3.3.1.2 Potential Exposure Pathways

Complete or potentially complete exposure pathways include:

- Incidental ingestion and dermal contact with soil (includes sediment and weathered bedrock) - all receptors.
- External gamma exposure associated with soil (includes sediment and weathered bedrock) (radionuclides only) - all receptors.
- Incidental ingestion and dermal contact with contaminants on building surfaces - construction worker or trespasser.
- External gamma exposure to radiation emitted from building surfaces (radionuclides only) - construction worker or trespasser.
- Inhalation of fugitive dust originating from soil - all receptors.
- Inhalation of fugitive dust originating from building surfaces - construction worker or trespasser.
- Inhalation of volatile compounds (volatilizing from soil and groundwater) to ambient air - all receptors.
- Inhalation of volatile compounds (volatilizing from soil and groundwater) to indoor air - resident or industrial worker.
- Ingestion of (drinking water source) and dermal contact (domestic use scenario) with groundwater – resident.
- Incidental ingestion of and dermal contact with groundwater (includes seeps and springs) - construction worker and trespasser.
- Indirect exposure to chemicals in soil and groundwater via uptake into edible plants (i.e., homegrown produce for a rural resident) – resident.

Potential exposure pathways for offsite residents that will be qualitatively discussed in the EIS include:

- inhalation of fugitive dust from soil or building materials during building demolition and transportation offsite for disposal.
- external gamma radiation emitted from building materials during transportation of materials offsite for disposal (radionuclides only).
- ingestion of (drinking water source) and dermal contact (domestic use scenario) with offsite migration of storm water.

- inhalation of volatile compounds (volatilizing from offsite migration groundwater) to indoor air.

Incomplete exposure pathways that will be qualitatively discussed in the risk assessment due to limited exposure duration or frequency include:

- direct contact with or ingestion of stormwater during stormwater runoff events.

Soil Exposure Pathways

For purposes of evaluating soil data needs for the human health risk assessment for Area IV, three soil-depth ranges are considered: surface soil (0 to 2 feet bgs), near surface (2 to 4 feet bgs, and subsurface soil (4 to 10 feet bgs). All receptors are potentially exposed to surface soil at Area IV via incidental ingestion, dermal contact, inhalation of fugitive dust and volatile chemicals and external gamma radiation. Since construction workers would excavate soil, they would be potentially exposed to subsurface soils in addition to the surface soils. Residents may also be exposed to a mixture of surface and near surface soils if Area IV were to be regraded for residential development and surface and subsurface soils are mixed.

Air Exposure Pathways

Inhalation of site-related compounds in air represents a potentially complete exposure pathway at the site. Two air exposure pathways are considered: inhalation of fugitive dust and inhalation of chemicals volatilizing from soil and groundwater. Fugitive dust results when chemicals present in soils may be pulled into the air through wind erosion or mechanical disturbances of the soil resulting in fugitive dust. Typically, only small soil particles are light enough to be carried up in the air column and transported significant distances. Particulates in air can be a source of exposure, and may impact distant soils, surface water, and biota due to particulate re-deposition. Inhalation of fugitive dust is a complete exposure pathway for trespassers and all future receptors. Trespassers are evaluated qualitatively for this exposure pathway, while other receptors are evaluated quantitatively.

Another potential inhalation pathway is through volatilization. Volatile compounds in soil and/or groundwater may volatilize and subsequently be released to ambient air and/or indoor air. Potential exposure to compounds volatilizing from soil, soil vapor, weathered bedrock, or groundwater to ambient (outside) air is considered a complete pathway for current trespassers and all future receptors, but only for chemicals that meet DTSC's definition of a volatile compound. Residential receptors and industrial workers may also be exposed via inhalation of volatile chemicals in soil, soil vapor, weathered bedrock, or groundwater which volatilize to indoor air. This exposure pathway is complete for future residents and industrial workers, but incomplete for recreational visitors since recreational visitors would not be expected to spend time indoors. Exposures to contaminants in air are evaluated using models that estimate air concentrations from source mediums.

Building Exposure Pathways
Building surfaces in Area IV may emit gamma radiation from surface contamination or activated building materials. Building surfaces could also be a source of inhalation exposure from fugitive dust and ingestion exposure from surface residues. The exposure pathways are complete for future construction workers during building demolition and for trespassers. Exposures are evaluated quantitatively for trespassers and construction workers.

Groundwater Exposure Pathways
Future residents could be exposed to contaminants in groundwater if homes are constructed in Area IV and water supply wells are installed to supply household water to these homes. Ingestion, dermal contact, and inhalation (during showering) of chemicals of concern in groundwater are considered potentially complete exposure pathways for the future resident.

Direct exposure to groundwater is an incomplete pathway for future industrial workers and recreational visitors, since neither would have access to water supply wells.

Construction workers may be exposed to groundwater during excavation activities in areas where shallow or perched groundwater exist. Incidental ingestion of and dermal contact with groundwater are considered potentially complete exposure pathways for future construction workers. In addition to the evaluation of potential future onsite groundwater use, future impacts to groundwater due to contaminant transport from surficial media (soil, weathered bedrock, surface water, near-surface groundwater) to the Chatsworth Formation groundwater, or transport of contaminants within the Chatsworth Formation, will be evaluated in the risk assessment.

Future residents, workers, and recreational visitors may be exposed to groundwater emanating at seeps, but only minimally. Seeps do not yield enough water sufficient for water supply use or recreational use. In addition, seep water may be representative of shallow groundwater in the area of the seep. Therefore, data collected from seeps and springs are included in the data gap analysis.

Rural Residential Exposure Pathways
If residences are constructed at Area IV in the future, it is possible that produce may be grown in impacted soil in backyard gardens. Gardens may also be irrigated with contaminated groundwater. Contaminants in soil or groundwater may then be incorporated into edible plant tissues via root uptake. This pathway is complete for future residents, but incomplete for future workers and recreational visitors. Ingestion of homegrown produce is evaluated based on models that estimate bio-uptake from source medium concentrations (i.e., soil and groundwater data).

3.3.2 Ecological Risk Assessment

The ecological CSM for Area IV is shown in **Figure 3-2**. Per the SRAM WP for the SSFL (MWH 2005), the CSM indicates the pathways (sources, retention or transport media, exposure media, and exposure routes) potentially resulting in exposure of ecological receptors of interest. These include terrestrial and aquatic plants and animals potentially occurring onsite and offsite for locations that may be site-influenced. These may include common species that represent important trophic levels or communities as well as uncommon or rare species that warrant special consideration. Special species include those listed or proposed for listing as Threatened or Endangered (per the Endangered Species Act) as well as State Species of Special Concern. Each of these categories of receptors will be evaluated in the ERA conducted for Area IV.

This Data Gap Analysis report includes an evaluation of the adequacy of the existing analytical data for the indicated exposure media and identifies the additional data needed to evaluate the potential exposure pathways indicated in Figure 3-2. The potential exposure pathways for ecological receptors at Area IV are briefly described below.

For purposes of evaluating data needs for the ERA at Area IV, three soil-depth ranges are considered: surface soil (0 to 2 feet bgs), near subsurface (2 to 4 feet bgs), and subsurface soil (4 to 6 feet bgs). All terrestrial receptors are potentially exposed to surface soil at Area IV and in adjacent areas as a result of erosion and stormwater runoff or groundwater discharging at seeps. Per the SRAM WP for the SSFL (MWH 2005), burrowing animals, such as the deer mouse, are potentially exposed to soil down to 6 feet bgs. Per the SRAM WP, terrestrial plants were to be evaluated qualitatively. The evaluation of the existing soil data uses ESLs that are based on multiple exposure pathways to animal receptors, including external radiation and incidental ingestion of soil. Soil screening levels for radionuclides also incorporate a term for inhalation of suspended soil particles. Air pathways (inhalation), while potentially complete for surface-dwelling terrestrial wildlife species, are not evaluated for chemicals, because they are considered less significant relative to other routes of exposure (MWH 2005, EPA 2005).

Surface water and groundwater, a potential source of offsite seep and surface water, are evaluated as potential exposure media for both terrestrial and aquatic ecological receptors. Terrestrial animals are potentially exposed to surface water and groundwater discharging at seeps primarily through ingestion. Per the SRAM WP (MWH 2005), dermal contact and inhalation of vapor from surface water by terrestrial animals are not evaluated. Surface water and groundwater data are also evaluated as potential sources of exposure to aquatic biota (animals and plants) living in permanent surface-water bodies located onsite and offsite, respectively. Sediment data from permanent surface-water bodies are also evaluated as a potential exposure medium for aquatic biota over multiple exposure routes and for terrestrial animals that may incidentally ingest sediment while foraging. Per the SRAM WP for the SSFL (MWH 2005), dermal contact with sediment by terrestrial animals is not evaluated.

Animal receptors are potentially exposed to chemicals and radionuclides present in the tissues of their plant and animal food as a result of uptake from abiotic media. The adequacy of existing Area IV analytical data for biotic tissues is evaluated in this *Data Gap Analysis Report* and the additional data needed to evaluate ingestion of plant and animal tissue, as appropriate for the representative species chosen for the Area IV ERA, are identified.

The exposure of ecological receptors to contaminated building surfaces at Area IV is not evaluated because it is judged to be inconsequential. Building surfaces are unlikely to be a source of contamination to terrestrial food webs and direct contact of terrestrial receptors with building surfaces is expected to be minimal.

3.4 Screening Criteria

Health-risk based screening values were identified to assist in the determination of COIs and acceptable data for use in risk assessments and for defining nature and extent of contamination. Comparison of observed concentrations with background values, regulatory standards, and screening criteria enables the list of detected chemicals at Area IV to be focused on the potential risk drivers for the reuse scenarios. Focusing on the risk drivers helps to locate potential source areas and identify areas requiring further characterization. Several screening values adopted for Area IV are described below.

3.4.1 Background

Certain chemicals and radionuclides occur naturally in the environment. In order to evaluate the concentration or activity present due to a particular source area, such as Area IV, it is necessary to know the naturally occurring ambient concentrations and activities (background concentrations activities) of these constituents. The selection of background screening levels for the chemical and radiological constituents used in this *Data Gaps Analysis Report* are discussed below.

3.4.1.1 Chemical

Metals and polychlorinated dioxin and furan compounds (dioxin/furan) are found naturally in the environment at concentrations that vary regionally depending on specific environmental conditions such as geology. As part of the RCRA RFI at SSFL, a range of background concentrations for these constituents was determined and approved for use in that program by the California DTSC. The procedure for determining these background values are described in the *Soil Background Report Santa Susana Field Laboratory, Ventura County, California* (MWH 2005).

The background concentrations for metals and dioxin/furan determined for the RFI Program have been selected for use in the data gaps analysis for screening data. The information concerning potentially elevated metals and dioxin values in samples collected after the Topanga fire, were not used in the screening, because it was assumed that the ash layer produced by the fire was incorporated back into the soil

layer. The methods for determining the background concentrations, as described in the *Soil Background Report*, are summarized here.

The dataset used for background concentration determination was developed from six specific sampling events occurring from 1992 through 2005. Each of these sampling programs was conducted in accordance with DTSC-reviewed work plans. All samples were collected from a depth between 0 to 1 foot bgs. Samples were collected from areas unaffected from SSFL activities, and at locations approved by DTSC for use in the background data set. Because the studies from which data were selected were conducted over a number of years, analytical methods, lists of analytes and laboratory reporting limits varied from study to study. This resulted in a need to fill in the dataset with additional samples, sometimes collected at the same locations as previous samples, to assure a consistent list of analytes analyzed to the same reporting limits.

The RCRA Background Study was conducted such that it was compliant with both EPA and California DTSC guidelines and requirements for background studies. The EPA guidance (EPA 2002) states that background reference areas "should have the same physical, chemical, geological and biological characteristics as the site being investigated, but has not been impacted by activities on the site." To meet this requirement, the Background Study samples were selected from areas both within the undeveloped portions of the SSFL and the areas surrounding the SSFL. Only samples collected on geologic units that were found within the SSFL were included.

Due to wide variations of geologic units and soil types, as well as variations in vegetation, geomorphology and hydrology, a relatively large data set was used. Samples were collected from 29 widely-spaced locations up to 4.8 kilometers (3 miles) away from the SSFL (See Figures 2-1 and 2-2 in the *Soil Background Report*). A total of 41 metals analyses were selected from 21 locations within the SSFL and 8 locations outside of the SSFL. Seventeen dioxin analyses from 17 of the metals locations were used as the dataset for dioxin background.

The analyses were validated by chemists at AMEC Earth & Environmental and a limited number of analyses were also reviewed and validated by DTSC. All data were validated per EPA guidelines (EPA 1994a, EPA 1994b) per individual laboratory analytical methods, AMEC Standard Operating Procedures (SOPs) and validation procedures. The majority of the data were determined to be usable with the exception of 6 antinomy, 6 mercury and 9 selenium samples. In order to complete the dataset, these samples were re-collected and analyzed in the 2005 sampling event.

Data distribution statistics are summarized in the *Soil Background Report* (MWH 2005) per DTSC background policy. For those metals with low frequency of detection, probability plots were prepared with the non-detects eliminated, and with one-half of the detection limit used as the concentration. All data were within two orders of magnitude, and most were within one order of magnitude. Probability plots indicated coefficients of variation (CV) were less than one for most metals. Exceptions were

molybdenum (1.3) and antimony (1.1) and it was determined that these higher CVs were due to the influence of soil types and source rock variations. Significant non-detects influenced the distribution of antimony, boron, cadmium, fluoride, mercury, selenium, silver, and thallium. In general, the higher concentrations of most metals were associated with samples containing fine-grained (silt and clay) material or collected over geologic formations containing fine-grained rock (siltstone and shale).

The Background Study also evaluated the potential impact of wind-born contaminants from the SSFL. The upper populations or highest concentrations of metals showed no correlation with wind direction relative to the SSFL. There is also a lack of correlation of higher concentrations near specific potential sources (engine testing and thermal treatment areas) of airborne metals.

To represent the upper range of ambient metals concentrations, the highest single concentration was designated as the "comparison value." The comparison values are listed in **Table 3-1**.

The 17 dioxin analyses were handled similarly. For background determination, the dioxin congeners were evaluated individually, and not totaled. All the data were within two orders of magnitude, and the CVs for all but 8 congeners were less than 1. The variability is largely due to a high frequency of non-detects. No geographic distribution of higher dioxin concentrations, indicative of a wind-borne distribution from SSFL source areas, was identified. The congener comparison values are the highest detected concentration or the highest detection limit (for congeners with no detections). The background dioxin congener and toxicity equivalent (TEQ) values are shown on Table 3-1.

3.4.1.2 Radionuclides

Natural radionuclides in the environment are of two general classes: primordial and cosmogenic. The identification sources and global ranges of these are discussed in **Appendix C**. While above-ground nuclear testing represents a man-made, not natural, source of radionuclides, associated radionuclides are present in the environment in the absence of onsite operations. Contribution to background from nuclear testing is also discussed in Appendix C.

Radionuclide Constituents – Method

As discussed in Appendix C, a number of the radiological site related contaminants (SRCs) like radium, uranium, and thorium are present as natural constituents of nonsite-impacted environmental media. Other SRCs like ^{137}Cs and ^{90}Sr were produced during above-ground nuclear testing primarily dating back to the early 1960s and, while man-made, still comprise a fraction of the total *background* radioactivity in the environment. Background concentrations of these and other SRCs are estimated here to assure incremental lifetimes risk estimates for Area IV are attributable to site-related activities and not only to naturally-occurring constituents. Background concentrations are also subtracted during compliance testing under some radiological applicable or relevant and appropriate requirements (ARARs) and to-be-considered

(TBC) guidelines, such as with DOE Order 5400.5. Therefore, average concentrations and 95 percent upper tolerance levels (with 95 percent coverage; UTL95) are estimated for SRCs present in background.

Concentrations of primordial radionuclides are dependent on the geological formation in which the soil is found. In addition, concentrations of cosmogenic and fallout radionuclides may have been affected by the climate and topography of the area since they affect runoff, sedimentation and movement through soil. Therefore, it is desirable to develop background concentrations from unaffected locations that are in the same geologic formation and similar in climate and topography. Therefore, a background data set was developed using the data collected by prior investigators from the unaffected areas surrounding the site in the same geological zones. The background dataset was established using a series of data filters as described in **Appendix D.**

Radiological Constituents – Results

Table 3-2 presents summary statistics for the SRCs ^{137}Cs, ^{90}Sr, ^{40}K, ^{3}H, ^{232}Th, ^{226}Ra, ^{230}Th, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, and ^{239}Pu, including the number of samples considered per analyte, maximum and average results, the coefficient of variation, and the proposed UTL95 screening value. The UTL95 was used as an estimate of the upper bound on the background population for screening purposes. A total of 112 samples from the Chatsworth Formation and 69 samples from the Santa Susana Formations survived the screening process to produce the tabulated results. **Figure 3-3** presents the sample locations from prior investigations that are included in the background screening value estimates. The Chatsworth and Santa Susana Formation footprints are presented for reference as are the SSFL boundaries. Not all SRCs were analyzed for all samples.

The thorium series contains the long-lived radionuclides ^{232}Th, ^{228}Ra, and ^{228}Th. Offsite results are available for all three SRCs plus some results for associated short-lived decay products. The data analysis revealed ^{228}Th as the most consistently reported SRC and the SRC whose results best approximate normality. Thorium-228 was therefore used as a proxy for all radionuclides in the decay series, presented in Table 3-2 as the parent nuclide of the series: ^{232}Th. This assumption is reasonable for background conditions given the relatively short half-lives down the entire series, with maximums of only 5.75 years for ^{228}Ra and 1.91 years for ^{228}Th.

Figure D-1 of **Appendix D** presents a series of probability plots for naturally-occurring SRCs and **Figure D-2** of Appendix D present plots for man-made SRCs. As many as three data series are presented: sample results associated with the Chatsworth Formation, the Santa Susana Formation, and sample results identified as outliers. Potential outliers were identified for five radionuclides (represented as red squares in the figures) and are discussed in Appendix D. Appendix D also discusses the differences in the Chatsworth Formation and Santa Susana Formation populations. Finally, an evaluation of deviations from linear is discussed in Appendix D.

In conclusion, presented results are generally consistent with expected conditions including normal-like distributions, relative concentrations consistent with naturally occurring decay series, and appropriateness of scale. The combined dataset produces generally conservative screening values for soils within the dominant onsite formation (the Chatsworth Formation) and is still reasonable if applied to the Santa Susan Formation. A combined dataset also simplifies the data screening and data gap analysis process, thus the combined Chatsworth Formation/Santa Susana Formation values presented in Table 3-2 are deemed appropriate for use in SSFL background screening and average background subtraction, if used. However, separate values may be developed should additional background samples be collected for use in the risk assessment.

3.4.1.3 Ecological Background Data

Soil background concentration data described for the human health risk assessment were used to evaluate data requirements for the ERA based on Area IV concentration data. Per the methods described in Section 3.4.1.1 and 3.4.1.2, a review of the available data for SSFL Area IV found that approved background concentration data exists only for chemicals and radionuclides in surface soil (0 to 2 feet) and chemicals in groundwater (MWH 2005). These soil data may be employed as background data for the Area IV ERA. However, there are currently data gaps associated with radionuclide data for groundwater and chemical and radionuclide data for surface water, sediment, and biological tissues as samples have not been collected from appropriate locations for these data sets. Background sample locations and analyses required to address these data gaps for the ERA will be presented in the FSAP and will be selected in coordination with regulatory authorities, as necessary. Background data currently available are not used to eliminate chemicals or radionuclides from the ERA.

3.4.2 Human Health Risk-Based Preliminary Remedial Goals

As discussed in *Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)* (RAGS, Part B) and *Radiation Site Cleanup Regulations: Technical Support Document for the Development of Radiation Cleanup Levels for Soil* (EPA 402-R-96-011 A), chemical-specific PRGs are concentration goals for individual chemicals in specific media and land use combinations which are used by risk managers as long-term targets during the analysis and selection of remedial alternatives. They are based on readily available information and are preliminary in nature. They are revised as site-specific data become available. The chemical-specific PRGs discussed below are concentrations based on human health risk assessments.

3.4.2.1 EPA Region 9 Residential PRGs for Chemical Contaminants

EPA Region 9 has established PRGs for chemical contaminants. PRGs are generic risk-based screening values to be used as guidelines for determining whether additional investigation is necessary. They can also be used as initial cleanup goals, if applicable. PRGs are not enforceable standards. These PRGs are calculated for cancer

risk levels of $1.0E^{-6}$ and hazard index (HI) levels of 1. EPA Region 9 PRGs are available for several media (soil, tap water, and ambient air). Tap water PRGs (and MCLs discussed in Section 3.4.4) were used for comparison to groundwater concentrations. Soil PRGs are also provided for both residential and industrial scenarios. Residential criteria were included as screening criteria for Area IV since EPA often requires a remedy to address a future residential scenario. Comparisons to criteria based on residential exposures will exaggerate any potential health threats for non-residential exposure that might currently occur at the facilities. Soil chemical PRGs are based on exposure to chemicals in soil via incidental ingestion, dermal contact and inhalation.

To address the fact that CalEPA has its own toxicity criteria for selected chemicals, the EPA Region 9 PRG list includes Cal-modified PRGs. These Cal-modified PRGs are applicable to Area IV. However, EPA Region 9 PRGs were last updated in October 2004. To account for updates in toxicity values, PRGs were recalculated using the formulas in the PRG user's guidance for chemicals with updated CalEPA cancer potency values dated January 25, 2008 and CalEPA's most recent list of reference exposure levels (RELs) accessed March 7, 2008. A more thorough explanation of how these values were updated is provided in **Appendix H**, Update to PRGs.

3.4.2.2 Rural Residential PRGs for Chemical Contaminants

As noted in the SRAM WP, the residential reuse scenario for Area IV needs to consider that rural residents may grow fruits and vegetables for local consumption. EPA Region 9 did not include this exposure pathway in the development of its PRGs. In order to address this pathway in the screening, agricultural land use PRGs from the RAIS, which were last updated in May 2007, were included in the screening process. These soil PRGs include the ingestion of fruits and vegetables exposure pathway and are calculated for cancer risk levels of 1.0E-6 and hazard levels of one using equations developed for assessment of sites on the Oak Ridge Reservation in Oak Ridge, Tennessee, and approved by EPA Region 4 assuming 25 percent of consumption from contaminated sources. Calculations of PRGs for soil contributing contaminants to home grown produce are back-calculated from PRGs estimated for fruits and vegetables. EPA Region 9 PRGs described in Section 3.4.2.1 were updated using the EPA Region 4 agricultural PRGs to account for exposure through ingestion of fruits and vegetables. A more thorough explanation of how these values were updated is provided in Appendix H, Update to PRGs.

3.4.2.3 Radiological PRGs

The radiological PRGs for the SSFL are based on default EPA methods presented on the following Web site:

http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search,

and the CSM described in Section 3.3. Onsite human receptors potentially considered by the risk assessment include a rural residential (including resident gardener), industrial worker, construction worker, and a recreational visitor. However, because data gap analysis decisions will be made based on the most conservative (i.e., lowest)

PRGs, only the rural residential and non-gardening residential receptors are discussed here. Exposure pathways include inhalation or fugitive dust, incidental soil ingestion, and external gamma radiation exposure. Ingestion of homegrown fruit and vegetables are also considered by the resident gardener.

The PRGs are calculated at the so-called point of departure, representing the 10^{-6} threshold as the target. Toxicity values are based on the cancer risk coefficients presented in Federal Guidance Report No. 13[1] assuming short lived decay products are in equilibrium with the nearest long-lived parent. Default EPA inputs were used except it was assumed that the rural resident would consume approximately 25 percent of its fruit and vegetables grown onsite while the resident would not consume crops grown onsite. This assumption is consistent with the July 1992 State of California's Office of the Science Advisor default exposure scenarios. The particulate emission factor for Los Angeles was also used, selected from the on-line PRG search pull-down menu.

Table 3-3 presents utilized toxicity values and calculated PRGs for residential receptors. The "+D" notation after certain radionuclides indicates the presence of short-lived decay products in equilibrium with the specified parent nuclide, where short-lived is defined as having a half-life less than six months. Results show that most often there is an indistinguishable difference in the gardening and non-gardening PRGs. This is because external gamma typically dominates results from other pathways. Exceptions are noted for radionuclides like ^{59}Ni, ^{210}Pb+D, and ^{90}Sr+D that produce no or negligible gamma radiation.

3.4.3 Ecological PRGs (Radionuclides) and ESLs (Chemical)

To evaluate the quality and usability of historical data for assessing risk to ecological receptors in the SSFL Area IV EIS, PRGs (as defined above) are required for chemicals and radionuclides potentially occurring in four abiotic media: soil and water, including surface water and daylighting groundwater seeps, for terrestrial biota, and sediment and surface water for aquatic biota. Radionuclide PRGs are listed for terrestrial biota in **Table 3-4** and for aquatic biota in **Table 3-5.** As shown in the preliminary ecological CSM (Figure 3-2), terrestrial biota are potentially exposed directly and indirectly to chemicals and radionuclides in soil, groundwater discharged at the surface (i.e., seeps), and storm water present on Area IV and adjacent offsite locations. Aquatic biota are potentially exposed to chemicals and radionuclides that have migrated to surface water bodies by erosion and storm-water runoff, and in some cases, groundwater transport. The PRGs for soil are also used for biotic tissue samples where data allow.

