICATION

4.1. The TCLP is designed to determine the mobility of both organic and inorganic analytes present in liquid solid, and multiphasic wastes.

5.0 SUMMARY

5.1. For liquid wastes (i.e., those containing less than 0.5% dry solid material), the waste, after filtration through a 0.6 to 0.8 um glass fiber filter, is defined as the TCLP extract.

5.2. For wastes containing greater than or equal to 0.5% solids, the liquid, if any, is separated from the solid phase and stored for later analysis; the particle size of the solid phase is reduced, if necessary. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the alkalinity of the solid phase of the waste. Following extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8 um glass fiber filter.

5.3. If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration.

6.0 DEFINITIONS

6.1. Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is to be carried through the complete sample preparation and analytical procedure. It is used to assess contamination resulting from the analytical process. A minimum of one method blank must be included with each set of 20 or fewer samples.

6.2. Matrix Spike (MS): An aliquot of environmental sample to which known quantities of the method analytes are added in the laboratory. For TCLP, the addition occurs after sample extraction but before extract preservation and analysis. The spiking volume should be limited to 5% or less of the sample volume. The MS is to be carried through the complete sample preparation and analytical procedure and is used to determine whether the sample matrix contributes any bias to the analytical results. A minimum of one MS must be included with each set of 20 or fewer samples.

The background concentration of the analytes in the sample matrix must be determined in a separate aliquot of sample and the measured value in the MS corrected for the background concentration. Through this, the recovery of the spiked analytes can be determined and matrix bias, if any, can be observed.

6.3. Matrix Spike Duplicate (MSD): A duplicate of the Matrix Spike used to determine the precision and bias of a method in a given sample matrix. A minimum of one MSD must be included with each set of 20 or fewer samples.

6.4. Duplicate (DUP): A randomly-selected or client-assigned sample that is processed through the entire sample preparation and analytical procedure twice. Analysis of the sample duplicate can indicate precision associated with the laboratory procedures by removing variations contributed by sample collection, preservation, and storage procedures. For clients that require a duplicate to be analyzed, a minimum of one DUP must be included with each set of 20 or fewer samples.

7.0 INTERFERENCES

7.1. Potential interferences that may be encountered during analysis are discussed in the individual analytical methods.

8.0 SAFETY

8.1. All samples should be treated as hazardous.

8.2. Appropriate PPE should always be worn (gloves, lab coat, safety glasses)

8.3. Use acetic acid in a fume hood.

9.0 EQUIPMENT AND SUPPLIES

9.1. Extraction Vessels

9.1.1. For Volatile analytes: Zero-Headspace Extraction Vessel (Millipore)

9.1.2. For Metals analytes: 68 oz plastic bottle

9.1.3. For Semivolatile analytes: 2 L wide mouth amber glass bottle.

9.2. Filtration Device

9.2.1. Filter holder and funnel

9.2.2. Filtering flask

9.2.3. Filter for Non-Metals: 12.5 cm glass microfiber filter, Grade F (Lab Sales and Service 908-231-1160)

9.2.4. Filter for Metals: Acid washed filter paper, 110 mm, 0.7 µm (Environmental Express)

9.2.5. Vacuum pump

9.3. pH Meter

9.4. ZHE extract collection devices (TEDLAR® bag)

9.5. Analytical Balance

9.6. Thermometer

9.7. Custom built TCLP rotator capable of rotating at 30 ± 2 rpm.

10.0 REAGENTS AND STANDARDS

10.1. Reagent water

10.2. Hydrochloric Acid, concentrated

10.3. Hydrochloric Acid, 1N: Carefully add 8.6 mL of concentrated Hydrochloric Acid to 75 mL of reagent water in a 100-mL volumetric flask. Dilute to the mark.

10.4. Nitric Acid, concentrated

10.5. Nitric Acid, 1N: Carefully add 6.3 mL of concentrated Nitric Acid to 75 mL of reagent water in a 100-mL volumetric flask. Dilute to the mark.

10.6. Sodium Hydroxide pellets

10.7. Sodium Hydroxide, 10 N: Add 400 g Sodium Hydroxide pellets to 500 mL reagent water in a 1-L volumetric flask. Carefully swirl the contents of the flask to let the sodium hydroxide completely dissolve. Let cool, then dilute to the mark.

10.8. Glacial Acetic Acid

10.9. pH 4 Buffer

10.10. pH 7 Buffer

10.11. pH 10 Buffer

10.12. Extraction Fluids

10.12.1. Extraction Fluid #1: To a 4 L bottle that has been marked with a fill line, add 2 L reagent water, 22.8 mL glacial acetic acid, and 25.7 mL 10 N sodium hydroxide. Dilute to the 4 L mark with reagent water. When correctly prepared, the pH of this fluid will be 4.93 ± 0.05.

10.12.2. Extraction Fluid #2: To a 4 L bottle that has been marked with a fill line, add 2 L reagent water and 22.8 mL glacial acetic acid. Dilute to 4 L with reagent water. When prepared correctly, the pH of this fluid will be 2.88 ± 0.05.

Note: Larger volumes of fluid can be made and stored in a large vessel, however, the pH of the fluid must be checked each day of use to make certain that the pH is still within the allowed range. If, after the day of preparation, the fluid pH is found to be outside the allowed range, no pH adjustments may be made and the fluid shall be discarded. New fluid will need to be prepared. If large volumes of fluid are made

and stored, the extraction fluids should be monitored frequently for impurities. If impurities are found, the fluid shall be discarded and fresh extraction fluid prepared.

10.13. Analytical standards shall be prepared according to the appropriate analytical method.

11.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

11.1. All samples shall be collected using an appropriate sampling plan.

11.2. The TCLP procedure may place requirements on the minimal size of the field sample, depending upon the physical state or states of the waste and the analytes of concern. The TCLP procedure requires that a minimum of 100 g of sample be used for non-volatile analyses, and 25 g be used for volatile analyses. An aliquot is also needed for preliminary evaluation to determine which extraction fluid is to be used for the nonvolatile analyte extraction procedure, the percent solids of the sample, or if the sample requires size reduction. Quality control measures may require additional aliquots. It is always wise to collect more sample just in case something goes wrong with the initial attempt to conduct the test. If there is not enough sample to achieve the minimum amounts, the Project Manager will need to obtain client permission to proceed, or the client will need to submit additional sample.

11.3. Preservatives shall not be added to samples before extraction.

11.4. Samples may be refrigerated unless refrigeration results in irreversible physical change to the waste. If precipitation occurs, the entire sample (including precipitate) should be extracted.

11.5. When the waste is to be evaluated for volatile analytes, care shall be taken to minimize the loss of volatiles. Samples shall be collected and stored in a manner intended to prevent the loss of volatile analytes (e.g., samples should be collected in Teflon-lined septum capped vials and stored at less than 6°C, but not frozen. Samples should be opened only immediately prior to extraction).

11.6. TCLP extracts should be prepared for analysis and analyzed as soon as possible following extraction. Extracts or portions of extracts for metallic analyte determinations must be acidified with nitric acid to a pH <2, unless precipitation occurs (see section 14.2.9 if precipitation occurs). Extracts should be preserved for other analytes according to the guidance given in the individual analysis methods. Extracts or portions of extracts for organic analyte determinations shall not be allowed to come into contact with the atmosphere (i.e., no headspace) to prevent losses.

11.7. Samples must undergo TCLP extraction within the following time periods:

SAMPLE MAXIMUM HOLDING TIMES (Days)				
	From: Field Collection **To**: TCLP Extraction	**From**: TCLP Extraction **To**: Preparative Extraction	**From**: Preparative Extraction **To**: Determinative Analysis	Total Elapsed Time
Volatiles	14	NA	14	28
Semi-volatiles	14	7	40	61
Mercury	28	NA	28	56
Metals, except Mercury	180	NA	180	360

NA = Not Applicable

If sample holding times are exceeded, the values obtained will be considered minimal concentrations. Exceeding the holding time is not acceptable in establishing that a waste does not exceed the regulatory level. Exceeding the holding time will not invalidate characterization if the waste exceeds the regulatory level.

12.0 QUALITY CONTROL

12.1. Method Blank: A minimum of one method blank must be extracted (using the same extraction fluid as the samples) and analyzed for every 20 extractions that have been conducted in an extraction vessel.

12.2. A minimum of one matrix spike must be analyzed for each analytical batch for each matrix type. As a minimum, follow the matrix spike addition guidance provided in each analytical method.

12.2.1. Matrix spikes are to be added after filtration of the TCLP extract and before preservation (for metals analysis), preparative extraction (for semivolatiles analysis), or analysis (for volatiles analysis). Matrix spikes should not be added prior to TCLP extraction of the sample.

12.2.2. In most cases, matrix spikes should be added at a concentration equivalent to the corresponding regulatory level. If the analyte concentration is less than one half the regulatory level, the spike concentration may be as low as one half of the analyte concentration, but may not be less than five times the method detection limit. In order to avoid differences in matrix effects, the matrix spikes must be added to the same nominal volume of TCLP extract as that which was analyzed for the unspiked sample.

12.2.3. Use of other internal calibration methods, modification of the analytical methods, or use of alternate analytical methods may be needed to accurately measure the analyte concentration in the TCLP extract when the recovery of the matrix spike is below the analytical method performance.

12.3. All quality control measures described in the appropriate analytical methods shall be followed.

12.4. The use of internal calibration quantitation methods shall be employed for a metallic contaminant if: (1) Recovery of the contaminant from the TCLP extract is not at least 50% and

the concentration does not exceed the regulatory level, and (2) The concentration of the contaminant measured in the extract is within 20% of the appropriate regulatory level.

12.4.1. The method of standard additions shall be employed as the internal calibration quantitation method for each metallic contaminant.

12.4.2. The method of standard additions requires preparing calibration standards in the sample matrix rather than reagent water or blank solution. It requires taking four identical aliquots of the solution and adding known amounts of standard to three of these aliquots. The forth aliquot is the unknown. Preferably, the first addition should be prepared so that the resulting concentration is approximately 50% of the expected concentration of the sample. The second and third additions should be prepared so that the concentrations are approximately 100% and 150% of the expected concentration of the sample. All four aliquots are maintained at the same final volume by adding reagent water or a blank solution, and may need dilution adjustment to maintain the signals in the linear range of the instrument technique. All four aliquots are analyzed.

12.4.3. Prepare a plot, or subject data to linear regression, of instrument signals or external-calibration-derived concentrations as the dependent variable (y-axis) versus concentrations of the additions of standard as the independent variable (x-axis). Solve for the intercept of the abscissa (the independent variable, x-axis) which is the concentration in the unknown.

12.4.4. Alternately, subtract the instrumental signal or external-calibration-derived concentration of the unknown (unspiked) sample from the instrumental signals or external-calibration-derived concentrations of the standard additions. Plot or subject to linear regression of the corrected instrument signals or external-calibration-derived concentrations as the dependent variable versus the independent variable. Derive concentrations for unknowns using the internal calibration curve as if it were an external calibration curve.

13.0 CALIBRATION AND STANDARDIZATION

13.1. See the appropriate analytical SOPs for calibration and standardization procedures and criteria.

14.0 PROCEDURE

14.1. PRELIMINARY EVALUATIONS

14.1.1. Preliminary Determination of Percent Solids

14.1.1.1. If the waste will obviously yield no liquid when subject to pressure filtration (i.e., is 100% solids) proceed to section 14.1.2.

14.1.1.2. If the sample is liquid or multiphasic, separation of the liquid and solid phases is required and is describe below.

14.1.1.2.1. Pre-weigh the filter and the container that will receive the filtrate.

14.1.1.2.2. Assemble the filter holder and filter.

14.1.1.2.3. Weigh out 100 g of the waste and record the weight of the sample + the vessel that the sample was weighed into.

14.1.1.2.4. Allow slurries to stand to allow the solid phase to settle. Centrifugation can be used as an aid to filtration.

14.1.1.2.5. Allow the sample to reach room temperature and decant the liquid phase into the filtering apparatus. Gradually apply vacuum, and slowly increase the pressure to 50 psi. Stop the filtration when no liquid has passed through the filter for 2 minutes.

14.1.1.2.6. Weigh the vessel from 14.1.1.2.3 and subtract it from the sample + vessel weight in order to determine the total weight of the waste that was filtered.

14.1.1.2.7. Determine the weight of the liquid phase by subtracting the weight of the filtrate container (see section 14.1.1.2.1) from the total weight of the filtrate-filled container. Record this weight.

14.1.1.2.8. Dry the filter and solid phase at 100 ± 20 °C until two successive weights yield the same value within ± 1%. Record the final weight.

14.1.1.2.9. Calculate the percent solids as follows:

$$\% \text{ Solids} = \frac{[\text{Weight of dried solid+Filter (section 14.1.1.2.8)}] - \text{tared weight of filter}}{\text{Total weight of waste filtered (Section 14.1.1.2.6)}} \times 100$$

14.1.1.2.10. If the percent solids determined in 14.1.1.2.9 is less than 0.5%, then proceed to section 14.1.2 if nonvolatile TCLP is to be performed, and to section 14.3 if volatile TCLP is to be performed.

14.1.1.2.11. If the percent solids determined in 14.1.1.2.9 is equal to or greater than 0.5% and of nonvolatile TCLP is to be determined, proceed to 14.1.2 to determine if particle size reduction is necessary. If volatile TCLP is to be determined, proceed to section 14.3.

14.1.2. Determination of Particle Size Reduction Necessity

14.1.2.1. If particles are capable of passing through a 9.5 mm sieve, then the sample does not need particle size reduction.

14.1.2.2. If any particles cannot pass through the 9.5 mm sieve, then the sample needs to be prepared for extraction by crushing, cutting, or grinding the waste to a size that will pass through the sieve.

14.1.3. Determination of Appropriate Extraction Fluid

14.1.3.1. Place 5 g of sample, size reduced if necessary, into a 500mL beaker.

14.1.3.2. Add 96.5 mL reagent water and cover with a watch glass. Stir vigorously with a magnetic stirrer for 5 minutes. Measure and record the pH. If the pH is less <5.0, use extraction fluid #1 and proceed to section 14.2.

14.1.3.3. If the pH from 14.1.3.2 is >5.0, add 3.5 mL 1N HCl, stir briefly cover with a watchglass, heat to 50 °C and hold at 50 °C for 10 minutes.

14.1.3.4. Let the solution cool to room temperature and record the pH. If it is < 5.0, use extraction fluid #1. If it is >5.0, use extraction fluid #2. Proceed to section 14.2.

14.2. PROCEDURE FOR NONVOLATILE EXTRACTION

14.2.1. Weigh out 100 g of sample. If the sample will obviously yield no water when subjected to filtration (i.e. 100% solid) proceed to section 14.1.1.2.10

14.2.2. If the sample is liquid or multiphasic, liquid/solid separation is required.

14.2.2.1. Pre-weigh the filter and the container that will receive the filtrate.

14.2.2.2. Assemble the filter holder and filter.

14.2.2.3. Weigh out 100 g of the waste and record the weight of the sample + the vessel that the sample was weighed into.

14.2.2.4. Allow slurries to stand to allow the solid phase to settle. Centrifugation can be used as an aid to filtration.

14.2.2.5. Allow the sample to reach room temperature and decant the liquid phase into the filtering apparatus. Gradually apply vacuum, and slowly increase the pressure to 50 psi. Stop the filtration when no liquid has passed through the filter for 2 minutes.

14.2.2.6. Weigh the vessel from 14.2.2.3 and subtract it from the sample + vessel weight in order to determine the total weight of the weight that was filtered.

14.2.2.7. Determine the weight of the liquid phase by subtracting the weight of the filtrate container (see section 14.2.2.1) from the total weight of the filtrate-filled container. Record this weight.

14.2.2.8. Dry the filter and solid phase at 100 ± 20 °C until two successive weights yield the same value within ± 1%. Record the final weight.

14.2.2.9. Calculate the percent solids as follows:

$$\% \text{ Solids} = \frac{[\text{Weight of dried solid+Filter (section 14.1.1.2.8)}] - \text{tared weight of filter}}{\text{Total weight of waste filtered (Section 14.1.1.2.6)}} \times 100$$

14.2.2.10. If the waste contains less than 0.5% solids, proceed to 14.2.7. If the waste contains greater than 0.5% solids and if particle size reduction was necessary in 14.1.2, proceed to section 14.2.3. If the waste does not require particle size reduction, transfer the solid and the filter used in the separation of the solid and liquid phases into the extraction bottle and proceed to section 14.2.4.

14.2.3. Prepare the solid portion of the waste for extraction by crushing, cutting, or grinding the waste to a surface area or particle size as described in section 14.1.2. When the

particle size has been sufficiently reduced, transfer the solid into the extraction bottle, including the filter used in the separation of the solid and liquid phases.

14.2.4. If the 100 g portion of the waste from 14.2.1 yielded no water, add the waste to the extraction bottle and slowly add 2 L of the extraction fluid that was determined in 14.1.3. If the solid was filtered out of the liquid phase, use the formula below to determine the amount of extraction fluid to use and slowly add that amount to the waste.

$$\text{Weight of extraction fluid} = \frac{20 \times \%\ \text{solids (14.2.2.9)} \times \text{weight of waste filtered(14.2.2.7)}}{100}$$

14.2.5. Close the extraction bottle tightly, using Teflon tape if necessary, secure it in the rotary device, and rotate at 30 ± 2 rpm for 18 ± 2 hours. The ambient temperature during the extraction is to be maintained at 23 ± 2 °C during the extraction period.

Note: As agitation continues, pressure may build up within the extractor for some types of waste (e.g. limed or calcium carbonate containing wastes may evolve gases such as carbon dioxide). To relieve the excess pressure, the extractor bottle may be periodically opened (e.g. after 15 minutes, 30 minutes, and 1 hour) and vented into a hood.

14.2.6. As soon as possible following the 18 ± 2-hour extraction period, separate the material in the extractor vessel into its component liquid and solid phases by filtering it through a new glass fiber filter. If measuring for metals, the filter shall be acid washed.

14.2.7. Prepare the TCLP extract as follows:

14.2.7.1. If the waste contained no initial liquid phase, the filtered liquid material obtained in 14.2.6 is defined as the TCLP extract.

14.2.7.2. If the initial waste was multiphasic, the initial liquid phase from the waste and the liquid filtered from the extraction in 14.2.6 may be combined together, permitted that they do not form multiple layers. This combined liquid is defined as the TCLP extract.

14.2.7.3. If the initial liquid phase from the waste is not compatible with the liquid obtained from 14.2.6, do not combine the liquids. Analyze these liquids separately and combine the results mathematically as described in section 14.2.12.

14.2.8. Following the collection of the TCLP extract, the pH should be recorded.

14.2.9. Immediately aliquot and preserve the extract for analysis. Metals aliquots must be acidified with nitric acid to pH <2. If precipitation is observed upon the addition of nitric acid to a small aliquot of the sample, then the remaining portion of the sample for metals analysis shall not be acidified ant the extract shall be analyzed as soon as possible. All other aliquots must be stored under refrigeration (4°C) until analyzed.

14.2.10. The TCLP extract shall be prepared and analyzed according to the appropriate analytical methods.

14.2.11. TCLP extracts for metals shall be acid digested except for those instances where digestion causes loss of metallic analytes.

14.2.12. If the individual phases are to be analyzed separately, determine the volume of the phases (to ± 0.5%), conduct the appropriate analyses, and combine the results mathematically by using the following formula:

$$\text{Final Analyte Concentration} = \frac{(V_1)(C_1)+(V_2)(C_2)}{V_1+V_2}$$

Where:
V_1 = The volume of the first phase (L).
C_1 = The concentration of the analyte of concern in the first phase (mg/L).
V_2 = The volume of the second phase (L).
C_2 = The concentration of the analyte of concern in the second phase (mg/L).

14.3. PROCEDURE WHEN VOLATILES ARE INVOLVED

NOTE: Use the TCLP extract obtained from the ZHE device only for the analysis of volatile compounds. The extract from the ZHE shall not be used for the analysis of nonvolatile analytes.

NOTE: Minimize exposure of the waste to air as much as possible. Work with the sample at 4 °C to minimize loss of volatile compounds.

14.3.1. Pre-weigh a TEDLAR® bag and set aside.

14.3.2. Place the ZHE piston within the body of the ZHE (moistening of the o-rings with extraction fluid will help ease its movement). Position the piston to a height that will minimize the distance the piston will have to move when the ZHE is charged with the sample. Secure the gas inlet/outlet flange (bottom flange) onto the ZHE body. Secure the glass fiber filter between the support screens and set aside. Set the liquid inlet/outlet flange (top flange) aside.

14.3.3. If the sample was determined to be 100% solid in section 14.1.1, weigh out a 25 g subsample and proceed to 14.3.9.

14.3.4. If the waste contains <0.5% dry solids, as determined in section 14.1.1.2, the liquid portion of the waste, after filtration, is defined as the TCLP extract.

14.3.5. If the waste contains >0.5% dry solids, as determined in section 14.1.1.2, use the percent solids information obtained in section 14.2.2.9 to determine the optimal sample size to charge into the ZHE. The recommended sample size is as follows:

14.3.5.1. For wastes containing < 5.0% solids, weigh out a 500 g subsample of the waste. Record this weight.

14.3.5.2. For wastes containing > 5.0% solids, determine the amount of sample to charge into the ZHE with the following formula:

$$\text{Weight of waste to charge ZHE} = \frac{25}{\text{percent solids (section 14.2.2.9)}} \times 100$$

Weigh out a subsample of the waste of the appropriate size and record the weight.

14.3.6. If particle size reduction of the solid portion was determined to be necessary in section 14.1.2, continue to step 14.3.7. If particle size reduction was not necessary, proceed to section 14.3.8.

14.3.7. Prepare the sample for extraction by crushing or cutting the solid portion of the waste. The waste and the appropriate size reduction equipment should be refrigerated to 4 °C prior to particle size reduction to minimize the loss of volatile compounds. Exposure of the waste to the atmosphere should be avoided to the extent possible. The process of size reduction must not produce heat in and of itself.

14.3.8. Waste slurries should not be allowed to stand to permit the solid phase to settle. Do not centrifuge wastes prior to filtration.

14.3.9. Quickly quantitatively transfer the entire sample, liquid and solid phases, into the ZHE. Secure the filter and support screens onto the top flange and secure the top flange to the ZHE body. Tighten all of the ZHE fittings and place the devise in the vertical position with the gas inlet/outlet flange on the bottom.

14.3.10. Attach a gas line to the gas inlet/outlet valve, open the liquid inlet/outlet valve, and begin applying a pressure of 1-10 psi (or more if necessary) to force all headspace slowly out of the ZHE into a hood. At the first appearance of liquid, quickly close the liquid inlet/outlet valve and discontinue pressure. (If the waste is 100% solid, slowly increase the pressure to 50 psi to force most of the headspace out of the ZHE and proceed to section 14.3.15).

Note: Instantaneous application of high pressure can degrade the glass fiber filter and may cause premature plugging.

14.3.11. Attach the TEDLAR® bag from 14.3.1 to the liquid inlet/outlet valve and open the valve. Begin applying gentle pressure of 1-10 psi. If no additional liquid has passed through the filter in any two-minute interval, slowly increase the pressure in 10 psi increments to a maximum of 50 psi. If no liquid has passed through the filter after 2 minutes at 50 psi, stop the filtration. Close the liquid inlet/outlet valve, discontinue pressure to the piston, and disconnect and weigh the TEDLAR® bag used to collect the filtrate.

14.3.12. The material in the ZHE is defined as the solid phase of the waste and the filtrate is defined as the liquid phase. If the waste was determined to be less than 0.5 % solid, the filtrate is defined as the TCLP extract and is analyzed directly. Proceed to section 14.3.20.

14.3.13. The liquid phase may either be analyzed immediately, or stored at 4 °C until time of analysis.

14.3.14. Determine the weight of extraction fluid to add to the ZHE as follows:

$$\text{Weight of extraction fluid} = \frac{20 \times \%\ \text{solids (14.1.1.2)} \times \text{weight of waste filtered (14.3.5.2)}}{100}$$

14.3.15. Add the extraction fluid to the ZHE as follows:

14.3.15.1. Assemble and fill a second ZHE with the appropriate amount of extraction fluid. Place the device in the vertical position with the gas inlet/outlet valve on the bottom. Be sure to add extra volume of the fluid that corresponds with the volume of the stainless-steel gas line that will be used in the next step. This will ensure that the appropriate volume of fluid is added to the waste.

14.3.15.2. Attach a stainless-steel gas line to the liquid inlet/outlet valve. Attach the gas line to the gas inlet/outlet valve and open both the gas and liquid valves. Slowly and gently apply pressure until the first sign of liquid comes out of the end of the stainless-steel gas line attached to the liquid inlet/outlet valve, then immediately close the liquid inlet/outlet valve and discontinue pressure.

14.3.15.3. Attach the other end of the stainless-steel gas line to the liquid inlet/outlet valve of the ZHE that contains the solid portion of the waste. Open the gas inlet/outlet and valve of the ZHE that contains the waste. Attach one end of a tube to the gas inlet/outlet valve of the waste containing ZHE and place the other end in a beaker of water. Begin applying pressure to the ZHE that contains the fluid, and then open the liquid inlet/outlet valve of that ZHE followed by opening the liquid inlet/outlet valve of the ZHE containing the waste.

14.3.15.4. Slowly and gently increase the pressure being delivered to the ZHE that contains the fluid. Do not exceed 50 psi. As the ZHE containing the waste is filled, air below the piston will be expressed through the tube and into the beaker of water. When the bubbling ceases, the fluid transfer is complete.

14.3.15.5. Close all the valves of the ZHEs. Disconnect the stainless-steel gas line from the waste containing ZHE. Manually rotate the ZHE containing the waste and extraction fluid end over end 2 or three times and reposition the ZHE with the liquid inlet/outlet valve on the top. Connect the gas source to the gas inlet/outlet valve of the ZHE and pressurize the ZHE with 5-10 psi. Slowly open the liquid inlet/outlet valve to expel any air that may have been introduced during the addition of the extraction fluid. Close the valve immediately at the first appearance of liquid from the valve.

14.3.15.6. Re-pressurize the ZHE with 5-10 psi and check that all the ZHE fittings are closed.

14.3.16. Place the ZHE in the rotary agitation apparatus and rotate at 30 ± 2 rpm for 18 ± 2-hours. The temperature must be maintained at 23 ± 2 °C during agitation.

14.3.17. As soon as possible following the 18 ± 2-hour agitation period, check the pressure behind the piston by quickly opening the gas inlet/outlet valve and noting the escape of gas. If pressure was not maintained, the ZHE is leaking. The extraction will need to be repeated with a new sample of waste.

14.3.18. If the pressure was maintained, the liquid in the ZHE will need to be collected. The leachate must be collected as soon as possible after the agitation period is completed. If the waste contained an initial phase of liquid, the liquid in the ZHE can be added to the TEDLAR® bag that the original liquid phase was collected into, provided that combining will not create multiple phases and that there is enough volume left in the TEDLAR® bag to accept the full volume of the extraction fluid. If the original waste contained no initial liquid phase, the fluid within the ZHE is defined as the TCLP extract.

14.3.19. To collect the fluid from the ZHE, begin applying pressure to the piston in 10 psi increments, increasing the pressure when, after 2 minutes, no liquid is expelled from the ZHE. Do not exceed 50 psi.

14.3.20. Immediately prepare the extract for analysis, or store at 4 °C until analysis. Analyze the TCLP extract according to the appropriate analytical methods.

14.3.21. If the individual phases are to be analyzed separately, combine the results mathematically using the formula below:

$$\text{Final Analyte Concentration} = \frac{(V_1)(C_1)+(V_2)(C_2)}{V_1+V_2}$$

where:
V_1 = The volume of the first phase (L).
C_1 = The concentration of the analyte of concern in the first phase (mg/L).
V_2 = The volume of the second phase (L).
C_2 = The concentration of the analyte of concern in the second phase (mg/L).

15.0 CALCULATIONS

15.1. Calculation of percent solids:

$$\%\ \text{Solids} = \frac{[\text{Weight of dried solid+Filter (section 14.1.1.2.8)}]- \text{tared weight of filter}}{\text{Total weight of waste filtered (Section 14.1.1.2.6)}} \text{ x } 100$$

15.2. Weight of extraction fluid to use for non-volatile extraction:

$$\text{Weight of extraction fluid} = \frac{20 \times \%\ \text{solids (14.2.2.9)} \times \text{weight of waste filtered(14.2.2.7)}}{100}$$

15.3. Weight of waste to charge the ZHE for volatile analytes:

$$\text{Weight of waste to charge the ZHE} = \frac{25}{\text{percent solids (section 14.2.2.9)}} \times 100$$

15.4. Weight of extraction fluid to add to the ZHE:

$$\text{Weight of extraction fluid} = \frac{20 \times \%\ \text{solids (14.1.1.2)} \times \text{weight of waste filtered (14.3.5.2)}}{100}$$

15.5. If the original waste was multiphasic and the individual phases are to be analyzed separately, mathematically combine the results as follows:

$$\text{Final Analyte Concentration} = \frac{(V_1)(C_1)+(V_2)(C_2)}{V_1+V_2}$$

Where:

V_1 = The volume of the first phase (L).
C_1 = The concentration of the analyte of concern in the first phase (mg/L).
V_2 = The volume of the second phase (L).
C_2 = The concentration of the analyte of concern in the second phase (mg/L).

15.6. Matrix spike recoveries are calculated by the following formula:

$$\%\text{Recovery} = \frac{100 \times (X_s - X_u)}{K}$$

Where:

X_s = measured value for the spiked sample
X_u = measured value for the unspiked sample
K = known value of the spike in the sample

15.7. See the appropriate analytical SOPs for any additional calculations that are relevant to those analyses.

16.0 METHOD PERFORMANCE

16.1. Ruggedness: Determination of the sensitivity of small procedural variations which might be expected to occur during routine laboratory application. EPA Method 1311 Discusses the following:

16.1.1. Metals – The following conditions were used when leaching a waste for metals analysis:

Varying Conditions	
Liquid/Solid ratio	19:1 vs. 21:1
Extraction time	16 hours vs. 18 hours
Headspace	20% vs. 60%
Fluid #2 acidity	190 meq vs. 210 meq
Acid-washed filters	Yes vs. no
Filter type	0.7 µm glass fiber vs. 0.45 µm vs. polycarbonate
Bottle type	Borosilicate vs. flint glass

Of the seven method variations examined, acidity of the extraction fluid had the greatest impact on the results. Four of 13 metals from an API separator sludge/electroplating waste (API/EW) mixture and two of three metals from an ammonia lime still bottom waste were extracted at higher levels by the more acidic buffer. Because of the sensitivity to pH changes, the method requires that the extraction fluids be prepared so that the final pH is within + 0.05 units as specified.

16.1.2. Volatile Organic Compounds – The following conditions were used when leaching a waste for volatiles analysis:

Varying Conditions	
Liquid/Solid ratio	19:1 vs. 21:1
Headspace	0% vs. 5%
Fluid #1 acidity	60 meq vs. 80 meq
Method of storing extract	Syringe vs. Tedlar® bag
Aliquotting	Yes vs. No
Pressure behind piston	0 psi vs. 20 psi

None of the parameters had a significant effect on the results of the ruggedness test.

16.2. Precision: Many TCLP precision (reproducibility) studies have been performed, and have shown that, in general, the precision of the TCLP is comparable to or exceeds that of the EP toxicity test and that method precision is adequate. One of the more significant contributions to poor precision appears to be related to sample homogeneity and inter-laboratory variation (due to the nature of waste materials).

16.2.1. Metals – The results of a multi-laboratory study are shown in Table 6 of the EPA 1311 method, and indicate that a single analysis of a waste may not be adequate for waste characterization and identification requirements.

16.2.2. Semi-Volatile Organic Compounds - The results of two studies are shown in Tables 7 and 8 of the EPA 1311 method. Single laboratory precision was excellent with greater than 90 percent of the results exhibiting an RSD less than 25 percent. Over 85 percent of all individual compounds in the multi-laboratory study fell in the RSD range of 20 - 120 percent. Both studies concluded that the TCLP provides adequate precision. It was also determined that the high acetate content of the extraction fluid did not present problems (i.e., column degradation of the gas chromatograph) for the analytical conditions used.

16.2.3. Volatile Organic Compounds - Eleven laboratories participated in a collaborative study of the use of the ZHE with two waste types which were fortified with a mixture of VOCs. The results of the collaborative study are shown in Table 9 of the EPA 1311 method. Precision results for VOCs tend to occur over a considerable range. However, the range and mean RSD compared very closely to the same collaborative study metals results in Table 6 of the EPA 1311 method. Blackburn and Show concluded that at the 95% level of significance: 1) recoveries among laboratories were statistically similar, 2) recoveries did not vary significantly between the two sample types, and 3) each laboratory showed the same pattern of recovery for each of the two samples.

17.0 POLLUTION PREVENTION

17.1. The EPA has established guidelines of environmental management techniques to institute pollution prevention in the workplace. Whenever feasible, laboratory personnel use pollution prevention techniques to address their waste generation and minimize pollution resulting from any laboratory activity.

18.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QUALITY CONTROL MEASURES

18.1. Extraction Fluid pH:

18.1.1. Fluid 1 must be pH 4.93 ± 0.05 and the Fluid 2 pH must be 2.88 ± 0.05. Do not use fluid that does not meet these criteria. Use of fluid that do not meet these criteria will require a NCD, and the resulting data may not be accepted.

18.2. Rotation Speed:

18.2.1. The rotator must turn at 30 ± 2 rotations per minute. If the rotator does not meet this requirement, it must not be used and must be repaired. Samples will have to be loaded onto a different rotator or subcontracted.

18.2.2. If the rotation stops during the 18-hour agitation step, the leaching process must be repeated with a new 100 g portion of sample.

18.3. Leachate Filtration:

18.3.1. The solid and liquid phases of the leachate must be separated by filtration as soon as possible after the agitation step is completed. Failure to filter the leachate will result in the leaching process to be prolonged past the method specifications. See section 20.3 for instructions on handling leachates that were not filtered in a timely manner.

18.4. Refer to the appropriate analytical methods for quality control acceptance criterion.

19.0 CORRECTIVE ACTIONS FOR OUT-OF-CONTROL DATA

19.1. Refer to the appropriate analytical methods.

20.0 CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1. Minimum sample amount requirements: If the amount of sample submitted is less than the minimum amount required for testing, the client was unable to provide additional sample, and the client gave the lab permission to proceed with testing, the data will need to be flagged and the situation narrated in the final report.

20.2. Occasionally, there are materials are received for TCLP analysis that require special treatment. These materials are sometimes filters, fabrics, or other atypical materials. Often, these materials are unable to be processed as this procedure requires. If special treatment is needed, the Project Manager needs to contact the client to discuss, and come to an agreement on, a modified procedure. The report will need to include a narration of the modification.

20.3. Failure to filter the leachate as soon as possible after agitation is complete:

20.3.1. If the analytical results are ND, the data can be reported, but an NCD must be filed to accompany the data.

20.3.2. If the analytical results had detections, but the detections were below the regulatory limits, the acceptability of the data to the client must be determined by the Technical

Director and Quality Assurance Director, or their designee, before it can be sent to the client.

20.3.3. If the analytical results had detections, and the detections were above the regulatory limits, the data cannot be used. The sample(s) must be leached again using a fresh 100 g aliquot of sample.

20.3.3.1. If there is not enough sample to repeat the leaching procedure, contact the PM must contact the client to request additional sample or obtain other instructions.

