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Site Characterization Work Plan

Former Wastewater Treatment Plant
Larkspur, California

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Prepared for

Sanitary District No. 1
of Marin County
2960 Kerner Boulevard
San Rafael, CA 94901

K/J Project No. 1565036.00

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Section 1: Introduction

This *Site Characterization Work Plan* (Work Plan) describes the approach to implement site characterization actions presented to the United States Environmental Protection Agency (USEPA) in a meeting dated 18 April 2016, to support remediation of the Former Larkspur Wastewater Treatment Plant site located at 2000 Larkspur Landing Circle, Larkspur, California (Site). The property and former wastewater treatment plant are owned by the Sanitary District No. 1 of Marin County (District).

The scope of activities described herein presents a plan for characterization of surficial soil, subsurface soil and debris, as well as drainage sediments to support remedial actions and final Site closure. The Work Plan provides a rationale and implementation plan for sampling and the framework for assessing the data to determine the limits of remediation to comply with Site cleanup goals and to characterize materials for waste disposal during remediation.

1.1 Document Organization

This Work Plan has been prepared in general conformance with USEPA guidance, with the content organized into the following sections.

- **Section 1 – Introduction:** identifies the purpose and objectives of the Work Plan.
- **Section 2 – Background Information:** summarizes the Site history, previous Site characterization and remediation activities, and the current understanding of the nature and extent of chemical impacts at the Site.
- **Section 3 – Site Characterization:** describes the site characterization plan, with supporting sampling rationale and design details.
- **Section 4 – Field Sampling Methods:** describes the field procedures for scheduling, locating, and collecting samples; field quality assurance/quality control sampling and sample custody requirements.
- **Section 5 – Laboratory Analysis:** describes and the laboratory preparation procedures, analysis procedures, and quality assurance/quality control.
- **Section 6 – Data Management, Review, and Analysis:** describes the process of evaluating the sampling data and comparing the data to Site cleanup goals and waste disposal limits.
- **Section 7 – Record Keeping and Reporting:** describes the procedures for documenting findings from implementation of the sampling and analysis program.
- **References:** provides a list of documents referenced in the Work Plan.

Tables, figures, and appendices are included in separate sections at the end of the Work Plan.

1.2 Objectives

This Work Plan identifies the locations and describes the procedures for collecting samples for Site characterization. This Work Plan is developed in general conformance with USEPA Toxic Substances Control Act (TSCA) guidance (2005).

The work proposed in this document is based on the conceptual site model developed from reviewing historical site documents. Several phases of sampling and excavation have been conducted at the Site (as summarized in subsequent sections), and numerous subsurface samples from test pits, soil borings, and confirmation samples from previous excavations have been collected. Data from soil remaining in place is included in Table 1, and was used to develop the sampling and analysis plan presented herein.

Sampling and analysis will be conducted at the following locations:

- Onsite areas where untested imported fill was used to bring the Site to its current grade in 2012.
- Subsurface deposits of imported fill used to backfill the demolition excavations.
- Subsurface deposits of soil and debris used to backfill the demolition excavations.
- Onsite drainage basins and swales.

Laboratory analytical results will be used for two purposes:

- To evaluate if the sampled materials contain concentrations of total polychlorinated biphenyls (PCBs) exceeding the Site cleanup goal of 0.24 milligram per kilogram (mg/kg).
- To characterize materials for waste disposal, in support of the presumptive remedial action at the Site – soil and debris excavation and offsite disposal.

Section 2: Background Information

This section briefly summarizes the current understanding of the physical setting, history, and existing information regarding the Site. The following section includes a site history describing the demolition and backfilling of the Site, investigation and remediation activities performed at the Site, and narrative conceptual site model for the Site.

2.1 Site History and Setting

The District owned and operated the Larkspur Wastewater Treatment Plant (LWTP), located at 2000 Larkspur Landing Circle in Larkspur, California (Figure 1), between 1948 and 1985. The LWTP facility was no longer needed for local wastewater treatment, following completion of the much larger, centralized wastewater treatment plant by the Central Marin Sanitation Agency in 1985. The District began planning for removal of the treatment plant and redevelopment of the approximately 10.5 acre parcel in 1995. In 1998 and 1999, the District demolished the on-site concrete structures and associated piping. The crushed concrete material was mixed with on-site soils and used as a non-expansive engineered fill to backfill the excavations left by the demolition process. The site is currently used as an operations base for District, and includes two modular buildings and an area for sewer maintenance and operations equipment, vehicles, and materials staging.

2.1.1 Site Description

The former LWTP site was purchased by the District in the 1940's. The LWTP was constructed in 1948 and consisted of a Control Room building and connected Sludge Digester, Clarifiers #1 and #2, Biofilters #1 and #2, and the Sludge Holding Pit. By the early 1960's, Clarifier #3 and Biofilter #3 were added to the Plant. In the mid-1970's, a Chlorine Contact Chamber and microscreens were added to the southeast portion of the Site. The LWTP was decommissioned in 1985 when wastewater treatment for the Ross Valley service area was shifted to the Central Marin Sanitation Agency (CMSA) Wastewater Treatment Plant. A Site Plan of the former LWTP is included as Figure 2.

2.1.2 LWTP Demolition and Material Reuse

Demolition of the former LWTP facilities was conducted in 1998 and 1999. The treatment plant structures were primarily composed of reinforced concrete and concrete block, and steel. The exteriors of the aboveground portions of the Treatment Plant were painted with a cream to light green colored industrial paint. The LWTP structures were demolished and the concrete was crushed on-site for use as backfill material. Records indicate that the thin veneer of paint that had been applied to the exterior surfaces did not chip or flake off and was not practical to remove from the concrete. Some of the concrete pipes removed during the demolition process were also crushed and utilized as fill material.

The crushed concrete was tested for the presence of total and soluble lead, due to the paint that existed on the structures prior to demolition. Lead was known at the time to be a common constituent of industrial paint and testing of building materials and paint for lead was a standard practice. Testing of two crushed samples revealed low levels of total lead (42 milligrams per kilogram [mg/kg] in both samples) and soluble lead at 0.8 milligrams per liter (mg/l) and less

than 0.50 mg/l (non-detectable at the analytical method reporting limit of 0.5 mg/l). The reported total and soluble lead concentrations were below applicable threshold concentrations and not considered to represent an adverse risk to human health or the environment for the intended future site use (residential and commercial mixed use). At the time (1998-1999) it was not realized that the paint on the concrete surfaces contained PCBs. The presence of PCBs in paint was a poorly publicized environmental concern, and testing for PCBs in paint on concrete was not a standard practice at the time. Activities conducted during site demolition were reported to the California Department of Toxic Substances Control (DTSC) by Questa Engineering in 2000.

The grading plan for the overall development included filling in excavations created during building demolition, and importing soils to complete the site grading. The crushed concrete material was mixed with site soils and used as backfill in the various excavation areas created during the demolition process. Some of the crushed concrete was mixed with soils at the bottoms of deep excavations to stabilize wet, clayey soils, but a majority of the crushed concrete/soil mixture was used to backfill pits created by the demolition of the three clarifiers, the Sludge Digester with attached Control Room, and the Sludge Holding Pond. These areas had been excavated to relatively deep depths to remove the concrete tanks and structures. A thin layer of crushed concrete/soil mixture (approximately one foot thick) was also placed near surface grade in the areas of the three biofilters, and in other low lying areas of the site. Figure 3 illustrates the approximate extent of the crushed concrete and mixed fill soil in cross sections through the various site locations.

Subsequent to backfilling with the engineered fill, imported fill was brought onto the site and placed over the crushed concrete material. Testing of this imported fill after grading revealed low concentrations of TPH as diesel fuel (TPHd), TPH as motor oil (TPHmo), and polychlorinated biphenyls (PCBs). Site remediation activities were conducted in 2005 and 2006 and in October 2006, the DTSC issued a "No Further Action" letter for the site.

2.1.3 Site Stabilization and Grading

In May 2012 the District re-graded the site to minimize erosion and clean-up its appearance, spreading out clean soil stockpiles that were brought onsite by District as surplus emergency construction materials and by the previous property developer (Campus-St. James) in 2007/2008. The District also installed a stormwater conveyance system and erosion control measures on-site; and maintains best management practices to capture and control runoff, including a CalTrans-type grass mix on the sloped and terraced surfaces to prevent stormwater run-on and run-off from eroding the soils

2.1.4 Current Site Use

The Site is currently used as a District vehicle parking area, Supervisory Control and Data Acquisition (SCADA) computer monitor/control building (and building expansion to the adjacent sanitary sewer pump station called "PS 10 Landing B"), sanitary sewer pipeline and manhole storage area (for new spare parts that are used on an as-needed basis), and incidental employee check-in (to the building). The southernmost approximate two acres are used for this area. The site is completely fenced off from the public with a cyclone chain-link fence of approximately 8-ft in height, and has a locked swing-gate at the main entrance. Lighting is provided by the SCADA Building / PS 10 Building Expansion, which serves as the employee check-in location. Employees meet here for an hour in the morning, and an hour at the end of

the day. The SCADA Building / PS 10 Building Expansion is a pre-fabricated building that will eventually be replaced by a District Headquarters/Corporation Yard building.

2.2 Historical Site Investigation and Remediation Activities

Detailed information on the individual investigations and/or remedial actions can be found in the following reports, which are available on DTSC's Envirostor website:

- 1996 Questa Investigation (Questa 1996)
- 2000 Questa Report, June 12 (Questa 2000)
- 2004 Questa Phase II Investigation (Questa 2004b)
- 2006 EKI, Report documenting removal of contaminated fill (EKI 2006)
- 2006 NFA from DTSC
- 2007/2008 Questa Phase II Investigation (Questa 2008).

The following summarizes the investigation and remediation activities conducted at the Site between 1995 and 2008.

2.2.1 Pre-Demolition Preliminary Site Characterization

A Phase I Environmental Site Assessment and a Phase II Subsurface Investigation of accessible site locations were conducted between 1995 and 1996, and reported by Questa Engineering Corporation (Questa) in September 1996. Information from the Phase I and Phase II investigations was used to identify the areas of the site to be investigated further in conjunction with demolition of site facilities.

2.2.2 LWTP Demolition Sampling

In 1998, District contracted with Nute Engineering to prepare Demolition and Restoration Plans for the LWTP. The Plans called for the crushing of the concrete plant facilities on site and re-using the material as engineered fill.

- **Phase I:** Phase I of the site demolition included removal of the Chlorine Contact Chamber, Sludge Thickener, and the eastern parking lot. Concrete slabs were temporarily stored in the Sludge Holding Pond area, and later crushed for re-use during Phase II of the demolition. Phase I demolition was accomplished between January and May of 1999.
- **Phase II:** Phase II demolition was conducted between July and September 1999. The structures demolished during Phase II included Biofilters No.1, 2, and 3; Clarifiers No.1, 2, and 3; and the Sludge Digester with attached Control Room. The results of samples collected during demolition were presented in a 12 June 2000 Questa report.

2.2.3 Import Fill Characterization

In 2004, a characterization of the imported fill was conducted by Questa to determine if any chemicals of potential concern were present in the imported soils. Results were presented in the June 2004 report prepared by Questa. The investigation included collecting samples using hand augers and electric augers. Twenty-six boreholes to depths of 2.5 to 3.0 feet below the ground surface were advanced and 88 soil samples were collected and composited for testing. Laboratory results indicated several chemicals of potential concern in the import fill, including TPHd, TPHmo, and PCBs. These constituents were found to occur in four specific site areas that had received imported fill.

2.2.4 Remedial Excavation and DTSC No Further Action

Excavation and removal of contaminated fill containing constituents of concern exceeding the site-specific remedial goals approved by the DTSC (TPHd at 100 mg/kg, TPHmo at 500 mg/kg, and total PCBs at 0.22 mg/kg) from the four sub-sites was completed between September and November 2005. Results of confirmation sampling indicated that the residual contaminant concentrations were reduced in the four areas to levels below the site cleanup goals. A fifth sub-site was identified during completion of this work, and removal of soil exceeding the cleanup goals was achieved between February and March 2006. Erler & Kalinowski, Inc. (EKI) submitted a report in 2006 to the DTSC describing the removal actions, and on 20 October 2006, the DTSC issued a no further action letter for the site.

2.2.5 Subsequent Site Characterization and Remedial Excavation:

In November 2007, TRC/Lowney conducted an additional investigation of fill quality for John Laing Homes. TRC/Lowney's report, dated December 4, 2006, indicated that several additional areas of the imported fill contained TPHd, TPHmo, and PCBs in excess of the site cleanup goals. A follow up investigation was performed by Questa and additional excavation work removed the contaminated imported fill from six small areas. Sampling conducted in 2007, following the additional remediation work, showed that some of the engineered fill (soil mixed with crushed concrete) located below the imported fill (i.e., below 3 feet below ground surface [bgs]) contained detectable concentrations of total PCBs, especially in the areas of the former Clarifiers, Sludge Digester, and Control Room Building, where thick sections of fill were placed following demolition of LWTP facilities. Low levels of total PCBs were also found to be prevalent in the location of the concrete crusher but at much shallower depths.

The results from the 2007 sampling event, showing detectable concentrations of PCBs at depths below three feet bgs, indicated that further investigation was needed. Additional soil and groundwater sampling was conducted in November 2007 and February 2008, to evaluate the extent of, and PCB concentrations in, the engineered fill material (crushed concrete and soil mixture) placed in the former wastewater treatment plant structure areas following their demolition. In total, the investigation included digging 46 test pits from 5 to 10 feet bgs and advancing 14 soil borings to depths ranging from 15 to 25 feet bgs. Test pits and boreholes were sited to more fully evaluate the presence of PCBs within the engineered fill material. Sample locations are illustrated on Figure 4 and soil and groundwater results are presented in Tables 1 and 2, respectively.

- **Soil Samples:** Field records confirmed that the engineered fill is present at varying thicknesses within the former LWTP structure backfill areas. Furthermore, laboratory results indicated that these materials contained total PCBs at concentrations varying from trace levels (0.01 mg/kg) to moderate concentrations (up to 47 mg/kg), with a single outlier sample result at 53 mg/kg (QTP-CL#1-1 @8'), which likely was due to the presence of paint chips concentrated in the sample tested by the laboratory.
- **Solubility Testing of Soil Samples:** Solubility testing conducted on select soil samples indicated that the PCBs in the paint samples are non-soluble. A summary of these data is presented in Table 4.
- **Groundwater Samples:** Groundwater samples were collected from nine open boreholes. Groundwater sample laboratory results indicated that PCBs concentrations in the nine samples were non-detect, at a reporting limit of 0.5 micrograms per liter ($\mu\text{g/l}$) for Aroclor 1254 and Aroclor 1260, the two Aroclors detected in soil samples at the site. Note that groundwater samples were filtered with a 0.425 micron filter by the laboratory prior to analysis. If groundwater sample laboratory analysis is conducted in the future, the results will be reported with a reporting limit less than 0.5 $\mu\text{g/l}$.
- **Surface Sediment Samples:** A grass lined swale located along the eastern and southern portions of the former plant site collects surface water and transmits it to a storm drain collection system at the southern site boundary, adjacent to Sir Francis Drake Boulevard. Samples of the sediment were collected from the former plant area and tested for the presence of total PCBs. Results of the testing indicated trace levels of total PCBs at or below 0.10 mg/kg wet weight in five of the seven samples collected, which corresponds to 0.125 mg/kg dry weight if a 25% moisture content is assumed (note: future sediment sampling will include measurement of moisture content to facilitate reporting on a dry weight basis). Sample locations are shown in Figure 4 and results are included in Table 3. Two samples contained total PCBs at concentrations of 0.8 mg/kg and 1.1 mg/kg by wet weight. These two samples were located within the backfill of Clarifier #3, which contained crushed concrete materials.
- **Surface Water Samples:** During the soil removal activities, groundwater seeped into several excavation areas, and stormwater flowed into several pits. Analysis of filtered water samples showed no detectable concentrations of PCBs in the samples collected.

Figures 5 and 6 are topographic maps illustrating site-related grades and features prior to and after grading conducted in 2012. Figure 7 represents a cut/fill map that shows the relative change in site elevations, based on the grading activities. The re-grading activities did not remove any soil from the property, and did not re-distribute the PCB-impacted soils. However, the sample depths (as measured from ground surface) recorded during previous site investigations have changed because of the re-grading activities. Revised sample depths have been calculated based on elevation changes illustrated on the cut/fill map and are included in the summary tables.

2.3 Conceptual Site Model

The following summary integrates the previous site characterization and remediation information to describe a conceptual model of the Site, focused on combining the following key areas of understanding:

- Physical setting, primarily backfill deposits that may contain PCBs
- Nature and extent of contamination in soil at the Site
- Fate and transport of contaminants in soil at the Site.

Data limitations are acknowledged and potential additional subsurface characterization work is identified to address the information gaps.

2.3.1 PCB Source Identification

Literature review, field observations, and additional crushed concrete material sampling was completed to identify the probable source of the low levels of total PCBs. During literature review, it was found that PCBs have been used in various industrial applications in addition to their common usage in transformer oils (<http://www.epa.gov/pcb/>). Most notably for the site are references to PCBs being present in industrial paints at other sites in the United States and as pipe coatings in water and wastewater applications. A plasticizer was reportedly manufactured by Monsanto Corporation that included concentrations of PCBs between 5 and 14 percent. This plasticizer was sold to independent paint manufacturers and suppliers who added the plasticizer to paint to create paint with a smooth glossy durable finish. This was reportedly used predominantly in industrial paints and other products (Environmental Protection, April 2001, Vol. 12, No. 4, page 58).

Samples collected from several excavation areas revealed the presence of crushed concrete with painted surfaces and the presence of coated or glazed crushed ceramic pipes. Samples were prepared following USEPA Method 3550B with a sulfuric acid cleanup following USEPA Method 3665 and analyzed following USEPA Method 8082. Laboratory analysis of these materials revealed concentrations of total PCBs in paint chips scraped from concrete at a concentration of 48,000 mg/kg; and crushed painted concrete samples at 0.75 mg/kg. Samples from pipe coatings had trace (0.078 mg/kg) to low (4.5 mg/kg) concentrations of total PCBs.

2.3.2 Chemicals of Concern

Site soils and imported fill materials were tested for the presence of total petroleum hydrocarbons and associated volatile organic compounds (VOCs), lead, and PCBs, based on the known historical industrial activities conducted at the Site. Laboratory results of samples collected in 2004 and 2005 identified TPHd, TPHmo, and PCBs as chemicals of concern in the imported fill material and demolition debris backfill used onsite. In 2006, the District excavated impacted soils containing those compounds at concentrations that exceeded the site-specific remedial goals. The DTSC issued a no further action letter for the site in October 2006. In 2007, an investigation conducted by a prospective property developer identified additional areas of the site where elevated concentrations of PCBs existed in the engineered fill. No other compounds

are known or suspected to be present at the site at concentrations that would represent a human health or an environmental concern.

2.3.3 Nature and Extent of PCBs

Past Site characterization activities have identified residual PCBs in the paint adhered to the crushed concrete as the constituents of concern for the Site. As such, PCBs are expected to occur at depths greater than 4 feet bgs, at locations where engineered fill was previously used onsite. This includes areas where former LWTP structures were removed and excavations were filled, as well as the area used for crushing the concrete during Site demolition activities. Three fill horizons have been characterized at the Site:

- **Clean Surface Deposits:** This material is comprised of clean import soil used for infrastructure repair projects throughout the District, and clean soils imported in 2008 to support development activities. Surplus material was stockpiled at the Site and then subsequently graded into the ground surface to promote positive drainage at the Site. The spatial extent of this material is shown on Figure 8 and generally only resides at the ground surface. The lateral extent of the material is mostly limited to the LWTP demolition footprint. This material has not been characterized onsite and will be included in the scope of the site characterization.
- **Demolition Excavation Backfill – Import Soil:** This material is comprised of import soil backfilled on top of demolition debris backfill during grade restoration following the facility demolition activities. Sampling and analysis following backfilling with this material indicates that the import soil contains PCBs. The spatial extent of the material is collocated with the demolition debris backfill, as shown on Figure 8, and generally only resides in the shallow soil to a depth of approximately 4 feet bgs. This material will be further characterized as part of the scope of the site characterization to support delineation of the excavation limits and waste disposal.
- **Demolition Excavation Backfill – Demolition Debris:** This material is comprised of crushed concrete from the demolition of the facility. Demolition debris was reused at the Site as backfill and generally placed at depth into the facility foundation demolition excavations, which extend as deep as approximately 20 feet bgs. Sampling and analysis following backfilling with this material indicates that the demolition debris contains PCBs. This material will be further characterized as part of the scope of the site characterization to support delineation of the excavation limits and waste disposal.

PCBs detected in onsite samples include Aroclor 1254 and Aroclor 1260. Detectable concentrations of total PCBs in soil range from 0.01 mg/kg to 53 mg/kg, with only one sample exceeding the 50 mg/kg TSCA threshold and one additional sample exceeding the 25 mg/kg threshold for low occupancy use (40 CFR Part 761.61 (a)(4)(i)(B)(1)). The two samples are QTP-08-17 (47 mg/kg @ 5.9 feet bgs), and QTP-CL#1-1 (53 mg/kg at 11 feet bgs). Sample locations are illustrated on Figure 4. The anticipated spatial extents of PCBs in soil at the Site are shown on Figure 8 and a conceptual cross-section of the fill horizons is shown on Figure 9. Samples with PCB concentrations exceeding the USEPA screening level concentration of 0.24 mg/kg for residential use are located in the demolition footprint, at depths ranging from 0.7 to 16 feet bgs.

As indicated in Section 2.2.5 and based on the analytical results summarized in Table 4, historical groundwater sampling and analysis and solubility testing of soil samples indicate that dissolution and migration of PCBs from the demolition debris backfill is not occurring. The source deposits containing PCBs are stable and stationary at the Site. Therefore, groundwater sampling is not included as part of the site characterization activities.

Section 3: Characterization Plan

The purpose of the site characterization is to assess the scope and extent of PCB contamination at the Site. The characterization will allow the District to:

- Excavate and remove PCB contaminated material from the Site.
- Select an appropriate offsite disposal facility for the removed contaminated material to be
- Pursue unrestricted land use for the Site.

Sampling and analysis will be conducted to characterize the various surface and subsurface materials at the Site that may contain elevated concentrations of PCBs (Section 2.3.3). It is anticipated that following the site characterization, drawings showing the extent and depth of proposed remediation (excavation and removal) will be developed.

This section identifies the need for characterization data, summarizes the materials to be sampled and analyzed, and presents the rationale for sample locations. Sample collection and laboratory analytical procedures are described in Sections 4 and 5, respectively.

3.1 Presumed Remedial Approach and Supporting Characterization Needs

The presumed remedial approach for the Site is soil and debris removal with off-site disposal. Site characterization will be conducted to assess the following materials:

- The upper layer of import material that was graded across the site in 2012.
- The demolition debris emplaced at the Site following demolition of the former wastewater treatment plant.
- The soils below the proposed sidewalk area along the western edge of the property.
- The sediments in the drainage swale along the eastern and southern extents of the property.
- Native soils beyond the lateral and vertical limits of the above materials.

This approach involves performing sampling and analysis activities prior to commencing with material removal operations. Specifically, samples will be collected from the debris and import fill for waste characterization purposes, and from native soils horizontally beyond and vertically beneath the limits of the in-place debris and import fill to pre-confirm the limits of excavation. Based on the results of the pre-confirmation sampling and analysis, the excavation limits may be adjusted and additional pre-confirmation sampling and analysis may be conducted. Based on the results of the in-place waste characterization sampling and analysis, the material will be pre-profiled and landfill acceptance will be secured.

Following the sampling and analysis activities, the District will begin planning and contracting for removal operations, which are expected to include excavation, direct loading (with stockpiling as needed for waste management), and off-hauling. Additional sampling and analysis may be conducted if field observations or laboratory results suggest that material removed during excavation warrants further consideration for disposal characterization. In that case, the material will be segregated and further characterized for proper disposal.

Sample collection will include the following:

- **Graded Surface and Near-Surface Soil:** The District will collect surface soil (0 to 3 inches bgs) and near-surface (18 to 24 inches bgs) soil samples to evaluate the presence of PCBs in surface and near surface soils distributed across the Site from clean import stockpiles during grading activities in 2012. These soils will be used as backfill material following completion of the remedial actions, if characterization results confirm the material does not contain concentrations of PCBs exceeding the site remedial goal.
 - **Within Demolition Footprint** – Within the former LWTP footprint, the sampling will be conducted with the same spacing as the Demolition Backfill samples discussed below and shown on Figure 10. Approximately 420 samples will be collected from 250 locations for potential analysis within this area of the Site.
 - **Outside Demolition Footprint** – Impacts from demolition and past operations are not anticipated outside of the former LWTP footprint. As summarized in EKI 2006, pre-demolition and demolition phase soil and groundwater sampling and analysis was conducted in the vicinity of the former shop and maintenance buildings, the former 500 and 1,000 gallon fuel aboveground storage tanks (ASTs), and the former chlorine contact chamber. The analytical results were presented to DTSC in support of Site closure, which was subsequently granted (See EKI 2006 for sampling locations and analytical results; see DTSC 2006 for closure approval, which was granted following review of the information presented in EKI 2006.) Accordingly, the sampling in this area will be conducted with a wider spacing (i.e., approximately 100-foot by 100-foot grid, as shown on Figure 10) than the Demolition Backfill and Pre-Confirmation samples discussed below. Additionally, one verification sampling location to collect surface and near surface samples for PCB analysis will be situated at each of these historic locations (i.e., the former shop and maintenance buildings, the former 500 and 1,000 gallon fuel ASTs, and the former chlorine contact chamber). Approximately 50 samples will be collected from 25 locations for analysis within this area of the Site.

The total number of Graded Surface and Near-Surface Soil samples is approximately 470 samples from 275 locations.

- **Demolition Backfill Samples:** Samples of the import fill material and demolition debris backfill that exists beneath the graded surface soils within the former LWTP footprint will be collected for analysis to characterize the material for waste disposal. The sampling will be conducted on a grid spacing designed to provide statistically significant results for comparison with the PCB cleanup goal (Section 3.2.1). Samples will be collected from each material type encountered at each of the approximately 250 locations shown on Figure 10. Based on historical information, it is anticipated that one to three different types of material

may be encountered in the demolition backfill; therefore, an estimated minimum of 500 samples will be collected for laboratory analysis.

- Pre-Confirmation Outer Perimeter Samples:** Samples of presumed native soil outside the limits of the demolition debris and import fill materials (i.e., former LWTP footprint) will be collected for analysis to pre-confirm the limits of removal. The sampling will be conducted with spacing designed to provide statistically significant results for comparison with the PCB cleanup goal (Section 3.2.1). Two samples, one from the near surface soils and one from the base of the boring, will be collected from each of the 60 locations shown on Figure 10, for a total of 120 samples collected for laboratory analysis. The maximum depth of the Pre-Confirmation Outer Perimeter borings is approximately 4 feet bgs.
- Pre-Confirmation Interior Perimeter Samples:** Samples of presumed native soil laterally outside the limits of the clarifiers, sludge pit, sludge digester, and biofilters will be collected for analysis to pre-confirm the limits of removal of the construction debris from these previous backfilling activities. The Pre-Confirmation Interior Perimeter Samples will be collected from presumed native soil that exists outside the former deeper excavation, but are physically located inside the outer perimeter sample locations. The sampling will be conducted with spacing designed to provide statistically significant results for comparison with the PCB cleanup goal (Section 3.2.1), as shown on Figure 10. Boring depths will range from approximately 8 to 20 feet bgs, depending on location, and confirmation samples will be collected every five feet, vertically, for laboratory analysis. Approximately 200 samples will be collected and analyzed from approximately 100 locations..
- Pre-Confirmation Depth Samples:** Samples of presumed native soil beneath the demolition debris and import fill used to backfill the clarifiers, sludge pit, sludge digester and biofilters will be collected for analysis. The sampling will be conducted with the same spacing as the Demolition Backfill samples discussed above and shown on Figure 10 to provide statistically significant results for comparison with the PCB cleanup goal. An estimated 250 samples will be collected for laboratory analysis from approximately 250 locations.
- Stockpile Samples:** There are four remaining stockpiles of clean import soil at the Site, as shown on Figure 10. For the purposes of this Work Plan, the stockpiles designations and general dimensions are as follows:

Stockpile	Length	Width	Maximum Height
1A	70 feet	20 feet	7 feet at center
1B	50 feet	25 feet	8 feet at center
2	35 feet	20 feet	6 feet at center
3	110 feet	12 feet	3 feet at center

One discrete soil sample will be collected per 50 cubic yards of stockpiled material. A grid will be superimposed on each stockpile to establish approximately 50-cubic yard cells, based on the dimensions indicated above. Discrete samples will be collected from each cell, with the sampling depth alternating between surface (0 to 3 inches bgs) and near surface (18 to 24 inches bgs). The stockpiled soil will be used as backfill material following completion of the remedial actions, if characterization results confirm the material does not

contain concentrations of PCBs exceeding the site remedial goal. Approximately 40 discrete samples will be collected for laboratory analysis.

Soil beneath the stockpiles will be sampled and analyzed in accordance with those grid-based sampling locations situated beneath the stockpiles (see preceding descriptions of sampling locations for Graded Surface and Near-Surface, Demolition Backfill, and Pre-Confirmation sampling). At least one sampling location will be situated beneath each stockpile location. If a grid-based sample location is not situated beneath a particular stockpile, then a surface and near surface sampling location will be added in the field.