[1] EPA (U.S. Environmental Protection Agency) 1999. *Cancer Slope Coefficients for Environmental Exposure to Radionuclides*, Federal Guidance Report No. 13, EPA 402-R-99-001, Air and Radiation, September.

3.4.3.1 Ecological PRGs for Radiological COIs

The process for the identification of ecological PRGs for radionuclides was derived from *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002). PRGs are either Biota Concentration Guides (BCGs) published in DOE (2002) or BCGs calculated using the equations provided therein. According to DOE (2002), BCGs are "appropriately conservative limiting concentrations of radionuclides in environmental media." The BCGs are based on threshold doses for the protection for ecological receptors of 1 rad/day for aquatic biota and terrestrial plants and 0.1 rad/day for terrestrial animals. These dose limits meet the requirements of DOE Order 5400.5, "*Radiation Protection of the Public and Environment*" (DOE 1990a), and DOE Order 5400.1, "*General Environmental Protection Program*" (DOE 1990b), and they equal the dose limits for protection of biota put forth by the NCRP (1991) and IAEA (1992). The smaller of the separate BCGs calculated for plants and animals for a given medium was selected as the PRG for that medium. The BCGs for animals were lower than the BCG for plants for all Area IV radionuclides.

The BCGs are calculated using conservative exposure assumptions and parameter values. DOE (2002) reports calculated BCGs for most of the SSFL Area IV radionuclides. For those radionuclides without reported values, BCGs are calculated using the equations in DOE (2002) and published exposure parameter values (see **Appendix E,** Ecological Risk – RAD Calculations). Sources of parameter values include DOE (2002) for metabolic parameters; Eckerman et al. (1988) for assimilation factors; Eckerman and Ryman (1993) for radionuclide half-lives and disintegration energies; Baes et al. (1984), EPA (1999), DOE (2002) for uptake factors, and Zach (1985) for inhalation-ingestion normalization factors. As appropriate for screening values, it was conservatively assumed that there is no biological decay in or loss of radionuclides from receptor tissues.

3.4.3.2 Ecological Screening Levels for Chemicals

Typically, site chemical data are compared to conservative ESLs to determine the potential for adverse effects to ecological receptors from direct exposure to site media. The ESLs are conservative levels that in most cases represent thresholds for ecologically significant adverse effects in selected ecological receptors. ESLs, from sources such as the EPA, are for the most part linked directly to toxicity to one or more organisms or receptor groups. In some cases, ESLs are general and do not represent a toxicity threshold, but instead, are recommended values to protect a specific land use, such as agriculture. Direct exposures to contaminants can include dermal absorption, inhalation, and ingestion of potentially toxic contaminants. Although inhalation can be a significant route of exposure for certain organisms, adequate means to independently assess this exposure route are generally unavailable. Therefore, direct exposures to chemical contaminants and the resulting ESLs were developed based primarily on ingestion and, in some cases, indirect measurements of dermal absorption. However, the SRAM WP (MWH 2005) presents ESLs for a small number of volatile organic compounds (VOCs) that were developed for use in the evaluation of the inhalation by burrowing mammals.

The selected preliminary ESLs are being used to evaluate the quality and usability of historical data and to determine that the laboratory detection limits are sufficiently low for the upcoming sampling efforts. Collectively, if deemed usable, the historical and newly collected data will be used for assessing risk to ecological receptors in the SSFL Area IV EIS.

Preliminary ESLs presented for each medium were identified through a literature survey, and represent conservative, generic criteria for the protection of plants, soil microorganisms, soil invertebrates, birds, and mammals. These do not consider bioaccumulation potential and the related possible adverse effects on upper trophic level biota. Several sources of ESLs were evaluated prior to selection of the final ESL for each chemical of concern.

The ESLs selected for use as ecological PRGs for surface water, sump water, and groundwater seep data include:

- SRAM surface water screening values (MWH 2005)
- EPA Region 3 BTAG Freshwater Screening Benchmarks (2006)
- EPA National Recommended Water Quality Criteria -- Criteria Continuous Concentration (2006)
- EPA Region 5 RCRA Ecological Screening Levels (2003)
- EPA Region 4 Waste Management Division Freshwater Surface Water Screening Values for Hazardous Waste Sites (2001)

The ESLs selected for use as PRGs for sediment data include:

- SRAM sediment screening values (MWH 2005)
- EPA Region 3 BTAG Freshwater Sediment Screening Benchmarks (2006)
- EPA Region 5 RCRA Ecological Screening Levels (2003)

The ESLs selected for use as PRGs for the soil (0 to 2, 2 to 4, and 4 to 6 feet depth intervals) and sump soil data include:

- SRAM soil, terrestrial mammal, terrestrial avian, terrestrial invertebrate screening values (MWH 2005)
- EPA Region 5 RCRA Ecological Screening Levels (2003)
- EPA Region 4 Recommended Ecological Screening Values for Soil (2001)
- Van den Berg, et al. (1998)

- EPA Region 3 BTAG (1995)

The ESLs selected for use as PRGs for soil gas include:

- SRAM terrestrial mammal inhalation screening values (MWH 2005)

As several ESLs have been selected for each medium, as noted above, a hierarchy for use was developed for the evaluation of the data. The SRAM WP was selected as the primary source for ESLs for each medium and receptor. If the SRAM WP presented one ESL for a particular medium, it was employed as the ESL. If the SRAM WP presented more than one ESL for a given medium, the lowest ESL was employed for use in the preliminary screening of the chemical data.

If the SRAM WP did not present an ESL for a given chemical, an EPA regional or national ESL was selected as a secondary ESL, with the following hierarchy employed. If only one EPA ESL was available from the above mentioned EPA sources for a medium, it was employed as the ESL. If more than one regional or national EPA value was available, the most recently updated regional or national value was selected as the ESL. For evaluation of surface water, groundwater seep, and sump water data, both EPA National Recommended Water Quality Criteria – Chronic (NRWQC) and Region 3 BTAG Freshwater Screening Benchmarks were updated in 2006. As they are the most recent sources of ESLs for those media, the lowest ESL between the two sources was selected for that chemical as the secondary ESL. For the evaluation of dioxin soil data, TCDD equivalents (Van den Berg, 1998) are to be calculated as ESLs.

3.4.4 Groundwater Maximum Contaminant Levels

Maximum contaminant levels are used as screening values for comparison with groundwater concentrations under the conservative assumption that groundwater at Area IV is used as drinking water. The MCLs developed by the EPA are health protective, Federally-enforceable National Primary Drinking Water Regulations for drinking water systems that are derived taking into account analytical and treatment limitations. For some chemicals, CalEPA has also established more stringent state-specific MCLs. The CalEPA MCLs were considered as screening criteria for Area IV.

The EPA also established non-enforceable criteria, maximum contaminant level goals (MCLGs) and Secondary MCLs. The MCLGs provide health-based guidance and are calculated such that non-carcinogenic health effects are set at a level believed to be safe and carcinogens are set at zero. Unlike the MCLs, The MCLGs do not consider feasibility. Secondary MCLs are based on aesthetics and palatability. The MCLGs and secondary MCLs were not included as screening criteria for Area IV.

3.5 Evaluated Media

Each of the site media (soil, groundwater, seeps, soil vapor, surface water, sediment, biota [ecological], air, and buildings) were evaluated with respect to the data required to perform human health and ecological risk assessments as well as characterization

for the EIS. The evaluation of each media considered in this data gap analysis is described below.

3.5.1 Soil

Area IV soil data were evaluated using a statistical approach to determine if there are a sufficient number of samples to characterize the soil and perform a human health risk assessment. These risk assessments require evaluation of exposure to specific depth intervals of soil. Therefore the data from different depth intervals were screened for each evaluation. In addition, the radiological data were evaluated as a separate depth interval recognizing the shielding ability of soil. The depth intervals used for each evaluation include:

- Human Health Risk Assessment (chemical data): 0 to 2 feet, and 2 to 10 feet, per standard EPA risk assessment procedures.

- Human Health Risk Assessment (radionuclide data): 0 to 0.5 feet, 0.5 to 2 feet, and 2 to 10 feet. These intervals mirror the protocols for chemical data but also address the shielding effects of shallow soil.

3.5.2 Groundwater

Data gaps related to groundwater media are being addressed as two media: near surface (or shallow) groundwater and the deep groundwater associated with bedrock (see Section 2.3.2.2). Analytical data gaps were identified through an evaluation of the sufficiency of existing data to define the lateral and horizontal extent of contamination. The usability of the data for risk assessments was evaluated and the availability of hydrologic data required to assess the CSM was also evaluated.

3.5.3 Seeps

Seep data were evaluated for use in the ERA with a focus on the terrestrial biota exposed via drinking water at seeps located within the buffer area and on nearby offsite slopes. If it is determined that surface water bodies are present outside the SSFL, the seep data will be used to evaluate risk to aquatic biota.

The seep analytical data were also evaluated with respect to groundwater characterization.

3.5.4 Soil Vapor

Soil vapor chemical data will be used to evaluate exposure to the deer mouse, a burrowing mammal and ecological receptor, via the inhalation pathway when the animal is in its burrow. Soil vapor data will also be used qualitatively to describe risk to humans under the residential risk scenario and to evaluate the extent of groundwater contamination.

3.5.5 Surface Water

Surface water data collected as part of the NPDES monitoring program were reviewed for applicability to the human health and ecological risk assessments. This review included the NPDES monitoring analyte list, analytical detection limits, discharge limits, frequency of exceedences by analyte, chronic and acute toxicity test results, and the NPDES sampling protocols. This review was performed to determine what additional sampling may be required.

Overall, surface water is very limited in Area IV due to the climate and presence along the top of a mountain ridge. There are no natural ponds in Area IV, and stormwater is present only during and immediately following storm events. The primary data for surface water is that collected for the NPDES compliance program. Surface water and sediment data for internal drainages is extremely limited becoming a data gap.

Given limited potential for exposure to stormwater, the human health risk assessment proposes to address surface water exposure in a qualitative manner. However, for the ecological risk assessment additional surface water and sediment data are needed as described in Section 4.0.

3.5.6 Sediment

Sediment is being evaluated for human health and ecological risk. Due to the offsite transport considerations associated with sediment, sediment from Area IV, as well as sediment found downstream of Area IV, is considered in the evaluation.

3.5.7 Biota (Ecological)

Whole-body tissue concentration data will be used in the ERA to assess risk to the sampled biota and their predators.

3.5.8 Air

The onsite human health risk assessment for radionuclides will model exposure from the inhalation pathway based on resuspension of particulates, per standard methods. Offsite exposure calculations in the EIS (e.g., from demolition or other construction-related activities) will be based on existing datasets such as those presented in NESHAP reports. Therefore, air data does not contribute to the data gap.

3.5.9 Building Surfaces

Remaining site buildings will be quantitatively addressed by the human health risk assessment in order to evaluate the No Action alternative, as is required under NEPA. The building surface data will also be used to evaluate the risks of building demolition and debris transport to be considered among the range of alternatives in the EIS. Therefore, the gap analysis assesses the adequacy of radiological building data quantity and quality both for the onsite risk assessment and offsite release estimates for the EIS and transportation and final disposition planning.

3.5.10 Walkover Radiation Surveys

Gamma walkover surveys are an integral part of the MARSSIM survey process for release of radiologically-contaminated sites. The GWS data are not used in risk calculations, rather they are used to support sample density and MARSSIM classification decisions and to identify small areas of elevated activity that would most likely be missed by sampling alone. The intent is to provide a high density of gamma radiation data in the areas with the highest potential for exceeding site criteria (e.g., MARSSIM Class 1), and to scale back on density requirements with decreasing likelihood of contamination with recommended walkover of 100 percent of Class 1 areas, 10 to 100 percent of Class 2 areas and judgmental (typically professional judgment in terms of defining sample number and density) for Class 3 areas.

3.5.11 Bedrock

Bedrock at the SSFL is shallow and in some areas is exposed at the surface. Bedrock in some instances can act as a barrier to contaminant migration or can harbor contaminants (i.e., be a media of concern). Physical properties of bedrock are important for evaluation of groundwater contaminant transport and fate mechanisms. Therefore, bedrock data will be an important evaluation factor for alternatives evaluation in the EIS.

3.6 Human Health Soil Media

Exhibit 3-1 presents a flow diagram for the data gaps analysis process for soils to address data needs for a CERCLA risk assessment. Further details and rationale are presented in the following subsections.

3.6.1 Review of Existing Documents

The soil data gap analysis for human health was performed using available relevant documents for information on operational, process, and release history. In particular, documents which themselves were generated as part of regulatory programs and which included detailed review and summary of information from many historical documents. In particular documents generated under the SSFL RCRA Program were used for information pertaining to historical chemical use in Area IV and the HSA were used for information on Area IV radiological process history.

3.6.1.1 Review of the RCRA Program Documents

The SSFL is regulated under RCRA and a great deal of environmental assessment and remedial work has been, and is currently being, completed in Area IV under various RCRA programs. This work, particularly the information compiled under the overall SFFL RCRA Corrective Action Program, was used in this data gaps analysis to provide the process-related information required for an analysis of the nature and extent of contamination.

The RCRA Corrective Action Program includes the RCRA Facility Assessment (RFA), the RCRA RFI, the RCRA Corrective Measures Studies (CMS), and the Corrective

Measures Implementation. The RFA Report (SAIC 1994), the RFI Program Report (MWH 2004), and various other RFI Program documents were reviewed for process history.

RCRA Facility Assessment
The RFA of the SSFL was completed by SAIC in 1994 for Rockwell International (SAIC 1994). The RFA included a preliminary review of relevant files, a visual site inspection (VSI), and sampling program. The preliminary review included files collected from EPA Region 9, the California Department of Health Services/DTSC, the Regional Water Quality Control Board of Los Angeles, the DOE, and the NRC. The VSI was conducted in 1990 to verify information found in the file review and determine if there was a release of hazardous waste from the Solid Waste Management Units (SWMUs) throughout the SSFL. Although all SWMUs were visited, some Areas of Concern (AOCs), such as leach fields, could not be located and were not visited. Sampling was conducted under a multi-media sampling program at the Brandies-Bardin Institute (BBI) and the Santa Monica Mountain Conservancy. The results of the RFA were presented in the 1994 *RFA Report*.

RCRA Facility Investigation
In 1999 the DTSC identified two Operable Units (OUs) at the SSFL – Surficial Media (soil, soil vapor, sediment, surface water, near-surface groundwater, air, biota, and weathered bedrock), and the Chatsworth Formation (Chatsworth Formation groundwater, and saturated and unsaturated competent bedrock). The ongoing RFI is being conducted to collect, evaluate and report data to identify potential releases from SWMUs and AOCs. The *RFI Program Report* (MWH 2004) stated that 135 SWMUs and AOCs had been identified at the SSFL and that 29 of these were either closed or being closed as part of other environmental programs and needed no further action as part of the RFI. The remaining 106 SWMUs and AOCs had been grouped into 51 RFI Sites. Thirty-two RFI sites and AOCs are completely, or partially, within SSFL Area IV. Descriptions of these SWMUs and AOCs and summary of their history and chemical use are found in Appendix A.

3.6.1.2 Review of Historical Site Assessment Document

The primary purpose of an HSA is to collect existing information concerning the site and its surroundings. The primary objectives of an HSA are to:

- Identify potential sources of contamination.
- Determine whether or not sites pose a threat to human health and the environment.
- Differentiate impacted from non-impacted areas.
- Provide input to scoping and characterization survey designs.
- Provide an assessment of the likelihood of contaminant migration.
- Identify additional potential radiation sites related to the site being investigated.

An HSA entitled *Historical Site Assessment of Area IV, Santa Susana Field Laboratory, Ventura County, California*, was prepared by Sapere Consulting, Inc. and Boeing for DOE in 2005. This HSA focused only on radionuclide contamination and was developed to summarize the operational history of Area IV for both the DOE and Boeing from a radiological perspective. The purpose was to identify areas of radiological operations, compile information on prior radiological cleanups and releases and to identify further actions needed to ensure that the radiological cleanup of Area IV is completed.

Nuclear-related operations were conducted at SSFL Area IV from 1953 until 1988, with non-nuclear operations continuing through 1998. The DOE has focused on completing radiological cleanup since 1989. Over the period of Area IV operations, buildings and land in the radiological areas have been decommissioned, and if necessary, remediated, surveyed, verified and released for reuse by the appropriate regulatory agency (i.e., the U.S. Energy Research and Development Administration (ERDA) a DOE predecessor agency, DOE, NRC and the California Department of Health Services (DHS)).

Buildings have been decommissioned and released and contaminated soil remediated using appropriate regulatory standards as authorized by Congress and the State of California. Based on this history, portions of Area IV have been identified as radiologically impacted or radiologically non-impacted, consistent with applicable California and Federal regulations, and based on MARSSIM guidance.

The DOE and Boeing evaluated 272 numbered structures (collectively referred to as "sites") and any other areas of radionuclide contamination that existed in Area IV since its establishment in 1953. This was to ensure all areas where any types of operations were performed in Area IV were evaluated for radiological impact. To evaluate each site, a site summary was prepared using operational records, incident reports, site maps, decommissioning reports and personnel interviews. The site summaries include information about historical and current use and information about the management and use of regulated radiological materials at the site. Based on the information presented in the site summaries, all sites were classified either as radiologically-impacted or non-impacted. Sites that had any indication of management or use of regulated radiological material were classified as impacted. A summary of the information contained in the site summaries is contained in Appendix B.

The information contained in the HSA was used as a basis for developing the process knowledge for classifying various areas of Area IV as Class 1, Class 2, and Class 3 as defined by MARSSIM and discussed below. Although Boeing and DOE concluded that some portions of Area IV were non-impacted, the approach used here was to assume that all portions of Area IV were impacted and are Class 3 at a minimum. The classifications assigned to different regions of Area IV in the HSA were not used as a basis for assigning classifications in this data gap analysis.

3.6.2 Selection of Exposure Units

For the determination of data gaps, Area IV was divided based on chemical and process use information into exposure unit areas of no greater than 20 acres. The 20-acre maximum (most of the units actually are approximately 17 acres) was chosen for planning purposes only as tool to evaluate existing data and total data requirements. This preliminary establishment of EUs allowed for averaging of data across a common area for the determination of data gaps. When the risk assessment is conducted, specific exposure areas will be defined based on land use, spatial distribution of the data including sample density and extent of contamination, and relevance to the exposure pathways being assessed for Area IV. Individual exposure areas evaluated in the human health risk assessment will likely be much smaller than 20 acres; however, based on the identified data gaps for Area IV, the delineation of these risk assessment exposure areas cannot be performed at this time.

Area IV was divided into the 16 EUs shown on **Figure 3-4** of size ranging between 17 and 20 acres. The EU boundaries were generally selected to respect existing site features (e.g., Area IV boundaries and roads) and former and current operational boundaries (process areas and RFI site boundaries) in order to group areas with similar process history and contamination potential that would present similar risk to Human receptors. Risks may also be calculated for specific RFI sites for chemicals and SUs for radionuclides within each exposure unit depending on the exposure model used.

3.6.3 Radionuclide Data Assessment

3.6.3.1 Definition of Survey Units

The MARSSIM provides detailed guidance for planning, implementing, and evaluating environmental and facility radiological surveys conducted to demonstrate that compliance with remedial objectives has been met (DOE et al. 2000). The MARSSIM is intended to apply to final status surveys, but the principles may be adapted and used as guidance for application to scoping surveys. MARSSIM principles were adapted and used in this gap analysis for evaluating soil, water, and building radiological data requirements necessary for the evaluation of risk-based alternatives in the SSFL Area IV EIS.

The MARSSIM approach is designed to place greater emphasis in areas with highest potential for contaminant impact. Areas that have no potential for contamination are generally classified as non-impacted. For the Area IV data gap analysis, a conservative assumption was made that all areas have some potential of residual contamination. Therefore, no part of Area IV has been classified as non-impacted (i.e., all current evidence indicates no potential for contamination).

Impacted areas are sub-divided into Class 1, Class 2 or Class 3 survey unit (SU) areas. The classes are defined below from least to most potential for impact by radionuclides. The definitions have been modified from the MARSSIM document to be inclusive of chemical contamination.

- Class 3 SUs are expected to contain minimal residual radioactivity from activities adjacent to the Class 3, or are expected to contain levels of residual radioactivity at a small fraction of the DCGL or PRG. This determination is based on site operating history and previous radiation surveys and chemical sampling programs. Class 3 SUs are limited to a maximum size of 20 acres. For purposes of this Data Gaps Analysis "a small fraction of the DCGL or PRG" was defined as 25 percent.

- Class 2 SUs are areas that have or have had (prior to remediation) a potential for radioactive or chemical contamination but are not expected to exceed the DCGL or PRG. Other site-specific justifications can be used to classify an area as Class 2. The maximum size of Class 2 SUs is 2 acres.

- Class 1 SUs have or have had (prior to remediation) a potential for radioactive or chemical contamination, or known contamination (based on previous radiation surveys and sampling). The maximum size of Class 1 SUs is 0.5 acres. For purposes of this data gap analysis "known contamination" was defined as greater than or equal to 100 percent of the DCGL or PRG.

Consistent with the MARSSIM approach, both existing data and process history were used to assign each part of Area IV to Class 1, 2, or 3 SU. A two-step process was used to accomplish the classification:

- The refined Area IV data set was screened against PRGs and background concentrations, and the information graphically displayed.

- Knowledge of process areas and operational history was applied and SU boundaries were drawn accordingly.

3.6.3.2 Application of Process Knowledge and Drawing of Survey Unit Boundaries (Radionuclides)

As expected, the available sample locations generally clustered in areas that had previously been investigated because there was a suspected release of contamination. Often these areas corresponded to RFI sites or are related to particular former radiological process areas. Some areas contained data points exceeding DCGLs for some analytes, and were therefore classified as Class 1 SUs. Other areas were classified as Class 1 solely based on the process history indicating the high potential for contamination or on areas that were know to have been remediated to other cleanup standards.

Few concentrations between 25 and 100 percent of the DCGLs were identified (or were in close proximity to other points which exceeded DCGLs and were therefore include in Class 1 SUs). Class 2 SUs were drawn in those areas where an isolated, or few data points, exceed DCGLs but where there were no known processes or releases. Conversely, known process areas where no data exceeded the DCGLs were also sometimes classified as Class 2.

Some areas, particularly in the southern part of Area IV, are undeveloped (no process areas) and have very few data points. These areas were assigned to Class 3. Any areas within individual EUs that were not assigned to Class 1 or Class 2 were assigned to Class 3 by default.

In drawing the EU and SU boundaries, RFI site boundaries, as defined by Boeing, were generally respected in the delineating boundaries. Thus two SUs of the same class may be contiguous but be considered separately for the data gap analysis because they are assigned to different EUs based on RFI site boundary conditions.

3.6.4 Screening of Refined Dataset

All analytical soil data were considered together for purposes of defining SUs, regardless of the soil depth interval. This was done because a positive detection at any soil depth could indicate the potential for an area to be impacted or contain residual contamination.

Each constituent was assigned a DCGL which was set equal to the $1E^{-6}$ PRG for screening purposes. This was done separately for the residential and rural residential PRGs. If a background screening value was available and was higher than the PRG, then the twice the background screening value was used as the DCGL. Twice the background was assumed in order to prevent the assumption that remediation of background will occur. Constituents with no PRG or background values, and therefore no DCGL, were not carried through the screening stage.

Non-detected results with MDLs greater than the DCGL were eliminated from consideration since they do meet the sensitivity objectives and do not provide information relative to risk assessment. However, it should be noted that if the DCGLs change, these data may become useable if they are less than the new DCGL.

All sample constituents were assigned to one of three groups:

- Concentrations less than 25 percent of the DCGL or non-detected
- Detected concentrations between 25 and 100 percent of the DCGL
- Detected concentrations greater than 100 percent of the DCGL

Each of the groups was assigned a color code and sample locations were displayed on the map of Area IV as shown in **Figure 3-5** for chemical analytes and in **Figure 3-6** for radionuclides.

3.6.5 Selection of Soil Contaminants of Interest

A multi-step screening process was followed to determine which chemicals and radionuclides detected in Area IV soil are COIs that need to be considered for the data gap analysis. The purpose of identifying the COIs is to focus the list of chemicals and radionuclides that are more likely to have a significant impact on current or future

human health and ecological exposures in Area IV. The COI list will then be used for determining the number and location of samples recommended to resolve data gaps identified by the spatial distribution of the COI samples. Note that COIs are not the same as COPCs, which will be determined in the quantitative risk assessment. Contaminants of concern (COCs) will be identified in the risk assessment as probable drivers for risk management of the site.

3.6.5.1 Results of Screening for Soil COI Identification

For COI screening, an abbreviated screening assessment of PARCC parameters and sensitivity (blanks) was conducted. Data representativeness is the extent to which available data characterize potential exposure conditions for human or ecological receptors. Proper selection of sampling locations, consideration of potential hot spots, assessment of background concentrations, and collection of a sufficient number of samples help maximize data representativeness. It is this aspect of data quality that is being addressed in this data gap analysis.