20.4. Refer to the appropriate analytical methods.

21.0 WASTE MANAGEMENT

21.1. Refer to the Waste Disposal SOP, document # J-0010.

22.0 REFERENCES

22.1. EPA 1311

23.0 ATTACHMENTS

23.1. Attachment 1: EPA 1311 page 33, Figures 1 and 2, Rotary Agitation Apparatus and ZHE diagrams.

23.2. Attachment 2: EPA 1311 pages 34-35, TCLP sample processing flow chart.

24.0 DOCUMENT REVISION HISTORY

Date	Description of Revision
Sept 2015	• Updated the format of the SOP to meet the TNI 2009 Standard SOP Template.
January 2017	• Section 11.5: changed preservation temperature to read “less than 6°C, but not frozen” • Added “as soon as possible” in the instructions pertinent to filtering the leachate after the agitation is complete (Sections 14.2.6, 14.3.17, and 14.3.18) • Section 16.1: Added “EPA Method 1311 Discusses the following:” • Section 18: Added assessment instructions for fluid pH, rotation speed, and filtration time. • Added Section 20.3
January 2018	• Revised the note in section 10.12 • Added discussion about minimum sample amount in section 11.2 • Inserted 20.1 and 20.2

ATTACHMENT 1

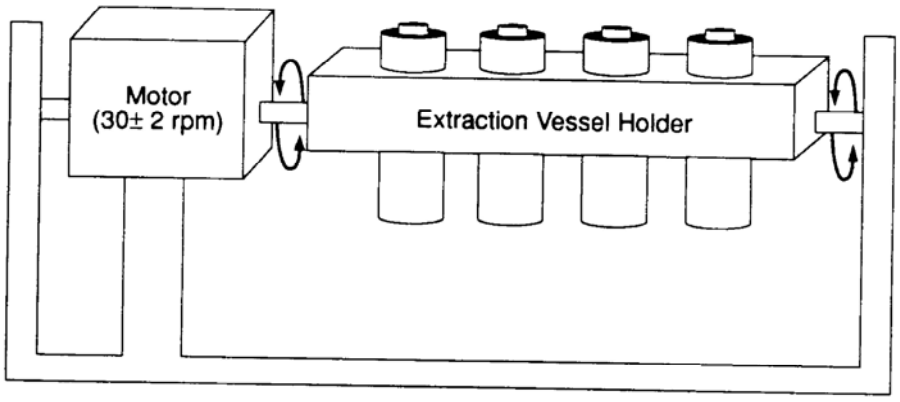


Figure 1. Rotary Agitation Apparatus

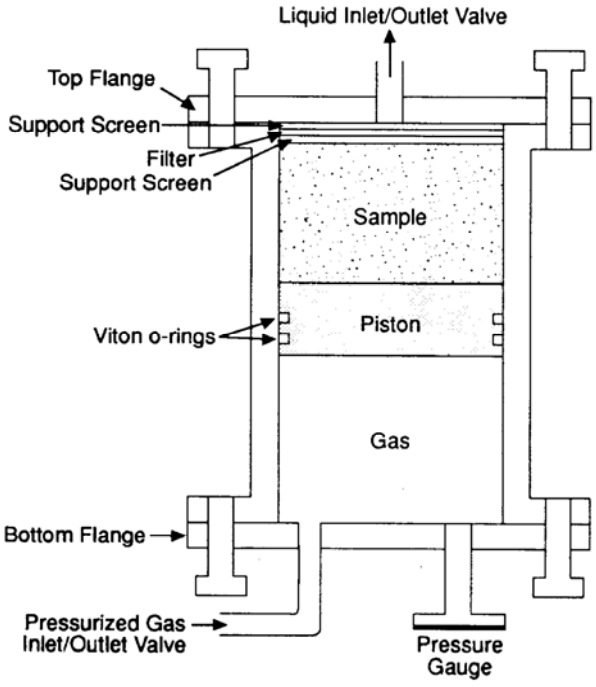
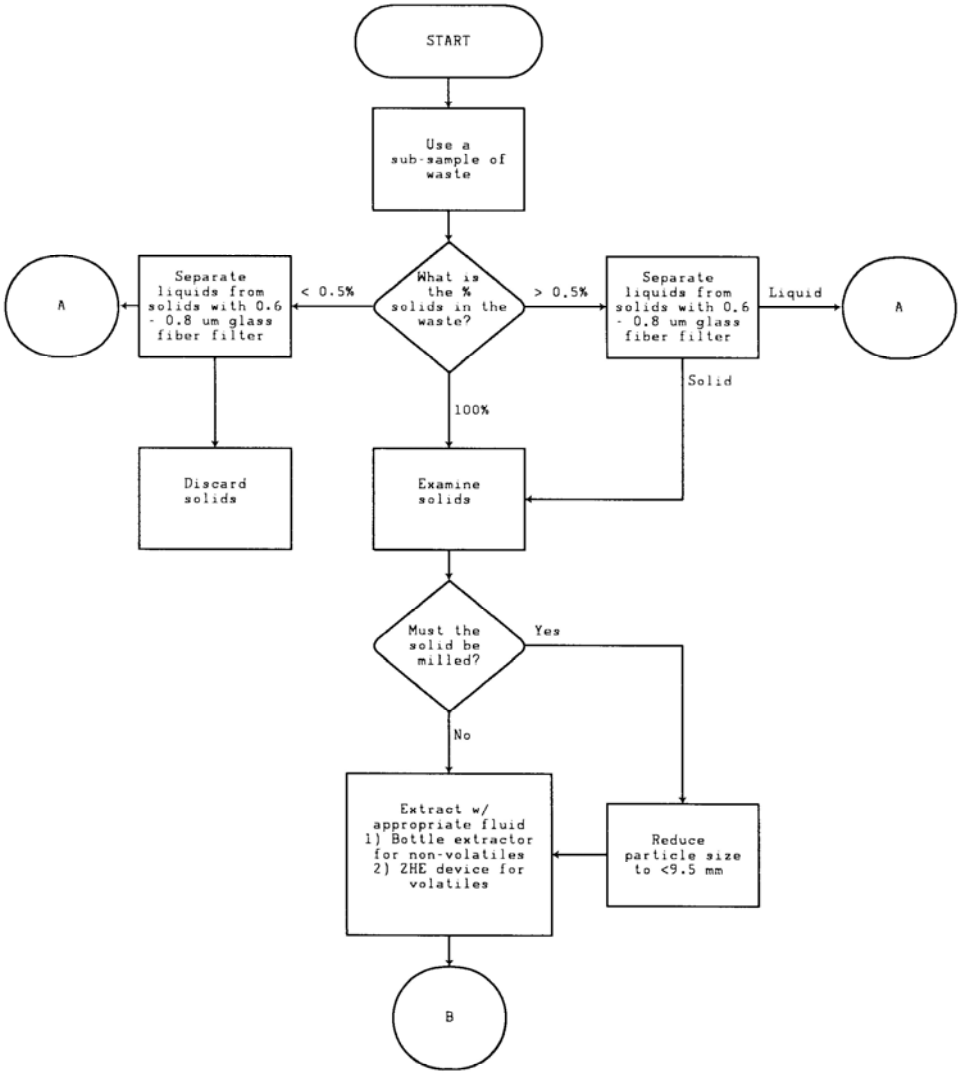


Figure 2. Zero-Headspace Extractor (ZHE)

ATTACHMENT 2

METHOD 1311

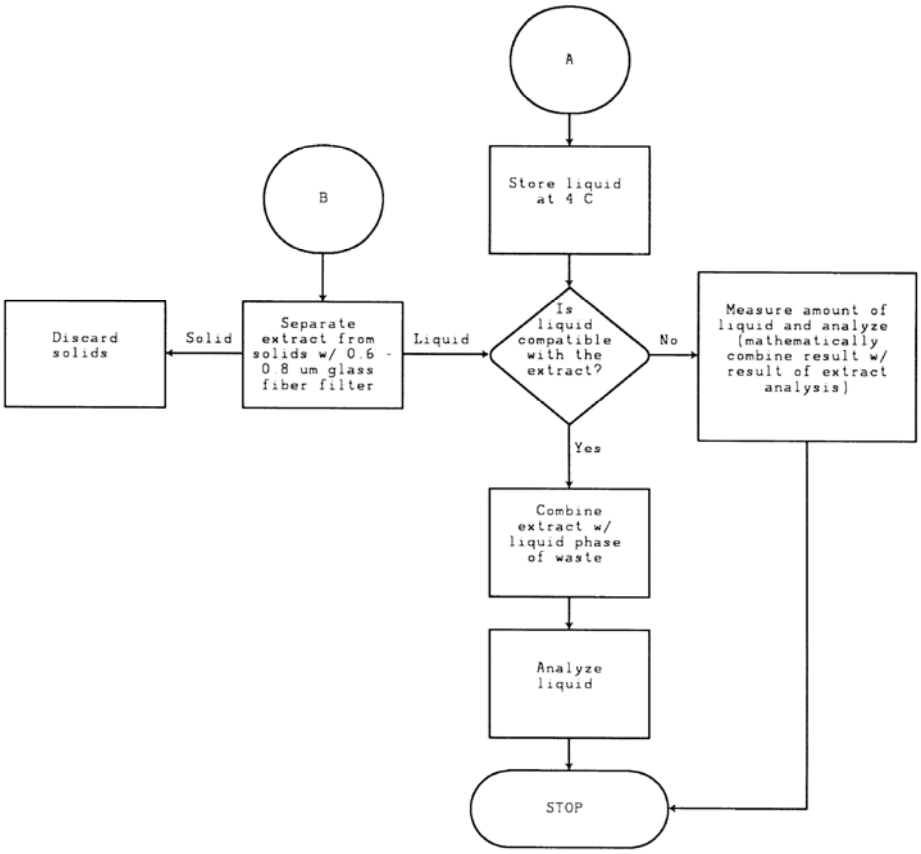
TOXICITY CHARACTERISTIC LEACHATE PROCEDURE



ATTACHMENT 2 (continued)

METHOD 1311 (CONTINUED)

TOXICITY CHARACTERISTIC LEACHATE PROCEDURE



ENTHALPY ANALYTICAL

931 W. Barkley Ave.
Orange, CA 92868

STANDARD OPERATING PROCEDURE

MERCURY
COLD VAPOR ANALYSIS

EPA SW846, Method 7471A

SOP Number:	F-0012		
Prepared By:	Clifford Baldridge	Revision:	2
Effective Date:	10/11/2018	Supersedes:	1.3

Approved By:	Signature:	Date:
Kedy Nguyen Department Manager		10/11/18
Hongling Cao Technical Director	Hongling Cao	10/11/18
Clifford Baldridge QA Director		10/11/18
Reapproved By:	Signature:	Date:

1.0 IDENTIFICATION OF THE TEST METHOD

1.1. The method is EPA 7471A.

2.0 APPLICABLE MATRIX OR MATRICES

2.1. This method is used for determining the concentration of mercury in soils, sediments, bottom deposits, and sludge type materials.

3.0 DETECTION LIMITS

3.1. The detection limit of reporting (DLR) for these methods is 0.14 mg/Kg

4.0 SCOPE AND APPLICATIONS

4.1. This method measures total mercury, organic and inorganic.

5.0 SUMMARY

5.1. Prior to analysis, the solid or semi-solid samples must be prepared according to the procedure discussed in this method

5.2. Method 7471A, a cold-vapor atomic absorption method, is based on the absorption of radiation at the 253.7-nm wavelength by mercury vapor. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak area) is measured as a function of mercury concentration.

6.0 DEFINITIONS

6.1. Reporting Detection Limit (RDL): The lowest concentration that can be measured with the consideration for practical limitations such as sample size, matrix interferences and dilutions.

6.2. Method Detection Limit (MDL): Minimum concentrations of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The sample is carried through the entire method under ideal conditions. This is performed on an annual basis, or more frequently as methods demand, by the laboratory.

$MDL = t_{(n-1,\ 1-\alpha)} \times S$

Where: S = the standard deviation of the replicate analyses

$t_{(n-1,\ 1-\alpha)}$ = the student's t-value appropriate to a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom.

Number of Samples	t-value
7	3.143
8	2.998
9	2.896
10	2.821
11	2.764
12	2.718

13	2.681
14	2.650
15	2.624

6.3. Calibration: A plot of concentrations of known analyte standards versus the instrument response to the analyte. It is a reproducible reference point to which all sample measurements can be correlated. The appropriate linear or nonlinear coefficient for standard concentration to instrument response should be greater than or equal to 0.995.

6.4. Calibration Standards: A series of known analyte standards used for the calibration of the instrument. These are prepared by diluting a stock standard solution to produce working standards, which cover the working range of the instrument.

6.5. Initial Calibration Verification Standard (ICV): A standard used to confirm the accuracy of the instrument calibration. This is prepared from a different stock solution (a different lot number or vendor) than was used to prepare the calibration standards and at concentrations within the linear working range of the instrument. ICV must be performed automatically right after initial calibration.

6.6. Continuing Calibration Verification Standard (CCV): A standard that periodically confirms that the instrument response has not changed significantly from the initial calibration. It also confirms accurate analyte quantitation for the previous samples analyzed. Its concentration should be at or near the mid-range levels of the calibration curve. It is analyzed automatically every 10 samples and the end of the run.

6.7. Initial Calibration Blank (ICB): A volume of reagent water treated in the same manner as the calibration standards. It is used to check carryovers and contamination. It is run automatically after the ICV and should be below the reporting limit of the method.

6.8. Continuing Calibration Blank (CCB): A volume of reagent water treated in the same manner as the calibration standards. It is used to check carryovers and contamination. The CCB is analyzed automatically after CCV. It should be below the reporting limit of the method.

6.9. Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is to be carried through the complete sample preparation and analytical procedure. It is used to assess the samples in the preparation batch for possible contamination during the preparation and processing steps.

6.10. Laboratory Control Sample (LCS): An aliquot of laboratory reagent blank to which known quantities of the method analytes are added in the laboratory. The LCS is to be carried through the complete sample preparation and analytical procedure and is used to evaluate the performance of the total analytical system, including all preparation and analysis steps.

6.11. Matrix Spike (MS): An aliquot of environmental sample to which known quantities of the method analytes are added in the laboratory. The addition occurs prior to sample preparation and analysis. The MS is to be carried through the complete sample preparation and analytical procedure and is used to determine whether the sample matrix contributes any bias to the analytical results.

The background concentration of the analytes in the sample matrix must be determined in a separate aliquot of sample and the measured value in the MS corrected for the background concentration. Through this, the recovery of the spiked analytes can be determined and matrix bias, if any, can be observed.

6.12. Matrix Spike Duplicate (MSD): A duplicate of the Matrix Spike used to determine the precision and bias of a method in a given sample matrix.

6.13. Duplicate (DUP): A randomly-selected or client-assigned sample that is processed through the entire sample preparation and analytical procedure twice. Analysis of the sample duplicate can indicate precision associated with the laboratory procedures by removing variations contributed by sample collection, preservation, and storage procedures.

6.14. Dissolved mercury**:** The concentration of mercury determined in the portion of a sample that passes through a 0.45um filter.

6.15. Suspended mercury: The concentration of metals determined in the portion of a sample that is retained by a 0.45um filter.

6.16. Total mercury: The concentration of metals determined in a sample following digestion.

6.17. Linear dynamic range: The concentration range over which the analytical curve is linear.

7.0 INTERFERENCES

7.1. Glassware and reagents may contribute positive interference.

7.2. A laboratory blank is run to show the procedure is free from interference.

7.3. Glassware is acid- cleaned and used only for mercury analysis.

7.4. Potassium permanganate is added to eliminate possible interference from sulfide.

7.5. High Chloride concentrations require additional permanganate for oxidation. The Chlorine formed is removed by the addition of the hydroxylamine sulfate reagent.

7.6. Contamination by carryover can occur whenever high level and low-level samples are sequentially analyzed.

8.0 SAFETY

8.1. All normal lab safety practices must be followed. These procedures use strong acids and corrosive chemicals, which must be handled with caution.

8.2. In addition, mercury vapor is produced during the analysis. This vapor is highly toxic and must be vented to the exhaust hood.

8.3. Each laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of chemicals specified in this method. A reference file of Material Safety Data Sheets(MSDS) should be made available to all personnel involved in the chemical analysis. Refer to Associated Labs safety manual.

9.0 EQUIPMENT AND SUPPLIES

9.1. Perkin-Elmer Flow Injection Mercury System (FIMS 400), which includes: Flow Injection Mercury System, Computer System, Perkin-Elmer Mercury AS90 Auto-Sampler, Printer, AA Winlab Analyst Software (version 6.5), Argon gas supply with mercury free.

9.2. Modblock 100ml (33 places), Mini Controller (P/N 4370-010230), and Sample Rack 100ml (4370-010240).

9.3. Analytical Balance with capability to measure to 0.1mg.

9.4. Hood for sample preparation.

9.5. Peristaltic pump tubing: Red-red for reagent introduction (B019-3160), Yellow-yellow for sample introduction (B109-3161), Black-white for drain (B019-6741), Sample probe and sample tubing (B300158).

9.6. Calibrated mechanical pipettes: 100-1000uL, 1000-5000uL.

9.7. Mercury-free pipette tips, one milliliter(part# 7512) and five milliliters(part# 11269P)

9.8. 15-ml mercury-free polypropylene auto-sampler sample tubes (part# 8584).

9.9. 50-ml mercury-free polypropylene with caps auto-sampler standard tubes (part#SS3261).

9.10. Lab Glassware: All reusable lab glassware should be sufficiently clean for the task objectives. Particular attention should be given to all ground glass surfaces during cleaning. Routinely all items should be soaked in 30% HNO3 and rinsed three times in reagent water

9.11. Glassware: Volumetric flasks and graduated cylinders.

9.12. Sample tubes, hinged cups, 100ml (P/ N 4370-0120202).

10.0 REAGENTS AND STANDARDS

10.1. Reagent water

10.2. Concentrated Nitric Acid, HNO_3, Reagent grade

10.3. Concentrated Hydrochloric Acid, HCl, Reagent grade

10.4. Aqua regia: Prepare immediately before use, three volumes of concentrated hydrochloric acid to one of concentrated nitric acid.

10.5. Reducing solution: 1.1% $SnCl_2$ in 3% HCl solution. To a 1 L volumetric flask that contains 750 mL of reagent water, add 11 g of $SnCl_2$ and 30 mL of conc. HCl. Dilute to 1 L with reagent water. This solution must be prepared daily. S*tannous chloride is hygroscopic; it must be stored in the desiccator after opening.*

10.6. Carrier solution (3% HCL solution): To a 1 L volumetric flask that contains 750 mL of reagent water, add 30 mL of hydrochloric acid. Dilute to 1 L with reagent water. This solution is prepared daily.

10.7. Sodium chloride: anhydrous crystals

10.8. Sodium Chloride-hydroxylamine hydrochloride solution: Dissolve 12 g of sodium chloride and 12 g of hydroxylamine hydrochloride in 100 mL of reagent water. This solution is prepared weekly.

10.9. Potassium permanganate (5% solution): Dissolve 5 g of potassium permanganate in 100 mL of reagent water. This solution is prepared weekly.

10.10. Potassium persulfate (5% solution): Dissolve 5 g of potassium persultate in 100 mL of reagent water. This solution is prepared monthly.

10.11. 1000 µg/mL Primary Mercury Standard from commercial manufacture (used for calibration curves and CCVs).

10.12. 1000 µg/mL LCS Mercury Standard: Must be purchased from a secondary source (different lot number or different vendor) (used for LCS, ICV, MS and MSD).

11.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

11.1. Samples should be collected in plastic or glass bottles, and 200 g sample is needed.

11.2. Samples are transited and stored at between 0°C and 6°C.

11.3. Samples must be analyzed within 28 days of collection.

11.4. The client will be contacted when the sample requires handling in manners not specified in the method.

12.0 QUALITY CONTROL

12.1. Method Detection Limit (MDL) is determined in an annual basis or more often if necessary due to a change in instrumentation or the sample procedure which might affect the detection limits of the instrument.

12.2. Method Blank (MB) is analyzed with each batch of maximum 20 samples. It must be carried through all stages of sample preparation and measurement. The MB concentration must be less than the concentration of the reporting limit (DLR) if method blank is higher than the reporting limit then follow these steps: No action for samples whose concentrations are non-detect, and no action for samples whose concentrations are greater than 10x the blank concentration. If detected sample concentrations are less than 10x the blank concentration, those samples must be re-prepared and re-analyzed in a new QC batch. The Method blank (MB) may be used as the Initial Calibration Blank (ICB).

12.3. Laboratory Control Sample (LCS) is analyzed with each batch of maximum 20 samples. It must be carried through all stages of sample preparation and measurement. The lab control sample spike is prepared from a standard that is of a different source than the standards used for the calibration. The LCS recovery must be 80-120% of the true value. If the percent recovery for the LCS is outside the acceptance limits, follow these steps: No action is required if the LCS fails above 120% recovery and the sample result is non-detect. Samples must be re-prepared and

reanalyzed in a new batch if the LCS fails below 80%, or if samples are detected when an LCS fails above 120%. LCS may be used as the Initial calibration verification (ICV).

12.4. MS/MSD & RPD: Matrix spikes and matrix spike duplicates are prepared at a frequency of 20 samples per batch. They must be carried though all stages of sample preparation and measurement. The matrix spike recovery limits are 75-125%. The maximum RPD is 20%. If MS/MSD recoveries and/or the % RPD are outside the acceptance limits but the LCS recovery is acceptable, there is possibly matrix interference. The analyst must investigate to make sure there no errors in preparation, spiking, or analysis. If no errors are found, no corrective action is required, but the reported QC must be qualified. If errors are found in the preparation or spiking, the batch must be re-prepared. If errors are found in the analysis, the samples must be reanalyzed.

12.5. Sample Duplicate is analyzed when a sample result is detected or is requested by a client. It must be carried through all stages of sample preparation and measurement.

13.0 CALIBRATION AND STANDARDIZATION

13.1. STANDARD PREPARATION: all standard solutions are prepared from commercial standard solutions (1000 ppm) which are traceable to NIST standards. All standards are obtained with traceable certificates, which are filed in the Department. To cross-check for accuracy, standards are obtained from two different sources/ vendors.

13.1.1. Intermediate Standard (1 ppm): The intermediate standard is prepared every 6 months: Add 1.5 mL HNO_3 and 1 mL of 1000 ppm Hg stock standard to a 1 L volumetric flask that contains 750 mL of reagent water. Dilute with reagent water to 1 L.

13.1.2. Working Standard (0.1 ppm): The working standard is prepared daily; Add 0.15 mL HNO_3 and 10 mL of 1.0 ppm Hg intermediate standard (1 ppm) to a 100 mL volumetric flask that contains 50 mL of reagent water. Dilute with reagent water to 100 mL.

13.1.3. Working LCS mercury standard (1 ppm): This standard is prepared every 6 months: Add 1.5 mL HNO_3 and 1 mL of 1000 ppm Hg stock standard (second source stock standard) to a 1 L volumetric flask that contains 750 mL of reagent water. Dilute with reagent water to 1 L.

13.2. INSTRUMENT CALIBRATION

13.2.1. Initial Calibration Standard: These following calibration standards are prepared and digested same time and same procedure with samples. Prepare a calibration curve each day with a minimum of five concentration levels and a blank.

The mean signal (peak area) from each standard is plotted versus the concentration of each individual standard using linear regression. The correlation coefficient must be ≥0.995. If the initial calibration criteria is not met, then the calibration must be reanalyzed.

Calibration Standard Level	Calibration Standard Concentration (ppb)	Volume of 0.1 ppm Working Standard (mL)	Final Volume (mL)
1	0	0	100
2	0.4	0.4	100
3	1	1.0	100
4	3	3.0	100
5	5	5.0	100
6	10	10	100

13.2.2. Initial Calibration Verification (ICV): The initial calibration verification standard acceptance criteria is 90-110%.

Standard	Standard Concentration, ppb	Volume of 1 ppm Working LCS Mercury Standard (mL)	Final Volume (mL)
ICV	50	0.5	100

13.2.3. Continuing Calibration Verification: The continuing calibration verification (CCV) is at midpoint of calibration (5.0ppb) and calibration standard 4 is used as CCV. Acceptance criteria is 90-110%.

Standard	Standard Concentration, ppb	Volume of 0.1 ppm Working Standard (mL)	Final Volume (mL)
CCV	5	5.0	100

14.0 PROCEDURE

14.1. PREPARATION

14.1.1. SAMPLE PREPARATION

14.1.1.1. Mix sample well to obtain representative sample. If necessary, use a #10 sieve. Weigh a 0.6-0.7 g portion of sample and place in the bottom of the 100 ml sample tube.

14.1.1.2. Add 10ml of 1:1 aqua regia.

14.1.1.3. Heat two minutes in the midblock at 95 ± 3°C. Note the temperature of the Modblock on the preparation log sheet.

14.1.1.4. Cool, and then add 50 mL DI water and 15 mL potassium permanganate solution to each sample bottle.

14.1.1.5. Mix thoroughly and place in the Modblock for 30 minutes at 95 ± 3°C. Start timing when the sample temperature reaches 95 ± 3°C and record time started and time finished on the preparation log sheet.

14.1.1.6. Cool. Add 6 mL of sodium chloride-hydroxylamine sulfate solution to reduce the excess permanganate (the solution will become colorless). Volume the sample up to 100 mL.

Caution: Do this addition under a hood as chlorine could be evolved.

14.1.1.7. Filter samples with Whatman 41 filter paper. Centrifuge the sample if necessary to remove insoluble material that might clog the sample probe and tubing.

14.1.2. MATRIX SPIKE/ MATRIX SPIKE DUPLICATE (MS/MSD)

14.1.2.1. Pick one sample in the batch to represent as MS and MSD.

14.1.2.2. Weigh a 0.6-0.7 g portion of sample and place in the bottom of a 100 mL digestion tube. Add 0.50 mL of 1 ppm Hg working LCS standard into the matrix (spike amount is 5 ppb in solution).

14.1.2.3. Proceed to sections 14.1.1.2 thru 14.1.1.7 for the digestion procedure.

14.1.3. METHOD BLANKS (MB)

14.1.3.1. Transfer 10 mL DI water into the digestion tube.

14.1.3.2. Proceed to sections 14.1.1.2 thru 14.1.1.7 for the digestion procedure.

14.1.4. LABORATORY CONTROL SAMPLES (LCS)

14.1.4.1. Transfer 10 mL of DI water into digestion tube, add 0.50 mL of 1 ppm Hg working LCS standard into the DI water. The spike amount is 5 ppb in solution.

14.1.4.2. Proceed to sections 14.1.1.2 thru 14.1.1.7 for the digestion procedure.

14.2. WIPE SAMPLE PREPARATION

14.2.1. Place the entire wipe into a 100 mL digestion vial.

14.2.2. Proceed to sections 14.1.1.2 thru 14.1.1.7 for the digestion procedure.

14.3. NON-AQUEOUS SAMPLES

14.3.1. All non-aqueous samples are to be treated as solid samples.

14.3.2. Other situations not specified in the method, client services will be notified for appropriate handling.

14.4. ANALYZING SAMPLES USING PERKIN-ELMER FIMS:

14.4.1. Connect the computer with the FIMS400 analyzer and turn on the lamp and let it warm up for 10-15 minutes before beginning analysis.

14.4.2. Check the peristaltic pump tubing for wear and replace them if necessary.

14.4.3. While the lamp is warming up, put the reductant reagent line into the 1.1% $SnCl_2$ and the carrier reagent line into the 3% HCl. Turn the reagent pumps on to fluch the lines and reaction apparatus out.

14.4.4. Make a schedule to run samples by logging in the computer using “AA Win Lab Analyst” software.

14.4.5. Open the sample information editor window. Type in Lab request, sample numbers, sample dilutions, and sample units, including all QC samples that are not run automatically.

14.4.6. The Initial Calibration Verification (ICV) and The Initial Calibration Blank (ICB) are running automatically right after initial calibration to verify the instrument calibration.

14.4.7. A continuing calibration verification (CCV) and continuing calibration blank (ICB) are run automatically every 10 samples and are not entered as samples.

14.4.8. Save and print out the sample information list.

14.4.9. Pour each sample into a sample tube and place it in the loading tray according to the sample information file.

14.4.10. Pour the calibration blank and calibration standards in plastic tubes and place in calibration row of the tray.

14.4.11. Put the tray on the Auto-sampler (AS90).

14.4.12. Start analysis.

14.5. THE MERCURY METHOD INCLUDES THESE FEATURES FOR CALIBRATION:

14.5.1. The mercury method plots mercury concentration as a function of peak area.

14.5.2. Replicates: Each sample is analyzed two times. The mean of the two reading is used in reporting the final result.

14.5.3. The calibration blank is a standard 0.

14.5.4. Calibration standard (CAL): 0.4ppb (standard1), 1ppb (standard2), 3ppb (standard3), 5ppb (standard4), 10ppb (standard5).

14.5.5. Initial Calibration Verification (ICV): It is performed automatically right after initial calibration. Recovery criteria is 90-110%.

14.5.6. Initial Calibration Blank (ICB): It is performed automatically right after ICV.

14.5.7. Continue Calibration Verification (CCV): It is run automatically every 10 samples and the end of the run. Recovery criteria is 90-110%.

14.5.8. Continue Calibration Blank (CCB): It is run automatically right after CCV.

14.5.9. A linear curve with calculated intercept is used for the calibration.

14.5.10. The correlation Coefficient (r^2-value) must be 0.995 or higher. If these criteria are not met; calibration will be automatically re-analyze.

14.6. THE MERCURY METHOD INCLUDES THESE FEATURES FOR SAMPLE ANALYSIS

14.6.1. Two readings are made of each sample.

14.6.2. The peak area is used to calculate concentration and the mean concentration is calculated.

14.6.3. If a sample peak area is greater than the peak area of the highest standard, it is noted with the data for further dilution, and the run is continuing.

14.6.4. A CCV and CCB are run automatically every 10 samples and at the end of the run. Calibration standard 4 and the calibration blank are used as a CCV and CCB.

14.6.5. If the QC standards (ICV, ICB, CCV, CCB) fall outside the limits imbedded in the program, the QC standard is automatically re-run. Terminate analysis if the criteria are still not met.

14.7. The summary of the run will show all the QC samples' acceptance limits. The computer run log will indicate this on the printout.

14.8. The computer run log will indicate on the printout if the sample concentrations (peak areas) are greater than that of the highest standard.

14.9. The printout will indicate if the ICV, ICB, CCV, and CCB meet the method criteria.

14.10. OPERATING CONDITIONS

14.10.1. Atomic Absorption Flow Rates: Argon flow rate in the range 40-100ml/min is generally suitable.

14.10.2. Atomic Absorption Conditions: Wavelength is 253.7 nm, Replicate is two times.

14.10.3. Report Format: Date of analysis will be print automatically. Operator ID needs to be typed in. Sequence number will be print automatically. Sample ID needs to be typed in.

14.11. Dilution Test: A dilution test is performed when a new or unusual matrix is encountered. The selected sample is serial diluted to determine whether interferences are present. An analysis of a 1:5 dilution should be agree within ± 10% of the original determination. If not, a chemical or physical interference effect should be suspected.

14.12. Recovery Test: If the results from the dilution test do not agree, matrix interference may be suspected and a spiked sample should to analyze to help confirm the finding from the dilution test. Withdraw another aliquot of the test sample and add a known amount of analyte to bring the concentration of the analyte to 5 times the original concentration. Analyze the spiked sample and calculate the spike recovery. If the recovery is less than 85% or greater than 115%, the method of standard additions shall be used for all samples in the batch.

14.12.1. Withdraw another aliquot of the test sample and add a known amount of analyte to bring the concentration of the analyte to 5 times the original concentration.

14.12.2. Analyze the spiked sample and calculate the spike recovery. If the recovery is less than 85% or greater than 115%, the method of standard additions shall be used for all samples in the batch.

15.0 CALCULATIONS

15.1. All calibration curves and sample result calculations are dine by the Perkin Elmer operating software. Sample weights, final volumes and any dilutions are entered into the software and final results are calculated on the instrument printout.

15.2. Calibration equation linear calculated intercept is used.

15.3. Report mercury concentration to the proper significant figures in ug/Kg or mg/Kg as required.

15.4. Report mercury concentrations as follows:

15.4.1. Below 0.14 mg/Kg will be reported as ND or report to MDL as client requirement.

15.4.2. Between 0.14 and 1.0 mg/Kg: Two significant figures.

15.4.3. Equal to or above 1.0 mg/Kg: Three significant figures.

15.4.4. Final Result (ppm=mg/Kg)

$$\text{Sample Concentration, mg/Kg} = \frac{C \times V \times DF \times \frac{1mg}{1000\mu g}}{W}$$

Where:

C = On instrument sample concentration, ug/L
V = Prepared Sample Volume, L
D = Sample Dilution Factor
W = Initial Sample Weight, Kg

15.4.5. Calculation of LCS percent recovery:

$$\text{\% Recovery} = \frac{Concentration\ found}{True\ concentration} \times 100$$

15.4.6. Calculation of MS/MSD percent recovery:

$$\% \text{ Recovery} = \left(\frac{spike\ sample\ result - source\ sample\ result}{spike\ concentration}\right) \times 100$$

15.4.7. Calculation of Relative Percent Recovery:

$$\% \text{ RPD} = \left(\frac{|MS - MSD|}{\frac{MS+MSD}{2}}\right) \times 100$$

Note: This formula can also be applied to the Sample Duplicate RPD calculation by replacing MS in the formula with Sample Result and MSD with Sample Duplicate Result

16.0 METHOD PERFORMANCE

16.1. The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero.

16.2. Initial Demonstration of Capability (IDOC) must be performed prior to use any test method, and at any time there is a change in instrument type, personnel or test method. The Demonstration of Capability is updated annually. The following steps shall be performed:

16.2.1. For IDOC: At least four consecutive laboratory control samples with acceptable levels of precision and accuracy.

16.2.2. For DOC:

16.2.2.1. Acceptable performance of a blind sample.

16.2.2.2. Four LCSs with acceptable levels of precision and accuracy.

17.0 POLLUTION PREVENTION

17.1. Prepare only sufficient standard and reagent volume that can be used within the expiration date, to reduce the volume of waste generated by the laboratory and to reduce production costs.

18.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA

18.1. DATA ASSESSMENT:

18.1.1. The RSD% limit for the two replicate readings is 20%. If it is more than 20%, the samples shall be re-analyzed except in the cases where there is a negative value and when the results are less than DLR.

18.1.2. If the sample results are falling outside the linear range of the instrument must be diluted and re-analyzed.

18.1.3. The results taken are from the average integrated value and are multiplied by dilution factor that may have been applied to the sample. All results less than the current DLR are entered as ND (not detected).

18.2. QC ACCEPTANCE CRITERIA

18.2.1. Method Blank: The results of the Method Blank must be below the reporting limit otherwise the sample data is not acceptable. See section 19.6 for corrective actions and exceptions.

18.2.2. Laboratory Control Sample (LCS): 80-120%

18.2.3. Matrix Spike (MS) and Matrix Spike Duplicate (MSD): 75-125% recovery and 20% RPD

19.0 CORRECTIVE ACTIONS FOR OUT-OF-CONTROL DATA

19.1. If the ICV is outside the limits, it is automatically re-run. If it is still outside the limits, the instrument is re-calibrated and re-run ICV. If the ICV is still outside the limits, terminate analysis, identify and document problem. Re-calibrate and re-analyze a re-prepared ICV and all associated samples.

19.2. If the ICB outside the limits, it is automatically re-run. If it is still outside the limits, the instrument is re-calibrated and the ICB is re-run. If the ICB is still outside the limits then terminate analysis, determine source of contamination. The ICB is re-prepared and re-analyzed all samples associated with a contaminated blank.

19.3. If a CCV sample fails to meet recovery limits, the CCV is automatically re-run. If the CCV still fails to meet the limits, re-calibrate and re-run all samples since the last acceptable CCV. In case where the CCV is exceeded high (high bias), samples which are non-detected may be reported.

19.4. If a CCB sample fails to meet the specified limit, the CCB is automatically re-run. If a CCB sample still fails to meet the limit, the run is terminated, the problem corrected, re-run all samples since the last acceptable CCB are re-analyzed. If failure occurs consistently, the DLR should be re-evaluated (Note: A common cause of failure is insufficient washout time).

19.5. If both the Matrix Spike and Matrix Spike Duplicate do not meet the specified limit, the sample result should be flagged for potential matrix interference showing poor recovery. A post-digestion spike may be done any spike has poor matrix spike recovery for verification. Better accuracy may be achieved by analyzing the samples by the Method of Standard Additions (MSA). If the relative percent difference between the matrix spike and the matrix spike duplicate is greater than 20%, the analysis should be repeated or the result flagged for out –of-limit precision. If the method blank exceeds the reporting limit, the samples must be re-prepared and re-analyzed (Exception: If the sample results are exceed ten times the method blank value then it is not necessary to re-prepared and re-analyze).

19.6. If the Method Blank (MB) exceeds the reporting limit, the samples must be re-prepared and re-analyzed (Exception: Samples are reportable if the sample results exceed ten times the Method Blank value, or if the sample results are non-detect).

19.7. If the Laboratory Control Sample (LCS) fails to meet the recovery limits, refer to the instructions in section 12.3.

19.8. Document entire analytical process. All raw data must be saved and kept for at least 5 years including failed data.

20.0 CONTINGENCIES FOR HANDLING OUT-OF -CONTROL OR UNACCEPTABLE DATA

20.1. Generally, any data that is out of control is considered unusable. However, if the data is used it will be thoroughly narrative noted.

20.2. The client will be informed of the situation. Preliminary results can be released; however, the client is informed that the result can change.

21.0 WASTE MANAGEMENT

21.1. All samples must be neutralized before being disposed.

21.2. Detail refers to SOP-Laboratory Hazardous Waste Disposal (J0010).

22.0 REFERENCES

22.1. SW846 EPA method 7471A

22.2. “Statement of Work for Inorganic Analysis,” Document No. ILM02.0, USEPA.

22.3. “Setting Up and Performing Analysis,” Perkin-Elmer Flow Injection Mercury System Manual.

22.4. “Installation Maintenance System Description,” Perkin-Elmer Flow Injection Mercury System Manual.

22.5. “Software Guide,” Perkin-Elmer Flow Injection Mercury System Manual.

22.6. “AS-90 Series Autosampler for Atomic Spectrometry,” Perkin-Elmer User’s Guide.