- **Sidewalk Samples:** Based on standard sidewalk designs, samples of the surface and near surface native soils within a 5-foot wide approximately 375-foot long corridor along the western edge of the property will be collected and analyzed for the presence of PCBs prior to constructing a sidewalk in this area. Sample locations will be spaced approximately 50 feet apart in an alternating staggered alignment, as shown on Figure 10. If laboratory results indicate that PCBs exist in this area at concentrations exceeding the site remedial goal, remediation will occur prior to sidewalk construction. Approximately 16 samples (eight locations) will be collected for laboratory analysis.
- **Catchment Basin Sediment Samples:** The four on-site stormwater catchment basins will be inspected prior to conducting the sampling event. If a catchment basin contains a sufficient amount of sediment, a sample will be collected for analysis.
- **Drainage Swale Sediment Samples:** Based on field observations, the drainage swale that exists along the eastern/southern property boundary is approximately 850 feet long, with a top of bank width spanning eight to 20 feet wide and a depth ranging from 2.5 to 5 feet deep, depending on location along the swale. Surface sediment samples will be collected based on the general longitudinal topographic gradient of the swale, with samples located near retention/ponding locations that may accumulate sediments. Sample locations will be spaced approximately 100 feet apart in an alternating staggered alignment to assess sediments along the bank and at the flow line of the swale, as shown on Figure 10. Approximately 10 samples (10 locations) will be collected from the swale and analyzed for the presence of PCBs. Samples will be collected using a pre-cleaned stainless-steel trowel as described for the surface soil samples.

Sample locations are shown on Figure 10. The number, type, and location of the samples to be collected are summarized in Table 5. Additional details regarding the Demolition Backfill and Pre-Confirmation sampling programs are provided in the following sections.

3.2 Grid-Based Soil Sample Collection

Demolition Backfill and Pre-Confirmation samples will be collected and analyzed to evaluate the concentrations of PCBs within and beyond the limits of the former clarifiers, sludge pit, sludge digester and biofilters. In general, it is anticipated that samples will be collected from up to four (4) vertical sample intervals at each location, as indicated by the conceptual cross section of backfill materials shown on Figure 9. The four vertical sample intervals will characterize the following materials:

- Clean graded surface soil (graded surface and near surface soils)

- Import fill backfilled during demolition
- Construction debris backfilled during demolition (demolition debris)
- Underlying native soil (pre-confirmation depth samples).

Sampling and analysis will be conducted in general accordance with the applicable cleanup verification requirements of 40 CFR Part 761 for bulk remediation waste. Sampling, handling, laboratory, and QA/QC procedures for confirmation sampling and analysis will generally follow those described in Section 4. Laboratory analytical procedures are described in Section 5.

These samples will be collected on an approximate 25-foot by 25-foot grid within the limits of the former wastewater treatment plant footprint (clarifiers, sludge pit, sludge digester and biofilters), resulting in approximately 250 sample locations, with multiple samples being collected at each location, as described above. The rationale for the sample grid spacing is presented in Sections 3.2.1 and 3.2.2, below. Samples will be collected from the ground surface down to the native soil horizon below the construction backfill. Samples will be collected from each material type encountered at each sample location and analyzed for waste characterization to facilitate offsite disposal. Target drilling depths are shown on Figure 11, and are based on the depth of construction backfill (Figure 8).

Pre-confirmation samples will be collected in three groups, including grid samples and perimeter samples.

- **Grid Samples:** Pre-confirmation Depth samples will be collected on an approximate 25-foot by 25-foot grid within the limits of the former demolition activities to define the lower limits of the excavation. Approximately 250 samples will be collected and analyzed. The rationale for the sample grid spacing is presented in Sections 3.2.1 and 3.2.2, below. Samples will be collected from the native soil horizon below the construction backfill, with estimated depths based on the limits of excavation and backfilling conducted during the demolition activities, as shown on Figure 11. Samples collected at the target drilling depth will be visually confirmed to be native soil, then collected and submitted to the laboratory for PCB analysis. The actual depth of the pre-confirmation samples may be adjusted based on field observations of soil type and the presence or absence of debris.
- **Outer Perimeter Samples:** Perimeter samples will be collected around the perimeter of the former demolition activities (Figure 10). The sample spacing is approximately 25-foot on center to be consistent with the grid spacing, resulting in approximately 60 sample locations around the outer perimeter. One sample will be collected in the upper 12-inches of the soil column and one sample from the base of the boring, with the maximum depth to be equal to the base of the demolition backfill in the nearest grid sample (approximately 2 to 4 feet bgs), as shown on Figure 10.
- **Interior Perimeter Samples:** Interior samples will be collected around the perimeter of individual deeper excavation backfill areas within the interior of the former demolition activity footprint (Figure 10). The sample spacing will be approximately 25-feet on center to be consistent with the grid spacing, resulting in approximately 100 sample locations around the inner perimeter features. One sample will be collected every 5 vertical feet, with the

maximum depth to be equal to the base of the demolition backfill in the nearest grid sample to the interior of the perimeter sample location, as shown on Figure 10.

The following sections provide details regarding the grid sampling design.

3.2.1 Sample Design Parameters

The pre-confirmation sampling program is designed to support an excavation-and-removal remedy that will result in the removal of all soils at the Site containing PCBs at concentrations above the cleanup criterion of 0.24 mg/kg. Accordingly, a statistically-based sampling grid will be used to determine the limits of removal and to confirm that the soil cleanup goal (0.24 mg/kg) will be met.

The statistical hypotheses are:

- **Null Hypothesis (H₀)**: This is the baseline condition and asserts that the true mean total PCB concentration in residual soil is greater than 0.24 mg/kg.
- **Alternative Hypothesis (H_a)**: This condition represents achieving the cleanup goal and asserts that the true mean total PCB concentration in residual soil is at or less than 0.24 mg/kg.

Unless there is conclusive information from the pre-confirmation sampling data to reject the null hypothesis, it will be assumed that the baseline condition is true. Two error types are considered in designing the sampling program:

- **False Rejection Error (Type I Error)**: In this case, a true null hypothesis is erroneously rejected and remaining soil would contain PCB concentrations exceeding the cleanup goal.
- **False Acceptance Error (Type II Error)**: In this case, a false null hypothesis is not rejected and resources are expended to remove and dispose of soil containing PCBs concentrations less than the cleanup goal.

Due to the potential risk associated with a Type I Error, the decision error tolerance for this type of error (i.e., the parameter α) will be no greater than five (5) percent. An α value of five (5) percent provides 95 percent confidence in the results, which is a widely accepted confidence interval for environmental decision making (e.g., 95 percent UCL). The corresponding Type II Error decision error tolerance (i.e., the parameter β) will be no greater than ten (10) percent, which is twice the Type I Error tolerance. The extent of the “grey region” will be equal to the cleanup goal of 0.24 mg/kg, indicating that the District is willing to accept a higher probability of cleaning up soil that may contain no PCBs given that it will require fewer confirmation samples and is more protective than if a narrower grey region were selected (i.e., the situation resulting from choosing a lower β value).

3.2.2 Sampling Design and Rationale

Demolition backfill and pre-confirmation depth sampling will be conducted using a square grid layout to confirm the proposed limits of removal and compliance with the cleanup goals. The

grid spacing was developed using Visual Sample Plan (VSP) software (VSP Development Team 2016) for two sampling design objectives:

- Estimating sample locations for comparing a mean to a fixed threshold. This design is intended to estimate a statistically significant number and distribution of grid sample locations for comparison with the cleanup goal and relevant disposal criteria.
- Estimating sample locations for confirming an enclosing boundary. This design is intended to estimate a statistically significant number and distribution of samples (Pre-Confirmation Outer Perimeter Samples and Pre-Confirmation Interior Perimeter Samples) for comparison with the cleanup goals. Although the VSP design is based on incremental sampling and compositing the results, composite or incremental sampling methods will not be used along the boundaries of these areas. Instead, each primary pre-confirmation sample location determined from the VSP design will be compared individually to the cleanup goals.

Parameters input into VSP included the decision error parameters defined in the preceding section and estimates of site-specific standard deviation of PCB concentrations in soil currently at the Site. The estimated standard deviation was 1.231 mg/kg. The key VSP design results are as follows:

- Based on the input parameters, the minimum number of samples required to confirm compliance with the cleanup goal within the limits of the former demolition area is 227. The current sampling plan includes approximately 250 samples.
- The minimum number of samples required to determine cleanup along the boundary of the former demolition area and around interior features is 60 and 100, respectively, which are the approximate number of samples proposed for each condition.

The geometry of the former demolition footprint and the statistical parameters result in a grid spacing of 25 feet. The grid will be laid out in the field, sample points physically marked, and sample locations and depths recorded as described in Section 4. The technical basis for this determination, along with example sampling grids, is provided in Appendix A.

3.3 Waste Characterization

It is anticipated that excavation may generate two classes of soil, which have different disposal requirements based upon the PCB concentrations. These waste material types include the following:

- **Soil with a Total PCB Concentration of Less Than 50 mg/kg:** This material may be disposed at one of the following locations – an approved PCB facility; or when disposed pursuant to 40 CFR Part 761.61(a) or (c), a permitted municipal solid waste or non-municipal non-hazardous waste facility; or a RCRA Sec. 3004 or Sec. 3006 permitted hazardous waste landfill. Soil with a total PCB concentration less than 50 mg/kg does not need to be shipped under a Uniform Hazardous Waste Manifest.
- **Soil with a Total PCB Concentration of 50 mg/kg or greater:** This material must be disposed in a RCRA Sec. 3004 or Sec. 3006 permitted hazardous waste landfill or an

approved PCB disposal facility. Soil with a total PCB concentration equal to or greater than 50 mg/kg must be shipped under a Uniform Hazardous Waste Manifest.

Demolition Backfill samples collected at the grid locations identified in the preceding section will be analyzed for PCBs to determine which of the above bulk PCB waste categories apply to the sample location and depth interval. The sample results, depth interval, and grid spacing will be used to establish waste disposal cells with the associated offsite disposal requirements to be met during remediation.

In addition to the PCB waste analysis, select samples may also be analyzed in accordance with the typical requirements of offsite disposal facilities. The samples will be submitted under chain of custody protocols for analysis using appropriate USEPA methods at a state-certified analytical laboratory. Analytical data will be used to characterize the material in accordance with RCRA and Title 22 of the California Code of Regulations. Although sampling frequencies and analytical requirements are dependent upon disposal facility requirements, it is anticipated that the following analytical data, in addition to PCBs, may be required by disposal facilities:

- Title 22 metals
- Volatile Organic Compounds (VOCs)
- Semi-Volatile Organic Compounds (SVOCs)
- Total Petroleum Hydrocarbons
- Pesticides
- Asbestos.

It is anticipated that the initial frequency of waste profile sampling and analysis is anticipated to correspond to one sample per 1,000 cubic yards of material.

Section 4: Field Sampling Methods

This section discusses the field procedures to be followed during the field sampling program. Sample collection and handling will be performed in general accordance with USEPA guidance (USEPA 1996a, 1996b, 2002) following the standard operating guidelines contained in Appendix B, to the extent practicable. These standard operating guidelines identify general procedures for collecting samples; custody procedures used to document sample integrity during the collection, transportation, storage, and analytical processes; and sample custody and documentation. Specific details modifying and/or augmenting those presented in the general standard operating guidelines that are applicable to this Site and required to comply with 40 CFR Part 761 are presented herein.

4.1 Sampling Procedures

Samples will be collected for waste characterization and pre-confirmation as described in Section 3. Samples will be collected in situ from the surface to a maximum depth of approximately 20 feet bgs. Sample results will be reviewed and evaluated prior to initiating the soil and debris removal activities at the Site. Samples will be collected in accordance with the sampling protocol described in this section and analyzed in accordance with the protocol described in Section 5.

4.1.1 Sample Locations

Field personnel will establish the sampling locations during the field program using a differential global positioning system (GPS) referenced to the North American Datum of 1983 (NAD83), California State Plane Coordinate System, Zone 3. The sample grid coordinates will be pre-programmed into the GPS unit prior to sampling. At the onset of sampling, a known survey marker at the Site will be used to calibrate the GPS unit. The positioning objective is to accurately determine and record the positions of each sampling location.

4.1.2 Sample Collection

Samples will be collected consistent with the Standard Operating Guidelines included in Appendix B using manual sampling methods (e.g., scoops, trowels, spoons, or hand auger) where sample depths are shallow or using mechanical drilling methods (e.g., direct push drill rig) for samples at depths below 1 foot bgs. Sample collection will be performed as follows:

- **Manual Sampling:** Stainless steel spoons or disposable trowels and/or scoops may be used for collecting samples of material at the ground surface (i.e., zero to three inches below ground surface), where deeper sampling is not anticipated, and from catch basins and drainage swales. Sample procedures will generally include:
 - Remove existing vegetation and debris from the sample location prior to collecting the sample.
 - Collect at least 100 grams of sample material into laboratory-provided glass jars that will be capped, labeled for identification, placed in a re-sealable plastic bag and stored in a

- cooled ice chest until being transported to the analytical laboratory under chain-of-custody procedures following the sample handling protocols described herein.
- Classify the sample material in the field in general accordance with the visual-manual procedure of the Unified Soil Classification System (USCS; ASTM D 2488-90).
 - Decontaminate the sampling spoon, trowel, or scoop in general accordance with 40 CFR Part 761.79(c)(2) and as summarized in Section 4.1.4 of this Work Plan and then proceed to the next surface sample location to repeat the sample collection process.
- **Stockpile Sampling:** A slide hammer will be used to collect samples from stockpiles at the Site, using the following procedures:
 - Remove existing vegetation and debris from the sample location prior to collecting the sample.
 - Collect the sample using a clean slide hammer lined with a 6-inch long by 2.5-inch diameter stainless steel tube. The slide hammer will be used to drive the sample tube into the undisturbed soil.
 - Recover the sample tube from the boring and remove it from the slide hammer. The ends of the sample tube will be capped, labeled for identification, placed in a re-sealable plastic bag and stored in a cooled ice chest until being transported to the analytical laboratory under chain-of-custody procedures following the sample handling protocols described herein.
 - Decontaminate the slide hammer and shovel in general accordance with 40 CFR Part 761.79(c)(2) and as summarized in Section 4.1.4 of this Work Plan and then proceed to the next stockpile sample location to repeat the sample collection process.
 - **Hand Auger Sampling:** Hand augers may be used to advance boreholes and collect samples in the shallow subsurface (e.g., less than four feet below ground surface). Hand augers typically consist of a two- to four-inch stainless steel auger bucket with a cutting head.
 - Advance the auger bucket to the target boring depth using the attached auger handle.
 - Remove the auger bucket used to advance the borehole and attach a clean auger bucket. Place the clean auger bucket in the borehole and advance the auger deeper to collect the sample material from the target sample interval.
 - Collect samples into laboratory-provided glass jars that will be capped, labeled for identification, placed in a re-sealable plastic bag and stored in a cooled ice chest and transported to the analytical laboratory under chain-of-custody procedures following the sample handling protocols described herein.
 - Decontaminate the auger and bucket in general accordance with 40 CFR Part 761.79(c)(2) and as summarized in Section 4.1.4 of this Work Plan and then proceed to the next sample location to repeat the sample collection process.

- **Direct Push Drill Sampling:** Continuous cores will be collected at deeper sampling locations using a direct push drilling rig operated by a California-licensed driller. Samples will be collected from the cores following logging.
 - Load the drill sampler with a new acetate sleeve, push or drive the sampling rod to the desired depth, and extract the sampling rod from the ground.
 - Remove the acetate sleeve from the sampler and log the core using the USCS (ASTM D-2488-93) system. General procedures for borehole logging are presented in Appendix B.
 - Cut out sections of the acetate sleeve to collect samples from each distinct material horizon within the core. The acetate sleeve sections retained for sampling will be capped, labeled for identification, placed in re-sealable plastic bags, and transported to the analytical laboratory under chain-of-custody procedures following the sample handling protocols described herein.
 - Decontaminate the sampling equipment and tools in general accordance with 40 CFR Part 761.79(c)(2) and as summarized in Section 4.1.4 of this Work Plan and then proceed to the next sample location to repeat the sample collection process.

4.1.3 Sample Containers, Preservation, and Holding Times

The analytical laboratory will provide certified, pre-cleaned, USEPA-approved containers for samples not being collected in acetate liners, as well as coolers and packing material. Manually collected samples will be transferred from the sampler to clean, laboratory-provided, wide-mouthed, glass jars using a clean stainless steel or plastic spoon. Samples collected from drill cores will be removed and sealed directly from the drilling equipment using the driller-supplied liners and Teflon-coated caps. Table 6 displays the sample container size, preservation, and holding time requirements for each laboratory analysis.

4.1.4 Sampling Equipment Decontamination

Non-disposable equipment used to collect, handle, or measure samples will be decontaminated before reusing the equipment. Decontamination will be conducted in general accordance with 40 CFR Part 761.79(c)(2), 40 CFR Part 761.79(e), and the standard operating procedures (Appendix B), to the extent possible. In particular, the double wash/rinse procedures described in Subpart S will be implemented as follows:

- Excess material adhering to tools and equipment will be scraped off using manual methods such as brushes, shovels, or other tools.
- Tools and equipment will be placed into a first bucket containing detergent and water for thorough scrubbing with a brush.
- Tools and equipment will be transferred to a second bucket containing hexane for a first rinsing.

- Tools and equipment will be transferred to a third bucket containing hexane for a second scrubbing.
- Tools and equipment will be transferred to a fourth and final bucket containing hexane for a second and final rinsing.
- Rinsed tools and equipment will be placed on a clean barrier for drying.
- Rinsate generated during decontamination activities will be contained and managed as investigation derived waste.

Disposable equipment intended to be used only once will not be decontaminated, but rather contained and managed as investigation-derived waste.

Decontamination records will be maintained to document compliance with 40 CFR Part 761.79(f).

4.1.5 Investigation-Derived Waste Management

Investigation-derived waste will include the PPE worn by the field personnel, disposable sampling equipment and supplies, and rinsate from decontamination activities. Investigation-derived waste will be handled in general accordance with standard operating procedures (Appendix B), to the extent possible, with the following modifications:

- Spent disposable sampling equipment and PPE will be disposed as PCB remediation waste following the requirements of 40 CFR Part 761.61(a)(5).
- Wastewater from decontamination activities will be accumulated in a water-tight container and disposed at their current PCB concentration following 40 CFR Part 761.79(g).

Investigation-derived waste will be characterized, managed, and transported off-site in general conformance with Subpart D of 40 CFR Part 761 (Storage and Disposal).

4.1.6 Field Quality Control Checks

The purpose of collecting field quality control samples is to demonstrate the reliability and defensibility of data. Quality control samples collected in the field will be used to assess the overall quality of the sampling and analysis processes. The following field quality control samples will be collected to evaluate the precision, accuracy, and representativeness of the sampling and analysis program.

- **Equipment Blanks:** Samples may be collected using non-disposable equipment (e.g., slide hammers, drilling rigs, etc.). Equipment rinsate samples demonstrate whether the decontamination procedure is effective in removing contaminants from field equipment used to collect samples. An equipment rinsate sample is collected after a sampling device is subjected to standard decontamination procedures, as described in Section 4.1.6. Water for the intended analysis will be poured over or through the sampling equipment, reserved in a sample container, and sent to the laboratory for analysis.

Contamination in the equipment rinsate indicates that the cleaning procedures for field equipment is not sufficient, allowing for the possibility of cross-contamination. The frequency of collection for equipment rinsates has been established based on the activity-specific requirements of this project. Criteria used to determine the collection frequency for equipment rinsates include factors such as the type of sampling equipment being used and the expected level of contamination at the site. For this Site, one equipment rinsate will be collected per sampling device type per day of sampling. The total number of equipment rinsates should not generally exceed 10 percent of the total number of samples collected. Rinsates will be analyzed for the same parameters as the field samples collected. The results of equipment rinsate analyses will be used to qualify data or to evaluate analyte levels in the field samples.

- **Field Duplicates:** Field duplicates are additional samples collected at a sampling location to enable statistical analysis of the resulting data, including overall sampling and analysis precision as well as representativeness of sample results. Field duplicate samples are two samples collected at the same time, from the same source, at the same depth or sample location as the associated field sample. Field duplicates will be collected at a frequency of one for every 20 samples (i.e., 5 percent) of the same matrix.

Field quality control samples will be analyzed per the same analytical method used to analyze the primary samples as described in Section 5.

4.2 Sample Handling and Documentation Procedures

Standard sample custody procedures will be used to document sample integrity during the collection, transportation, storage, and analytical processes. Sample custody and documentation will follow the requirements specified in standard operating procedures (Appendix B), to the extent possible. The following sections describe sample handling and documentation procedures to be followed in the field, during transport to the laboratory, and when the sample arrives at the laboratory.

4.2.1 Sample Identification and Labeling

A unique Sample Identification (Sample ID) will identify each sample collected. The coding system will provide a tracking record to allow retrieval of information about a particular sample and to ensure that each sample is uniquely identified. Sample IDs will be sequential and not be representative of any particular equipment or personnel. To be consistent with electronic deliverable formats, the Sample ID will not contain blanks, commas, or quotes. The Sample ID coding system is as follows:

- **Primary Field Pre-Confirmation Sample:** The identification system for primary field samples will indicate the site number, sample type, and location number, as in the following example:

<u>Location Number</u>	<u>Sample Type</u>	<u>Sample Depth</u>
001	CONF or WC	[0.0]

For example, 001CONF[0.0] identifies a pre-confirmation sample collected at location number 001 at a depth of 0.0 feet below the ground surface; 001WC[0.0] identifies a waste characterization sample collected at location number 001 at a depth of 0.0 feet bgs.

- **Field Duplicate Sample:** The identification system for duplicate field samples will indicate duplicate designation, date, and sequential order for that day of sampling, as in the following example:

<u>Duplicate</u>	<u>Date</u>	<u>Sequential Order</u>
DUP	070116	-1

For example, DUP070112-1 identifies the first field duplicate sample collected on 1 July 2016.

- **Equipment Rinsate Blank:** The identification system for equipment rinsate blanks will consist of a combination of the preceding Sample ID, the equipment blank designation, and the succeeding Sample ID, as in the following example:

<u>Preceding Location</u>	<u>Sample Type</u>	<u>Equipment Blank</u>	<u>Preceding Location</u>	<u>Sample Type</u>
001	CONF	RB	002	CONF

For example, 001CONFRB002CONF identifies an equipment rinsate blank collected following the collection of sample 001CONF and before the collection of sample 002CONF.

The Sample ID will be entered onto sample labels, field forms, chain-of-custody forms, logbooks, and other records documenting the sampling activities.

Sample ID labels will be used in accordance with standard operating procedures (Appendix B), to the extent possible. Sample containers will be clearly labeled at the time of sampling. A preprinted adhesive sample label will be affixed to all sample containers sent to the laboratory. This identification label will be completed with the following information written in indelible ink:

- Project name and site number
- Sample identification number
- Date and time of sample collection
- Preservation used
- Sample collector's initials

- Filtering (if applicable)
- Analysis required.

If a sample is split with another organization, sample labels with identical information will be attached to each sample container. After labeling, each sample will be refrigerated or placed in a cooler pre-chilled with ice to maintain a sample temperature of four (4) degrees Celsius ($\pm 2^{\circ}\text{C}$).

4.2.2 Sample Packaging and Shipping

Samples collected during the field effort must be identified as environmental samples. Environmental samples are defined as samples of soil, groundwater, or other matrices that are not saturated or mixed with product material. US Department of Transportation regulations will be followed during sample packaging and shipment. Standard chain-of-custody procedures will control transfers of samples. The following procedures meet these requirements and are explained in USEPA guidance on field operations methods (USEPA 1996a, 1996b, 2002).

- The cooler will be filled with sample bottles and packing material. Adequate shock-absorbent packing material (e.g., bubble wrap) will be used to prevent sample containers from making contact during shipment. A sufficient amount of blue ice or wet ice will be double-bagged in sealable plastic bags and placed within the cooler to maintain a sample temperature of four (4) degrees Celsius ($\pm 2^{\circ}\text{C}$) during shipment.
- The chain-of-custody records will be placed inside a plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The courier airbill, if required, will be filled out before the samples are handed over to the courier. The laboratory will be notified if the sampler suspects that the sample contains any substances that would require laboratory personnel to take safety precautions.
- The cooler will be closed and taped shut with strapping tape around both ends. If the cooler has a drain, the drain will be taped shut both inside and outside of the cooler.
- Two signed custody seals will be placed on the cooler (one on the front and one on the side) such that opening the cooler will require breaking the seal. Wide clear tape will be placed over the seals to prevent accidental breakage.
- The cooler will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container, and consultant's office name and address) to enable positive identification. On each side of the cooler a "This End Up" arrow label will be attached and a "Fragile" label will be attached to the top of the cooler.
- The chain-of-custody record will be transported inside the sealed cooler. When the analytical laboratory receives the cooler, laboratory personnel will open it and sign the chain-of-custody record to document the transfer of samples.

Samples may be held on site for more than three (3) days during weekend field activities if there is no threat of exceeding analytical holding times. Samples collected on the weekend will be stored under refrigeration and shipped the following Monday. Samples for analytes with

extremely short holding times, such as 48 hours, will be shipped the day of sampling; these samples should not be collected during the weekend unless proper arrangements are made.

Coolers will be hand-delivered to the laboratory, picked up by a delivery service courier, or shipped by a delivery service to the designated laboratory. These packaging and shipping procedures are in accordance with US Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24.

4.2.3 Sample Custody

Sample custody is the responsibility of the field sampling personnel from the time of sample collection until the samples are personally delivered to the laboratory or accepted by a courier service for delivery to the laboratory. The analytical laboratory maintains the sample custody thereafter. The major components of the sample custody include the following:

- **Custody Seals:** Custody seals will be used on each sample transport container to ensure that no tampering occurs. Custody seals used during the project will consist of security tape with the date and initials of the sampler or field team leader. Sample transport containers will be sealed in this manner immediately after the samples are packaged. The tape will be placed such that the seal must be broken to gain access to the contents of the transport container.
- **Chain-of-Custody Records:** Samples are in custody if they are in the custodian's view, stored in a secure place with restricted access, or placed in a container secured with custody seals. Chain-of-custody procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field until they are accepted at the laboratory. The chain-of-custody record will also be used to document the number of samples collected and the analyses requested. Laboratory-specific chain-of-custody records are typically used. A chain-of-custody record will be signed by each person who has custody of the samples and will accompany the samples at all times.

Chain-of-custody procedures and sample shipment for samples collected in accordance with this Work Plan will follow the requirements stated in standard operating procedures (Appendix B), to the extent possible. At a minimum, field personnel will record the following information on the chain-of-custody record:

- Project name and number
- Name and signature of sampler
- Destination of samples (laboratory name)
- Sample identification number
- Sample location, description, and depth (when applicable)
- Date and time of collection.
- Sampling type (e.g., composite or grab)
- Number and type of containers filled
- Analyses requested
- Preservatives used
- Filtering (if applicable)
- Signatures of individuals involved in custody transfer (including date and time of transfer)
- Laboratory purchase order number

- Airbill number (if applicable)
- Relevant remarks related to sample analyses (such as samples selected for MS/MSD analysis).

Unused lines on the chain-of-custody record will be crossed out and initialed. Chain-of-custody records initiated in the field will be signed by the field personnel, the airbill number will be recorded, and the record will be placed in a plastic bag and taped to the inside of the lid of the shipping container used for sample transport. Copies of the chain-of-custody record and the airbill will be retained and filed by the field personnel before the containers are shipped. A copy of the chain-of-custody record will be delivered to the District Project Manager or designee as soon as possible after sampling. Multiple coolers may be sent in one shipment to the laboratory. Each cooler will contain a separate chain-of-custody record of the samples. The outside of the coolers will be marked to indicate the number of coolers in the shipment. Copies of the chain-of-custody will be included in laboratory and QA/QC reports.

- **Cooler Receipt:** The person(s) transferring custody of the sample containers will sign the chain-of-custody form upon transfer of sample possession to the analytical laboratory. Upon receiving a cooler, laboratory personnel will review the contents, sign the chain-of-custody form and airbill, and retain both documents for their records. The following information will be recorded on the chain-of-custody record or another appropriate document at the time of sample receipt:
 - Status of the custody seals
 - Temperature of the cooler
 - Identification number of any broken sample containers
 - Description of discrepancies between the chain-of-custody records, sample labels, and requested analyses
 - Observations of visible headspace in vials of water destined for volatile compound analysis, indicating inadequate sample collection
 - The pH of water samples received (the pH of water samples destined for volatile compound analysis will be documented at the time of analysis).
 - Storage location of the sample and sample extracts.

Laboratory personnel will contact the sampling personnel regarding discrepancies in paperwork and sample preservation. Non-conformances and corrective actions will be documented in accordance with laboratory SOPs. These procedures will be available on file at the laboratory. After samples have been accepted, checked, and logged, the laboratory must maintain them in a manner consistent with the custody and security requirements specified in the laboratory quality assurance plan.

4.3 Field Documentation

During field operations, effective data management is essential in providing consistent, accurate, and defensible documentation of data quality. Sampling activities during the field effort require several forms of documentation in addition to the chain-of-custody forms discussed previously. Such documents are prepared to maintain sample identification and chain-of-custody and to provide records of significant events or observations. Additional documentation

prepared during field sampling activities will include field activities log books, data sheets, and photographs.

- **Field Activities Log Books:** Field activities and observations will be noted in field log books during the fieldwork. The field activities logbook is a hardbound notebook in which full descriptions of daily activities associated with the field investigation are recorded. The logbook is intended to provide sufficient data to reconstruct events that occur during the field project, including sample collection and handling activities.

The logbook will be signed and dated by appropriate project personnel. Logbook entries will include information about sampling location, field activities, instrument calibration, personnel, sampling, and general observations. Changes that occur at the site (e.g., personnel, responsibilities, deviations from the plan of operation, etc.) and the reasons for these changes will be documented in the field log book.

The pages in the logbook will be consecutively numbered, and entries will be made in indelible ink. Erasures will not be used. Incorrect entries will be addressed by drawing a single line in indelible ink through the entry and initialing the correction. Pages will not be removed, even if illegible. Each consecutive day's first entry will be made on a new, blank page. Requirements for logbook entries will include the following:

- Names of field staff
- Sampling equipment
- A record of site health and safety meetings, updates, and related monitoring
- Sample location and name
- Date and collection time of each sample
- Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
- Sample description
- Deviation from the Work Plan.

A sample collection checklist will be produced prior to sampling and completed following sampling operations at the sample location. The checklist will include sample location designations, types of samples to be collected (e.g., one jar for PCBs), and whether blind field duplicates or additional sample volumes for laboratory quality control analyses are to be collected.