The potential COI list started with a list of all chemicals for which samples were analyzed in soil at Area IV. The potential COI list was then focused to finalize the COI list through the following steps:

Step 1: Determine usable data. Analytical data for Area IV were collected by a number of different consultants and analyzed by a number of analytical laboratories over several years. Sampling protocols and analytical methods vary and data quality is not consistent. In addition, acceptable laboratory methodologies and standards for detection limits have changed over time. The purpose of this step was to identify and remove data of insufficient quality or that was otherwise inappropriate for site characterization.

To accomplish the first data screen, pre-remediation soil data from remediated areas were removed from the dataset. Thus, all data in the dataset represents soil that has not been removed from Area IV. Tentatively identified chemicals (TIC) were also removed from the list because it is not clear whether a TIC compound is actually present. TICs are frequently identified for general classes of compounds and do not have specific toxicity data, and toxicity data are often not available for TICs. Chemicals reported as not being detected above MDLs were also removed from the list. Chemicals not detected, but on the initial COI list are presented in **Table 3-6. Table 3-7** lists chemicals detected in Area IV. (However, note that non-detected chemicals were retained for further uncertainty analysis regarding whether their detection limits were sufficient for risk determination. This will be addressed in the quantitative risk assessment.)

Step 2: Determine whether the data are above background concentrations. Detected inorganic compounds were compared to the background concentrations established for the SSFL (see Section 3.4.1) in the SSFL background study (MWH 2005). Inorganic compounds with concentrations that were less than established background values were attributed to background and removed from the COI list. **Table 3-8** lists the

number of samples for each chemical that is above background. Radionuclides with MDLs that were greater than the PRGs or background were also removed from the COI list.

Step 3: Determine whether data are likely to be toxicologically significant. Detected chemicals in soil were compared to EPA Region 9 PRGs as updated with OEHHA toxicity values and agricultural PRGs. As described in Section 3.4, these screening values were developed using target risk levels of 10^{-6} and target HI of 1. To address the potential for cumulative effects of chemicals, instead of screening directly against the PRGs, one-tenth of the screening criteria were used for the comparison. In effect, this procedure adjusts the target risk levels to 10^{-7} and the HI to 0.1 for each individual chemical. Chemicals with maximum concentrations less than one-tenth the PRGs were removed from the COI list. Table 3-8 lists the number of soil samples for each chemical above PRGs.

Chemicals without PRGs were further evaluated to check if toxicity criteria are available from the EPA or OEHHA toxicity databases. Toxicity criteria have not yet been established for all detected chemicals. Quantitative risks and hazards cannot be calculated in the absence of these toxicity criteria. As such, chemicals without available toxicity criteria were determined to be toxicologically insignificant or with unquantifiable risk and removed from the COI list. (Although chemicals without toxicity values were removed from the COI list, they will be evaluated further in the uncertainty analysis for the quantitative risk assessment.)

There were several inorganic elements that are generally recognized as non-toxic and are essential minerals and may not be addressed in the risk assessment. These elements include calcium, sodium, potassium, magnesium, chloride, and fluoride. Due to process history usage, potassium and sodium may be included as part of future investigations as an indicator of contamination.

Some essential minerals, such as iron and manganese, were not eliminated in this step. Such metals, though essential, can be associated with adverse effects and were retained unless eliminated in subsequent selection steps.

Step 4: Assess detection frequency of data. Chemicals that are detected very infrequently at Area IV are not likely, with few exceptions, to contribute significantly to overall risk. Some chemicals were reported in fewer than 5 percent of soil samples. These chemicals may not represent a significant release at Area IV, and may not, in some cases, be site-related. Thus, elimination of these chemicals focuses the COI list on potential significant releases. However, prior to eliminating infrequently detected chemicals, the following criteria must be met.

Infrequently detected chemicals in soil were not eliminated if they were: (1) known human carcinogens; (2) were detected at very high concentrations compared to minimum levels that could be associated with adverse effects (e.g., PRGs); and/or (3) were found in localized "hotspots." Hotspots are defined as relatively small areas with

chemical concentrations that are significantly higher than those in surrounding areas. In most, but not all, cases, hotspots correlate with source areas. In addition, chemicals were not eliminated if fewer than 20 samples were available for the area.

Chemicals that were infrequently detected in soil and do not fall into any of the above categories were eliminated from the COI list.

Step 5: Group remaining chemicals. For the purpose of determining the number of samples required per EU for the risk assessment and for ease of reference, the chemicals on the resultant COI list were then grouped into the following categories: volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), inorganics, PCBs, and dioxins/furans. PCB-1242, PCB-1248, PCB-1254, and PCB-1260 were selected as surrogates to represent all PCBs, and TCDD (as expressed by dioxin TEQ), was selected as a surrogate to represent dioxin/furans congeners on the COI list. These surrogates are selected due to their representative toxicity of their respective groups of chemicals and their frequency of detection in Area IV.

The final list of soil COI and their groups is shown in **Table 3-9**.

3.6.5.2 Process History Confirmation of Chemical COIs

The list of chemical COIs generated through the screening process described above was reviewed for consistency with the types of chemicals used at the site. Classes of chemicals retained include solvents, polynuclear aromatic hydrocarbons (PAHs), fuel constituents (benzene, toluene, ethylbenzene, and xylenes), PCBs, dioxins, metals, and phthalates. With the exception of phthalates, Area IV processes or operations using each of these groups of chemicals were identified in the review of historical documents. Phthalates were retained because storage and landfill areas of the site may have been used for storage, handling or disposal of these chemicals without specific documentation.

Other process-related chemicals were identified as being used in specific EUs and chemical use areas. These chemicals include terphenyls, propellents, and energetics. The adequacy of the available data for determining if these chemicals have been released to the environment, and the extent of contamination, was considered in this data gaps analysis. These and other process-related chemicals are also being sampled for under the current RFI program.

3.6.5.3 Radionuclide Contaminants of Interest

Previous assessments of the site, such as the ETEC EA and the HSA, assumed a base list as the potential radionuclides of concern. This base list includes the radionuclides shown in **Table 3-10**.

Not all of these radionuclides were assumed to be final radionuclides of concern in the previous assessments. Some were eliminated based on not being detected at concentrations near the applicable limits assumed for those assessments. This data gap analysis will use this list as a starting point. However, several additional fission

products, activation products, and decay chain daughters have been added to the COI list based on process knowledge and professional judgment. These include the activation products ^{14}C, neutron capture product ^{237}Np and fission products ^{99}Tc since these are known to be produced in reactors in significant quantities and have relatively long half-lives.

Radionuclides with half-lives of less than 1 year were eliminated, since it has been more than 20 years since nuclear operations have been conducted at SSFL Area IV causing less than 1 millionth of the original amount to still be present. Of these radionuclides listed above, only ^{54}Mn was eliminated by this rule.

The existing dataset was screened to determine if other radionuclides have been detected. The only additional radionuclides that were detected with half lives greater than 1 year were ^{125}Sb, ^{155}Eu, ^{243}Cm and the natural decay chain daughters of thorium and uranium isotopes. The radioisotopes ^{125}Sb, ^{155}Eu, and ^{243}Cm were added to the COI list but the natural decay chain daughter were not added since they are included in the +D slope factors and PRGs of their parents.

The final list of radionuclides of interest that will be used for screening of the existing database is shown in **Table 3-11**. Since many of these radionuclide have either had minimal or no sampling or have been analyzed with detection limits that do not meet the PRGs that will be used for screening, the data gap for risk assessment will be measured against the entire list. However, the COI list may be reduced to a smaller COC list after further sampling and prior to risk assessment by eliminating radionuclides that are not detected at levels greater than one-tenth of the screening levels or above background screening levels

3.6.6 Determination of Required Number of Samples

3.6.6.1 Radionuclide Sample Number for Risk Assessment and Delineation Based on MARSSIM

For radionuclides, the number of samples required in each SU was determined using MARSSIM statistical tables. This requires assumptions of the α and β values (defined in the project DQOs) and calculation of the standard deviation and relative shift of each of the COIs. The relative shift is the ratio of the gray region and the standard deviation. The gray region is where the consequences of decision errors are relatively minor: the upper bound of the gray region is defined as the DCGL, and the LBGR is a site-specific variable generally initially selected to equal one half the $DCGL_W$ and adjusted to provide an acceptable value for the relative shift. In the statistical approach the gray region defines the level above which there is confidence that the contamination is less than the DCGL and below which there is confidence that contamination is less than the DCGL.

The MARSSIM protocol results in a determination of the number of required samples to be collected in a Survey Unit, regardless of size. The protocol also establishes maximum sizes for the Class 1, 2, and 3 Survey Units. Since MARSSIM was applied in this data gap analysis as a tool for the design of a characterization survey for the

SSFL Area IV EIS, and not as a final status survey for property transfer determination, the MARSSIM-recommended size limitations and resulting sample density were modified by using a sample density that is a factor of four lower for Class 1 and Class 2 areas than would be otherwise defined by MARSSIM. This sample density was determined appropriate to collect the required data for conducting a risk assessment for a representative exposure area. This adaptation of MARSSIM allows the sample density to continue to be proportional to the potential for contamination and sufficiently conservative to address CERCLA risk assessment data needs requirements.

For this Data Gaps Analysis, the MARSSIM protocol was also modified to allow for Class 1 and Class 2 Survey Units of larger than the established sizes and the number of samples determined by the statistical analysis was prorated to obtain the equivalent number of sample density across the total area of each Class of survey unit. For example, if the statistical analysis determined that in a particular EU, 15 samples would be required for a Class 1 Survey Unit (2-acre size limit), and the total area of Class 1 Survey Units in that EU would be 4 acres, then the number of required samples is 30. This allowed for the sample density to be proportional to the potential for exceeding the DCGL. Areas with standard deviation closer to the DCGLs (a lower relative shift) will have a higher density of samples based on the MARSSIM recommended statistical tests (Sign Test for COIs with no background value and Wilcoxon Rank Sum Test for COIs with a background value).

The calculation of required number of samples was performed for each COI for each soil interval. The relative shift is dependent, in part, on the DCGL or background value. Therefore, the calculation was also performed for both the residential and rural residential PRGs.

Standard deviations were calculated using data from samples in each SU. If a constituent was not detected, the actual value was used unless the result was reported exactly equal to the MDA or exactly half the MDA, indicating the reported results were manipulated. In those cases, half the MDA was used in the calculations.

In some cases there were not enough samples (less than eight) from the SU to determine a statistically valid standard deviation. In those cases, the relative shift was set to 1.5 for that constituent. Similarly, when all the samples had the same result (usually due to the detection limit being reported) and the standard deviation is zero, the relative shift was set to 3.0. Also, in some cases, the number of samples was greater than eight, but the average of the samples was greater than the DCGL or the standard deviation was greater than the LBGR. In those cases, obtaining the number of samples necessary to prove the area meets the DCGL is not reasonable and the conclusion can already be drawn that remediation is required. Since further sampling will be required after remediation, in these cases, the relative shift was set to 1.5 just to make sure that enough samples are collected to adequately characterize the area for nature and extent of contamination.

The MARSSIM guidelines apply to surface media and are not necessarily intended for use with subsurface contamination (i.e., subsurface soils cannot be field screened using standard GWS instrumentation because the overlying surface soil absorbs the subsurface emissions) (DOE et al. 2000). However, the MARSSIM SU classification system can still be used for assessing the potential for contamination. Therefore, sampling requirements for subsurface soils were evaluated based on SU process history especially where existing data was limited.

3.6.6.2 Chemicals Sample Number for Risk Assessment

For Chemicals, the number of samples required for Risk Assessment was determined through a process similar to that described above for Radionuclides. However, the statistical calculation was performed for each EU rather than for each SU since the SUs only apply to radionuclides. The same screening and statistical rules were applied except if a constituent was not detected, a value of one-half of the detection limit was used in the calculation of the standard deviation for chemical constituents.

3.6.6.3 Determination of Sample Numbers for Extent Delineation

The objective of the Area IV data gap analysis was to identify additional site characterization data necessary to evaluate a full range of risk-based remedial alternatives in an EIS. Through the RFI program many areas with documented soil chemical contamination have been identified as requiring clean-up. In addition, the RCRA program has identified Chemical Use Areas within many SWMUs and AOCs that need further characterization. As part of the data gap analysis, maps of EUs, showing detections above the DCGL of chemical COIs, by chemical group, were created from information in the database. Maps were developed for both the 0 to 2-feet and 2 to 10-feet depth intervals. These maps are compiled in **Appendix F**.

The existing analytical information in each Chemical Use Area was evaluated to determine if sufficient information exists for the evaluation of risk-based alternatives in the EIS. The analysis considered whether the areas have been previously characterized, and if areas of known contamination are adequately delineated. An evaluation of the distribution of existing sample locations coupled with the contaminant concentrations was used to determine a preliminary estimate of how many additional samples, if any, are required to characterize the soil or delineate the extent (laterally and vertically) of soil contamination in order to provide a cost estimate in the EIS. The analyses required for additional samples were also considered and evaluated.

3.6.7 Calculation of the Soil Sample Analytical Data Gaps

The analytical data gap is the difference between the required number of samples as determined using the MARSSIM approach for radionuclides and statistical approach for chemicals and the number of valid analyses already in the database. The analytical data gaps for soils were determined for each constituent in each soil depth interval with respect to each PRG (rural and residential). If additional samples, beyond those required for the risk assessment, are required to sufficiently delineate or characterize

suspected or identified contamination for chemicals, the sampling requirements are included in the data gap.

3.6.8 Gamma Walkover Survey Data Gap Analysis Methodology

A large number of radiological surveys have been performed over the last two decades within Area IV of SSFL to document achievement of remedial goals in various portions of the site. Independent third parties such as the staffs of California regulatory agencies and of the Oak Ridge Institute for Science and Education have also performed independent verification surveys to reconfirm results for many of the original surveys. For soils (i.e., unconsolidated materials), surveys have included soil sampling and analysis, assessment of ambient gamma radiation levels and gamma walkover (or "walk about") surveys.

Soil sampling efforts document the average concentrations of site contaminants. Gamma walkover surveys, by contrast, assist in assuring that soil sampling results are representative and that unidentified areas of residual contamination exceeding cleanup goals do not exist. Documentation of gamma walkover surveys was reviewed as an integral part of this data gap analysis to assure that survey information is comprehensive and fully defensible.

Gamma walkover surveys are utilized to identify areas in which gamma radioactivity is elevated when compared to normal site background radioactivity. These elevated areas are subsequently subjected to sampling and laboratory analysis to assure that small areas of elevated radioactivity are fully investigated and appropriately remediated. Failure of gamma walkover surveys to appropriately detect elevated concentrations of site contaminants could lead to residual contamination exceeding criteria. As such, the data gap review of gamma walkover survey reports was based upon availability of information to:

- Document that instrument scan minimum detectable concentrations were able to detect contamination at cleanup levels and, to the extent practicable, at 10 to 50 percent of such levels. (This standard includes assessment of instrument MDCs, survey procedures which were implemented and action levels used to enable the appropriate identification of areas of elevated activity.)

- Independently confirm that appropriate instrument quality assurance/quality control procedures were implemented as necessary to assure that data obtained were of defined quality.

- Clearly delineate the area(s) previously subject to gamma walkover surveys and, as related, provide assurances that all portions of a given area have been subject to the appropriate investigations.

- Assure the availability to decision makers of detailed survey data files.

The MARSSIM provides a nationally consistent consensus graded approach to conducting radiation surveys and investigations at potentially contaminated sites.

Gamma walkover surveys are an integral part of the graded approach with the highest data density collected in the areas most likely to contain contamination.

Surveys implemented prior to the development of MARSSIM must be individually assessed to evaluate their acceptability for use. The data gap analysis focuses on the usability of these data for identifying gross surface contamination or small areas of elevated activity within the context of MARSSIM. Because these data are not used in the risk calculations, not all radionuclides emit gamma radiation that is distinguishable from background, and because it is assumed unlikely that contamination exists in large areas but in small hot spots, all available GWS data will be considered by the data gap analysis. However, data obtained that is not compliant with MARSSIM guidance will require resurvey using MARSSIM compliant protocols and equipment.

3.7 Groundwater

Groundwater occurs in overburden and bedrock in Area IV. The units were distinguished during the data gap analysis since health effects and, ultimately, remedial action alternatives can differ for each unit. For example, VOCs in shallow groundwater in the overburden will likely have more of an impact on vapor intrusion than VOCs at depth in the bedrock. Also, contamination in the overburden may be addressed with one remediation technology, but the same technology may not be applicable to address the same contaminant type in bedrock.

3.7.1 Identification of Groundwater COIs

Groundwater COIs were identified by screening reported groundwater concentrations of all detected constituents against one-tenth the EPA Region 9 PRGs and one-tenth the MCLs. All groundwater data from wells located in Area IV were considered. However, since groundwater constituents may migrate beyond Area IV, which contrasts with soil where negligible lateral migration occurs, data from wells located beyond the Area IV boundary were also included. Wells located at a distance of 500 feet from the Area IV boundary (plus the more distal wells to the northwest) were included in the screening. Any constituent that exceeded its respective PRG or MCL screening value was identified as a COI. If a COI was identified at a well beyond Area IV, other site data (e.g., potentiometric surfaces) were evaluated to determine if the COI was applicable to Area IV. Some wells (e.g., RD-58B in Area III) beyond Area IV were linked to identified COIs, but no COIs were eliminated based on the review of other site data. The groundwater COI list is presented in **Table 3-12**. The screening values and the maximum detected concentrations are also posted in the table.

3.7.2 Statistical Evaluation of COI Distribution

Statistics were prepared for each COI. The statistical parameters are

- Frequency of detection

- Maximum concentration detected
- Well identifier for maximum concentration
- Minimum concentration detected
- Frequency of exceedance of the PRG
- Frequency of exceedance of the MCL

These statistics were evaluated to identify the most ubiquitous COIs, which were then used to assess the extent of contamination.

3.7.3 Characterization of Groundwater and Contaminant Migration

Groundwater and contaminant migration were evaluated using two approaches. First, historical reports were reviewed to evaluate the completeness of the groundwater CSM. Second, COI data from the Area IV database were evaluated in graphical and tabular format to determine if additional conclusions could be drawn regarding contaminant and groundwater migration.

3.7.3.1 Review of Groundwater CSM

Many field activities have been conducted and reports prepared to develop a CSM for the SSFL. Significant research on fractured rock hydrogeology has been conducted at the SSFL and is reported on to describe the CSM (Cherry et al. 2007). Many other historical reports were also reviewed to assist in evaluating the Area IV hydrogeology and contaminant transport.

3.7.3.2 Data Evaluation

The database was used to determine if additional data gap information could be gained regarding the CSM. Data were compared in tabular and graphical form. The data were used to determine if detected concentrations in one medium would suggest that another medium should be evaluated. Also, contaminant types were evaluated; the data were used to assess if a detected concentration of a contaminant type would suggest a related contaminant should be evaluated.

3.7.4 Evaluation of Efficacy of Groundwater Monitoring Network

The evaluation of the conceptual model and data was used to estimate if the monitoring well network was sufficient to characterize Area IV. In general, the following three categories were used to evaluate the efficacy of the monitoring well network:

- Are monitoring wells installed in locations and at depths to properly delineate plumes of detected groundwater contamination?

- Are monitoring wells located in areas of elevated soil contamination sufficient to evaluate groundwater impacts due to soil?

- Do soil vapor concentrations suggest elevated VOC concentrations in uncharacterized groundwater?

While evaluating the data to determine if the network is sufficient, the CSM was also evaluated to determine if site information supported the proposed model. The results of this evaluation is presented in Section 4.

3.8 Surface Water and Sediment

Surface water and sediment data collected as part of the NPDES monitoring program and other investigations were reviewed in relation to the needs to assess exposure for human health and ecological risk assessment. Given the nature of the NPDES data that considers water quality standards protective of human health, and given the ephemeral nature of stormwater flows, the NPDES data were deemed adequate to address human health assessment. No additional water quality data is proposed for human health risk characterization.

Also related to human health risk evaluation, the dry drainage sediment will be considered as part of the surface soil exposure as part of the evaluating risk. That is, the sediment data will be combined with soil data for the exposure unit in calculating risk. A review of the distribution of the sediment data for Area IV indicates that it will be adequate for incorporation into the human health risk assessment. No additional sediment data was deemed necessary for that purpose.

Regarding ecological receptors, the review of NPDES program analytes and the ecological COIs indicates that additional water quality data may be necessary for certain Area IV COIs. Also, a review of the distribution of sediment data has identified some locations within Area IV where additional sediment data may be warranted.

3.9 Radiological Air Data Analysis Methodology and Conclusions

Radiological air data were reviewed from annual Site Environmental Reports from 1991 to 2006; predecessor environmental surveys and environmental monitoring reports from 1955 to 1990; and NESHAP reports for DOE operations in SSFL Area IV from 1991 to 2006. These data are comprised of both effluent air data reflecting the emissions to the environment from a given facility and ambient air sampling information from monitoring stations established in designated locations. Gross alpha/beta and radionucide data have been reported. Section 4 presents the data reviewed as part of this effort.

Rather than using existing air data for the site, the risk assessment supporting the EIS alternatives analyses will fully consider the inhalation pathway for radionuclides

based on their concentration in site soils and the levels of contamination that exist on building surfaces. In addition, the existing NESHAPs data addresses potential exposures to offsite receptors for the range of operational conditions encountered over a period of many years.

3.10 Ecological Receptors

3.10.1 Data Relevant to the Ecological Risk Assessment

From the current database, soil (including soil data from 0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and sump soil), surface water (including groundwater seep and sump water), sediment, and soil gas data will be used in the development of the ERA. Some data in the database are not necessary for the ERA (e.g., groundwater data not related to seeps).

As described in Section 3.4.3, the selected preliminary chemical ESLs were used to evaluate the quality and usability of historical data and to determine that the laboratory detection limits from those data were sufficiently low for the upcoming sampling efforts. If the laboratory detection limits for a chemical from a medium were higher than the lowest ESL for that chemical in that medium, then the results for that chemical in that medium were not deemed usable for purposes of assessing risk to ecological receptors. Collectively, the historical data that are deemed usable and data to be collected as a result of this data gaps analysis will be used for assessing risk to ecological receptors in the *SSFL Area IV EIS*.

3.10.2 Selection of Preliminary CPECs

As discussed in the SRAM WP (MWH 2005), preliminary chemical and radiological CPECs were selected for each medium based on the usable historical data. Following the initial screening of the usable historical chemical and radionuclide data, chemicals and radionuclides not detected above laboratory detection limits in a given medium were not retained as preliminary CPECs for that medium. If the maximum detected concentration of a chemical in a given medium was below the lowest ESL, then the chemical or radionuclide was not retained as a preliminary CPEC in that medium.

Chemicals detected in a given medium that were without a primary ESL from the SRAM WP or a secondary ESL from EPA were retained as CPECs for that medium. If the maximum detected concentration of a chemical in a given medium was above the lowest ESL, then the chemical was retained as a preliminary CPEC in that medium. Following the methods described in Section 3.1 of the SRAM WP (MWH 2005), benzene, toluene, ethylbenzene, xylenes, naphthalene, and 2-methylnaphthalene were selected as preliminary CPECs when TPH fraction C8-C11 was selected as a CPEC. PAHs were selected as CPECs when either TPH fraction C11-C14, C14-C20, or C20-C30 was selected as a CPEC. Finally, all 12 PCB congeners described in Section 2.7 of the SRAM WP (MWH 2005) were selected as CPECs when any PCB was selected as a CPEC. However, the selected list of CPECs included in this report is likely to be amended in the ERA following the collection and evaluation of additional chemical

and radionuclide data for each medium anticipated as a result of this data gap analysis. Results of the CPEC determination are provided in Section 4.7.

3.11 Building Data Gaps Analysis Methodology

The review of building radiological survey information indicates that gross alpha and beta measurements and volumetric samples of activated materials have been collected for some buildings. The associated gross alpha and beta measurements have included smear surveys to assess the quantity of removable contamination as well as scans and fixed point measurements. Building data is being evaluated based on its usage for a number of distinct purposes to include: (1) evaluation of risks associated with radiation exposure to building occupants for the No Action Alternative; (2) estimation of the source term and volumes for contaminated building materials that would require packaging, transportation, and disposal, and the assessment of the risks including the potential risk to members of the public associated with transportation of the waste as well as to demolition workers; (3) decision-making relative to disposition decisions to assure disposal of building wastes that is both cost effective and compliant with all regulatory requirements; and (4) development of radiation safety procedures and estimation of the costs associated with such requirements. (Such safety procedures are necessary to assure that building demolition is fully compliant with requirements, including those associated with maintaining radiation exposures to demolition workers and members of the public at levels which are "as low as reasonably achievable".) Assessment of building data gaps uses professional judgment to evaluate the available radiological contamination information for existing structures relative to the data required to meet each of the above stated needs.

3.12 Soil Vapor

The presence of volatile chemicals in soil vapor is a concern for ecological receptors, human health during excavation (inhalation), and indoor air contamination for structures overlying contaminated soil. Soil vapor is also useful in locating contaminant sources in soil and for tracing volatile chemical migration in groundwater.