23.0 ATTACHMENTS

23.1. Attachment 1: 7471 Flow Chart

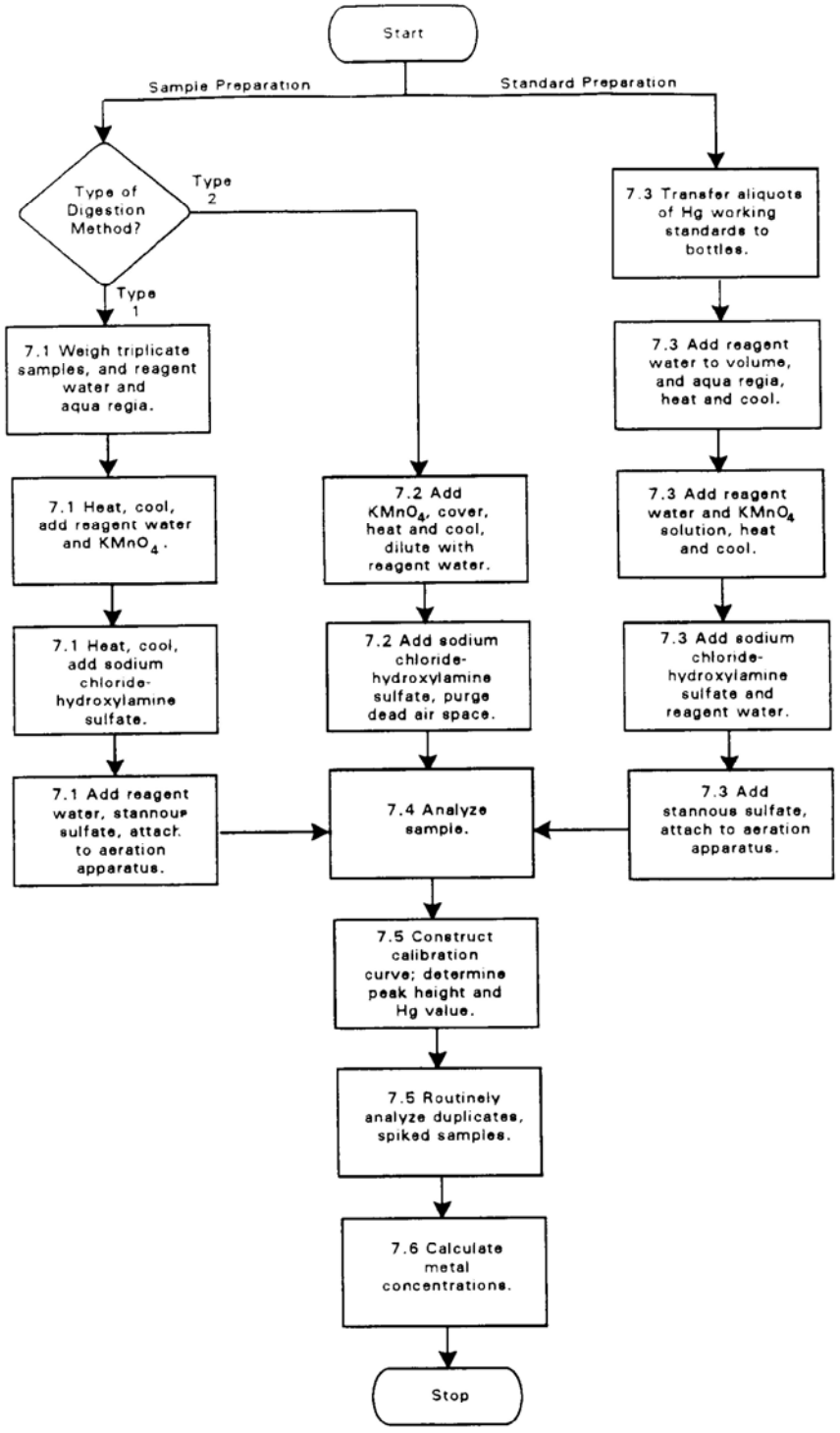
23.2. Attachment 2: Operation of Perkin Elmer System FIMS

24.0 DOCUMENT REVISION HISTORY

Date	Description of Revision
October 2018	• Sections 6.9-6.13: Removed frequency criteria from the QC definitions. That info is in Section 12: Quality Control • Removed section 19.8 (regarding repreparation and reanalysis of samples with detections)
October 2017	• Sections 3.1, 15.4.1, 15.4.2, and 15.4.3: Fixed unit typo for soil RL. Changed from µg/Kg to mg/Kg
September 2016	• Removed "PQL" from definitions • 10.11 and 10.12: Added clarification on standard use • 12.0: Added details for acceptance and decision making for QC samples. • 14.5.11: (3 ppb CCV) Redacted • 14.11: Clarified Dilution Test • 15.0: Edited formulas • 17.0: Edited • Other minor edits throughout to correct typos
September 2015	• 14.1.1.4: Changed 45 mL water to 50 mL water. • Edits to 14.1.1.6, 14.4 • Formatting corrections
June 2015	• Edits to sections 10.0 and 15.0
April 2015	• Updated the format of the SOP to meet the TNI 2009 Standard SOP Template.

Attachment 1: 7471 Flow Chart

METHOD 7471A
MERCURY IN SOLID OR SEMISOLID WASTE (MANUAL COLD-VAPOR TECHNIQUE)



Appendix: Operation of Perkin Elmer System FIMS

1. General Considerations:

    1.1. See the Perkin-Elmer Flow Injection Mercury System "Installation Maintenance System Description" guide manual.

    1.2. Daily usage as well as any problems or repairs to the instrument are to be recorded in the Instrument Log Book.

2. Nightly Shutdown:

    2.1. Flush the lines and the sample loop with DI water.

    2.2. Dry the lines and the sample loop.

    2.3. Record sample information and any problems encountered in the Instrument Log Book.

    2.4. Close the AA Win Lab program and shut down the instrument.

3. *Routine Maintenance:*

    3.1. For safety reasons, and to avoid contaminating new samples, make sure that the instrument and the work area are kept absolutely clean. Wipe up spills immediately before they can cause further contamination or damage.

    3.2. Regularly wipe over the surfaces of the autosampler with a lint-free cloth moistened with a dilute solution of laboratory detergent. Immediately clean all spilled materials from the affected area. Wear protective gloves if the materials are toxic or corrosive.

    3.3. If the sampling probe becomes blocked, clear it by inserting the cleaning wire.

    3.4 Check the condition of the sample tube regularly. If it shows signs of contamination or deterioration, or if it is kinked, replace it.

    3.5. System troubleshooting and maintenance is described in the "FIMS, Flow Injection Mercury System, Installation Maintenance System Description" Manual. The maintenance guide is summarized in the attached maintenance checklist. For details refer to the manual.

MAINTENANCE GUIDE – PERKIN ELMER FIMS MERCURY ANALYZER

COMPONENT	SERVICE	DAILY	WEEKLY	MONTHLY	6 MONTH
Fluid System	Before closing the system, remove	X			
	chemicals by pumping DI water				
	through all lines for 5 min, then				
	pump air through to dry lines.				
	Examine tubes for kinks or damage	X			
Auto sampler	Clean surface	X			
	Clean and apply oil to rod			X	
	Examine sample tubing replace	X			
	if necessary				
Pump	Spray silicon on cloth, apply to			X	
	rollers				
	Replace pump tubing				X
	Release pressure on tubing after	X			
	cleaning				
Manifold	Clean and dry surfaces	X			
	Check separator filter, replace if	X			
	necessary				
	Replace tubing				X
Injection Valve	Clean port and valve connectors		X		
	Flush with acid			X	
Cell	Measure cell absorbance, clean if		X		
	sensitivity is decreased				
Air filter	Check, replace if dirty			X	
Carrier Gas	Check nonreturn valve – replace			X	
	rubber sleeve if necessary				
Waste Bottle	Empty regularly, never allow level	X			
	to reach end of drain tube, check				
	daily				

ENTHALPY ANALYTICAL

931 W. Barkley Ave.
Orange, CA 92868

STANDARD OPERATING PROCEDURE

EPA 200.7
EPA 6010B
SM 2340 B

METALS BY INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRY

SOP Number: F-0016
Prepared By: Kedy Nguyen
Effective Date: 10/15/2018

Revision: 2
Supersedes: 1.0

Approved By:	Signature:	Date:
Kedy Nguyen Department Manager		10/12/18
Hongling Cao Technical Director		10/12/2018
Clifford Baldridge QA Director		10/12/18
Reapproved By:	**Signature:**	**Date:**

1.0 IDENTIFICATION OF THE TEST METHOD

1.1. Method is 6010B and 200.7

1.2. Test name is Inductively Coupled Plasma-Atomic Emission Spectroscopy.

2.0 APPLICABLE MATRIX OR MATRICES

2.1. Method 6010B is used to determine the concentration of Metals in solution. Matrices: ground water, aqueous samples, soil, solid wastes, wastewater, TCLP, STLC, SPLP and EP extracts, industrial and organic wastes, sludge, and sediments.

2.2. Method 200.7 is used to determine the concentration of metals in drinking water, surface water, ground water, storm runoff, domestic and industrial wastewaters.

3.0 DETECTION LIMIT

3.1. Detection Limits are as follows:

Analyte	Detection Limit (mg/L)	Analyte	Detection Limit (mg/L)
Aluminum	0.050	Molybdenum	0.010
Antimony	0.030	Nickel	0.010
Arsenic	0.010	Phosphorus	2.00
Barium	0.010	Potassium	0.500
Beryllium	0.001/0.005*	Selenium	0.030
Bismuth	0.050	Silicon	0.100
Boron	0.050	Silicon, as Silica	0.214
Cadmium	0.005	Silver	0.005
Calcium	0.100	Sodium	0.500
Chromium	0.010	Strontium	0.050
Cobalt	0.005	Sulfur	1.000
Copper	0.010	Thallium	0.030
Iron	0.020	Tin	0.020
Lead	0.010	Titanium	0.010
Lithium	0.010	Tungsten	0.050
Magnesium	0.100	Vanadium	0.005
Manganese	0.010	Zinc	0.050

*Detection limits for drinking water and other waters are different. The drinking water reporting limit is 0.001 mg/L.

4.0 SCOPE AND APPLICATION

4.1. This standard operating procedure describes the analysis of environmental samples for metals using ICP-OES (Inductively Coupled Plasma-Optical Emission Spectroscopy).

4.2. This SOP is intended to be a summary of the method and QA criteria. More detail may be found in EPA document (EPA Method 6010B, 200.7, SW846, and 3rd Edition).

5.0 SUMMARY

5.1. This SOP describes the analysis of groundwater, aqueous samples, drinking water, surface water, domestic and industrial wastewaters, TCLP, SPLP, STLC, and EP extracts, soils, other solid wastes, sludge, and sediments which are required digestion prior to analyze and analyzed by using inductively coupled plasma-optical emission spectroscopy.

5.2. Prior to analysis or digestion, all water samples must be preserved with nitric acid to pH <2. If water samples are received for method 200.7 that have a pH >2, method 200.7 requires that additional nitric acid be added to achieve a pH <2 and the sample held 24 for hours. After 24 hours, the pH must be rechecked to confirm the sample remains <2 before analysis or digestion can begin. If water samples are received for method 6010B that have a pH >2, additional nitric acid must be added to achieve a pH <2 before digestion may begin. Method 6010B does not require the sample be held an additional 24 hours.

5.3. Water samples may be analyzed for dissolved metals without digestion if the sample has been filtered through 0.45um pore diameter membrane filter at the time of collection or as soon thereafter as practically possible and immediately acid-preserved to pH <2. Otherwise, all water samples must be prepared by digestion with acids using EPA 3010 or 200.7 preparation procedures.

5.4. For 200.7 method: Samples may be analyzed without going through the digestion procedure if the sample is drinking water and the sample turbidity is < 1NTU. The sample is made ready for analysis by the appropriate addition of nitric acid to pH <2.

5.5. Prior to analysis, the metals in aqueous and solid samples are solubilized by digestion using the appropriate sample preparation methods; soil/solid samples are prepared by digestion with acid using EPA Method 3050A, waters by EPA Method 3010 or EPA 200.7.

5.6. This method describes multi-elemental determinations by ICP-OES using sequential or simultaneous optical systems and axial or radial viewing of the plasma. The instrument measures characteristic emission spectra by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific emission spectra are produced by radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and the intensities of the emission lines are monitored by photosensitive devices.

5.7. Background correction is required for trace element determination. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. In one mode of analysis the position used should be as free as possible from spectral interference and should reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. Analysts should recognize the possibility of additional interferences, as identified in Section 7.

5.8. Detailed recommendations for standards preparation, recommended wavelengths, possible interferences and corrective actions are discussed in detail in the EPA 6010B Method and the

manufacturer's instrument manuals. This document is meant to be a summary of the method for analysts with at least six months of experience with ICP analysis.

6.0 DEFINITIONS

6.1. Reporting Detection Limit (RDL): The lowest concentration that can be measured with the consideration for practical limitations such as sample size, matrix interferences and dilutions.

6.2. Method Detection Limit (MDL): Minimum concentrations of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The sample is carried through the entire method under ideal conditions. This is performed on an annual basis, or more frequently as methods demand, by the laboratory.

$$MDL = t_{(n-1,\ 1-\alpha)} \times S$$

Where: S = the standard deviation of the replicate analyses

$t_{(n-1,\ 1-\alpha)}$ = the student's t-value appropriate to a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom.

Number of Samples	t-value
7	3.143
8	2.998
9	2.896
10	2.821
11	2.764
12	2.718
13	2.681
14	2.650
15	2.624

Since the MDL is below the lowest calibration point, results reported down to the MDL must be qualified as estimated values and, as such, carry a "J" qualifier designation.

6.3. Calibration: A plot of concentrations of known analyte standards versus the instrument response to the analyte. It is a reproducible reference point to which all sample measurements can be correlated. The appropriate linear or nonlinear coefficient for standard concentration to instrument response should be greater than or equal to 0.995.

6.4. Calibration Standards: A series of known analyte standards used for the calibration of the instrument. These are prepared by diluting a stock standard solution to produce working standards, which cover the working range of the instrument. One calibration standard must be at or below the reporting limit for the method.

6.5. Initial Calibration Verification Standard (ICV): A standard used to confirm the accuracy of the instrument calibration. This is prepared from a different stock solution (a different lot number or vendor) than was used to prepare the calibration standards. It must be performed automatically right after the initial calibration.

6.6. Continuing Calibration Verification Standard (CCV): A standard that periodically confirms that the instrument response has not changed significantly from the initial calibration. It also

confirms accurate analyte quantitation for the previous samples analyzed. This is prepared from the same stock solution that was used to prepare the calibration standards or different stock solution (same stock solution with ICV). Its concentration should be at or near the mid-range levels of the calibration curve. It must be analyzed at the beginning and end of a sample run, and periodically during a run (after every 10th sample).

6.7. Initial Calibration Blank (ICB): A volume of reagent water treated in the same manner as the calibration standards. It is used to check carryovers and contamination. It must be analyzed after the initial calibration and should be below the reporting limit of the method.

6.8. Continuing Calibration Blank (CCB): A volume of reagent water treated in the same manner as the calibration standards. It is used to check carryovers and contamination. The CCB must be analyzed at the beginning and end of a sample run, and periodically during a run (after every 10th sample). It should be below the reporting limit of the method.

6.9. Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is to be carried through the complete sample preparation and analytical procedure. It is used to assess the samples in the preparation batch for possible contamination during the preparation and processing steps. A minimum of one method blank must be included with each batch of maximum 20 samples or less. It should be below the reporting limit of the method.

6.10. Laboratory Control Sample (LCS): An aliquot of laboratory reagent blank to which known quantities of the method analytes are added in the laboratory. The LCS is to be carried through the complete sample preparation and analytical procedure and is used to evaluate ongoing laboratory performance and analyte recovery in a clean matrix. A minimum of one LCS must be included with each batch of maximum 20 samples or less.

6.11. Matrix Spike (MS): An aliquot of environmental sample to which known quantities of the method analytes are added in the laboratory. The addition occurs prior to sample preparation and analysis. The spiking volume should be limited to 5% or less of the sample volume. The MS is to be carried through the complete sample preparation and analytical procedure and is used to determine whether the sample matrix contributes any bias to the analytical results. A minimum of one MS must be included with each batch of 20 samples or less for Method 6010B, and one for every 10 samples for Method 200.7, up to 20 samples in a batch.

The background concentration of the analytes in the sample matrix must be determined in a separate aliquot of sample and the measured value in the MS corrected for the background concentration. Through this, the recovery of the spiked analytes can be determined and matrix bias, if any, can be observed.

6.12. Matrix Spike Duplicate (MSD): A duplicate of the Matrix Spike used to determine the precision and bias of a method in a given sample matrix. A matrix duplicate sample is a sample brought through the entire sample preparation and analytical process in duplicate. A minimum of one MSD must be included with each batch of 20 samples or less.

6.13. Duplicate (DUP): A randomly-selected or client-assigned sample. Aliquots of a sample taken from the same container under laboratory conditions and processed through the entire sample preparation and analytical procedure. Analysis of the sample duplicate can indicate precision associated with the laboratory procedures by removing variations contributed by sample

collection, preservation, and storage procedures. For clients that require a duplicate to be analyzed, a minimum of one DUP must be included with each batch of 20 samples or less.

6.14. Limit of Detection (LOD): is an estimate of the minimum amount of a substance that an analytical process can reliably detect.

6.15. Limits of Quantitation (LOQ): is the minimum level, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. Per NELAC guidelines, the lowest calibration standard is the lowest concentration for which quantitation data are to be report, or LOQ is acceptable to be replaced. LOQ must be quantitative after calibration/ recalibration or prior analyze samples. The accepting limits must be within 50-150% of expected concentration.

6.16. Instrument Detection Limit (IDL): is the concentration equivalent to the analyte to the analyte signal, which is equal to the average of the standard deviations of the three runs on three non-consecutive days from the analysis of reagent blank solution with seven consecutive measurements per day.

6.17. Internal Standard: is a chemical substance (not identical to the element of interest in the samples) that is added in a constant amount to samples, blank and standards solution. Internal standard used to measure the relative response of other analytes that are components of the same sample or solution.

6.18. Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES): is the instrument which uses to analyze metals in sample solution. An induction coil is wrapped around a quartz tube in which a stream of charge argon particles and sample solute is flowing. The interaction between the induced magnetic field from the coil and the argon plasma create an extremely high temperature.

6.19. Total Metals: is concentration of metals determined by analysis of the solution extract of a solid sample or not pre-filtered aqueous sample following digestion as specified in the method. And results should always be equal or greater than dissolved metals analysis results.

6.20. Dissolved Metals: is concentration of metals in aqueous sample that will pass through a 0.45um membrane filter assembly prior to sample acidification. Dissolved metals analysis results are equal or lower than total metals. Note: If the sample is filtered in the laboratory then whole batch must go through the same process as the sample (method blank (MB) and laboratory control sample (LCS) must be filtered with 0.45um as well).

6.21. Drinking Water: is aqueous sample that has been designated a potable or potential potable water source. Drinking water sample may be analyzed directly by pneumatic nebulization without acid digestion if the sample has been properly preserved with HNO_3 to pH <2 and has turbidity of < 1 NTU at the time of analysis.

6.22. Non-Potable Water: is aqueous sample excluded from the definition of Drinking Water matrix. Includes surface water, groundwater, effluents, water treatment chemicals, and TCLP or other extracts.

6.23. Aqueous: Aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.

6.24. Solids: includes soils, sediments, sludges and other matrices with >15% settleable solids.

6.25. Non-aqueous Liquid: any organic liquid with < 15% settleable solids.

6.26. Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

6.27. Proficiency Testing: a means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source.

6.28. Proficiency Test Sample (PT): a sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria.

6.29. Sensitivity: the capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.

6.30. Spike: a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

6.31. Stock Standard Solution: is concentrated standard solution containing one or more method analytes prepared in the laboratory or purchased from a reputable commercial source.

6.32. Linear Dynamic Range (LDR): the concentration range over which the instrument response to an analyte is linear. Accepting to report the results up to 90% of linear range.

6.33. Interference Check Standard (ICS): is standard prepared or purchased to contain known concentration of interfering elements that will demonstrate the magnitude of interferences and provide an adequate test of any corrections.

6.34. Interference Check Standard A (ICSA): is standard that contains 400ppm Al, Ca, Mg and 160ppm Fe. All other analytes tested in the method should be below reporting limit. Acceptance criteria for these analytes are 80-120% of the expected concentration. All other analytes tested in the method should be below reporting limit. Method 6010B is required to analysis after calibration or prior to analysis the samples. Method 200.7 is required to analysis after calibration, or prior to analysis samples, every 8 hours, and end of the run.

6.35. Interference Check Standard A & B (ICSAB): is standard that contain ICSA plus 1ppm of (Ag, Cd, Ni, Ag, Pb, and Zn) and 0.5ppm of Ba, Be, Co, Cr, Cu, Mn, and V). Acceptance (criteria is $80 - 120\%$. Method 6010B is required to analysis after calibration, prior to analysis the samples. Method 200.7 is required to analysis after calibration, prior to analysis samples, every 8 hours, and end of the run.

6.36. Interelement Correction Factor (IEC): is mathematical factor that is used to correct the spectral overlap from other elements. **Note:** See chapter 8 in Winlab32 Instrument Control Software guide for detail instruction.

6.37. Multicomponent Spectral Fitting (MSF): is a mathematical model to distinguish analyte spectra from interfering spectra. **Note:** See chapter 9 in Winlab32 Instrument Control Software guide for detail instruction.

6.38. Standard Addition (SA): The addition of a standard solution (spikes) to sample aliquots of the same size. Measurements are made on the original and after each addition.

6.39. Serial Dilution: A dilution test is performed when a new or unusual matrix, the dilution of a sample by a known factor. When corrected by the dilution factor, the diluted sample must agree with the original undiluted sample within specified limits. Serial dilution may reflect the influence of interferences. For method 6010B, 1:5 dilutions will be performed and should be agreed within ±10% compared to undiluted sample results and for method 200.7, 1:4 dilution will be performed and should be agreed within ± 10% compared to undiluted sample. If not, a chemical or physical interference effect should be suspected.

6.40. Dilution Test: A dilution test is performed when a new or unusual matrix is encountered. The selected sample is serial diluted to determine whether interferences are present. For method 6010B, an analysis of a 1:5 dilution should be agreed within ± 10% of the original determination. And for method 200.7, an analysis of a 1:4 dilution should be agreed within ±10% of original determination. If not, a chemical or physical interference effect should be suspected.

6.41. Recovery Test: If the results from the dilution test do not agree, matrix interference may be suspected and a spiked sample should to analyze to help confirm the finding from the dilution test. Withdraw another aliquot of the test sample and add a known amount of analyte to bring the concentration of the analyte to 5 times the original concentration. Analyze the spiked sample and calculate the spike recovery. Accepting criteria limit is ± 25% for method 6010B, and ± 15% for method 200.7, if not a matrix interference should be suspected.

6.42. Post Digestion Spike Addition: An analyte spike added to a portion of a prepared sample, or its dilution, should be recovered to within 75% to 125% of the known value for method 6010B and 85-115% for method 200.7. The purpose of the post-digestion spike is to determine if the unacceptable MS/MSD results are due to the digestion part of the procedure or the analysis part of the procedure. An acceptable post-digestion spike means the unacceptable MS/MSD results were caused by the digestion (this is very typical for analytes like antimony in soil sample). An unacceptable post-digestion spike means the problem may be with the analysis stage due to matrix interferences.

7.0 INTERFERENCES:

7.1. Interferences can arise from a variety of sources and serve to diminish the bias and precision of analytical data, particularly when determining elements at trace levels.

7.2. Spectra interferences can arise from several sources. Techniques to identify and compensate for spectral interferences are discussed below.

7.2.1. Background emission from continuous or recombination phenomena and/ or stray light from the line emission of high concentration elements.

7.2.1.1. Compensation for background emission and stray light can usually be conducted by subtracting the background emission determined through measurements obtained adjacent to the analyte wavelength peak. Spectral scans of samples or single-element solutions in the analyte regions may indicate when the use of alternate wavelengths is desirable because of sever spectral interference. These scans will also show whether the most appropriate estimate of the background emission is provided by an interpolation from measurements obtained on both sides of the wavelength peak, or by measured emission obtained only on one side.

The locations selected for the measurement of background intensity will be determined by the complexity of the spectrum adjacent to the wavelength peak. The locations used for routine measurement must be free of off-line spectral interference (interelement or molecular), or otherwise adequately corrected to reflect the same change in background intensity as that which occurs at the wavelength peak. For multivariate methods using whole spectral regions, background scans should be included in the correction algorithm.

7.2.1.2. To determine the appropriate location for off-line background correction, the area adjacent to the wavelength on either side must be scanned, so that the apparent emission intensity from all other method analytes may be recorded. This spectral information must be documented and kept on file. The location selected for background correction must be either free of off-line inter-element spectral interference or a computer routine must be used for automatic correction on all determinations. If a wavelength other than the recommended wavelength is used, the analyst must determine and document both the overlapping and nearby spectral interference effects from all method analytes and common elements and provide for their automatic correction on all analyses. Tests to determine spectral interferences must be performed using analyte concentrations that will adequately describe the interference. Normally, 100 mg/L, single-element solutions are sufficient. However, for analytes such as iron, that may be found in the sample at high concentration, a more appropriate test would be to use a concentration near the upper limit of the analytical range.

7.2.2. Overlaps from the molecular spectra of the same target element may be avoided through the use of an alternate wavelength for quantitation.

7.2.3. Optical Spectral-line overlaps between target elements.

7.2.3.1. Interelement spectral overlaps are typically compensated through the use of equations that correct for interelement contributions. Instruments that use equations for interelement correction necessitate that interfering element(S) are analyzed at the same time as the target element(S) of interest. When operative and uncorrected, interelement interferences will produce false positive or positively biased determinations. However, if the interference affects the point selected for background correction, the resulting overcorrection will cause a negative bias. More extensive information on interferent effects at various wavelengths and resolutions is available in reference wavelengths tables and software guide. Analyst may apply interelement-correction equations

determined on their instruments with tested concentration ranges to compensate (off-line or on-line) for the effects of interfering elements. Selected potential spectral interferences observed for the recommended wavelengths are given in Table 1.

7.2.3.2. For multivariate calibration methods that employ whole spectral regions, spectral interferences are handled by including spectra of the interfering elements in the calibration algorithm. The interferences listed in Table 1 are those that occur between method analytes. Only interferences of a direct overlap nature are shown. These overlaps were observed with a single instrument having a working resolution of 0.035nm.

7.2.3.3. When using interelement-correction equations, the interference may be expressed as analyte concentration equivalents (i.e., false positive analyte concentrations) arising from 100mg/L of the interference element. For example, if As is to be determined at 193.696nm in a sample containing approximately 10mg/L of Al, according to Table 1, 100mg/L of Al will yield a false positive signal equivalent to an As concentration of approximately 1.3 mg/L. Correspondingly, the presence of 10mg/L of Al will result in a false positive signal for As equivalent to approximately 0.13mg/L. The analyst is cautioned that alternate instruments may exhibit somewhat different levels of interference than those shown in Table 1. The interference effects must, therefore, be evaluated for each individual instrument, since the intensities will vary (see Sec.7.1.3.5.).

7.2.3.4. Interelement corrections will vary for the same emission line among instruments because of differences in resolution. Such differences are determined by the grating, entrance and exit slit widths, and by the order of dispersion. Interelement corrections will also vary depending upon the choice of background correction points. Selecting a background correction point where an interfering emission line may appear should be avoided when practical Interelement corrections that constitute a major portion of an emission signal may not yield accurate data. Analysts should continuously note that some samples may contain uncommon elements that could contribute spectral interferences.

7.2.3.5. As already noted (Sec. 7.1.3.3.), the interelement effects must be evaluated for each individual instrument, whether configured as a sequential or simultaneous instrument. For each instrument, intensities will vary not only with optical resolution, but also with operation conditions (such as power, viewing height and argon-flow rate). When using the recommended wavelengths, the analyst must determine and document for each wavelength the effect from referenced interferences (Table 1) as well as any other suspected interferences that may be specific to the instrument or matrix. The analyst should utilize a computer routine for automatic correction on all analyses.

7.2.3.6. Analyst of sequential instruments must verify the absence of spectral interference by scanning over a range of 0.5nm, centered on the wavelength of interest, for several samples. The range for lead, for example, would be from 220.6-220.1 nm. The procedure must be repeated whenever a new matrix is to be analyzed and when a new calibration curve using different instrumental

conditions is to be prepared. Samples that show an elevated background emission across the range may be background-corrected by applying a correction factor equal to the emission adjacent to the line or at two points on either side of the line and interpolating between them. An alternate wavelength that does not exhibit a background shift or spectral overlap may also be used.

7.2.3.7. The accuracy of interelement corrections should be verified daily through the analysis of spectral-interference check (SIC) solutions ICSA and ICSAB.

7.2.3.8. When interelement corrections are not used, the absence of interferences must be verified.

7.3. Physical interferences are affects associated with the sample nebulization and transport processes. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or acid concentrations. If physical interferences are present, they must be reduced through (1) sample dilution, (2) the use of a peristaltic pump, (3) the use of an internal standard, (4) the use of a high-solids nebulizer.

Another problem that can occur, when high concentrations of dissolved solids are present, is salt buildup at the tip of the nebulizer, thus affection aerosol flow rate and resulting in instrumental drift. Salt buildup can be controlled through (1) wetting the argon prior to nebulization, (2) use of a tip washer, (3) use of a high –solids nebulizer, or (4) sample dilution. Also, it has been reported that better control of the argon flow rate, especially to the nebulizer, improves instrument performance. This may be accomplished with the use of mass flow controllers.

7.4. Chemical interferences include molecular compound formation, ionization effects, and solute vaporization effects. Normally, these effects are not significant with the ICP technique. However, if observed, they can be minimized by (1) careful selection of operating conditions (i.e., incident power, observation position, etc.), (2) buffering of the sample through matrix-matching, and (3) standard-addition procedures. Chemical interferences are highly dependent on matrix type and analyte.

7.4.1. The majority of interferences likely to be encountered when using this method can be managed successfully using the techniques throughout Sec. 7.1. However, based on professional judgment, the method of standard additions may be useful when certain specific inferences are encountered. Refer to method 7000 for more detailed discussion on the use and application of the method of standard additions.

7.4.2. An alternative to the method of standard additions is the use of an internal standard(S). In the internal standard technique, one or more elements not found in the samples, and verified to not cause an interelement spectral interference, are added to the samples, calibration standards, and blanks. Yttrium or scandium is often used for this purpose. The concentration of the matrix. The internal standard element intensity is used to ratio the analyte intensity signals for both calibration and quantitation. This technique is very useful in overcoming matrix interferences, particularly in high solids matrices.

7.5. Memory interferences result when analytes in a previous sample contribute to the intensity signals measured in a subsequent sample. Memory effects can result from sample deposition

on the uptake tubing to the nebulizer and from the buildup of sample material in the plasma torch and spray chamber. The site where these effects occur is dependent on the element and can be minimized by flushing the system with a rinse blank between samples. The possibility if memory interferences should be considered within an analytical run. When recognized, suitable rinse times should be established to reduce them. The rinse times necessary for a particular element must be estimated prior to analysis. The estimation may be made by aspiration a standard containing the element(S) of interest at a concentration level that is ten times the typical or expected amount, or the upper limit of the linear range. The aspiration time for the rinse time-estimation standard should be the same as a normal sample analysis period, followed by analysis of the rinse blank at a series of designated intervals. The length of the rinse time necessary for reducing the analyte signal(S) to less than or equal to the IDL should be noted. A rinse period of at least 60 Seconds should be used between samples and standards until a more suitable rinse time can be established. If memory interference is determined to be present, the sample must be reanalyzed following use of the newly established rinse period. Alternate rinse times may be established by the analyst based upon the project-specific DQOs.

7.6. Analyst is advised that high salt concentrations can cause analyte signal suppressions and confuse interference tests. If the instrument does not display negative values, fortify the SIC check solution with the elements of interest at 0.5-1 mg/L and measure the added standard concentration accordingly. Concentrations should be within 20% of the true spiked concentration or dilution of the samples will be necessary. In the absence of measurable analyte, overcorrection could go undetected if a negative value is reported as zero.

7.7. The calibration blank may restrict the quantitation sensitivity, or otherwise degrade the precision and bias of the analysis.

7.8. Reagents and sample processing hardware may yield artifacts and/ or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks.

8.0 SAFETY

8.1. The ICP emits radiofrequency energy which might interfere with pacemakers.

8.2. A reference file of Safety Data Sheets (SDS) is available to all personnel involved in chemical analysis.

8.3. Good laboratory technique and safety practices should be followed at all times.

8.4. Safety glasses should be worn at all times when handling samples, reagents, or when in the vicinity of others handling these items.

8.5. Liquid argon represents a potential cryogenic hazard, and safe handling procedures should be used when handling liquid argon tanks at all times

8.6. The Perkin Elmer ICP is full interlocked to protect the user from dangers such as high voltages, radio frequency generators, and intense ultra-violet light. At no time should the operator attempt to disable these interlocks or operate the instrument if any safety interlock is known to be disabled or malfunctioning.

8.7. Spilled samples, reagents, and water should be cleaned up from instrument and autosampler surfaces immediately. In the case of acid spills, the acid should be neutralized with sodium bicarbonate solution before cleanup.

8.8. The acidification of samples containing reactive materials may result in release of toxic gases, such as cyanides or sulfides. Acidification of samples should be done in a fume hood

8.9. All additional company safety practices should be followed at all times.

9.0 EQUIPMENT AND SUPPLIES

9.1. Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES): Perkin Elmer Optima 4300 DV and 8300 DV.

9.2. Winlab 32 software: Version 3.1.0.0107 and 6.6.0.0714

9.3. Autosampler: Perkin Elmer S10 (serial no. 10214020837) and ESI FST02 (serial no. TSP090902)

9.4. Argon gas supply (metal free)

9.5. Air compressor: Craftsman, model 921.165720

9.6. Chiller: Poly Science, model N0772046.

9.7. Computers and printers.

9.8. Class A volumetric flasks

9.9. Calibrated auto pipettes: 0.1-1mL, and 1-5 mL.

9.10. Peristaltic pump tubing:

9.10.1. Black/Black: 0.76 mm i.d. (for sample introduction)

9.10.2. Red/ Orange: 0.19 mm i.d. (for internal standard introduction)

9.10.3. Purple/ White: 2.79 mm i.d. (for waste/drain)

9.11. Sampling probe (epoxy polymer) (B300-0055)

9.12. Sample tube: 0.6 mm i.d.

9.13. 15 mL plastic autosampler tubes (metal-free)

9.14. 50 mL plastic autosampler tubes with caps (metal-free)

10.0 REAGENTS AND STANDARDS

10.1. Reagent water equivalent to ASTM Type II water (ASTM D1193).

10.2. Standards: All standard solutions are prepared from commercial stock standard solutions (1,000, 5,000 or 10,000 ppm), which are traceable to NIST standards. All standards are

obtained with traceability certificates, which are filed in the ICP department. To cross-check for accuracy, standards are obtained from two different sources/vendors.

10.3. All acids used for this method must be of trace metals grade. Standards are prepared in a solution with of 1% Nitric acid and 5% Hydrochloric acid.

10.4. Concentrated hydrochloric acid (HCl): Trace metal grade.

10.5. Hydrochloric acid (1:1): Add 250 mL concentrated HCl to 100 mL reagent water and volume to 500 mL. Mix well prior used.

10.6. Concentrated nitric acid (HNO_3): Trace metal grade

10.7. Nitric acid (1:1): Add 250 mL concentrated HNO_3 to 100 mL reagent water and volume to 500 mL. Mix well prior used.

10.8. Yttrium: is used for internal standard.

10.9. ICP stock standards for calibration curves (1,000/5,000/10,000 ppm), Primary Sources:

10.9.1. 1000 ppm standards of Ag, Sb, As, Ba, Be, Cd, Co, Cu, Pb, Mo, Se, V, Zn, Al, Fe, B, Mn, Sr, Bi, Ti, S, Sn, W, Li, P, Si.

10.9.2. 10,000 ppm standards of Cr, Tl, Ca, Mg, K, and Na.

10.9.3. Mix 4 Standard: A Mix containing 5000 ppm each of Ca, Mg, K, and Na.

10.10. Quality Control Standard 21 (secondary source) 100 ppm, used for ICV/ LCS/MS/MSD: As, Be, Ca, Cd, Co, Cr, Cu, Fe, Li, Mg, Mn, Mo, Ni, Pb, Sb, Se, Sr, Ti, Tl, V and Zn.

10.11. Quality Control Standard 7 (secondary source), used for ICV/LCS/MS/MSD:

10.11.1. 1000 ppm K

10.11.2. 50 ppm Si

10.11.3. 100 ppm Al, Ba, B, Ag, and Na

10.12. Custom 4 Element Mix (secondary source) 10,000 ppm, used for ICV/LCS/MS/MSD: Ca, Mg, K, and Na

10.13. Custom 6 Element Mix (secondary source) 1000 ppm, used for ICV/LCS/MS/MSD: Si, S, Sn, W, P, and Bi

10.14. Interference Check Standard A stock solution (ICSA): 5000 ppm of Al, Ca, and Mg, and 2000 ppm Fe.

10.15. Interference Check Standard B stock solution (ICSAB): 1 ppm of Ag, Cd, Ni, Ag, Pb, and Zn, and 0.5 ppm of Ba, Be, Co, Cr, Cu, Mn, and V.

10.16. Cal4 Mix, secondary source: 5000 ppm each of Ca, Mg, K, and Na

10.17. 1 ppm Be LOQ (intermediate standard): to a 100 mL digestion tube, add 50 mL of reagent water, followed by 1 mL of HNO_3, 5 mL of HCl, and 0.1 mL of the Be stock standard in section 10.9.1.

10.18. 1000 ppm stock standards of secondary sources: Bi, W, Sn, Si, P

11.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

11.1. Bottles: Water samples may be collected in polyethylene or glass containers. Solid samples may be collected in polyethylene, glass, plastic sleeves, bags, or other soil collection containers.

Note: Samples requiring Boron or Silicon cannot be collected in glass containers, as glass is made of borosilicate.

11.2. Preservation: HNO_3 to pH <2

11.2.1. Method 200.7: All samples must be acidified to pH <2 with HNO_3 at the time of sample collection. If samples are received at a pH >2, the samples must be acidified in the laboratory to pH <2 within 14 days and held for 24 hours. After 24 hours, the pH must be checked to verify that the samples are still pH <2. If not, add additional acid and wait another 24 hours before checking the pH again. If the sample is still pH >2, notify the PM prior to proceeding with sample preparation and analysis.

11.2.2. Method 6010B: All samples must be acidified to pH <2 with HNO_3 at the time of sample collection. If samples are received at a pH >2, the samples must be acidified in the laboratory to pH <2 prior digestion.

11.3. Holding Time: 6 months

11.4. Storage: Cold storage is not required, but is encouraged to be consistent with the routine storage of other laboratory analyses.

11.5. Transit: On ice with Temperature 0-6 °C.

12.0 QUALITY CONTROL

12.1. PERFORMANCE SENSITIVITY CHECK

12.1.1. Method detection limit (MDL) is determined on an annual basis or more often if necessary due to a change in instrumentation or the sample procedure which might affect the detection limits of the instrument. In order to determine the MDL in a matrix, the analyses should be spiked into the matrix of interest at a level that is three to five times the estimated MDL. The spiked matrix is then carried through the entire sample preparation procedure. The MDL is lower than RDL and is statistical calculation, since the MDL is below the point of calibration, the results report down to MDL are not reliable and must be qualified as estimated values and, as such, carry a “J” qualifier designation.