- **Field Data Sheets:** Field data sheets and sample description forms will be completed as a permanent record of the sampling or field measurement activities. The field data sheets are used to record the specifics related to sample collection and to connect sample analytical results to the sample collected. A reference date and activity will be entered into the log book to refer to the field data sheets being generated.
- **Photographs:** Photographs will be collected using a digital camera at field sampling locations. Electronic photograph files will be saved and named so that photographs can be easily retrieved. The photograph file naming convention will include the sample location name, the date the photograph was taken, and the number of the photo taken at that location on that day (e.g., 001-070116-01).

4.4 Field Deviations

During implementation of this Work Plan, actual Site conditions may differ from those anticipated during preparation of the Work Plan and may require deviations to the field sampling program as presented herein. Field conditions at the time of sampling may dictate that the actual samples be collected using techniques not described in this Work Plan, or ones that are otherwise not in conformance with the approach described. Deviation from this Work Plan will be implemented in consultation with USEPA, who will be notified. Implemented deviations will be documented in the Site Characterization Report.

Section 5: Laboratory Analysis

This section summarizes the chemical analyses and laboratory quality controls and assurance procedures performed for the characterization of samples collected at the Site.

5.1 Analytical Parameters and Methods

The samples will be submitted under chain-of-custody to an analytical laboratory accredited by the National Environmental Laboratory Accreditation Program (NELAP) for analysis of PCBs, with select samples also analyzed for common waste constituents to facilitate landfill acceptance. Laboratory procedures (e.g., sample preparation, cleanup, and analysis) will comply with the methods presented in the latest version of the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (USEPA SW-846 latest update).

5.1.1 Sample Preparation

Sample preparation will be performed in accordance with 40 CFR Parts 761.272 and 761.292. Extraction and cleaning to remove potential interferences will be conducted for all samples by one of the following methods:

- USEPA Method 3540C – Soxhlet Extraction for Solid Samples
- USEPA Method 3550B – Ultrasonic Extraction
- USEPA Method 3630 – Silica Gel Cleanup.

It is anticipated that Silica Gel Cleanup may only be required for samples collected to characterize common waste constituents to facilitate landfill acceptance.

Soxhlet extraction will be the first preference for sample preparation for PCB analysis. Prior to PCB analysis, samples will be extracted and prepared using USEPA Method 3540C (Soxhlet). A minimum of 30 grams of solid sample material will be provided to the laboratory for the Soxhlet extraction. The sample material will be homogenized by the laboratory prior to collecting an aliquot for Soxhlet extraction. Approximately one liter of liquid sample material (i.e., equipment blanks) will be provided to the laboratory for extraction. If the laboratory is not set up for Soxhlet extraction, then ultrasonic extraction will be performed.

5.1.2 Sample Analysis

Samples will be analyzed for PCBs using USEPA Method 8082A (or latest revision). Sample results will be reported on a dry-weight basis as micrograms of PCBs per gram of sample. Samples collected to characterize common waste constituents to facilitate landfill acceptance may be analyzed for the following constituents:

- Metals by USEPA Method 6020
- Total Petroleum Hydrocarbons by USEPA Method 8015

- Volatile Organic Compounds by USEPA Method 8260
- Semi-Volatile Organic Compounds by USEPA Method 8270
- Pesticides by USEPA Method 8081.

Analytical reporting limits consistent with the cleanup levels and waste characterization limits will be specified. The analytical methods are summarized in Table 6. Field quality control samples will be analyzed per the same analytical method used to analyze the parent samples as identified above. Turn-around times for sample analyses are anticipated to be approximately 14 days from laboratory receipt, but may be expedited to facilitate execution of the field sampling program, as needed.

5.1.3 Holding Times

Samples will be maintained according to the appropriate holding times and temperatures for individual analysis, as summarized in Table 6. Samples collected as part of this Work Plan will be held/archived no longer than one year from the date of collection. Samples that have not been analyzed within this time-frame will be disposed properly by the analytical laboratory.

5.1.4 Laboratory Custody Procedures

Upon receipt at the laboratory, sample shipments will be inspected to assess the condition of the shipping and the individual samples, including verifying sample integrity. The accompanying chain-of-custody records will be cross-referenced with the samples contained in the shipment. The laboratory sample custodian will sign the chain-of-custody records and maintain a copy. The original chain-of-custody form will be included with the hard copy laboratory report. It is the laboratory's responsibility to maintain internal log books and records throughout sample receipt, preparation, analysis, and data reporting.

5.2 Laboratory Quality Control Checks

Laboratory quality assurance will be implemented according to the analytical laboratory's quality assurance program, plan, and SOPs. The analytical laboratory will perform quality control checks as required by the individual analytical methods to be used. These quality control checks are used to determine precision and accuracy and to demonstrate the absence of laboratory induced interferences and/or contamination. The following laboratory internal quality checks will be performed based on SW-846 requirements and USEPA guidance and the results included in the laboratory reports.

- **Method Blanks:** A method blank sample consists of laboratory-provided sample matrix containing the same reagents used in the analytical procedure. The method blank is prepared and analyzed in the same manner as a field sample. Method blanks are used to monitor the laboratory preparation and analysis systems for interferences and contamination introduced by the laboratory. Method blanks are analyzed as part of the calibration process and with each laboratory analytical batch to monitor the overall laboratory procedures and purity of the reagents used. Method blanks should not contain target analytes or interferences above the reporting limit.

- **Laboratory Control Samples:** Laboratory control samples (LCSs) and laboratory control duplicates (LCDs) are used to monitor the analytical process, independent of the particular sample matrix. LCSs consist of laboratory-provided sample matrix spiked with a known quantity of specific target analytes. LCSs are prepared and analyzed in the same manner as a field sample. LCSs are used to monitor the laboratory performance by measuring spiked target analyte recoveries in a controlled matrix. LCSs are analyzed with each laboratory analytical batch to monitor accuracy, precision, and potential matrix effects (when combined with matrix spike samples). Analytical accuracy is characterized by the percent recovery of the spiked compound in the LCS. Analytical precision is characterized by the relative percent difference (RPD) between the LCS/LCD pair.
- **Matrix Spike and Matrix Spike Duplicates:** Matrix spike samples measure matrix-specific method performance. A matrix spike (MS) or matrix spike duplicate (MSD) is prepared by adding a known quantity of target analyte to a single field sample prior to sample digestion or extraction to determine how well the target analytes can be recovered from the sample matrix. The accuracy of the matrix-specific method can be determined by the recovery of the spiked analytes after native concentrations of the spike analytes are subtracted. If an MSD is analyzed, the matrix-specific precision of the method may also be calculated.
- **Surrogate Standards:** Surrogate standards consist of known concentrations of non-target analytes, which are added to field and quality control samples before sample preparation and analysis for organic analytes. The surrogate standard measures the efficiency of the analytical method in recovering target analytes from the sample matrix. Surrogate standards indicate laboratory accuracy and matrix effects for organic analyses by monitoring purge efficiency, the extraction process, and analytical performance. Surrogate percent recoveries obtained from sample analysis are evaluated against laboratory-established control limits to characterize analytical accuracy. Factors such as matrix interferences and high analyte concentrations may affect surrogate recoveries. Surrogate recoveries outside of the laboratory-established control limits may require re-extraction and/or re-analysis, if sufficient sample is available.
- **Calibration Checks:** Calibration of laboratory instruments will be performed in accordance with the published methods and procedures approved by the analytical laboratory and included in the laboratory's quality assurance manual. Instruments and equipment will be initially calibrated and continuously calibrated at required intervals as specified by either the manufacturer or more updated methodology requirements. Calibration standards used as reference standards will be traceable to USEPA, National Institute of Standards and Technology, or another recognized reference standard source.

Analytical methods and quality control measurements and criteria are based on SW-846 requirements and USEPA guidance. Data quality evaluation will be based on these laboratory QC samples. Results of the quality control analysis will be included in the laboratory report.

5.3 Laboratory Reports

The analytical laboratory will prepare detailed reports documenting the activities associated with the sample analyses, including:

- **Case Narrative:** A detailed report describing sample receipt, analyses performed, and corrective actions undertaken.
- **Chain-of-Custody Documentation:** Chain-of-custody documentation will be included for the samples received, documenting basic sample demographics such as client and project names, sample identification, analyses requested, and special instructions.
- **Data Summary Form:** A tabular listing of concentrations and/or detection limits for target analytes, amount of sample analyzed, dilution factors, sample processing dates, extraction dates, date of analyses, extract cleanups, and surrogate recoveries.
- **Quality Assurance/Quality Control Summary:** Results of quality control analyses, including blank results, spike recovery information, matrix recovery information, and surrogate information.
- **Instrument Calibration Forms and Raw Data:** Initial and continuing calibration summaries and instrument tuning data, sample chromatograms, laboratory bench sheets, and log book pages.

Sample results data will be delivered to both in PDF form and as an electronic data deliverable. Reports will be submitted to USEPA, as required.

Section 6: Data Management, Review, and Analysis

The procedures for managing and using the sample analytical laboratory data are discussed below.

6.1 Data Review, Verification, and Usability

Sample analytical laboratory results will be reviewed and verified for compliance with project reporting requirements.

6.1.1 Review

Data review includes cross-checking that sample names and sample dates have been reported correctly on the preliminary laboratory report, and that calculated analytical sensitivities or detection levels are as expected. Once the preliminary results are received from the laboratory, the data is reviewed and discrepancies are reported to the laboratory in a timely manner. The laboratory then corrects and reissues the analytical data report.

6.1.2 Verification

Data verification includes checking that results have been transferred correctly from laboratory data printouts to the finalized laboratory report and to the EDD, and that both the laboratory report and EDD are complete before using the data. If discrepancies are found, the laboratory will be notified in order to correct the issue.

6.1.3 Usability

Data quality and usability will be measured and evaluated in terms of precision, accuracy, representativeness, completeness, and comparability parameters, as described below:

- **Precision:** Precision is the degree to which individual measurements of the same property agree and characterizes the reproducibility of the measurement or analytical results. Precision is evaluated by collecting and analyzing field and laboratory duplicates. Results of duplicate analysis are used to calculate the relative percent difference (RPD) using the following formula:

$$RPD = \frac{|C_{\text{primary}} - C_{\text{duplicate}}|}{\frac{(C_{\text{primary}} + C_{\text{duplicate}})}{2}} \times 100\%$$

Where C_{primary} = Primary Sample Concentration
 $C_{\text{duplicate}}$ = Duplicate Sample Concentration

Four factors that may impair the precision of duplicate data include:

- **Matrix Interference :** Constituents present in the field sample may interfere with the accurate quantification of target analytes.

- Laboratory Imprecision: Laboratory imprecision could be introduced by inconsistently preparing and analyzing samples.
- Sample Heterogeneity: Heterogeneity of soil samples is inherent due to the varied composition of natural materials and the associated difficulty in collecting a homogeneous sample.
- Nature of the RPD Calculation: When duplicates contain extremely high or low concentrations of the target analyte, the RPD calculation may indicate high variances unrelated to the analytical precision.

Data will be qualified as estimated when the duplicate results do not meet the laboratory-derived control limits and where matrix interference or laboratory imprecision are suspected.

- **Accuracy:** Accuracy is the degree to which an analytical measurement and a known reference value agree. Accuracy is affected by errors introduced by the sample matrix and through the sampling and analysis process. Sampling accuracy is evaluated by analyzing field blanks and analytical accuracy is evaluated by analyzing method blanks and samples spiked with surrogate standards, including MS/MSD and LCS/LCD samples. Accuracy is evaluated by calculating the percent recovery using the results of the spiked samples:

$$\text{Percent Recovery} = \frac{C_{\text{spike}} - C_{\text{sample}}}{C_{\text{true}}} \times 100\%$$

Where

- C_{spike} = Measured Spike Sample Concentration
- C_{sample} = Sample Concentration
- C_{true} = True or Actual Concentration of the Spike

If surrogate sample recoveries fall below the laboratory-derived control limit, sample data will be reviewed to evaluate the potential for false negative data. If LCS percent recovery is outside the laboratory-derived control limits, the data will be considered rejected and samples will be re-extracted and/or reanalyzed. If MS percent recovery or MS/MSD RPD is outside the laboratory-derived control limits, the data will be evaluated to determine the source(s) of the difference, (e.g., matrix effect or analytical error).

- **Representativeness:** Representativeness describes the degree to which sample data accurately and precisely represent the environmental conditions that the data are intended to represent. Representativeness can be achieved by consistently using established field and laboratory procedures. If during the verification or validation it is determined that the results are not representative, re-analysis of field samples or collection of additional field samples may be required. Otherwise, non-representative data may be reported only if flagged by appropriate qualifiers and limits of uncertainty.
- **Completeness:** Completeness measures the portion of field sample analytical results that are usable and valid. A completeness value is calculated, following the completion of sampling efforts and receipt of validated data, by dividing the number of validated sample results by the total number of target samples results.

- **Comparability:** Comparability assesses whether analytical conditions are sufficiently uniform for each analytical run to that the reported data will be consistent such that separate data sets can be used jointly to make collective conclusions. Comparability can be achieved by using similar sampling and analytical methods from one sampling event or phase of field implementation to the next.

Data rejected during review and verification may not be used to compare with the cleanup goal. Laboratory re-analysis or sample re-collection may be requested and the data review and verification process amended to complete the comparison with the cleanup goal.

6.2 Data Analysis and Comparison to Cleanup Levels

Analysis of the data will be performed on final verified analytical laboratory results and compared to cleanup goals to inform delineation of soil and debris removal limits and waste disposal requirements.

6.2.1 Data Analysis

The analytical results will be tabulated and a statistical summary of analytical laboratory results will be prepared, including the following information:

- Number of Verified Samples
- Detection Frequency
- Range of Detection Limits (each Aroclor)
- Maximum Concentration Detected
- Average Concentration Detected
- Number of Samples Exceeding the Established Criteria, including:
 - Number of pre-confirmation samples exceeding the cleanup goal
 - Number of grid samples exceeding the disposal characterization limit for total PCBs of 50 mg/kg.

Although USEPA guidance (1992) indicates that the 95 percent UCL of the arithmetic mean should be used to evaluate potential exposures to chemicals in environmental media, the District has decided to compare individual pre-confirmation sample results to the cleanup level when evaluating the limits of soil and debris removal. However, contingency protocols are described in the subsequent subsection that may be invoked if repeated and/or extensive additional pre-confirmation sampling and analysis is indicated by the laboratory analytical results.

6.2.2 Contingency Protocols

Pre-confirmation sample analytical results of PCB concentrations may be evaluated using USEPA's ProUCL statistical program. The 95 percent UCL concentration will be calculated for the analytical laboratory results in accordance with the ProUCL User Guide (USEPA 2015). The 95 percent UCL will be calculated using ProUCL Version 5.1.00, or more recent version of the ProUCL statistical software available from the USEPA.

Prior to calculating the 95 percent UCLs, the following criteria will be used to determine the representative concentration for duplicate samples:

- If both samples are detected values, the two values will be averaged, and the result will be considered a detected value in the calculations.
- If one sample is a detected value and the other sample is a non-detect, the detected value will be used in the calculations.
- If both samples are non-detects, the lower detection limit will be used as a non-detect in the calculations.

The ProUCL output will include goodness of fit test results for the parametric distributions and a suggested UCL based on the calculated statistics. If the ProUCL output indicates too few data points to calculate a 95 percent UCL, no additional statistical analyses will be conducted.

ProUCL will be applied consistent with the decision rules or scenarios provided below.

- **Scenario 1:** If the results of PCB pre-confirmation sample analyses indicate PCB concentrations are all below the cleanup goal, then the ProUCL calculation is not necessary and the cleanup may be considered complete.
- **Scenario 2:** If the results of PCB pre-confirmation sample analyses include non-detects and PCB concentrations above the cleanup goal, the expansion of the excavation limits may be required, depending of the following three options.
 - **Option 1** – Run ProUCL and evaluate the spatial distribution of all PCB pre-confirmation sample analytical results. If the 95 percent UCL of the mean of these results is at or below the cleanup goal and the spatial distribution of the data does not suggest the presence of potential hot spots or need for targeted expansion of the excavation limits, the PCB removal limits may be considered complete.
 - **Option 2** – Expand the excavation limits in the areas where the pre-confirmation sample PCB analytical results are above the cleanup goal and resample those areas.
 - ◆ If the PCB analytical results of all pre-confirmation samples are non-detect after expanding the excavation limits, follow the above Scenario 1.
 - ◆ If the PCB analytical results of all pre-confirmation samples are equal to or below the cleanup goal (including non-detects), follow the above Scenario 1.

- ◆ If the PCB analytical results of pre-confirmation samples include detected PCB concentrations above the cleanup goal, follow the above Scenario 2, Option 1. The PCB analytical results of pre-confirmation samples from expanded excavation areas will be used to run ProUCL in addition to the results from PCB analysis of pre-confirmation samples where excavation expansion was not necessary.
- **Scenario 3:** If all or the majority of the PCB analytical results of pre-confirmation samples are detected above the cleanup goal, then expansion of the excavation limits will be considered. Additional pre-confirmation samples will be collected as follows:
 - Scenario 1 will be followed if each of the additional pre-confirmation sample PCB analytical results are non-detect or below the cleanup level.
 - Scenario 2 will be followed if all or portions of the additional pre-confirmation sample PCB analytical results are still above the cleanup goal.
- **Insufficient number of PCB pre-confirmation samples:** If the number of pre-confirmation sample PCB analytical results is insufficient to determine the statistical distribution of the data set, then ProUCL recommends comparing the maximum sample result to the cleanup goal. If that maximum result is above the cleanup goal, then expansion of the excavation limits may be necessary. If the maximum result is below the cleanup goal then the excavation limits would not require expansion.
- **Situations where the data set contains a high proportion of non-detects relative to the entire data set:** ProUCL will be used to calculate the exposure point concentration, which will be compared to the PCB cleanup goal. The inputs to ProUCL include all PCB sample analytical results above the detection limit and the detection limit for that portion of the data set composed of non-detects. Consistent with USEPA risk assessment guidance, half of the detection limit will be used for non-detect results as input to ProUCL. The use of the detection limit or half of the detection limit is allowed provided the detection limit is below the cleanup level.

6.2.3 Refining the Limits and Scope of Remediation

USEPA will be consulted on the results of sampling and analysis, decisions regarding the limits of remediation, waste management, and material onsite reuse.

- **Pre-Confirmation Samples:** If PCBs are detected at concentrations exceeding the cleanup level (0.24 mg/kg) in pre-confirmation samples collected at the initially estimated limits of soil and debris removal, the District will perform additional step out sampling. Subsequent sample results that do not exceed the cleanup level will be used to delineate the limits of soil and debris removal carried forward for remediation planning and implementation. Step-out locations will be based on the same 25-foot by 25-foot grid, with up to three samples being collected to further define each step-out area. Contingency protocols may be invoked as described in the previous subsection if repeated and/or extensive additional pre-confirmation sampling and analysis is indicated by the laboratory analytical results.
- **Sediment Samples:** If PCBs are detected at concentrations exceeding the cleanup level (0.24 mg/kg) in surface sediment samples collected in the drainage swale and catch basins,

these areas will be included in the scope of soil and debris removal carried forward for remediation planning and implementation.

- **Waste Characterization for Profiling and Disposal:** Demolition backfill sample analytical results will be compared to waste thresholds to determine disposal requirements.
- **Material Testing for Reuse:** Surface and near surface soil sample analytical results in areas filled during the 2012 grading activities will be compared to screening levels to determine the potential for reusing this material onsite following soil and debris removal.

The results of these data evaluations will be documented as findings, conclusions, and recommendations in a Site Characterization Report submitted to the USEPA.

Section 7: Record Keeping and Reporting

The District will retain the cleanup completion report, along with records of sampling and analysis, decontamination, and disposal of investigation-derived wastes as described below.

7.1 Records Retention

Copies of records, if requested, will be made available to USEPA. Records will be maintained in accordance with the District's records retention policy and project-specific records management requirements. In addition, all records will be retained in accordance with 40 CFR Part 761 as discussed below.

- **Sampling and Analysis Records:** The District will retain sampling and analysis records, including analytical laboratory reports, data validation reports, and field sampling records such as chain-of-custody forms, daily field reports, and field sampling forms, for five (5) years per 40 CFR Part 761.61(a)(9).
- **Decontamination Records:** The District will retain decontamination records for non-disposable equipment or tools exposed to greater than 50 mg/kg of PCBs for three (3) years per 40 CFR Part 761.79(f)(2).
- **Waste Management, Transportation, and Disposal Records:** The District will retain waste profiles, manifests, bills of lading, and certificates of disposal for three (3) years.

7.2 Site Characterization Report

Following completion of the sampling and analysis activities and evaluation of the resulting data, the District will prepare and submit a Site Characterization Report (Report) to USEPA. The Report will include the following:

- Sample location map
- Photographs and documentation of observations of sampling activities
- Boring logs and cross-sectional mapping
- Tabulated summaries of the analytical data
- Laboratory analytical data reports and chain-of-custody forms
- QA/QC summary and evaluation
- Findings, conclusions, and recommendations, including statistical analysis of the data, comparison with cleanup levels, and recommendations regarding the extent of soil and debris removal
- Signature and stamp by a California-licensed Professional Engineer or Professional Geologist.

The Report will be submitted to the USEPA approximately 60 days following USEPA approval of the verified data.

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Tables

Table 1: PCB Concentrations in Samples of Remaining Soil

SAMPLE ID AND DEPTH	Depth (ft bgs)	Revised Depth ^(a) (ft bgs)	Aroclor							PCBs (total) ^(b)
			1016	1221	1232	1242	1248	1254	1260	
			Concentration (mg/kg)							
Excavation Areas D & E 2006										
D2-W@1.25'	1.25	5.25	ND ^(c)	ND	ND	ND	ND	ND	ND	ND
D7-S@1.25'	1.25	1.25	ND	ND	ND	ND	ND	ND	0.15	0.15
D9-N@1.25'	1.25	4.25	ND	ND	ND	ND	ND	ND	ND	ND
D11-B@5.5'	5.5	8.5	ND	ND	ND	ND	ND	ND	ND	ND
D12-B@5.5'	5.5	8.5	ND	ND	ND	ND	ND	ND	0.12	0.12
D14-E@2.5'	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND
D15-E@2.5'	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND
D-16-(B)@6'	6.0	6	ND	ND	ND	ND	ND	ND	ND	ND
D-17-B@6'	6.0	6	ND	ND	ND	ND	ND	ND	ND	ND
D-19-NE@6'	6.0	6	ND	ND	ND	ND	ND	ND	0.15	0.15
D-20-B@5.5'	5.5	5.5	ND	ND	ND	ND	ND	ND	0.13	0.13
D-22-B@5.5'	5.5	5.5	ND	ND	ND	ND	ND	ND	0.057	0.057
D23-E@2.5'	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND
D24-B@5.5'	5.5	5.5	ND	ND	ND	ND	ND	ND	ND	ND
D25-N@2.5'	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND
E6-B@6.5'	6.5	8.5	ND	ND	ND	ND	ND	ND	ND	ND
E7-S@3'	3.0	5	ND	ND	ND	ND	ND	ND	0.049	0.049
E8-W@3'	3.0	5	ND	ND	ND	ND	ND	ND	0.082	0.082
E10-N@3'	3.0	5	ND	ND	ND	ND	ND	ND	ND	ND
E11-B(S)@3.75'	3.75	5.75	ND	ND	ND	ND	ND	ND	0.045	0.045
E12-SE@1'	1.0	3	ND	ND	ND	ND	ND	ND	0.01	0.01
E14-E@3'	3.0	5	ND	ND	ND	ND	ND	ND	0.14	0.14
E17-B(NE)@9.0'	9.0	11	ND	ND	ND	ND	ND	ND	ND	ND
Excavation areas F, I, J, & K 2007										
F1N@1.5'	1.5	1.5	ND	ND	ND	ND	ND	0.120	0.086	0.206
F5BM@3.5'	3.5	3.5	ND	ND	ND	ND	ND	ND	ND	ND
F6BE@3.5'	3.5	3.5	ND	ND	ND	ND	ND	ND	0.020	0.020
F8NE@1.5'	1.5	1.5	ND	ND	ND	ND	ND	ND	0.033	0.033
F9NW@1.5'	1.5	1.5	ND	ND	ND	ND	ND	ND	ND	ND
F12E@1.5'	1.5	1.5	ND	ND	ND	ND	ND	0.047	0.038	0.085
F13SE@1.5'	1.5	1.5	ND	ND	ND	ND	ND	ND	ND	ND
F14SW@1.5'	1.5	1.5	ND	ND	ND	ND	ND	ND	0.018	0.018
F15BW@5.0'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
F16W@2.0'	2.0	2	ND	ND	ND	ND	ND	ND	0.029	0.029
F17BFW@4.0'	4.0	4	ND	ND	ND	ND	ND	ND	ND	ND
J3E@2.5'	2.5	2.5	ND	ND	ND	ND	ND	0.057	0.081	0.138
J5B@5.0'	5.0	5	ND	ND	ND	ND	ND	ND	0.017	0.017
J6N@2.5'	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND
J7S@2.5'	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND
J8WN@2.5'	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND
J10BW@5'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
J12WS@2.5'	2.5	2.5	ND	ND	ND	ND	ND	0.310	0.150	0.460
K1S@2.5'	2.5	3.5	ND	ND	ND	ND	ND	ND	ND	ND
K2N@2.5'	2.0	3	ND	ND	ND	ND	ND	0.100	0.094	0.194
K3E@2.5'	2.5	3	ND	ND	ND	ND	ND	0.180	0.100	0.280
K4W@2.5'	2.5	3.75	ND	ND	ND	ND	ND	0.013	0.016	0.029
K5B@5.0'	5.0	6	ND	ND	ND	ND	ND	0.096	0.100	0.196

Table 1: PCB Concentrations in Samples of Remaining Soil

SAMPLE ID AND DEPTH	Depth (ft bgs)	Revised Depth ^(a) (ft bgs)	Aroclor							PCBs (total) ^(b)
			1016	1221	1232	1242	1248	1254	1260	
			Concentration (mg/kg)							
Cleanup Area H 2007										
H5B@4.0'	4.0	6.8	ND	ND	ND	ND	ND	ND	ND	ND
H6NE@2.0'	2.0	4.5	ND	ND	ND	ND	ND	0.075	0.056	0.131
H9SW@2.0'	2.0	11	ND	ND	ND	ND	ND	ND	ND	ND
H10EN@2.0'	2.0	4.6	ND	ND	ND	ND	ND	ND	ND	ND
H11ES@2.0'	2.0	4.75	ND	ND	ND	ND	ND	ND	ND	ND
H12WN@2.0'	2.0	5	ND	ND	ND	ND	ND	ND	ND	ND
H13WS@2.0'	2.0	5	ND	ND	ND	ND	ND	ND	ND	ND
H14BNE@4.0'	4.0	7	ND	ND	ND	ND	ND	ND	ND	ND
H15BSW@4.0'	4.0	7	ND	ND	ND	ND	ND	ND	ND	ND
H17SE@2.0'	2.0	5	ND	ND	ND	ND	ND	0.038	0.052	0.090
H18EN@2.0'	2.0	4.9	ND	ND	ND	ND	ND	ND	ND	ND
H19ES@2.0'	2.0	4.9	ND	ND	ND	ND	ND	0.130	0.071	0.201
H21BNE@6.0'	6.0	9	ND	ND	ND	ND	ND	ND	ND	ND
H24NW/COR@2.0'	2.0	5	ND	ND	ND	ND	ND	ND	ND	ND
H25NW/W@2.0'	2.0	5	ND	ND	ND	ND	ND	ND	ND	ND
H26BNW/W@4.0'	4.0	7	ND	ND	ND	ND	ND	ND	ND	ND
H27BNW/E@4.0'	4.0	7	ND	ND	ND	ND	ND	0.038	0.035	0.073
H28 NW/SE@2.0'	2.0	4.6	ND	ND	ND	ND	ND	0.027	0.054	0.081
H30 NW/NW@2.0'	2.0	5	ND	ND	ND	ND	ND	ND	ND	ND
H31 NWB@4.0'	4.0	6.75	ND	ND	ND	ND	ND	ND	0.016	0.016
H32NECORNER@2'	2.0	4.25	ND	ND	ND	ND	ND	0.023	0.016	0.039
H33NECBOTTOM@5'	5.0	7.3	ND	ND	ND	ND	ND	ND	ND	ND
H34NN@2'	2.0	4.75	ND	ND	ND	ND	ND	0.034	0.033	0.067
H35ECORNER@2.0'	2.0	4.25	ND	ND	ND	ND	ND	0.240	0.260	0.500
H36SESIDEWALL@2.0'	2.0	4.4	ND	ND	ND	ND	ND	0.036	0.040	0.076
H37EB@4.0'	4.0	6.3	ND	ND	ND	ND	ND	ND	ND	ND
Cleanup Area G 2008										
G1N@3.0'	3.0	4	ND	ND	ND	ND	ND	0.057	0.100	0.157
G3E@2.0'	2.0	2.5	ND	ND	ND	ND	ND	0.160	0.032	0.192
G5SW@3.5'	3.5	4	ND	ND	ND	ND	ND	0.021	0.030	0.051
G6NW@2.0'	2.0	3	ND	ND	ND	ND	ND	ND	ND	ND
G8SWB@6.5'	6.5	6.5	ND	ND	ND	ND	ND	0.026	0.029	0.055
G10B@7.5'	7.5	7.5	ND	ND	ND	ND	ND	0.055	0.074	0.129
G11S@3.0'	3.0	3	ND	ND	ND	ND	ND	0.071	0.074	0.145
G18BN@7.0'	7.0	9	ND	ND	ND	ND	ND	0.080	0.090	0.170
G20BW@7.0'	7.0	7	ND	ND	ND	ND	ND	0.044	0.054	0.098
G24BW@7.0'	7.0	7	ND	ND	ND	ND	ND	0.140	0.071	0.211
G34BN@7'	7.0	9	ND	ND	ND	ND	ND	0.049	0.050	0.099
G39BOTWS@7'	7.0	8	ND	ND	ND	ND	ND	ND	ND	ND
G41BOTN@7.5'	7.5	9.5	ND	ND	ND	ND	ND	0.078	0.079	0.157
G52BOTE6.5'	6.5	7.5	ND	ND	ND	ND	ND	ND	ND	ND
G55SESW@6.5'	6.5	6.5	ND	ND	ND	ND	ND	0.036	0.046	0.082
G58BOT@9.5'	9.5	9.5	ND	ND	ND	ND	ND	0.360	0.710	1.070
G59BOT@9.5'	9.5	9.5	ND	ND	ND	ND	ND	0.160	0.260	0.420
G60BOT SEN@8'	8.0	8	ND	ND	ND	ND	ND	0.140	0.400	0.540
G61BOT SES@8'	8.0	8	ND	ND	ND	ND	ND	0.130	0.180	0.310
G62SE@4.5'	4.5	4.5	ND	ND	ND	ND	ND	0.240	0.450	0.690
G63SE@4.5'	4.5	4.5	ND	ND	ND	ND	ND	3.400	4.800	7.800