3.12.1 Review the Existing Data

Soil gas samples were collected from 259 locations at depths ranging from 1 foot bgs to 27 feet bgs in 1993, 1997, 1999, 2000, 2001, 2002, 2003, 2006 and 2007. Soil vapor sample locations were located near previous buildings and known source areas. Not all chemicals were analyzed at the same locations. A breakdown of samples by depth is provided in **Table 3-13**. Because the primary exposure pathway for soil vapor is migration to indoor air, the shallower soil gas samples (0 to 5 feet bgs) will be used in the calculation of exposure point concentrations in the quantitative risk assessment analysis. However, soil gas from deeper samples could in theory represent a source of VOCs at shallow depths, so these deeper soil gas samples are also presented. These statistics help ensure that no detected constituent was overlooked in the shallower data.

Chemicals detected in soil vapor are summarized in **Table 3-13**. All detections were detected in soil vapor samples collected from depths ranging from 3 to 15 feet bgs. Detections of 1,2-dichloroethane (1,2-DCA), tetrachlorothene (PCE), trichloroethene (TCE), and vinyl chloride were above CHHSLs, indicating that these chemicals are potential chemicals of interest in soil vapor at Area IV.

Detection limits were compared to CHHSLs for shallow soil gas (less than 1.5 meters bgs) under residential land use in Table 3-13. Exceedances were detected in EU-01, EU-06, EU-09, and EU-11. Based on this comparison, the detection limits for 1,2-DCA, benzene, and carbon tetrachloride were all above CHHSLs. Therefore, although Table 3-13 shows that benzene and carbon tetrachloride were not detected above detections limits, these chemicals may exist at Area IV at concentrations greater than the CHHSL. Detection limits for PCE, TCE, and vinyl chloride were above CHHSLs for some samples.

3.12.2 Identification of Soil Vapor Data Gaps

Soil vapor data have been collected in 12 of the 16 EUs defined for Area IV. There are four exposure units (EU-02, EU-014, EU-15, and EU-16) where no soil vapor data were collected. Historically there have been no buildings in EU-14, EU-15, and EU-16. At one time there was a building in the upper northwest portion of EU-02.

The existing soil gas data was not used to evaluate data gaps in the same manner as soil and groundwater data were. Soil gas sampling is typically used by investigators as a survey and screening tool to locate volatile chemical releases and plumes. The soil gas data were use in this study to assist in understanding of chemical use area data, areas of soil contamination, and possible sources of groundwater contamination. Therefore, the soil gas data were not reviewed in terms of specific requirements to collect additional soil gas data. There is a potential that as the field sampling program is developed, that data gap investigators may identify additional soil gas sampling needs to assist in contaminant source and extent delineation. In accordance with DTSC guidance (2005), if buildings are not located near (within 100 feet) areas of concern, the indoor air inhalation pathway is incomplete and need not be considered. However, soil gas sampling requirements may need to be revisited if future development proposes future buildings near areas of concern.

3.13 Bedrock

A review of the database and documents prepared for the numerous investigations performed within Area IV indicate that data that can be used to characterize bedrock for the presence of chemical and radionuclide COIs is extremely limited and inadequate for the purpose of defining nature and extent of contamination. Therefore, characterization data for bedrock is a data gap for the field sampling investigation. As part of development of the field sampling investigation, process information and COI data will be used to identify locations where data for vertical extent is important and where bedrock should be sampled. In addition, bedrock

samples will be targeted at monitoring well locations both for chemical and physical property analyses.

Data Gap Evaluation Process for Soils

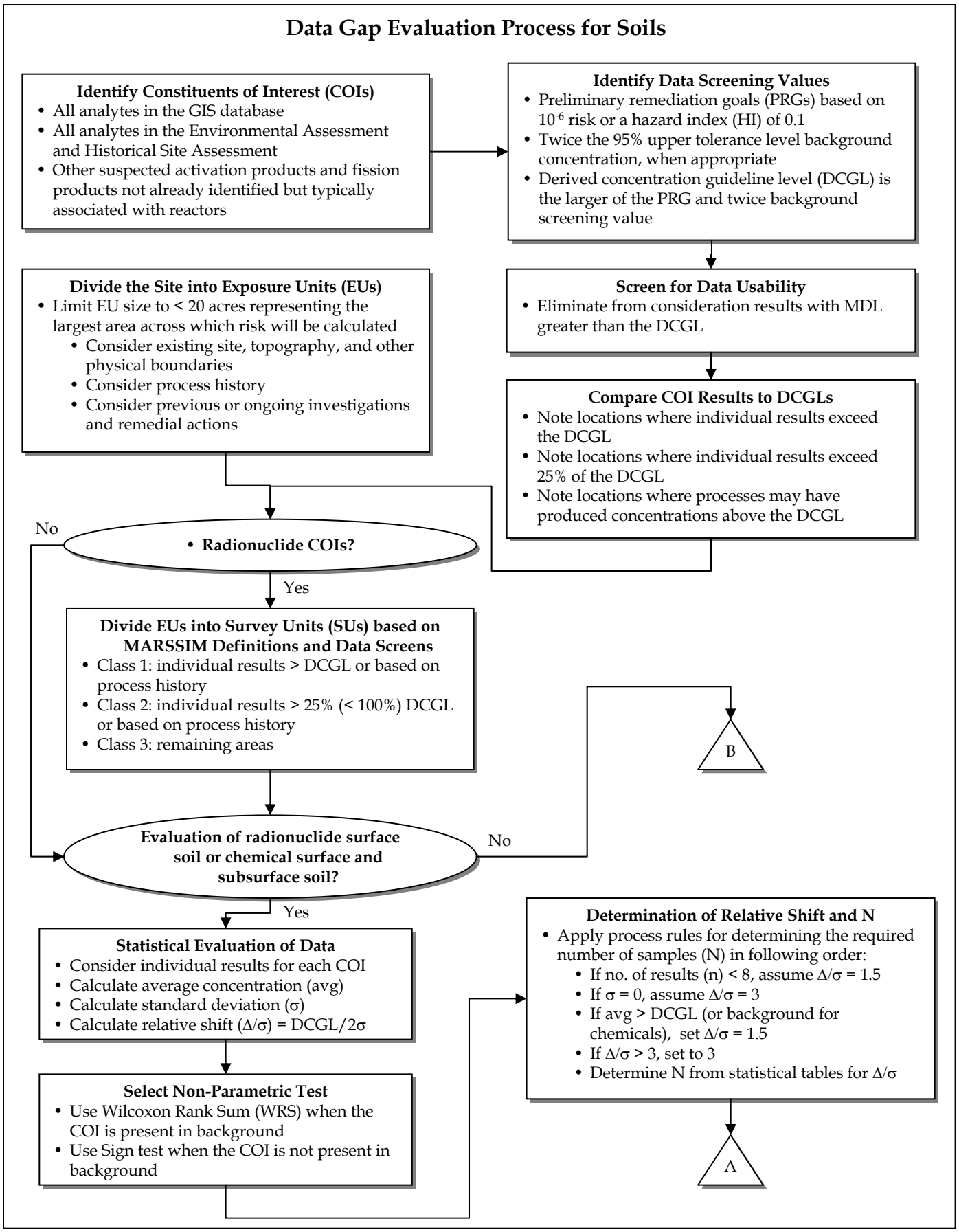


Exhibit 3-1a
Data Gap Evaluation Process for Soils

CDM

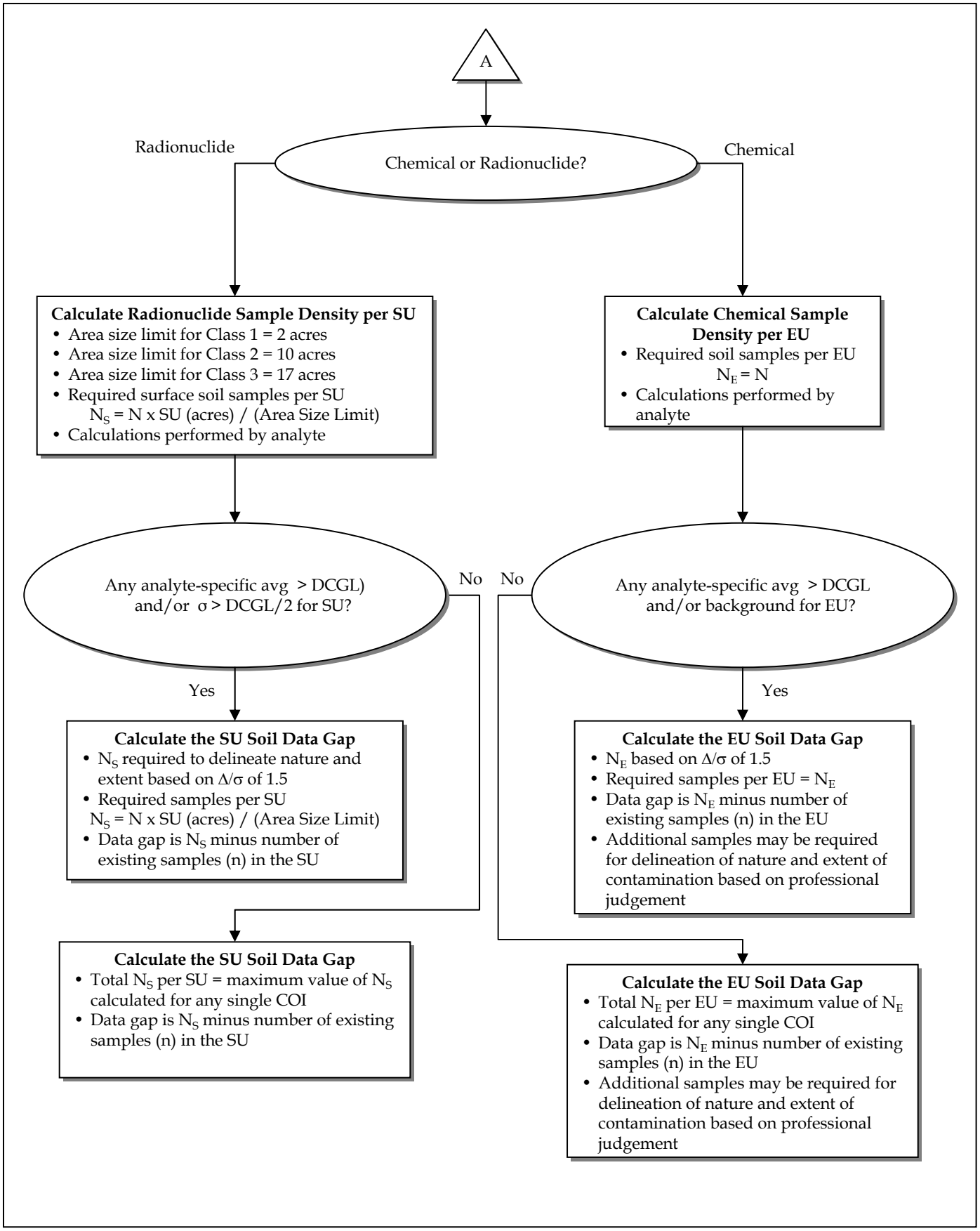


Exhibit 3-1b
Data Gap Evaluation Process for Soils

CDM

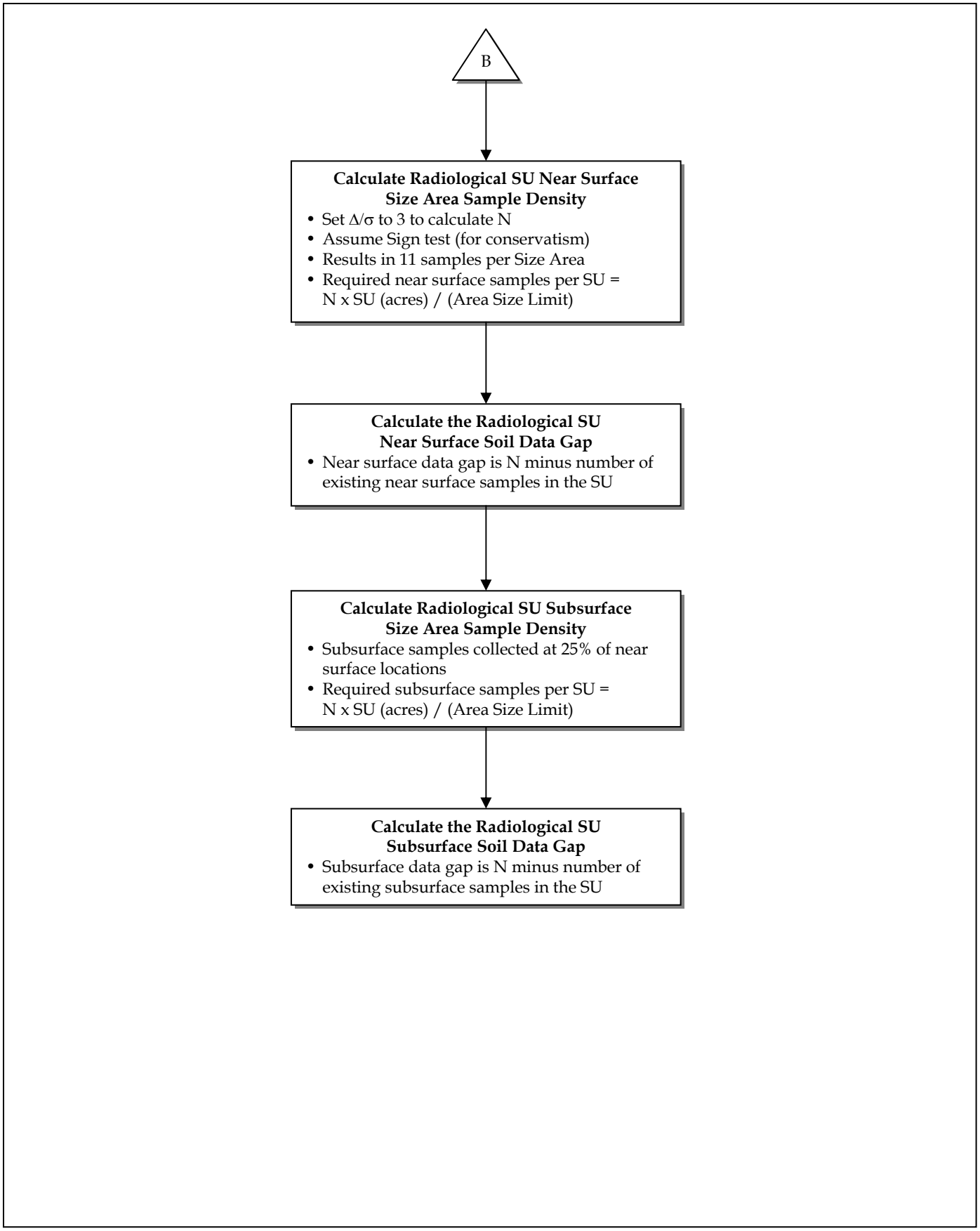
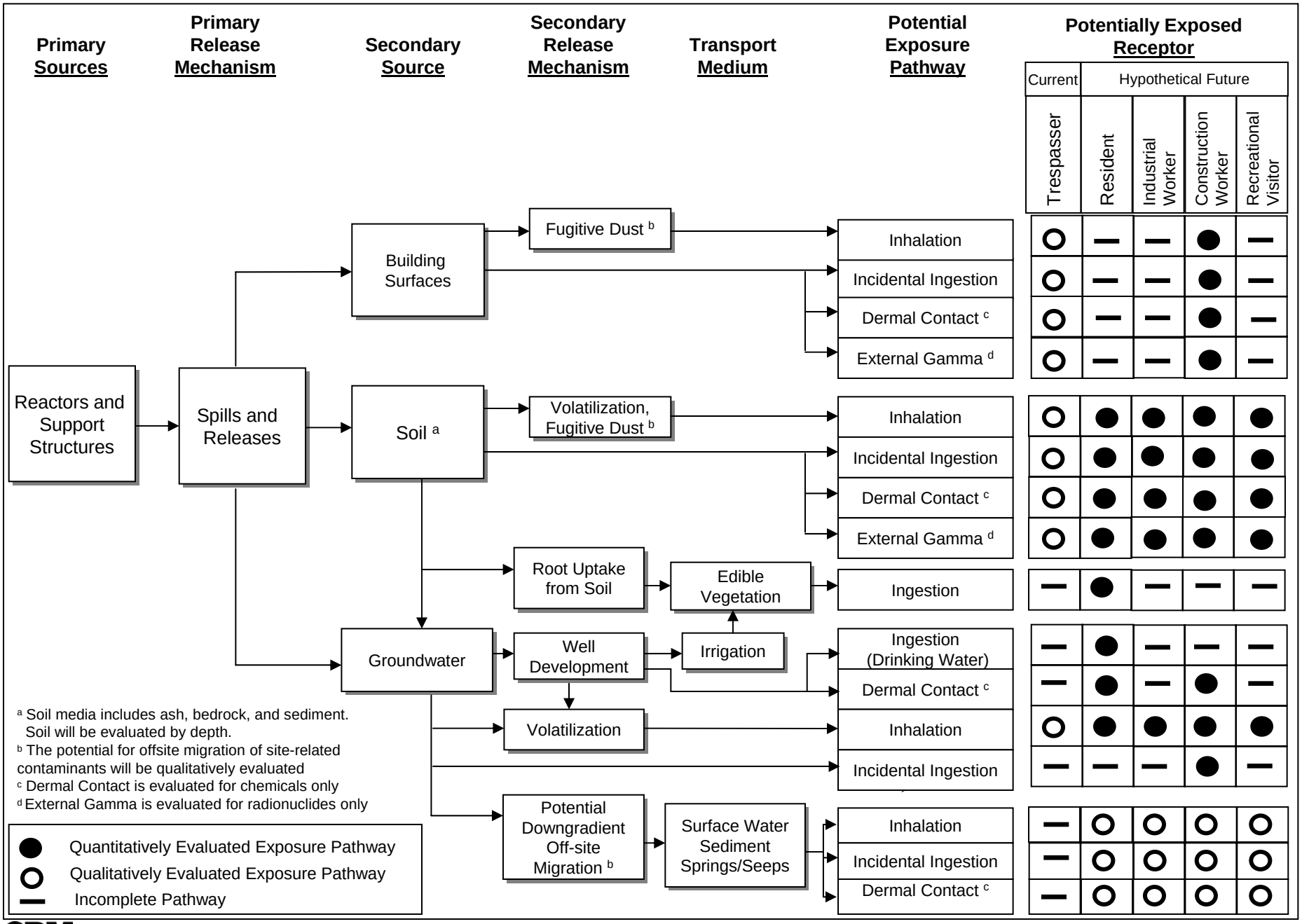


Exhibit 3-1c
Data Gap Evaluation Process for Soils

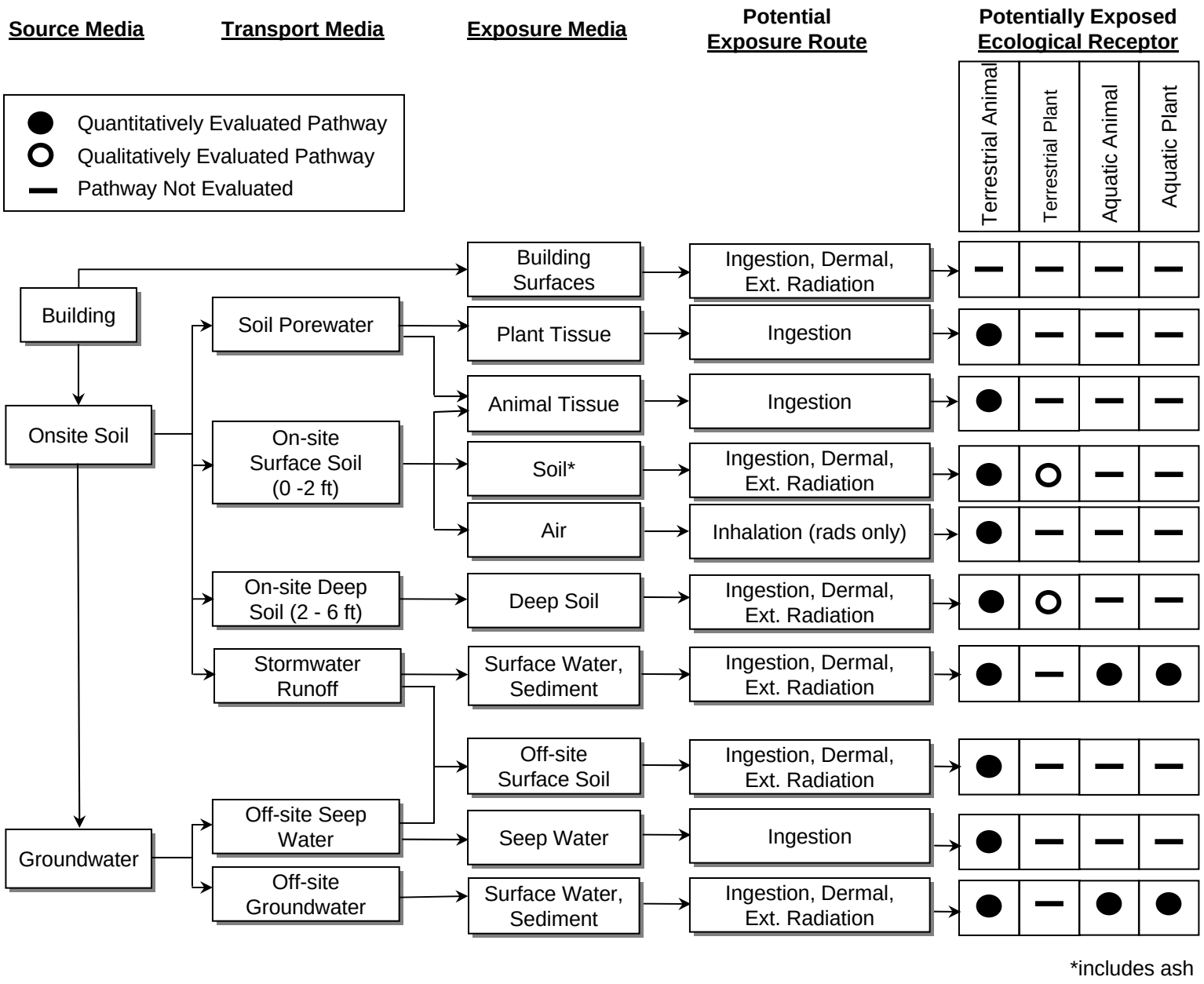
CDM



CDM

Santa Susana Field Laboratory Area IV
Ventura County, California

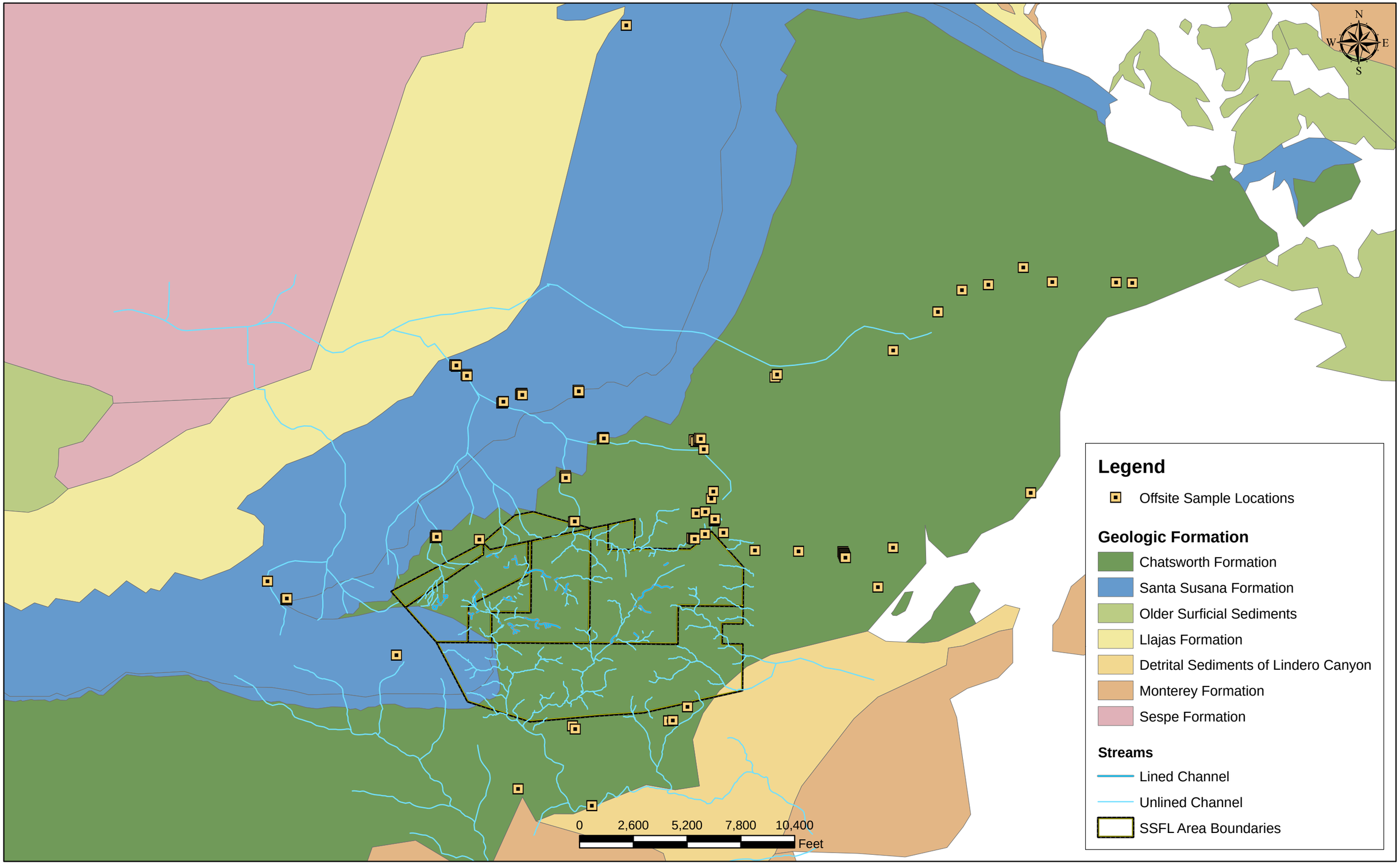
Figure 3-1
Site Conceptual Exposure Model for Human Health