12.1.2. Limits of quantitation (LOQ): These standards are analyzed after the initial calibration and before the analysis of samples and batch QC. These standards are used to

determine whether the instrument sensitivity is adequate to achieve the reporting detection limit.

12.1.3. Internal Standard response: is a good measure of instrument drift and enhancements or suppression of instrumental response caused by sample matrix.

12.1.4. Linear check: will be performed annually or more often if necessary due to a change in instrumentation.

12.2. BATCH QC REQUIREMENTS:

12.2.1. Method Blank: A method blank is prepared and/or analyzed with each batch of up to a maximum of 20 samples. It should be carried through all stages of sample preparation and analysis.

12.2.2. Laboratory Control Sample (LCS): A LCS is prepared and/or analyzed with batch of up to a maximum 20 of samples. It should be carried through all stages of sample preparation and analysis.

12.2.3. Matrix Spike/ Matrix Spike Duplicate (MS/MSD) & RPD: Matrix spikes and matrix spike duplicates are prepared at a frequency that depends on method requirements. They must be carried though all stages of sample preparation and analysis.

12.2.3.1. Method 200.7: 1 MS is required for batch with 10 samples or less. A second MS is required for batch with more than 10 samples, however, a batch cannot contain more than 20 samples. Percent recovery must be calculated and recorded.

12.2.3.2. Method 6010B: A MS and MSD is required each batch of up to 20 samples. Percent recovery and percent RPD must be calculated and recorded.

12.2.4. Sample Duplicate: Sample duplicates are prepared and analyzed only when specified by the client's project. Sample duplicates are prepared at a frequency that depends on method requirements. The frequency is the same as what is required for the MS. It must be carried through all stages of sample preparation and analysis.

12.2.5. Post Digestion Spike: When a pre-digestion spike recovery falls outside the control limits and the sample result does not exceed 4X the spike added, performance of a post-digestion spike is recommended for those elements that do not meet the specified criteria. The same sample from which the MS/MSD aliquots were prepared should be spiked with a post digestion spike. Spike the source sample at 2x the indigenous level or 10x RDL, whichever is greater. An analyte spike added to a portion of a prepared sample, or its dilution, should be recovered to within 75-125% of the known value for method 6010B and 70-130% for method 200.7. The spike addition should produce a minimum level of 10 times and a maximum of 100 times the instrumental detection limit. If the spike is not recovered within the specified limits, a matrix effect should be suspected.

12.2.6. Standard Addition: The method of standard-addition (MSA) technique involves adding known amounts of standard to one or more aliquots of the processed sample solution.

This technique compensates for a sample constituent that enhances or depresses the analyte signal, thus producing a different slope from that of the calibration standards. It will not correct for additive interferences that cause a baseline shift.

12.3. Sequence QC Requirements:

12.3.1. Initial Calibration Verification (ICV): The ICV must be analyzed immediately following the initial calibration. The recovery requirements are method dependent:

12.3.1.1. Method 200.7: ±5%

12.3.1.2. Method 6010B: ±10%

12.3.2. Initial Calibration Blank (ICB): The ICB must be analyzed immediately following the initial calibration. The resulting concentration must be below the reporting limit.

12.3.3. Interference Check Sample A (ICSA): Must be analyzed following the ICB and, for 200.7, must be analyzed every 8 hours thereafter. The recovery of the spiked analytes must be within 80-120%. All unspiked analytes must be below the reporting limit.

12.3.4. Interference Check Sample AB (ICSAB): Must be analyzed following the ICSA and, for 200.7, must be analyzed every 8 hours thereafter. The recovery of the spiked analytes must be within 80-120%.

12.4. LOQ Verification:

12.4.1. Since the lowest calibration standard is above the reporting limit (allowed for metals per TNI 2009), the LOQ must be verified to demonstrate that the instrument is sensitive enough to detect target analytes. The recovery must be ± 50%.

12.4.1.1. If the LOQ verification for an analyte fails above 150%, the analyte can only be reported if it is ND or above the concentration of the lowest calibration standard.

12.4.1.2. If the LOQ verification for an analyte fails below 50%, the analyte can only be reported if its concentration is above the lowest calibration standard. NOTE, the MB for that analyte cannot be reported in this instance, unless it is reanalyzed in a sequence with a passing LOQ, or an LOQ that is above 150%.

13.0 CALIBRATION AND STANDARDIZATION

13.1. Calibration Standard:

13.1.1. ICP- STD8 (200ppm GM): Made from Ca, Mg, Na, and K Primary Source individual stock standards, section 10.9.2.

13.1.1.1. In a 1000 mL, metal free, volumetric flask, add 500 mL reagent water, 10 mL HNO_3, 50 mL HCl. Add the volumes of the standards as detailed in the table below. Once all the analytes have been added, volume to 1000 mL with reagent water and mix well. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

Source Standards/Analytes	Concentration of Stock Standards (mg/L)	Volume to add (mL)	Final Concentration (mg/L)
Mix solution of Ca, Mg, Na, and K	10,000	4	20

13.1.2. ICP-STD7 (10 ppm): Made from primary source individual stock standards in section 10.9

13.1.2.1. In a 1000 mL, metal free, volumetric flask, add 500 mL reagent water, 10 mL HNO_3 and 50 mL HCl. Add the volumes of the standards as detailed in the table below. Once all the analytes have been added, volume to 1000 mL with reagent water and mix well. The final concentrations of analytes are listed below. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

Source Standards/Analytes	Concentration of Stock Standards (mg/L)	Volume to add (mL)	Final Concentration (mg/L)
P, S	1,000	10	10

13.1.3. ICP-STD6 (10/50): Made from primary source individual stock standards in section 10.9

13.1.3.1. In a 1000 mL, metal free, volumetric flask, add 500 mL reagent water, 10 mL HNO_3 and 50 mL HCl. Add the volumes of the standards as detailed in the table below. Once all the analytes have been added, volume to 1000 mL with reagent water and mix well. The final concentrations of analytes are listed below. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

Source Standards/Analytes	Concentration of Stock Standards (mg/L)	Volume to add (mL)	Final Concentration (mg/L)
Ca, Mg	10,000	1	10
K, Na	10,000	5	50
Si	1,000	10	10

13.1.4. ICP-STD5 (2 ppm Ag): Made from primary source individual stock 10.9.

13.1.4.1. To a 100 mL metal free volumetric flask, add 50 mL of reagent water and 1mL HNO_3. Add the volume of Ag standard as detailed in the table below. Once all the analytes have been added, volume to 1000 mL with reagent water and mix well. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

Source Standards/Analytes	Concentration of Stock Standards (mg/L)	Volume to add (mL)	Final Concentration (mg/L)
Ag	1,000	0.2	2

13.1.5. ICP-STD4 (5/10/20/30/50 ppm): Made from primary source individual stock standards in 10.9).

13.1.5.1. In 1000 mL metal free of volumetric flask, add 500 mL of reagent water, 10 mL HNO_3, 50mL HCl. Add the volumes of the standards as detailed in the table below. Once all the analytes have been added, volume to 1000 mL with reagent water and mix well prior using. The final concentrations of the analytes are listed below. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

Source Standards/Analytes	Concentration of Stock Standards (mg/L)	Volume to add (mL)	Final Concentration (mg/L)
Al, B, Bi, W, Zn	1000	50	50
Sb, Se	1000	30	30
Fe	1000	20	20
As, Ba, Cu, Mn, Mo, Ni, Pb, Sn, Ti	1000	10	10
Be, Cd, Co, V	1000	5	5
Cr	10000	1	10
Tl	10000	3	30

13.1.6. ICP-STD3 (0.5/1/2/3/5ppm): In a 500 mL, metal free, volumetric flask, add 200 mL reagent water, 5 mL HNO_3, 25 mL HCl. Add 50mL of section 13.1.5, and volume to 500 mL with reagent water and mix well. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

13.1.7. ICP-STD2 (0.05/0.1/0.2/0.3/0.5ppm): In a 500 mL, metal free, volumetric flask, add 200 mL reagent water, 5 mL HNO_3, 25 mL HCl. Add 50mL of section 13.1.6, and volume to 500 mL with reagent water and mix well. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

13.1.8. ICP-STD1 (0.005/0.01/0.02/0.03/0.05ppm): In a 500 mL, metal free, volumetric flask, add 200 mL reagent water, 5 mL HNO_3, 25 mL HCl. Add 50mL of section 13.1.7 + 5mL 13.1.3 + 50mL 13.1.2, and volume to 500 mL with reagent water and mix well. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

13.2. Initial/ Continue calibration verifications (ICVs/CCVs):

13.2.1. ICP-ICV/CCV Cam metals (1ppm): In a 1000mL metal free volumetric flask, add 500 mL of reagent water, 20 mL of HNO_3, 10 mL of QC21 (section 10.10) and 10mL of QC7 (section 10.11). Volume up to 1000 mL with reagent water, and mix well prior using. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest. The concentrations are as follows:

Standard/Analytes	Final Concentration (mg/L)
QC21: As, Be, Ca, Cd, Co, Cr, Cu, Fe, Li, Mg, Mn, Mo, Ni, Pb, Sb, Se, Sr, Ti, Tl, V and Zn	1
QC7: K	10
QC7: Si	0.5
QC7: Al, Ba, B, Ag, and Na	1

13.2.2. ICP- ICV/CCVGM (100 ppm): In a 1000 mL metal free of volumetric flask, add 500 mL of reagent water, 10 mL HNO_3, 50 mL HCl, and 10 mL of secondary source of Mix 4 Standard solution (Ca, Mg, Na, and K) (section 10.12). Volume to 1000 mL with reagent water and mix well prior to using. Or, in a 1000 mL, metal free, volumetric flask, add 500 mL of reagent water, 10 mL HNO_3, 50 mL of HCl, and 20 mL of section 10.16, volume to 1000 mL with reagent water and mix well prior to using. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

13.2.3. ICP-CCV (Si, W, P, Sn, Bi, and Sn) 5 ppm: In a 1000 mL metal free volumetric flask, add 500 mL of reagent water, 10 mL HNO_3, 50 mL HCl, 10 mL of 6 element mix (section 10.13). Volume to 1000 mL with reagent water and mix well prior using. Or, in a 1000 mL, metal free, volumetric flask, add 500 mL of reagent water, 10 mL HNO_3, 50 mL of HCl, and 5 mL of individual secondary stock standard (1000ppm) section 10.18., volume to 1000 mL with reagent water and mix well prior to using. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

13.3. Interference Check Sample:

13.3.1. Interference Check Standard A (ICSA): In 1000 mL metal free volumetric flask, add 500 mL of reagent water, 10 mL HNO_3, 50 mL HCl, and 80 mL of ICSA stock standard (10.14). Volume to 1000 mL with reagent water and mix well prior using. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

13.3.2. Interference Check Standard AB (ICSAB): In 1000 mL metal free volumetric flask, add 500 mL of reagent water, 10 mL HNO_3, 80 mL of ICSA (section 10.14), and 10 mL of ICSAB (section 10.15). Volume to 1000 mL with reagent water and mix well before using. This solution will expire after 6 months from the date of prep, or on the earliest expiration date of a stock standard, whichever is earliest.

13.4. Limit of Quantitation (LOQ) solutions: These solutions are made daily

13.4.1. 0.005 ppm Ag: In a 50 mL digestion tube, add 25 mL of reagent water, 1 mL of HNO_3, and 0.125 mL of ICP-STD4 (section 13.1.4). Volume to 50 mL with reagent water and mix well prior using.

13.4.2. 0.001 ppm Be: In a 100 mL digestion tube, add 50 mL of reagent water, 1 mL of HNO_3, 5 mL of HCl, and 0.1 mL of the 1 ppm Be standard in section 10.17. Volume to 100 mL with reagent water and mix well prior using.

13.5. Spike Solutions: These solutions are expired after 6 months or when the primary stock standard expires, whichever comes first.

13.5.1. 50ppm mix metals spike solution: Add 100 mL of QC 21 (section 10.10.) +100 mL of QC 7(section 10.11.) to final volume 200mL. Mix well prior using.

13.5.2. 1000ppm GM spike solution: Add 200 mL of reagent water + 5 mL HNO3+ 25 mL HCL + 50mL of GM mix stock standard (10.12.). Volume to 500 mL with reagent water, mix well prior using.

14.0 PROCEDURE.

14.1. INSTRUMENT OPERATION (Perkin Elmer ICP-OES 4300 DV and ICP-OES 8300)

14.1.1. Double click on **Winlab32** icon.

14.1.2. Check connection to **plasma generator, spectrometer**, and **autosampler.**

14.1.3. Open the **Method** needed for analysis

14.1.4. Click the plasma switch to **ON** in the **Plasma Control Window** to ignite the plasma. Let the instrument warm up 15- 30 minutes while allowing DI water to be pumped into the nebulizer.

14.1.5. Operating Conditions:

ICP Gas Flows (L/min):	Plasma: 15 Auxiliary: 0.2 Nebulizer: 0.55
ICP Power:	RP Power: 1400
Pump flow Rate:	2.0 mL/min
Air compressor:	80-120 PSI
Argon (high purity):	80-120 PSI
Chiller:	40-60 PSI

14.1.6. Torch Viewing Position Alignment: Adjust the plasma viewing position of the spectrometer entrance optics for the highest signal intensity. This should be done daily or whenever maintenance has been done on the instrument.

14.1.6.1. Mercury Alignment: Go to **TOOL menu** and click on **Spectrometer Control**, then click the on **Hg realignment mode**. The slit adjustment should be -3 to +3.

14.1.6.2. Aspirate a 1 ppm Mn solution and select **Axial Mode** to do the Axial alignment. The instrument automatically locates the highest signal intensity.

14.1.6.3. Aspirate 10 ppm MN solution and select **Radial Mode** to adjust the radial alignment. The instrument automatically locates the highest signal intensity for the radial position

14.1.7. Click on **Sample Information** icon and type the sample information (Sample ID, weight, volume, dilutions, method, QC batch #, sample location)

14.1.8. **Save** the file with convention **MMDDYY**, if more than one file in a day then saves the file as **MMDDYYA, B, C**. The letter indicator is at the end of the file name.

14.1.9. Click on **Automated Analysis Control** icon, click on **set up** page and confirm **sample information file and method**.

14.1.10. Still under set up page, results will be saved under **Result Data Set Name** (type the name of the save file with convention **MMDDYY)**

14.1.11. Still under set up page, check box of **Save Data** and **Print log during the analyses.**

14.1.12. Click on **Automated Analysis Control** icon, click on **Analyze** page, click **Reset Sequence or Rebuild List.**

14.1.13. Click on **Analyze All, Calibrate, or Analyze** which are located on **Automated Analysis control page.**

14.1.13.1. **Analyze All:** To generate a new calibration and continue with samples

14.1.13.2. **Calibrate**, examine the calibration and recalibrate if desired. When ready to analyze samples then click on **Analyze Sample:** To generate a new calibration, examine it, and continue with sample.

14.1.13.3. To recalibrate only, then click on **Calibrate**

14.1.13.4. **Analyze Samples:** To analyze samples when a calibration is automatically recalled with the method.

14.1.13.5. To manually recall a calibration and then analyze samples, in the **Analysis** menu, click on Recall Calibration, then select the results data set that contains the desired calibration. Then click on Analyze Samples.

14.2. Autosampler Operation: Rinse time between samples and rinse pump speed are pre-set up in the instrument method.

14.3. The Summary of Instrument Calibration: calibration and profiling of the ICP instrument is done at least daily using following standards:

14.3.1. Calibration Blank

14.3.2. STD1 (13.1.8)

14.3.3. STD2 (13.1.7)

14.3.4. STD3 (13.1.6)

14.3.5. STD4 (13.1.5)

14.3.6. STD5 (13.1.4)

14.3.7. STD6 (13.1.3)

14.3.8. STD7 (13.1.2)

14.3.9. STD8 (13.1.1)

The regression type used for calibrations is "linear, forced through zero." The correlation coefficient of each element must be ≥0.995. If the criteria is not met, the calibration must be rerun for that particular element.

All standards must be plasma grade standards, and the acid matrix must match the samples to be analyzed.

The calibration intensity for each element should also be checked against historical levels (the previous day) values. A change greater than 10% may indicate problems with the instrument.

Per NELAC guidelines, the lowest calibration standard is the lowest concentration for which quantitative data are to be reported, or a standard corresponding to the limit of quantitation must be analyzed prior analyzed samples (LOQs had been replaced). The acceptance limit is ±50%.

14.4. Calibration Curve Verification: the calibration curve must be verified initially, immediately after the calibration (ICV) and periodically throughout the sequence (CCV) with a second source standard. These standards are:

14.4.1. ICV CAM metal/ ICV GM/ ICV Si, P standard (13.1.6): accepting limits as followings

14.4.1.1. Method 200.7: Recovery must be within 95-105%

14.4.1.2. Method 6010B: Recovery must be within 90-110%

14.4.1.3. If the sequence is a combination of both method 200.7 and method 6010B, the ICV recovery must be within 95-105%.

Note: If the ICV does not meet the acceptance criteria, the instrument should be recalibrated. Any samples that were analyzed following the failing ICV must be reanalyzed.

14.4.2. ICB is immediately analyzed after the ICV: The resulting concentrations must be less than the reporting limit. If it is not, the ICB must be reanalyzed. If an ICB has a detection above the reporting limit, ND samples may be reported and samples that have a detection that is 10x greater than the detection in the ICB may be reported. However, at the time of ICB analysis, sample concentrations are usually not yet known. It is recommended that the ICB be reanalyzed immediately in the event of a failure.

14.4.3. CCV standards (13.1.6): must be analyzed after every tenth sample and at the end of the run. Acceptance criteria is 90-110% recovery. If the CCV recovery fails outside the acceptance limits, the CCV is automatically rerun. If a parameter in the CCV fails above 110%, only samples where that parameter is ND may be reported.

14.4.4. CCB is immediately analyzed after CCVs: The resulting concentrations must be less than the reporting limit. If it is not, the CCB must be reanalyzed. If a CCB has a detection above the reporting limit, ND samples may be reported and samples that have a detection that is 10x greater than the detection in the CCB may be reported.

Note: If the CCV and CCB standards do not meet acceptance criteria, sample analysis should be discontinued, determine the cause, document, and recalibrate. All samples since last acceptable CCV and CCB that are affected by the CCV or CCB failure must be reanalyzed. Continue the run for all samples with CCV/CCB every tenth sample as long as CCV and CCB criteria are met.

14.5. Interference Check (ICSA/ICSAB): Analyzed after calibration and prior to analysis of samples. (See section 6.34 and 6.35). The interfering element correction factors are re-determined annually, or more often if problems are noted with the ICS check standards or other check standards.

14.5.1. ICSA standard: Acceptance limit: 80-120% for spiked parameters and < RL for unspiked analytes. If the ICSA falls outside the acceptance limits, remake new ICSA solution and rerun, recalibrate the instrument, or perform other corrective action.

14.5.2. ICSAB standard: Acceptance limit 80-120%: If the ICSAB falls outside the acceptance limits, remake new ICSAB solution and rerun, recalibrate the instrument, or perform other corrective action.

14.6. Limits of Quantitation check (13.4) as followings: Acceptance Criteria: ± 50%. If a parameter falls outside of the acceptance limits, reanalyze the LOQ solution. If it fails again, recalibrate the instrument.

14.6.1. 0.005 ppm Ag

14.6.2. 0.001 ppm Be

14.7. Summary of Analytical Sequence:

14.7.1. Calibration Blank (compared with historical values from previous day)

14.7.2. Calibration STD1

14.7.3. Calibration STD2

14.7.4. Calibration STD3

14.7.5. Calibration STD4

14.7.6. Calibration STD5

14.7.7. Calibration STD6

14.7.8. Calibration STD7

14.7.9. Calibration STD8

14.7.10. ICV (mix 28 metals): Acceptance limit of 95-105% for method 200.7 and 90-110% for method 6010B.

14.7.11. ICVGM (mix 4 metals): Acceptance limit of 95-105% for method 200.7 and 90-110% for method 6010B.

14.7.12. ICV (P, Si, Sn, W, Bi): Acceptance limit of 95-105% for method 200.7 and 90-110% for method 6010B.

14.7.13. ICB: Must be less than reporting limit

14.7.14. 0.005 ppm Ag (LOQ): Acceptance limit of 50-150%

14.7.15. 0.001 ppm Be (LOQ): Acceptance limit of 50-150%

14.7.16. ICSA: Acceptance limit of 80-120%

14.7.17. ICSAB: Acceptance limit of 80-120%

14.7.18. MB: concentrations must be less than reporting limit (DLR). If the concentration of an analyte in the MB is higher than the reporting limit then follow these steps: No action if the samples are non-detect, and no action if the lowest sample concentrations are greater than 10x the blank concentration. All other samples must be prepared again with another batch and re-analyzed.

14.7.19. LCS: Recovery must be within 85-115% for method 200.7, and 80-120% for method 6010B. If the percent recovery for the LCS is outside the acceptance limits, follow these steps: No action is required if the LCS fails above acceptance limits and the sample results are non-detect. If the LCS fails below the accepting limit, the run must be stopped. Identify, document, and correct the problems and re-analyze all samples if the problems are from instrument or a clog in the system. If the LCS still falls below the limits, then whole batch must be re-prepared and re-analyzed.

14.7.20. Samples 1-5

14.7.21. MS: Acceptance limit 75-125% for method 6010B and 70-130% for method 200.7 (*)

14.7.22. MSD: Acceptance limit 75-125% for method 6010B and 70-130% for method 200.7 (*)

14.7.23. Samples 6-10 (which include the duplicate sample, dilution samples, post spike sample, and serial dilution sample, if necessary)

14.7.24. CCVs: Acceptance limits 90-110%

14.7.25. CCB: must be less than reporting limit

14.7.26. Another 10 injections or less

14.7.27. CCVs: Acceptance limits 90-110%

14.7.28. CCB: must be less than reporting limit

(*): If MS/MSD recoveries and/or the %RPD are outside the acceptance limits but the LCS recovery is acceptable, there is possible matrix inference. The analyst must investigate to make sure there no errors in preparation, spiking, or analysis. If no errors are found, no corrective action is required, but the reported QC must be qualified. If errors are found in the preparation or spiking, the batch must be re-prepared and re-analyzed. If errors are found in the analysis, the samples must be reanalyzed.

If the sample has concentrations greater than the linear range of the instrument, the sample must be diluted and re-analyzed.

Addition QC: The following additional QC samples may be required either for new matrices or samples to check quantitation accuracy: 1) Serial Dilution Sample: If the result is greater than 50 times the detection limit, a 1 to 5 dilution should agree within 10% of the undiluted sample. 2) A Post Digest Spike: The sample should give 75-125% recovery of the spike. If not, the sample can be quantitated by the method of standard additions (only one addition is required).

Duplicate sample: For results are greater than 5 times the reporting limit, the relative percent difference between the sample and duplicate should be less than 20%. If not, the analysis should be repeated or the result should be flagged for precision out-of-limits.

14.8. The Instrument Run Method Includes These Features for Sample Analysis and Print-Out:

14.8.1. Name of method
14.8.2. Date and time of data collected (original)
14.8.3. Sample location
14.8.4. Page #
14.8.5. Sequence #
14.8.6. Data type: (Original/ reprocessed)
14.8.7. Date and time of data was reprocessed
14.8.8. Analyst
14.8.9. Sample weight
14.8.10. Sample initial volume
14.8.11. Dilution
14.8.12. Sample prep. Volume
14.8.13. Analyte
14.8.14. Mean corrected intensity
14.8.15. Calibration concentration units
14.8.16. Standard deviation
14.8.17. Sample concentration units
14.8.18. %RSD for the replicate readings
14.8.19. ICV/ICB/ICSA/ICSAB will automatically run after ICAL
14.8.20. CCVs/CCB will automatically run every 10 injections or end of the run

14.8.21. If the QC standards (ICV/ICB/CCV/CCB) fall outside the limits imbedded in the program, the QC standard is automatically re-run.
14.8.22. The summary of the run will show all the QC samples' acceptance limits. The computer run log will indicate this on the print-out.
14.8.23. The print-out will indicate if the ICV, ICB, CCV, and CCB meet/ not meet the method criteria.

14.9. Logbooks: All reagents, stock standards, intermediate/working standards must be recorded in the appropriate logbooks. All laboratory-monitoring activities – pipette and balance calibration checks, instrument maintenance – must be properly documented.

14.10. Data package for turning to QA include the following:

14.10.1. ICAL
14.10.2. ICVs/ICB/CCVs/CCB
14.10.3. ICSA/ICSAB
14.10.4. LOQs
14.10.5. Checklist
14.10.6. Raw data (inclusive of sample data and batch QC)
14.10.7. Sample prep batch
14.10.8. NCD (if applicable)

15.0 CALCULATIONS:

15.1. All calibration curve and sample result calculations are performed by the PerkinElmer Operating Software. Sample weight, final volumes and dilutions are entered into the software and final results are calculated on the instrument printout. Results are transferred to the LIMS without the necessity of manual entry.

15.2. Report results concentration to the proper significant figures in mg/L for water samples and mg/Kg for solid sample.

15.3. Final result in solid (ppm = mg/Kg)

$$\text{Sample Concentration, mg/Kg} = \frac{C \times V \times DF}{W}$$

Where:

C = On instrument sample concentration, mg/L
V = Prepared Sample Volume, L
DF = Sample Dilution Factor
W = Initial Sample Weight, Kg

15.4. Final result in aqueous (ppm =mg/L) = $\frac{Weight\ (mg)}{Volume\ (L)}$

15.5. Calculation of LCS Percent Recovery

$$\text{\% Recovery} = \frac{Concentration\ found}{True\ concentration} \times 100$$

15.6. Calculation of MS/MSD Percent Recovery

$$\% \text{ Recovery} = \left(\frac{spike\ sample\ result - original\ sample\ result}{spike\ concentration}\right) \times 100$$

15.7. Calculation of Relative Percent Recovery

$$\% \text{ RPD} = \left(\frac{|MS - MSD|}{\frac{MS+MSD}{2}}\right) \times 100$$

Note: This formula can also be applied to the Sample Duplicate RPD calculation by replacing MS in the formula with Sample Result and MSD with Sample Duplicate Result.

15.8. Calculate of Dry Weight Basis = $\frac{W*100}{\%\ S}$

Where:

W = Wet weight result (not adjusted for sample moisture content)
%S = Percent of solids (provided by lab or client)

15.9. Calculation of Calcium Hardness = (mg/L Ca^{2+}) x (100g CaCO3/ 40g Ca^{2+})

15.10. Calculation of Magnesium Hardness = (mg/L Mg^{2+}) x (100g CaCO3/24.312g Mg^{2+})

15.11. Total Hardness = Section 15.9. + Section 15.10.

16.0 METHOD PERFORMANCE

16.1. The method detection limit (MDL): see section 6.2.

16.2. Initial Demonstration of Capability (IDOC): must be performed prior to performing the method, and at any time there is a change in instrument type, personnel. The Demonstration of Capability is updated annually. One in the following performed will be accepted.

16.2.1. Four laboratory control samples (LCS) shall be prepared and analyzed according to the test method either concurrently or over a period of days. Acceptance limits are 85-115% for method 200.7, 80-120% for method 6010B, and both methods must meet a %RPD between 4 LCS of 20%.

16.2.2. Proficiency Testing (PT) Studies: The proficiency of the analyst with the analytical method is periodically assessed by performing PT studies. PT samples are blind standards purchased from and independent outside source. The results are compared to predetermined acceptance limits. Records of all PT studies are maintained by the QA department. Problems identified through participation in performance are also used a part of a laboratory certification program to objectively determine the capabilities of a laboratory to achieve high quality results.

17.0 POLLUTION PREVENTION

17.1. To reduce the volume of waste generated by the laboratory and to reduce production costs, prepare only sufficient standard and reagent volumes that can be used within the expiration date.

18.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QUALITY CONTROL MEASURES

18.1. Data Assessment:

18.1.1. If the sample results fall outside the linear range of the instrument, the sample must be diluted and re-analyzed

18.1.2. The RSD% limits for two replicate readings is 20%. If it is more than 20%, the samples shall be re-analyzed except in the cases where the results are less than DLR.

18.1.3. The results taken are from the average integrated value and are multiplied by dilution factor that may have been applied to the sample. All result concentrations less than the current MDL are entered as ND (non-detected).

18.2. QC Acceptance Criteria:

18.2.1. Initial Calibration Verification (ICV): Acceptance limits are 95-105% for method 200.7 and 90-110% for method 6010B.

18.2.2. Continue Calibration Verification (CCV): Acceptance limits are 90-110% for both methods 200.7 and 6010B.

18.2.3. ICB/CCB: Should be below RDLs

18.2.4. ICSA: Acceptance limit is 80-120% for spiked analytes. (non- spike analytes must be below DLR)

18.2.5. ICSAB: Acceptance limit is 80-120%

18.2.6. LOQs: Acceptance limit is 50-150%

18.2.7. MB: Should be below LOQ or less than 10 times of the lowest concentration in the batch.

18.2.8. LCS: Should be 85-115% for method 200.7 and 80-120% for method 6010B

18.2.9. Matrix Spike (MS)/ Matrix Spike Duplicate (MSD): should be 75-125% for method 6010B and 70-130% for method 200.7

18.2.10. %RPD for MS/MSD: ≤20%

18.2.11. Sample Duplicate % RPD: ≤20%

18.2.12. Serial Dilution: Acceptance limit is ±10% when compared to the undiluted sample

18.2.13. Post digestion spike: percent recovery must be within 75-125% for method 6010B and 85-115% for method 200.7.

18.2.14. Internal Standard: Acceptance limit is 70-130%

19.0 CORRECTIVE ACTIONS FOR OUT-OF-CONTROL DATA

19.1. MB: if exceeds the reporting limit, the samples must be re-prepared and re-analyzed (Exception: Samples are reportable if the sample results exceed ten times the MB value, or if the sample results are non-detect).

19.2. LCS: If fails to meet the recovery limits, the samples must be re-prepared and re-analyzed (Exception: Samples are reportable if the LCS fails above the upper limit and the sample results are ND)

19.3. MS/MSD: If both do not meet recovery limit, a post digestion spike may be performed for any analyte that had a poor spike recovery. Better accuracy may be achieved for the samples in this matrix by analyzing the samples by the Method of Standard Addition (MSA).

If the control limits for MS/MSD are not satisfied and an LCS was within control limits, then the samples do not need re-analyzed or re-preparation. The sample result should be flagged for potential matrix interference showing poor recovery.

If the relative percent difference (%RPD) between the matrix spike and the matrix spike duplicate is greater than 20%, the analysis should be repeated or the result flagged for out-of-control precision.

19.4. ICV: If the ICV fails to meet the recovery limits, it is automatically re-run. If it is still outside the limits, the instrument is re-calibrated and the ICV re-run. If the ICV is still outside the limits, terminate analysis, identify and document problem. Re-calibrate and re-analyzed a freshly prepared ICV and all associated samples.

19.5. ICB: If the ICB exceeds the reporting limit, it is automatically re-run. If it is still outside the limits, the instrument is re-calibrated and the ICB is re-run. If the ICB is still outside the limits then terminate analysis, determine source of contamination. The ICB is re-prepared and re-analyzed all samples associated with a contaminated ICB.

19.6. CCV: If the CCV fails to meet the recovery limits, the CCV is automatically re-run. If the CCV still fails to meet the limits, re-calibrate and re-run all samples since the last acceptable CCV. In case where the CCV is exceeded high (high bias), samples which are non-detected may be reported.

19.7. CCB: If the CCB exceeds the reporting limits, it is automatically re-run. If it is still outside the limits, the run is terminated, the problem corrected. Re-run all samples since the last acceptable CCB. Exception: Sample results are reportable if the sample results ND, or exceed ten times the CCB value.

19.8. ICSA: If the ICSA fails to meet the recovery limits, re-make the solution and re-analyze

19.9. ICSAB: If the ICSAB fails to meet the recovery limits, re-make the solution and re-analyzed

19.10. LOQs: If an LOQ fails to meet recovery limits, it is re-run. If LOQs are still outside the limits, re-make the solution and re-analyze it. If it is still outside the limits, the run is terminated, the instrument recalibrated and the LOQ re-analyzed.

19.11. Internal Standard: If the Internal Standard fails to meet the recovery limits check if the sample has matrix interferences. If matrix interference is suspected, dilute the sample. If matrix interference is not suspected, check all the tubing for clogs, fix the problem and re-analyze the sample.

19.12. Sample Duplicate: If the Sample Duplicate fails to meet the RPD limit, there is a possibility the sample is non-homogeneous. If the cause of the failure is determined to be an error in the precision of the preparation process, the entire batch must be re-prepared and re-analyzed.

19.13. Serial Dilution: If the Serial Dilution fails to meet recovery limits, a chemical or physical interference effect should be suspected.

19.14. Serial Dilution: If the Serial Dilution fails to meet recovery limit, a matrix effect should be suspected.

19.15. When serial dilution or post spike have failed, use the Method of Standard Addition, single addition method.

20.0 CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1. Generally, any data that is out of control is considered unusable. However, if the data is used it will be thoroughly narrated.

20.2. The Client will be informed of the situation. Preliminary results can be released; however, the client is informed that the preliminary results can change.

21.0 WASTE MANAGEMENT

21.1. All samples must be neutralized before being disposed.

21.2. Detail refers to SOP-Laboratory Hazardous Waste Disposal

22.0 REFERENCES

22.1. EPA method 200.7, 6010B, SW846 and Perkin Elmer Winlab32 software and hardware guidance.

23.0 ATTACHMENTS

23.1. Attachment 1: Potential Interferences and Analyte Concentration Equivalents (mg/L) Arising from Interference at the 100 mg/L Level

23.2. Attachment 2: Instrument Maintenance

24.0 DOCUMENT REVISION HISTORY

Date	Description of Revision
October 2018	• Section 3.1: Revised some RLs • Sections 6.5 and 6.6: Removed acceptance criteria from definitions section • Section 9.3: Updated autosamplers that are in use • Section 10.9.2: Added Ca, Mg, K, and Na to the list of 10,000 ppm primary standards • Added section 10.16: Cal4 Mix, secondary • Added section 10.17: 1ppm Be LOQ (intermediate standard) • Added standards in section 10.18 • Revised the standards in section 13. See the draft of Revision 2 for details • Section 14.3: Updated the calibration standard reference sections • Section 14.6: Revised to only have Ag and Be LOQs • Section 14.7: Added calibration SDTs 7 and 8 to section 14.7.8 and 14.7.9 and removed LOQ standards, except for Ag and Be • Added calculations for hardness, sections 15.9, 15.10, and 15.11
March 2017	• Updated the format of the SOP to meet the TNI 2009 Standard SOP Template. • Combined Methods EPA 200.7 and EPA 6010B into one SOP. • Added details for clarification.

Attachment 1

TABLE 1

POTENTIAL INTERFERENCES AND ANALYTE CONCENTRATION EQUIVALENTS (mg/L) ARISING FROM INTERFERENCE AT THE 100-mg/L LEVEL

Analyte	Wavelength[c] (nm)	Interferent[a,b]									
		Al	Ca	Cr	Cu	Fe	Mg	Mn	Ni	Ti	V
Aluminum	308.215	--	--	--	--	--	--	0.21	--	--	1.4
Antimony	206.833	0.47	--	2.9	--	0.08	--	--	--	0.25	0.45
Arsenic	193.696	1.3	--	0.44	--	--	--	--	--	--	1.1
Barium	455.403	--	--	--	--	--	--	--	--	--	--
Beryllium	313.042	--	--	--	--	--	--	--	--	0.04	0.05
Cadmium	226.502	--	--	--	--	0.03	--	--	0.02	--	--
Calcium	317.933	--	--	0.08	--	0.01	0.01	0.04	--	0.03	0.03
Chromium	267.716	--	--	--	--	0.003	--	0.04	--	--	0.04
Cobalt	228.616	--	--	0.03	--	0.005	--	--	0.03	0.15	--
Copper	324.754	--	--	--	--	0.003	--	--	--	0.05	0.02
Iron	259.940	--	--	--	--	--	--	0.12	--	--	--
Lead	220.353	0.17	--	--	--	--	--	--	--	--	--
Magnesium	279.079	--	0.02	0.11	--	0.13	--	0.25	--	0.07	0.12
Manganese	257.610	0.005	--	0.01	--	0.002	0.002	--	--	--	--
Molybdenum	202.030	0.05	--	--	--	0.03	--	--	--	--	--
Nickel	231.604	--	--	--	--	--	--	--	--	--	--
Selenium	196.026	0.23	--	--	--	0.09	--	--	--	--	--
Sodium	588.995	--	--	--	--	--	--	--	--	0.08	--
Thallium	190.864	0.30	--	--	--	--	--	--	--	--	--
Vanadium	292.402	--	--	0.05	--	0.005	--	--	--	0.02	--
Zinc	213.856	--	--	--	0.14	--	--	--	0.29	--	--

NOTE: [a] Dashes indicate that no interference was observed even when interferents were introduced at the following levels:

Al at 1000 mg/L	Cu at 200 mg/L	Mn at 200 mg/L
Ca at 1000 mg/L	Fe at 1000 mg/L	Ti at 200 mg/L
Cr at 200 mg/L	Mg at 1000 mg/L	V at 200 mg/L

[b] The figures shown above as analyte concentration equivalents are not the actual observed concentrations. To obtain those figures, add the listed concentration to the interferent figure.

[c] Interferences will be affected by background and wavelength choice and other interferences may be present.