Table 1: PCB Concentrations in Samples of Remaining Soil

SAMPLE ID AND DEPTH	Depth (ft bgs)	Revised Depth ^(a) (ft bgs)	Aroclor							PCBs (total) ^(b)
			1016	1221	1232	1242	1248	1254	1260	
			Concentration (mg/kg)							
G64SE@4.5'	4.5	4.5	ND	ND	ND	ND	ND	0.380	0.680	1.060
G65SE@4.5'	4.5	4.5	ND	ND	ND	ND	ND	1.200	2.100	3.300
G66E@4.5'	4.5	5.5	ND	ND	ND	ND	ND	0.032	0.049	0.082
G67NE@4.5'	4.5	5.5	ND	ND	ND	ND	ND	ND	0.013	0.013
G68NE@4.5'	4.5	5.5	ND	ND	ND	ND	ND	0.120	0.240	0.360
G69N@4.5'	4.5	5.5	ND	ND	ND	ND	ND	ND	ND	ND
G70@8.5'	8.5	8.5	ND	ND	ND	ND	ND	0.200	0.190	0.390
G72@8'	8.0	8	ND	ND	ND	ND	ND	0.330	0.410	0.740
G73@11.5'	11.5	12.5	ND	ND	ND	ND	ND	0.052	0.066	0.118
G74@11.5'	11.5	11.5	ND	ND	ND	ND	ND	0.034	0.051	0.085
G76NWB@10'	10.0	12.5	ND	ND	ND	ND	ND	ND	ND	ND
G77NW@4.5'	4.5	7	ND	ND	ND	ND	ND	0.120	0.130	0.250
G78NW@9'	9.0	11.5	ND	ND	ND	ND	ND	3.400	2.100	5.500
G79WN@4.5'	4.5	7	ND	ND	ND	ND	ND	ND	ND	ND
G80WN@9'	9.0	11.5	ND	ND	ND	ND	ND	1.400	1.400	2.800
G81NWB@10'	10.0	12.5	ND	ND	ND	ND	ND	1.600	1.300	2.900
G82NBot@5'	5.0	7	ND	ND	ND	0.52	ND	0.450	0.370	1.340
G83@10'	10.0	10	ND	ND	ND	ND	ND	0.200	0.300	0.500
G84@11.5'	11.5	11.5	ND	ND	ND	ND	ND	ND	ND	ND
G85@5'	5.0	6	ND	ND	ND	ND	ND	0.200	0.200	0.400
G86@4.5'	4.5	4.5	ND	ND	ND	ND	ND	0.360	0.720	1.080
G87@4.5'	4.5	4.5	ND	ND	ND	ND	ND	0.220	0.230	0.450
G88@4.5'	4.5	4.5	ND	ND	ND	ND	ND	0.920	0.910	1.830
G89@4.5'	4.5	4.5	ND	ND	ND	ND	ND	0.870	0.790	1.660
G90@3'	3.0	3	ND	ND	ND	ND	ND	1.300	1.200	2.500
G91@3'	3.0	4	ND	ND	ND	ND	ND	0.830	0.720	1.550
G92@3'	3.0	4	ND	ND	ND	ND	ND	0.310	0.280	0.590
G93@3'	3.0	4	ND	ND	ND	ND	ND	2.300	2.300	4.600
G94@4'	4.0	5	ND	ND	ND	ND	ND	ND	ND	ND
G95@3'	3.0	5	ND	ND	ND	ND	ND	1.200	1.200	2.400
G96@4'	4.0	6	ND	ND	ND	ND	ND	ND	ND	ND
G97@7.5'	7.5	8.5	ND	ND	ND	ND	ND	ND	ND	ND
QTR-G1-N@4'	4.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTR-G1-SW-W@5'	5.0	6	ND	ND	ND	ND	ND	ND	ND	ND
QTR-G2-W@6.5'	6.5	6.5	ND	ND	ND	ND	ND	ND	ND	ND
QTR-G2-N@4.5'	4.5	4.5	ND	ND	ND	ND	ND	ND	ND	0.012
QTP-G5SE@4.5'	4.5	4.5	ND	ND	ND	ND	ND	0.048	0.063	0.111
QTP-G6SW@4.5'	4.5	5.5	ND	ND	ND	ND	ND	0.130	0.150	0.280
QTP-G7W@4.5'	4.5	5.5	ND	ND	ND	ND	ND	0.270	0.092	0.362
QTP-11@9'	9.0	9	ND	ND	ND	ND	ND	ND	ND	ND
QTP-12@9'	9.0	9	ND	ND	ND	ND	ND	0.210	0.320	0.530
QTP-13@9'	9.0	9	ND	ND	ND	ND	ND	ND	ND	ND
G-78@9'* TTLC	9.0	11.5	ND	ND	ND	ND	ND	3.400	2.500	5.900
Nov. 2007 Sampling										
QTP-BF#1-1@3'	3.0	5.25	ND	ND	ND	ND	ND	0.130	0.170	0.300
QTP-BF#1-1@4'	4.0	6.25	ND	ND	ND	ND	ND	1.400	2.000	3.400
QTP-BF#1-1@5.5'	5.5	7.75	ND	ND	ND	ND	ND	ND	ND	ND
QTP-BF#2-1@3'	3.0	4.5	ND	ND	ND	ND	ND	2.100	2.000	4.100
QTP-BF#2-1@5'	5.0	6.5	ND	ND	ND	ND	ND	ND	ND	ND

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SAMPLE ID AND DEPTH	Depth (ft bgs)	Revised Depth ^(a) (ft bgs)	Aroclor							PCBs (total) ^(b)
			1016	1221	1232	1242	1248	1254	1260	
			Concentration (mg/kg)							
QTP-BF#2-2@3'	3.0	3	ND	ND	ND	ND	ND	1.600	1.600	3.200
QTP-BF#2-2@5'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-BF#3-1@3'	3.0	3	ND	ND	ND	ND	ND	0.100	0.079	0.179
QTP-BF#3-1@5'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-BF#3-2@3'	3.0	3	ND	ND	ND	ND	ND	0.039	0.057	0.090
QTP-BF#3-2@5'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-BF#3-3@3'	3.0	3	ND	ND	ND	ND	ND	0.290	0.370	0.660
QTP-BF#3-3@6'	6.0	6	ND	ND	ND	ND	ND	0.022	0.017	0.039
QTP-BF#3-4@3'	3.0	3	ND	ND	ND	ND	ND	0.430	0.320	0.750
QTP-BF#3-4@5'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-OS-2@3'	3.0	6.25	ND	ND	ND	ND	ND	0.730	0.640	1.370
QTP-OS-2@5'	5.0	8.25	ND	ND	ND	ND	ND	0.032	0.025	0.057
QTP-CL#1-1@3'	3.0	6	ND	ND	ND	ND	ND	ND	ND	ND
QTP-CL#1-1@4.5'	4.5	7.5	ND	ND	ND	ND	ND	0.076	0.098	0.174
QTP-CL#1-1@6'	6.0	9	ND	ND	ND	ND	ND	0.160	0.220	0.380
QTP-CL#1-1@8'	8.0	11	ND	ND	ND	ND	ND	15.000	38.000	53.000
QTP-CL#1-1@10'	10.0	13	ND	ND	ND	ND	ND	0.024	0.034	0.058
QTP-SD1@3'	3.0	4	ND	ND	ND	ND	ND	0.048	0.035	0.083
QTP-SD1@5'	5.0	6	ND	ND	ND	ND	ND	0.022	0.029	0.051
QTP-SLT-1@3'	3.0	7	ND	ND	ND	ND	ND	ND	ND	ND
QTP-SLT-1@5'	5.0	9	ND	ND	ND	ND	ND	ND	ND	ND
QTP-AZ-1@3'	3.0	5.25	ND	ND	ND	ND	ND	ND	ND	ND
QTP-AZ-1@4.5'	4.5	6.75	ND	ND	ND	ND	ND	ND	ND	ND
QTP-PL-1@3'	3.0	3.75	ND	ND	ND	ND	ND	0.220	0.580	0.900
QTP-PL-1@5.5'	5.5	6.25	ND	ND	ND	ND	ND	ND	ND	ND
QTP-CL#3-1@3'	3.0	3	ND	ND	ND	ND	ND	2.000	2.200	4.200
QTP-CL#3-1@4.5'	4.5	4.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-CL#3-1@6'	6.0	6	ND	ND	ND	ND	ND	ND	ND	ND
QTP-CL#3-2@3'	3.0	2	ND	ND	ND	ND	ND	2.100	2.700	4.800
QTP-CL#3-2@4.5'	4.5	3.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-CL#3-3@3'	3.0	3	ND	ND	ND	ND	ND	ND	ND	ND
QTP-CL#3-3@5'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-CL#3-3@7'	7.0	7	ND	ND	ND	ND	ND	0.028	0.031	0.059
QTP-CL#3-3@9'	9.0	9	ND	ND	ND	ND	ND	0.049	0.016	0.065
QTP-PP-1@3'	3.0	3	ND	ND	ND	ND	ND	0.700	0.580	1.280
QTP-PP-1@5'	5.0	5	ND	ND	ND	ND	ND	0.280	0.220	0.500
QTP-PP-1@6.5'	6.5	6.5	ND	ND	ND	ND	ND	0.400	0.340	0.740
QTP-PP-1@8'	8.0	8	ND	ND	ND	ND	ND	0.087	0.073	0.160
QTP-OS-1@3'	3.0	3	ND	ND	ND	ND	ND	ND	ND	ND
QTP-OS-1@5'	5.0	5	ND	ND	ND	ND	ND	0.059	0.067	0.126
QTP-OS-1@7'	7.0	7	ND	ND	ND	ND	ND	0.025	0.022	0.047
Feb. 2008 Test Pit Sampling										
QTP-08-01@3'	3.0	7	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-01@4'	4.0	8	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-02@6" (0.5')	0.5	4.5	ND	ND	ND	ND	ND	1.200	1.100	2.300
QTP-08-02@3.0'	3.0	7	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-03@18" (1.5')	1.5	6.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-03@3'	3.0	8	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-04@1.5'	1.5	4.5	ND	ND	ND	ND	ND	ND	ND	ND

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SAMPLE ID AND DEPTH	Depth (ft bgs)	Revised Depth ^(a) (ft bgs)	Aroclor							PCBs (total) ^(b)
			1016	1221	1232	1242	1248	1254	1260	
			Concentration (mg/kg)							
QTP-08-04@3.0'	3.0	6	ND	ND	ND	ND	ND	ND	ND	0.015
QTP-08-04@4.5'	4.5	7.5	ND	ND	ND	ND	ND	0.039	0.053	0.094
QTP-08-05@1.5'	1.5	1.5	ND	ND	ND	ND	ND	0.230	0.170	0.400
QTP-08-05@2.5'	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-06@0.5'	0.5	0.7	ND	ND	ND	ND	ND	0.100	0.180	0.280
QTP-08-06@0.5'	0.5	0.7	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-06@1.5'	1.5	1.7	ND	ND	ND	ND	ND	ND	0.023	0.023
QTP-08-07@0.5'	0.5	1.5	ND	ND	ND	ND	ND	0.019	0.025	0.044
QTP-08-07@1.5'	1.5	2.5	ND	ND	ND	ND	ND	0.038	0.075	0.113
QTP-08-08@1.0'	1.0	1	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-08@20" (1.7')	1.7	1.7	ND	ND	ND	ND	ND	0.490	0.680	1.070
QTP-08-08@42" (3.5')	3.5	3.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-08INNER@12" (1.0')	1.0	1	ND	ND	ND	ND	ND	0.390	0.510	0.900
QTP-08-09@1.5'	1.5	1.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-09@2.5'	2.5	2.5	ND	ND	ND	ND	ND	2.800	3.900	5.700
QTP-08-09@4.0'	4.0	4	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-10@2.5'	2.5	2.5	ND	ND	ND	ND	ND	ND	0.012	0.012
QTP-08-10@4.0'	4.0	4	ND	ND	ND	ND	ND	3.000	4.700	7.700
QTP-08-10@5.0'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-11@28" (2.33')	2.3	2.33	ND	ND	ND	ND	ND	0.420	0.490	0.910
QTP-08-11@3.0'	3.0	3	ND	ND	ND	ND	ND	0.220	0.460	0.680
QTP-08-11@4.0'	4.0	4	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-12@2.5'	2.5	2.5	ND	ND	ND	ND	ND	0.290	0.360	0.670
QTP-08-12@5'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-13@2.5'	2.5	2.5	ND	ND	ND	ND	ND	0.240	0.230	0.470
QTP-08-13@4'	4.0	4	ND	ND	ND	ND	ND	0.260	0.760	1.020
QTP-08-13@5'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-14@3.5'	3.5	5	ND	ND	ND	ND	ND	2.700	3.100	5.800
QTP-08-14@4.5'	4.5	6	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-14@5.5'	5.5	7	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-15@3.5'	3.5	6	ND	ND	ND	ND	ND	1.200	1.100	2.300
QTP-08-15@4.5'	4.5	7	ND	ND	ND	ND	ND	1.100	1.100	2.200
QTP-08-15@5.5'	5.5	8	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-16@1.5'	1.5	4.5	ND	ND	ND	ND	ND	0.830	1.400	2.230
QTP-08-16@4'	4.0	7	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-17@12" (1.0')	1.0	2.9	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-17@48" (4.0')	4.0	5.9	ND	ND	ND	ND	ND	16.000	31.000	47.000
QTP-08-18@2.0'	2.0	2	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-18@3.75'	3.8	3.75	ND	ND	ND	ND	ND	0.076	0.090	0.166
QTP-08-18@5.0'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-19@2.0'	2.0	2	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-19@3.5'	3.5	3.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-20@2.5'	2.5	1.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-20@5.0'	5.0	4	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-21@2.5'	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-21@5.0'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-22@2.0'	2.0	1.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-22@4.0'	4.0	3.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-23@1.5'	1.5	1.5	ND	ND	ND	ND	ND	ND	ND	ND

Table 1: PCB Concentrations in Samples of Remaining Soil

SAMPLE ID AND DEPTH	Depth (ft bgs)	Revised Depth ^(a) (ft bgs)	Aroclor							PCBs (total) ^(b)
			1016	1221	1232	1242	1248	1254	1260	
			Concentration (mg/kg)							
QTP-08-23@3.5'	3.5	3.5	ND	ND	ND	ND	ND	0.150	0.170	0.320
QTP-08-23@5.5'	5.5	5.5	ND	ND	ND	ND	ND	0.110	0.130	0.240
QTP-08-24@20" (1.67')	1.7	1.67	ND	ND	ND	ND	ND	0.110	0.130	0.240
QTP-08-24@48" (4.0')	4.0	4	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-25@2.0'	2.0	0	ND	ND	ND	ND	ND	0.064	0.072	0.136
QTP-08-26@8" (0.67')	0.7	1.67	ND	ND	ND	ND	ND	0.014	0.029	0.043
QTP-08-27@1.0'	1.0	1	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-27@3.5'	3.5	3.5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-27@5.0'	5.0	5	ND	ND	ND	ND	ND	ND	ND	ND
QTP-08-28@2.5'	2.5	3.5	ND	ND	ND	ND	ND	0.200	0.350	0.550
QTP-08-28@4.5'	4.5	5.5	ND	ND	ND	ND	ND	2.900	3.700	6.600
QTP-08-28@6.0'	6.0	7	ND	ND	ND	ND	ND	ND	ND	ND
Feb. 2008 Borehole Sampling										
QB-08-01@2'	2.0	3.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-01@6'	6.0	7.5	ND	ND	ND	ND	ND	2.300	3.300	5.600
QB-08-01@8'	8.0	9.5	ND	ND	ND	ND	ND	0.320	0.420	0.740
QB-08-01@10'	10.0	11	ND	ND	ND	ND	ND	0.890	0.750	1.640
QB-08-01@12'	12.0	13.5	ND	ND	ND	ND	ND	0.019	0.021	0.039
QB-08-02@1'	1.0	2.5	ND	ND	ND	ND	ND	0.180	0.200	0.380
QB-08-02@6'	6.0	7.5	ND	ND	ND	ND	ND	0.100	0.110	0.210
QB-08-02@10'	10.0	11.5	ND	ND	ND	ND	ND	0.360	0.410	0.770
QB-08-02@11.5'	11.5	13	ND	ND	ND	ND	ND	0.760	0.620	1.380
QB-08-02@13'	13.0	14.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-03@5.5'	5.5	9.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-03@8'	8.0	12	ND	ND	ND	ND	ND	0.280	0.350	0.630
QB-08-03@11.5'	11.5	15.5	ND	ND	ND	ND	ND	0.040	0.044	0.084
QB-08-03@14.5'	14.5	18.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-03@15.5'	15.5	19.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-04@3.5'	3.5	5	ND	ND	ND	ND	ND	0.400	0.430	0.830
QB-08-04@6'	6.0	7.5	ND	ND	ND	ND	ND	0.740	0.910	1.650
QB-08-04@9'	9.0	10.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-04@12.5'	12.5	14	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-04@14.5'	14.5	16	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-04@20'	20.0	21.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-05@2'	2.0	3	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-05@5'	5.0	6	ND	ND	ND	ND	ND	0.190	0.280	0.470
QB-08-05@7'	7.0	8	ND	ND	ND	ND	ND	0.440	0.610	1.050
QB-08-05@12'	12.0	13	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-05@13.5'	13.5	14.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-06@7'	7.0	6.75	ND	ND	ND	ND	ND	0.220	0.240	0.460
QB-08-06@10'	10.0	9.75	ND	ND	ND	ND	ND	0.330	0.490	0.820
QB-08-06@13'	13.0	12.75	ND	ND	ND	ND	ND	0.068	0.140	0.208
QB-08-06@14'	14.0	13.75	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-07@1.5'	1.5	0.5	ND	ND	ND	ND	ND	0.058	0.072	0.130
QB-08-07@3.5'	3.5	2.5	ND	ND	ND	ND	ND	0.017	ND	0.017
QB-08-07@6.5'	6.5	5.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-07@10'	10.0	9	ND	ND	ND	ND	ND	0.023	ND	0.023
QB-08-07@11.5'	11.5	10.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-08@3'	3.0	3	ND	ND	ND	ND	ND	0.330	0.520	0.850

Table 1: PCB Concentrations in Samples of Remaining Soil

SAMPLE ID AND DEPTH	Depth (ft bgs)	Revised Depth ^(a) (ft bgs)	Aroclor							PCBs (total) ^(b)
			1016	1221	1232	1242	1248	1254	1260	
			Concentration (mg/kg)							
QB-08-08@5.5'	5.5	5.5	ND	ND	ND	ND	ND	ND	0.014	0.014
QB-08-08@8'	8.0	8	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-08@12'	12.0	12	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-08@14'	14.0	14	ND	ND	ND	ND	ND	0.260	0.420	0.680
QB-08-08@14.5'	14.5	14.5	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-09@3.5'	3.5	5.5	ND	ND	ND	ND	ND	0.390	0.580	0.970
QB-08-09@7.5'	7.5	9.5	ND	ND	ND	ND	ND	0.067	0.110	0.177
QB-08-09@8'	8.0	10	ND	ND	ND	ND	ND	1.100	1.800	2.900
QB-08-10@4.5'	4.5	8.5	ND	ND	ND	ND	ND	0.520	0.920	1.440
QB-08-10@7.5'	7.5	11.5	ND	ND	ND	ND	ND	0.440	0.780	1.220
QB-08-10@9'	9.0	13	ND	ND	ND	ND	ND	0.250	0.520	0.770
QB-08-10@11.5'	11.5	15.5	ND	ND	ND	ND	ND	0.220	0.160	0.380
QB-08-10@13'	13.0	17	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-11@2'	2.0	7	ND	ND	ND	ND	ND	0.620	0.860	1.480
QB-08-11@4'	4.0	9	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-11@5.5'	5.5	10.5	ND	ND	ND	ND	ND	1.500	2.600	4.100
QB-08-11@7'	7.0	12	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-11@10'	10.0	15	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-12@1'	1.0	6	ND	ND	ND	ND	ND	1.800	2.500	4.300
QB-08-12@3.5'	3.5	8.5	ND	ND	ND	ND	ND	0.170	0.400	0.570
QB-08-12@6'	6.0	11	ND	ND	ND	ND	ND	0.460	0.810	1.270
QB-08-12@6.5'	6.5	11.5	ND	ND	ND	ND	ND	0.250	0.360	0.610
QB-08-12@11'	11.0	16	ND	ND	ND	ND	ND	0.200	0.310	0.510
QB-08-12@13'	13.0	18	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-13@2'	2.0	2	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-13@3'	3.0	3	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-14@2'	2.0	5	ND	ND	ND	ND	ND	0.540	0.730	1.270
QB-08-14@5'	5.0	8	ND	ND	ND	ND	ND	0.200	0.240	0.440
QB-08-14@8'	8.0	11	ND	ND	ND	ND	ND	0.430	0.460	0.890
QB-08-14@11'	11.0	14	ND	ND	ND	ND	ND	0.240	0.290	0.530
QB-08-14@13'	13.0	16	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

(a) Sample depth changes due to Site grading activities in 2012.

(b) Total concentration is the summation of the 7 PCBs reported in the laboratory reports for each sample, not including non-detectable results.

(c) Not Detected at or above the analytical method reporting limit reported for that isomer

Table 2: PCB Concentrations in Groundwater Samples

SAMPLE ID	Aroclor							PCBs (total) ^(a)
	1016	1221	1232	1242	1248	1254	1260	
Concentration (µg/L)								
QB-08-01 GW	ND ^(b)	ND						
QB-08-02 GW	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-05 GW	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-06 GW	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-07 GW	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-08 GW	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-10 GW	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-12 GW	ND	ND	ND	ND	ND	ND	ND	ND
QB-08-14 GW	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

- (a) Total concentration is the summation of the 7 PCBs reported in the laboratory reports for each sample, not including non-detectable results.
- (b) Not Detected at or above the analytical method reporting limit reported for that isomer

Table 3: PCB Concentrations in Surface Sediment Samples

SAMPLE ID AND DEPTH	Depth (ft bgs)	Revised Depth ^(a) (ft bgs)	Aroclor							PCBs (total ^(b))	
			1016	1221	1232	1242	1248	1254	1260		
			Concentration (mg/kg)								
Swale Sed-CL#3	0.3	0.3	ND ^(c)	ND	ND	ND	ND	ND	0.450	0.650	1.100
SW-4-Surface	0.3	0.3	ND	ND	ND	ND	ND	ND	0.390	0.420	0.810
SW-6-Surface	0.3	0.3	ND	ND	ND	ND	ND	ND	0.050	0.051	0.101
SW-7-Surface	0.3	0.3	ND	ND	ND	ND	ND	ND	0.036	0.056	0.092
SW-3-Surface	0.3	0.3	ND	ND	ND	ND	ND	ND	0.027	0.031	0.058
SW-2-Surface	0.3	0.3	ND	ND	ND	ND	ND	ND	0.012	0.013	0.025
SW-5-Surface	0.3	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

(a) Sample depth changes due to Site grading activities in 2012.

(b) Total concentration is the summation of the 7 PCBs reported in the laboratory reports for each sample, not including non-detectable results.

(c) Not Detected at or above the analytical method reporting limit reported for that isomer

Table 4: PCB Solubility Testing Sample Results Summary

SAMPLE ID AND DEPTH	Depth (ft bgs)	Revised Depth ^(a) (ft bgs)	Aroclor							PCBs (total) ^(b)	Description
			1016	1221	1232	1242	1248	1254	1260		
			Concentration (mg/kg)								
SOL-1@9' STLC	9.0	11.8	ND ^(c)	ND	ND	ND	ND	ND	ND	ND	Crushed Concrete
G-78@9* TTLC	9.0	11.5	ND	ND	ND	ND	ND	3.400	2.500	5.900	Crushed Concrete
SOL-2@9' STLC	9.0	11.8	ND	ND	ND	ND	ND	ND	ND	ND	Crushed Concrete
SOL-2@9' TTLC	9.0	11.8	ND	ND	ND	ND	ND	1.100	1.300	2.400	Crushed Concrete
SOL-3@3' STLC	3.0	3.0	ND	ND	ND	ND	ND	ND	ND	ND	Crushed Concrete with soil
SOL-3@3' TTLC	3.0	3.0	ND	ND	ND	ND	ND	0.760	0.560	1.320	Crushed Concrete with soil
SOL-4@3' STLC	3.0	2.5	ND	ND	ND	ND	ND	ND	ND	ND	Crushed Concrete with soil
SOL-4@3' TTLC	3.0	2.5	ND	ND	ND	ND	ND	1.100	0.980	2.080	Crushed Concrete with soil
SOL-5@9.5' STLC	9.5	9.5	ND	ND	ND	ND	ND	ND	ND	ND	Brown Sandy Clay
SOL-5@9.5' TTLC	9.5	9.5	ND	ND	ND	ND	ND	0.085	0.090	0.175	Brown Sandy Clay
SOL-6@4.5' STLC	4.5	4.5	ND	ND	ND	ND	ND	ND	ND	ND	Crushed Concrete with soil
SOL-6@4.5' TTLC	4.5	4.5	ND	ND	ND	ND	ND	0.240	0.370	0.710	Crushed Concrete with soil
SOL-7@7' STLC	7.0	7.0	ND	ND	ND	ND	ND	ND	ND	ND	Brown Sandy Clay
SOL-7@7' TTLC	7.0	7.0	ND	ND	ND	ND	ND	0.250	0.190	0.430	Brown Sandy Clay
SOL-8@3' STLC	3.0	4.0	ND	ND	ND	ND	ND	ND	ND	ND	Crushed Concrete
SOL-8@3' TTLC	3.0	4.0	ND	ND	ND	ND	ND	0.730	0.760	1.490	Crushed Concrete
SOL-9@3' STLC	3.0	5.0	ND	ND	ND	ND	ND	ND	ND	ND	Crushed Concrete
SOL-9@3' TTLC	3.0	5.0	ND	ND	ND	ND	ND	8.400	14.000	22.400	Crushed Concrete
QTP-08-03@2.0' WET	2.0	7.0	ND	ND	ND	ND	ND	ND	ND	ND	
QTP-08-10@2.5' WET	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND	
QTP-08-11@28" (2.33') WET	2.3	2.3	ND	ND	ND	ND	ND	ND	ND	ND	
QTP-08-17@4.0' WET	4.0	5.9	ND	ND	ND	ND	ND	ND	ND	ND	
QTP-08-19@3.0' WET	3.0	3.0	ND	ND	ND	ND	ND	ND	ND	ND	
QTP-08-21@2.5' WET	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND	
QTP-08-24@20" (1.67') WET	1.7	1.7	ND	ND	ND	ND	ND	ND	ND	ND	
QB-08-02@12' WET	12.0	13.5	ND	ND	ND	ND	ND	ND	ND	ND	
QB-08-06@6.5' WET	6.5	6.2	ND	ND	ND	ND	ND	ND	ND	ND	
QB-08-07@7.5' WET	7.5	6.5	ND	ND	ND	ND	ND	ND	ND	ND	
QB-08-08@12' WET	12.0	12.0	ND	ND	ND	ND	ND	ND	ND	ND	
QB-08-13@3' WET	3.0	3.0	ND	ND	ND	ND	ND	ND	ND	ND	STLC Results

Notes:

(a) Sample depth changes due to Site grading activities in 2012.

(b) Total concentration is the summation of the 7 PCBs reported in the laboratory reports for each sample, not including non-detectable results.

(c) Not Detected at or above the analytical method reporting limit reported for that isomer

*Sample collected from the same location on an earlier date.

ND = None Detected

All results in mg/kg

Table 5: Summary of Sampling and Analysis Plan

Locations	Sample Types	Target Depth	Sampling Intervals	Analysis
Grid Samples (275 locations)	Graded Surface Soil within Demolition Footprint (250 locations, 420 samples)	2 ft bgs	Surface (0 – 3 in bgs) Near Surface (18 – 24 in bgs)	PCBs
	Graded Surface Soil outside Demolition Footprint (25 locations, 50 samples)	2 ft bgs	Surface (0 – 3 in bgs) Near Surface (18 – 24 in bgs)	PCBs
	Demolition Backfill within Demolition Footprint (250 locations, 500 samples)	Varies (8 to 20 ft bgs)	By Material Type (1 to 3 intervals anticipated)	PCBs Other analytes per landfill acceptance
	Pre-Confirmation Depth within Demolition Footprint (250 locations, 250 samples)	Varies (8 to 20 ft bgs)	Sample native soil at bottom of boring	PCBs
Perimeter Samples (160 locations)	Pre-Confirmation Outer Perimeter (60 locations, 120 samples)	4 ft bgs	Near Surface Sample native soil at bottom of boring	PCBs
	Pre-Confirmation Interior Perimeter (100 locations, 200 samples)	Varies (8 to 20 ft bgs)	5-ft vertical intervals	PCBs
Existing Stockpile Samples (4 locations)	Discrete Samples (40 samples; one per 50 cy)	Varies (0 to 2 ft deep)	Surface (0 – 3 in deep) Near Surface (18 – 24 in deep)	PCBs
Sidewalk Samples (8 locations)	(16 samples)	2 ft bgs	Surface (0 – 3 in bgs) Near Surface (18 – 24 in bgs)	PCBs
Drainage Samples (14 locations)	Swale (10 samples)	Surface	Surface (0 – 3 in bgs)	PCBs
	Catchment Basin (4 samples)	Surface	Surface (0 – 3 in bgs, if present)	PCBs

Notes:

- (a) "ft bgs" denotes feet below ground surface.
(b) "ft deep" denotes feet below surface of stockpile.
(c) "PCB" denotes polychlorinated biphenyls.