CDM

Santa Susana Field Laboratory Area IV
Ventura County, California

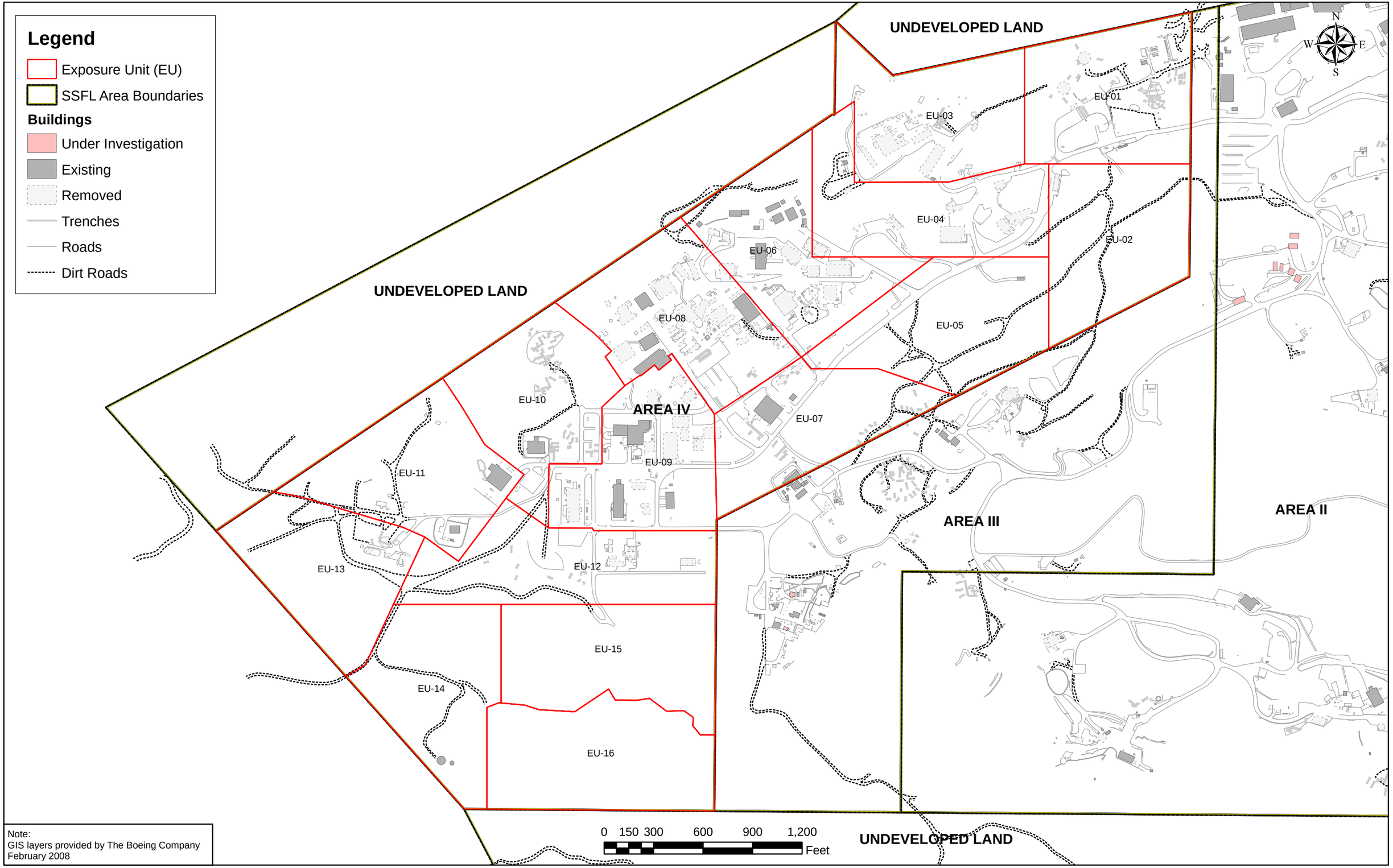
Figure 3-2
SSFL Area IV Preliminary Conceptual Model for Ecological Receptors



CDM

Santa Susana Field Laboratory Area IV
Ventura County, California

Figure 3-3
Location of Samples Included in Radiological Background Screening



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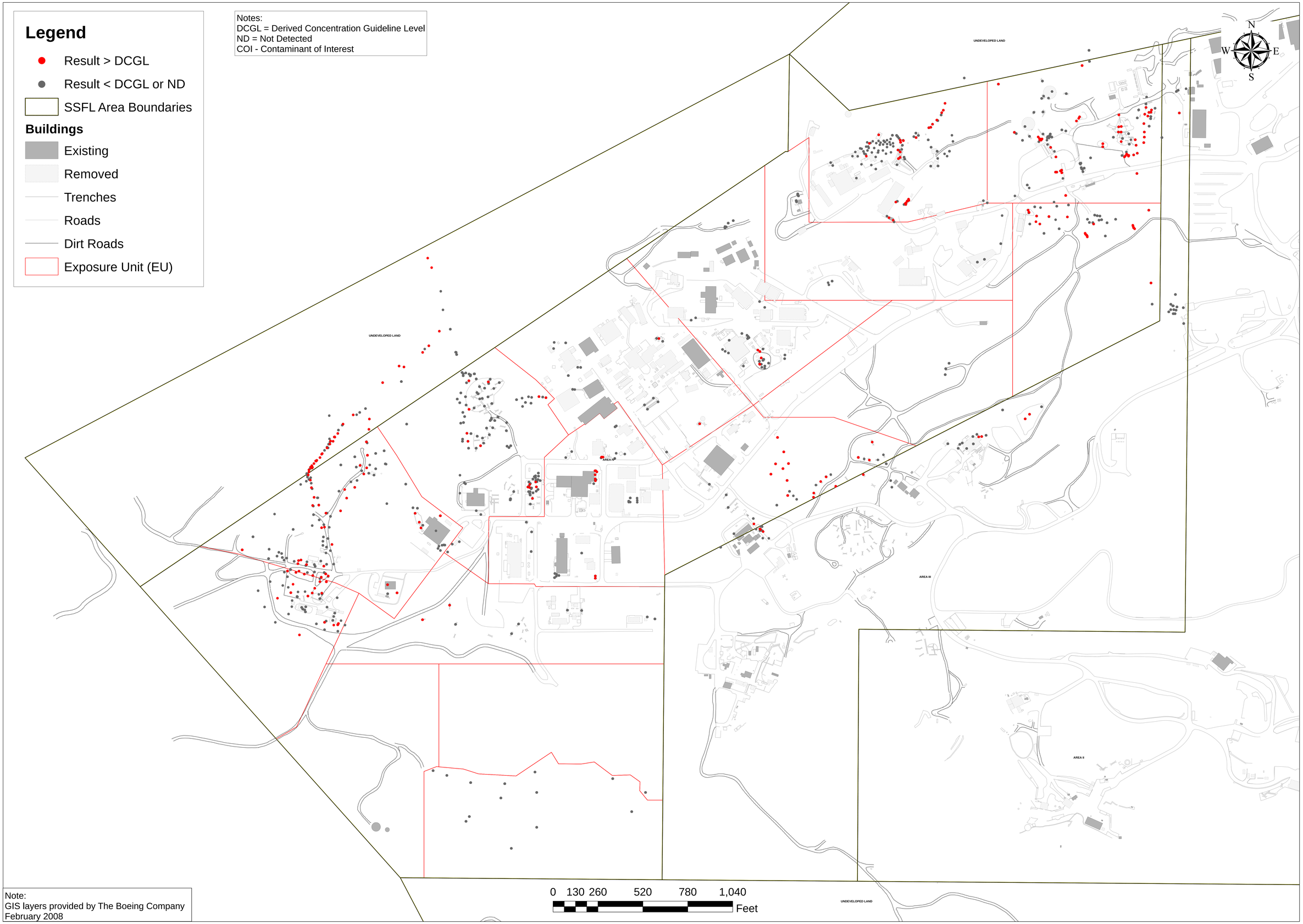
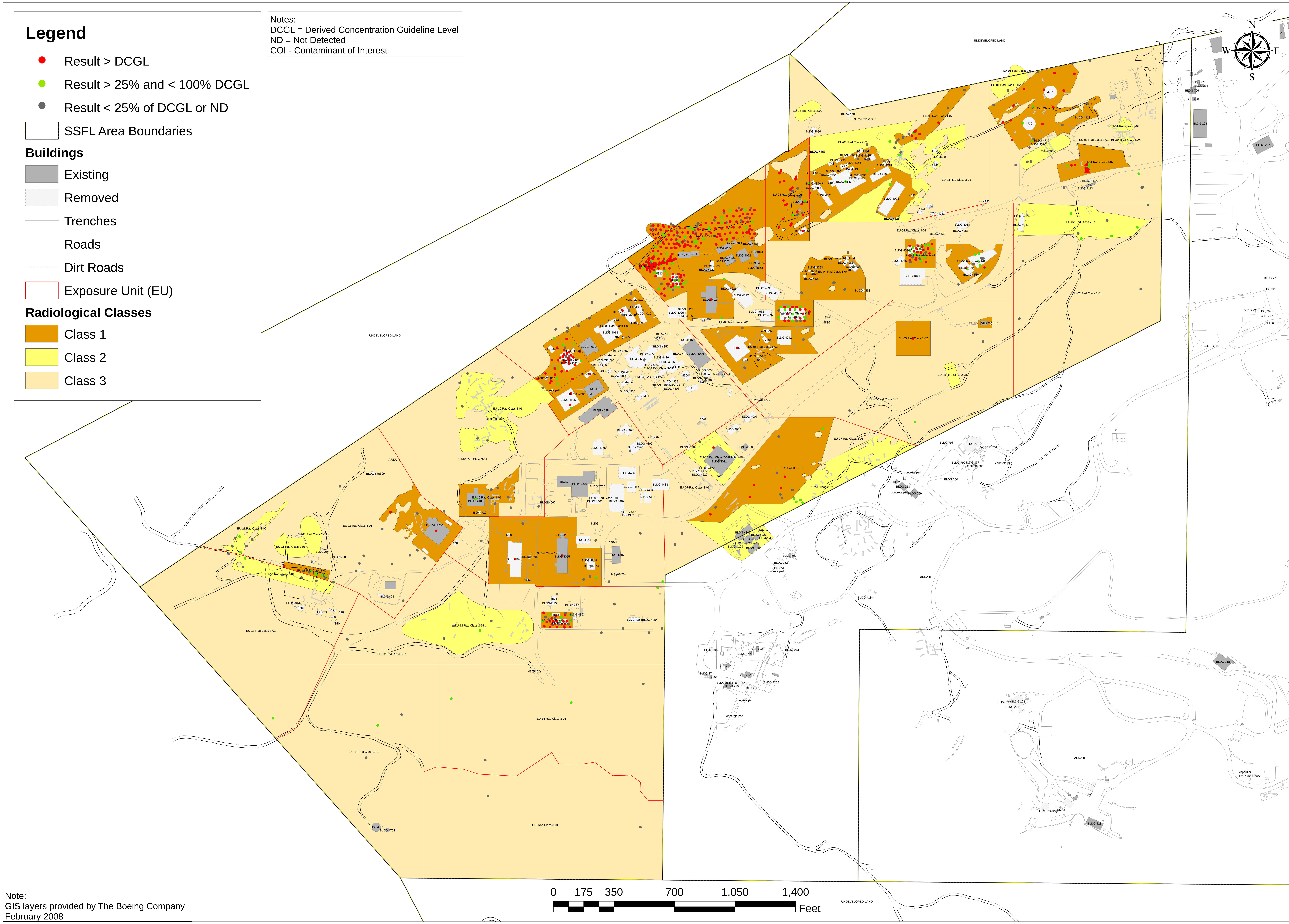
Santa Susana Field Laboratory Area IV
Ventura County, California

Figure 3-4
Location of Area IV Exposure Units



Santa Susana Field Laboratory Area IV
Ventura County, California

Figure 3-5
Location of Existing Chemical COI Samples



CDM

Santa Susana Field Laboratory Area IV
Ventura County, California

Figure 3-6
Location of Existing Radiological Samples

Table 3-1
SSFL Area IV Soil Background Comparison Values for Metals and Dioxins

Group	Analyte	CAS Number	Concentration	Units
Inorganic	Aluminum	7429-90-5	20000	mg/kg
Inorganic	Antimony	7440-36-0	8.7	mg/kg
Inorganic	Arsenic	7440-38-2	15	mg/kg
Inorganic	Barium	7440-39-3	140	mg/kg
Inorganic	Beryllium	7440-41-7	1.1	mg/kg
Inorganic	Boron	7440-42-8	9.7	mg/kg
Inorganic	Cadmium	7440-43-9	1	mg/kg
Inorganic	Chromium	7440-47-3	37	mg/kg
Inorganic	Cobalt	7440-48-4	21	mg/kg
Inorganic	Copper	7440-50-8	29	mg/kg
Inorganic	Iron	7439-89-6	28000	mg/kg
Inorganic	Lead	7439-92-1	34	mg/kg
Inorganic	Lithium	7439-93-2	37	mg/kg
Inorganic	Manganese	7439-96-5	495	mg/kg
Inorganic	Mercury	7487-94-6	0.09	mg/kg
Inorganic	Molybdenum	7439-98-7	5.3	mg/kg
Inorganic	Nickel	7440-02-0	29	mg/kg
Inorganic	Potassium	7440-09-7	6400	mg/kg
Inorganic	Selenium	7782-49-2	0.544	mg/kg
Inorganic	Silver	7440-22-4	0.79	mg/kg
Inorganic	Sodium	7440-23-5	110	mg/kg
Inorganic	Thallium	7440-28-0	0.46	mg/kg
Inorganic	Vanadium	7440-62-2	62	mg/kg
Inorganic	Zinc	7440-66-6	110	mg/kg
Inorganic	Zirconium	7440-67-7	8.6	mg/kg
Dioxins	1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	25	ng/kg
Dioxins	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	35822-46-9	130	ng/kg
Dioxins	1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	1.9	ng/kg
Dioxins	1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	7.3	ng/kg
Dioxins	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	39227-28-6	3.4	ng/kg
Dioxins	1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	3	ng/kg
Dioxins	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	57653-85-7	9.5	ng/kg
Dioxins	1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	4.3	ng/kg
Dioxins	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	19408-74-3	11	ng/kg
Dioxins	1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	4.9	ng/kg
Dioxins	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	40321-76-4	1.8	ng/kg
Dioxins	2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	4.5	ng/kg
Dioxins	2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	6.4	ng/kg
Dioxins	Octachlorodibenzofuran	39001-02-0	8.1	ng/kg
Dioxins	Octachlorodibenzo-p-dioxin	3268-87-9	140	ng/kg

Notes:
CAS: Chemical Abstracts Service
mg/kg: milligrams per kilogram
ng/kg: nanograms per kilogram

Table 3-2
SSFL Off-site Radionuclide Data Summary Statistics and Screening Levels

Parameter	Radionuclide											
	^{137}Cs	^{90}Sr	^{40}K	^{3}H	^{232}Th[a]	^{226}Ra	^{230}Th	^{234}U	^{235}U	^{238}U	^{238}Pu	^{239}Pu
Chatsworth Formation												
No. of Measurements	96	60	41	15	45	31	35	34	40	40	30	1
Max. Result (pCi/g)	0.42	0.14	27.7	0.16	2.04	2.44	1.63	1.50	0.10	1.60	0.050	0.060
Avg. Result (pCi/g)	0.100	0.046	22.2	0.11	0.81	1.41	0.55	0.72	0.046	0.75	0.020	NA
σ (pCi/g)	0.093	0.031	2.00	0.053	0.43	0.58	0.48	0.26	0.024	0.32	0.016	NA
Coefficient of Variance[b]	0.93	0.67	0.09	0.50	0.53	0.41	0.88	0.37	0.52	0.43	0.81	NA
Upper Tolerance Level (pCi/g)[c]	0.28	0.11	26	0.24	1.7	2.7	1.6	1.3	0.10	1.4	0.060	NA
Santa Susana Formation												
No. of Measurements	62	28	27	13	29	12	17	17	29	29	18	16
Max. Result (pCi/g)	0.22	0.060	29.5	0.24	1.60	0.65	1.10	0.98	0.10	1.33	0.031	0.018
Avg. Result (pCi/g)	0.07	0.016	26.9	0.047	0.97	0.62	0.94	0.79	0.049	0.84	0.012	0.0081
σ (pCi/g)	0.05	0.015	1.60	0.053	0.19	0.028	0.23	0.09	0.017	0.21	0.016	0.0061
Coefficient of Variance	0.76	0.91	0.06	1.14	0.20	0.04	0.24	0.12	0.34	0.25	1.36	0.75
Upper Tolerance Level (pCi/g)	0.17	0.05	30	0.19	1.4	0.70	1.5	1.0	0.09	1.3	0.050	0.023
Combined Off-site Soil Data												
No. of Measurements	158	88	68	28	74	43	52	51	69	69	48	17
Max. Result (pCi/g)	0.42	0.14	29.5	0.24	2.04	2.44	1.63	1.50	0.10	1.60	0.050	0.060
Avg. Result (pCi/g)	**0.087**	**0.036**	**24.0**	**0.078**	**0.88**	**1.19**	**0.68**	**0.74**	**0.05**	**0.79**	**0.017**	**0.011**
σ (pCi/g)	0.081	0.030	2.95	0.12	0.36	0.61	0.45	0.22	0.02	0.28	0.030	0.014
Coefficient of Variance	0.93	0.83	0.12	1.53	0.42	0.51	0.67	0.30	0.45	0.36	1.78	1.2
Upper Tolerance Level (pCi/g)	**0.24**	**0.10**	**30**	**0.35**	**1.6**	**2.5**	**1.6**	**1.2**	**0.09**	**1.3**	**0.080**	**0.023**

a) Thorium-232 (Th-232) concentrations assumed based on measured Th-228 results; reported values assumed to apply to entire thorium series.
b) Standard deviation divided by average result; a value greater than 1.0 indicates distribution is likely non-normal.
c) 95% upper confidence level with 95% coverage [average result + (standard deviation × k factor)]; k factors from Odeh, R.E. and D.B. Owen 1980. *Tables for Normal Tolerance Limits, Sampling Plans and Screening*. Marcel Dekker, Ltd., New York

Notes:
pCi/g: picoCuries per gram
σ: standard deviation

Table 3-3
Radionuclide Soil Human Health PRGs

	Toxicity Values				PRG	
	Soil Ingestion	Food Ingestion	Inhalation	External Gamma	Rural Resident	Resident
Isotope	(risk/pCi)	(risk/pCi)	(risk/pCi)	(risk-g/pCi-y)	(pCi/g)	(pCi/g)
^{228}Ac	5.55E-12	2.89E-12	4.92E-11	4.53E-06	6.8E-02	8.5E-02
^{241}Am	2.17E-10	1.34E-10	2.81E-08	2.76E-08	1.9E+00	2.0E+00
^{133}Ba	1.39E-11	9.44E-12	1.16E-11	1.44E-06	1.8E-01	1.8E-01
^{14}C	2.79E-12	2.00E-12	7.07E-12	7.83E-12	4.6E-01	2.8E+02
^{243}Cm	2.05E-10	1.23E-10	2.69E-08	4.19E-07	3.5E-01	3.5E-01
^{60}Co	4.03E-11	2.23E-11	3.58E-11	1.24E-05	3.6E-02	3.6E-02
^{134}Cs	5.81E-11	5.14E-11	1.65E-11	7.10E-06	1.6E-01	1.6E-01
^{137}Cs+D	4.33E-11	3.74E-11	1.19E-11	2.55E-06	6.0E-02	6.0E-02
^{152}Eu	1.62E-11	8.70E-12	9.10E-11	5.30E-06	4.2E-02	4.2E-02
^{154}Eu	2.85E-11	1.49E-11	1.15E-10	5.83E-06	5.0E-02	5.0E-02
^{155}Eu	5.40E-12	2.77E-12	1.48E-11	1.24E-07	3.8E+00	3.8E+00
^{55}Fe	2.09E-12	1.16E-12	7.99E-13	0.00E+00	2.7E+03	2.9E+03
^{3}H	2.20E-13	1.44E-13	1.99E-13	--	2.3E+00	2.7E+00
^{129}I	2.71E-10	3.22E-10	6.07E-11	6.10E-09	6.0E-01	2.5E+00
^{40}K	6.18E-11	3.43E-11	1.03E-11	7.97E-07	1.1E-01	1.4E-01
^{22}Na	1.97E-11	1.26E-11	3.89E-12	1.03E-05	8.7E-02	8.7E-02
^{59}Ni	7.33E-13	3.89E-13	4.66E-13	0.00E+00	2.1E+02	1.1E+03
^{63}Ni	1.79E-12	9.51E-13	1.64E-12	0.00E+00	9.5E+01	4.9E+02
^{237}Np+D	1.62E-10	9.1E-11	1.77E-08	7.97E-07	1.3E-01	1.4E-01
^{210}Pb+D	2.66E-09	3.44E-09	1.39E-08	4.21E-09	1.5E-01	4.5E-01
^{238}Pu	2.72E-10	1.69E-10	3.36E-08	7.22E-11	3.0E+00	3.3E+00
^{239}Pu	2.76E-10	1.74E-10	3.33E-08	2.00E-10	2.6E+00	2.9E+00
^{240}Pu	2.77E-10	1.74E-10	3.33E-08	6.98E-11	2.6E+00	2.9E+00
^{241}Pu	3.29E-12	2.28E-12	3.34E-10	4.11E-12	4.1E+02	4.5E+02
^{242}Pu	2.63E-10	1.65E-10	3.13E-08	6.25E-11	3.0E+00	3.0E+00
^{226}Ra+D	7.30E-10	5.15E-10	1.16E-08	8.49E-06	1.2E-02	1.3E-02
^{228}Ra+D	2.29E-09	1.43E-09	5.23E-09	4.53E-06	6.8E-02	8.5E-02
^{125}Sb+D	1.32E-11	7.21E-12	1.93E-11	1.81E-06	4.6E-01	4.6E-01
^{90}Sr+D	1.44E-10	9.53E-11	1.13E-10	1.96E-08	2.3E-01	3.9E+00
^{99}Tc	7.66E-12	4.0E-12	1.41E-11	8.14E-11	2.5E-01	9.6E+01
^{228}Th+D	8.09E-10	4.22E-10	1.43E-07	7.76E-06	1.5E-01	1.5E-01
^{230}Th	2.02E-10	1.19E-10	2.85E-08	8.19E-10	3.5E+00	3.8E+00
^{232}Th	2.31E-10	1.33E-10	4.33E-08	3.42E-10	3.1E+00	3.4E+00
^{234}U	1.58E-10	9.55E-11	1.14E-08	2.52E-10	4.0E+00	5.0E+00
^{235}U+D	1.63E-10	9.76E-11	1.01E-08	5.43E-07	2.0E-01	2.0E-01
^{238}U+D	2.10E-10	1.21E-10	9.35E-09	1.14E-07	7.4E-01	7.8E-01

Notes:
"--" indicates value not available.
"+D" indicates the inclusion of short-lived radioactive decay products in equilibrium with the indicated parent,
g: gram
pCi: picoCurie
PRG: preliminary remediation goal
y: year