Attachment 2

INSTRUMENT MAINTERNANCE
Recommended by PerkinElmer

1. At the end of each day, flush out the sample introduction system for five minutes with the plasma on, using deionized water with 2% nitric acid, followed by deionized water.
2. At the beginning of the day check the argon supply pressure and level. The tank pressure should be 80-120 psi
3. Each morning, drain the air compressor, turn on and check the tank pressure and line pressure should be 100-110 psi
4. Check the chiller on a weekly basis; add distilled water and a few drops of chloramines-T as needed. The pressure should be 60-65 psi and the temperature should be 18-20° C. The chiller should be flushed and refilled every six months.
5. Be sure to turn on the vent and check flow rate before instrument on. Turn off if instrument is without operation.
6. Check the torch, RF coil, nebulizer and chamber on a daily basis. Check the tubing daily and change as needed (at least weekly)
7. Check and clean the air filters as needed. If washed be sure that they are dry before put back on. Make sure the fine screen side is toward the instrument when replacing. Shut down the instrument before removing the filters.
8. Refer to the Perkin Elmer software and hardware technical manual for more troubleshooting problems with the instrumentation or software.

ENTHALPY ANALYTICAL

931 W. Barkley
Orange, CA 92868

STANDARD OPERATING PROCEDURE

POLYCHLORINATED BIPHENYLS
BY GAS CHROMATOGRAPHY

EPA Method 8082

SOP Number: H-0004
Prepared By: Brian Built
Effective Date: 1/25/2017

Revision: 1.0
Supersedes: May 2014

Approved By:	Signature:	Date:
Brian Built Department Manager		1/25/17
Hongling Cao Technical Director		1/25/17
Clifford Baldridge QA Director		1/25/17
Reapproved By:	Signature:	Date:

1.0 IDENTIFICATION OF THE TEST METHOD

1.1. The test methods covered by this SOP are EPA Method 8082 and EPA Method 608.

2.0 APPLICABLE MATRIX OR MATRICES

2.1. Applicable matrices are surface water, ground water, liquid, sediment, and solid.

3.0 DETECTION LIMIT

3.1. Detection limits are continuously up-dated on an annual basis, or more often as needed, and are tracked using the laboratory LIMS

4.0 SCOPE AND APPLICATION

4.1. Method 8082 is used to determine the concentrations of polychlorinated biphenyls (PCBs) as Aroclors from solid and aqueous matrices. Open-tubular, capillary columns are employed with electron capture detectors (ECD). Method 608 is applicable to the determination of Aroclors in municipal and industrial discharges as provided under 40CFR 136.1.

The following list contains Aroclors in Method 8082 and 608, and PCB congeners in Method 8082:

Table 1

Compound	CAS Registry No.	IUPAC #
Aroclor 1016	12674-11-2	-
Aroclor 1221	11104-28-2	-
Aroclor 1232	11141-16-5	-
Aroclor 1242	53469-21-9	-
Aroclor 1248	12672-29-6	-
Aroclor 1254	11097-69-1	-
Aroclor 1260	11096-82-5	-
Aroclor 1262	2051-60-7	1
Aroclor 1268	16605-91-7	5

4.2. Aroclors are multi-component mixtures. When samples contain more than one Aroclor, a higher level of analyst expertise is required to attain acceptable levels of qualitative and quantitative analysis. The same is true of Aroclors that have been subjected to environmental degradation ("weathering") or degradation by treatment technologies. Such weathered multi-component mixtures may have significant differences in peak patterns than those of Aroclor standards.

4.3. Quantitation of PCBs as Aroclors is appropriate for many regulatory compliance determinations, but is particularly difficult when the Aroclors have been weathered by long exposure in the environment. Therefore, this method provides procedures for the determination of selected individual PCB congeners. The 9 PCB congeners listed above have been tested by this method.

4.4. The PCB congener approach potentially affords greater quantitative accuracy when PCBs are known to be present. As a result, this method may be used to determine Aroclors, some PCB congeners, or "total PCBs," depending on regulatory requirements and project needs. The congener method is of particular value in determining weathered Aroclors. However, analysts should use caution when using the congener method when regulatory requirements are based on Aroclor concentrations.

4.5. Compound identification based on single-column analysis should be confirmed on a second column, or should be supported by at least one other qualitative technique. This method describes analytical conditions for a second gas chromatographic column that can be used to confirm the measurements made with the primary column. GC/MS Method 8270 is also recommended as a confirmation technique when sensitivity permits.

5.0 SUMMARY

5.1. A measured volume or weight of sample (approximately 1 L for liquids, 2 to 30 g for solids) is extracted using the appropriate matrix-specific sample extraction technique.

5.2. Aqueous samples are extracted at neutral pH with methylene chloride using Method 3510 (separatory funnel).

5.3. Solid samples are extracted by Method 3545 with Hexane:Acetone (1:1) or by Method 3550 with Methylene Chloride:Acetone (1:1).

5.4. Extracts for PCB analysis may be subjected to sulfuric acid/potassium permanganate cleanup (Method 3665) designed specifically for these analytes. This cleanup will remove (destroy) many single component organochlorine or organophosphorus pesticides. Therefore, Method 8082 is not applicable to the analysis of those compounds. Instead, use Method 8081.

5.5. After cleanup, the extract is analyzed by injecting a 1-uL aliquot into a gas chromatograph with a fused silica capillary column and electron capture detector (GC/ECD).

5.6. The chromatographic data may be used to determine the nine Aroclors, individual PCB congeners, or total PCBs.

6.0 DEFINITIONS

6.1. Reporting Detection Limit (RDL): The lowest concentration that can be measured with the consideration for practical limitations such as sample size, matrix interferences and dilutions.

6.2. Method Detection Limit (MDL): Minimum concentrations of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The sample is carried through the entire method under ideal conditions. This is performed on an annual basis, or more frequently as methods demand, by the laboratory.

$$MDL = t_{(n-1,\ 1-\alpha)} \times S$$

Where: S = the standard deviation of the replicate analyses

$t_{(n-1,\ 1-\alpha)}$ = the student's t-value appropriate to a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom.

Number of Samples	t-value
7	3.143
8	2.998
9	2.896
10	2.821
11	2.764
12	2.718

13	2.681
14	2.650
15	2.624

6.3. Calibration: A plot of concentrations of known analyte standards versus the instrument response to the analyte. It is a reproducible reference point to which all sample measurements can be correlated. The appropriate linear or nonlinear coefficient for standard concentration to instrument response should be greater than or equal to 0.995.

6.4. Calibration Standards: A series of known analyte standards used for the calibration of the instrument. These are prepared by diluting a stock standard solution to produce working standards, which cover the working range of the instrument. One calibration standard must be at or below the reporting limit for the method.

6.5. Initial Calibration Verification Standard (ICV): A standard used to confirm the accuracy of the instrument calibration. This is prepared from a different stock solution (a different lot number or vendor) than was used to prepare the calibration standards. It is run after the initial calibration and should be within 90-110%, of the expected concentration.

6.6. Continuing Calibration Verification Standard (CCV): A standard that periodically confirms that the instrument response has not changed significantly from the initial calibration. It also confirms accurate analyte quantitation for the previous samples analyzed. This is prepared from the same stock solution that was used to prepare the calibration standards. Its concentration should be at or near the mid-range levels of the calibration curve. It is analyzed at the beginning and end of a sample run, and periodically during a run (after every 10^{th} sample). The CCV should be within 90-110% of the expected concentration.

6.7. Initial Calibration Blank (ICB): A volume of reagent water treated in the same manner as the calibration standards. It is used to check carryovers and contamination. It is run after the initial calibration and should be below the reporting limit of the method.

6.8. Continuing Calibration Blank (CCB): A volume of reagent water treated in the same manner as the calibration standards. It is used to check carryovers and contamination. The CCB is analyzed at the beginning and end of a sample run, and periodically during a run (after every 10^{th} sample). It should be below the reporting limit of the method.

6.9. Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is to be carried through the complete sample preparation and analytical procedure. It is used to assess contamination resulting from the analytical process. A minimum of one method blank must be included with each set of 20 or fewer samples.

6.10. Laboratory Control Sample (LCS): An aliquot of laboratory reagent blank to which known quantities of the method analytes are added in the laboratory. The LCS is to be carried through the complete sample preparation and analytical procedure and is used to evaluate ongoing laboratory performance and analyte recovery in a clean matrix. A minimum of one LCS must be included with each set of 20 or fewer samples.

6.11. Matrix Spike (MS): An aliquot of environmental sample to which known quantities of the method analytes are added in the laboratory. The addition occurs prior to sample preparation and analysis. The spiking volume should be limited to 5% or less of the sample volume. The MS is to

be carried through the complete sample preparation and analytical procedure and is used to determine whether the sample matrix contributes any bias to the analytical results. A minimum of one MS must be included with each set of 20 or fewer samples.

The background concentration of the analytes in the sample matrix must be determined in a separate aliquot of sample and the measured value in the MS corrected for the background concentration. Through this, the recovery of the spiked analytes can be determined and matrix bias, if any, can be observed.

6.12. Matrix Spike Duplicate (MSD): A duplicate of the Matrix Spike used to determine the precision and bias of a method in a given sample matrix. A minimum of one MSD must be included with each set of 120 or fewer samples.

6.13. Duplicate (DUP): A randomly-selected or client-assigned sample that is processed through the entire sample preparation and analytical procedure twice. Analysis of the sample duplicate can indicate precision associated with the laboratory procedures by removing variations contributed by sample collection, preservation, and storage procedures. For clients that require a duplicate to be analyzed, a minimum of one DUP must be included with each set of 20 or fewer samples.

7.0 INTERFERENCES

7.1. Interferences co-extracted from the samples will vary considerably from matrix to matrix. While general cleanup techniques are referenced or provided as part of this method, unique samples may require additional cleanup approaches to achieve desired degrees of discrimination and quantitation. Sources of interference in this method can be grouped into three broad categories:

7.1.1. Contaminated solvents, reagents, or sample processing hardware.

7.1.2. Contaminated GC carrier gas, parts, column surfaces, or detector surfaces.

7.1.3. Compounds extracted from the sample matrix to which the detector will respond.

7.2. Interferences by phthalate esters introduced during sample preparation, or sample matrix can pose a major problem in PCB determinations.

7.2.1. Common flexible plastics contain varying amounts of phthalate esters which are easily extracted or leached from such materials during laboratory operations. Interferences from phthalate esters can best be minimized by avoiding contact with any plastic materials and checking all solvents and reagents for phthalate contamination.

7.2.2. Exhaustive cleanup of solvents, reagents and glassware may be required to eliminate background phthalate ester contamination.

7.2.3. These materials can be removed through the use of Method 3665 (sulfuric acid/permanganate cleanup).

7.3. Cross-contamination of clean glassware routinely occurs when plastics are handled during extraction steps, especially when solvent-wetted surfaces are handled. Glassware must be scrupulously cleaned. Clean all glassware as soon as possible after use by rinsing with the last solvent used. This should be followed be detergent washing with hot water, and rinses with tap

water and organic-free reagent water. Drain the glassware, and dry it in an oven at 130°C for several hours, or rinse with methanol and drain. Store dry glassware in a clean environment.

NOTE: Oven-drying of glassware used for PCB analysis can increase contamination because PCBs are readily volatilized in the oven and spread to other glassware. Therefore, exercise caution, and do not dry glassware from samples containing high concentrations of PCBs with glassware that may be used for trace analyses.

7.4. Elemental sulfur (S8) is readily extracted from soil samples and may cause chromatographic interferences in the determination of PCBs. Sulfur can be removed through the use of Method 3660.

7.5. Solvents, reagents, glassware, and other sample processing hardware must be demonstrated to be free from interferences under the conditions of the analysis by running method blanks. Before processing any samples, it should be demonstrated daily, through the analysis of a method blank, that the entire system is interference free.

8.0 SAFETY

8.1. Assume all samples contain hazardous and/ or potentially toxic materials; lab coat, gloves and safety glasses should be worn at all times while handling samples.

8.2. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical compound must be treated as a potential health hazard. Accordingly, exposure to these chemicals must be reduced to the lowest possible level. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of material safety sheets (MSDS) should also be made available to all personnel involved in the chemical analysis. Detail refers to Enthalpy Analytical Safety Manual.

8.3. PCBs have been classified as known human or mammalian carcinogens. Primary standards of these toxic compounds should be prepared in a hood. A NIOSH/MESA approved toxic gas respirator should be worn when the analyst handles high concentrations of these toxic compounds

9.0 EQUIPMENT AND SUPPLIES

9.1. Equipment:

9.1.1. Gas Chromatography: Agilent 7890B GC with dual ECD.

GC Setting and Temperature program:

- Injection port: 220C
- Injection volume: 1ul
- Oven temp program: 110°C hold for 1 min
  110°C to 220°C at 30°C/min
  220°C to 230°C at 7°C/min hold for 3 min
  230°C to 300°C at 30°C/min (hold 4 min)
- Carrier Gas: Nitrogen (He optional)
- Column flow rate: 1.2 ml/min
- ECD detectors: 300°C

9.1.2. Columns: A Restek Rtx CLPesticides 1&2 (30m, 0.25mm, 0.25um) dual column with "leak-free Y" or equivalent.

9.1.3. Workstation: EZ Chrom Software or MS Chemstation

9.2. Other Equipment:

9.2.1. Temperature controlled water bath: Capable of temperature control at 50 ±5 °C. The water bath should be used in the hood.

9.2.2. Extraction Apparatus:

9.2.2.1. Water samples: A 1000 ml separatory funnel (EPA 3510)

9.2.2.2. Solid waste: The Cole-Palmer Ultrasonic Homogenizer, Series 4710 (EPA 3550A). Pressurized Fluid Extraction with Dionex ASE 200 and 250.

9.2.3. Volumetric pipettes: Appropriate sizes with ground glass stoppers, class A glass.

9.2.4. Volumetric flasks: Class A glass, appropriate sizes, 10 mL, 100 mL, and 1.0 L

9.2.5. KD or Zymark Turbovac II Concentrators.

9.2.6. GC Vials.

9.2.7. Pasteur pipette.

9.2.8. Graduated cylinders – Appropriate sizes

9.2.9. Micro-syringes: 10 µL, 100 µL, 250 µL, 500 µL

9.2.10. Beakers: 100 mL, 250 mL, 500 mL

9.2.11. pH Paper – wide range

9.2.12. Balances

9.2.12.1. Analytical, capable of accurately weighing ± 0.0001 g

9.2.12.2. Top-loading balance capable of weighing 100 g ± 0.01 g

10.0 REAGENTS AND STANDARDS

10.1. Reagents:

10.1.1. Reagent grade or pesticide grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

NOTE: Store the standard solutions (stock, composite, calibration, internal, and surrogate) at 4C in polytetrafluoroethylene (PTFE)-sealed containers in the dark. When standards are prepared in high volume, it is recommended that aliquots of that lot be stored in individual small vials. All stock standard solutions must be replaced after one year or sooner if routine QC tests indicate a problem. All other standard solutions must be replaced after six months or sooner if routine QC indicates a problem.

10.1.2. Sample extracts prepared by Methods 3510, 3520, 3540, 3545, or 3550 need to undergo a solvent exchange step prior to analysis. The following solvents are necessary for dilution of sample extracts. All solvent lots should be pesticide quality or equivalent and should be determined to be phthalate-free.

10.1.2.1. N-Hexane, C_6H_{14}

10.1.2.2. (Optional) Iso-Octane, $(CH_3)_3CCH_2CH(CH_3)_2$

10.1.3. The following solvents may be necessary for the preparation of standards. All solvent lots must be pesticide quality or equivalent and should be determined to be phthalate-free.

10.1.3.1. Acetone, $(CH_3)_2CO$

10.1.3.2. Toluene, $C_6H_5CH_3$

10.1.4. Organic-free reagent water – All references to water in this method refer to organic-free reagent water. The quality of reagent water refers to the SOP of Reagent Water Monitoring.

10.2. Standards:

10.2.1. Stock standard solutions (500 ng/mL) – May be prepared from pure standard materials or can be purchased as certified solutions:

10.2.1.1. Prepare stock standard solutions by accurately weighing about 0.010 g of pure compound. Dissolve the compound in hexane (or Isooctane) and dilute to volume in a 10mL volumetric flask. If compound purity is 96 percent or greater, the weight can be used without correction to calculate the concentration of the stock standard solution. Commercially prepared stock standard solutions can be used at any concentration if they are certified by the manufacturer or by an independent source.

10.2.1.2. Commercially prepared stock standard solutions can be used at any concentration if they are certified by the manufacturer or by an independent source.

10.2.2. Calibration standards for Aroclors:

10.2.2.1. A standard containing a mixture of Aroclor 1016 and Aroclor 1260 will include many of the peaks represented in the other five Aroclor mixtures. As a result, a multi-point initial calibration employing a mixture of Aroclors 1016 and 1260 at five to seven concentrations should be sufficient to demonstrate the linearity of the detector response without the necessity of performing initial calibrations for

each of the seven Aroclors. In addition, such a mixture can be used as a standard to demonstrate that a sample does not contain peaks that represent any one of the Aroclors. This standard can also be used to determine the concentrations of either Aroclor 1016 or Aroclor 1260, should they be present in a sample. Prepare or purchase a minimum of five calibration standards containing equal concentrations of both Aroclor 1016 and Aroclor 1260 by dilution of the stock standard with hexane. The concentrations should correspond to the expected range of concentrations found in real samples and should bracket the linear range of the detector. The suggested range for these concentrations is 50 ng/mL to 1000 ng/mL.

10.2.2.2. Single standards of each of the other seven Aroclors are required to aid the analyst in pattern recognition. Assuming that the Aroclor 1016/1260 standards described in Sec. 10.2.2.1 have been used to demonstrate the linearity of the detector, these single standards of the remaining five Aroclors are also used to determine the calibration factor for each Aroclor. Prepare a standard for each of the other Aroclors. The concentrations should correspond to the mid-point, 500 ppb, of the linear range of the detector.

10.2.3. Surrogate standards:

10.2.3.1. When PCBs are to be determined as Aroclors, decachlorobiphenyl is used as a surrogate, and is added to each sample prior to extraction. Prepare a solution of decachlorobiphenyl at a concentration of 200 ng/mL in acetone.

10.2.3.2. When PCB congeners are to be determined, decachlorobiphenyl is recommended for use and a mixed solution of Tetrachlor-meta-xylene (TCMX) and Decachlorobiphenyl (200 ng/mL) each can be used.

10.2.4. Storage of Standard Solutions**:**

10.2.4.1. Store the stock standards in Teflon-sealed screw-cap bottles at 10°C or lower and protect the standards from light.

10.2.4.2. Store secondary dilution standards in Teflon-sealed screw-cap bottles with minimal head space at 10°C or lower, and protect the standards from light. The secondary dilution standards must be checked frequently for signs of degradation or evaporation, especially just prior to preparing working standards from them.

10.2.4.3. Standards must be brought to room temperature prior to analysis, checked for losses, and check that all components have remained in the solution.

10.2.5. Documentation of Standards:

10.2.5.1. The date when standards was received and opened is recorded on the standard container**.**

10.2.5.2. When standards are prepared, the following information is recorded in the Standard Preparation Notebook: Standard source and lot number, identity of compound or compounds, date prepared, expiration date, and initials of the

preparer. Assign a code number to all standards for traceability. Refer to SOP J-0011 for detail.

11.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

11.1. Bottles: 1 L amber glass bottles with a PTFE lined lid.

11.2. Preservation:

11.2.1. Chemical Preservation: None

11.2.2. Thermal Preservation: Samples must be chilled to 0-6°C after collection and maintained at that temperature until analysis. Field samples that will not be received at the laboratory on the day of collection must be packaged for shipment with sufficient ice to ensure that they will arrive at the laboratory with a substantial about of ice remaining in the cooler.

11.3. Holding Time:

11.3.1. Samples: 7 days

11.4. Extracts: 40 days (must be stored in the dark at -10C° or below.

12.0 QUALITY CONTROL (**Including data assessment and acceptance criteria for QC measures & corrective actions and contingencies for unacceptable data**):

Blanks, duplicates and matrix spike/matrix spike duplicates must be analyzed at a minimum of once for every batch of samples or each type of matrix or every 20 samples whichever is more frequent.

12.1. **Method Blank:**

12.1.1. The concentration of each target compound found in the blanks must be less the reporting limit for that compound.

12.1.2. If the blank exceeds the reporting limits, investigate the source of contamination and appropriate corrective measures must be taken and documented before further analyses proceeds. Reanalyze the blank. If the blank fails after reanalysis, re-prepare the batch, if possible. Otherwise, flag the data as having laboratory contamination. Data will not need this qualifier if the target analyte(s) in question are ND in the client sample.

12.2. **Laboratory Control Sample (LCS):**

12.2.1. The LCS spiking solution must consist of at least one Aroclor of interests (table 2) and must be from a second source:

12.2.2. LCS recovery limits are 75-125% for water samples and 70-130% for solid samples.

12.2.3. If the percent recoveries are outside the limits, terminate the analysis, correct the problem and re-analyze all samples associated with that LCS. If the reanalysis for the LCS still falls outside of recovery limits, re-prepare the batch, if possible. Otherwise,

flag the data as estimated due to the LCS failure. Data will not need this qualifier if the LCS recovery exceeds the upper limit and the sample is ND.

12.2.4. Matrix Spike/Matrix Spike Duplicate (MS/MSD):

12.2.4.1. Recovery limits for matrix spike/matrix spike duplicate are provided in the table below: (will be updated with in-house control limits)

Table 3

Matrix Spike Recovery and Relative Percent Difference Limits		
Compound	**% Recovery (Water)**	**RPD (Water)**
Aroclor 1016	70-130	30
Aroclor 1221	70-130	30
Aroclor 1232	70-130	30
Aroclor 1242	70-130	30
Aroclor 1248	70-130	30
Aroclor 1254	70-130	30
Aroclor 1260	70-130	30
Aroclor 1262	70-130	30
Aroclor 1268	70-130	30

12.2.4.2. Any MS/MSD that does not meet the acceptance criteria must be reanalyzed. If still outside the limits, and the LCS recoveries are acceptable, there is a possibility of a matrix interference.

12.3. Surrogate recoveries:

12.3.1. Percent recovery limits for surrogate compounds are provided in the table below: (will be updated with in-house control limits)

Table 4

Surrogate Recovery Limits	
Spike Compound	**Recovery Limits**
Tetrachlor-meta-xylene (TCMX)	70-145
Decachlorobiphenyl	70-145

12.3.2. If recovery is not within limits, the following procedures are required:

12.3.2.1. Check to be sure that there are no errors in the calculations, surrogate solutions or internal standards. If errors are found recalculate the data accordingly.

12.3.2.2. Check instrument performance. If an instrument performance problem is identified, correct the problem and re-analyze the extract.

12.3.2.3. If no problem is found, re-extract and re-analyzed the sample.

12.3.2.4. If, upon re-analysis, the recovery is again not within limits, flag the data.

12.4. Control Charts

12.4.1. Twenty to thirty data points (LCS, MS/MSD), Surrogate Recoveries must be generated before control charts can be constructed and control limits established. During the time prior to accumulation the required number of points, method-specific control limits or reasonable limits from another reference source should be used.

12.4.2. Control charts are generated using excel spreadsheet or LIMS. The data are either generated automatically or entered manually.

12.4.3. The central value, standard deviation, warning and control limits are calculated and the chart generated by the components.

12.4.3.1. Warning Limit (LWL/UWL): Avg % Rec ± 2 SD.

12.4.3.2. Control Limit (LCL/UCL): Avg % Rec ± 3 SD

12.4.4. RPD Chart:

12.4.4.1. Baseline = 0

12.4.4.2. Warning Limit = 2.456 x Avg RPD

12.4.4.3. Control Limit = 3.27 x Avg RPD

12.4.5. Recovery and RPD control limits must be equal or more stringent than the method specified control limits if applicable.

12.4.6. Following data reduction, the analysis shall enter calculated recoveries and RPDs on appropriate control charts and compare the current batch QC to established control limits. If the calculated values fall within control limits, the analysis is deemed acceptable. If either the recovery or RPD falls outside control limits, corrective action must be performed. This may include reviewing calculations, re-analyzing the LCS extract, and/or re-analyzing the sample batch.

12.4.7. The frequency at which control charts are updated is dependent on the software employed. Ideally, charts should be updated after each point this entered. However, updating control charts should be done at least after entry of twenty data points. The updating of control charts will depend on the analysis frequency and will be every twenty data points or monthly, whichever occurs first. Previous data points will be included in recalculations unless a significant change, such as method alteration, instrument reconfiguration or reagent use, has occurred.

12.4.8. The appropriate supervisor is responsible for reviewing control charts for potential problems. Charts will be observed for any patterns which may be indicative of systematic errors (e.g., cyclic patterns). Trends that are to be monitored include:

12.4.8.1. Two consecutive points outside warning limits

12.4.8.2. Seven consecutive points above average line

12.4.8.3. Seven consecutive points below average line

12.4.8.4. Five consecutive point trend upward

12.4.8.5. Five consecutive point trend downward

12.4.9. A Corrective Action Report is to be initiated for any of the above trends noted.

12.4.10. All Corrective Action Reports and corrective actions are to be kept with the appropriate control charts. Copies will be forwarded to the QA Officer for tracking purposes.

13.0 CALIBRATION AND STANDARDIZATION

13.1. Preparation of calibration mixtures.

13.1.1. Initial calibration consists of injecting each of six solutions containing:

- Aroclor 1016, Aroclor 1260

- the two surrogates tetrachloro-*meta*-xylene (TCMX) and decachlorobiphenyl (DCB) at a range of concentrations.

- These six solutions are purchased from AccuStandard (Part Number C/216/260-CAL-SET) as solutions in hexane or *iso*-octane containing the analytes in the concentrations shown below in the table 5. This standard procedure may be altered in several ways. Other calibration ranges may be chosen, calibration standards may be prepared from stock solutions instead of purchasing them, other Aroclors may be used, a different number of calibration points may be used, etc. Once choices are made, the calibration range should be chosen to extend from a lowest concentration that represents a reasonable quantitation limit to a highest concentration that is near the high end of the detector's linear response range.

Table 5

Unit in **ng/mL**	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Aroclor 1016	50	100	250	500	750	1,000
Aroclor 1260	50	100	250	500	750	1,000
TCMX	10	20	50	100	150	200
DCB	10	20	50	100	150	200

13.1.2. Inject the six standard solutions in order of increasing concentration, and generate calibration curves for the two surrogates and each of the chosen Aroclor peaks. The response factor for each level is the ratio of total area count to its concentration. Average response factor **Rf** is the average of the response factor of each level. The average response factor **Rf** will then be used for calculation of concentration of unknown samples, only if %RSD for the peak is less than 20% in the initial calibration. This initial calibration may be evaluated against either a quadratic or linear model. Whether using a quadratic or linear model, the same model must be used for all peaks.

13.1.3. If using a quadratic model, choose the option in the software to ignore the origin. The response factor **Rf** is generated from a quadratic equation. The initial calibration is acceptable only if all the following criteria are met:

13.1.3.1. A minimum of six different concentrations must be included in the quadratic model.

13.1.3.2. The Coefficient of Determination (r^2) is 0.99 or greater for each of the surrogates and each Aroclor peak used for quantitation. (The analyst should round the numbers reported by the software to 2 significant figures when evaluating the acceptability of the r^2 values. In other words, any reported r^2 value greater than 0.985 is acceptable)

13.1.4. If using a linear model, the analyst may choose any of the three origin options– ignore the origin, include the origin or force the line through the origin. The response factor **Rf** is the slope of the curve. In any case, the initial calibration is acceptable only if all the following criteria are met:

13.1.4.1. A minimum of five different concentrations must be included in the model.

13.1.4.2. The Relative Standard Deviation (RSD) is 15% or less for each of the surrogates and each Aroclor peak used for quantitation. (The analyst should round the numbers reported by the software to 2 significant figures when evaluating the acceptability of the RSD values. In other words, any reported RSD value less than 15.50% is acceptable).

14.0 PROCEDURE

14.1. **Sample Preparation:**

14.1.1. Aqueous samples employ EPA 3510, or alternate method as deemed suitable by supervisor.

14.1.1.1. Mark sample level on sample container then transfer contents to a 1000mL separatory funnel or continuous extractor. Determine the original sample volume by refilling the sample bottle to the mark and transferring the water to a 1000mL graduated cylinder. Record the sample volume to the nearest 5 mL.

14.1.1.2. Pipet 0.5mL of surrogate standard [5000 ng/ml] to all samples, spikes and blanks, and 0.5mL of matrix spike solution to all spike samples in the batch.

14.1.1.3. Use Methylene Chloride for the extraction solvent for method 3510

14.1.1.4. After extraction dry the extract by passing through Sodium Sulfate.

14.1.1.5. Concentrate the extract using a Zymark Turbovap or KD apparatus to a volume of approximately 5 mL.

14.1.1.6. Solvent exchange: add approximate 5-10ml of Hexane to the extract, then blow down to 5ml of final volume with Turbo Vap.

14.1.1.7. If the sample needs no further cleanup then make up to 5 mL final volume with Hexane or Isooctane and place in vial to be stored until analysis.

14.1.2. Soil and Sediment Samples employ EPA 3545 or 3550, as deemed suitable by supervisor.

14.1.2.1. Place 10.0g homogenized and 10g of sodium sulfate into either a 100mL glass beaker or a soxhlet thimble depending upon extraction method being deployed.

14.1.2.2. Pipet 1.0 mL of surrogate standard to all samples, spikes and blanks, and 1.0 mL of matrix spike solution [5000 ng/ml] to all spike samples in the batch.

14.1.2.3. For EPA 3545, use methylene chloride as the extraction solvent.

14.1.2.4. For sonicate method (EPA 3550) using 1:1 Methylene Chloride:Acetone mix (1:1) for the extraction solvent, as deemed suitable by supervisor.

14.1.2.5. After extraction dry the extract by passing through Sodium Sulfate.

14.1.2.6. Concentrate the extract using a Zymark Turbovap or KD apparatus to a volume of approximately 5 mL.

14.1.2.7. Solvent exchange: add approximate 5-10ml of Hexane to the extract, and blow down to 5ml of final volume with Turbo Vap.

14.1.2.8. If the sample needs no further cleanup then make up to 5 mL final volume with Hexane or Isooctane and place in vial to be stored until analysis.

14.2. **Sample Clean-up:**

14.2.1. If analysis is for PCB's only, then after making extract up to the required volume perform H_2SO_4 clean-up by adding 1.5ml of concentrated H_2SO_4, and shaking extract in vial. Several applications may be required for dirty samples by removing the previous acid layer with a pipette and adding clean acid. When extract is sufficiently clean remove acid layer and wash extract with reagent water. Submit extract for analysis or for further clean-up using Florisil column.

14.2.2. If analysis is for pesticides and PCB's the perform Florisil clean-up as follows:

14.2.2.1. Rinse and condition the Florisil column with Hexane solvent. Drain the excess solvent off the Florisil column.

14.2.2.2. Transfer sample residue through the Florisil column.

14.2.2.3. Wash the sample residues off the Florisil column sequentially with Hexane (3 washes, approximately to 30ml)

14.2.2.4. Concentrate the sample to near dryness and make up to 10ml with Hexane or Isooctane.

14.2.2.5. If necessary a sulfur cleanup may be performed by adding approximately 0.5 gm copper to the extract, shaking vigorously and allowing to settle.

14.3. **GC Analysis of Sample Extracts:**

14.3.1. The same GC operating conditions used for the initial calibration must be employed for sample analyses.

14.3.2. Values above the calibration range are not valid and may not be reported. Any values below the DLR but above the MDL maybe reported, at the analyst's discretion, as "J" values.

14.3.3. To quantitate Aroclor 1016 or Aroclor 1260, select three to five peaks in the Aroclor pattern and calculate the average of the concentrations reported for each of the chosen peaks in the Aroclor pattern of the sample.

14.3.4. For cases involving a limited number of samples containing Aroclors other than 1016 or 1260, it may be preferable to quantitate the Aroclors by performing single-point calibrations against Aroclor standards rather than performing a complete calibration. The Aroclor concentration in the standard must be 80% to 120% of the Aroclor concentration in the sample. Dilute the sample appropriately in order to meet this criterion for relative concentrations.

14.3.5. Alternatively, calibration curves may be generated for any of the other Aroclors, in a manner similar to the procedure described for Aroclors 1016/1260. Similar six-point calibration sets are commercially available for Aroclors 1221, 1232, 1242, 1248 and 1254. This approach is recommended for cases in which a large number of samples contain one or more Aroclors other than Aroclors 1016/1260.

14.3.6. Verify calibration each 12-hour shift by injecting calibration verification standards prior to conducting any sample analyses. A calibration standard must also be injected at intervals of not less than once every twenty samples (after every 10 samples is recommended to minimize the number of samples requiring re-injection when QC limits are exceeded) and at the end of the analysis sequence. For Aroclor analyses, the calibration verification standard should be a mixture of Aroclor 1016 and Aroclor 1260. The calibration verification process does not require analysis of the other Aroclor standards used for pattern recognition, but the analyst may wish to include a standard from one of these Aroclors after the 1016/1260 mixture used for calibration verification throughout the analytical sequence.

14.3.7. Qualitative identifications of target analytes are made by examination of the sample chromatograms, as described in Section 15.1.

14.3.8. Quantitative results are determined for each identified analyte (Aroclors or congeners), using the procedures described in Section 15.1for either the internal of the external calibration procedure. If the responses in the sample chromatogram exceed the calibration range of the system, dilute the extract and reanalyze. Peak height measurements are recommended over peak area when overlapping peaks cause errors in area integration.

14.3.9. Each sample analysis must be bracketed with an acceptable initial calibration, calibration verification standard(s) (each 12-hour shift), or calibration standards interspersed within the samples. When a calibration verification standard fails to meet the QC criteria, all samples that were injected after the last standard that last met the QC criteria must be re-analyzed. Multi-level standards (mixtures or multi-component analytes) are highly recommended to ensure that detector response remains stable for all analytes over the calibration range.

14.3.10. Sample injections may continue for as long as the calibration verification standards and standards interspersed with the samples meet instrument QC requirement. It is recommended that standards be analyzed after every 10 samples (required after every 20 samples and at the end of a set) to minimize the number of samples that must be re-injected when the standards fail the QC limits. The sequence ends when the set of samples has been injected or when qualitative or quantitative QC criteria are exceeded.

14.3.11. If the peak response is less than 2.5 times the baseline noise level, the validity of the quantitative result may be questionable.

14.3.12. Use the calibration standards analyzed during the sequence to evaluate retention time stability. If any of the standards fall outside their daily retention time windows, the system is out of control. Determine the cause of the problem and correct it.

14.3.13. If compound identification or quantitation is precluded due to interference (e.g., broad, rounded peaks or ill-defined baselines are present) cleanup of the extract or replacement of the capillary column or detector is warranted. Rerun the sample on another instrument to determine if the problem results from analytical hardware or the sample matrix.

15.0 CALCULATIONS

15.1. Qualitative identification:

15.1.1. Identification of Aroclors other than Aroclor 1016/1260 is accomplished by observing potential Aroclor patterns on GC column and comparing them to chromatograms of the Aroclor standards obtained under identical GC conditions. The presence of a suspected Aroclor should be confirmed by analyzing standards of the Aroclor at concentrations that are similar to the sample's concentration and comparing the chromatographic patterns, both for general shape and specific details of retention times, relative peak heights, etc.

15.2. Quantitation of PCBs as Aroclors:

15.2.1. The quantitation of PCB residues as Aroclors is accomplished by comparison of the sample chromatogram to that of the most similar Aroclor standard. A choice must be made as to which Aroclor is most similar to that the residue and whether that standard is truly representative of the PCBs in the sample.

15.2.2. Use the individual Aroclor standards (not the 1016/1260 mixtures) to determine the pattern of peaks on Aroclors 1221, 1232, 1242, 1248, and 1254. The patterns for Aroclors 1016 and 1260 will be evident in the mixed calibration standards.

15.2.3. Once the Aroclor pattern has been identified, compare the responses of 3 to 5 major peaks in the single-point calibration standard for that Aroclor with the peaks observed in the sample extract. The amount of Aroclor is calculated using the individual calibration factor for each of the 3 to 5 characteristic peaks chosen and the calibration model (linear or non-linear) established from the multi-point calibration of the 1016/1260 mixture. A concentration is determined using each of the characteristic peaks and then those 3 to 5 concentrations are averaged to determine the concentration of that Aroclor.

15.2.4. Weathering of PCBs in the environment and changes resulting from waste treatment processes may alter the PCBs to the point that the pattern of a specific Aroclor is no longer recognizable. Samples containing more than one Aroclor present similar problems. If the purpose of the analysis is not regulatory compliance monitoring on the basis of Aroclor concentrations, then it may be more appropriate to perform the analyses using the PCB congener approach described in this method. If results in terms of Aroclors are required, then the quantitation as Aroclors may be performed by measuring the total area of the PCB pattern and quantitating on the basis of the Aroclor standard that is most similar to the sample. Any peaks that are not identifiable as PCBs on the basis of retention times should be subtracted from the total area. When quantitation is performed in this manner, the problems should be fully described for the data user and the specific procedures employed by the analyst should be thoroughly documented.

15.3. Confirmation:

15.3.1. Second column is used for results confirmation

Refer to section 13.1.2 for Rf calculation:

Concentration (µg/L) $C_x = (D1)(D2)(A_x) / (Rf_x)$

Where:

A_x	=	Response for the analyte in the sample, units maybe in area counts or peak height.
D1	=	Extraction Dilution Factor.
D2	=	Dilution factor, if dilution was made on the sample prior to analysis. If no dilution was made, D2 = 1, dimensionless.
Rf_x	=	Response factor for the analyte x calculated from section 13.1.2

16.0 METHOD PERFORMANCE

16.1. Method performance is monitored on a continuous basis through the use of Laboratory Control Samples, Method Blanks, Matrix Spikes, and Sample Duplicates.

17.0 POLLUTION PREVENTION

17.1. The EPA has established guidelines of environmental management techniques to institute pollution prevention in the workplace. Whenever feasible, laboratory personnel use pollution prevention techniques to address their waste generation and minimize pollution resulting from any laboratory activity.

18.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QUALITY CONTROL MEASURES

18.1. Refer to Section: 12.0 Quality Control

19.0 CORRECTIVE ACTIONS FOR OUT-OF-CONTROL DATA

19.1. A Non-Conformance Document (NCD) form must be filled out if there is any out-of control data. Refer to Section 12.0 Quality Control for control limits.