Table 6: Summary of Analytical Methods, Sample Containers, Preservations, and Holding Times

Analyte	Method	Minimum Container	Preservative	Holding Time
Soil Samples				
Polychlorinated Biphenyls	USEPA 8082	4-ounce glass	4°C	14 days (40 days post-extraction)
Total Metals	USEPA 6010	4- ounce glass	4°C	180 days
Volatile Organic Compounds	USEPA 8260	4- ounce glass	4°C	14 days
Semi-Volatile Organic Compounds	USEPA 8270	4- ounce glass	4°C	7 days (40 days post-extraction)
Total Petroleum Hydrocarbons as Diesel and Motor Oil	USEPA 8015	4- ounce glass	4°C	14 days (40 days post-extraction)
Water Samples				
Polychlorinated Biphenyls	USEPA 8082	1-liter amber bottle	None	14 days (40 days post-extraction)
Total Metals	USEPA 6020	250-milliliter polypropylene container	HNO ₃	180 days
Volatile Organic Compounds	USEPA 8260	3 x 40-milliliter VOA vials	HCl	14 days
Semi-Volatile Organic Compounds	USEPA 8270	1-liter amber bottle	None	7 days (40 days post-extraction)
Total Petroleum Hydrocarbons as Diesel and Motor Oil	USEPA 8015	3 x 40-milliliter VOA vials	HCl	7 days (40 days post-extraction)

Notes:

(a) "°C" denotes degrees Celsius.

(b) "HCl" denotes hydrochloric acid.

Figures

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Source: EKI 2006

Notes:

- 1. All locations are approximate

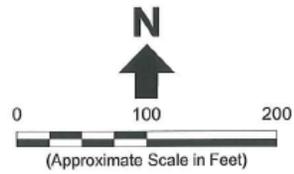
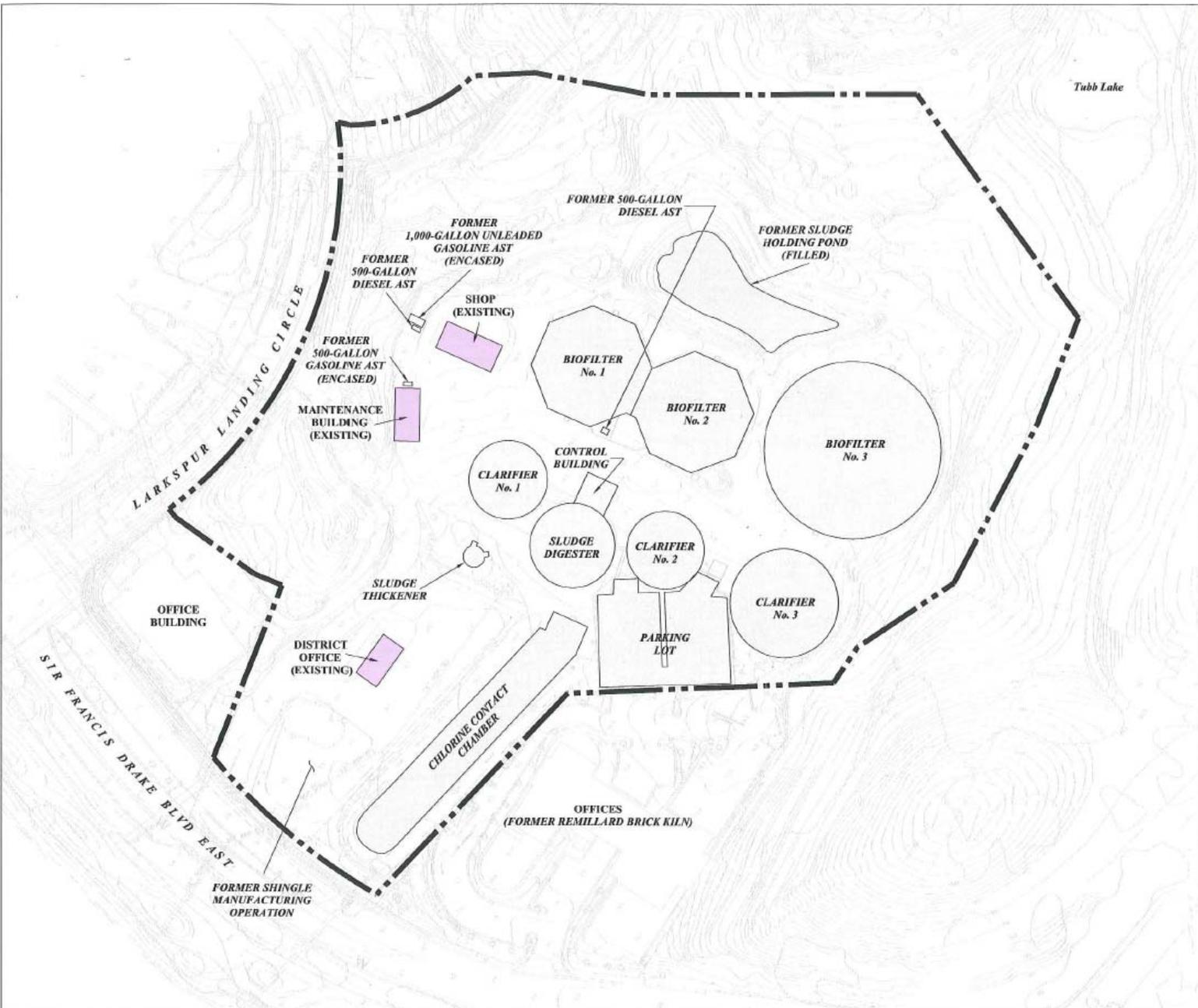
Kennedy/Jenks Consultants

Former Larkspur Wastewater Treatment Plant Site
2000 Larkspur Landing Circle, Larkspur, CA

Site Location Map

K/J 1565036*00
September 2016

Figure 1



Source: EKI 2006

Notes:

1. All locations are approximate.
2. Basemap source: Nate Engineering, San Rafael, California

Abbreviations:

AST = Above ground storage tank

Legend:

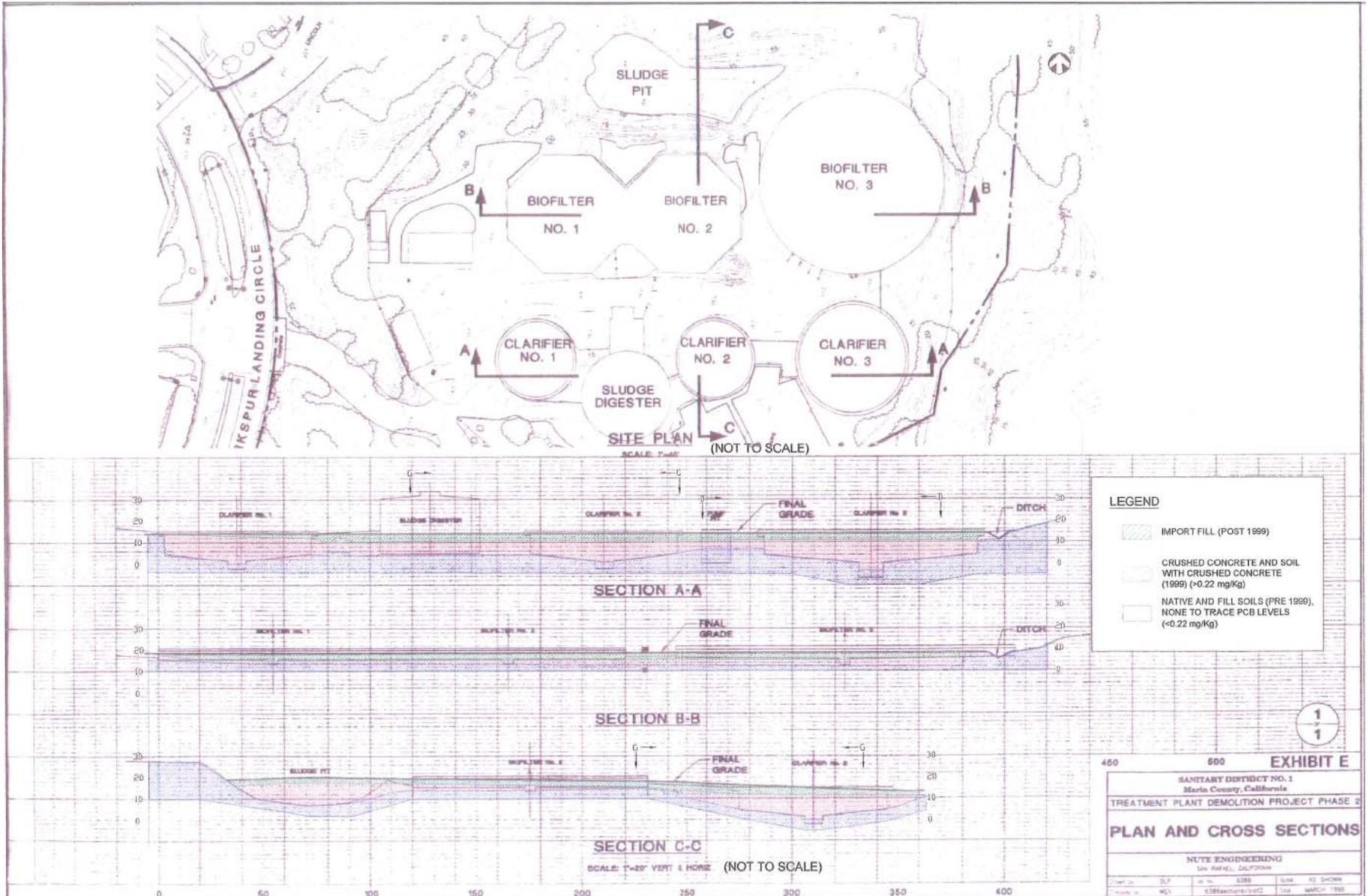
- Approximate Subject Property Boundary
- Former Site Features
- Existing Site Features

Kennedy/Jenks Consultants

Former Larkspur Wastewater Treatment Plant Site
 2000 Larkspur Landing Circle, Larkspur, CA
Former Wastewater Treatment Plant Facilities

K/J 1565036*00
 September 2016

Figure 2

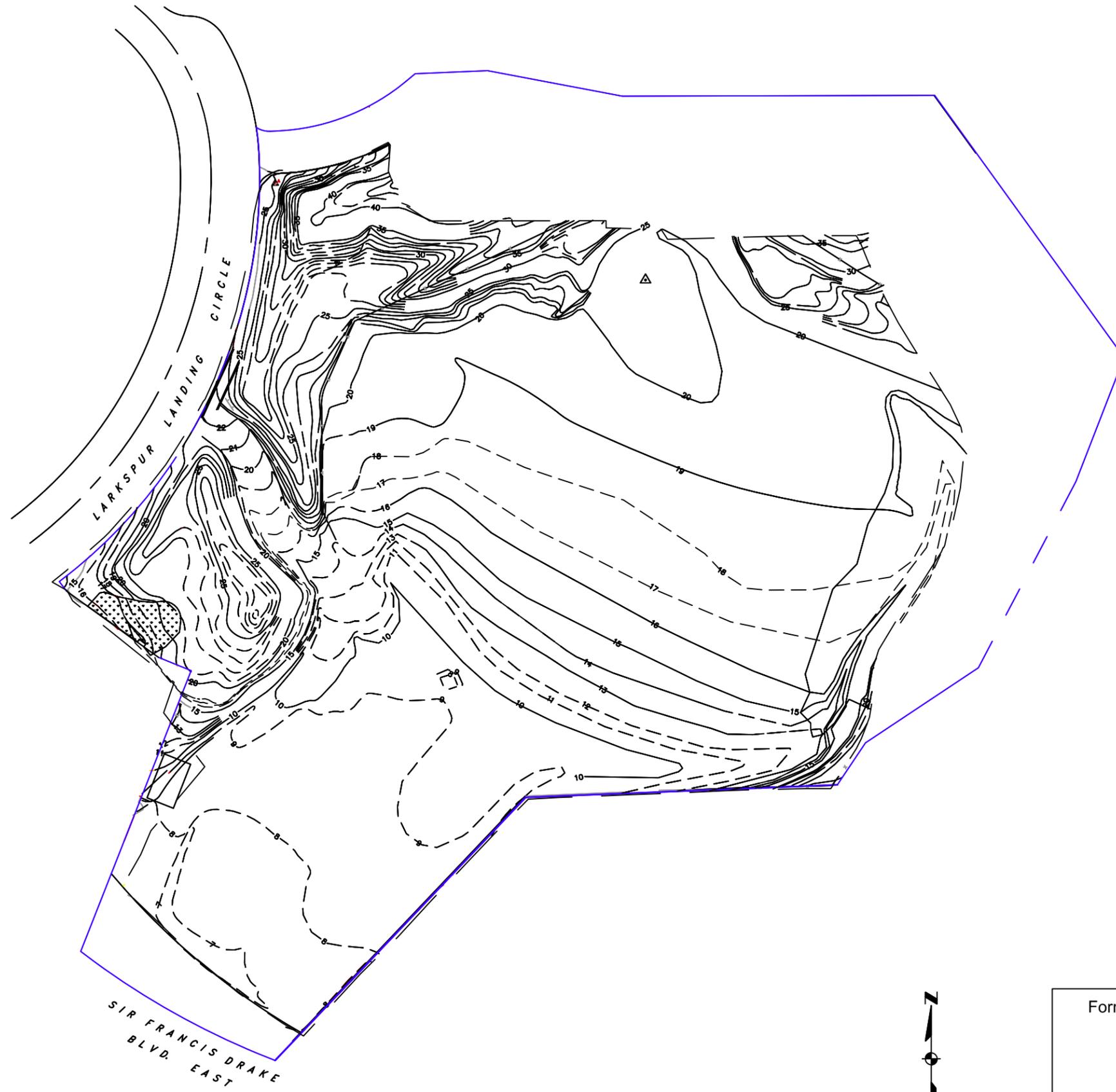


Source: EKI 2006

Kennedy/Jenks Consultants
Former Larkspur Wastewater Treatment Plant Site
2000 Larkspur Landing Circle, Larkspur, CA
Extent of Post-Demolition Fill

K/J 1565036*00
September 2016

Figure 3



LEGEND

— Approximate Subject Property Boundary

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**Site Topographic Map Prior to May 2012
Grading Activities**

K/J 1565036.00
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Figure 5

\\SFOCAD\Projects\IS-Prof\2015\1565036.00 SDMC Larkspur\05-Reports\Site Characterization Work Plan\004 Figures\Source Files\Figure06 Site Topographic Map After May 2012 Grading Activities.dwg 9/20/2016 4:33 PM RICK TECZON



LEGEND

— Approximate Subject Property Boundary

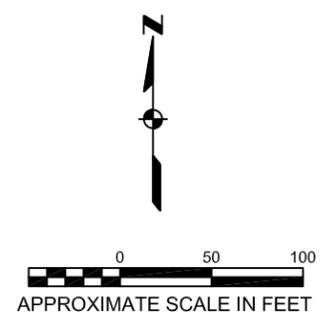
Kennedy/Jenks Consultants

Former Larkspur Wastewater Treatment Plant Site
2000 Larkspur Landing Circle, Larkspur, CA

**Site Topographic Map Subsequent to
May 2012 Grading Activities**

K/J 1565036.00
September 2016

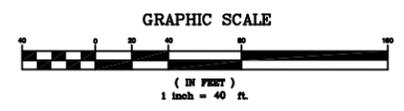
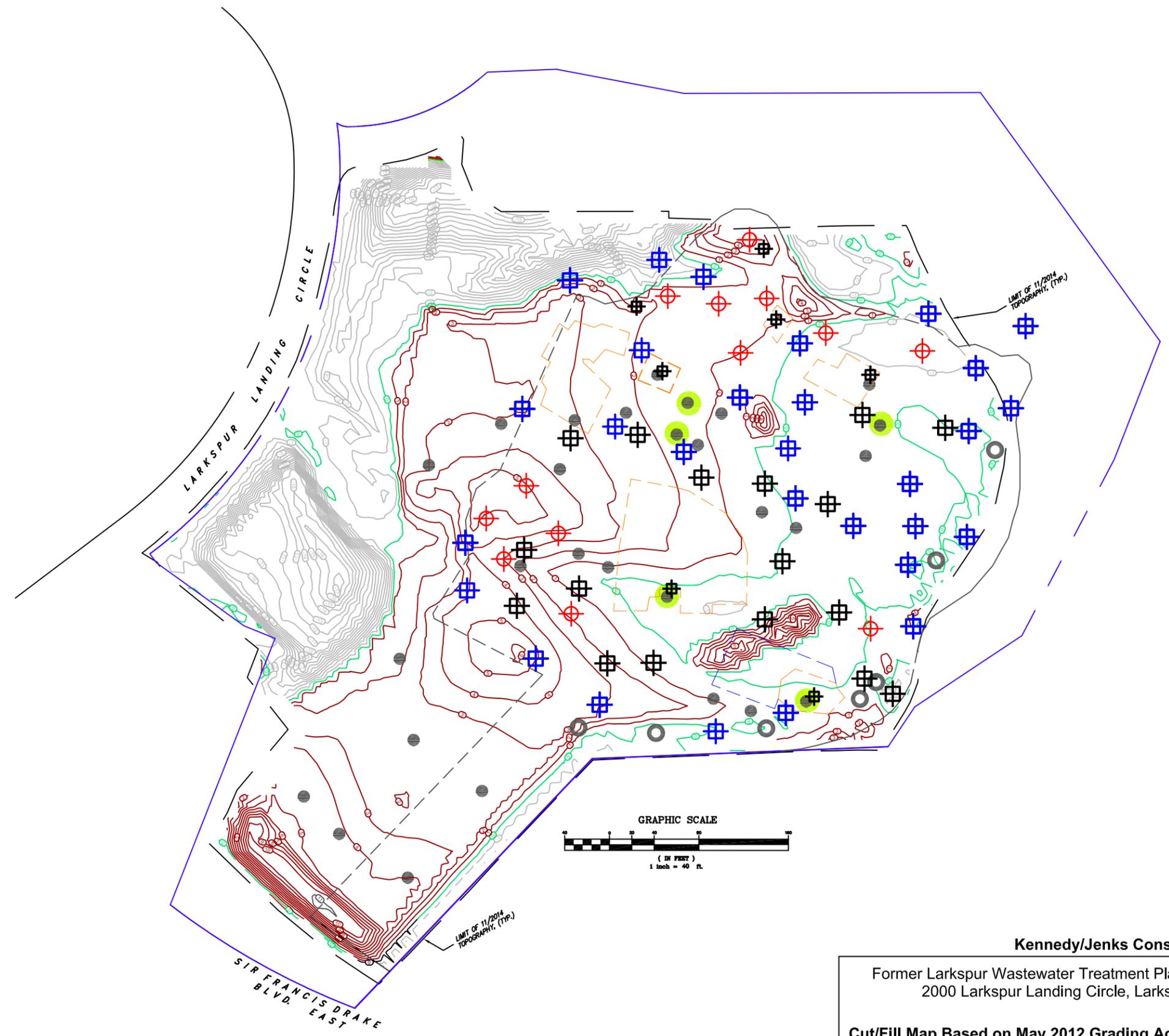
Figure 6



\\SFOCAD\Projects\IS-Proj\2015\1565036.00 SDMC Larkspur\08-Reports\Site Characterization\Work Plan\004 Figures\Source Files\Figure07 Cut-Fill Map Based on May 2012 Grading Activities.dwg
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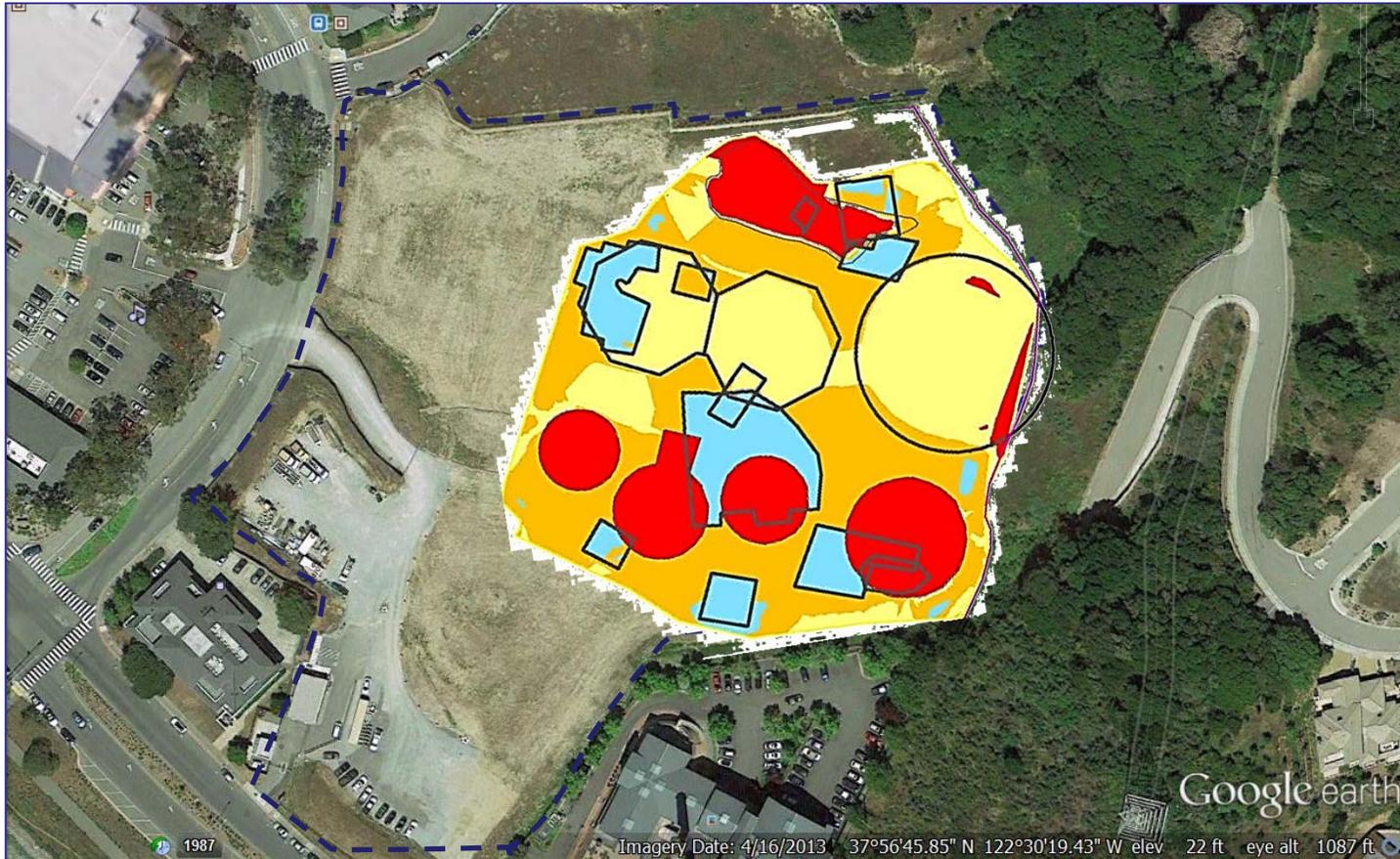
LEGEND

-  February 2008 Borehole Location 15-20 feet deep (QB-08-01 to QB-08-14)
-  February 2008 Test Pit Location 5 to 6 feet deep (QTP-08-01 to QB-08-28)
-  Approximate Lowney Soil Sample Location (November 2006)
-  Approximate Test Pit Soil Sample Location (2006 & 2007)
-  Deep Import Fill Soil Sample Location with Total PCBs less than 0.22 mg/kg
-  Approximate Test Pit Soil Sample Location (October - November 2007)
-  Approximate Swale Sediment Sample Location (November 2007)
-  Soil Excavation Areas (2007)
-  Soil Excavation Areas (2005)
-  Approximate Subject Property Boundary
-  Cut Change in Elevation
-  Fill Change in Elevation



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2000 Larkspur Landing Circle, Larkspur, CA
Cut/Fill Map Based on May 2012 Grading Activities

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Figure 7



-  **Site Boundary**
-  **Backfill Removed**
-  **0-2 ft Remaining**
-  **2-4 ft Remaining**
-  **4-20 ft Remaining**

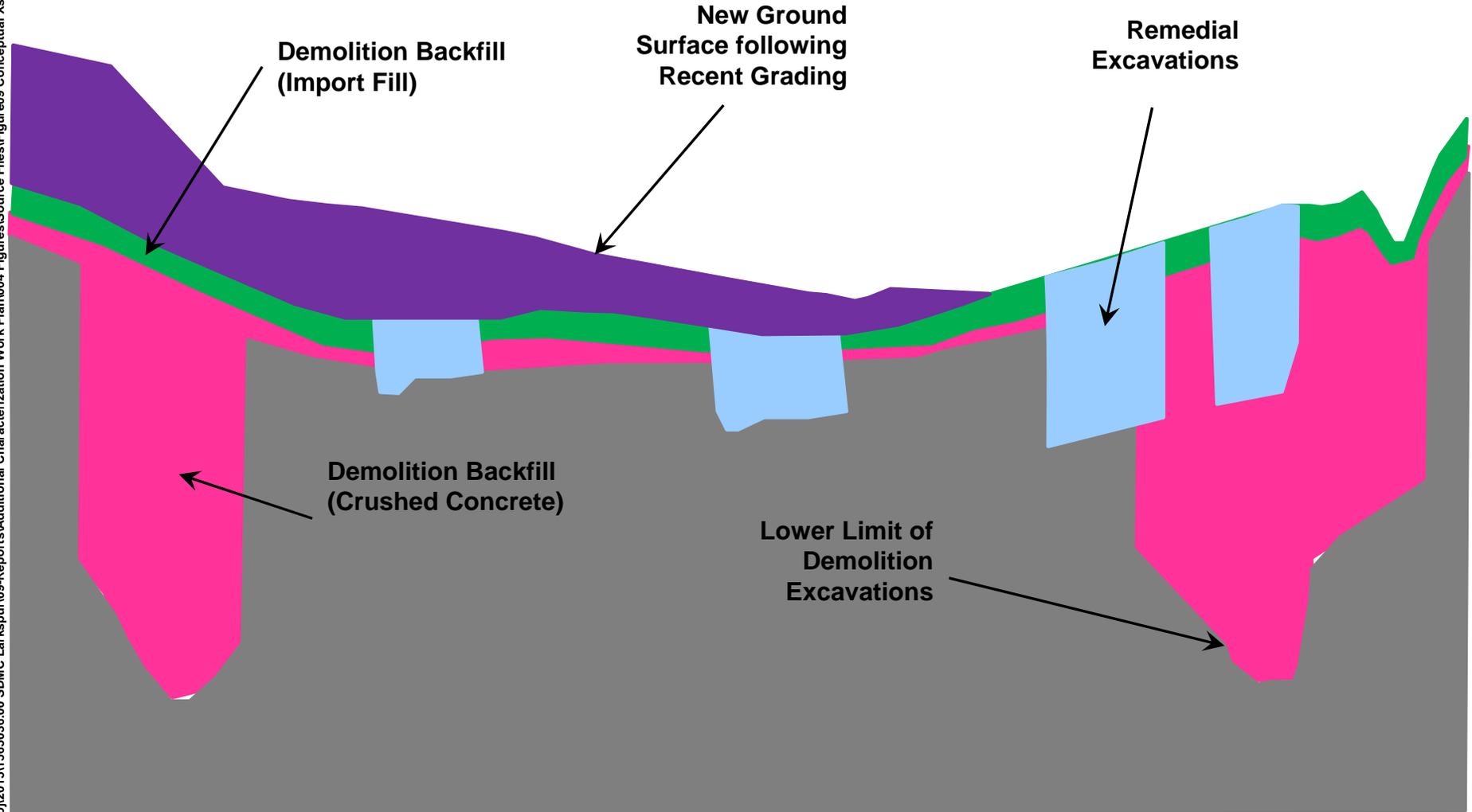
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Nature and Extent of PCBs in Soil

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Figure 8

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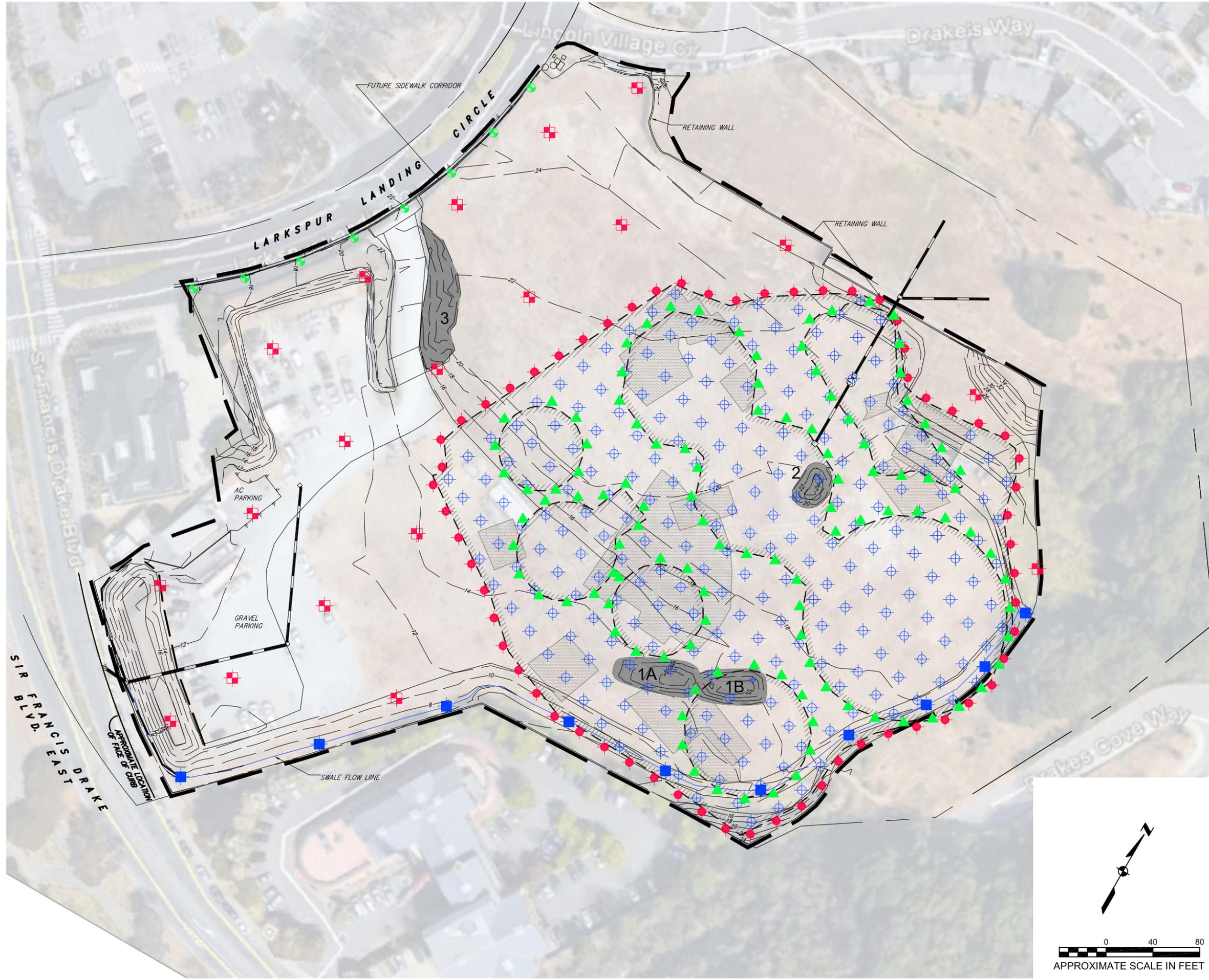
Conceptual Cross Section