Table 3 - 4
Terrestrial Ecological PRGs for Radionuclides

Preliminary Remediation Goals - Terrestrial		
Radionuclide	**Water (pCi/L)**	**Soil (pCi/g)**
Am-241	2.00E+05	4.00E+03
Ba-133	1.20E+03	6.67E+02
Cm-243/244	1.84E+05	4.06E+03
Co-60	1.00E+06	7.00E+02
Cs-134	3.26E+05	1.13E+01
Cs-137	6.00E+05	2.00E+01
Eu-152	2.55E+06	1.52E+03
Eu-154	2.00E+06	1.00E+03
Eu-155	3.00E+07	2.00E+04
Fe-55	1.00E+05	5.53E+04
H-3	2.00E+08	2.00E+05
I-129	5.70E+06	5.67E+03
K-40	1.93E+06	1.19E+02
Na-22	2.53E+01	1.64E+01
Ni-59	1.51E+05	2.68E+05
Ni-63	6.25E+04	1.04E+05
Np-237	6.49E+06	3.86E+03
Pb-210	2.92E+05	1.39E+03
Pu-238	1.89E+05	5.27E+03
Pu-239	2.00E+05	6.00E+03
Pu-240	5.13E+02	1.85E+01
Pu-241	1.07E+07	1.90E+05
Ra-226	8.00E+03	5.00E+01
Ra-228	7.00E+03	4.00E+01
Sb-125	6.97E+06	3.52E+03
Sr-90	5.00E+04	2.00E+01
Tc-99	2.00E+07	4.00E+03
Th-228	6.33E+04	5.30E+02
Th-230	4.52E+05	9.98E+03
Th-232	5.00E+04	2.00E+03
U-233	4.00E+05	5.00E+03
U-234	4.00E+05	5.00E+03
U-235	4.00E+05	3.00E+03
U-238	4.00E+05	2.00E+03

Notes:
pCi/L: picoCuries per liter
pCi/g: picoCuries per gram
PRG: preliminary remediation goals; biological concentration guides (DOE 2002)

Table 3 - 5
Aquatic Ecological PRGs for Radionuclides

Preliminary Remediation Goals - Aquatic		
Radionuclide	**Water (pCi/L)**	**Sediment (pCi/g)**
Am-241	4.38E+02	7.04E+05
Ba-133	6.76E+01	8.57E+04
Cm-243/244	6.63E+01	4.01E+06
Co-60	3.76E+03	1.49E+04
Cs-134	5.18E+02	2.28E+04
Cs-137	1.05E+03	4.93E+04
Eu-152	2.55E+04	3.06E+04
Eu-154	2.16E+04	2.59E+04
Eu-155	2.64E+05	3.18E+05
Fe-55	8.00E+02	6.51E+06
H-3	4.99E+09	7.04E+06
I-129	1.00E+06	4.93E+05
K-40	2.90E+03	5.80E+04
Na-22	3.56E+00	1.64E+04
Ni-59	3.58E+04	5.88E+06
Ni-63	1.47E+04	2.27E+06
Np-237	6.85E+01	7.86E+04
Pb-210	6.01E+02	9.18E+04
Pu-238	1.76E+02	3.95E+06
Pu-239	1.87E+02	7.04E+06
Pu-240	1.89E-01	4.00E+06
Pu-241	3.90E+03	7.69E+06
Ra-226	1.02E+01	1.45E+04
Ra-228	8.49E+00	2.90E+04
Sb-125	3.67E+05	7.04E+04
Sr-90	5.39E+04	3.52E+04
Tc-99	2.47E+06	4.69E+05
Th-228	3.74E+02	1.64E+04
Th-230	2.57E+03	2.74E+06
Th-232	3.04E+02	3.29E+06
U-233	2.00E+02	1.06E+07
U-234	2.02E+02	3.08E+06
U-235	2.17E+02	1.05E+05
U-238	2.23E+02	4.28E+04

Notes:
pCi/L: picoCuries per liter
pCi/g: picoCuries per gram
PRG: preliminary remediation goals; biological concentration guides (DOE 2002)

Table 3-6
Chemicals Analyzed But Not Detected In Area IV Soil

CAS Number	Analyte	Number of samples
630-20-6	1,1,1,2-Tetrachloroethane	165
79-34-5	1,1,2,2-Tetrachloroethane	278
79-00-5	1,1,2-Trichloroethane	278
563-58-6	1,1-Dichloropropene	80
87-61-6	1,2,3-Trichlorobenzene	80
96-18-4	1,2,3-Trichloropropane	82
120-82-1	1,2,4-Trichlorobenzene	213
96-12-8	1,2-Dibromo-3-chloropropane	165
106-93-4	1,2-Dibromoethane	80
95-50-1	1,2-Dichlorobenzene	325
78-87-5	1,2-Dichloropropane	264
122-66-7	* 1,2-Diphenylhydrazine	48
108-67-8	1,3,5-Trimethylbenzene	165
541-73-1	1,3-Dichlorobenzene	325
142-28-9	1,3-Dichloropropane	80
542-75-6	1,3-Dichloropropene	53
99-65-0	* 1,3-Dinitrobenzene	9
106-46-7	1,4-Dichlorobenzene	325
594-20-7	2,2-Dichloropropane	80
95-95-4	2,4,5-Trichlorophenol	104
88-06-2	2,4,6-Trichlorophenol	163
118-96-7	2,4,6-Trinitrotoluene	9
120-83-2	2,4-Dichlorophenol	138
105-67-9	2,4-Dimethylphenol	163
51-28-5	2,4-Dinitrophenol	163
121-14-2	* 2,4-Dinitrotoluene	158
87-65-0	2,6-Dichlorophenol	25
606-20-2	* 2,6-Dinitrotoluene	158
75-88-7	2-Chloro-1,1,1-trifluoroethane	124
110-75-8	2-Chloroethylvinyl ether	191
91-58-7	2-Chloronaphthalene	149
95-57-8	2-Chlorophenol	163
95-49-8	2-Chlorotoluene	80
88-74-4	2-Nitroaniline	104
88-75-5	2-Nitrophenol	163
88-72-2	* 2-Nitrotoluene	9
91-94-1	* 3,3'-Dichlorobenzidine	149
99-09-2	3-Nitroaniline	104
99-08-1	3-Nitrotoluene	9
72-54-8	* 4,4'-DDD	1
72-55-9	* 4,4'-DDE	1
50-29-3	* 4,4'-DDT	1
534-52-1	4,6-Dinitro-o-cresol	163
101-55-3	4-Bromophenyl phenyl ether	149
7005-72-3	4-Chlorophenylphenyl ether	149
100-02-7	4-Nitrophenol	163
99-99-0	4-Nitrotoluene	9
309-00-2	* Aldrin	1
319-84-6	* alpha-BHC	1
62-53-3	Aniline	59
12674-11-2	Aroclor 1016	395
11104-28-2	Aroclor 1221	395
11141-16-5	Aroclor 1232	395
37324-23-5	Aroclor 1262	6
11100-14-4	Aroclor 1268	6
103-33-3	Azobenzene	19

Table 3-6
Chemicals Analyzed But Not Detected In Area IV Soil

CAS Number	Analyte	Number of samples
92-87-5	* Benzidine	96
65-85-0	Benzoic acid	93
100-51-6	Benzyl alcohol	104
111-91-1	bis(2-Chloroethoxy)methane	149
111-44-4	* bis(2-Chloroethyl) ether	149
108-86-1	Bromobenzene	80
74-97-5	Bromochloromethane	80
75-27-4	Bromodichloromethane	278
75-25-2	Bromoform	278
74-83-9	Bromomethane	278
86-74-8	Carbazole	35
75-15-0	Carbon Disulfide	48
56-23-5	Carbon Tetrachloride	278
74-87-3	Chloromethane	278
79-38-9	Chlorotrifluoroethylene	135
10061-01-5	cis-1,3-Dichloropropene	213
57-12-5	Cyanides	8
124-48-1	Dibromochloromethane	195
74-95-3	Dibromomethane	80
25321-22-6	Dichlorobenzenes	12
75-71-8	Dichlorodifluoromethane	170
131-11-3	Dimethyl phthalate	160
122-39-4	Diphenylamine	25
58-89-9	* gamma-BHC	1
118-74-1	* Hexachlorobenzene	149
87-68-3	Hexachlorobutadiene	213
77-47-4	Hexachlorocyclopentadiene	149
67-72-1	Hexachloroethane	149
78-59-1	Isophorone	149
98-82-8	Isopropylbenzene	80
UKN048	m+p Cresol	12
108-10-1	Methyl isobutyl ketone (MIBK)	105
1634-04-4	Methyl tert-butyl ether	31
104-51-8	n-Butylbenzene	80
98-95-3	Nitrobenzene	158
55-63-0	Nitroglycerin	2
62-75-9	* n-Nitrosodimethylamine	291
621-64-7	* n-Nitrosodi-n-propylamine	149
103-65-1	n-Propylbenzene	80
95-48-7	o-Cresol	104
95-47-6	o-Xylene	165
32774-16-6	PCB-169	3
37680-65-2	PCB-18	1
7012-37-5	PCB-28	1
106-47-8	p-Chloroaniline	104
35421-08-0	p-Chloro-m-cresol	163
106-43-4	p-Chlorotoluene	80
106-44-5	p-Cresol	90
87-86-5	Pentachlorophenol	163
7601-90-3	Perchlorate	100
100-01-6	p-Nitroaniline	104
1336-36-3	Polychlorinated biphenyls	4
101-86-1	Pyridine	5
121-82-4	* RDX	9
135-9-88	sec-Butylbenzene	80
100-42-5	Styrene	121

Table 3-6
Chemicals Analyzed But Not Detected In Area IV Soil

CAS Number	Analyte	Number of samples
99-35-4	sym-Trinitrobenzene	9
994-05-8	tert-Amyl methyl ether	1
75-65-0	tert-Butyl alcohol	1
637-92-3	tert-Butyl ethyl ether	1
98-06-6	tert-Butylbenzene	80
7440-31-5	Tin	2
156-60-5	trans-1,2-Dichloroethene	258
10061-02-6	trans-1,3-Dichloropropene	225

Notes:

CAS: Chemical Abstracts Service

PCBs: polychlorinated biphenyls

SVOCs: semi-volatile organic compounds

VOCs: volatile organic compounds

*: Chemical not detected at site, but detection limit was above preliminary remediation goal

Table 3-7
Chemicals Detected In Area IV Soil

CAS Number	Analyte	Detections in All EUs	Number of samples	Group
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	94	171	Dioxins
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	120	171	Dioxins
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	63	171	Dioxins
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	70	171	Dioxins
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	64	171	Dioxins
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	66	171	Dioxins
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	91	171	Dioxins
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	62	171	Dioxins
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	85	171	Dioxins
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	52	171	Dioxins
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	50	171	Dioxins
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	76	171	Dioxins
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	64	171	Dioxins
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	68	171	Dioxins
38998-75-3	Heptachlorodibenzofurans	113	169	Dioxins
37871-00-4	Heptachlorodibenzo-p-dioxins	128	169	Dioxins
55684-94-1	Hexachlorodibenzofurans	110	169	Dioxins
34465-46-8	Hexachlorodibenzo-p-dioxins	110	169	Dioxins
39001-02-0	Octachlorodibenzofuran	99	171	Dioxins
3268-87-9	Octachlorodibenzo-p-dioxin	137	171	Dioxins
30402-15-4	Pentachlorodibenzofurans	99	169	Dioxins
36088-22-9	Pentachlorodibenzo-p-dioxins	68	169	Dioxins
1746-01-6	TCDD-TEQ (Total all)	141	299	Dioxins
30402-14-3	Tetrachlorodibenzofurans	96	169	Dioxins
41903-57-5	Tetrachlorodibenzo-p-dioxins	59	169	Dioxins
7429-90-5	Aluminum	349	351	Inorganic
7440-36-0	Antimony	113	345	Inorganic
7440-38-2	Arsenic	342	446	Inorganic
7440-39-3	Barium	403	405	Inorganic
7440-41-7	Beryllium	311	402	Inorganic
7440-42-8	Boron	88	308	Inorganic
7440-43-9	Cadmium	193	406	Inorganic
7440-70-2	Calcium	92	93	Inorganic
7440-47-3	Chromium	418	422	Inorganic
7440-48-4	Cobalt	396	402	Inorganic
7440-50-8	Copper	417	422	Inorganic
7439-89-6	Iron	97	98	Inorganic
7439-92-1	Lead	421	444	Inorganic
7439-93-2	Lithium	54	61	Inorganic
7439-95-4	Magnesium	92	93	Inorganic
7439-96-5	Manganese	98	98	Inorganic
7487-94-7	Mercury	289	546	Inorganic
7439-98-7	Molybdenum	138	397	Inorganic
7440-02-0	Nickel	399	422	Inorganic
7440-09-7	Potassium	199	201	Inorganic
7782-49-2	Selenium	90	385	Inorganic
7440-22-4	Silver	142	426	Inorganic
7440-23-5	Sodium	242	247	Inorganic
7440-28-0	Thallium	147	398	Inorganic
7440-62-2	Vanadium	401	402	Inorganic
7440-66-6	Zinc	421	422	Inorganic
7440-67-7	Zirconium	54	74	Inorganic
53469-21-9	Aroclor 1242	1	395	PCBs
12672-29-6	Aroclor 1248	12	395	PCBs
11097-69-1	Aroclor 1254	106	397	PCBs
11096-82-5	Aroclor 1260	62	395	PCBs

Table 3-7
Chemicals Detected In Area IV Soil

CAS Number	Analyte	Detections in All EUs	Number of samples	Group
32598-14-4	PCB-105	3	3	PCBs
74472-37-0	PCB-114	3	3	PCBs
31508-00-6	PCB-118	3	3	PCBs
65510-44-3	PCB-123	3	3	PCBs
57465-28-8	PCB-126	3	3	PCBs
38380-07-3	PCB-128	1	1	PCBs
35068-28-2	PCB-138	1	1	PCBs
35065-27-1	PCB-153	1	1	PCBs
38380-08-4	PCB-156	3	3	PCBs
69782-90-7	PCB-157	3	3	PCBs
52663-72-6	PCB-167	3	3	PCBs
35065-30-6	PCB-170	3	3	PCBs
35065-29-3	PCB-180	3	3	PCBs
52663-68-0	PCB-187	1	1	PCBs
39635-31-9	PCB-189	3	3	PCBs
52663-78-2	PCB-195	1	1	PCBs
40186-72-9	PCB-206	1	1	PCBs
41464-39-5	PCB-44	1	1	PCBs
35693-99-3	PCB-52	1	1	PCBs
32598-10-0	PCB-66	1	1	PCBs
32598-13-3	PCB-77	1	3	PCBs
34883-43-7	PCB-8	1	1	PCBs
70362-50-4	PCB-81	3	3	PCBs
83-46-5	.beta.-Sitosterol	1	1	SVOC
95-63-6	1,2,4-Trimethylbenzene	1	165	SVOC
90-12-0	1-Methyl naphthalene	4	103	SVOC
872-50-4	1-Methyl-2-Pyrrolidinone	2	2	SVOC
591-78-6	2-Hexanone	1	105	SVOC
91-57-6	2-Methylnaphthalene	24	282	SVOC
2216-33-3	3-Methyloctane	2	2	SVOC
83-32-9	Acenaphthene	12	388	SVOC
24887-75-0	Androstane	2	2	SVOC
120-12-7	Anthracene	22	388	SVOC
56-55-3	Benzo(a)anthracene	47	388	SVOC
50-32-8	Benzo(a)pyrene	49	387	SVOC
205-99-2	Benzo(b)fluoranthene	55	387	SVOC
192-97-2	Benzo(e)pyrene	1	1	SVOC
191-24-2	Benzo(ghi)perylene	44	389	SVOC
207-08-9	Benzo(k)fluoranthene	42	386	SVOC
117-81-7	bis(2-Ethylhexyl) phthalate	56	248	SVOC
85-68-7	Butyl benzyl phthalate	1	160	SVOC
601-53-6	Cholestan-3-one, (5.beta.)-	1	1	SVOC
218-01-9	Chrysene	63	389	SVOC
53-70-3	Dibenzo(a,h)anthracene	23	387	SVOC
84-66-2	Diethyl phthalate	13	248	SVOC
84-74-2	Di-n-butyl phthalate	53	248	SVOC
117-84-0	Di-n-octyl phthalate	2	160	SVOC
55193-56-1	Eicosane, 10-methyl-	1	1	SVOC
206-44-0	Fluoranthene	72	388	SVOC
86-73-7	Fluorene	10	388	SVOC
4860-03-1	Hexadecane, 1-chloro-	1	1	SVOC
193-39-5	Indeno(1,2,3-cd)pyrene	39	387	SVOC
91-20-3	Naphthalene	35	452	SVOC
630-02-4	n-Octacosane	3	3	SVOC
593-45-3	Octadecane	3	3	SVOC
3386-33-2	Octadecane, 1-chloro-	2	2	SVOC

Table 3-7
Chemicals Detected In Area IV Soil

CAS Number	Analyte	Detections in All EUs	Number of samples	Group
629-93-6	Octadecane, 1-iodo-	1	1	SVOC
57-10-3	Palmitic acid	1	1	SVOC
198-55-0	Perylene	1	1	SVOC
85-01-8	Phenanthrene	62	388	SVOC
108-95-2	Phenol	1	163	SVOC
129-00-0	Pyrene	79	389	SVOC
14167-59-0	Tetratriacontane	1	1	SVOC
80-56-8	.alpha.-Pinene	1	1	VOC
71-55-6	1,1,1-Trichloroethane	5	280	VOC
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	2	167	VOC
75-34-3	1,1-Dichloroethane	3	278	VOC
75-35-4	1,1-Dichloroethene	2	278	VOC
107-06-2	1,2-Dichloroethane	1	278	VOC
540-59-0	1,2-Dichloroethene	4	38	VOC
544-10-5	1-Chlorohexane	1	5	VOC
208-96-8	Acenaphthylene	4	388	VOC
67-64-1	Acetone	42	222	VOC
71-43-2	Benzene	3	293	VOC
123-72-8	Butanal	1	1	VOC
79-92-5	Camphene	1	1	VOC
76-22-2	Camphor	1	1	VOC
108-90-7	Chlorobenzene	2	284	VOC
75-00-3	Chloroethane	1	278	VOC
67-66-3	Chloroform	1	278	VOC
156-59-2	cis-1,2-Dichloroethene	3	197	VOC
5989-27-5	d-Limonene	1	1	VOC
100-41-4	Ethylbenzene	8	293	VOC
111-71-7	Heptanal	1	1	VOC
66-25-1	Hexanal	3	3	VOC
67-63-0	Isopropanol	3	7	VOC
136777-61-2	m,p-Xylenes	1	165	VOC
78-93-3	Methyl ethyl ketone	11	192	VOC
75-09-2	Methylene chloride	32	280	VOC
109-66-0	n-Pentane	1	1	VOC
99-87-6	p-Cymene	2	80	VOC
110-62-3	Pentanal	1	1	VOC
127-18-4	Tetrachloroethene	4	278	VOC
108-88-3	Toluene	25	293	VOC
79-01-6	Trichloroethene	8	280	VOC
75-69-4	Trichlorofluoromethane	2	206	VOC
75-01-4	Vinyl chloride	2	278	VOC
1330-20-7	Xylenes, Total	20	114	VOC

Notes:
CAS: Chemical Abstracts Service
PCBs: polychlorinated biphenyls
SVOCs: semi-volatile organic compounds
TCDD: tetrachlorodibenzo-p-dioxin
TEQ: total dioxin toxic equivalence
VOCs: volatile organic compounds

Table 3-8
Selection of Chemicals of Interest In Area IV Soil

CAS Number	Analyte	Group	Detections in All EUs	Number of Samples	Number of Samples Exceeding 0.1 x PRG	Number of Samples Exceeding Background	Is Chemical a Chemical of Interest?
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	Dioxins	94	171	20	67	Yes
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	Dioxins	120	171	109	75	Yes
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	Dioxins	63	171	6	60	Yes
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	Dioxins	70	171	21	58	Yes
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	Dioxins	64	171	19	59	Yes
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	Dioxins	66	171	13	58	Yes
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	Dioxins	91	171	37	71	Yes
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	Dioxins	62	171	6	38	Yes
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	Dioxins	85	171	79	63	Yes
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	Dioxins	52	171	52	30	Yes
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	Dioxins	50	171	35	48	Yes
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	Dioxins	76	171	23	61	Yes
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	Dioxins	64	171	58	46	Yes
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	Dioxins	68	171	68	23	Yes
38998-75-3	Heptachlorodibenzofurans	Dioxins	113	169	NO PRG	NO BACKGROUND	No
37871-00-4	Heptachlorodibenzo-p-dioxins	Dioxins	128	169	119	NO BACKGROUND	Yes
55684-94-1	Hexachlorodibenzofurans	Dioxins	110	169	NO PRG	NO BACKGROUND	No
34465-46-8	Hexachlorodibenzo-p-dioxins	Dioxins	110	169	NO PRG	NO BACKGROUND	No
39001-02-0	Octachlorodibenzofuran	Dioxins	99	171	51	59	Yes
3268-87-9	Octachlorodibenzo-p-dioxin	Dioxins	137	171	108	72	Yes
30402-15-4	Pentachlorodibenzofurans	Dioxins	99	169	NO PRG	NO BACKGROUND	No
36088-22-9	Pentachlorodibenzo-p-dioxins	Dioxins	68	169	NO PRG	NO BACKGROUND	No
1746-01-6	TCDD-TEQ (Total all)	Dioxins	141	299	125	88	Yes
30402-14-3	Tetrachlorodibenzofurans	Dioxins	96	169	NO PRG	NO BACKGROUND	No
41903-57-5	Tetrachlorodibenzo-p-dioxins	Dioxins	59	169	NO PRG	NO BACKGROUND	No
7429-90-5	Aluminum	Inorganic	349	351	346	36	Yes
7440-36-0	Antimony	Inorganic	113	345	35	13	Yes
7440-38-2	Arsenic	Inorganic	342	446	336	10	Yes
7440-39-3	Barium	Inorganic	403	405	18	18	Yes
7440-41-7	Beryllium	Inorganic	311	402	310	5	Yes
7440-42-8	Boron	Inorganic	88	308	0	12	No
7440-43-9	Cadmium	Inorganic	193	406	62	41	Yes
7440-70-2	Calcium	Inorganic	92	93	NO PRG	NO BACKGROUND	No
7440-47-3	Chromium	Inorganic	418	422	143	13	Yes
7440-48-4	Cobalt	Inorganic	396	402	2	1	Yes
7440-50-8	Copper	Inorganic	417	422	30	28	Yes
7439-89-6	Iron	Inorganic	97	98	95	0	Yes
7439-92-1	Lead	Inorganic	421	444	80	40	Yes
7439-93-2	Lithium	Inorganic	54	61	0	0	No
7439-95-4	Magnesium	Inorganic	92	93	0	NO BACKGROUND	No
7439-96-5	Manganese	Inorganic	98	98	93	3	Yes
7487-94-7	Mercury	Inorganic	289	546	13	104	Yes
7439-98-7	Molybdenum	Inorganic	138	397	4	4	Yes
7440-02-0	Nickel	Inorganic	399	422	118	12	Yes
7440-09-7	Potassium	Inorganic	199	201	NO PRG	5	Yes
7782-49-2	Selenium	Inorganic	90	385	9	36	Yes
7440-22-4	Silver	Inorganic	142	426	42	63	Yes
7440-23-5	Sodium	Inorganic	242	247	NO PRG	126	Yes
7440-28-0	Thallium	Inorganic	147	398	27	30	Yes
7440-62-2	Vanadium	Inorganic	401	402	399	6	Yes
7440-66-6	Zinc	Inorganic	421	422	42	55	Yes
7440-67-7	Zirconium	Inorganic	54	74	54	0	Yes
53469-21-9	Aroclor 1242	PCBs	1	395	1	NO BACKGROUND	Yes
12672-29-6	Aroclor 1248	PCBs	12	395	12	NO BACKGROUND	Yes
11097-69-1	Aroclor 1254	PCBs	106	397	106	NO BACKGROUND	Yes
11096-82-5	Aroclor 1260	PCBs	62	395	62	NO BACKGROUND	Yes
32598-14-4	PCB-105	PCBs	3	3	NO PRG	NO BACKGROUND	No
74472-37-0	PCB-114	PCBs	3	3	NO PRG	NO BACKGROUND	No