20.0 CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1. Refer to Section: 12.0 Quality Control

21.0 WASTE MANAGEMENT

21.1. Hazardous wastes generated are properly disposed of in accordance to existing federal and state regulations. For details, refer to SOP - Laboratory Hazardous Waste Disposal (J-0010).

22.0 REFERENCES

22.1. SW-846, 3rd Edition, Method 8000 & 8082.

23.0 ATTACHMENTS

23.1. None

24.0 DOCUMENT REVISION HISTORY

Date	Description of Revision
June 3, 2005	• Revised from February 2005 by adding reference SOP, Method Detection limit and DLR to Detection Limit section and reference to SOP to Waste Management Section.
Jan 24, 2013	• Revised from 2012 SOP by updating the QC limits and Section VII
Oct 27, 2016	• Update entire SOP to TNI format • Update Quality control and Procedure section.

ENTHALPY ANALYTICAL

931 W. Barkley Ave
Orange, CA 92868

STANDARD OPERATING PROCEDURE

SEMI-VOLATILE ORGANIC COMPOUNDS BY GAS CHROMATOGRAPHY / MASS SPECTROMETRY (GC/MS)

EPA 8270C
EPA 625

SOP Number:	H-0015		
Prepared By:	Brian Built	Revision:	2.0
Effective Date:	12/31/2017	Supersedes:	1.0

Department Manager Approval: _____ Date: 12/27/17
Brian Built

Technical Director Approval: _____ Date: 12/27/2017
Hongling Cao

QA Director Approval: _____ Date: 12/27/17
Clifford Baldridge

1 SCOPE AND APPLICATION:

1.1 Method 8270 is used to determine the concentration of semivolatile organic compounds in extracts prepared from various types of solid waste, soil and water matrices. Direct injection of a sample may be used in limited applications.

1.1 Method 8270 can be used to quantitate most neutral, acidic, and basic organic compounds that are soluble in methylene chloride and capable of being eluted, without derivatization, as sharp peaks from a gas chromatographic fused-silica capillary column coated with a slightly polar silicone. Such compounds include polynuclear aromatic hydrocarbons, chlorinated hydrocarbons and pesticides, phthalate esters, organophosphate esters, nitrosamines, haloethers, aldehydes, ethers, ketones, anilines, pyridines, quinolines, aromatic nitro compounds, and phenols, including nitrophenols. In most cases, Method 8270 is not appropriate for the quantitation of multicomponent analytes, e.g., Aroclors, Toxaphene, Chlordane, etc., because of limited sensitivity for those analytes. When these analytes have been identified by another technique, Method 8270 is appropriate for confirmation of the presence of these analytes when concentration in the extract permits.

1.2 The following compounds may require special treatment when being determined by this method:

1.3.1 Benzidine may be subject to oxidative losses during solvent concentration and its chromatographic behavior is poor.

1.3.2 Under the alkaline conditions of the extraction step from aqueous matrices, a-BHC, y-BHC, Endosulfan I and II, and Endrin are subject to decomposition. Neutral extraction should be performed if these compounds are expected.

1.3.3 Hexachlorocyclopentadiene is subject to thermal decomposition in the inlet of the gas chromatograph, chemical reaction in acetone solution, and photochemical decomposition.

1.3.4 N-Nitrosodimethylamine is difficult to separate from the solvent under the chromatographic conditions described.

1.3.5 N-Nitrosodiphenylamine decomposes in the gas chromatographic inlet and cannot be separated from Diphenylamine.

1.3.6 Pentachlorophenol, 2,4-Dinitrophenol, 4-Nitrophenol, Benzoic acid, 4,6-Dinitro-2-methylphenol, 4-Chloro-3-methylphenol, 2-Nitroaniline, 3-Nitroaniline, 4-Chloroaniline, and Benzyl alcohol are subject to erratic chromatographic behavior, especially if the GC system is contaminated with high boiling material.

1.3.7 Pyridine may perform poorly at the GC injection port temperatures listed in the method. Lowering the injection port temperature may reduce the amount of degradation. The analyst needs to use caution if modifying the injection port temperature as the performance of other analytes may be adversely affected.

1.3.8 Toluene diisocyanate rapidly hydrolyses in water (half-life of less than 30 min.). Therefore, recoveries of this compound from aqueous matrices should not be expected. In addition, in solid matrices, Toluene diisocyanate often reacts with alcohols and amines to produce urethane and ureas and consequently cannot usually coexist in a solution containing these materials.

1.4 The Reporting Limit (RL) of Method 8270 for determining an individual compound is approximately 250µg/kg (wet weight) for soil/sediment samples, 1-200 mg/kg for wastes (dependent on matrix and method of preparation), and 10µg/L for ground water samples. RLs will be proportionally higher for sample extracts that require dilution to avoid saturation of the detector. RLs will be proportionally higher for limited sample volume or low-density sample weights.

1.5 This method is restricted to use by or under the supervision of analysts experienced in the use of gas chromatograph/mass spectrometers and skilled in the interpretation of mass spectra. Each analyst must demonstrate the ability to generate acceptable results with this method.

2 SUMMARY OF METHOD:

2.1 A measured volume or weight of sample (approximately 1000 mL for liquids, 20g for solids) is extracted using the appropriate matrix-specific sample extraction technique. Adjusted final extract volumes are not recommended due to potential loss of phenols and lighter constituents during the concentration step, but may be necessary due to complex matrix.

2.2 Liquid samples are extracted using Method 3510 (separatory funnel). Solid samples are extracted using Method 3545 (Pressurized Fluid Extraction or PFE) or Method 3550 (ultrasonic extraction).

2.3 A variety of cleanup steps may be applied to the extract, depending on the nature of the matrix interferences and the target analytes. Suggested cleanups include alumina (Method 3610), Florisil (Method 3620), silica gel (Method 3630), gel permeation chromatography (Method 3640), and sulfur (Method 3660).

2.4 After cleanup, the extract is concentrated and analyzed by injecting anywhere from 1.0 to 4µL (i.e. consistent with the amount injected for the calibration standards and daily) of sample into a GC/MS.

3 DETECTION LIMIT:

3.1 Detection limits are continuously updated on an annual basis, or more often as needed, and are tracked using a separate system.

3.2 The current Reporting Limit (RL) and Method Detection Limit (MDL) are updated in LIMS. Refer to annual MDL study for current MDL and RDL. An example of MDL and RDL is attached in Appendix I.

3.3 Refer to QA manual for "Determination and Updating of MDL/RL Detection Limits."

4 DEFINITIONS:

4.1 Special terms are defined the first time they appear in the text. For additional clarification of terms, refer to SW-846 Method 8270C.

5 INTERFERENCES:

5.1 Contaminants in solvents, reagents, glassware, and other sample processing hardware may cause method interferences such as discrete artifacts and/or elevated baselines in the Extracted Ion Current Profiles (EICPs). All of these materials routinely must be demonstrated to be free from interferences under the conditions of the analysis by running laboratory method blanks. Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source.

5.2 Contamination by carryover can occur whenever high-concentration and low-concentration samples are sequentially analyzed. To reduce carryover, the sample syringe must be rinsed out between samples with solvent. Questionable or low-level hits in an extract analyzed after a high concentration extract with the same analytes should be confirmed with re-analysis.

6 SAFETY:

6.1 Each laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of chemicals specified in this method. A reference file of Material Safety Data Sheets (SDS) should be made available to all personnel involved in the chemical analysis.

7 APPARATUS AND EQUIPMENT:

7.1 Gas Chromatograph / Mass Spectrometer (GC/MS) System:

7.1.1 Analysis and quantitation for this method requires a properly equipped gas chromatograph / mass spectrometer (GC/MS) System. The primary GC/MS systems at Enthalpy Analytical are several Agilent 5977B Gas Chromatograph/Mass Spectrometer (GC/MS) System. The system consists of Agilent 7890B gas chromatograph equipped with a 7693 auto-sampler, connected to a 5977B MSD. The GC is equipped with a 30 meter HP-5ms column, 0.25mm ID and a coating thickness of 0.25µm.

7.1.1.1 GC/MS Computer Operating software: Agilent Masshunter version B.07.01 SP1/Build 7.1.524.1

7.1.1.2 GC Parameters:

Injector Temp: 270^{0}C Split/Splitless

Oven Program (DFTPP):
Initial: 150^{0}C, 2min hold
Ramp at 28^{0}C/min to 310^{0}C, 0.28min hold

Oven Program (SVOA):
Initial: *50^{0}C, hold 1.0 min*
Ramp at *28* ^{0}C/min to 270^{0}C, hold 0.5 min
Ramp at *3.0* ^{0}C/min to 296^{0}C, hold 0.98 mins

Alternate systems (GC/MS, columns, oven programs, etc.) may be incorporated after completion of a successful MDL study, provided all separation and Quality Control regulations can be met.

7.2 Syringe – 10µL.

7.3 Volumetric flasks, Class A - Appropriate sizes with ground glass.

7.4 See Apparatus and Materials in the appropriate SOPs for extraction equipment.

8 REAGENTS AND STANDARDS:

8.1 Reagents**:**

8.1.1 Acetone, methanol, methylene chloride – Pesticide quality or equivalent.
8.1.2 DI Water – free of contaminant.

8.2 Standards:

8.2.1 An internal standard solution of 1, 4-Dichlorobenzene-d_4, Naphthalene-d_8, Acenaphthene-d_{10}, Phenanthrene-d_{10}, Chrysene-d_{12}, and Perylene-d_{12} at 2000µg/mL is purchased from Restek (Cat #31886) and stored in Teflon lined screw cap vials. The vials are stored at 10^{0}C or less for the length of time recommended by the manufacturer. Standards are checked for concentration and degradation. Prior to analysis, each extract is spiked with internal standard solution at 20µg/mL. (e.g. a 1mL aliquot of extract undergoing analysis would be spiked with 5µL of the internal standard-4000µg/mL solution).

8.2.2 A purchased GC/MS tuning standard is used (Restek, Cat#31615). The solution contains 50µg/mL of Decafluorotriphenylphosphine (DFTPP) in methylene chloride. The standard should also contain 50µg/mL each Pentachlorophenol, Benzidine and 4,4'-DDT to verify GC column performance and degradation in injection port. (see section 10.1.2). Store at -10 to 20^{0}C or less when not being used.

8.2.3 Calibration standards are either purchased from Restek or other vendors,

which contain all compounds as illustrated in Appendix I. A 10-point calibration standard is prepared from an intermediate SVOA Mix at 200ug/ml. Refer to the following table (Restek) for details.

SV Working 10-pt Calibration

SVOA-Int-200 (200 ug/mL)				
Standard Name	**C1 (µg/mL)**	**V1 (mL)**	**V2 (mL) (Final Vol)**	**C2 (µg/mL) (Final Conc)**
8270 Mega Mix	1,000	0.50	2.5	**200**
Benzidines Mix 2	2,000	0.25		**200**
Benzoic Acid Mix	2,000	0.25		**200**
B/N Surrogate Mix	5,000	0.10		**200**
Acid Surrogate Mix	10,000	0.05		**200**
MeCl2 Balance		1.35		

Working ICAL Standard				
Standard Mix	**C1 (µg/mL)**	**V1 (mL) (Standard Vol)**	**V2 (mL) (Final Vol)**	**C2 (µg/mL) (Final Conc)**
8270_ICal-1	200	5	1.0	**1.0**
8270_ICal-2	200	10	1.0	**2.0**
8270_ICal-3	200	25	1.0	**5.0**
8270_ICal-4	200	50	1.0	**10**
8270_ICal-5	200	100	1.0	**20**
8270_ICal-6	200	200	1.0	**40**
8270_ICal-7	200	300	1.0	**60**
8270_ICal-8	200	400	1.0	**80**
8270_ICal-9	200	500	1.0	**100**
8270_Cal-10	200	600	1.0	**120**
Internal Standard	4,000	5.0	1.0	**20**

Note: Internal Standard is added to every calibration samples

8.2.4 The surrogate spiking solution contains the following compounds Nitrobenzenene-d_5, Terphenyl-d_{14} & 2-Fluorobiphenyl, Pyrene d_{10}, Phenol-d_6, 2, 4, 6-Tribromophenol & 2-Fluorophenol at concentrations of 40µg/mL. Surrogates are spiked into each extract prior to the extraction process and utilized to monitor extraction efficiency. Surrogates utilize the same calibration criteria as target analytes. The surrogate stock solutions are

purchased (Restek, cat # 31888, 31063) and stored according to manufacturer's recommendations.

Surrogate Spiking Solution				
Stock Standard	C1 (ug/mL)	V1 (mL) Standard Vol	V2 (mL) Final Vol	**C2 (ug/mL) (Final Conc)**
B/N Surrogates	5,000	0.4	25	**80**
Acid Surrogates	10,000	0.2	25	**80**

8.2.5 LCS Spike Standards: A set of standards, which are purchase from other vendor such as Accustandard, Ultra Scientific, or Restek with different lot number, is used as LCS Standard. LCS Spiking solution is made from LCS Standard and also used for MS and MSD samples. The following table illustrates standard purchased from AccuStandard Inc. LCS is also used as Initial Calibration Verification (ICV), which is analyzed following the Initial Calibration Curve.

LCS Spiking Solution				
Stock Standard	C1 (ug/mL)	V1 (mL) Standard Vol	V2 (mL) Final Vol	**C2 (ug/mL) (Final Conc)**
8270 LCS Stock	1,000	0.8	10	**80**
Benzidines	2,000	0.4	10	**80**
Benzoic Acid	2,000	0.4	10	**80**

ICV Standard (20 ug/mL)				
Standard Name	**C1 (µg/mL)**	**V1 (uL)**	**V2 (uL) (Final Vol)**	**C2 (µg/mL) (Final Conc)**
8270 Mega Mix	1,000	10	500	**20**
Benzidines Mix 2	2,000	5.0		**20**
Benzoic Acid Mix	2,000	5.0		**20**
B/N Surrogate Mix	5,000	2.0		**20**
Acid Surrogate Mix	10,000	1.0		**20**
IS Stock Standard	4,000	2.5		**20**
MeCl2 Balance		464.5		

8.2.6 Documentation of Standards

8.2.6.1 The date when standards are received and opened is recorded on the containers of the standards and in respective standard logbooks. Subsequent dilutions are recorded accordingly.

9 SAMPLE CONTAINER, PRESERVATION, AND STORAGE:

9.1 Samples must be protected from light and refrigerated at 4 ^{0}C $\pm$ 2 ^{0}C.

9.2 Samples extracts are stored at 10 degrees C or lower, protected from light, in sealed vials equipped with unpierced PTFE - lined septa.

9.3 Holding times – Water samples must be extracted within 7 days of collection and extracts analyzed within 40 days of extraction. Soil samples must be extracted within 14 days of collection.

`

10 CALIBRATION:

10.1 GC/MS Performance Test:

10.1.1 At the beginning of each 12-hour inject an aliquot of standard solution containing 50ng/µL of Decafluorotriphenylphosphine (DFTPP). The mass spectrum of DFTPP must meet the following criteria:

DFTPP Key Ions and Ion Abundance Criteria[a]

Mass	Ion Abundance Criteria
51	30-60% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	40-60% of mass 198
197	<1% of mass 198
198	Base peak, 100% relative abundance
199	5-9% of mass 198
275	10-30% of mass 198
365	>1% of mass 198
441	Present but less than mass 443
442	>40% of mass 198
443	17-23% of mass 442

Notes:
a) Alternate tuning criteria may be used (e.g. CLP, Method 525, or manufacturers' instructions), provided that method performance is not adversely affected.

10.1.2 The GC/MS tuning standard is also used to assess GC column performance and injection port inertness. The tailing factor must be less than 3.0 for 100ng of Benzidine. The tailing factor must be less than 5.0 for 50 ng of Pentachlorophenol.

10.1.3 Once the DFTPP passes, the daily or initial calibration is analyzed. Any set of extracts may resume and are valid if the IS criteria are met and have been injected within 12 hours of DFTPP injection.

10.1.4 See section 7.1 for instrument conditions.

10.2 GC/MS Calibration:

10.2.1 Analyze an aliquot of each calibration standard (containing internal standards) and tabulate the area of the primary characteristic ion against concentration for each compound. Calculate response factors (RFs) for each compound relative to one of the internal standards as follows:

$$\mathbf{RF = (A_x C_{is})/(A_{is} C_x)}$$

Where:
A_x = Area of the characteristic ion for the compound being measured.
A_{is} = Area of the characteristic ion for the specific internal standard.
C_{is} = Concentration of the specific internal standard (µg/L).
C_x = Concentration of the compound being measured (µg/L).

10.2.2 **SPCCs** (System Performance Check Compounds) must have a minimum average RF of 0.05 for the initial calibration. SPCCs are defined as the following analytes: N-nitrosodi-n-propylamine, Hexachlorocyclopentadiene, 2,4-Dinitrophenol, and 4-Nitrolphenol.

10.2.3 **CCCs** (Calibration Check Compounds) must exhibit an average RF no greater than 30% for the initial calibration. CCCs are defined as the following analytes: 1,4-Dichlorobenzene, 2,4,6-Trichlorophenol, 2,4-Dichlorophenol, 2-Nitrophenol, 4-Chloro-3-methylphenol, Acenaphthene, Benzo(a)pyrene, Di-n-octyl phthalate, Diphenylamine, Fluoranthene, Hexachlorobutadiene, Pentachlorophenol and Phenol.

10.2.4 RF vs. Linear Regression. Analytes exhibiting an average RF no greater than 15% for the initial calibration should employ the average RF for quantitation purposes. Analytes exhibiting an average RF exceeding 15% should employ a linear regression fit, each R-squared value no less than 0.99.

10.2.5 Calculation of Calibration % Error: When the calibration points are calculated against themselves, the % Error should be ≤ 30% for all standards except those that are at or below the reporting limit. The % Error for points at or below the reporting limit can be as much as ≤ 50%. This calculation is performed by the data software.

10.2.6 See section 7.1 for instrument conditions.

10.3 Daily GC/MS Calibration:

10.2.1 Prior to analysis of samples, the GC/MS tuning standard must be analyzed. A 50ng injection of DFTPP must result in a mass spectrum for DFTPP, which meets the criteria given in Section 10.1.1. These criteria must be demonstrated during each 12 hour shift. The tailing factors for Benzidine and Pentachlorophenol should be less than 3 & 5, respectively.

10.2.2 **SPCCs** (System Performance Check Compounds) must have a minimum average RF of 0.05 for the daily calibration. SPCCs are defined as the following analytes: N-nitrosodi-n-propylamine, Hexachlorocyclopentadiene, 2,4-Dinitrophenol, and 4-Nitrolphenol.

10.2.3 **CCCs** (Calibration Check Compounds) must exhibit an average RF no greater than 20% RSD, CCCs are defined as the following analytes: 1,4-Dichlorobenzene, 2,4,6-Trichlorophenol, 2,4-Dichlorophenol, 2-Nitrophenol, 4-Chloro-3-methylphenol, Acenaphthene, Benzo(a)pyrene, Di-n-octyl phthalate, Diphenylamine, Fluoranthene, Hexachlorobutadiene, Pentachlorophenol and Phenol.

10.2.4 If SPCC/CCC criteria are not met, the test may be repeated using a fresh calibration standard. If this still fails, corrective actions must be applied.

10.2.5 The daily ISs are used to monitor all subsequent injection's IS, which must be 50-200% of the daily CCC's ISs.

11 PROCEDURE:

11.1 Samples are extracted by the appropriate approved method. See the appropriate SOP for more information.

11.2 Following acceptable initial calibration (see section 10.2) and/or daily calibration (see section 10.3) aliquots of each extract are spiked with internal standard (see section 8.2.3.) and analyzed utilizing the same conditions (see section 7.1) employed for standards analysis.

11.3 Data are evaluated (see section 12) for target analytes, surrogates and QC (see section 13), compiled. The results entered into the appropriate section in LIMs.

12 CALCULATIONS:

12.1 Qualitative Analysis:

12.1.1 The qualitative identification of compounds determined by this method is based on retention time, and on comparison of the sample mass spectrum, after background correction, with characteristic ions in a reference mass spectrum. The reference mass spectrum must be generated by the laboratory using the conditions of this method. The characteristic ions from the reference mass spectrum are defined to be the three ions of greatest relative intensity, or any ions over 30% relative intensity if less than three such ions occur in the reference spectrum. Compounds should be identified as present when the criteria below are met:

12.1.2 The intensities of the characteristic ions of a compound maximize in the same scan or with one scan of each other. Selection of a peak by a data system target compound search routine where the search is based on the presence of a target chromatographic peak containing ions specific for the

target compound at a compound-specific retention time will be accepted as meeting this criterion.

12.1.3 The retention time of the sample component should be within + 0.06 minutes of the daily calibration retention time for the same component. However, it is not uncommon for retention time to “float” with complex matrix, in which case, corresponding surrogate and IS retention times should be used in evaluating sample hits retention times.

12.1.4 The relative intensities of the characteristic ions agree within 30% of the relative intensities of these ions in the reference spectrum. (Example: For an ion with an abundance of 50% in the reference spectrum, the corresponding abundance in a sample spectrum can range between 20% and 80%.)

12.1.5 Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

12.1.6 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component (i.e., a broadened peak with shoulder(s) or a valley between two or more maxima), appropriate selection of analyte spectra and background spectrum is important. Examination of extracted ion current profiles or appropriate ions can aid in the selection of spectra, and in qualitative identification of compounds. When analytes co-elute (i.e., only on chromatographic peak is apparent), the identification criteria can be met, but each analyte spectrum will contain extraneous ions contributed by the co-eluting compound.

12.1.7 For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Computer generated library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Only after visual comparison of sample spectra with the nearest library searches will the mass spectral interpretation specialist assign a tentative identification. Guidelines for making tentative identification are:

12.1.7.1 Relative intensities of major ions in the reference spectrum (ions > 10% of the most abundant ion) should be present in the sample spectrum.

12.1.7.2 The relative intensities of the major ions should agree within + 20%. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30 and 70%).

12.1.7.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

12.1.7.4 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.

12.1.7.5 Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting peaks. Data system library reduction programs can sometimes create these discrepancies.

12.1 Quantitative Analysis:

12.2.2 Initial and Daily Calibration (see sections 10.2 & 10.3) must be met prior to the analysis of sample extracts.

12.2.3 When a compound has been identified, the quantitation of that compound will be based on the integrated abundance from the EICP of the primary characteristic ion and should exhibit no less than a 70% match.

12.2.4 Compute the concentration of the analyte in the sample.

12.2.4.1 The concentration of the analyte in the liquid phase of the sample is calculated using the concentration of the analyte in the extract and the volume of liquid extracted, as follows:

$$\text{Concentration in liquid } (\mu g/L) = \frac{(C_{ex} * V_{ex})}{V_o}$$

Where:

V_{ex} = extract volume, in mL.
V_o = volume of liquid extracted, in L.

12.2.4.2 The concentration of the analyte in the solid phase of the sample is calculated using the concentration of the pollutant in the extract and the weight of the solids, as follows:

$$\text{Concentration in solid } (\mu g/kg) = \frac{C_{ex} * V_{ex}}{W_s}$$

Where:

V_{ex} = extract volume, in mL
W_s = sample weight, in Kg.

12.2.4.3 Where applicable, an estimate of concentration for non-calibrated components in the sample should be made. The formula given above should be used with the following modifications: The areas Ax and Axis should be from the total ion chromatograms and the RF for the compound should be

assumed to be 1. The concentration obtained should be reported indicating (1) that the value is an estimate and (2) which internal standard was used to determine concentration. Use the nearest internal standard free of interferences.

13 QUALITY CONTROL (Including data assessment and acceptance criteria for QC measures & corrective actions and contingencies for unacceptable data):

13.1 Before processing any samples, the analyst must analyze reagent water blank to demonstrate that interferences from the analytical system and glassware are under control. Each time a set of samples or reagents are changed, reagent water blank must be processed as a safeguard against laboratory contamination.

13.2 Method Blank:

The method blank must be below the reporting level. If the blank exceeds the above limits, investigate the source of contamination and appropriate corrective measures must be taken and documented before further analysis proceeds. Reanalyze the blank.

13.3 Laboratory Control Sample (LCS):

13.3.1 The laboratory must, on an ongoing basis, spike and analyze a LCS at a frequency of a minimum of 5% of all samples to monitor and evaluate laboratory data quality.

13.3.2 The LCS spiking solution must consist at least 16 of the calibration compounds and must be from a second source. (An example of 16 LCS spiking compounds are listed in APPENDIX II). All other targeted 8270 compounds shall be included in the spike mixture and monitored over two year period.

13.3.3 LCS recovery limits and control limits are generated from a minimum of 20 LCS data points and will be updated in the LIMS and APPENDIX II.

13.3.4 If the percent recoveries of the LCS are outside the limits, determine cause as extraction or analysis, re-extract and/or re-analyze, respectively. (This includes allowable marginal exceedance (ME). One analyte is allowed in ME of LCS control limit if 16 analytes are spiked.)

13.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD):

13.4.1 The laboratory must, on an ongoing basis, spike and analyze MS/MSD at a frequency of a minimum of 5% of all samples to monitor and evaluate laboratory data quality. Matrix spike recovery limits and relative percent difference limits are provided in the LIMS.

13.4.2 If MS/MSD exhibit outside of the limits, refer to chromatography evidence and LCS for same analytes to determine whether matrix effect is the cause.

13.5 Surrogate Recovery Limits:

13.5.1 Recovery limits and control limits for surrogates are generated from a minimum of 20 data point and will be updated in LIMS and APPENDIX III.

13.5.2 If recovery is not within limits, refer to chromatography evidence to determine whether matrix effect is the cause. If no problem is found, re-extract and re-analyze the sample.

13.6 All sample extracts must be injected after a valid DFTPP and Daily Calibration verification. All extracts must be injected on a "valid clock" (12hour) and must have IS recoveries within 50-200% of the daily ISs. If failure observed, check integration and re-analyze if necessary. The second analysis yields IS failure, a matrix affect may be determined.

13.7 The experience of the analyst should weigh heavily in the interpretation of chromatography.

14 METHOD PERFORMANCE:

14.1 Method performance is monitored on a continuous basis through the use of Laboratory Control Samples, Method Blanks, Matrix Spikes, and Sample Duplicates.

15 POLLUTION PREVENTION:

15.1 The EPA has established guidelines of environmental management techniques to institute pollution prevention in the workplace. Whenever feasible, laboratory personnel use pollution prevention techniques to address their waste generation and minimize pollution resulting from any laboratory activity.

16 WASTE MANAGEMENT:

16.1 Hazardous wastes generated are properly disposed of in accordance to existing federal and state regulations.

17 REFERENCES:

17.1 CFR 40, Appendix A to Part 136, revised 7 – 1- 1988, Method 625.

17.2 CLP/SOW for Organic Analysis, Analytical Method for Semivolatiles.

17.3 EPA 8270C

17.4 EPA 8000D

18 Revision History

October 18, 2013:	4-Nitroaniline's DRL was changed from 10 to 50. On page 3, the extraction solvent was corrected to Methyl Chloride.
Dec 12, 2016:	Update all calibration prep, LCS and Surrogate working standards. Update instruments and data acquisition software.
December 2017:	Changed calibration correlation coefficient in section 10.2.4 to 0.99 Added Calculation of Calibration % Error to section 10.2.5

ENTHALPY ANALYTICAL

931 W. Barkley Ave.
Orange, CA 92868

STANDARD OPERATING PROCEDURE

METHOD 8015B/LUFT

DIESEL FUEL

SOP Number:	H-0016		
Prepared By:	Robert Clark/Clifford Baldridge	Revision:	1.0
Effective Date:	12/31/2017	Supersedes:	September 2014

Department Manager Approval: _____ Date: 12/29/17
Brian Built

Technical Director Approval: _____ Date: 12/29/17
Hongling Cao

QA Director Approval: _____ Date: 12/29/17
Clifford Baldridge

I. SCOPE AND APPLICATION:

1. This method is used for the determination of diesel fuel in soil, water, and sludges by gas chromatography. It is recommended for use by, or under the supervision of, analysts experienced in the operation of GC and in the interpretation of chromatograms.

II. SUMMARY OF METHOD:

1. This method involves the determination of diesel-range organics by a solvent extraction method (Method 3510C or 3545). A sample, after extraction, is injected into a GC, and compounds in the GC extract are detected by an FID. The sensitivity of this method usually depends on the level of interference rather than on instrument limitations.

III. DETECTION LIMITS:

Detection limits (LOD) and Reported Detection Limits (DLR) are continuously up-dated on an annual basis, or more often as needed, and are tracked using a separate system.

Refer to QA manual for "Determination and Updating of LOD/DLR Detection Limits."

IV. DEFINITIONS:

1. See Appendix 1 – Definitions

2. Some special terms may also be defined in the text that follows as they appear for the first time.

V. INTERFERENCES:

1. Solvents, reagents, glassware, and other sample-processing hardware must be demonstrated to be free from interferences under the conditions of the analysis by running method blanks. Before processing any samples, it should be demonstrated daily, through the analysis of a solvent blank, that the entire system is interference free.

2. Contamination by carryover can occur whenever high-concentration samples are analyzed in sequence. To reduce the potential for carryover, the sample syringe must be rinsed out between samples with Methylene Chloride. Solvent blank must be run after high-concentration sample to confirm that analysis will be contamination free before running samples.

VI. SAFETY:

1. Components analyzed by this method are carcinogenic. Methylene Chloride, Methanol, and Acetone are toxic and/or flammable and should be considered dangerous. Handle chemicals while wearing appropriate gear (gloves, lab coat, and safety glasses). Samples should be considered hazardous; avoid exposure, skin contact, inhalation, or ingestion.

VII. APPARATUS AND MATERIALS:

1. Methylene chloride: pesticide quality or better.

2. Various Hamilton gas tight syringes (accuracy within ±1%), class A volumetric pipettes and volumetric flasks for preparation of standards and dilutions.

VIII. REAGENTS:

1. Sodium sulfate, anhydrous, ACS, granular or better.

2. Methylene chloride: pesticide quality or better.

3. MeOH: Purge-and-trap grade.

4. Sand: Ottawa Sand from Fisher Scientific.

5. Diesel Fuel Standard from AccuStandard (FU-009-D 40x or equivalent).

6. Diesel Fuel Spike Standard from Restek (31233 or equivalent).

7. Hydromatrix from Varian

8. Reagent water (Quality refers to SOP J-0004)

9. Multicomponent hydrocarbon window defining standard (Restek 31080 or equivalent).

10. *Surrogate solution: N-Triacontane-D62, 4927ug/ml in MEOH from AccuStandard.*

IX. SAMPLE HANDLING, PRESERVATION, & STORAGE:

1. Sample preservation, handling, and storage, including techniques on sample preservation and holding times, are summarized in the tables below:

Required Containers, Preservation Techniques; and Holding Times for Water Samples

Test	Container	Preservation	Maximum Holding Time
Total Petroleum Hydrocarbons, as Diesel fuel	Glass	Cool, 6 °C	Extract within 7 days, analyze extract within 40 days

Holding Time for Soil Samples

Analyte	Preservation	Holding Time for Soil
Total Petroleum Hydrocarbons, as diesel fuel	Cool, 6 °C	Extract within 14 days, Analyze Extract within 40 days

X. PROCEDURE:

1. Sample Preparation:

1.1. Diesel Fuel in Water – Follow extraction procedure listed in SOP 3535A.
1.2. Diesel Fuel in Soil – Follow extraction procedure listed in SOP 3545.

2. Initial Calibration:

2.1. GC Conditions – The recommended GC column and operating conditions are:

i. Column temperature is set at 45 °C at the time of injection
ii. Hold for 2 minutes, and programmed at 30 °C/minute to a final temperature of 320 °C, hold for 5 minutes.
iii. Ramp to 340°C at a rate of 30°C/minute and then hold for 8 minutes.
iv. GC parameters: Injector Temperature: 275-300 °C, Detector Temperature: 325-330°C, Initial Attenuation: 8, Range: 12, Column Flow: 1.4 mL/min, Make Up Gas: 25 mL/min, Hydrogen Flow: 30 mL/min, Air Flow: 375 ml/min, Split ratio: 25.

2.2. External Standard Calibration Procedure:

2.2.1. Prepare calibration standards at five concentrations (20ppm, 100ppm, 500ppm, 1000ppm, 2000ppm) by adding various volumes of diesel stock standards to a volumetric flask and diluting to volume with an appropriate solvent. The lowest external standards should be at a concentration near, but below, the detection limit.

2.2.2. Inject each calibration standard using the technique that will be used to introduce the actual samples into the gas chromatograph. Generate a calibration curve for target analyte by plotting the area against the concentration of the five calibration standards. This procedure is performed by Agilent software. This curve can be defined as first order. In the case of first order curve R^2 must be $\geq$ 0.99. If the coefficient factor is less than 0.99, then instrument problems or integrations shall be checked and corrected. If some points are off due to instrument problems, then these points may be rerun. If the calibration curve still fails after these actions, then all calibration standards must be rerun.

3. Retention Time Windows:

3.1. The retention time range for DROs is defined for each instrument whenever a new column is installed. A 100-200 ug/mL multicomponent hydrocarbon window defining standard is used for window study. The range is established from the retention times of the ***C_{10} and C_{28}*** alkanes. The retention time range is then calculated based on the lower limit of the RT windows for the first eluting component C10 and the upper limit of the RT window for the ***C28***. Details refer to SOP of Retention Time Windows.

3.2. For LUFT, the retention time range is calculated based on the lower limit of the first eluting component and the upper limit of the last eluting component.

4. Daily Calibration:

4.1. The working calibration curve or calibration factor must be verified on each working day by the injection of one or more calibration standards. The frequency of verification is dependent on the detector. Detectors, such as the electron capture detector, that operate in the sub-nanogram range are more susceptible to changes in detector response caused by GC column and sample effects. Therefore, more frequent verification of calibration is necessary. The flame ionization detector is much less sensitive and requires less frequent verification. If the response for any analyte varies from the predicted response by more than $\pm$ 15%, a new calibration curve must be prepared for that analyte.

$$\text{Percent Difference} = \frac{R1 - R2}{R1} \times 100$$

Where: R1 = Calibration Factor from first analysis.

R2 = Calibration Factor from succeeding analyses.

5. Sample Analysis:

5.1. Diesel fuel in Water & Soil:

5.1.1. All samples should be extracted according to appropriate sample preparation method.

5.1.2. Daily GC continuing calibration criteria must be met before analyzing of samples.

5.1.3. 1ul of the extract is then injected into the gas chromatograph.

5.1.4. If the initial analysis of a sample or a dilution of the sample has a concentration that exceeds the initial calibration range, the sample must be re-analyzed at a higher dilution. When a sample is analyzed that has saturated response from a compound, this analysis should be followed by a solvent blank analysis. If the blank analysis is not free of interferences, the system must be decontaminated. Sample analysis may not resume until a blank can be analyzed that is free of interferences.

5.1.5. All dilutions should keep the response of the major constituents (previously saturated peaks) in the upper half of the linear range of the curve.

5.1.6. The baseline is projected over the entire hydrocarbon region and is examined for each sample to ensure that the integration parameters are correct. If the baseline appears to be incorrectly established then corrections are made by the analyst. Correction has to be remained and initialized.

5.1.7. The integration range used for diesel is the C10 through C28 interval.

XI. CALCULATIONS:

1. For the analysis of Diesel Range Organics (DRO), sum the area of all peaks eluting between C_{10} and C_{28}.

2. Aqueous Samples:

Concentration (*m*g/L) = $[(A_x) (A) (V_t) (D)] / [(A_s) (V_i) (V_s)]$

Where:

A_x = Response for the analyte in the sample, units may be in area counts or peak height.

A = Amount of standard injected, ng.

A_s = Response for the external standard, units same as for Ax.

Vi = Volume of extract injected, L.

D = Dilution factor, if dilution was made on the sample prior to analysis. If no dilution was made, D = 1.

Vt = Volume of total extract, *m*L.

V_s = Volume of sample extracted, *m*L.

3. <u>Non-aqueous Samples</u>:

Concentration (*m*g/kg) = $[(A_x) (A) (V_t) (D)] / [(A_s) (V_i) (W)]$

Where:

W = Weight of sample extracted (g). The wet weight or dry weight may be used, depending upon the specific applications of the data.

4. All sample results are calculated with the equation derived by Varian Star software.

XII. QUALITY CONTROL (*<u>Including data assessment and acceptance criteria for QC measures & corrective actions and contingencies for unacceptable data</u>*):

1. Method Blanks, Laboratory Control Sample (LCS) Matrix Spikes and Matrix Spike Duplicates (MS/MSD) are analyzed with each analytical batch. (Up to a maximum of 20 samples/batch) for each matrix.

2. Method Blanks:

   2.1. The concentration of each target compound found in the blanks must be less than the detection limit of that compound.

   2.2. If the blank exceeds the above limits, investigate the source of contamination and appropriate corrective measures must be taken and documented before further analyses proceeds. Reanalyze the blank.

3. Matrix Spike/Matrix Spike Duplicate (MS/MSD): If samples are not expected to contain target analytes, laboratories should use a matrix spike and matrix spike duplicate pair, spiked with the Diesel Standard. Any MS/MSD that does not meet the acceptance criteria (70%-130%) must be reanalyzed. If still outside the limits, and the LCS/LCSD recoveries are acceptable, there is possibility a matrix interference.

4. Laboratory Control Sample (LCS): The LCS contains the same analytes at the same concentrations as the matrix spike and must be from a second source. If the LCS does not

meet the QC limit (70%-130%), then the LCS may be rerun. If it still fails, then samples in that batch must be reprepared and rerun.

5. Surrogate Recoveries. *(Limit: 60% - 140%):* If recovery is not within limits, the following is required.

   5.1. Check to be sure that there are no errors in the calculation or surrogate solutions. If errors are found recalculate the data accordingly.