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September 2016

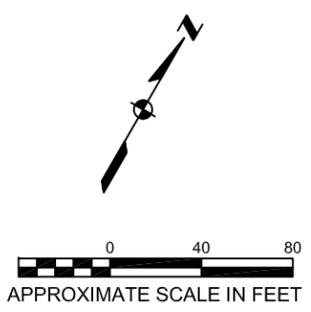
Figure 9

\\SFOCAD\Projects\IS- Proj\2015\1565036.00 SDMC Larkspur\05-Reports\Site Characterization Work Plan\04 Figures\Source Files\Figures\10 Sampling Locations_rev - Copy.dwg 9/20/2016 4:39 PM RICK TECZON



LEGEND

- Grid Boring Location
 - Outside Demolition Footprint
 - Graded Surface
 - Near Surface
 - 100-ft x 100-ft Grid
 - Approximately 20 Locations (with 5 additional locations at historical site features not shown)
 - Inside Demolition Footprint
 - Graded Surface
 - Near Surface
 - Demolition Backfill
 - Pre-Confirmation Depth
 - 25-ft x 25-ft Grid
 - Approximately 250 Locations
- Perimeter Boring Location
 - Pre-Confirmation Outer Perimeter
 - 25-ft Spacing
 - Approximately 60 Locations
- ▲ Internal Perimeter Boring Locations
 - Pre-Confirmation Interior Perimeter
 - 25-ft Spacing
 - Approximately 100 Locations
- Drainage Swale Sediment Locations
 - Surface
 - 100-ft Spacing
 - Approximately 10 Locations
 - Situate Locations Within Swale and Stagger Placement Alternating Between Flow Line and Bank
- Sidewalk Locations
 - Surface
 - Near Surface
 - 50-ft Spacing
 - Approximately 8 Locations
 - Situate Locations Within 5-ft Wide Corridor and Stagger Placement Across Width (not shown)
- Limits of Previous Demolition Excavation
- Limits of Previous Remedial Excavation
- 2 Stockpile

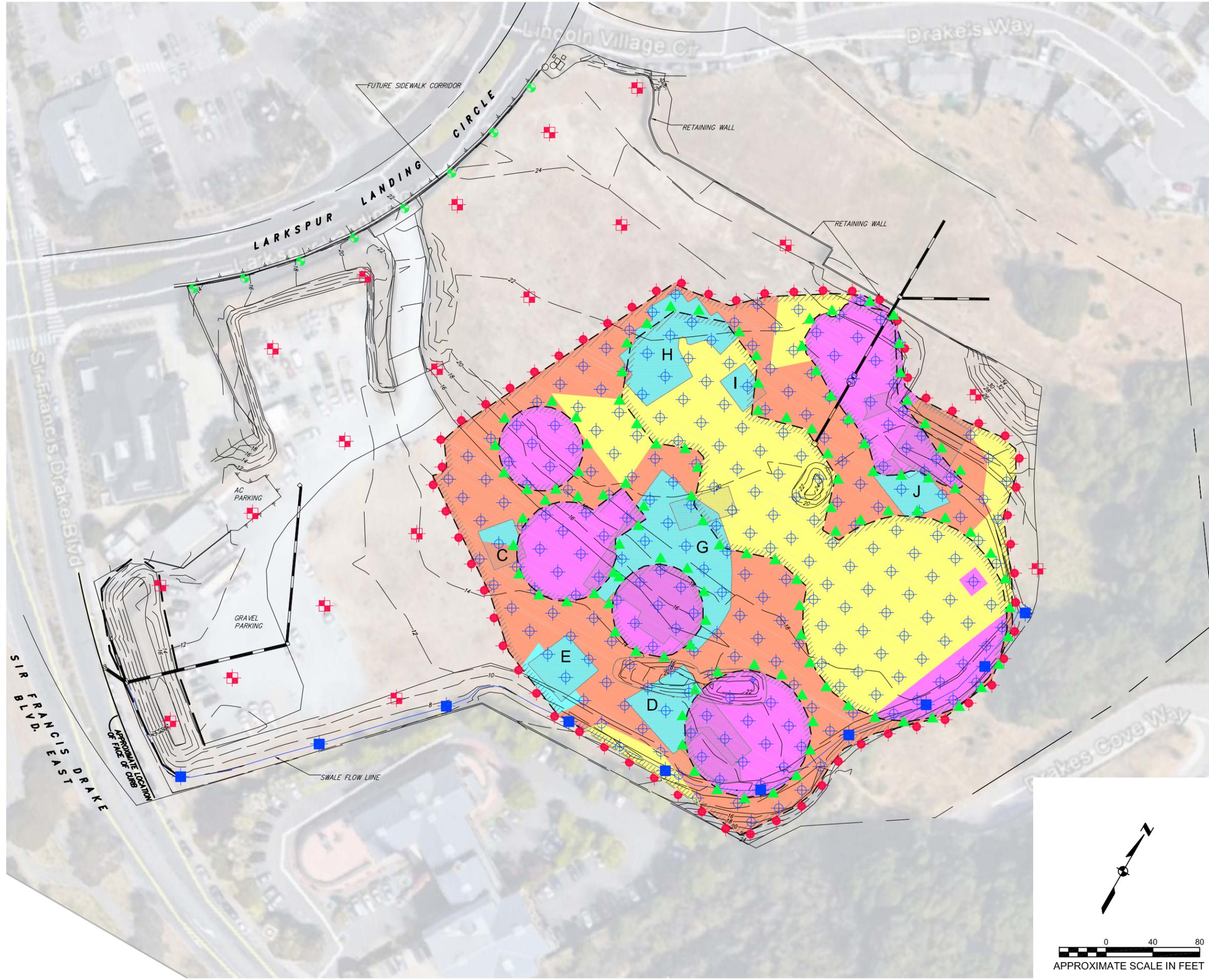


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**Proposed Characterization
 Sample Locations**
 1565036.00
 September 2016

Figure 10

I:\SFOCAD\Projects\IS- Proj\2015\1565036.00 SDMC Larkspur\05-Reports\Site Characterization Work Plan\04 Figures\Source Files\Figures\11 Target Depths_rev.dwg
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LEGEND

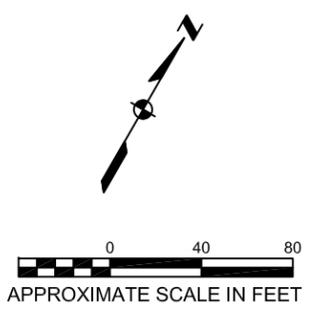
- Grid Boring Location Outside Demolition Footprint
Target Boring Depth - 2 ft bgs
- ⊕ Grid Boring Location Inside Demolition Footprint
Target Boring Depth - See DEPTH KEY
- Perimeter Boring Location
Target Boring Depth - 4 ft bgs
- ▲ Internal Perimeter Locations
Target Boring Depth - See DEPTH KEY
- Drainage Swale Sediment Location
Target Boring Depth - Surface
- Sidewalk Location
Target Boring Depth - 2 ft bgs

- Limits of Previous Demolition Excavation
- Limits of Previous Remedial Excavation

DEPTH KEY

- Confirm Previous Excavation
Depth Various by Location
(see table below)
- Target Boring Depth 2 ft bgs
- Target Boring Depth 4 ft bgs
- Target Boring Depth 20 ft bgs

Excavation	Depth
C	2 ft bgs
D	6 ft bgs
E	6 ft bgs
G	8 ft bgs
H	5 ft bgs
I	3 ft bgs
J	5 ft bgs



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**Proposed Characterization
 Target Depths**
 1565036.00
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Figure 11

Appendix A – Visual Sampling Plan Reports

Area Report

Perimeter Reports

Appendix A: Systematic Sampling Locations for Comparing a Mean with a Fixed Threshold (Parametric)

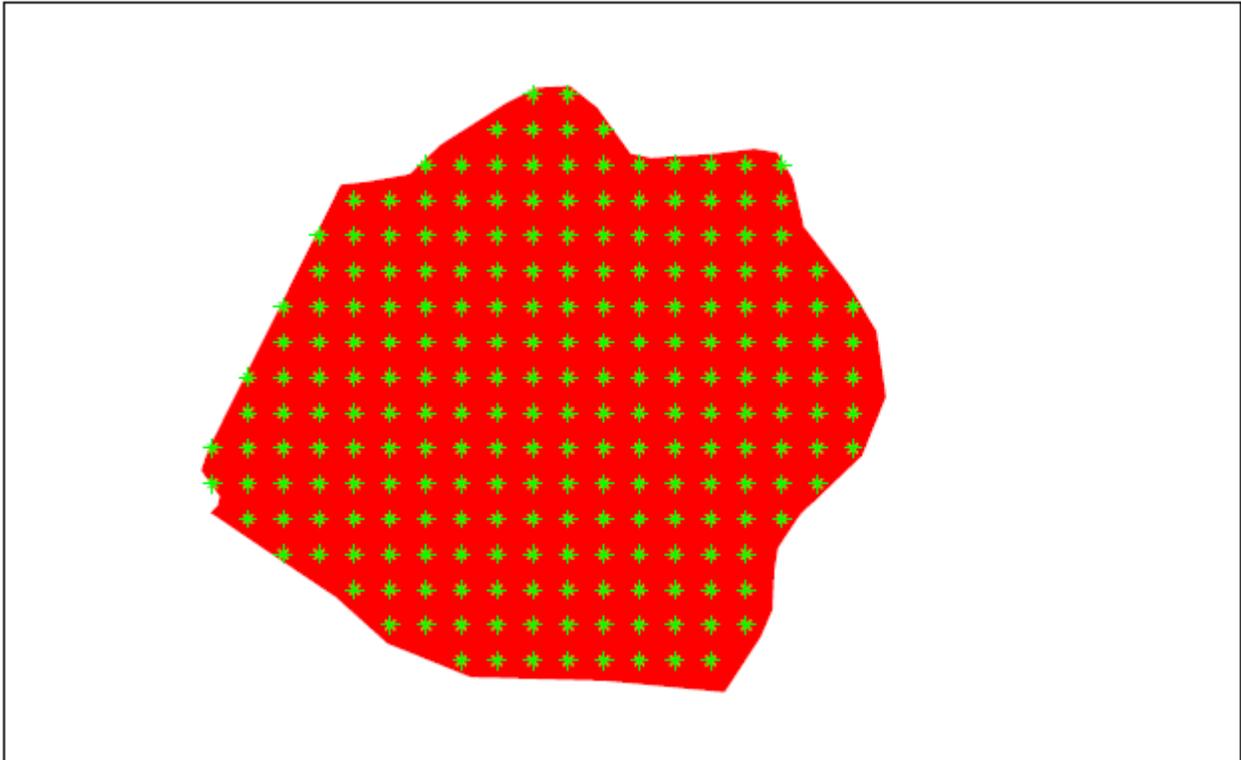
Summary

This report summarizes the sampling design and associated statistical assumptions. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for PCB, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Systematic with random start location
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	227
Number of samples on map a	227
Number of selected sample areas b	1
Specified sampling area c	158,486.46 ft ²
Size of grid / Area of grid cell d	26.4231 feet / 698.178 ft ²
Grid pattern	Square

- a. This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
- b. The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
- c. The sampling area is the total surface area of the selected colored sample areas on the map of the site.
- d. Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.



Primary Sampling Objective

The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach

A parametric design was used to determine the number of samples. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

VSP offers many options to determine the locations at which measurements are made or samples are collected and subsequently measured. For this design, systematic grid point sampling was chosen. Locating the sample points systematically provides data that are all equidistant apart. This approach does not provide as much information about the spatial structure of the potential contamination as

simple random sampling does. Knowledge of the spatial structure is useful for geostatistical analysis. However, it ensures that all portions of the site are equally represented. Statistical analyses of systematically collected data are valid if a random start to the grid is used.

Number of Total Samples: Calculation Equation and Inputs

The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability (1-β) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2} (Z_{1-\alpha} + Z_{1-\beta})^2 + 0.5Z_{1-\alpha}^2$$

Where

- n Is the number of samples
- S is the estimated standard deviation of the measured values including analytical error
- Δ is the width of the gray region
- α is the acceptable probability of incorrectly concluding the site mean is less than the threshold
- β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold
- Z_{1-α} is the value of the standard normal distribution such that the proportion of the distribution less than Z_{1-α} is 1-α
- Z_{1-β} is the value of the standard normal distribution such that the proportion of the distribution less than Z_{1-β} is 1-β

The values of these inputs that result in the calculated number of sampling locations are:

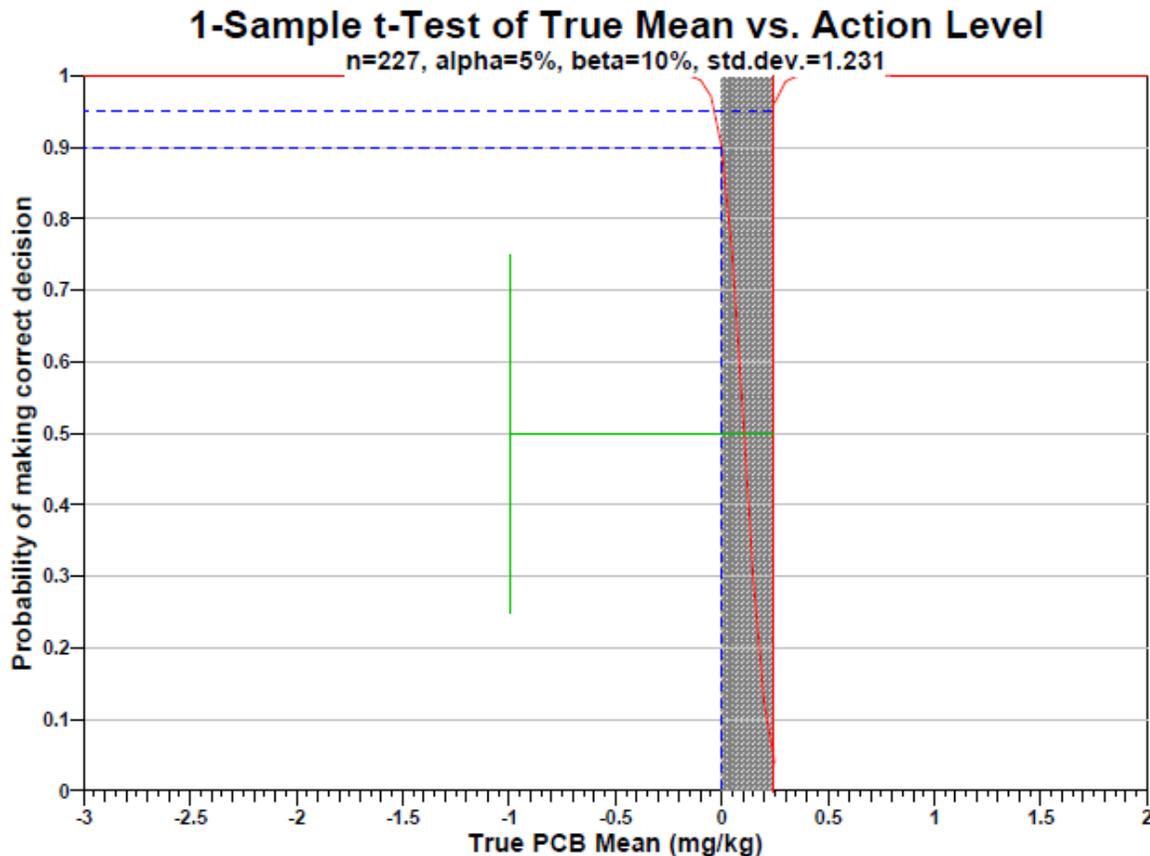
Analyte	n	Parameter					
		S	Δ	α	β	Z _{1-α} ^a	Z _{1-β} ^b
Total PCB	227	1.231 mg/kg	0.24 mg/kg	0.05	0.10	1.64485	1.28155

- a. This value is automatically calculated by VSP based upon the user defined value of α.
- b. This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for PCB, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to D; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to

the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at $1-\alpha$. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2 , is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that $\mu >$ action level and alpha (%), probability of mistakenly concluding that $\mu <$ action level. The following table shows the results of this analysis.

Number of Samples							
AL=0.24		$\alpha=5$		$\alpha=10$		$\alpha=15$	
		S=2.462	S=1.231	S=2.462	S=1.231	S=2.462	S=1.231
LBGR=25	$\beta=5$	2026	508	1603	402	1346	337
	$\beta=10$	1604	402	1230	309	1006	252
	$\beta=15$	1347	338	1007	253	805	202
LBGR=15	$\beta=5$	1578	396	1249	313	1084	263
	$\beta=10$	1249	314	958	241	784	197
	$\beta=15$	1049	264	784	197	627	157
LBGR=5	$\beta=5$	1264	317	1000	251	839	211
	$\beta=10$	1000	251	767	193	628	158
	$\beta=15$	840	211	628	158	502	126

S = Standard Deviation

LBGR = Lower Bound of Grey Region (% of Action Level)

α = Alpha (%), Probability of mistakenly concluding that $\mu <$ action level

β = Beta (%), Probability of mistakenly concluding that $\mu >$ action level

AL = Action Level (Threshold)

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Appendix A: VSP Sample Design Report for Sampling the Enclosing Boundary of a Site

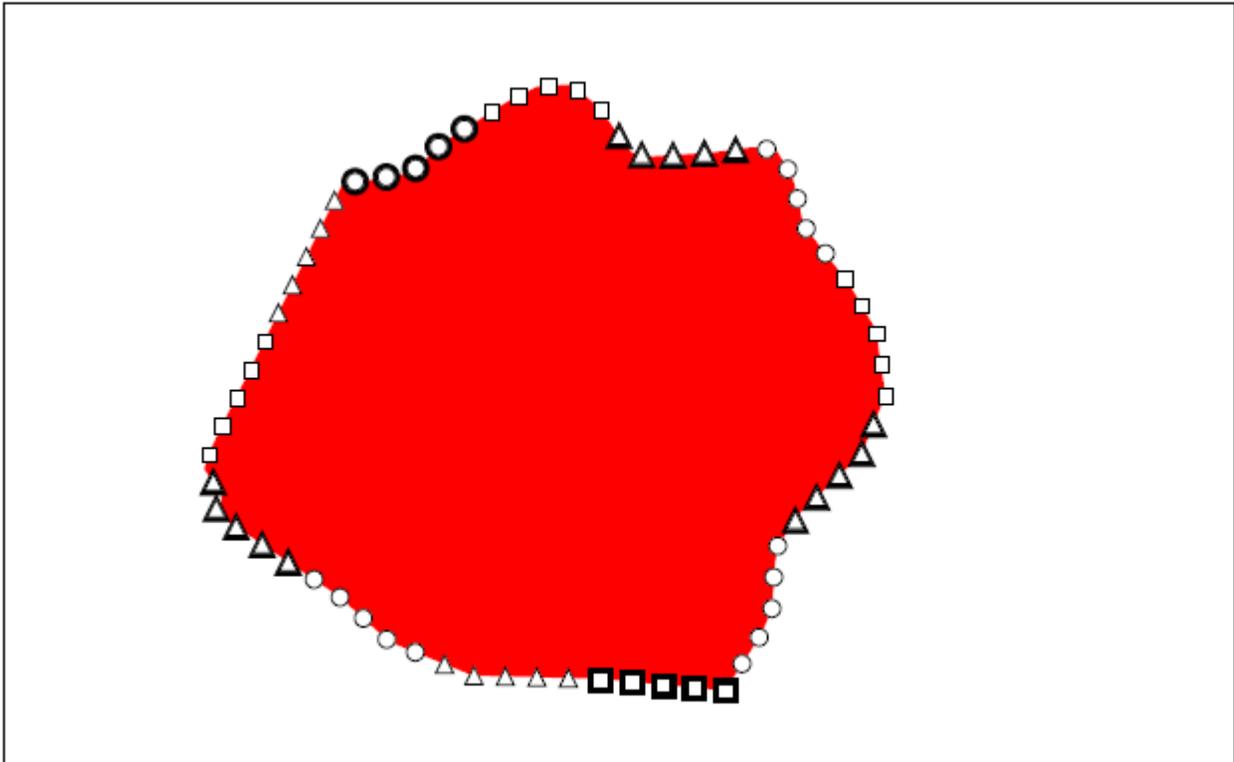
Summary

This report summarizes the sampling design developed in VSP for determining if the boundary of a site needs to be expanded because contaminants in soil may have migrated outside the boundary. This report also documents the statistical assumptions made in developing the design. Sampling plan components presented here include the number and placement of soil samples along the boundary and site maps that show the initial boundary. Other details of the sampling plan such as the methods of sample collection, the physical size, shape, and depth of soil samples collected, and the handling, transport and laboratory analysis procedures are assumed to be documented elsewhere.

The following table summarizes the sampling design. The table is followed by a map that shows the initial site boundary.

SUMMARY OF BOUNDARY SAMPLING DESIGN	
Primary Objective of Design	Determine whether the boundary encloses the region of contaminated soil
Sampling Design Strategy	Divide boundary into segments and collect multiple increment soil samples to statistically test contamination in each segment to see if it exceeds action level
Statistical test used for each segment	Compare the upper confidence limit (UCL) on the mean for each analyte against its action limit.
Specified width of plume at the boundary that must be detected	25 feet
Minimum primary sampling locations along each segment	5
Optimum length of segments along the boundary	125 feet
Analytes (and Action Limits)	PCB (0.24 mg/kg)
Number of selected sample areas a	1
Original boundary converted to a convex hull	No
Length of boundary	1,526.73 feet
Area enclosed by perimeter	158,486.46 ft ²
Number of segments on boundary	13
Total number of segments	39

- a. The number of selected sample areas is the number of colored areas on the site map. For this sample design, a sample area represents a region of contaminated soil enclosed by the perimeter boundary.



Primary Sampling Objective

The primary purpose of sampling at this site is to determine if a soil contamination plume of critical width may have migrated beyond the current boundary (perimeter or fence line) that encloses the site.

Selected Sampling Approach

Initial Number of Samples and Spacing of Sampling Locations

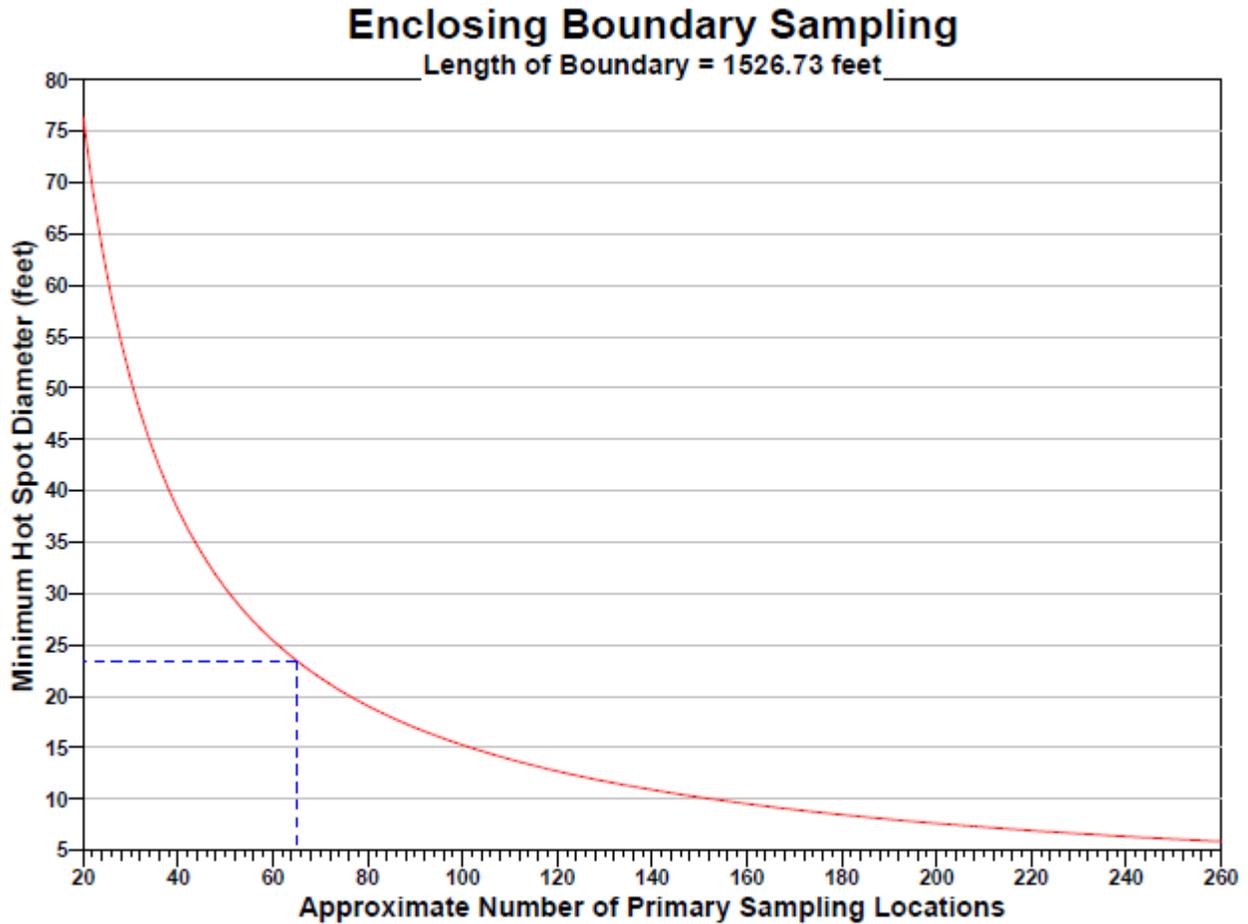
First, VSP calculates the optimum length of sampling segments along the boundary of the site. The optimum segment length is the specified width of the contamination plume multiplied by the number of primary sample locations. In this case, the optimum segment length is

$$25 \text{ feet} \times 5 = 125 \text{ feet}$$

Next, the number of segments is computed by dividing the boundary length by the optimum segment length and rounding up to the nearest whole number. This process ensures that the spacing between primary sampling locations will not exceed the specified width of the contamination plume. Next, the actual length of each sampling segment is computed by dividing the actual boundary length by the number of segments. Finally, the 5 primary sampling locations are evenly spaced along each sampling segment.

VSP requires at least 5 segments to have a second (duplicate) sample collected using the same sampling pattern used for the first sample. The VSP user chose to collect a duplicate multiple increment sample for at least 5 of the segments.

The following graph shows the relationship between the number of primary sampling locations and the minimum hot spot size that can be detected. The dashed blue line shows the current number of primary sampling locations for this design (which may differ from the optimum number because of rounding and bump-out effects).



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Appendix A: VSP Sample Design Report for Sampling the Interior Boundaries of a Site

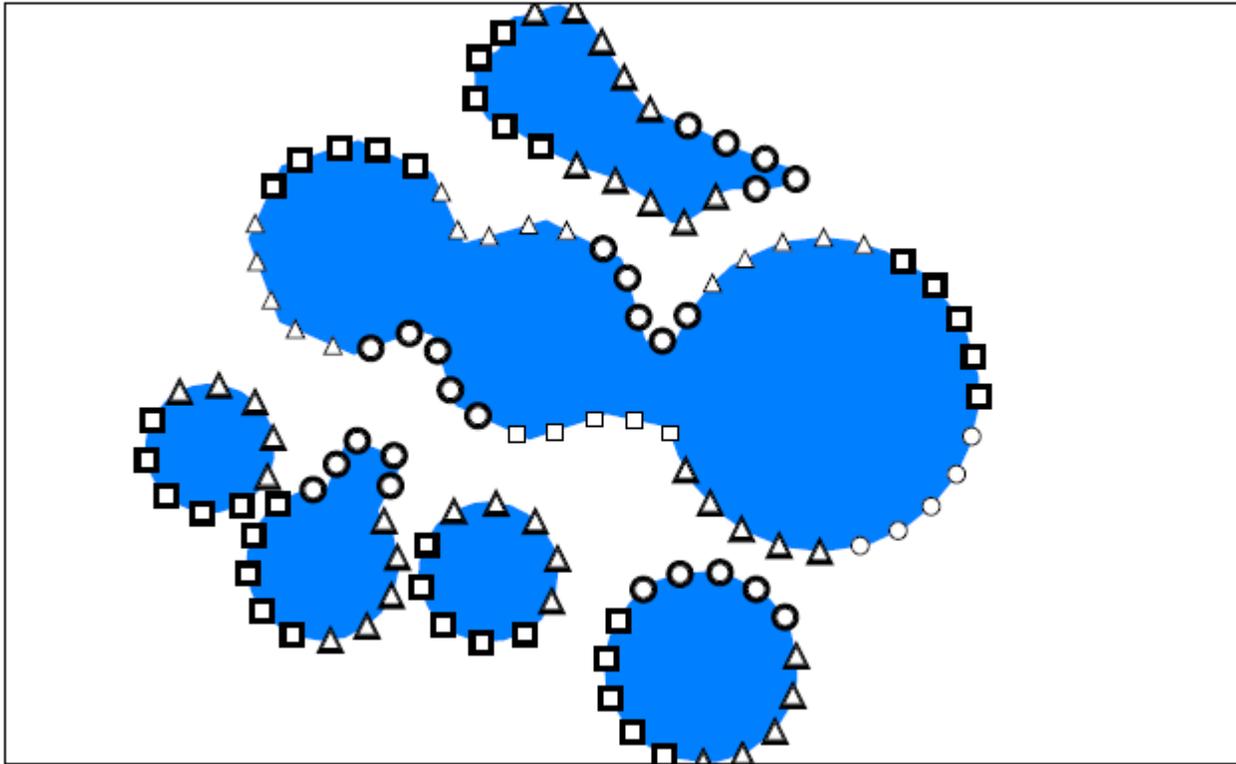
Summary

This report summarizes the sampling design developed in VSP for determining if the boundary of a site needs to be expanded because contaminants in soil may have migrated outside the boundary. This report also documents the statistical assumptions made in developing the design. Sampling plan components presented here include the number and placement of soil samples along the boundary and site maps that show the initial boundary. Other details of the sampling plan such as the methods of sample collection, the physical size, shape, and depth of soil samples collected, and the handling, transport and laboratory analysis procedures are assumed to be documented elsewhere.