Table 3-8
Selection of Chemicals of Interest In Area IV Soil

CAS Number	Analyte	Group	Detections in All EUs	Number of Samples	Number of Samples Exceeding 0.1 x PRG	Number of Samples Exceeding Background	Is Chemical a Chemical of Interest?
31508-00-6	PCB-118	PCBs	3	3	NO PRG	NO BACKGROUND	No
65510-44-3	PCB-123	PCBs	3	3	NO PRG	NO BACKGROUND	No
57465-28-8	PCB-126	PCBs	3	3	NO PRG	NO BACKGROUND	No
38380-07-3	PCB-128	PCBs	1	1	NO PRG	NO BACKGROUND	No
35068-28-2	PCB-138	PCBs	1	1	NO PRG	NO BACKGROUND	No
35065-27-1	PCB-153	PCBs	1	1	NO PRG	NO BACKGROUND	No
38380-08-4	PCB-156	PCBs	3	3	NO PRG	NO BACKGROUND	No
69782-90-7	PCB-157	PCBs	3	3	NO PRG	NO BACKGROUND	No
52663-72-6	PCB-167	PCBs	3	3	NO PRG	NO BACKGROUND	No
35065-30-6	PCB-170	PCBs	3	3	NO PRG	NO BACKGROUND	No
35065-29-3	PCB-180	PCBs	3	3	NO PRG	NO BACKGROUND	No
52663-68-0	PCB-187	PCBs	1	1	NO PRG	NO BACKGROUND	No
39635-31-9	PCB-189	PCBs	3	3	NO PRG	NO BACKGROUND	No
52663-78-2	PCB-195	PCBs	1	1	NO PRG	NO BACKGROUND	No
40186-72-9	PCB-206	PCBs	1	1	NO PRG	NO BACKGROUND	No
41464-39-5	PCB-44	PCBs	1	1	NO PRG	NO BACKGROUND	No
35693-99-3	PCB-52	PCBs	1	1	NO PRG	NO BACKGROUND	No
32598-10-0	PCB-66	PCBs	1	1	NO PRG	NO BACKGROUND	No
32598-13-3	PCB-77	PCBs	1	3	NO PRG	NO BACKGROUND	No
34883-43-7	PCB-8	PCBs	1	1	NO PRG	NO BACKGROUND	No
70362-50-4	PCB-81	PCBs	3	3	NO PRG	NO BACKGROUND	No
83-46-5	.beta.-Sitosterol	SVOC	1	1	NO PRG	NO BACKGROUND	No
95-63-6	1,2,4-Trimethylbenzene	SVOC	1	165	0	NO BACKGROUND	No
90-12-0	1-Methyl naphthalene	SVOC	4	103	NO PRG	NO BACKGROUND	No
872-50-4	1-Methyl-2-Pyrrolidinone	SVOC	2	2	NO PRG	NO BACKGROUND	No
591-78-6	2-Hexanone	SVOC	1	105	NO PRG	NO BACKGROUND	No
91-57-6	2-Methylnaphthalene	SVOC	24	282	0	NO BACKGROUND	No
2216-33-3	3-Methyloctane	SVOC	2	2	NO PRG	NO BACKGROUND	No
83-32-9	Acenaphthene	SVOC	12	388	0	NO BACKGROUND	No
24887-75-0	Androstane	SVOC	2	2	NO PRG	NO BACKGROUND	No
120-12-7	Anthracene	SVOC	22	388	0	NO BACKGROUND	No
56-55-3	Benzo(a)anthracene	SVOC	47	388	43	NO BACKGROUND	Yes
50-32-8	Benzo(a)pyrene	SVOC	49	387	49	NO BACKGROUND	Yes
205-99-2	Benzo(b)fluoranthene	SVOC	55	387	49	NO BACKGROUND	Yes
192-97-2	Benzo(e)pyrene	SVOC	1	1	NO PRG	NO BACKGROUND	No
191-24-2	Benzo(ghi)perylene	SVOC	44	389	NO PRG	NO BACKGROUND	No
207-08-9	Benzo(k)fluoranthene	SVOC	42	386	21	NO BACKGROUND	Yes
117-81-7	bis(2-Ethylhexyl) phthalate	SVOC	56	248	11	NO BACKGROUND	Yes
85-68-7	Butyl benzyl phthalate	SVOC	1	160	0	NO BACKGROUND	No
601-53-6	Cholestan-3-one, (5.beta.)-	SVOC	1	1	NO PRG	NO BACKGROUND	No
218-01-9	Chrysene	SVOC	63	389	14	NO BACKGROUND	Yes
53-70-3	Dibenzo(a,h)anthracene	SVOC	23	387	23	NO BACKGROUND	Yes
84-66-2	Diethyl phthalate	SVOC	13	248	0	NO BACKGROUND	No
84-74-2	Di-n-butyl phthalate	SVOC	53	248	0	NO BACKGROUND	No
117-84-0	Di-n-octyl phthalate	SVOC	2	160	0	NO BACKGROUND	No
55193-56-1	Eicosane, 10-methyl-	SVOC	1	1	NO PRG	NO BACKGROUND	No
206-44-0	Fluoranthene	SVOC	72	388	1	NO BACKGROUND	Yes
86-73-7	Fluorene	SVOC	10	388	0	NO BACKGROUND	No
4860-03-1	Hexadecane, 1-chloro-	SVOC	1	1	NO PRG	NO BACKGROUND	No
193-39-5	Indeno(1,2,3-cd)pyrene	SVOC	39	387	39	NO BACKGROUND	Yes
91-20-3	Naphthalene	SVOC	35	452	2	NO BACKGROUND	Yes
630-02-4	n-Octacosane	SVOC	3	3	NO PRG	NO BACKGROUND	No
593-45-3	Octadecane	SVOC	3	3	NO PRG	NO BACKGROUND	No
3386-33-2	Octadecane, 1-chloro-	SVOC	2	2	NO PRG	NO BACKGROUND	No
629-93-6	Octadecane, 1-iodo-	SVOC	1	1	NO PRG	NO BACKGROUND	No
57-10-3	Palmitic acid	SVOC	1	1	NO PRG	NO BACKGROUND	No
198-55-0	Perylene	SVOC	1	1	NO PRG	NO BACKGROUND	No

Table 3-8
Selection of Chemicals of Interest In Area IV Soil

CAS Number	Analyte	Group	Detections in All EUs	Number of Samples	Number of Samples Exceeding 0.1 x PRG	Number of Samples Exceeding Background	Is Chemical a Chemical of Interest?
85-01-8	Phenanthrene	SVOC	62	388	NO PRG	NO BACKGROUND	No
108-95-2	Phenol	SVOC	1	163	0	NO BACKGROUND	No
129-00-0	Pyrene	SVOC	79	389	2	NO BACKGROUND	Yes
14167-59-0	Tetratriacontane	SVOC	1	1	NO PRG	NO BACKGROUND	No
80-56-8	.alpha.-Pinene	VOC	1	1	NO PRG	NO BACKGROUND	No
71-55-6	1,1,1-Trichloroethane	VOC	5	280	0	NO BACKGROUND	No
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	VOC	2	167	0	NO BACKGROUND	No
75-34-3	1,1-Dichloroethane	VOC	3	278	1	NO BACKGROUND	Yes
75-35-4	1,1-Dichloroethene	VOC	2	278	2	NO BACKGROUND	Yes
107-06-2	1,2-Dichloroethane	VOC	1	278	0	NO BACKGROUND	No
540-59-0	1,2-Dichloroethene	VOC	4	38	NO PRG	NO BACKGROUND	No
544-10-5	1-Chlorohexane	VOC	1	5	NO PRG	NO BACKGROUND	No
208-96-8	Acenaphthylene	VOC	4	388	NO PRG	NO BACKGROUND	No
67-64-1	Acetone	VOC	42	222	1	NO BACKGROUND	Yes
71-43-2	Benzene	VOC	3	293	1	NO BACKGROUND	Yes
123-72-8	Butanal	VOC	1	1	NO PRG	NO BACKGROUND	No
79-92-5	Camphene	VOC	1	1	NO PRG	NO BACKGROUND	No
76-22-2	Camphor	VOC	1	1	NO PRG	NO BACKGROUND	No
108-90-7	Chlorobenzene	VOC	2	284	0	NO BACKGROUND	No
75-00-3	Chloroethane	VOC	1	278	0	NO BACKGROUND	No
67-66-3	Chloroform	VOC	1	278	0	NO BACKGROUND	No
156-59-2	cis-1,2-Dichloroethene	VOC	3	197	0	NO BACKGROUND	No
5989-27-5	d-Limonene	VOC	1	1	NO PRG	NO BACKGROUND	No
100-41-4	Ethylbenzene	VOC	8	293	3	NO BACKGROUND	Yes
111-71-7	Heptanal	VOC	1	1	NO PRG	NO BACKGROUND	No
66-25-1	Hexanal	VOC	3	3	NO PRG	NO BACKGROUND	No
67-63-0	Isopropanol	VOC	3	7	NO PRG	NO BACKGROUND	No
136777-61-2	m,p-Xylenes	VOC	1	165	0	NO BACKGROUND	No
78-93-3	Methyl ethyl ketone	VOC	11	192	0	NO BACKGROUND	No
75-09-2	Methylene chloride	VOC	32	280	7	NO BACKGROUND	Yes
109-66-0	n-Pentane	VOC	1	1	NO PRG	NO BACKGROUND	No
99-87-6	p-Cymene	VOC	2	80	NO PRG	NO BACKGROUND	No
110-62-3	Pentanal	VOC	1	1	NO PRG	NO BACKGROUND	No
127-18-4	Tetrachloroethene	VOC	4	278	4	NO BACKGROUND	Yes
108-88-3	Toluene	VOC	25	293	0	NO BACKGROUND	No
79-01-6	Trichloroethene	VOC	8	280	6	NO BACKGROUND	Yes
75-69-4	Trichlorofluoromethane	VOC	2	206	0	NO BACKGROUND	No
75-01-4	Vinyl chloride	VOC	2	278	2	NO BACKGROUND	Yes
1330-20-7	Xylenes, Total	VOC	20	114	0	NO BACKGROUND	No

Notes:
CAS: Chemical Abstracts Service
PAH: polyaromatic hydrocarbon
PCBs: polychlorinated biphenyls
SVOCs: semi-volatile organic compounds
TCDD: tetrachlorodibenzo-p-dioxin
TEQ: total dioxin toxic equivalence
VOCs: volatile organic compounds

NO PRG: Chemical does not have PRG
NO BACKGROUND: Chemical does not have background value

Table 3-9
Chemicals of Interest In Area IV Soil

CAS Number	Analyte	Group
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	Dioxins
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	Dioxins
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	Dioxins
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	Dioxins
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	Dioxins
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	Dioxins
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	Dioxins
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	Dioxins
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	Dioxins
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	Dioxins
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	Dioxins
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	Dioxins
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	Dioxins
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	Dioxins
37871-00-4	Heptachlorodibenzo-p-dioxins	Dioxins
39001-02-0	Octachlorodibenzofuran	Dioxins
3268-87-9	Octachlorodibenzo-p-dioxin	Dioxins
1746-01-6	TCDD-TEQ (Total all)	Dioxins
7429-90-5	Aluminum	Inorganic
7440-36-0	Antimony	Inorganic
7440-38-2	Arsenic	Inorganic
7440-39-3	Barium	Inorganic
7440-41-7	Beryllium	Inorganic
7440-43-9	Cadmium	Inorganic
7440-47-3	Chromium	Inorganic
7440-48-4	Cobalt	Inorganic
7440-50-8	Copper	Inorganic
7439-89-6	Iron	Inorganic
7439-92-1	Lead	Inorganic
7439-96-5	Manganese	Inorganic
7487-94-7	Mercury	Inorganic
7439-98-7	Molybdenum	Inorganic
7440-02-0	Nickel	Inorganic
7440-09-7	Potassium	Inorganic
7782-49-2	Selenium	Inorganic
7440-22-4	Silver	Inorganic
7440-23-5	Sodium	Inorganic
7440-28-0	Thallium	Inorganic
7440-62-2	Vanadium	Inorganic
7440-66-6	Zinc	Inorganic
7440-67-7	Zirconium	Inorganic
53469-21-9	Aroclor 1242	PCBs
12672-29-6	Aroclor 1248	PCBs
11097-69-1	Aroclor 1254	PCBs
11096-82-5	Aroclor 1260	PCBs
56-55-3	Benzo(a)anthracene	SVOC
50-32-8	Benzo(a)pyrene	SVOC
205-99-2	Benzo(b)fluoranthene	SVOC
207-08-9	Benzo(k)fluoranthene	SVOC
117-81-7	bis(2-Ethylhexyl) phthalate	SVOC
218-01-9	Chrysene	SVOC
53-70-3	Dibenzo(a,h)anthracene	SVOC
206-44-0	Fluoranthene	SVOC
193-39-5	Indeno(1,2,3-cd)pyrene	SVOC
91-20-3	Naphthalene	SVOC
129-00-0	Pyrene	SVOC
75-34-3	1,1-Dichloroethane	VOC

Table 3-9
Chemicals of Interest In Area IV Soil

CAS Number	Analyte	Group
75-35-4	1,1-Dichloroethene	VOC
67-64-1	Acetone	VOC
71-43-2	Benzene	VOC
100-41-4	Ethylbenzene	VOC
75-09-2	Methylene chloride	VOC
127-18-4	Tetrachloroethene	VOC
79-01-6	Trichloroethene	VOC
75-01-4	Vinyl chloride	VOC
208-96-8	Acenaphthylene	SVOC

Notes:
CAS: Chemical Abstracts Service
PCBs: polychlorinated biphenyls
SVOCs: semi-volatile organic compounds
TCDD: tetrachlorodibenzo-p-dioxin
TEQ: total dioxin toxic equivalence
VOCs: volatile organic compounds

Table 3-10
Previous Assessment Potential Radionuclides of Concern

Radionuclide	HSA Identified	EA Identified	Source	Half Life (years)
^{241}Am	X	X	Neutron Capture	458
^{60}Co	X	X	Activation Product	5.3
^{134}Cs	X		Fission Product	2.1
^{137}Cs	X	X	Fission Product	30
^{152}Eu	X	X	Activation Product	12.7
^{154}Eu	X	X	Activation Product	16
^{55}Fe	X	X	Activation Product	2.6
^{3}H	X	X	Activation Product	12.3
^{129}I		X	Fission Product	1.70E+07
^{40}K	X	X	Natural	1.30E+09
^{54}Mn	X		Activation Product	0.85
^{22}Na	X		Activation Product	2.6
^{59}Ni	X	X	Activation Product	8.00E+04
^{63}Ni	X	X	Activation Product	92
^{210}Pb		X	Natural	21
^{238}Pu	X	X	Neutron Capture	86.4
^{239}Pu	X	X	Fuel material	2.40E+04
^{240}Pu	X	X	Neutron Capture	6.60E+03
^{241}Pu	X	X	Neutron Capture	13.2
^{242}Pu	X	X	Neutron Capture	3.80E+05
^{226}Ra	X	X	Natural	1.60E+03
^{228}Ra		X	Natural	5.8
^{90}Sr	X	X	Fission Product	27.7
^{228}Th	X	X	Natural	1.9
^{230}Th		X	Natural	8.00E+04
^{232}Th	X	X	Fuel material	1.40E+10
^{234}U	X	X	Fuel material	2.30E+05
^{235}U	X	X	Fuel material	7.10E+08
^{238}U	X	X	Fuel material	4.50E+09

Notes: HSA = Historical Site Assessment. EA = Environmental Assessment.

Table 3-11
Radiological Contaminants of Interest

Radionuclide	Source	Half Life (years)
^{241}Am	Neutron Capture in Fuel	458
^{133}Ba	Activation Product Detected Onsite	10.5
^{14}C	Neutron Capture in Graphite and Soil	5.73E+03
^{243}Cm	Neutron Capture in Fuel	29.1
^{60}Co	Activation Product in Reactors	5.3
^{134}Cs	Fission Product	2.1
^{137}Cs +D	Fission Product	30
^{152}Eu	Activation Product in Reactors	12.7
^{154}Eu	Activation Product in Reactors	16
^{155}Eu	Activation Product Detected Onsite	4.7
^{55}Fe	Activation Product in Reactors	2.6
^{3}H	Activation Product in Reactors	12.3
^{129}I	Fission Product	1.70E+07
^{40}K	Natural and Activation Product	1.30E+09
^{22}Na	Activation Product in Coolant	2.6
^{59}Ni	Activation Product in Reactors	8.00E+04
^{63}Ni	Activation Product in Reactors	92
^{237}Np +D	Neutron Capture in Fuel	2.14E+06
^{210}Pb +D	Natural Only	21
^{238}Pu	Neutron Capture in Fuel	86.4
^{239}Pu	Fuel material	2.40E+04
^{240}Pu	Neutron Capture in Fuel	6.60E+03
^{241}Pu	Neutron Capture in Fuel	13.2
^{242}Pu +D	Neutron Capture in Fuel	3.80E+05
^{226}Ra +D	Natural Only	1.60E+03
^{228}Ra +D	Natural Only	5.8
^{125}Sb +D	Fission Product Detected Onsite	2.758
^{90}Sr	Fission Product	27.7
^{99}Tc	Fission Product	2.13E+05
^{228}Th +D	Natural and Fuel Material	1.9
^{230}Th	Natural and Fuel Material	8.00E+04
^{232}Th	Natural and Fuel Material	1.40E+10
^{234}U	Natural and Fuel Material	2.30E+05
^{235}U +D	Natural and Fuel Material	7.10E+08
^{238}U +D	Natural and Fuel Material	4.50E+09

Table 3-12
Groundwater Chemicals of Interest

Analyte	Analyte Group	Units	Maximum Concentration Detected	MCL (1/10 value)	PRG (1/10 value)
1,1,1-Trichloroethane	VOC	ug/L	15000	20	173.220339
1,1,2,2-Tetrachloroethane	VOC	ug/L	1.5		0.005239864
1,1,2-Trichloro-1,2,2-trifluoroethane	VOC	ug/L	12000	120	5917.985748
1,1,2-Trichloroethane	VOC	ug/L	4.5	0.5	0.018637778
1,1-Dichloroethane	VOC	ug/L	2800	0.05	0.194464113
1,1-Dichloroethene	VOC	ug/L	4600	0.6	13.51851852
1,2,3-Trichloropropane	VOC	ug/L	0.04		0.000554223
1,2,3-Trichloropropene	VOC	ug/L	80		0.217693837
1,2-Dibromo-3-chloropropane	VOC	ug/L	0.0032	0.02	0.000158349
1,2-Dichloroethane	VOC	ug/L	250000		0.016329905
1,2-Dichloropropane	VOC	ug/L	2.3	0.5	0.030790151
1,4-Dichlorobenzene	VOC	ug/L	2	0.5	0.032320432
Acetone	VOC	ug/L	36000		547.5
Acrylonitrile	VOC	ug/L	42		0.001108445
Benzene	VOC	ug/L	15	0.1	0.011084454
Bromodichloromethane	VOC	ug/L	170		0.008526503
Bromoform	VOC	ug/L	41		0.85103208
Bromomethane	VOC	ug/L	4		0.866101695
Carbon Tetrachloride	VOC	ug/L	29000	0.05	0.007389636
Chloroethane	VOC	ug/L	6		0.382222567
Chloroform	VOC	ug/L	71000		0.052837367
cis-1,2-Dichloroethene	VOC	ug/L	810	0.6	6.083333333
Dibromochloromethane	VOC	ug/L	190		0.011791973
Ethylbenzene	VOC	ug/L	43	30	0.122086236
Methyl ethyl ketone	VOC	ug/L	1300		696.8181818
Methylene chloride	VOC	ug/L	440000	0.5	0.211893925
m-Xylene	VOC	ug/L	60		20.57337221
o-Xylene	VOC	ug/L	110		20.57337221
Tetrachloroethene	VOC	ug/L	2100	0.5	0.01040135
Tetrahydrofuran	VOC	ug/L	10		0.159905091
Toluene	VOC	ug/L	1900	15	57.63157895
trans-1,2-Dichloroethene	VOC	ug/L	410	1	12.16666667
Trichloroethene	VOC	ug/L	5000	0.5	0.138742649
Trichlorofluoromethane	VOC	ug/L	560	15	128.8235294

Table 3-12
Groundwater Chemicals of Interest

Analyte	Analyte Group	Units	Maximum Concentration Detected	MCL (1/10 value)	PRG (1/10 value)
Vinyl chloride	VOC	ug/L	3900	0.05	0.004105353
Xylenes, Total	VOC	ug/L	3900	175	121.6666667
1,2,4-Trichlorobenzene	SVOC	ug/L	1.2	0.5	0.715686275
1,3,5-Trimethylbenzene	SVOC	ug/L	2		1.232618196
1,4-Dioxane	SVOC	ug/L	600		0.249005683
2,4,6-Trichlorophenol	SVOC	ug/L	1.7		0.096045049
2-Chlorophenol	SVOC	ug/L	10		3.041666667
4,6-Dinitro-o-cresol	SVOC	ug/L	5		0.365
Benzo(k)fluoranthene	SVOC	ug/L	0.07		0.005602628
bis(2-Chloroethyl) ether	SVOC	ug/L	540		0.000443378
bis(2-Ethylhexyl) phthalate	SVOC	ug/L	390	0.4	2.241051145
Kepone	SVOC	ug/L	0.11		0.000420197
Naphthalene	SVOC	ug/L	16		0.009237045
Nitrobenzene	SVOC	ug/L	380		0.339534884
Pentachlorophenol	SVOC	ug/L	3	0.1	0.083001894
Aldrin	Pesticides	ug/L	0.37		0.00039548
Aluminum	Inorganic	ug/L	4400	100	3650
Antimony	Inorganic	ug/L	16	0.6	1.46
Arsenic	Inorganic	ug/L	19	1	0.000711445
Barium	Inorganic	ug/L	340	100	255.5
Beryllium	Inorganic	ug/L	1.8	0.4	7.3
Boron	Inorganic	ug/L	1840		730
Cadmium	Inorganic	ug/L	6.1	0.5	1.825
Chromium	Inorganic	ug/L	88	5	
Cobalt	Inorganic	ug/L	230		73
Copper	Inorganic	ug/L	250	130	146
Cyanides	Inorganic	ug/L	360	15	73
Iron	Inorganic	ug/L	27000		1095
Lead	Inorganic	ug/L	120	1.5	
Manganese	Inorganic	ug/L	18400		87.6
Mercury	Inorganic	ug/L	0.8	0.2	1.095
Molybdenum	Inorganic	ug/L	88		18.25
Nickel	Inorganic	ug/L	990	10	73
Perchlorate	Inorganic	ug/L	56		0.365

Table 3-12
Groundwater Chemicals of Interest

Analyte	Analyte Group	Units	Maximum Concentration Detected	MCL (1/10 value)	PRG (1/10 value)
Selenium	Inorganic	ug/L	80	5	18.25
Silver	Inorganic	ug/L	23		18.25
Strontium	Inorganic	ug/L	2200		2190
Thallium	Inorganic	ug/L	3.7	0.2	0.2409
Vanadium	Inorganic	ug/L	37	2	3.65
Zinc	Inorganic	ug/L	9800		1095
1,3-Dinitrobenzene	Explosive	ug/L	43		0.365
n-Nitrosodimethylamine	Explosive	ug/L	1300		0.000420197
n-Nitrosodi-n-propylamine	Explosive	ug/L	34		0.00096045
n-Nitrosodiphenylamine	Explosive	ug/L	70		0.747017048
1,2,3,4,6,7,8-Heptachlorodibenzofuran	Dioxins	ug/L	0.0046		5.17166E-06
1,2,3,4,7,8,9-Heptachlorodibenzofuran	Dioxins	ug/L	0.0051		5.17166E-06
1,2,3,4,7,8-Hexachlorodibenzofuran	Dioxins	ug/L	0.006		5.17166E-07
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	Dioxins	ug/L	0.0056		5.17166E-07
1,2,3,6,7,8-Hexachlorodibenzofuran	Dioxins	ug/L	0.0049		5.17166E-07
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	Dioxins	ug/L	0.0059		5.17166E-07
1,2,3,7,8,9-Hexachlorodibenzofuran	Dioxins	ug/L	0.0053		5.17166E-07
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	Dioxins	ug/L	0.0064		5.17166E-07
1,2,3,7,8-Pentachlorodibenzofuran	Dioxins	ug/L	0.0068		1.03433E-06
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	Dioxins	ug/L	0.005		5.17166E-08
2,3,4,6,7,8-Hexachlorodibenzofuran	Dioxins	ug/L	0.0048		5.17166E-07
2,3,4,7,8-Pentachlorodibenzofuran	Dioxins	ug/L	0.0058		1.03433E-07
2,3,7,8-TCDD	Dioxins	ug/L	0.0045	0.000003	5.17166E-08
2,3,7,8-TCDD TEQ	Dioxins	ug/L	0.00055	0.000003	5.17166E-08
2,3,7,8-Tetrachlorodibenzofuran	Dioxins	ug/L	0.0024		5.17166E-07
Heptachlorodibenzo-p-dioxins	Dioxins	ug/L	0.0204		5.17166E-06
Hexachlorodibenzo-p-dioxins	Dioxins	ug/L	0.00136		5.17166E-07
Octachlorodibenzofuran	Dioxins	ug/L	0.0114		0.000517166
Octachlorodibenzo-p-dioxin	Dioxins	ug/L	0.55		0.000517166
Actinium-228	Radionuclide	pCi/L	354	0.5	2.39
Americium-241	Radionuclide	pCi/L	16.4	1.5	0.0458
Antimony-125	Radionuclide	pCi/L	6.28	30	0.928
Cesium-134	Radionuclide	pCi/L	109	8	0.113
Cesium-137	Radionuclide	pCi/L	4.7	20	0.157

Table 3-12
Groundwater Chemicals of Interest

Analyte	Analyte Group	Units	Maximum Concentration Detected	MCL (1/10 value)	PRG (1/10 value)
Cobalt-60	Radionuclide	pCi/L	5.9	10	0.303
Europium-152	Radionuclide	pCi/L	7.52	6	0.784
Europium-154	Radionuclide	pCi/L	7.48	20	0.462
Europium-155	Radionuclide	pCi/L	7.68	60	2.51
Gross alpha	Radionuclide	pCi/L	100	1.5	
Gross beta	Radionuclide	pCi/L	6.7	1.5	
Lead-210	Radionuclide	pCi/L	3850		0.00375
Manganese-54	Radionuclide	pCi/L	2.48	30	2.09
Potassium-40	Radionuclide	pCi/L	1430	29.6	0.193
Radium-226	Radionuclide	pCi/L	1340	0.5	0.0000816
Radium-228	Radionuclide	pCi/L	4.01	0.5	0.00458
Ruthenium-106	Radionuclide	pCi/L	34	3	
Sodium-22	Radionuclide	pCi/L	2.54	40	0.495
Thorium-228	Radionuclide	pCi/L	0.6	1.5	0.0159
Thorium-230	Radionuclide	pCi/L	1.28	1.5	0.0523
Thorium-232	Radionuclide	pCi/L	0.662	1.5	0.0471
Total uranium	Radionuclide	pCi/L	41.9		0.73
Tritium	Radionuclide	pCi/L	117000	2000	14.4
Uranium-234	Radionuclide	pCi/L	12.7		0.0674
Uranium-235	Radionuclide	pCi/L	498		0.0663
Uranium-238	Radionuclide	pCi/L	41.9		0.73
Fluoride	General	ug/L	3700	200	219
Nitrate-N	General	ug/L	5000	0.001	1000

Table 3-13
Number of Existing Soil Vapor Samples by Depth

Exposure Units	Number of Samples 0-5 feet bgs	Number of Samples >5-10 feet bgs	Number of Samples >10-27 feet bgs	Number of Samples
EU-01	20	9	1	30
EU-02	0	0	0	0
EU-03	9	3	6	18
EU-04	2	1	0	3
EU-05	2	0	0	2
EU-06	11	1	0	12
EU-07	28	6	0	34
EU-08	9	4	1	14
EU-09	4	2	0	6
EU-10	42	44	20	106
EU-11	7	5	1	13
EU-12	2	1	0	3
EU-13	11	7	0	18
EU-14	0	0	0	0
EU-15	0	0	0	0
EU-16	0	0	0	0
TOTALS	**147**	**83**	**29**	**259**
Percentage	57%	32%	11%	

Notes:

bgs = below ground surface

Table 3-14
Summary Statistics of Chemicals Detected in Soil Vapor in Area IV

Chemical	Number of Detections	Number of Samples	Detection Frequency	Minimum Detected (ug/m3)	Maximum Detected (ug/m3)	Residential CHHSL (ug/m3)	Exceeds CHHSL?
1,1,1-Trichloroethane	3	185	2%	2,000	15,000	991,000	No
1,1,2-Trichloro-1,2,2-trifluoroethane	4	185	2%	1,400	3,500	—	No
1,1-Dichloroethene	6	188	3%	9.72	10,000	—	No
1,2-Dichloroethane	1	185	1%	1,500	1,500	50	Yes
cis-1,2-Dichloroethene	3	188	2%	681.34	15,000	15,900	No
Dichlorodifluoromethane	1	184	1%	1,100	1,100	—	No
Isopropanol	1	3	33%	427.5	427.50	—	No
Methane	12	44	27%	9,900	27,000	—	No
Tetrachloroethene	6	188	3%	26.28	3,400	180	Yes
trans-1,2-Dichloroethene	2	188	1%	109.26	157.55	31,900	No
Trichloroethene	9	188	5%	210.97	66,000	528	Yes
Trichlorofluoromethane	1	185	1%	4,500	4,500	—	No
Vinyl chloride	1	188	1%	26.47	26.47	13	Yes

Notes:
CHHSL: California Human Health Screening Level (EPA 2005)
ug/m^3: micrograms per cubic meter.