   5.2. If the surrogate recoveries in blanks do not meet the criteria, take remedial actions.

   5.3. If the surrogate recovery in a sample does not meet the criteria, reanalyze the sample. If still outside the limits, and the LCS surrogate recoveries are acceptable, there is possibly a matrix interference.

   5.4. If the surrogate peak overlaps with analytes, the recovery is over upper limit, it must be flagged on the report.

XIII. METHOD PERFORMANCE:

1. Method performance is monitored on a continuous basis through the use of Laboratory Control Samples, Method Blanks, Matrix Spikes, Sample Duplicates and Surrogate Recoveries.

XIV. POLLUTION PREVENTION:

1. The EPA has established guidelines of environmental management techniques to institute pollution prevention in the workplace. Whenever feasible, laboratory personnel use pollution prevention techniques to address their waste generation and minimize pollution resulting from any laboratory activity.

2. Methylene Chloride, Acetone, and other extraction solvents are only used in the extraction room.

XV. WASTE MANAGEMENT:

Refer to SOP - Laboratory Hazardous Waste Disposal (J 0010).

XVI. REFERENCES:

1. LUFT Field Manual

2. EPA Methods 3500B, 3510C, 3545, 8015B December 1996

XVII. REVISION HISTORY

April 29, 2005: SOP 8015B was revised by adding more details to definition and changing the method from 8015M to 8015B and adding reference SOP to Waste Management section.

May 16, 2005: Reference SOP is added to the Retention Time Windows.

July 28, 2005: Revised from SOP of April by adding LUFT specification at Retention Time Window Section.

August 7, 2007: Revised by adding GC#16 parameters to GC condition section.

May 13, 2008: Revised by changing the Surrogate from O-Terphenyl to N-Triacontane – D62 and the integrate range from the C10 - C18 to C10 - C28.

July 6, 2009: Revised by updating the surrogate recovery control limits and Instrumentation.

July 6, 2010: Revised by updating calibration standard levels and injection volume.

November 8, 2011: Revised by updating Section III Detection Limits and change the prep method for water from 3510C to 3535A.

March 27, 2013: Change the initial calibration criteria R^2 from 0.99 to 0.98.

September 16, 2013: Update instrumentation.

APPENDIX I

DEFINITIONS

1. GC – Gas Chromatography

2. FID – Flame Ionization detector

3. Analytical QC Sample Batch – A sequence of samples, which is analyzed within a 24-hour period and which includes no more than 10 field samples of the same matrix type. An Analytical QC Sample Batch must also include all required QC samples, which do not contribute to the maximum field sample total of 10.

4. QC Samples: Laboratory Method Blank (MB), Laboratory Control Sample (LCS) and Matrix Spike (MS) and Matrix Spike Duplicate (MSD).

5. Laboratory Method Blank (MB) – An aliquot of reagent water or clean sand as soil matrix that is treated exactly as a field sample, including exposure to all glassware, equipment, solvents, reagents and procedures that are used with the field samples. The LRB is used to determine if target analytes or other interferences are present in the laboratory environment, reagents, or apparatus. It must be processed with the field samples and is therefore subject to all extraction, cleanup (when used) and analytical processes.

6. Calibration Standards (CAL Std's)– A series of solutions used to initially establish instrument calibration and develop calibration curves for individual target analytes across a fixed concentration range.

7. Continuing Calibration Verification Standard(s) (CCV) – A CAL solution that is analyzed at a minimum after every tenth field sample. The CCC verifies the previously established calibration curve and confirms accurate quantitation for the analytes by the calibration curve.

8. Method Detection Limit (MDL) – The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero.

9. Surrogate Standard (Surr.) – A pure analyte, which is unlikely to be found in any sample. The surrogate is added prior to any sample processing. The purpose of the surrogate is to monitor method performance with each sample.

Appendix B – Health and Safety Plan (HASP)

HEALTH AND SAFETY PLAN
LEAD BUILDERS INC.
ENVIRONMENTAL SERVICES
THOUSAND OAKS, CALIFORNIA

Prepared for

Lead Builder Inc.
2060 D. Avenida de Los Arboles
Thousand Oaks, CA 91362

Prepared by

Terraphase Engineering Inc.
18401 Von Karman Avenue, Suite 410
Irvine, CA 92612

Updated May 15, 2020

Project Number S073.001

terraphase engineering

THIS PAGE LEFT INTENTIONALLY BLANK

CONTENTS

FIGURES

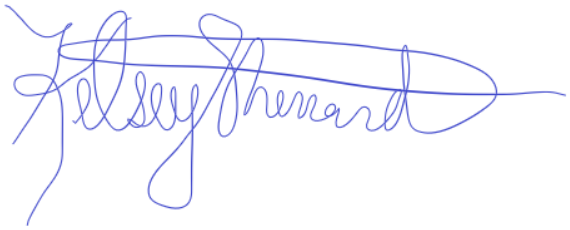
APPENDICES

SIGNATURE SHEET

This section provides a detailed listing of the individuals responsible for drafting, reviewing, implementing, and approving this HASP.

Project Manager Approval:

Project Manager:



5/22/20

Kelsey Sherrard — Date
Project Geologist

Corporate Health and Safety Officer Approval:

5/15/20

Daren Roth — Date
Associate Geologist/EH&S Manager

THIS PAGE LEFT INTENTIONALLY BLANK

ACRONYMS AND ABBREVIATIONS

ANSI	American National Standards Institute
APR	air-purifying respirator
BMP	best management practice
Cal/OSHA	California Occupational Safety and Health Administration
CAMP	Community Air Monitoring Plan
CCR	California Code of Regulations
CFR	Code of Federal Regulations
COPCs	chemicals of potential concern
CPR	cardiopulmonary resuscitation
CTPV	Coal tar pitch volatiles
dBA	decibels
DEET	N,N-diethyl-metatoluamide
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
kV	kilovolts
mph	miles per hour
NRR	noise reduction rating
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PEL	Permissible exposure limits
PID	photoionization detector
PM	Project Manager
PPE	personal protective equipment
ppm	parts per million
REL	Recommended exposure limits
NPS	National Parks Service
QA/QC	quality assurance and quality control
SMMNRA	Santa Monica Mountains National Recreation Area

SPF	sun protection factor
SSHO	Site Safety and Health Officer
Terraphase	Terraphase Engineering Inc.
the Site	Santa Monica Mountains National Recreation Area
TM	Task Manager
TWA	time weighted average
USA	Underground Services Alert

1.0 INTRODUCTION

Terraphase Engineering Inc. (Terraphase) has prepared this Health and Safety Plan (HASP) for environmental services performed at the Santa Monica Mountains National Recreation Area, California ("the Sites", Figure 1) for the Lead Builders Inc.

This HASP is central to the safety and health program for the project. This HASP addresses the potential hazards associated with planned pre-construction soil sampling and environmental activities to be conducted at the Site by Terraphase. This HASP is intended to be a "living document" and may be modified over time to address issues that may arise over the course of the project. Activities conducted at the Site will be performed in compliance with applicable Occupational Safety and Health Administration (OSHA) regulations, particularly those in Title 8 California Code of Regulations (CCR) 5192, and other applicable federal, state, and local laws, regulations, and statutes.

This HASP may not address hazards associated with tasks and equipment that are specialties of the contractors and subcontractors (e.g., operation of heavy equipment). Therefore, contractors and subcontractors are responsible for developing, maintaining, and implementing their own health and safety programs, policies, and procedures. At a minimum, all Terraphase subcontractor employees working on site must:

- have read and understood the requirements contained in this HASP.
- have completed all training requirements specified in Title 29, Code of Federal Regulations (CFR), Part 1910, Section 120 (29 CFR 1910.120) and Title 8 CCR, Section 5192 (8 CCR 5192).
- provide their own health and safety equipment as indicated in this HASP and comply with the minimum requirements established by this HASP.
- if the contractor or subcontractor has prepared its own HASP, that HASP must at least meet the requirements contained in this HASP in addition to all applicable federal, state, and local health and safety requirements.

A hardcopy of this HASP will remain onsite at all times during the field activities.

1.1 Field Work Activities

Terraphase is contracted to conduct real-time monitoring for airborne asbestos, heavy metals, polycyclic aromatic hydrocarbons, coal tar pitch volatiles, and particulate matter of each designated work area when certain activities are in progress, as described in the Community Air Monitoring Plan (CAMP). Terraphase will also conduct shallow soil sampling. Typical tasks anticipated during this project are listed in the following sections. If additional tasks are identified with different hazards, this plan will be amended.

1.1.1 Real-Time Air Monitoring

Baseline or background concentrations will be established for the above contaminants of concern prior to demolition and excavation activities. Additionally, sampling will be conducted during the daily construction/ demolition of the tasks to document ambient air conditions at the site.

Dust monitoring will be conducted utilizing direct reading aerosol (particulate matter) equipment capable of continuous air flow monitoring. The primary hazards associated with air sampling and monitoring are chemicals of potential concern (COPCs) and ergonomic hazards.

1.1.2 Soil Sampling

Soil samples will be collected using hand tools including trowels and hand augers. The primary hazards associated with soil sampling are chemicals of potential concern (COPCs) and ergonomic hazards. These hazards are addressed in sections 3.1 and 3.3.11.

1.2 Corporate Policy

Safety should take the highest priority in any Terraphase project, as is evident in Terraphase's corporate motto "Safety First." It is Terraphase's policy that its personnel and its subcontractor(s) onsite shall assume full responsibility and liability for compliance with all applicable federal, state, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the Site, and persons occupying areas adjacent to the Site. Terraphase's hard-earned reputation as a successful consulting company directly correlates to our high standards for safety during our projects. The goal for safety is no illness or injuries with zero lost work days due to work conditions.

2.0 SITE DESCRIPTION AND BACKGROUND

2.1 Site Description

The Site is located in the Santa Monica Mountains National Recreation Area (SMMNRA) and is comprised of nine areas where sampling will occur. Sampling will be conducted at the following locations: Paramount Ranch, Peter Strauss Ranch, Rocky Oaks, Cooper Brown, Arroyo Sequit, Circle X Ranch, Morrison Ranch, Miller Property, Dragon Property.

2.2 Site Background

The Site is located in the SMMNRA in Los Angeles and Ventura Counties, California. The Site consists of 182,440 acres of land. The National Park Service (NPS) controls 23,620 acres of the SMMNRA and the California State Park system controls 42,000 acres, while the rest of the SMMNRA lands are local agency parks, university study reserves, and private property conservation easements. In November of 2018, the Woolsey Fire destroyed 21,000 acres (88%) of NPS land within the Site, including 269 known archaeological sites, two cultural landscapes and 32 historical buildings. The Site contains nine project areas (Figure 1) where structures were destroyed in the Woolsey Fire, detailed in the sections below.

2.2.1 Paramount Ranch

Paramount Ranch is a 2,700-acre ranch located in Agoura Hills, California (34.115508°, -118.756145°). Paramount Ranch and features burned in the Woolsey Fire are shown on Figure 2. The land was purchased by Paramount Studios in 1927 and, prior to the Woolsey Fire, was used as a movie set where numerous television shows and movies have been filmed. Paramount Ranch is open to the public for tours of the property and private events, and contains hiking trails. A total of ten structures were burned in the Woolsey fire including the following: the freight building, private quarters 107, the mercantile building, the pavilion, the saloon, the horse barn, the jail, the restroom, the hotel, and the telegraph office. In 1956, the owner of Paramount Ranch built a road-racing track adjacent to Medea Creek. The track was 2 miles in length and featured 11 turns and a bridge and underpass in the northern section of the course. The racetrack bridge was the eleventh feature burned in the Woolsey Fire.

2.2.2 Peter Strauss Ranch

Peter Strauss Ranch is a located in Agoura Hills, California (34.113496°, -118.779316°). Peter Strauss Ranch and the features burned in the Woolsey Fire are shown on Figure 3. Peter Strauss Ranch was first owned by automobile manufacturer Henry Miller and used as a weekend retreat, and in 1926, Miller built the stone ranch rouse, look-out tower and aviary. The property was sold in the mid-1930s to developers Warren Shobert and Arthur Edison who turned the property into a recreational amusement park called Lake Enchanto. The property was sold to actor Peter Strauss in 1976, who turned the property into a private estate. The land was sold to the Santa Monica Mountains Conservancy in 1983 and later to the NPS in 1987. The ranch

contains hiking trails, a swimming pool in the Lake Enchanto dam and previously allowed access to the stone ranch house. The ranch house was burned in the Woolsey Fire.

2.2.3 Rocky Oaks

Rocky Oaks is located in Malibu, California (34.098123°, -118.813196°). Rocky Oaks and the features burned in the Woolsey Fire are shown on Figure 4. This area was originally part of the Rocky Oaks Ranch, established in the 1920s by Albert and Anna Bradenberger. The area is maintained by the NPS and contains hiking trails and a seasonal man-made pond. Features destroyed in the Woolsey Fire include the Quarters 102 House, the Museum Building, a vault restroom and a chicken coup.

2.2.4 Cooper Brown

Cooper/Brown is located directly adjacent to and west of the Rocky Oaks park unit in Malibu, California (34.097067°, -118.815981°). The Cooper Brown area and features burned in the Woolsey Fire are shown on Figure 4. The area contained the Bradenberger-Brown house, or the Cooper Brown house, constructed by Albert and Anna Bradenberger in the 1940s. The Cooper Brown house contained the LaKretz Field Station for California Conservation Science, operated by the University of California at Los Angeles (UCLA), which burned in the Woolsey Fire.

2.2.5 Arroyo Sequit

Arroyo Sequit is located in Malibu, California (34.086259°, -118.890645°). the Arroyo Sequit area and features burned in the Woolsey Fire are shown on Figure 5. It was purchased by Richard Mason and Mabel Kelch in the 1920s and sold to the State of California in 1985, following a large wildfire in the area. The NPS acquired the land in 1991. Arroyo Sequit contained a picnic area for visitor use and a wood frame ranch house used as a ranger residence. Features destroyed in the Woolsey Fire include the Quarters 113 house, the survey office, the vault restroom and the pump house.

2.2.6 Circle X Ranch

Circle X Ranch is located in Malibu, California (34.109734°, -118.937229°). Circle X Ranch and the features burned in the Woolsey Fire are shown on Figure 6. The site was a former Boy Scout Camp created by the Exchange Club of Los Angeles and the Boney Ridge Country Club in 1949. In 1951, the Boy Scouts of America (BSA) signed a 99-year lease with the Circle X Ranch foundation, and in 1979, the foundation deeded the land to the BSA. In 1987, the NPS bought the land from the BSA and the NPS has managed an on-site campground since 1989 as well as several hiking trails open to the public. Features destroyed in the Woolsey Fire include the basketball court, and vault toilets A and B.

2.2.7 Morrison Ranch

Morrison Ranch is located in Agoura Hills, California (34.154874°, -118.727014°). Morrison Ranch and the features burned in the Woolsey Fire is shown on Figure 7. The property was

purchased by John W. Morrison in 1904 and was used as a cattle ranch. Morrison Ranch was acquired by the NPS in 1999. Features destroyed in the Woolsey Fire include the Morrison Ranch house, the chicken coup and the corral area.

2.2.8 Miller Property

The Miller Property is located in Malibu, California (34.074250°, -118.784160°). The Miller Property and features burned in the Woolsey Fire are shown on Figure 8. The property is a recent purchase of the NPS. The Miller Property, which is a roofed area which covered recreational vehicles, was burned in the Woolsey Fire.

2.2.9 Dragon Property

The Dragon Property is a park unit located in Malibu, California (34.050842°, -118.852780°). The Dragon Property and features burned in the Woolsey Fire are shown on Figure 9. The property is a recent purchase of the NPS. The structures destroyed during the Woolsey Fire include an Air Stream trailer, a school bus called the Life Estate, and a pump house.

2.3 Previous Site Investigations

Previous site investigations have been conducted at the Site that are pertinent to this project. In January 2020 Terraphase conducted ash and shallow background soil sampling.

3.0 HAZARDS

Hazards that could be encountered include chemical hazards, environmental hazards, biological hazards, and/or physical hazards.

3.1 Chemical Hazards

Chemical hazards may be encountered during the field activities to be conducted at the Site. These hazards may be encountered through inhalation, absorption, or ingestion. The soils at the Site have potentially been contaminated with contaminants such as metals, dioxins and furans, PCBs, coal tar pitch volatiles, and asbestos as byproducts generated from burned building materials. In some areas, knowledge of construction materials for the burned structures is limited or incomplete. No building materials survey for the nine areas of the Site was available for review at this time.

3.1.1 Absorption and Ingestion Risk

In general, the anticipated concentrations of chemicals of potential concern (COPCs) in ash and soil are such that the absorption and ingestion risk can be minimized by proper personal hygiene and use of personal protective equipment (PPE). The PPE requirements are discussed further in Section 8.0. If work is anticipated in areas where one or more of the COPCs exceed acceptable risk-based screening levels; the work practices, engineering controls, and required PPE will be assessed and modified as necessary in an addendum to this HASP.

3.1.2 Inhalation Risk

3.1.2.1 Metals and other Chemicals of Concern

The inhalation risk associated with metals and other chemicals of concern at the site impacts is unlikely during the boring and sampling activities because the sampling methods should generate minimal dust. The inhalation risk is greater during remedial excavation activities. When working around heavy equipment that is generating visible dust, it is recommended that staff work upwind of the equipment whenever possible and only enter the excavation areas to record the particulate readings and then return to an upwind location. The action levels for the site activities is

3.2 Environmental Hazards

Santa Monica Mountains National Recreation Area has a coastal Mediterranean climate with an average temperature of 61.7 degrees Fahrenheit (^{o}F), characteristic of a Mediterranean-type climate with mild temperatures. The average wind speed in neighboring Los Angeles is 7.5 miles per hour (mph). Annual high temperatures in Santa Monica Mountains average 69.7 ^{o}F, and annual low temperatures average 54.0 ^{o}F. The average annual precipitation is approximately 13.2 inches. However, field personnel should be prepared for a change in weather conditions.

3.2.1 Heat Stress

Heat stress or hyperthermia is caused by a number of interacting factors, including environmental conditions of high temperature and humidity, clothing, workload, etc., as well as the physical and conditioning characteristics of the individual. All employees must be informed of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress disorders.

Heat stress monitoring and work/rest cycle implementation must commence when the ambient temperatures exceed 80°F. The Site Safety and Health Officer (SSHO), PM, and/or task manager (TM) should monitor the anticipated high temperatures prior to the start of work, as well as monitor real-time temperatures during the work day using a reputable website (i.e., http://www.weather.gov/) or onsite weather station.

The following control measures can be used to help control heat stress:

- Site workers will be encouraged to drink plenty of water and electrolyte replacement fluids throughout the day. Potable water must be provided at the jobsite in sufficient quantities (at least one quart per employee per hour for the entire shift).
- Onsite drinking water will be kept cool (below the ambient temperature, but not so cool that it causes discomfort).
- A work regimen that will provide adequate rest periods for cooling down will be established, and based on the work activities, level of PPE, and anticipated daily temperatures.
- All personnel will be advised of the dangers and symptoms of heat stroke, heat exhaustion, and heat cramps.
- Cooling devices (i.e., cooling vests) should be used when personnel must wear impermeable clothing in conditions of extreme heat (>95°F).
- Employees should be instructed to monitor themselves and co-workers for signs of heat stress and to take additional breaks as necessary. If an employee is working alone in hot weather, the PM/TM should schedule regular check-ins with the employee.
- A shaded rest area must be available near the job site. The site workers will either utilize natural shade (i.e., building structures, trees, etc.), or a temporary shade structure will be erected. The shaded area must be large enough to accommodate the number of employees on rest or recovery periods. The interiors of cars or trucks are not considered shade unless the vehicles are air-conditioned or kept from heating up in the sun in some other way.

- All breaks should take place in the shaded rest area and the employees must not be assigned to other tasks during breaks.
- Employees must remove impermeable garments during rest periods. This includes white Tyvek-type garments.
- Employees shall be allowed and encouraged to take a preventative cool-down rest in the shade at a time when they feel the need to do so to protect themselves from overheating. Such access to shade shall be permitted at all times. An individual employee who takes a preventative cool-down rest (A) shall be monitored and asked if he or she is experiencing symptoms of heat illness, (B) shall be encouraged to remain in the shade, and (C) shall not be ordered back to work until any signs or symptoms of heat illness have abated, but in no event less than 5 minutes in addition to the time needed to access the shade.

High heat procedures will be implemented in accordance with the California OSHA (Cal/OSHA) heat illness prevention regulations if the temperature at the Site equals or exceeds 95°F. This must include the following:

1. Ensuring that effective communication by voice, observation, or electronic means is maintained so that employees at the work site can contact a supervisor when necessary. An electronic device, such as a cell phone or text messaging device, may be used for this purpose only if reception in the area is reliable.
2. Observing employees for alertness and signs or symptoms of heat illness. The employer shall ensure effective employee observation/monitoring by implementing one or more of the following:
    a. Supervisor or designee observation of 20 or fewer employees, or
    b. Mandatory buddy system, or
    c. Regular communication with sole employee such as by radio or cellular phone, or
    d. Other effective means of observation.
3. Designating one or more employees on each worksite as authorized to call for emergency medical services, and allowing other employees to call for emergency services when no designated employee is available.
4. Reminding employees throughout the work shift to drink plenty of water.

5. Pre-shift meetings before the commencement of work to review the high heat procedures, encourage employees to drink plenty of water, and remind employees of their right to take a cool-down rest when necessary.

3.2.2 Hypothermia

Hypothermia or cold stress can result from abnormal cooling of the core body temperature. It is caused by exposure to a cold environment and wind-chill. Wetness or water immersion can also play a significant role. Typical warning signs of hypothermia include fatigue, weakness, lack of coordination, apathy, and drowsiness. A confused state is a key symptom of hypothermia. Shivering and pallor are usually absent, and the face may appear puffy and pink. Body temperatures below 90°F require immediate treatment to restore temperature to normal. Current medical practice recommends slow re-warming as treatment for hypothermia, followed by professional medical care. This can be accomplished by moving the person into a sheltered area and wrapping with blankets in a warm room. In emergency situations, where body temperature falls below 90°F and heated shelter is not available, use a sleeping bag, blankets, and body heat from another individual to help restore normal body temperature.

3.2.3 Ultraviolet (UV) Radiation (Sunlight)

Moderate to high potential for overexposure to UV light exists for field personnel. To prevent erythema (sunburn), workers will be provided Sun Protection Factor (SPF) 30 or greater sunscreen to apply to areas not covered with clothing or PPE. Workers will be encouraged to seek shade whenever possible.

3.3 Physical Hazards

Physical hazards discussed under this section include excavations; machinery and moving parts; electrical hazards; confined spaces; noise; equipment and motor vehicle operation; slips, trips, and falls; utilities; traffic; and ergonomic hazards.

3.3.1 Underground and Overhead Utilities

Reasonable efforts will be made to identify the location(s) of underground utilities (e.g., pipes, electrical conductors, fuel lines, and water and sewer lines) before mechanized soil intrusive work is performed. The state underground utility notification authority, Underground Services Alert (USA), will be notified at least 48 hours (not including the day of the notification) before field activities start. USA in turn will notify representatives of the utility companies, who will mark the locations of underground services entering the property. USA markings will be noted prior to drilling to prevent damage to utility lines.

The PM is responsible for ensuring that underground utility locations are identified prior to the commencement of any subsurface (> 1 foot) activities that are under the oversight of Terraphase. Resources include site plans, utility companies, and regional utility locating services.

The proper utility company personnel should certify the deactivation of utilities, and the certification should be retained in the permanent log.

In accordance with CCR, Title 8, Section 1541 (Excavations), an excavation shall not commence until:

- The excavation area has been marked as specified in Government Code Section 4216.2 by the excavator; and
- The excavator has received a positive response from all known owner/operators of subsurface installations within the boundaries of the proposed project; those responses confirm that the owner/operators have located their installations, and those responses either advise the excavator of those locations or advise the excavator that the owner/operator does not operate a subsurface installation that would be affected by the proposed excavation.

Only qualified persons shall perform subsurface installation locating activities, and all such activities shall be performed in accordance with this section and Government Code Sections 4216 through 4216.9.

When excavation or boring operations approach the approximate location of subsurface installations, the exact locations of the installations shall be determined by safe and acceptable means that will prevent damage to the subsurface installation, as provided by Government Code Section 4216.4.

While the excavation is open, subsurface installations shall be protected, supported, or removed as necessary to safeguard employees.

An excavator discovering or causing damages to a subsurface installation shall immediately notify the facility owner/operator or contact the Regional Notification Center to obtain subsurface installation operator contact information immediately after which the excavator shall notify the facility operator. All breaks, leaks, nicks, dents, gouges, grooves, or other damages to an installation's lines, conduits, coatings, or cathodic protection shall be reported to the subsurface installation operator.

If a utility strike presents an immediate danger to the work crew or general public (e.g., electrical, gas, high-pressure water line), then the crew should evacuate to a safe distance, contact 911 immediately, and cordon off the area to prevent public access.

All utility strikes should be reported out to the PM and/or SSHO as soon as it is safe to do so, and then a plan will be made for reporting to the utility company and client. If a utility strike does occur, refer to the accident reporting requirements in Section 6.0.

Prior to mechanized drilling, the following techniques will be employed to determine the location of subsurface structures:

- contracting the services of a qualified private utility locator
- subsurface testing (i.e., potholing) to the expected depth of probable utilities (not less than 5 feet bgs)

If utilities cannot be located, and/or if unlocated utilities are suspected to be present, subsurface activities (e.g., borings, excavation) should not be conducted prior to confirming the location(s) or absence of underground utilities.

Equipment with articulated upright booms or masts shall not be permitted to pass within 20 feet of an overhead utility line (less than 50 kilovolts [kV]) while the boom is in the upright position. For transmission lines in excess of 50 kV, an additional distance of 4 inches for each 10 kV over 50 kV will be used.

Excavation, drilling, crane, or similar operations adjacent to overhead lines shall not be initiated until operations are coordinated with the utility officials. Operations adjacent to overhead lines are prohibited unless one of the following conditions is satisfied:

- Power has been shut off and positive means (e.g., lockout/tagout) have been taken to prevent lines from being energized. Wherever possible, the SSHO will observe power shut-off and place a lock and tag on the switch. In all cases, utility company personnel shall certify in writing to the PM or SSHO the deactivation of overhead utilities, and the certification shall be retained in the project files. The Site Manager or SSHO must also attempt to verify power shut-off by checking that power is no longer available to the affected building or equipment.

- Equipment, or any part of the equipment, cannot come within the following minimum clearance from energized overhead lines (Terraphase recommends an additional 10 feet be added to the minimum required clearances presented below):

Power Lines Nominal System (kV)	Minimum Required Clearance
0-50	10 feet
50- 75	11 feet
75-125	13 feet
125-175	15 feet
175-250	17 feet
250-370	21 feet
370-550	27 feet

550-1000	42 feet

3.3.2 Machinery/Moving Parts

Excavation and debris removal equipment may have various motors, booms, and other equipment. These present a general physical hazard from moving parts. Personnel will stand clear of machinery at all times unless specific instructions are given by the trained operator, or other person in authority. Steel toed shoes or boots will be worn at all times when on the site. When possible, appropriate guards will be in place during equipment use. Field personnel should be careful to keep loose clothing, hands, and feet away from vacuum hose inlets.

3.3.3 Hand and Power Tools

Use of power tools presents potential physical hazards (e.g., pinch points, electrical hazards, flying debris, and struck-by/caught-between hazards) to personnel operating them. The following safety rules must be implemented:

- Inspect tools frequently for defects. Turn in all tools which are burred, mushroomed, have split or loose handles, have worn or sprung jaws, have exposed wires, or are generally unsafe.
- Use hand tools properly and for their intended use only.
- Do not to operate power tools, machinery, or equipment without proper training or supervision.
- Do not operate equipment unless all guards and other protective devices are properly secured and correctly adjusted.
- Keep cords of electrical equipment coiled when not in use.
- When using electrical equipment, position its power cord to avoid its being run over by vehicles or equipment.
- Turn off, and if possible, unplug, machinery before cleaning, oiling, adjusting, or repairing unless the equipment is designed or fitted with safeguards to protect the person performing the work.
- Do not wear loose or frayed clothing, dangling ties, finger rings, etc. when operating or working near moving machinery or other mechanical sources of entanglement.
- Do not lift or lower portable electric tools by means of a power cord; use a handline.
- Never throw tools, equipment, or material up or down from one working level to another; always use a handline. Do not disconnect air hoses at compressors until hose line has been bled.

3.3.4 Confined Spaces

Confined space entry is not anticipated for this project. Terraphase field personnel will not enter any confined space without specific approval of the Project Manager. Subcontractors may need to conduct permit-required confined space entries. In the event that a subcontractor project manager determines a permit-required confined space entry is necessary, the Terraphase Project Leader should be notified.

If confined space entries are conducted, they will be in accordance with the subcontractor's confined space entry program. An attendant will be stationed above the confined space while the entrant(s) are in the confined space. A full-body harness with emergency retrieval equipment or another means of egress (e.g. ladder) shall be in use if necessary.

Before conducting any work inside a confined space (e.g. tank), the personnel will conduct a visual inspection of the area from the opening to identify any hazards before proceeding. Gas measuring devices will be utilized to detect any presence of harmful or dangerous atmospheres. Any floating or rotating machinery that are in the confined space are turned off and locked out prior to beginning any work.

3.3.5 Noise

Appropriate hearing protection (earmuffs or ear plugs with a noise reduction rating (NRR) of at least 20 decibels A weighting [dBA]) will be used if individuals work near high-noise generating equipment above the OSHA Action Level (> 85 dBA). Determination of the need for hearing protection will be made by the Project Supervisor and in accordance with any applicable Noise Mitigation Plan for the site.

In addition, the Project Supervisor and SSHO will need to periodically assess hearing protection and procedures to allow the ability to hear two-way radios or other communication devices where emergency information may need to be relayed.

3.3.6 Slips, Trips, and Falls

Slips, trips, and falls are a leading cause of injury on construction and remediation work sites. Water and slime collect on horizontal surfaces and stairs, posing a potential hazard. Proper housekeeping is the key to preventing injuries of this nature. To minimize potential for injuries, the following measures will be implemented:

- Areas around open manholes, excavations, trenches, etc. will be kept clean and orderly.
- All potential trip and fall hazards will be clearly marked, modified to reduce the hazard, or engineered in a configuration to eliminate the hazard (if possible).
- All floors and stair treads will be kept clean of water, oil, and polymer.
- All hoses will be coiled and stored out of the way when not in use.
- There will be no running at the site.

As with all field work sites, caution will be exercised to prevent slips on rain slick surfaces, stepping on sharp objects, etc. Work will not be performed on elevated platforms without fall protection.

Before conducting any work adjacent (such as opening, measuring water level, etc.) to an underground storage tank access area (e.g., manhole), the personnel will conduct a visual inspection of the area from the opening to identify any trip/slip hazards. Personnel who are within 10 feet of the opening will use full-body harness and a self-retracting lifeline with fall arrestor. The fall protection system will be tied into a suitable anchor (e.g., tree, truck, etc.) that allows for work to be conducted around the underground storage tank opening. The access cover shall be completely closed and bolted to the frame (if bolts are present) prior to the fall protection system being removed.

3.3.7 Heavy Equipment Operation

Physical hazards can arise from loading and off-loading heavy equipment from tractor-trailers and locating equipment to designated areas of use. Hazards will be mitigated by personnel avoiding close proximity to moving equipment and immovable objects.

Belts and rotating parts have the ability to injure, crush, or amputate body parts and limbs. Personnel will avoid contact with any moving part. Any loose items will be removed before working around moving or rotating equipment. Any moving parts that can be guarded will have an appropriate machine guard installed. Equipment will not be operated without the proper guards in place. Repairs/adjustments will be done with the equipment stopped and locked out as appropriate.

The following measures will be implemented for heavy equipment operation:

- The minimum required work uniform for all field personnel (e.g. Level D protection) shall be general work clothes, steel-toed construction boots [American Society of Testing and Materials (ASTM F2412-05 and F2413-05)] tested and approved, safety goggles or glasses, work gloves, high visibility vest, hearing protection, and a hard hat [American National Standards Institute/International Safety Equipment Association (ANSI/ISEA) Z89.1-2014 approved and compliant hard hat].
- Adequate workspace shall be maintained during equipment operation.
- Equipment shall be inspected for proper working condition prior to use.
- Field personnel shall only approach operating equipment from the operator's angle of view, and only after making eye contact with the equipment operator.
- A 10-foot perimeter will be maintained around all active equipment as a "Danger Zone".
- Only trained and qualified persons shall operate individual equipment.

3.3.8 Motor Vehicle Operation

Employees may be exposed to vehicle accident hazards associated with the operation of vehicles during the project. To control these hazards, the following safety requirements will be strictly enforced:

- Seat belts shall be worn any time a vehicle is in motion, regardless of speed or distance to be traveled. Seat belt requirements also apply to the operation of backhoe and other construction equipment;
- The basic speed law shall be followed at all times; and
- Vehicles shall never be operated at a speed that is not safe for the conditions (i.e., road surface, traffic, visibility, weather, etc.).

3.3.9 Ergonomic Hazards

The initial site safety briefing given to all workers prior to the start of the project will cover the basics of ergonomics and focus on the following topics:

- Ergonomic injuries – their prevalence, causes, and significance
- Proper lifting procedures and planning all lifts
- Proper posture when standing, or operating a motor vehicle or heavy equipment
- Avoiding overexertion
- Awareness of repetitive tasks and the hazards that they can pose

3.3.9.1 Hand Augering

In addition to the precautions listed in the Back Safety discussion below, additional care should be taken to prevent injuries when using slide hammers.

- Wear cotton or leather gloves when rotating the auger.
- Avoid putting pressure on the palms of your hands; use a good grip to spread the pressure over the entire hand.
- Take frequent stretch breaks to stretch and relax your back, arms, and hands.

3.3.9.2 Back Safety

Using the proper techniques to lift and move heavy pieces of equipment (greater than 50 pounds) is important to reduce the potential for back injury. The following precautions should be implemented when lifting or moving heavy objects:

- Bend at the knees, not the waist. Let your legs do the lifting;
- Do not twist while lifting;
- Bring the load as close to you as possible before lifting;

- Be sure the path you are taking while carrying a heavy object is free of obstructions and slip, trip, and fall hazards;
- Use mechanical devices to move objects that are too heavy to be moved manually; and
- If mechanical devices are not available, ask another person to assist you.

3.3.10 Traffic Hazards

Some of the work activities may occur along busy streets and with active parking lots and structures. Vehicular traffic presents opportunities for serious injury to persons or property. Workers and other pedestrians are clearly at risk during periods of heavy traffic. Risk from motor vehicle operations may be minimized by good operating practices and alertness, and care on the part of workers and pedestrians. Employees should always follow:

- The traffic control plan prepared for the work (if required),
- Park work vehicle between on-coming traffic and work zone to the extent feasible
- Demarcate the work zone with high visibility traffic cones
- Wear high visibility vest (minimum of Class II vest per Caltrans specification)
- Follow all laws regarding pedestrian crossing of streets
- Traffic considerations should be made to minimize driver frustration and confusion
- Provide as much barrier between work area and traffic lanes as practicable
- When possible, employees should not walk between the traffic cones and the active lane of traffic
- Equipment and supplies should be unloaded from the back of the vehicle or the sidewalk side of the vehicle to minimize the potential to travel in the active traffic lane

3.3.11 Project Lighting

Scheduled work is anticipated to be conducted outdoors and during daylight hours. If site activities are to occur during non-traditional hours (i.e., night-time), an addendum to this HASP will be prepared to specify auxiliary lighting requirements as outlined in the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard.

3.4 Biological Hazards

This section provides health and safety precautions against potential biological agents that might be encountered by field personnel during field activities. The biological hazards that may be encountered include insects and wild animals.

3.4.1 Arthropods – Insects and Spiders

Nearly all work sites may contain ticks, venomous spiders (e.g., black widow, brown recluse), chiggers, and venomous insects. Appropriate insect repellants (with N,N-diethyl-metatoluamide

[DEET]) will be provided. Educational information will be given on the identification of ticks and Lyme disease. Field personnel wearing light-colored clothing can easily inspect themselves for insects and ticks. Venomous insects and spiders are generally reclusive, and the greatest potential for exposure arises when personnel are opening containers, structures, buildings, or well casings, and/or are handling idle equipment and construction material stockpiles. Caution should be taken when opening monitoring wells. Field personnel should inspect themselves at the end of each workday.

The work area may have venomous spider populations. The only venomous spider native to Northern California is the female black widow spider. The female black widow is normally shiny black, with a red hourglass marking on the underside of abdomen. Black widows can be found both outdoors and indoors. In indoor settings, black widows prefer undisturbed, cluttered areas. Field personnel should wear long sleeves and work gloves if they need to move stored material or debris at the site to avoid black widow bites.

3.4.2 Snakes

The work area includes is a mix of pavement, grass, trees, and dirt areas and the potential exists for snakes to be present. Workers will be encouraged to be vigilant of the possibility of snakes on the site. Poisonous and nonpoisonous species of snakes including rattlesnakes may be encountered at the Site.

Snakes typically do not attack people but will bite when provoked or accidentally injured. If a snake is encountered, one should avoid making quick, jerky motions and loud noises. Retreat must be accomplished slowly. If bitten, seek medical attention immediately.

Workers should take the following steps to prevent a snake bite:

- Do not try to handle the snake
- Wear boots and long pants when working outdoors
- Wear leather gloves when handling brush and debris
- Stay away from tall grass and piles of leaves when possible
- Be aware that snakes tend to be active at night and in warm weather

Workers should take the following steps if they are bitten by a snake:

- Seek Medical attention as soon as possible (dial 9-1-1 or call local EMS)
- Remain still and calm. This will slow the spread of venom.
- Try to remember the color and shape of the snake, which can help with treatment of the snake bite
- Inform your supervisor and others working at the site.