The following table summarizes the sampling design. The table is followed by a map that shows the initial site boundary.

SUMMARY OF BOUNDARY SAMPLING DESIGN	
Primary Objective of Design	Determine whether the boundary encloses the region of contaminated soil
Sampling Design Strategy	Divide boundary into segments and collect multiple increment soil samples to statistically test contamination in each segment to see if it exceeds action level
Statistical test used for each segment	Compare the upper confidence limit (UCL) on the mean for each analyte against its action limit.
Specified width of plume at the boundary that must be detected	25 feet
Minimum primary sampling locations along each segment	5
Optimum length of segments along the boundary	125 feet
Analytes (and Action Limits)	PCB (0.24 mg/kg)
Number of selected sample areas a	6
Original boundary converted to a convex hull	No
Length of boundary	2,761.65 feet
Area enclosed by perimeter	79,746.20 ft ²
Number of segments on boundary	24
Total number of segments	72

- a. The number of selected sample areas is the number of colored areas on the site map. For this sample design, a sample area represents a region of contaminated soil enclosed by the perimeter boundary.



Primary Sampling Objective

The primary purpose of sampling at this site is to determine if a soil contamination plume of critical width may have migrated beyond the current boundary (perimeter or fence line) that encloses the site.

Selected Sampling Approach

Initial Number of Samples and Spacing of Sampling Locations

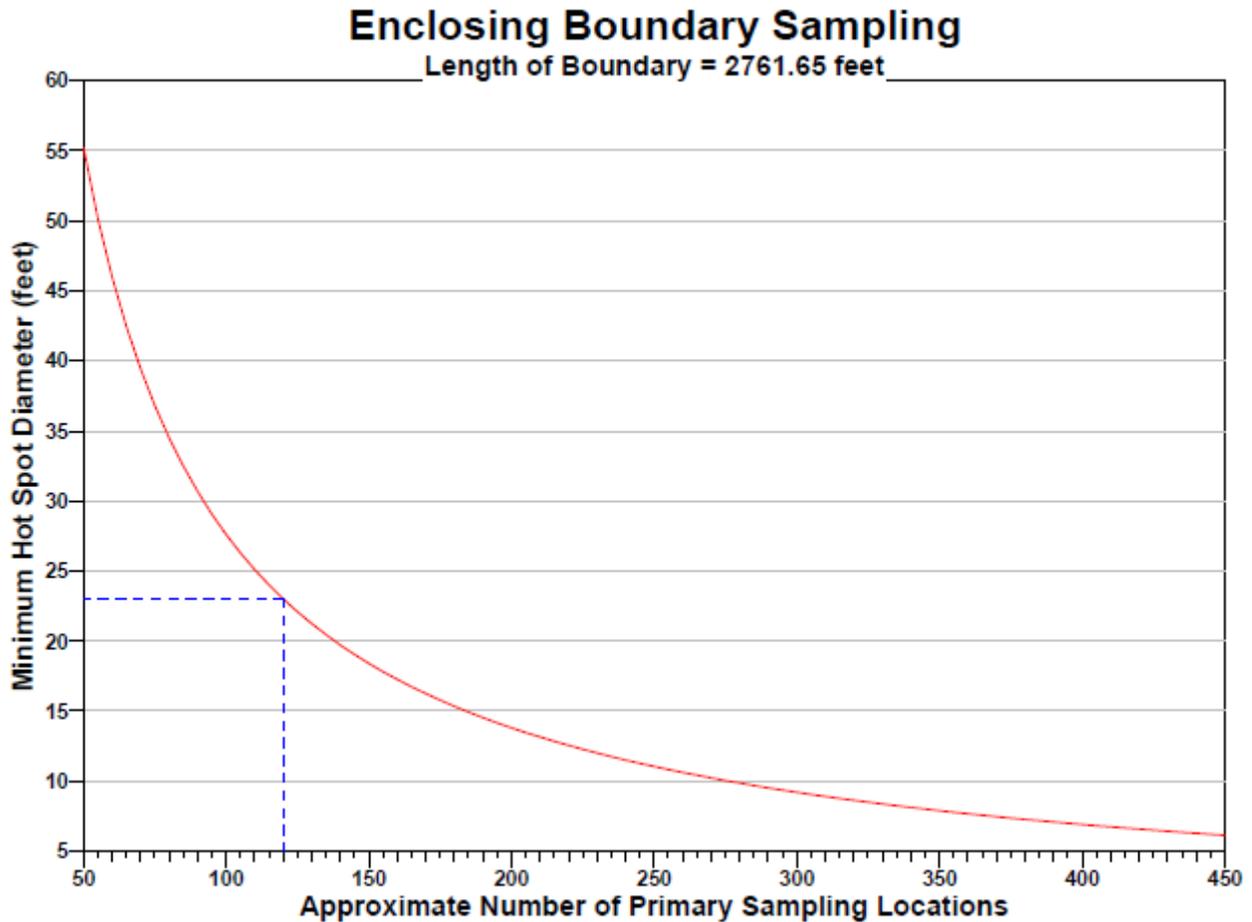
First, VSP calculates the optimum length of sampling segments along the boundary of the site. The optimum segment length is the specified width of the contamination plume multiplied by the number of primary sample locations. In this case, the optimum segment length is

$$25 \text{ feet} \times 5 = 125 \text{ feet}$$

Next, the number of segments is computed by dividing the boundary length by the optimum segment length and rounding up to the nearest whole number. This process ensures that the spacing between primary sampling locations will not exceed the specified width of the contamination plume. Next, the actual length of each sampling segment is computed by dividing the actual boundary length by the number of segments. Finally, the 5 primary sampling locations are evenly spaced along each sampling segment.

VSP requires at least 5 segments to have a second (duplicate) sample collected using the same sampling pattern used for the first sample. The VSP user chose to collect a duplicate multiple increment sample for at least 5 of the segments.

The following graph shows the relationship between the number of primary sampling locations and the minimum hot spot size that can be detected. The dashed blue line shows the current number of primary sampling locations for this design (which may differ from the optimum number because of rounding and bump-out effects).



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Appendix B – Standard Operating Guidelines

Borehole Logging

Surface and Shallow Soil Sampling

Typical Hydraulic Push/Drive Sampling Procedures

Boring and Subsurface Soil Sampling

Sample Packaging and Shipping

Equipment Decontamination

Personnel Decontamination

Handling and Disposal of Investigation-Derived Waste

Appendix B: Standard Operating Guideline Borehole Logging

B.1 Introduction

This Standard Operating Guideline (SOG) provides the procedures typically followed by Kennedy/Jenks Consultants personnel for classifying soils and preparing boring logs and other types of soil reports. The purpose of this SOG is to facilitate the acquisition of uniform descriptions of soils encountered during borehole programs and to promote consistency in the logging practices used by Kennedy/Jenks Consultants personnel. This SOG provides guidance on procedures that are generally consistent with standard practices used to classify soils. Deviations from, and additions to, the procedures described herein may be appropriate based on project-specific objectives, site-specific conditions, and/or regulatory requirements. The user of this SOG should modify the sampling procedures used, as appropriate, to conform to the project-specific requirements and then document such deviations from this SOG in the project-specific documentation of subsurface exploration activities.

Borehole logging is the systematic observation and recording of geologic and hydrogeologic information from subsurface borings and excavations. The Unified Soil Classification System (USCS) (ASTM D2487-00) is used to identify, classify, and describe soils principally for engineering purposes, and is based on laboratory tests.

For field applications, ASTM D2488-06 (Visual-Manual Procedure) is used as the general guide adopted under this SOG.

Both ASTM D2487 and ASTM D2488 utilize the same group names and symbols. However, soil reports should state that boring logs are not formal USCS laboratory determinations, but are based on the visual-manual procedures described in ASTM D2488.

This SOG contains the following sections:

- Field Equipment/Materials
- Typical Procedures
 - Soil Classification
 - Classification of Coarse-Grained Soil
 - Classification of Fine-Grained Soil including Organic Soils
- Other Logging Parameters
- Logging Refuse
- References.

B.2 Field Equipment/Materials

Material/equipment typically required for classifying soils and preparing boring logs may include:

- Pens, pencils, waterproof pens, and field logbook or other appropriate field forms (e.g., boring log forms), water-tight field case.
- Daily inspection report forms

- USCS (ASTM D 2488-06) table and classification chart
- Soil color chart (i.e., Munsell) If used, the edition of the Munsell chart should be specified on each borehole log as the color descriptions and hue, color values and chromas have changed between editions. Also, whenever possible, the newest version of Munsell's color charts should be used due to fading of color chips over time.
- American Geological Institute (AGI) Data Sheets
- Graph paper
- Engineer's scale
- Previous project reports and boring logs (if available)
- Pocket knife or putty knife
- Hand lens
- Supply of clean water
- Dilute hydrochloric acid (HCl) (make sure MSDS for HCl is included in the project HASP)
- Aluminum foil, Teflon® sheets, and paper towels
- Sample containers (brass, stainless steel or aluminum liners, plastic or glass jars)
- Clean rags or paper towels
- Sample shipping and packaging supplies
- Personnel and equipment decontamination supplies
- Personal protective equipment as described in the Health and Safety Plan (HASP).

B.3 Typical Procedure

Soil classification and borehole logging should be conducted by a qualified geologist, engineer or other personnel trained and experienced in the classification of soils.

Soils are typically logged in conjunction with advancing boreholes and sampling subsurface soils. Although the guideline focuses on classifying soil samples obtained from boreholes, this particular procedure also applies to soils and sediments collected using other techniques (e.g., post hole digger, scoop, Ekman, Ponar, or Van Veen grab samplers, and backhoe).

The USCS as described in ASTM D2488-06 categorizes soils into 15 basic group names, each with distinct geologic and engineering properties. The following steps are required to classify a soil sample:

1. Observe basic properties and characteristics of the soil. These include grain-size grading and distribution and influence of moisture on fine-grained soil.
2. Assign the soil a USCS classification and denote it by the standard group name and symbol.
3. Provide a written description to differentiate between soils in the same group, if necessary.

Many soils have characteristics that are not clearly associated with a specific soil group. These soils might be near the borderline between groups, based on either grain-size grading and distribution, or plasticity characteristics. In this case, assigning dual group names and symbols might be appropriate (e.g., GW-GC or ML-CL).

The two basic soil groups are:

1. **Coarse-Grained Soils** – For soils in this group, more than half of the material is larger than No. 200 sieve (0.074 mm).
2. **Fine-Grained Soils (including Organic Soils)** – For soils in this group, one half or more of the material is smaller than No. 200 sieve (0.074 mm).

Note: No. 200 sieve is the smallest size that can be seen with the naked eye.

B.4 Classification of Coarse-Grained Soils

Coarse-grained soils are classified on the basis of:

1. Grain size and distribution
2. Quantity of fine-grained material (i.e., silt and clay)
3. Character of fine-grained material

Classification uses the following symbols:

Basic Symbols	Modifying Symbols
G - gravel	W - well graded
S - sand	P - poorly graded
	M - with silt fines
	C - with clay fines

The following are basic facts about coarse-grained soil classification:

- The basic symbol G is used if the estimated volume percentage of gravel is greater than that for sand. In contrast, the symbol S is used when the estimated volume percentage of sand is greater than the percentage of gravel.
- Gravels include material in the size range from 3 inches to 0.2 inches (i.e., retained on No. 4 sieve). Sand includes material in the size range from 0.2 inches to 0.003 inches. Use the grain size scale used by engineers (ASTM Standards D422-63 and D643-78) to further classify grain size as specified by the USCS.

- Although not specifically treated in ASTM D2488-06, cobbles range in size from 3 inches to 10 inches and boulders refer to particles with a single dimension greater than 10 inches. They are included here for the purpose of completeness and for their hydrogeologic significance.

Note: The ASTM grain size scale differs from the Modified Wentworth Scale used in teaching most geologists. Also, it introduces a distinction between sorting and grading (i.e., well graded equals poorly sorted and poorly graded equals well sorted.)

- The modifying symbol W indicates good representation of a range of particle sizes in a soil.
- The modifying symbol P indicates that there is a predominant excess or absence of particle sizes.
- The symbol W or P is only used when a sample contains less than 15 percent fines.
- Modifying symbol M is used if fines have little or no plasticity.
- Modifying symbol C is used if fines have low to high plasticity (clayey)

The following rules apply for the written description of the soil group name:

Types of Soil	Rule
Sands and gravels (clean)	Less than 5 percent fines
Sands (or gravels) with fines	5 to 15 percent fines
Silty (or clayey) sands or gravels	Greater than 15 percent fines

- Other descriptive information may include:
 - Color (e.g., Munsell Soil Color chart, specify edition). Soil color is named and coded using the Munsell Soil Color chart if required for the project. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “dk brn (7.5 YR, 3/4).”
 - Relative Density/Penetration Resistance. For cohesionless materials use very loose, loose, medium, dense, or very dense estimated from drive sample hammer blows or other field tests. Blow counts may be used, if reliable.
 - Maximum grain size (fine, medium, coarse, as described in AGI data sheets or USCS). Note the largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
 - Composition of grains (mineralogy)
 - Approximate percentage of gravel, sand, and fines (use a percentage estimation chart as provided in the AGI data sheets)

Modifiers Description

Trace	Less than 5 percent
Few	5 to 10 percent
Little	15 to 25 percent
Some	30 to 45 percent
Mostly	50 to 100 percent

- Angularity (round, subround, angular, subangular)
- Shape (flat or elongated)
- Moisture Condition (dry, moist, wet)
 - o Dry - Absence of moisture to the touch.
 - o Damp - Contains enough water to keep the sample from being brittle, dusty or cohesionless; is darker in color than the same material in the dry state.
 - o Moist - Leaves moisture on your hand, but displays no visible free water.
 - o Wet - Displays visible free water.
- HCl Reaction (none, weak, strong)
- Cementation (Crumbles under finger pressure: weak, moderate, or strong)
- Range of Particle Sizes (sand, gravel, cobble, boulder)
- Maximum Particle Size (fine, medium, coarse)
- Cementation (weak, moderate, or strong)
- Hardness (breaks with hammer blow)
- Structure (stratified, laminated, fissured, slickensided, blocky, lensed, homogeneous)
- Organic material
- Odor
- Iridescent sheen (based on sheen test)
- Debris (e.g., paper, wood, plastic, cloth, concrete, construction materials, etc.).
- Additional Comments (e.g. roots or rootholes, difficult drilling, borehole caving, presence of mica, contact and/or bedding dip, bedding features, sorting, structures, fossils, cementation, geologic origin, formation name, minerals, oxidation, etc.

B.5 Classification of Fine-Grained Soils

Fine-grained soils are classified on the basis of:

1. Liquid limit
2. Plasticity

Classification uses the following symbols:

Basic Symbols	Modifying Symbols
M - silt	L - low liquid limit
C - clay	H - high liquid limit
O - organic	
Pt - peat	

The following rules apply for the written description of the soil group name:

Types of Soil	Rule
Silts and clays with sand and/or gravel	5 to 15 percent sand and/or gravel
Sandy or gravelly silts or clays	Greater than 15 percent sand and/or gravel

The following are basic facts about fine-grained soil classification:

- The basic symbol M is used if the soil is mostly silt, while symbol C applies if it consists mostly of clay. Use of symbol O indicates that organic matter is present in an amount sufficient to influence soil properties. The symbol Pt indicates soil that consists mostly of organic material.
- Modifying symbols are based on the following hand tests conducted on a soil sample:
 - Dry strength (crushing resistance : none, low, medium, high, very high)
 - Dilatancy (molded ball reaction to shaking: none, slow, rapid)
 - Toughness (resistance to rolling or kneading near plastic limit : low, medium, high)
 - Plasticity (nonplastic, low, medium, high).
- Soil designated ML has little or no plasticity and can be recognized by none to low dry strength, slow to rapid dilatancy, and low toughness.
- CL (lean clay) indicates soil with medium plasticity, which can be recognized by medium to high dry strength, no or slow dilatancy, and medium toughness.
- OL is used to describe an organic, fine-grained soil that is less plastic than CL soil and can be recognized by low to medium dry strength, medium to slow dilatancy, and low toughness. In some cases, it may be possible to differentiate organic silts (OL) from organic clays (OH), based on correlations between dilatancy, dry strength, toughness, or laboratory tests.
- MH soil has low to medium plasticity and can be recognized by low to medium dry strength, no to slow dilatancy, and low to medium toughness.
- Soil designated CH (fat clay) has high plasticity and is recognizable by its high to very high dry strength, no dilatancy, and high toughness.
- OH is used to describe an organic fine-grained soil that is less plastic than CH soil and can be recognized by medium to high dry strength, slow dilatancy, and low to medium toughness. In some cases, it may be possible to differentiate organic silts (OL) from organic clays (OH), based on correlations between dilatancy, dry strength, toughness, or laboratory tests.

Note: PT (peat) is used to describe a highly organic soil composed primarily of vegetable tissue with a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor.

- Other descriptive information includes:
 - Color (e.g., Munsell) Soil color is named and coded using the Munsell Soil Color chart if required for the project. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “reddish brn (5YR, 4/4).”
 - Moisture condition,
 - Omit moisture terms below the regional water table and when drilling with mud or air-mist rotary systems.
 - Consistency (thumb penetration test: very soft, soft, firm, hard, very hard . For fine sediments use very soft, soft, medium, stiff, very stiff, and hard.) These are estimated from drive sample hammer blows or other field tests. Blow counts may also be used, if reliable.
 - Structure (same descriptors as coarse grain)
 - Compactness (loose, dense) for silts
 - Odor
 - Iridescent sheen (based on sheen test)
 - Debris (e.g., paper, wood, plastic, cloth, concrete, construction materials, etc.).
 - HCl Reaction (none, weak, strong).
 - Additional Comments (e.g. roots or rootholes, difficult drilling, borehole caving, presence of mica, , contact and/or bedding dip, bedding features, cementation, structures, fractures, fracture fillings, fossils, formation name, minerals, oxidation).

Fine-Grained Rock Description

- Textural Classification
- Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “gry grn (5G, 5/2).”
- Hardness. Very hard, hard, medium, soft, very soft..
- Moisture Content. Dry, damp, moist, wet (saturated).
- Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay).
- Estimated Permeability. Very low, low, moderate, or high. This is based primarily on grain size, sorting, and cementation. Estimate secondary permeability due to natural rock fractures when applicable.
- Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.

- Fractures are identified by depth, angle, width, and associated mineralization if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]) should be stated. For example, “NF @90.8', 25 deg to axis, 0.1” wide, minor calcite.”
- Coarse-Grained Rock Description
- Textural Classification.
- Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. Presence of mottling and banding also is recorded. For example, “gry olive grn (5GY, 3/2).”Hardness. Very hard, hard, medium, soft, very soft.
- Moisture Content. Dry, damp, moist, and wet (saturated).
- Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay).
- Grain Shape. Angular, subangular, subrounded, rounded, or well-rounded, for grains larger than sand size.
- Grain Size. The largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
- Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.
- Fractures are identified by depth, angle, width, and associated mineralization, if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]), should be stated. For example, “NF @126.1', 35 deg to axis, 0.1” wide, minor calcite.”

B.6 Other Logging Parameters

Rock Quality Designation

This designation generally follows ASTM D6032-08 Standard Test Method for Determining Rock (RQD) of Rock Core.

The RQD denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. This method is generally applied to core barrel samples.

Standard Penetration Tests

This method generally follows ASTM D1586-08A Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. This method provides a means of assigning a relative density to the soil by counting the number of hammer blows (blow counts) required to advance a split-barrel sampler a specified distance into the undisturbed soil ahead of the lead

auger. This method is not applicable to boreholes advanced with direct-push sampling equipment. It is used primarily in conjunction with hollow stem auger drilling apparatus as the test can be performed through the auger string without removal of the augers thereby allowing the borehole to remain open to the bottom of the drill string without risk of caving. As the sampler is advanced by the repeated drop of a hammer of known weight, the blow counts are recorded on the log and used to provide a relative density descriptor to the soil penetrated during the test.

The number of blows required to drive the sampler 6 in. by a 140-lb hammer falling 30 in. Fifty blow counts per 6-in drive is considered “refusal,” and sampling at this depth is usually terminated. In addition, a total of 100 blow counts per 18-in. drive, or no observed advance of the sampler during ten successive hammer blows, is also considered “refusal.” During coring, leave this section blank. Normally, the second and third 6-in. intervals are recorded and added as the number of blows per feet.

Sampler Type/Depth. Give sampler type by the letter code listed below and identify the depth at the top of the sampling interval in feet below ground surface (bgs).

Sampler type	Inside diameter(in.)	Code
Standard penetrometer	1.38	SP
Split-barrel (small)	2.0	SBS
Split-barrel (large)	2.5	SBL
HQ wireline core	2.3	PC

Those descriptors are as follows for coarse grained soils:

Very Loose	0 to 3 SPT Sampler	0 to 4 Mod CA Sampler
Loose	4 to 7 SPT Sampler	5 to 10 Mod CA Sampler
Medium Dense	8 to 23 SPT Sampler	11 to 30 Mod CA Sampler
Dense	24 to 38 SPT Sampler	31 to 50 Mod CA Sampler
Very Dense	> 38 SPT Sampler	>50 Mod CA Sampler

Relative Density Descriptors for fine grained soils are as follows:

Very Soft	<1 SPT Sampler	0 to 1 Mod CA Sampler
Soft	1 to 3 SPT Sampler	2 to 4 Mod CA Sampler
Firm	4 to 6 SPT Sampler	4 to 8 Mod CA Sampler
Stiff	7 to 12 SPT Sampler	8 to 15 Mod CA Sampler
Very Stiff	13 to 23 SPT Sampler	15 to 30 Mod CA Sampler
Hard	> 23 SPT Sampler	>30 Mod CA Sampler

Regardless of the degree of adherence to the ASTM Standard Method, split barrel samplers are used as the preferred method of undisturbed sample acquisition in a hollow stem auger drilling. Upon retrieval of the sampler from the borehole, the sampler should be opened without making contact with its interior contents and the logging personnel should record the percent recovery or length of the sample recovered. Sample containers should be removed with a clean gloved (gloves may not be needed, depending upon requirements of HASP) hand and placed in a clean, dry area for examination and logging. The sample will be described per the above. Any lithologic changes that may be observable in the exposed ends of the intact core over the sampled interval should be recorded on the log before any disturbance thereof. The depth of the lithologic changes should be estimated and recorded on the boring log. The least disturbed sample container of the two deeper six-inch sample increments should be secured with Teflon® or aluminum end sheets and snug fitting plastic end caps, sealed with silicon tape, depending upon testing, sampler may be filled with one inch rings instead of 6 inch. Sealing material should also be compatible with subsequent testing requirements.

Ambient Temperature Head-Space:

Organic vapor analyzers such as photoionization detectors (PIDs) or flame ionization detectors (FIDs) are generally used to assess the relative concentration of volatile hydrocarbons in the soil as the borehole is advanced and recorded as a value in parts per million on the boring log. This can be done by placing a uniform amount of soil in a Ziploc® bag, glass jar or other clean container, allowing the soil in the container to equilibrate to the ambient temperature, then inserting the probe of the PID or FID into the sealed container and recording the maximum PID or FID reading.

Non-Aqueous Phase Liquid (NAPL) Containing Soil

Appropriate observations of NAPL containing soil should include the following:

Appearance: If a separate phase liquid appears to be present, it might be described as “dark brown viscous fluid or liquid observed in the soil matrix.” This remark should follow the lithologic description in the borehole log. Observations of color should be made such as “black streaks” or “mottled gray to “olive brown”, however, it should not be inferred or remarked that the color is a necessary consequence of petroleum staining.

Odor: If the soil smells like petroleum it might be remarked that it has a “petroleum like” or “solvent like” odor. The use of terms like “strong” or “slight” should be avoided because there is no way to ensure that these terms can be applied uniformly in the field between various persons performing the logging (i.e., each person's olfactory sense is different). The use of terms like “chemical odor” should also be avoided as there is no common reference point. Notations regarding the type of petroleum distillate present (e.g., “diesel-like odor” or “gasoline odor”) are inappropriate as these are determinations that can only be accurately made by laboratory analysis.

B.7 Logging Refuse

This procedure applies to the logging of subsurface samples collected from a landfill or other waste disposal sites:

1. Observe refuse as it is brought up by the hollow stem auger, bucket auger, or backhoe.
2. If necessary, place the refuse in a plastic bag to examine the sample.

3. Record observations according to the following:
 - a. Composition (by relative volume), e.g., paper, wood, plastic, cloth, cement, construction debris. Use such terms as "mostly" or "at least half." Do not use percentages.
 - b. Moisture content: dry, damp, moist, wet.
 - c. State of decomposition: highly decomposed, moderately decomposed, slightly decomposed, etc.
 - d. Color: obvious mottling included.
 - e. Texture: spongy, plastic (cohesive), friable.
 - f. Odor.
 - g. Combustible gas indicator readings (measure downhole).

Miscellaneous: dates of periodicals and newspapers, degree of drilling effort (easy, difficult, very difficult).

B.8 References

Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.
ASTM D1586-08A

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
ASTM D2488-06.

Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). ASTM D2487-00

Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core.
ASTM D6032-08.

Grain Size Scale Used by Engineers. ASTM D422-63 and ASTM D643-78.

Compton, R. R. 1962. *Manual of Field Geology*. New York: John Wiley & Sons, Inc.

U.S. Department of the Interior. 1989. *Earth Manual*. Washington, D.C.: Water and Power Resources Service.

International Society for Rock Mechanics. Commission on Classification of Rocks and Rock Masses. *Int. J. Rock Mech. Min. Sci. & Geomech. Abstr.* 1981, Vol. 18, pp. 85-110, Great Britain.

Appendix B: Standard Operating Guideline Surface and Shallow Soil Sampling

B.1 Introduction

This guideline describes the equipment and procedures that are used by Kennedy/Jenks Consultants personnel for collecting surface and shallow soil samples.

B.2 Equipment

- Stainless steel or plastic scoops
- Hand auger
- Split-spoon drive sampler (2.5-inch or 2.0-inch I.D.) and associated drill rods, wrench and other tools needed to break down equipment
- Slide hammer
- 2.5-inch or 2.0-inch brass liners and sealing materials (plastic end caps, Teflon seals, silicon tape, zip-lock plastic bags)
- Shovel
- Post hole digger
- Pick
- Breaker bar
- Foxboro FID-Organic Vapor Analyzer (OVA)
- HNU PID-Organic Vapor Analyzer
- OVM
- Measuring tape or measuring wheel
- Stakes or spray paint for sampling grid
- Sampler cleaning equipment
 - Steamcleaner (if available)
 - Generator (if available)
 - Stiff-bristle brushes
 - Buckets
 - High priority phosphate-free liquid soap, such as Liquinox
 - Trisodium phosphate (TSD) for use if samples are oily
 - Methanol (if necessary)
 - 0.1N nitric acid (if necessary)
 - Deionized water
 - Potable water
- Insulated sample storage and shipping containers
- Personal protective equipment (as specified in site safety plan)

B.3 Typical Procedure

1. Obtain applicable drilling and well construction permits, prior to mobilization, if necessary.
2. Clear locations for underground utilities and structures by Underground Service Alert (USA) and subcontractors, if necessary.

3. Measure and mark sampling locations prior to initiation of the sampling program, as specified in the sampling and analysis plan. If sampling locations are based on a grid pattern, stakes can be used to define the grid layout.
4. Collect soil samples for chemical analysis by using precleaned scoops or a hand auger, or by driving a split-spoon drive sampler.
5. If overlying soil is to be removed (as specified in the sampling and analysis plan), use shovels, picks, or post-hole diggers, as needed.
6. Collect soil samples for lithologic logging purposes.
7. If applicable, as described in the site safety plan, use an OVA to analyze *in situ* air samples from the breathing zone and other locations as necessary.
8. Have the soils classified in the field in approximate accordance with the visual-manual procedure of the Unified Soil Classification System (ASTM D 2488-90) and the Munsell Color Classification (refer to SOG 21).
9. Prior to each sampling event, decontaminate sampling equipment as specified in the sampling and analysis plan. If not specified in the sampling and analysis plan, wash sampling equipment (scoops, hand auger, split-spoon drive sampler, and brass liners) with high purity phosphate-free soap. Double-rinse it with deionized water and methanol, and/or 0.1N nitric acid, as appropriate.
10. At each sampling interval, collect soil and place it in the appropriate sampling container. Fill the sample container and compact the soil to minimize air space. Minimize handling of the soil, especially if it is being collected for analysis of volatile compounds.
11. If a split-spoon drive sampler is being used, select one brass liner for potential laboratory analysis. Cover the ends of this sample in Teflon sheets, seal it with plastic caps, and wrap it with silicon or Teflon tape. Place a completed sample label on the brass liner.
12. Place the selected samples in appropriate containers and store them at approximately 4 °C.
13. As a field screening procedure (if applicable), for each sampling interval, place soil not selected for chemical analysis in an airtight container (e.g., plastic bag or jar) and allow it to equilibrate. After this, monitor the headspace in the container using either a HNU, OVM or OVA. Record the headspace concentration in the field notes (refer to SOGs 4 and 5).
14. Complete chain-of-custody forms in the field and transport the selected samples in insulated containers, at an internal temperature of approximately 4°C, to the analytical laboratory (refer to SOGs 3).