3.4.3 Vermin

Feral cats, raccoons, skunks, rats, mice, squirrels, and rabbits may be carriers of disease. Where vermin are identified in work areas, the Project Supervisor shall be immediately notified. Bites will be immediately reported and medical care obtained. Infections may occur in humans associated with activities that bring humans into contact with rodents, rodent saliva, or rodent excreta. Disturbing rodent-infested areas may bring humans into contact with the etiologic agents causing infections. Transmission of disease may occur through broken skin, contact with conjunctivae, ingestion of contaminated food or water, or inhalation of aerosols. Personal hygiene practices, such as frequent hand washing, will help prevent rodent-borne diseases as well as using caution in areas likely to be occupied by vermin.

Workers will be advised that if a fever or respiratory illness develops within 45 days of the potential exposure, they should seek medical attention and inform the physician of potential Hantavirus exposure. All precautions will be made to ensure Hantavirus exposure is eliminated in the field. Rodent-borne diseases, including Hantavirus, result in severe respiratory distress and plague.

3.4.4 Mountain Lions

Mountain lions are wild predators but usually do not confront humans. If you encounter one:

- Stay calm. Hold your ground or back away slowly. Face the lion and stand upright.
- Do not approach a lion. Never approach a mountain lion especially one that is feeding or with kittens. Most mountain lions will try to avoid a confrontation. Give them a way to escape.
- Do not run from a lion. Running may stimulate a mountain lion's instinct to chase. Instead, stand and face the animal. Make eye contact.
- Do not crouch down or bend over. Biologists surmise mountain lions don't recognize standing humans as prey. On the other hand, a person squatting or bending over looks a lot like a four-legged prey animal. If you're in mountain lion habitat, avoid squatting, crouching or bending over.

3.4.5 Poison Oak

The potential to encounter poison oak on the Site is low. Poison oak has poisonous sap (urushiol) in its roots, stems, leaves, and fruits. The urushiol may be deposited on the skin by direct contact with the plant or by contact with contaminated objects, such as clothing, shoes, tools, and animals. The poison oak leaf looks like a miniature oak leaf, a triple leaf pattern leading off one stem with prominent veins and a shiny, waxy, surface. In some regions, the leaves remain green during the entire time they are on the stem. In other areas, the leaves change to various colors with the changing seasons. After the leaves fall off, the bare wood is also dangerous and so are the roots. It can grow in the form of vines, trailing shrubs, or upright woody shrubs.

Approximately 85 percent of the general population will develop an allergy if exposed to poison oak. Field staff should be able to identify poison oak and know the signs and symptoms of contact with poison oak.

The best defense is to stay away from any vegetation that you suspect may be poison oak. Avoid contact with anything that touched it, including clothing, equipment, and tools.

If field staff must work in close proximity to an area with known poison oak, the following precautions should be taken:

- Wear protective clothing such as long-sleeved shirts, long pants tied around the ankles, leather or nitrile gloves and neckerchiefs. Tyvek suits can also be worn over your clothes.
- Several protective creams are available which form barriers to protect against the toxic oil found in all parts of the plant.
- When removing clothing, take shoes off first and leave them outside for decontamination by washing.
- Remove all clothing and wash it separately.
- Any object you touch after having been exposed to poison oak can act as a carrier to contaminate others.
- If you come in contact with poison oak, wash immediately using strong soap or detergent. Some sources site that rubbing alcohol can remove oily resin up to 30 minutes after exposure. You can also clean with “tecnu”, a product that can help remove the rash-causing oil, even without water.
- When dressing, put shoes on last so that any poisonous substance remaining on shoes does not contaminate the inside of trousers.

The symptoms of exposure to poison oak (poison oak dermatitis) may include the following:

- Itching
- Redness
- Burning sensation
- Swelling
- Blisters
- Rash (may take up to 10 days to heal).
- The rash can generally be treated at home but contact a medical professional if you experience a severe allergic reaction.

3.4.6 Animal and Bird Droppings

It often contains mold and bacteria which may represent a significant respiratory hazard, including lung disease in the immune compromised individuals. Personnel will be instructed to avoid direct

contact with these waste products. Good personal hygiene practices, such as washing with soap and water, will help minimize the adverse health effects of exposure.

3.4.7 COVID-19

To help prevent infection from, or the spread of, the coronavirus (COVID-19), all staff should follow the recommendations from federal, state, and local experts, including mitigation strategies issued by the Centers for Disease Control and Prevention (CDC; https://www.cdc.gov/coronavirus/2019-ncov/community/index.html).

At a minimum, field staff should practice the following:

- Social distancing – Maintain a distance of at least 6 feet from other workers at the Site, including other Terraphase staff. Consider conducting daily safety tailgate meeting over the phone or using another remote meeting.
- In lieu of obtaining signatures on site forms, document attendees of safety meetings, etc. in a field log and with photos.
- Avoid touching your face, especially eyes, nose and mouth.
- Cough/sneeze into a tissue or the inside of your elbow.
- Wear eye protection to minimize the potential for respiratory droplets to contact your eyes
- Utilize good hygiene practices and wash hands regularly with soap and water for at least 20 seconds, especially before eating or getting into your field vehicle.
- Face coverings should be worn in settings where maintaining social distancing is not feasible as described below.
- If time permits, consider ordering supplies to be shipped to your location or the site instead of visiting stores to purchase them.
- Carry a jug of water and hand soap so you can wash hands when permanent or portable facilities are not available.
- Wear nitrile gloves when working in areas where handwashing is not readily available. Change your gloves often and use standard donning and doffing procedures.
- Utilize disposable barriers (e.g. visqueen) to cover work surfaces provided by or shared with contractors at a site.
- Thoroughly disinfect shared equipment and supplies at the end use.
- To the extent feasible, clean and disinfect frequently touched surfaces in Terraphase fleet vehicles prior to transferring the vehicle to another staff.
- If you are sick with any cold or flu-like symptoms, especially those listed by the CDC as potential symptoms of COVID, or expect that you have been exposed to someone with a confirmed case, please stay home, contact project managers so that alternative staffing/scheduling arrangements can be made, and contact Human Resources.
- Additional site-specific protocols may be posted at field sites or communicated by a client, contractor or other site-specific safety representative, especially at construction sites or active businesses and facilities.

3.4.7.1 Face Coverings

- Face coverings are required or recommended by many local jurisdictions and the CDC to be worn when maintaining social distancing is not feasible or in establishments determined to be essential, such as grocery stores and gas stations. Face coverings should not be considered an alternate to social distancing when it is possible. The purpose of the face coverings is to mitigate the transmission of respiratory droplets that are expelled during sneezing, coughing, and breathing.
- The type of face coverings used should follow the local requirements and/or CDC recommendations. Reusable face coverings are to be washed daily, and disposable masks are to be discarded at least daily.
- Staff performing field activities must have face coverings on their person at all times.
- If face coverings must be worn for an extended period of time or during physical tasks, implement scheduled breaks in areas where face coverings can be removed for the duration of the break. Face coverings should not be used when driving alone in a vehicle.
- Engineering controls (such as maintaining social distancing) should be used when possible to minimize the time spent wearing face coverings.

4.0 ROLES AND RESPONSIBILITIES

The following section describes the roles and responsibilities of the personnel involved with the project. See Figure 1 (below) for a schematic of roles and levels of authority. Appendix A has a list of contact names and phone numbers related to this project.

4.1 Project Manager

The Project Manager has the responsibilities to:

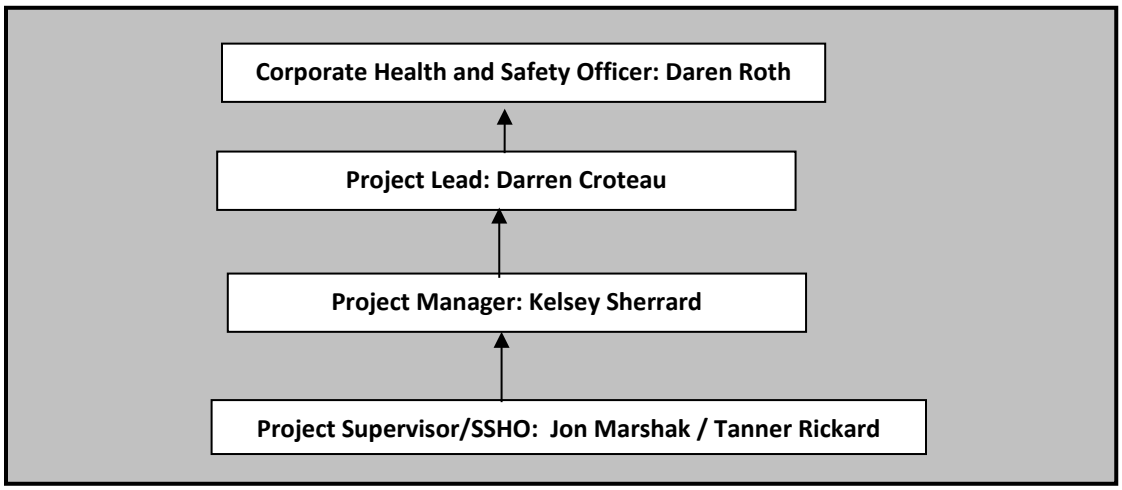
- staff the project with qualified personnel (including proper training and certifications);
- ensure that proper documentation is being collected and maintained;
- provide adequate resources and equipment to field personnel;
- monitor the performance of field activities; and
- ensure that company policy is in compliance with all applicable regulations.

4.2 Project Supervisor

The Project Supervisor will serve as the SSHO and will report to the PM. The Project Supervisor has the responsibilities to:

- act as the liaison between field personnel and the subcontractor(s);
- lead the daily and weekly safety meetings;
- ensure that the HASP is being followed;
- provide adequate resources and equipment to field personnel; and
- monitor the performance of field activities.

Figure 1: Project Personnel Structure



4.3 Subcontractor(s)

Terraphase is responsible for the oversight and implementation of the project safety program. Each subcontractor under their oversight will be required to designate one individual to work directly with and under the authority of the SSHO to ensure that safety responsibilities are being met. Coordination and control of workflow will be achieved through frequent meetings (formal and informal) and job site inspection. The designated subcontractor safety designee (subcontractor project manager) must be granted stop work authority over persons from their company.

Subcontractor control and coordination will be through the chain of command identified in Figure 1. Although each subcontractor is ultimately responsible for the performance and actions of their employees, the SSHO has the authority to take action when a violation of safety guidelines is in question.

4.4 Training

Field personnel engaged in project operations that potentially expose them to hazardous wastes, hazardous substances, or any combination of hazardous wastes or hazardous substances shall have satisfied, at a minimum, the following training requirements:

- Initial 40-hour HAZWOPER training
- Annual 8-hour HAZWOPER refresher training current within one year

4.4.1 General Site-Specific Training

All potential field personnel will review this HASP before commencing work which will serve as site-specific training. The SSHO will review the HASP before field operations begin and the SSHO, or designee, will conduct daily tailgate safety meetings (i.e., pre-entry briefings) to bring up appropriate health and safety concerns and discuss any changes in field conditions. The SSHO will conduct additional pre-entry briefings with entrants to the site who are not present for the tailgate safety meeting. Field personnel will certify their review by signing a HASP acknowledgement form (Appendix B).

Any additional site-specific safety concerns, such as noise, heat illness prevention, or lock-out/tag-out, will be addressed by the PM, and the SSHO will be provided with proper Site-specific training with accordance with any Cal/ OSHA regulations prior to the start of the project, as applicable.

COVID-19 awareness training was conducted in April 2020 by the project supervisors.

4.4.2 First Aid/CPR

Medical assistance is in near proximity to the Site, and therefore, per 29 CFR 1910.151, a designated first aid provider is not required. Personnel trained in first aid/cardiopulmonary

resuscitation (CPR) and bloodborne pathogens (29 CFR 1910.151 and 1910.1030) may administer first aid and CPR if needed.

5.0 SAFETY MEETINGS

All workers who are permitted access to the site will receive a site orientation briefing and a review of pertinent aspects of the project and HASP before the start of work. Personnel will sign a form (Appendix B) documenting that they have had an opportunity to review the HASP, understand the requirements, and agree willfully to adhere to the safety aspects of the plan.

The site orientation briefing will include the following aspects:

- Key personnel and responsibilities
- Site hazards (known and potential)
- PPE requirements
- Emergency procedures (including signals, evacuation locations, and what constitutes an emergency)
- Location and route to the nearest medical facility
- Incident reporting procedures

Daily informal safety meeting will be conducted each morning before work commences. Daily meeting attendance will be documented. Sign-in sheets for the safety meetings are included in Appendix C.

Personnel are encouraged to immediately report any unsafe work conditions or work practices observed to the Project Supervisor.

6.0 ACCIDENT REPORTING

Workers are required to immediately report all accidents, incidents, near-miss incidents, injuries, illnesses and injuries requiring first-aid (no matter how trivial) to their supervisor and/or the SSHO.

In the event of a worker injury or illness, the SSHO must be notified, who will in turn immediately report the incident to the Project Manager to assist with the coordination of required medical assistance and related workers compensation case management follow-up.

Should an incident such as a serious injury (requiring hospitalization), explosion, fire, or a spill or release of toxic materials occur during the project, the SSHO will immediately report the incident to the Project Manager and appropriate government agencies. The written report must include the following information:

- Name, organization, telephone number, and location of the contractor
- Name and title of the person(s) reporting the incident
- Date and time of the incident
- Location of the incident
- Approximate chronological summary of details occurring before and at the time of the incident
- Cause of incident (if immediately known)
- Casualty information (fatalities or disabling injuries)
- Details of any existing chemical hazard or contamination
- Estimated property damage (if applicable)
- Nature of the damage and effect on the contract
- Actions taken to preserve safety and security
- Other damages or injuries sustained
- Witness statements

If a utility strike does occur, report this to the PM and utility operator as soon as it is safe to do so. The contact information for potential utility operators near the Site is available in the USA ticket.

7.0 PERSONAL HYGIENE AND SANITATION FACILITIES

The following personal hygiene requirements will be observed.

Water Supply. A water supply will be available during all field work and will meet the following requirements:

- Potable Water: an adequate supply of potable water will be available for field personnel consumption. Potable water will be provided in the form of water bottles, canteens, or water coolers. Potable water containers will be properly identified in order to distinguish them from non-potable water sources.

- Non-Potable Water: non-potable water may be used for hand washing and cleaning activities. Non-potable water will not be used for drinking purposes. All containers of non-potable water will be marked with a label stating: “Non-Potable Water; Not Intended for Drinking Water Consumption.”

Toilet Facilities: Toilet facilities are available at the Paramount Ranch Site in the National Park Service building.

8.0 PERSONAL PROTECTIVE EQUIPMENT

PPE in the form of protective footwear and appropriate work clothing is required for all field activities. PPE for specific field activities is listed below.

All Field Activities (Level D PPE):

- Boots – chemical resistant, steel toe and shank (ASTM F2412-11 and F2413-11); boots shall be equipped with deep traction sole
- Safety vests (Yellow or orange with reflective strips)
- Work clothing (e.g., long pants)

Drilling or work around heavy equipment:

- Safety Glasses (ANSI Z87.1-2015)
- Hard Hat (ANSI/ISEA Z89.1-2014 Class A, B, and C)
- Hearing Protection (foam inserts)
- Gloves - Chemical (Nitrile) and resilient work gloves (leather or equivalent) if using sharp tools to cut acetate liners or handling equipment that could result in abrasions or punctures

Soil Sampling:

- Gloves – chemical (nitrile)

If necessary:

- Tyvek® suit or similar coverall (splash hazard)
- Rubber boots or overboots (wet conditions)

PPE offers a high degree of protection, yet the equipment must be maintained and inspected on a regular basis. Hard hats should be discarded if cracked. Boots should be maintained (use waterproofing if necessary) to prevent injuries, disease (from wet conditions), and insect/snake bites.

Employees required to wear PPE will be trained to know at least the following:

- When PPE is necessary.
- What PPE is necessary.
- How to properly put on, take off, adjust, and wear the PPE.
- The limitations of the PPE.
- Proper care, maintenance, useful life, and disposal of PPE.

Changes in the workplace or in the type of required PPE that make prior training obsolete may require additional training or retraining of employees.

9.0 AIR MONITORING

9.1.1 Monitoring

Dust monitoring will be conducted utilizing direct reading aerosol (particulate matter) equipment capable of continuous air flow monitoring. As described herein, ambient air samples will also be collected downwind of removal activities and analyzed for asbestos, heavy metals and CTPVs as surrogate for PAHs. Additionally, meteorological parameters consisting of wind speed, wind direction, temperature and relative humidity will be monitored.

Based on regulatory guidance and Division of Occupational Safety and Health of California (Cal/OSHA)'s time-weighted average (TWA) Permissible Exposure Limits (PELs) and consensus guidance of the National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limits (RELs), perimeter air quality Action Levels for Particulate Matter, Asbestos, Heavy Metals and CTPVs are summarized in the table below from the CAMP:

Table 2-1

Perimeter Action Levels for Particulate Matter, Asbestos, Heavy Metals & PAHs

	Particulate Matter	Asbestos	Heavy Metals	PAHs
Activity	During ash and debris removal activities			

Action Level	50 µg/m^3 greater than background (30 min. avg.) for debris removal of less than 50 cubic yards,
	
	OR
	
	25 µg/m^3 greater than background (30 min. avg.) for earth moving of equal to or more than 50 cubic yards,
	
	OR
		The Action Levels for asbestos, heavy metals and PAHs:
		
		• Asbestos = 0.01 f/cc
		• Heavy Metals[1]:
		  ○ Arsenic (Inorganic) = 0.5 µg/m^3
		  ○ Cadmium = 0.25 µg/m^3
		  ○ Chromium (IV) = 0.25 µg/m^3
		  ○ Lead = 3.0 µg/m^3
		
		• Coal Tar Pitch Volatiles[2] = 100 µg/m^3		

	persistent visible fugitive dust is leaving the site.			
Response	If the action level concentration is reached downwind, confirm background level. If the working site particulate exceeds the action level, implement dust suppression techniques.			

Stop Work Limit	50 µg/m^3 greater than background (30 min. avg.) for earth moving of less than 50 cubic yards,
	
	OR
	
	25 µg/m^3 greater than background (30 min. avg.) for earth moving of equal to or more than 50 cubic yards,
	
	OR
	
	persistent visible fugitive dust is leaving the site.
		The stop work Actions Levels are as follows:
		
		• Asbestos = 0.01 f/cc
		• Heavy Metals[1]:
		  ○ Arsenic (Inorganic) = 0.5 µg/m^3
		  ○ Cadmium = 0.25 µg/m^3
		  ○ Chromium (IV) = 0.25 µg/m^3
		  ○ Lead = 3.0 µg/m^3
		• Coal Tar Pitch Volatile[2] = 100 µg/m^3
		
		Action Levels and suppression techniques shall be reviewed if analytical results exceed these levels.		

Sampling Period	30 minutes average	8 hours minimum		
Sampling Method	TSI DustTrak DRX Aerosol Monitor 8533	Integrating Asbestos Air Sampling in Accordance with NIOSH Methods	Integrating Metals Air Sampling in Accordance with NIOSH and OSHA Methods	Integrating CTPVs Air Sampling in Accordance with OSHA Method
Location	Up wind and downwind locations, if different than the fixed monitoring points.	Downwind locations, determined based on wind direction.		
Frequency	Continuously during all demolition and excavation activities.	Asbestos, heavy metals, and PAHs shall be sampled during the beginning of debris removal activities and at the onset of each significantly different activity until three days' sample results are returned. If results for the same site location are below the Action Levels, sampling will be suspended.		

[1] Safety Factor of 10 Applied to OSHA Permissible Exposure Limits as Community Protection Factor
[2] Coal Tar Pitch Volatiles is used as surrogate for polycyclic aromatic hydrocarbons

9.1.2 Particulate Matter Air Monitoring

As described in Section 4.0 of the CAMP, TSI DustTrak DRX Aerosol Monitor 8533 or equivalent shall be used to for particulate matter. This direct reading instrument has an aerosol measurement range from 0.001-150 mg/m^3 (1-150,000 µg/m^3) and provides appropriate sensitivity for monitoring at the Site.

These direct reading instruments will be calibrated on a daily basis and maintained in accordance with the manufacturer's specifications. All real-time monitoring data will be logged. Data records will be referenced to site location, time and date of reading, and the initials of the field technician. The air-monitoring information will be monitored throughout the day during site activities and reviewed with the documentation package to ensure the airborne levels at the site perimeter are less than the established action levels.

9.1.3 Air Monitoring Action Levels

As described in Section 4.2.2 in the CAMP, Table 4-1 provides Action Levels for airborne asbestos, heavy metals, and coal tar pitch volatiles (CTPVs) as surrogate for polycyclic aromatic hydrocarbons (PAHs), detection limits, sampling methods, sampling media and sampling period.

Asbestos, heavy metals, and coal tar pitch volatiles (CTPVs) air samples will be collected using battery operated SKC Universal pumps (or equivalent) at the perimeter locations over time periods that average approximately eight (8) - ten (10) hours a day.

Meteorological data and real-time data collected will be evaluated and used to select what sample is anticipated to be the downwind sample for each day of monitoring if there is any uncertainty regarding the predominant wind direction.

TABLE 4-1

AIR MONITORING ACTION LEVELS, D

Air Contaminant	Action Level	Detection Limit	Sampling Method	Sampling Media	Sampling Period
Asbestos	PCM Total Fibers = 0.01 f/cc TEM Asbestos Fibers = 0.01 f/cc	PCM = 0.002 f/cc TEM = 0.002 f/cc	NIOSH Methods 7400/7402	25 mm MCE Filter	8 hours
Heavy Metals	Arsenic (Inorganic) = 0.5 µg/m^3 Cadmium = 0.25 µg/m^3 Chromium (IV) = 0.25 µg/m^3 Lead = 3.0 µg/m^3	As = 0.009 Cd = 0.0037 Cr(VI) = 0.009 µg/sample Pb = 0.023	As/Cd/Pb NIOSH Method 7303 Cr(VI) OSHA Method ID-215	37 mm MCE Filter 37 mm PVC Filter	8 hours
PAHs as Coal Tar Pitch Volatiles	CTPVs = 100 µg/m^3	CTPVs = 6 µg/sample	OSHA Method 58	37 mm PFTE Filter	8 hours

NIOSH and OSHA Methods are selected based on Galson Laboratory recommendations
NIOSH Method 7402 TEM analysis may be used to confirm asbestos fibers if NIOSH 7400 PCM analysis exceed 0.01 f/cc

9.2 Air Monitoring Action Levels

Adherence to a proper quality assurance and quality control (QA/QC) plan is essential for a meaningful air sampling effort. The major concerns of a QA/QC plan are calibration of equipment and document control.

9.2.1 Calibration and Maintenance Procedures

All direct reading instruments will be calibrated daily before work or as recommended by the manufacturer. Calibration records will be kept that detail date, time span, gas or other standard, and the name of the person performing the calibration. The SSHO will perform no other maintenance procedures unless approved by the Project Manager.

9.2.2 Documentation

Strict adherence to document and data control procedures is essential for good QA/QC. Data and calibration records must be accounted for and retrievable at all times. Types of documents that are essential include notes, logbooks, maps, data sheets, and reports. These must be placed in the project files. Copies of all field data reports and personal sampling records will be sent to the Project Manager for review.

Documentation of employee exposure monitoring results must be made available and maintained in compliance with Title 8, California Code of Regulations Section 3204 (for California projects) and 29 CFR 1910.1020.

10.0 DECONTAMINATION OF PERSONNEL AND EQUIPMENT

Despite protective procedures, personnel and equipment may come in contact with potentially hazardous compounds while performing work tasks. If so, decontamination must occur using a broom or brush, or Alconox or TSP wash, followed by a rinse with clean water. Standard decontamination procedures for this task are as follows:

- equipment drop and/or decontamination
- safety boot decontamination
- nitrile glove removal
- field wash of hands and face

The SSO shall maintain adequate quantities of clean water to be used for personal decontamination (i.e., field wash of hands and face) whenever a suitable washing facility is not located in the immediate vicinity of the work area. Disposable items will be disposed of in an appropriate container. Wash and rinse water generated from decontamination activities will be handled and disposed of properly. Non-disposable items may need to be sanitized before reuse. Each site worker is responsible for the maintenance, decontamination, and sanitizing of his/her own PPE.

Safety boots and clothing may be decontaminated as follows:

Before exiting an excavation area, employees must inspect their clothing and footwear to prevent transport of potentially contamination soil off the site, into their vehicles, homes, etc. A visual inspection of employee boots will be conducted at the sidewall of the excavation or on visqueen adjacent to the excavation prior to exiting to the surrounding clean soils or hardscape. Gross contaminants will be brushed off and/or washed off.

Used equipment may be decontaminated as follows:

- An Alconox or TSP and water solution will be used to wash the equipment.
- The equipment will then be rinsed with clean water.

Each person must follow these procedures to reduce the potential for transferring chemically affected materials off site.

11.0 MEDICAL SURVEILLANCE

Any field personnel engaged in project operations that expose them to hazardous wastes, hazardous substances, or any combination of hazardous wastes or hazardous substances shall be participants in a Medical Surveillance program that meet the requirements of 8 CCR 5192(f). These persons must be medically evaluated and cleared for use of respiratory protection devices and protective clothing for working with hazardous materials by the examining physicians. The medical clearance shall be current within one year through at least the last day of field operations. The applicable requirements under the Cal/OSHA standards for HAZWOPER and Respiratory Protection Program will be observed. Current copies of training certificates and statements of medical program participation for all Terraphase personnel are maintained by the Terraphase headquarters office.

12.0 FIRST AID AND MEDICAL TREATMENT

All persons onsite must report any near-miss incident, accident, injury, or illness to the SSHO. A trained site first aid provider will provide first aid. Injuries and illnesses requiring medical treatment must be documented. The SSHO must conduct an accident investigation as soon as emergency conditions no longer exist and first aid and/or medical treatment have been completed. All necessary reports must be completed and submitted to the PM within 24 hours after the incident.

If treatment beyond first aid is required, the injured should be transported to the nearest medical facility offsite. If the injured is not ambulatory, or shows any sign of not being in a comfortable and stable condition for transport, then an ambulance/paramedic should be summoned. If there is any doubt as to the injured worker's condition, it is best to let the local paramedic or ambulance service examine and transport the worker.

FIGURES

File: K:\GIS\Prj\S073.001 Woolsey Fire Cleanup\MXDs\Fig1_Fire Site Location Map.mxd 10/15/2019 Created by: Initial Checked by: Initial Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

APPENDIX A
CONTACT NAMES AND PHONE NUMBERS

Emergency Contacts

Emergency	
Ambulance	911
Police	911
Fire Department	911
Non-Emergency	
Los Angeles City Fire Station 65	(213) 485-6265
LA County Sheriffs Dept. Malibu/Lost Hills Sheriff's Station	(818) 878-1808
Hospitals	
Westlake Village Urgent Care	Emergency Center: (805) 379-9125
Los Robles Regional Medical Center	Emergency Center: (805) 497-2727
Other	
Poison Control Center	(800) 233-3360
CHEMTREC (spills)	(800) 424-9300

Terraphase Engineering Inc.

Office Number: (510) 645-1850

Corporate Health and Safety Officer: Daren Roth

Office Number: (510) 645-1850 X38
Cell Number: (925) 719-5496

Project Lead: Darren Croteau

Office Number: (949) 377-2227 x76
Cell Number: (415) 902-3570

Project Manager: Kelsey Sherrard

Office Number: (775) 234-2459 x140
Cell Number: (530) 249-0493

Project Supervisor/SSHO: Jon Marshak

Office Number: (510) 645-1850 x103
Cell Number: (713) 305-3463

Additional Project Supervisor/SSHO: Tanner Rickard

Office Number: (949) 377-2227 x142
Cell Number: (310) 971-7107

THIS PAGE LEFT INTENTIONALLY BLANK

APPENDIX B
HASP REVIEW AND ACCEPTANCE FORM

HASP Review and Acceptance Form

All field personnel working on the site must be familiar with the HASP. By signing below, you confirm that you have read, understand, and agree to abide by the HASP. Any questions regarding health and safety on this site may be directed to either the Project Supervisor/SSHO or Project Manager.

Name	Company	Date

THIS PAGE LEFT INTENTIONALLY BLANK

APPENDIX C
SAFETY MEETING SIGN-IN SHEETS

Safety Meeting Sign-In Sheet

Conducted By:

Date:

Topics Discussed:

Concerns/Problems/Hazards:

Meeting Attendees

Name	Company

THIS PAGE LEFT INTENTIONALLY BLANK

APPENDIX D
DIRECTIONS TO THE NEAREST HOSPITAL

24-hour Emergency Services:

Hospital:	Los Robles Regional Medical Center
Address:	215 West Janss Rd, Thousand Oaks, CA 91360
Phone:	(805) 497-2727
	Emergency Room Wait Time: Text “ER” to 32222

Directions to 24-hour Emergency Services

1. Take CA-23 N in Los Angeles County
2. Follow CA-23 N to US-101 N
3. Merge onto US-101 N (4.0 mi)
4. Take Exit 45 from US-101 N to Lynn Rd (0.3 mi)
5. Turn right onto Lynn Rd (1.9 mi)
6. Follow Lynn Rd to Medical Center Dr (30 ft)
7. Continue on Medical Center Dr to destination
8. 215 West Janss Rd, Thousand Oaks, CA 91360

Nearest Urgent Care Services:

Hospital:	**Westlake Village Urgent Care**
Address:	1220 La Venta Dr #101, Westlake Village, CA 91361
Phone:	Emergency Center (805) 379-9125

Directions to Urgent Care Services

From Circle X Ranch Site Location:

1. Take Yerba Buena Rd to CA-23 N in Los Angeles County (6.0 mi)
2. Slight left onto CA-23 N (6.7 mi)
3. Continue on Agoura Rd to destination (0.5 mi)
4. 1220 La Venta Dr #101, Westlake Village, CA 91361

From Arroyo Sequit Site Location:

1. Head north on Mason Rd toward Mulholland Hwy (0.2 mi)
2. Turn right onto Mulholland Hwy (1.8 mi)
3. Slight left onto CA-23 N (6.7 mi)
4. Continue on Agoura Rd to destination (0.4 mi)
5. Turn right at the 3rd cross street onto La Venta Dr (154 ft)
6. Turn left (249 ft)
7. Turn left (52 ft)
8. 1220 La Venta Dr #101, Westlake Village, CA 91361

From Peter Strauss Ranch Site Location:

1. Head west on Mulholland Hwy toward Troutdale Dr (46 ft)
2. Turn right onto Troutdale Dr (0.4 mi)
3. Turn right onto Kana Rd (2.8 mi)
4. Turn left onto Agoura Rd (3.6 mi)
5. Turn left onto La Venta Dr (194 ft)
6. Turn left (429 ft)
7. Turn left (52 ft)
8. 1220 La Venta Dr #101, Westlake Village, CA 91361

From Rocky Oaks/Cooper Brown Site Location:

1. Head southwest toward Mulholland Hwy (341 ft)
2. Turn left onto Mulholland Hwy (423 ft)
3. Turn left onto Kana Rd (6.0 mi)
4. Turn left onto Agoura Rd (3.6 mi)
5. Turn left onto La Venta Dr (194 ft)
6. Turn left (249 ft)
7. Turn left (52 ft)

8. 1220 La Venta Dr #101, Westlake Village, CA 91361

From Paramount Ranch Site Location:

1. Head east on Paramount Ranch Rd toward Cornell Rd (0.2 mi)
2. Turn left onto Cornell Rd (2.0 mi)
3. Turn right onto Kanan Rd (0.2 mi)
4. Turn left at the 1st cross street onto Agoura Rd (3.6 mi)
5. Turn left onto La Venta Dr (194 ft)
6. Turn left (249 ft)
7. Turn left (52 ft)
8. 1220 La Venta Dr #101, Westlake Village, CA 91361

From Morrison Ranch Site Location:

1. Get on US-101 N from Alsace Dr and Las Virgenes Rd (1.7 mi)
2. Follow US-101 N to Lindero Canyon Rd in Westlake Village. Take exit 39 (6.4 mi)
3. Follow Lindero Canyon Rd and Agoura Rd to the destination (01.4 mi)
4. 1220 La Venta Dr #101, Westlake Village, CA 91361

Hospital: **Malibu Urgent Care**
Address: 23656 Pacific Coast Hwy, Malibu, CA 90265
Phone: Emergency Center (805) 379-9125

Directions to Urgent Care Services

From Miller Property Site Location:

1. Head southeast on Latigo Canyon Rd toward McReynolds Rd (6.4 mi)
2. Turn left onto CA -1 S (3.7 mi)
3. Turn right (125 ft)
4. 23656 Pacific Coast Hwy, Malibu, CA 90265

From Dragon Property Site Location:

1. Head west on Schwind Rd (1.0 mi)
2. Continue onto Trancas Canyon Rd (1.9 mi)
3. Turn left onto CA-1 S (9.5 S)
4. Turn right (125 ft)
5. 23656 Pacific Coast Hwy, Malibu, CA 90265

APPENDIX E
ADDITIONAL SITE SAFETY RESOURCES

TAILGATE SAFETY TOPIC
Protect Your Hands

Let's take a minute to talk about your hands. How would your life be affected if you lost a finger? Not much? A lot? How about if you lost your thumb? No problem you say? Try using any tool effectively without your thumb. What if you lost a hand? Or both hands? I know of one person's grandfather who lost both of his hands and forearms in a farming accident when he was a kid. While he was a remarkable and successful man, there were many things that people with two good hands take for granted that took him years to master. Like eating with a fork (he refused to use prosthetics), or dealing from a deck of cards. What would you do if you lost your hands? Think about it. It probably would not be what you are doing now.

All accidents just don't happen, they are caused by not paying attention and by not thinking of what can go wrong before it goes wrong. I am sure that you can think of instances in your own life where you or somebody you know or love was injured because of these simple reasons. The grandfather who lost his hands as a young boy did so because he didn't shut down the threshing machine before he tried to unclog it. You may be shaking you head and thinking that you would never to such a thing. But how many times A DAY do you do something that could result in an accident to yourself or those around you? Someone, somewhere suffers an injury every single day, every single hour, and probably every minute.

The construction trades and manufacturing industries are especially prone to hand injuries, especially when the company has no safety meetings. There are rough materials to handle, objects to be stacked and stored, tools to be utilized, equipment to be operated. All pose special risks to hand injury. To come up with a list on how to protect your hands in each and every situation would be impossible. The list would be never-ending. Each new advance in technology also advances the opportunities for people to damage their hands and they will, be it by operating a 100-ton press or testing a circuit board.

People usually approach their tasks "at hand" in one of two ways: they either don't think of safety at all before they jump into the task, or they think that they "won't" or "can't" hurt themselves. Wrong. They will. If not today, then most likely sooner than later. Do the smart thing: Before you begin a project, or take up a tool, or start a piece of equipment, think of the accident that CAN and WILL happen unless you make sure that it doesn't. Apply the "what if" criteria of safety to what you are doing: What if...the knife slips while I am stripping this wire? Will I cut myself? What if...the screw driver slips off this stubborn screw I'm trying to remove from this box in my hand? Will I punch the screwdriver through the palm of my hand? What if...that pallet of material falls off the forklift while I am holding this gate open? Will my hands be crushed?

Keep your mind on your hands. "Hand Safety Sense" is just plain ol' "Common Sense"...use yours BEFORE you lose yours, make sure you read the relevant safety training. If your coworker seems to be lacking in common sense then use yours BEFORE they lose theirs. Keep your mind on safety first and your hands will continue to provide you with a way to achieve your personal goals.

TAILGATE SAFETY TOPIC
Preventing Slips, Trips, and Falls (Fall Protection)

Did you know that slips, trips, and falls are second only to automobile accidents in causing personal injury? On stairways alone, falls result in almost two million disabling injuries yearly. There are thousands more minor injuries caused by slips, trips, and falls each year. Most alarming of all is the fact that industrial falls cause over 1,000 deaths each year. This week's Tailgate Safety Topic discusses what can be done to prevent slips, trips, and falls. Most of the suggestions in this article can be used on the job and at home.

Slips occur when there is too little friction between a person's feet and the walking surface. Many factors can cause a slip. Ice, oil, water, cleaning fluids, and other slippery substances are probably the most obvious causes. However, the flooring may be inappropriate—perhaps it is a slick material—or the person who slips may not be wearing proper shoes. To prevent slips, avoid walking in areas which pose slipping hazards if at all possible. Always promptly clean up spills of slippery substances. Better yet, prevent the spills in the first place. If an area is a chronic problem, re-route foot traffic in order to avoid it. If flooring is a problem, replace it or coat it with a non-slip surfacing material. Always follow your company's safe shoe policy. Most safe shoe policies require a slip-resistant sole.

Trips occur when a person's foot contacts an object and they are thrown off balance. The main cause of tripping is obvious—anytime something is in a walkway it could cause someone to trip. Another culprit is an object which projects into the walkway—perhaps material stored low on a shelf. Poor lighting and uneven walking surfaces also cause tripping. Prevention of trips is simple but does require diligence. Keep objects that could cause someone to trip out of the way. Repair uneven flooring and install proper lighting if required.

Falls can be caused by a number of things. Slips and trips frequently result in a fall. Falls also occur for other reasons. Improper use of ladders and scaffolding can result in a fall—usually a very serious one. Falls also happen when people climb objects without using fall protection equipment. Don't risk serious injury by taking shortcuts. If you are working on a ladder, scaffold, or other elevated platform, make sure you know the requirements for using them safely. Always use fall protection equipment when it is required.

Slips, trips, and falls cause numerous injuries every day. But they are among the easiest hazards to correct. Take the time to look around your worksite for these hazards and work to prevent them. Take care not to cause any slip, trip, or fall hazards as you go about your daily activities. Follow the instructions set in your safety program. Don't let a slip, trip, or fall keep you from enjoying all that life has to offer.