B.4 Equipment Cleaning

Prior to collection of each soil sample, the sampling equipment should be decontaminated as specified in the sampling and analysis plan. If not specified in the sampling and analysis plan, the sampling equipment should be either steamcleaned or hand washed. If the sampling equipment is hand washed, wash excavation equipment with a brush, in a solution of high purity phosphate-free

soap and potable water. Rinse the equipment with potable water and methanol, and/or 0.1N nitric acid, as appropriate. Follow this with double-rinsing using distilled water (refer to SOG 11).

B.5 Investigation-Derived Residuals

If sufficient volumes of soil cuttings and other residuals are generated, contain the material in appropriately labeled containers for disposition by the client. All soil samples transported to the laboratory must be returned to the client for disposition if required by the laboratory. Kennedy/Jenks Consultants is available to assist the client with options for disposition of residuals (refer to SOG 20B).

Appendix B: Standard Operating Guideline Typical Hydraulic Push/Drive Sampling Procedures

B.1 Introduction

This guideline describes the equipment and procedures typically used by Kennedy/Jenks Consultants personnel for collecting soil and reconnaissance groundwater samples with a hydraulic push/drive system.

B.2 Equipment

- Portable, hydraulic push/drive sampling system
- 6-inch long, 1.75-inch O.D. stainless steel or brass liners and liner sealing materials (Teflon sheets, plastic end caps, Ziploc plastic bags)
- Type II Portland cement
- 1-inch O.D. Schedule 40 PVC screen (0.010-inch slot size)
- 1-inch O.D. Schedule 40 PVC blank casing
- 0.75-inch diameter stainless steel or Teflon bailer
- FID or PID organic vapor analyzer
- Water level indicator
- Temperature, specific conductivity and pH meters
- Equipment cleaning materials
 - Steam cleaner
 - Generator
 - Stiff-bristle brushes
 - Buckets
 - High-purity phosphate-free liquid soap
 - Deionized water
 - Rinsate collection system
- Personal protective equipment
- Appropriate groundwater sample containers
- Chain-of-custody forms
- Insulated sample storage container and ice substitute

B.3 Typical Procedures

1. Applicable drilling permits will be obtained prior to mobilization.
2. Sample locations will be cleared for underground utilities.
3. All downhole equipment will be steam cleaned prior to use at each location.
4. Soil borings will be advanced using a portable, hydraulic push/drive sampling system that simultaneously drives two nested, steel sampling rods into the ground to collect continuous soil cores.

5. As the sampling rods are advanced, the soil core will be collected in a 1-7/8-inch diameter, 3-foot long sample barrel, which is attached to the end of the inner rods. After being advanced 3 feet, the inner rods will be removed from the borehole with a hydraulic winch. The sampler (containing new stainless steel liners) and inner rods will then be lowered back into the borehole to the previous depth and the rods are driven another 3 feet. This process will be repeated until the desired depth is reached.
6. The soil samples will be retained for lithologic logging and chemical analyses, if appropriate.
7. The soils will be classified in the field in approximate accordance with the visual-manual procedure of the Unified Soil Classification System (ASTM D-2488-93), and the Munsell Color Classification.
8. If required, soil samples will be collected at selected intervals for laboratory analysis. At these intervals, the ends of one or more of the soil sample liners will be covered with Teflon end sheets and plastic end caps, and labeled. Labels will document the sample designation, type, date and time of collection, collector(s), location, and any additional information.
9. If groundwater samples will not be collected, the soil borings will be grouted to the ground surface with a neat cement grout (Type II Portland cement) using the tremie method.
10. Upon encountering the uppermost groundwater surface during sampling, the sample barrel and inner rods will be removed and the well screen and casing will be installed within the outer drive casing to facilitate collection of a groundwater sample. The drive casing will be pulled up approximately 3 feet to expose the slotted PVC casing. Groundwater samples will then be collected from within the PVC casing with a 0.75-inch diameter Teflon or stainless steel bailer.
11. The depth to groundwater will be measured prior to groundwater sampling.
12. The sample will be drained directly from the bailer into sample containers. The containers will be labeled to document the sample designation, type, date and time of collection, collector(s), location, and any additional information.
13. After collecting the reconnaissance groundwater sample, decant groundwater into a clean container and record the following field parameters/observations:
 - Temperature (C)
 - pH
 - Specific conductivity (mhos/cm)
 - Depth to water
 - Color
 - Other observations (odors, free-phase product)
14. After sample collection, the boring will be grouted to ground surface with a neat cement grout (Type II Portland cement) using the tremie method.

B.4 Equipment Cleaning

1. Downhole equipment (rods, sampler) will be steam cleaned prior to each borehole.

2. The sampling equipment should be decontaminated as specified in the sampling and analysis plan. If not specified in the sampling and analysis plan, sampling equipment (sampler) will be steam cleaned or washed with a brush in a solution of high-purity phosphate-free soap and potable water, then rinsed with potable water followed by double rinsing with deionized water prior to each sampling run.
3. Downhole equipment and vehicles which warrant it, will be steam cleaned prior to leaving site at completion of sampling.

B.5 Investigation-Derived Residuals

Soil cuttings will be placed in labeled 5-gallon DOT-approved pails with bolt-on covers. Decontamination water and groundwater residuals will be contained in labeled 55-gallon DOT-approved drums with bolt-on covers. All residuals generated during sampling activities will be stored at the site.

Appendix B: Standard Operating Guideline Boring and Subsurface Soil Sampling

B.1 Introduction

This guideline describes the equipment and procedures that are used by Kennedy/Jenks Consultants personnel for drilling and collecting soil samples.

B.2 Equipment

- Drill rigs and associated drilling and sampling equipment as specified in work plan:
 - Hollow stem auger
 - Air-rotary casing hammer
 - Dual tube percussion hammer
 - Cable tool
 - Mud rotary
 - Reverse rotary
- CME, 5 ft x 94 mm continuous-core barrels (hollow-stem auger)
- 2.5-inch or 2.0-inch I.D. split-spoon drive sampler
- 2.5-inch or 2.0-inch brass liners and sealing materials (plastic end caps, Teflon seals, silicon tape, zip-lock plastic bags)
- Large capacity stainless steel borehole bailer
- Foxboro FID-Organic Vapor Analyzer (OVA)
- HNU PID-Organic Vapor Analyzer
- OVM
- Sampler cleaning equipment
 - Steamcleaner
 - Generator
 - Stiff-bristle brushes
 - Buckets
 - High purity phosphate-free liquid soap, such as Liquinox
 - Methanol (if necessary)
 - 0.1N nitric acid (if necessary)
 - Deionized water
 - Potable water
- Insulated sample storage and shipping containers
- Personal protective equipment (refer to project site safety plan)

B.3 Typical Procedure

1. Obtain applicable drilling and well construction permits prior to mobilization.
2. Clear drilling locations for underground utilities and structures by Underground Service Alert (USA) and subcontractors.
3. Have all downhole equipment steamcleaned prior to drilling each boring.

4. Ensure that soil borings not to be completed as monitoring wells are drilled with an auger drill rig, using hollow stem augers of appropriate size.
5. Make sure that borings not completed as monitoring wells are grouted to the surface, using a neat cement-bentonite grout (containing approximately 5 percent bentonite).
6. Ensure that borings made to construct shallow monitoring wells are drilled with an auger drill rig that uses hollow stem augers of appropriate size to provide an annular space of a minimum of 2 inches between borehole wall and well casing.
7. Verify that drill borings used to construct deeper monitoring wells are drilled with a dual tube percussion hammer or air-rotary casing hammer, using a steel drive casing of appropriate size, or with hollow stem augers through a steel conductor casing.
8. Collect soil samples for lithologic logging purposes with a CME continuous coring system in 5-foot increments.
9. Collect soil samples for lithologic logging and chemical and physical analyses by driving a split-spoon drive sampler, in 2.5- to 5-foot increments, below the depth of the auger bit with a rig-mounted hammer. Record the standard penetration resistance. If the sample is pushed rather than driven, be sure to record the push force.
10. When drilling with air-driven drill rigs, collect soil samples for lithologic logging purposes from the cyclone separator discharge on the dual tube percussion hammer, which separates air from formation cuttings as the drive casing is advanced.
11. Have the soils classified in the field in approximate accordance with the visual-manual procedure of the Unified Soil Classification System (ASTM D-2488-90) and the Munsell Color Classification.
12. Prior to each sampling event, decontaminate sampling equipment as specified in the sampling and analysis plan. If not specified in the sampling and analysis plan, wash the split-spoon drive sampler and brass liners with high purity phosphate-free soap, and double-rinse them with deionized water and methanol and/or 0.1N nitric acid, as appropriate.
13. At each sampling interval, collect soil in one brass liner for potential laboratory analysis. Cover this sample in Teflon sheets, seal it with plastic caps, and wrap it with silicon tape. Place a completed sample label on the brass liner. Then see that the samples are placed in appropriate containers and stored at approximately 4°C.
14. As a field screening procedure (if applicable), at each sampling interval put the soil from one of the brass liners into an airtight container and allow it to equilibrate. After this, use an OVA to monitor the headspace in the container. If significant organic vapors are detected with the OVA, save the appropriate brass sample liners for potential laboratory analysis.
15. Complete chain-of-custody forms in the field and transport the samples in insulated containers, at an internal temperature of approximately 4 °C, to the selected laboratory.
16. If applicable, as described in the site safety plan, use an OVA to analyze in situ air samples from the breathing zone, the inside of the augers or casing, and other locations as necessary.

B.4 Installation and Testing of Isolation Casing

1. Upon completion of the initial small-diameter boring, use a rotary drill bit of appropriate diameter to ream the boring to a depth (to be determined). Use a bentonite mud mixture, in accordance with standard drilling practice, to maintain hole stability and to minimize infiltration and development of a mud cake on the borehole wall.
2. When reaming is completed, install isolation casing in the boring. Use conductor casing of an appropriate grade of 14-inch diameter steel with a wall thickness of 0.25 inch, per the following specifications:
 - Sections are 20, 10, or 5 feet in length.
 - Casing sections are beveled or butt-jointed.
 - Field joints are arc-welded with 70 percent weld penetration, having a minimum of two passes per circumference.
 - Welding rod is compatible with casing material.
 - Joints are watertight.

Casing centralizers are set on the bottom, middle, and top of the total casing length. Centralizers are installed in sets of four, spaced at 90°, and attached at the bottom by a tack weld. They are flanged 2 inches at the top and bottom to contact the borehole wall.

3. Make volumetric calculations prior to grouting, to estimate the total volume of grout required to fill the annular space. The amount of grout actually used must be compared with this estimate. Ensure that the grout meets the following specifications:
 - Volumes of grout used must be within 10 percent of estimated value.
 - The grout consists of ASTM C150 Type II cement and water at a ratio of 5 gallons of water per 94 lb sack of cement, weighing approximately 118 lbs per foot. Approximately 5 lb of powdered bentonite for each sack of cement is mixed into the grout.
4. Note that leakage tests or a bond log might be required to validate the grout seal.
5. Grout conductor casing into place by one of the following methods:
 - Pressure-grout from the bottom of the casing, using a packer or Braden-head to force the grout into the annular space between the conductor casing and the borehole wall.
 - Fill the casing with grout and use a spacer plug apparatus to force the grout into the annular space between the conductor casing and the borehole wall. The spacer plug must be composed of a material that can be left in the boring and later drilled through to complete it.
6. After allowing the grout to set, continue drilling with an appropriate diameter hollow stem auger. A rotary bit can be used initially to drill through any grout that might have hardened in, or directly below, the casing.

B.5 Equipment Cleaning

1. Prior to drilling each boring, steamclean downhole equipment (augers, well casing, sampler).
2. Before collection of each drilling sample, decontaminate sampling equipment as specified in the sampling and analysis plan. If not specified in the sampling and analysis plan, steamclean or

wash sampling equipment (sampler and brass liners) with a brush, in a solution of high purity phosphate-free soap and potable water. Rinse the equipment with potable water and methanol and/or 0.1N nitric acid, as appropriate. Follow this with double-rinsing using distilled water.

3. Before leaving the site at completion of drilling, decontaminate sampling equipment as specified in the sampling and analysis plan. If not specified in the sampling and analysis plan, steamclean downhole equipment and vehicles that require cleaning.

B.6 Investigation-Derived Residuals

Place soil cuttings and other residuals in appropriately labeled containers for disposition by the client. All soil samples transported to the laboratory must be returned to the client for disposition. Kennedy/Jenks Consultants is available to assist the client with options for disposition of residuals.

Appendix B: Standard Operating Guideline Sample Packaging and Shipping

B.1 Introduction

This guideline presents methods for shipping non-hazardous materials, including most environmental samples via United Parcel Service (UPS), Federal Express and Greyhound. Many local laboratories offer courier service as well. Follow the procedures specifically identified in the sampling and analysis plan. If sample packaging and shipping procedures are not identified in the sampling and analysis plan, then follow the procedures presented herein.

B.2 Equipment

- Coolers or ice chests
- Sorbent material
- Bubble-wrap
- Strapping tape
- Labels and pens
- Chain-of-Custody forms
- Chain-of-Custody seals
- UPS, Federal Express, or Greyhound manifests

Samples shipped to each analytical laboratory can be sent by UPS or Federal Express on a next-day basis unless other arrangements are made. Greyhound bus service should only be used if there is direct service (e.g., Sacramento or Bakersfield to San Francisco). Ice chests, used to refrigerate perishable items, can be used to convey non-hazardous samples to the analytical laboratory.

Absorbent pads should be placed in the bottom of the shipping container to absorb liquids in the event of sample container breakage. Transportation regulations require absorbent capacity of the material to equal the amount of liquid being shipped; each pad absorbs approximately 1 quart of liquid. Liquid samples in glass jars or bottles should also be wrapped in plastic bubble wrap. A small amount of air space is desirable in filled plastic containers. This often prevents the cap of the container from coming off should the container undergo compression. Volatile organics analysis (VOA) vials should be packed in sponge holders. Additionally, exposure of filled VOA vials to other types of sample containers, by placement in the same shipping container, is not recommended. Various non-VOA sample containers are solvent-rinsed which may contaminate the VOA vials before or after sample collection. Therefore, a separate shipping container for VOA vials is recommended. An equal weight of ice substitute should be used to keep the samples below 4 degrees Centigrade for the duration of the shipment (up to 48 hours). Care in choosing a method of sample chilling should be observed so that the collected samples are not physically or chemically damaged. Re-usable blue ice blocks, block ice, ice cubes, or dry-ice are suitable for keeping samples chilled. Labels of samples may get wet. Use of waterproof pens and labels is desirable for identification of sample containers. Use of clear tape to cover each affixed sample label is helpful in ensuring sample identification. Strong adhesive tape should be used to band the coolers closed. Additionally, it is recommended that the drain plug be covered with adhesive tape to prevent any liquid from escaping.

Specific requirements for packaging materials may apply if the samples being shipped are known to be hazardous materials as defined in 49 CFR 171.8 (samples are not considered hazardous waste and therefore manifest requirements do not apply). UPS holds shippers responsible for damage occurring in the event of accidents when a hazardous material is shipped as a non-hazardous material. Samples which obviously are hazardous materials should therefore be shipped as such, and samples which most likely are not hazardous materials should be shipped in coolers. Guidelines for shipping hazardous materials by UPS are provided in the *Guide for Shipping Hazardous Materials* available from UPS. Specific labels for shipping of hazardous materials are available.

Chain-of-custody documentation should accompany shipments of samples to the analytical laboratory. Often, the chain-of-custody document contains an analytical request section which may be completed following sample collection. Chronological listing of collected samples is desirable. A copy of the completed chain-of-custody form should be retained in the event that the original form is lost or destroyed.

It should be noted that samples retained by the analytical laboratory which are not chosen for analysis may be assessed a fee for disposal. Often a disposal fee is assigned to a sample, typically soil, that has been retained beyond standard analytical holding periods. Therefore, consultation with project management is recommended to determine which samples may be of interest. Contacting the selected analytical laboratory regarding disposal policies is also recommended. Arrangements may be made with the analytical laboratory for return of the unanalyzed samples for later disposal to the area of origin.

Appendix B: Standard Operating Guideline Equipment Decontamination

B.1 Introduction

This guideline describes field procedures typically followed by Kennedy/Jenks Consultants personnel during the decontamination of sampling and monitoring equipment. Proper decontamination procedures minimize the potential for cross-contamination among sampling points on a single site or between separate sites. Follow the procedures specifically identified in the sampling and analysis plan. If equipment decontamination procedures are not identified in the sampling and analysis plan, then follow the procedures presented herein.

B.2 Equipment

- Two or three containers (e.g., 5-gallon buckets, or 5- or 10-gallon plastic tubs) for dip rinsing, washing, and collection of rinse water.
- Two or three utility brushes or test tube brushes for removal of visible contamination. A test tube brush (or similar) can be stapled to the end of a dowel and used to clean the inside of a bailer.
- Non-phosphate Alconox, Liquinox, or trisodiumphosphate (TSP) to be mixed with potable or distilled water.
- Rinse solutions, such as methyl alcohol (methanol), dilute nitric acid (0.1 molar), deionized or distilled water, and/or tap water. Deionized water is preferable to distilled water because the deionization process typically results in greater removal of organic compounds as discussed below:
 - Acid rinse (inorganic desorption) 10% nitric or hydrochloric acid solution reagent grade nitric or hydrochloric acid and deionized water (1% to be used for low carbon steel equipment).
 - Solvent rinse (organic desorption isopropanol, acetone, or methanol; pesticide grade).
 - Deionized water is preferable to distilled water because the deionization process typically results in greater removal of organic compounds.
- Multi-gallon storage containers filled with potable water to be used for rinsing or washing.
- Spray bottles, squirt bottles, or garden sprayers to apply rinse liquid. A separate bottle should be used for each liquid.
- Solvex or neoprene gloves that extend, as a minimum, halfway up the forearm. In cooler weather, it is advisable to use different resistant chemicals neoprene gloves that provide better insulation against cold temperatures.
- Paper towels to wipe off gross contamination.
- Garbage bags, or other plastic bags, and aluminum foil to wrap clean sampling equipment after decontamination, to store sampling equipment or and to dispose of decontamination debris.

- Sample bottles for rinsate blanks. For these blanks, Laboratory Type II (millipore) water should be used. Purified water from the selected analytical laboratory is recommended. This water is often filtered and boiled to remove impurities.
- DOT-approved container (e.g., 55-gallon drum) to store contaminated wash and rinse water. Contained decontamination should be labeled appropriately.
- Steamcleaner with power source and water supply.

B.3 Procedures

In most cases, the following procedures are adequate to remove contamination.

1. Preclean sampling equipment. If there is gross contamination on equipment, wipe it off with paper towels and/or rinse it off with water. Additional internal decontamination may be possible by circulation of water or cleaning solutions.
2. Wash all parts of equipment with detergent water and scrub with brushes. Take equipment apart when appropriate to remove visible contamination.
3. Steamclean sampling equipment. The steamcleaner is effective in removing contamination, especially volatile hydrocarbons. Steamcleaning is highly recommended in most cases and sometimes is the only method for decontaminating equipment that is grossly contaminated with hydrocarbons.
4. Rinse equipment by dipping in rinse solution, spraying, or pouring solution over it. Dip rinsing can introduce contaminants into solution. Spraying might not allow a thorough rinsing of the equipment, but it is a more efficient rinsing method because less rinse solution is used. Appropriate rinsing solutions are specified in the project sampling and analysis plan. Some typical solutions are indicated in the equipment section of this SOG.
 - Methanol (used to remove organic compounds)
 - Dilute acids (used to remove metals and other cations)
 - Tap water
 - Deionized/distilled water.
5. Rinse the sampler with generous amounts of deionized water. Pouring water over the sampler is best, although spraying or using a squirt bottle to apply rinse water might be adequate if you are trying to minimize waste.
6. Prepare rinsate blanks. To ensure proper decontamination, submit a rinsate blank for analysis. It is best to do this just before sampling. The blank should be analyzed for the same chemicals the samples are being checked for and for the chemical used to decontaminate equipment, if appropriate.

[Note: The heading for this section indicates procedures to remove contamination.]

To prepare a rinsate blank, pour millipore analyte-free water through or over the into the sampler. Collect the rinsate water in a clean bottle. Pour the collected rinsate water into the appropriate sample container(s). It is advisable to prepare one rinsate blank every day in the field. Use water specifically for blank preparation.

7. Wipe sampling equipment with a paper towel or allow it to air dry.
8. Place samplers in clean plastic bags or sealed containers, or wrap them in aluminum foil for storage in an undisturbed location that is free of contamination.

B.4 Investigation-Derived Residuals

For details of handling investigation-derived residuals refer to the project sampling and analysis plan.

B.5 Special Notes

- To reduce the potential for cross-contamination, samples should be collected so that the least contaminated stations areas are sampled first. Subsequent sampling should be completed in the order of increasing contamination. Areas that typically have lower levels of contamination include those upgradient of source, background areas, and the periphery of the contaminated area.
- Prepare rinsate blanks. To ensure proper decontamination, submit a rinsate blank for analysis. It is best to do this just before sampling. The blank should be analyzed for the same chemicals the samples are being checked for and for the chemical used to decontaminate equipment, if appropriate.
- To prepare a rinsate blank, pour analyte-free water through or into the sampler. Pour the collected rinsate water into the appropriate sample container(s). It is advisable to prepare one rinsate blank every day in the field. Use water specifically for blank preparation.
- Monitoring instruments that come into contact with sampled materials must be decontaminated, along with sampling devices. They should be washed, or at least rinsed before monitoring other sampling sites.
- As determined from analysis of rinsate blanks, decontamination using soap and water is adequate in removing detectable quantities of contaminants. This type of decontamination has been compared to laboratory procedures for decontaminating sampling bottles. Using methanol as a rinse does help in cases of contamination with organic compounds.

B.6 References

U.S. Environmental Protection Agency. 1987. *Handbook: Groundwater*. U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.

Washington Department of Ecology. 1982. *Methods for Obtaining Waste Samples*. Ch. 173-303 WAC. Washington State Department of Ecology, Olympia, Washington.

Appendix B: Standard Operating Guideline Personnel Decontamination

B.1 Introduction

This guideline describes field procedures typically followed by Kennedy/Jenks Consultants for personnel decontamination. Decontamination of personnel is critical to health and safety during and after environmental fieldwork. It protects personnel from hazardous substances that can contaminate and eventually permeate protective clothing, respiratory equipment, tools, vehicles, and other equipment used onsite. Decontamination reduces exposure of site personnel to such substances by minimizing the transfer of harmful materials into clean areas and preventing the mixing of incompatible chemicals. It also protects the community by preventing uncontrolled transportation of contaminants from the site. Follow the procedures specifically identified in the sampling and analysis plan. If personnel decontamination procedures are not identified in the sampling and analysis plan, then follow the procedures presented herein.

B.2 Equipment

The materials, equipment, and facilities described in the following list are not required in every case of personnel decontamination. However, they represent all that might be required for sites where maximum decontamination procedures are necessary.

- Drop cloths (plastic or other suitable material) on which heavily contaminated equipment and outer protective clothing can be deposited.
- Collection containers, such as drums or suitably lined trash cans, for storing disposable clothing, heavily contaminated personal protective clothing, or equipment that must be discarded.
- Lined box with absorbent for wiping or rinsing off gross contaminants and liquid contaminants.
- Large tubs to hold wash and rinse solutions; tubs should be at least large enough to hold a worker's booted foot and allow full access for washing.
- Non-phosphate wash solutions (e.g., Alconox, Liquinox) to wash off debris and chemicals and reduce hazards associated with any contaminants.
- Rinse solutions (e.g., potable or distilled water) to remove contaminants and contaminated wash solutions.
- Long-handled soft-bristled brushes to wash and rinse off contaminants.
- Paper or cloth towels for drying protective clothing and equipment.
- Lockers or containers for storage of decontaminated non-disposable clothing (e.g., hard hat, boots) and equipment.
- Department of Transportation (DOT)-approved containers for contaminated wash and rinse solutions.

- Plastic sheeting, sealed pads with drains, or other appropriate means of secondary containment of contaminated wash and rinse solutions that might be spilled during decontamination.
- Shower facilities for full body wash or, at a minimum, wash sinks available to personnel.
- Soap or wash solution, wash cloths, and towels for personnel.
- Lockers or containers for clean clothing and personal item storage.

B.3 Decontamination Procedures

B.3.1 Level C

At a minimum, the following procedures apply when operating in a Level C exclusion zone:

1. Deposit items used onsite on plastic drop cloth. Segregation at the drop site reduces the probability of cross-contamination.
2. Scrub outer boots, gloves, and splash suit with decontamination solution or detergent water. Rinse items with generous amounts of water. Follow this step scrupulously for protective clothing that is not disposable.
3. Remove outer boots and gloves; deposit or discard them in container with plastic liner.
4. To continue decontamination outside the exclusion zone, change canister or mask when leaving the zone. Upon re-entering, remember to gear up again.
5. Remove boots, chemical-resistant splash suit, and inner gloves and deposit them in separate containers lined with plastic.
6. Remove respirator by taking off facepiece. Avoid touching the face with the fingers. Deposit the facepiece on a plastic sheet.
7. As a field wash, clean hands and face thoroughly and shower as soon as possible. Wash respirator facepiece with respirator cleaning solution.
8. Ensure that all decontamination procedures are in accordance with the project sampling and analysis plan and Kennedy/Jenks Consultants Standard Operating Guideline, Investigation-Derived Residuals (Unit 9.0).

B.3.2 Level D

If operating in a Level D area, perform the following procedures before leaving the site:

1. Wash and rinse all reusable equipment and garments. If gear is to be used elsewhere, wash it with detergent and then rinse with generous amounts of water.
2. If grossly contaminated, discard disposable protective clothing in appropriate container.
3. Wash hands and face thoroughly, and shower as soon as possible.

B.4 Special Notes

When working in an exclusion zone, be sure that the decontamination area is placed in an upwind direction (plus or minus 20 degrees) from the site.

B.5 Investigation-Derived Wastes

Refer to the specific project sampling and analysis plan for details of disposition of investigation-derived wastes.

B.6 Emergency Decontamination Procedures

1. If the decontamination procedure is essential to the life saving process, decontamination must be performed immediately.
2. If a heat-related illness develops, protective clothing should be removed as soon as possible. Protective clothing and equipment should be washed, rinsed, and/or cut off.
3. If medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized or until decontamination will not interfere with medical treatment.
4. Dispose of contaminated clothing and equipment properly.
5. Alert medical personnel to the emergency.
6. Instruct medical personnel about potential contamination.
7. Instruct medical personnel about specific decontamination procedures.

B.7 References

- NIOSH/OSHA/USCG/EPA. 1985. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*. Washington, DC. Federal Way.
- U.S. Environmental Protection Agency. 1988. *Standard Operating Safety Guidelines*. United States Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC.

Appendix B: Standard Operating Guideline Handling and Disposal of Investigation-Derived Waste

B.1 Introduction

Environmental site investigations usually result in generation of some regulated waste, particularly if the project involves drilling and construction of monitoring wells. Any potentially hazardous or dangerous material that is generated during a site investigation must be handled and disposed of in accordance with applicable regulations (22 CCR, Chapter 30). This guideline provides a procedure to be used for dealing with investigation-derived wastes that have the potential of being classified as hazardous or dangerous, including soil cuttings, well development water, and decontamination water. Follow the procedures specifically identified in the sampling and analysis plan. If investigation-derived waste handling and disposal procedures are not identified in the sampling and analysis plan, then follow the procedures presented herein.

B.2 Equipment

- DOT-approved packaging (typically DOT 17E or 17H drums)
- Funnel
- Bushing wrench
- 15/16-inch socket wrench
- Shovel
- Appropriate markers (spray paint, paint pen)
- Plastic sheeting
- Drip pans
- Pallets

B.3 Typical Procedures

B.3.1 Preparing Containers

1. Place each container on a pallet if it is to be moved with a fork lift after it is full.
2. Place plastic sheeting under containers for soil and drip pans under containers used to hold water.
3. Ensure that packaging materials are compatible with the wastes to be stored in them. Bung-type drums should be used to contain liquids. If a liquid is corrosive, a plastic or polymer drum should be used.
4. Solids should be placed in open-top drums. Liners are placed in the drums if the solid material is corrosive or contains free liquids. Gaskets are also used on open-top drums.

B.3.2 Storing Wastes

1. As waste materials are generated, place them directly into storage containers.

2. Do not fill storage drums completely. Provide sufficient outage so that the containers will not be overfull if their contents expand.
3. After filling a storage drum, seal it securely, using a bung wrench or socket wrench, for a bung-type or open-top drum, respectively.
4. Label drums or other packages containing hazardous or dangerous materials and mark them for storage or shipment. To comply with marking and labeling requirements, affix a properly filled out yellow hazardous waste marker and a DOT hazard class label to each waste container. Do not mark drums with Kennedy/Jenks Consultants' name. All waste belongs to the client. Mark accumulation start date.
5. During an ongoing investigation, use a paint marker to mark the contents, station number, date, and quantity of material on each drum or other container. Do not mix investigation-derived wastes with one another or with other materials. Do not place items such as Tyvek, gloves, equipment, or trash into drums containing soils or liquids, and do not mix water and soil. Disposable protective clothing, trash, soil, and water materials should be disposed of in separate containers.
6. Upon completion of field work, or the portion of the project that generates wastes, notify the client as to the location, number, contents, and waste type of waste containers. Remind the client of the obligation to dispose of wastes in a timely manner and in accordance with applicable regulations.

B.4 Regulations

22 CCR, Chapter 30 *California Hazardous Waste Regulations*.

49 CFR 100-177, *Federal Transportation of Hazardous Materials Regulations*.

EPA Region X, Technical Assistance Team. 1984. *Manual for Sampling, Packaging, and Shipping Hazardous Materials*. Seattle, WA: EPA.