Section 4
Data Gap Analysis Results

The data gap analysis, performed according to the methodologies described in Section 3, has resulted in the identification of specific data requirements for completion of the EIS. The information and data needs for each potentially impacted media identified in the human health and ecological risk assessment conceptual site models (Figures 3-1 and 3-2) are discussed below. These media include soil, groundwater, surface water, sediment, air, buildings and bedrock. The data requirements identified through this analysis will be addressed with a flexible field sampling program designed to fill these gaps.

4.1 Soil

The chemical and radiological Data Gaps identified for the soil media are described below.

4.1.1 Chemical Data Gaps

As described in Section 3.6, chemical analytical data gaps were identified using: 1) a statistical approach to determine the number of samples needed to perform a human health risk assessment consistent with CERCLA; and 2) standard practice and experience to determine the number of samples needed to characterize areas that have not been previously sampled and the nature and extent of chemicals that have already been identified in soils at concentrations greater than DCGLs. The results reflecting the number of required additional sample analyses, as determined through both approaches, are summarized in **Table 4-1**. Details of the analysis are presented in the Tables in **Appendix I**.

4.1.1.1 Statistical Approach

As discussed in Section 3.6.6, a statistical approach was used to determine the minimum number of samples required for chemical analyses for a risk assessment consistent with CERCLA. The analysis was performed on an individual constituent basis because not every previously collected sample was analyzed for the same suite of analytes. Therefore, the data gap (the number of additional required samples) is driven by the largest number of additional samples needed for any constituent within a specific chemical group (e.g., VOCs). Similarly, the overall data gap for a particular EU is the largest data gap between the chemical groups for that unit. To determine the total data gap for Area IV, the data gaps for each EU were added together to establish the number of additional samples that need to be collected for a given risk assessment scenario. This analysis was performed for two soil depth intervals (0 to 2 feet and 2 to 10 feet) and two exposure use scenarios (residential and rural residential) on an EU-specific basis to calculate the minimum number of additional samples needed (i.e., data gap) to meet the requisites to conduct a risk assessment consistent with CERCLA.

The details shown in the Appendix I tables also indicate if each EU is currently considered "impacted" by at least one COI in the chemical group. A unit is considered to be impacted if the average concentration of at least one COI in that chemical group is greater than the DCGL (provided the number of existing sample results is equal to or greater than eight). If the EU is not considered impacted, then the impact status of the unit is considered "indeterminate" because the unit either may not have been impacted or there may have been an insufficient number of samples to perform the statistical analysis. If an EU was determined to be impacted, then the number of additional samples required for each chemical group was adjusted ("Adjusted No. of Samples" column) according to the following rules:

1. If the relative shift for an analyte was less than 1.0, then the relative shift for that analyte was set to 1.0 and the data gap (required number of samples) was calculated. If the relative shift was greater than or equal to 1.0, then no adjustment to the relative shift was made. The number of existing valid analyses was subtracted from the number of required samples, to calculate the data gap. The largest data gap for any analyte after this adjustment was reported for the chemical group.

2. The largest (maximum) data gap of the five chemical groups is considered the overall data gap for that EU.

The minimum number of additional samples required to adequately perform a human health risk assessment under a residential use scenario is 459 (i.e., 223 samples from the 0 to 2 feet soil interval and 236 samples from the 2 to 10 feet soil interval). For the rural residential use scenario, 479 additional samples are required (i.e., 237 samples from the 0 to 2 feet soil interval and 242 samples from the 2 to 10 feet soil interval).

4.1.1.2 Characterization and Extent of Contamination Approach

A separate evaluation based on standard practice and experience in characterizing and determining the nature and extent of contamination at CERCLA sites was conducted to identify additional data requirements for conducting the EIS evaluation of alternatives. In determining the data gaps, maps indicating soil contamination distribution (from existing data) at each RFI Chemical Use Area were examined. These maps also showed the location of the RFI Chemical Use Areas as provide by various RFI reports and planning documents (MWH 2006, MWH 2007, MWH 2008, CH2M HILL 2008, Boeing 2008).

The evaluation identified three types of data requirements:

- data required to adequately characterize areas where some chemical use is indicated but where insufficient sampling has been conducted to determine if a release has occurred;

- data required in areas where chemicals are present at concentrations above DCGLs but the lateral and/or vertical extent has not been sufficiently determined for the purposes of evaluating alternatives in the EIS; and

- data in areas of the EU where there are no Chemical Use Areas, but data are required to fully characterize the entire EU.

The identified data gaps in each EU are summarized below:

- EU1 – Data gaps at RFI Sites within this EU include:

  - At the Old Conservation Yard RFI Site additional characterization sampling is required at the Former Rocketdyne Conservation Yard, Former AST 4731 Earthen Berm, North Slope Debris Area B, Container Storage Area, Transformer Area 737, the Southwest Transformer Area, and the Transformer Area South of the Old Conservation Yard. Further delineation of identified contamination at the Old Conservation Yard is required at the Former AI Conservation Yard, Former Fueling Area at Building 320, Former North Slope Storage Area, Former AST 4732 Earthen Berm, Former Telephone Pole Storage Area, Southern Debris Area, Former SRE Discharge Line, Northern Debris Area (including vertical delineation), North Slope Debris Area A, Southeast Transformer Area, and the Topographic Low Spot (including vertical delineation).

  - At the Building B204 Waste Oil Tank RFI Site, further lateral and vertical delineation of known contamination is needed.

  - Additional samples are also required to fully characterize undeveloped areas within EU1.

- EU2 – The only RFI Site within this EU is the New Conservation Yard. Further lateral delineation of known contamination is required at the two Chemical Use Areas, the New Conservation Yard and the Ash Pile. Vertical delineation of the Ash Pile is also required. There is a significant amount of undeveloped land within EU 2 and additional samples are required to fully characterize these areas.

- EU3 – The only RFI Site within EU3 is the Sodium Reactor Experiment (SRE) Complex Area. Further characterization is required at UST-71, UST-27, SRE Pond Influent Channels, Sodium Compound Cleaning Area, Building 4133 Debris Area, SCE Steam Power Plant, and the AS Storage Area. Characterization of soil is also needed in at Buildings 4153, 4184, 4505, and 4695. Further lateral delineation of existing contamination is required at the Oil Stain at Building 4003, and both lateral and vertical delineation of contamination at the SRE Pond, Transformer Area 4693, and the Transformer Area South of Building 4003. Downstream extent needs to be delineated in the SRE Pond Discharge Pipeline, and Downslope drainage and Pond Areas. Confirmation and lateral and vertical delineation samples are required in the Building 4003 Leach Field. Deeper (greater than 10 feet) samples may be required

in the area of the three underground storage tanks to confirm that the areas are clean. Vertical delineation is also required at the Toluene Process Unit, the Former Industrial Dry Well, and the SCE Cooling Tower at the Steam Power Plant. Additional samples are also required to characterize undeveloped areas within EU3.

- EU4 – Characterization sampling for chemicals is required at all 15 Chemical Use Areas within the DOE Leach Fields located in this EU except the USTs which were used for radiological processes only. Characterization of the 2 to 10 feet interval is required at the Building 4064 Leach Field RFI Site as well as the four Chemical Use Areas at the Hazardous Waste Material Facility (HWMF) RFI Site. Deeper samples should also be collected from the Building 4064 Leach Field and the Building 4133 at the HWMF. One Chemical Use Area from the RCRA Program "Unaffiliated Areas", Building 4037, is located in this EU and also requires further Characterization. Additional samples are also required to characterize undeveloped areas within EU4.

- EU5 – Characterization sampling is required at Building 4029 (Reactive Metal Storage Yard), the Southeast Drum Storage Yard and the Building 4005 Coal Gasification Process Development Unit (PDU) and Leach Field RFI Sites. Additional samples are also required to characterize undeveloped areas within EU5.

- EU6 – Characterization sampling is required at all 23 Radioactive Material Handling Facility Chemical Use Areas, 2 DOE Leach Fields 3 Unaffiliated Areas, 8 PDU Site Chemical Use Areas, and 1 Hazardous Material Storage Area Chemical Use Area. Additional samples are also required to characterize undeveloped areas within EU6.

- EU7 – Characterization samples are required from the 17th Street Drainage Area (PDU Site), 9 of the 10 Boeing Leach Fields Chemical Use Areas, and the ASTs, Cryo Lab and Test Cells, and Hazardous Material Storage Pad of the Environmental Effects Laboratory (EEL) RFI Site. Lateral delieation of contamination is also needed at the 17th Street Drainage Area, and Lateral and vertical delineation of identified contamination is required at and Building 4011 Leach Field Compound A, as well as the Transformers at the EEL RFI Site. Deeper sampling at the Boeing Leach Fields UST is required for characterization. Additional samples are also required to characterize undeveloped areas within EU7.

- EU 8 – Several RFI Sites are located within EU8:

    - All 10 PDU RFI Site Chemical Use Areas located within EU 8 require characterization sampling. Deeper samples for characterization should also be collected in the area of the Building 4006 Tanks. Some delineation sampling is

required at the Substations, and deeper delineation samples need to be collected at the Building 4005 and 4006 Leach Field.

- Characterization sampling is required at 8 Building 4059 Former SNAP Reactor Facility Chemical Use Areas.
- Characterization sampling is required at all 17 DOE Leach Fields 2 RFI Site Chemical Use Areas.
- Characterization sampling is required at the 9 Building 4457 HMSA RFI Site Chemical Use Areas. Vertical delineation sampling is also required in the area of the Building 4457 and Sumps area.
- Two Unaffiliated Area Chemical Use Areas require characterization sampling.
- Two Boeing Leach Fields Chemical Use Areas are located in EU8. Characterization sampling is required at the Sodium Component Test Installation and the Building 4502 Parking Lot. Delineation of identified contamination is required at the Building 4735 AST.
- Additional samples are also required to characterize undeveloped areas within EU8.

- EU9 – Characterization sampling is required at 5 of the 6 Building 4065 Metals Laboratory Clarifier Chemical Use Areas, 3 of the 4 Building 4020 Rockwell International Hot Laboratory and Leach Field Chemical Use Areas, all 7 DOE Leach Fields Chemical Use Areas, and all 9 Chemical Use Areas included in the Unaffiliated Areas RFI Site. Delineation of known contamination is required at the Building 4065 Metals Clarifier and Transformer 4762, the Metals contamination at the Northeast Corner of the Metals Clarifier, and deeper samples should be collected for characterization and delineation at the Unaffiliated Areas USTs. Additional samples are also required to characterize undeveloped areas within EU9.

- EU 10 – the Building 4100 trench and Building 4056 Landfill RFI Sites are located within this EU.
  - Characterization samples are required at the Building 4100 and Building 4100 Leach Field Transformer 4709, and at the Hummocky Terrain. The vertical extent of contamination in the trenches should be delineated, but this may be able to be accomplished visually.
  - Confirmation samples to confirm that the extent of contamination has been defined should be collected at the B056 Land Fill and the Southern Debris Area. Delineation samples are required in the Building 056 Excavation Debris Area and the Building 100 Discharge Area. The vertical extent of contamination should be delineated in the Building 4056 Landfill.

- Additional samples are also required to characterize undeveloped areas within EU10.

- EU11 – The Former Sodium Disposal Facility (FSDF) and the Building 4009 Leach Field are located within this EU.

  - At the Building 4886 (FSDF) samples are required to delineate the extent of contamination at the South of Former Disposal Facility, Ponds, and Building 4886, the Southern Investigation Area, the Former Drum Debris Area, and the FSDF Pistol Range. Vertical delineation of contamination is required at the Steam Lance, Solar Concentrator, and Southern Investigation Area. Bedrock samples to confirm removal of contamination in the Pond areas may be required.

  - At the Building 4009 Leach field characterization samples are required at Building 4009, and the Transformer Pole. Confirmation samples beneath the former Leach Field and Septic Tank should be collected. Delineation samples are required at the Solar Concentrator Facility. Deep samples may also required at the SGR Liquid Waste Hold-up Tank Area.

  - Additional samples are also required to characterize undeveloped areas within EU11.

- EU12 – Samples are required for delineation of contamination and further characterization in the Area IV Pond Dredge Area. Characterization samples are required at 9 DOE Leach Fields Chemical Use Areas. Vertical delineation is also required at the Building 4353 and Leach Field Chemical Use Area. Additional samples are also required to characterize undeveloped areas within EU12.

- EU13 – The Empire State Atomic Development Authority (ESADA) is the only RFI Site located in this area. Characterization samples are needed at the Transformer Pole X35. Samples are required for delineation of contamination at the Former ESADA Storage Yard, the PDU AST Area, and the ESADA Pistol Range. Deeper samples may also be required for delineation of the Former ESADA Storage Yard, Pistol Range and PDU AST Tank Area, although sampling at depth may require bedrock samples. Deeper characterization samples from the Former ESADA Storage Yard are also required. Additional samples are also required to characterize undeveloped areas within EU13.

- EU14 – No RFI Sites are located in this area. Samples will be required for the human heath risk assessment of this area.

- EU-15 - No RFI Sites are located in this area. Samples will be required for the human heath risk assessment of this area.

- EU-16 - No RFI Sites are located in this area. Samples will be required for the human heath risk assessment of this area.

Estimated numbers of samples as well as the analyses necessary to fill these data gaps are shown in **Tables I-7 and I-8**. The process histories were reviewed to determine which common chemical groups (VOCs, SVOCs, pesticides/PCBs, metals and dioxins/furans) used in the areas. In some cases less common chemical groups were also considered (e.g., cyanide, energetics, and propellants). Petroleum hydrocarbons (TPH) were not considered a separate chemical group as the constituent hydrocarbons used in the human health risk assessment will be address through the analysis for VOCs and SVOCs.

In determining the analyses required to be performed, samples from areas where characterization is the primary need are generally considered for analysis of the full suite of common chemical constituents. In some areas, the chemicals associated with the use are limited (e.g., PCB and oils are associated with transformers). If use of some of the less common constituents is indicated in the process history, those analyses are also identified as a data gap. Samples from areas requiring delineation are generally considered for analysis of the particular COI chemical group(s) present in that area. Where VOC data are needed to fill a data gap, the gap could potentially be filled with either soil vapor data or soil data, and the specific sampling requirements will be documented in the sampling plan.

The estimated number of additional required samples, and the chemical analyses required for each of the approximately 250 Chemical Use Areas are shown in Tables I-7 and I-8. The number of locations at each Chemical Use Area is shown on Table I-7, however two samples (i.e., one from the 0 to 2 feet soil interval and one from the 2 to 10 feet soil interval) are generally assumed to be required from each sample location identified in the table. In addition, it is assumed that one additional sample will be needed from locations identified in appendix Table I-8 at a depth below 10 feet to determine the vertical extent of contaminated soil.

Some EUs have no identified Chemical Use Areas (EUs 14, 15, and 16). The number of samples required to be collected from these EUs is the number required to perform a risk assessment consistent with CERCLA. As calculated in the risk assessment statistical method, 15 samples from each depth interval is required from each of these EUs. In these areas, sampling can be conducted randomly, on a grid (approximately 1 acre areas), or biased toward any features identified as potential source areas prior to sampling.

The total number of samples estimated to be required to characterize and delineate areas of known or suspected contamination is approximately 2180. However, a number of site-specific factors may increase or decrease the number of actual samples required. Such factors include:

- Shallow bedrock that precludes the need and ability to collect deeper samples (note that some bedrock samples may be collected from the soil/bedrock interface for analysis)

- Identification of contamination in areas not previously characterized that then requires lateral and vertical delineation
- The presence of natural (topographic and bedrock) features that aid in the delineation of soil contamination.
- Newly-identified facility-specific conditions such as new process information, samples being collected under the active RFI program or removal actions under other programs.

Some of these factors will be identified and the actual numbers and locations of samples adjusted during the preparation of the Field Sampling Plan. Other factors may be addressed through application of the TRIAD approach during implementation of the sampling program.

As mentioned in previous sections, numerous samples are being collected under the current RFI program. A preliminary review of the sampling program indicates that, potentially, many of the identified data gaps could be filled with data collected during the RFI. However, they remain data gaps until the analytical data have been reviewed, and use of the data for purposes of risk assessment, characterization and delineation can be verified.

The RFI program is not collecting samples in areas where no chemical uses are indicated such as in EUs 14, 15, and 16, and in the undeveloped areas of other EUs. The number of samples required to fully characterize undeveloped areas and to provide data for the human health risk assessment in EUs where no chemical use has been documented, is 296.

4.1.2 Radionuclide Analysis Data Gap

4.1.2.1 Surface Soils

The results of the calculation of the required number of surface samples for radionuclide analysis for each SU, determined according to MARSSIM guidelines, and the sample size determined for a CERCLA risk assessment are shown on **Table 4-2** for the residential and rural residential exposure scenarios. The analysis was performed on an individual radionuclide basis for each SU, not every previously-collected sample was analyzed for the same suite of analytes. Therefore the data gap is driven by the largest number for any constituent in the SU. However, radionuclides that are being investigated as COIs but have never been detected above background levels in Area IV were not used to drive the data gap since it is uncertain if they will become COCs until further sampling and analysis is performed. Details of the calculation of the data gap for surface soils are shown for each radiological COI and each SU in the tables in **Appendix G**.

Under both the residential and rural residential scenario, 17 Class 1 SUs had average results for at least one constituent (with at least eight valid sample results) that was over the DCGL or had a standard deviation greater than one-half the DCGL. For these areas, collection of the statistical number of samples required to have confidence that the area does not exceed the DCGL will not be required. These SUs are denoted

with a 1 in the remediation test column of the tables in Appendix G in the row for the analyte that exceeds a DCGL. The numbers of samples required for these areas to further define the extent and nature of contamination was calculated assuming a relative shift of 1.5 and the SU size.

The total number of samples required to adequately characterize and delineate radiological contamination in Area IV surface soil for both the residential and rural residential land use exposure scenarios, as determined by the CERCLA risk assessment area size limit, is 616. This is the data gap for radiological surface soils.

4.1.2.2 Near Surface and Subsurface Soils

The gap analysis identified an insufficient number of existing sample results for near surface and subsurface samples in Area IV on which to base future sampling decisions. There are only 12 samples for near surface and 40 samples for subsurface across all of Area IV. Of these, there is only a limited list of analytes and most of them had a "method detection uncertain" status. Because of the lack of data, the statistical calculation of the data gap was based on assumptions. Since the required detection limits will be set lower than the DCGL for future sampling and since contamination of the near surface soils is considered unlikely and even less likely for subsurface soils, the number of near surface samples was calculated assuming a relative shift of 3.0 and applied using the same area size limits for risk assessment as for surface soils. Subsurface soils will be collected at all near surface soil locations. However, analyses will only be performed for 25 percent of the subsurface surface soil locations with a minimum of one sample per SU unless concentrations above the background screening value are detected in near surface soils. The data gap is shown in Table 4-2 for both near surface and subsurface soils. The required number of near surface samples is 491 and of subsurface soil samples is 151, although a total of 491 samples should be collected to allow further analysis based on near surface results. The data gap is shown for each SU in **Table 4-3**.

4.1.2.3 Gamma Walkover Survey Data Gap

A large number of radiological surveys have been performed within SSFL to document achievement of remedial goals in various portions of the site. Independent third parties such as the staffs of California regulatory agencies and of the Oak Ridge Institute for Science and Education have performed independent verification surveys to reconfirm results for many of the original surveys. Documentation of gamma walkover surveys has been reviewed as an integral part of this data gap analysis to assure that survey information is comprehensive and fully defensible. Results of this review are addressed within this section. **Table 4-4** presents SU classification, acreage, the planned GWS coverage and the coverage already completed, based on the analysis below.

Surveys implemented prior to the development of MARSSIM were individually assessed to evaluate their acceptability for use. A summary of GWS data collected for SSFL Area IV is presented below. Results are designated as being either compliant or non-compliant for use in final verification decision-making, where non-compliant

data may represent a data gap. Rationale for designating data as compliant or non-compliant is provided in the discussion, below.

It is assumed that no additional GWS data are required for those areas where the historical GWS data are considered compliant thus reducing future coverage requirements as presented in **Table 4-4**. Areas with compliant GWS coverage are illustrated in **Figure 4-1.**

MARSSIM-non-compliant walkover surveys have been performed on greater than 80 percent of Area IV and were originally used to direct sampling activities. These data can assist in MARSSIM classification decisions. However, future verification decisions will be supported only by GWS deemed compliant with MARSSIM guidance or collected as part of this data gap sampling program.

To date, MARSSIM-compliant walkover surveys have been completed for a total of about 9 acres. Although GWSs of the appropriate quality have been performed for about 23 percent of EUs -01 and -06, and 40% of NA-03 (an area within the Undeveloped Area), GWSs performed to date include less than 7 percent of other EUs. MARSSIM guidance requires less than 100% coverage of Class 2 and Class 3 SUs for final status surveys. However, 100% coverage will be performed for the characterization surveys performed for the Area IV EIS in order to provide full characterization of the site and to verify the process knowledge.

Compliant Gamma Walkover Data/Areas
The following presents supporting information for GWS data deemed MARSSIM compliant for use in final verification decision making. The reference documents for these GWS data include:

1. Final Status Survey Report: Characterization and Final Status Survey Radioactive Materials Handling Facility Perimeter, Cabrera Services, March 2006 (8 survey units located north and west of the Radioactive Materials Handling Facility);
2. Final Status Survey Report: Final Status Survey Post Historical Site Assessment Sites, Block 1, Cabrera Services, March, 2007 (Sites 4023, 4028, 4030, 4363 and 4583 as noted in the report);
3. Characterization and Final Status Survey Report: Radioactive Materials Handling Facility Holdup Pond (Site 4614);
4. Building 4059 Final Status Survey Report (Phase A and Phase B), July 2005 with Revision February 2008 and associated Building 4059 Final Status Survey Procedure Procedure, September 2004;
5. 17th Street Drainage Final Status Survey Report, March 2000; and
6. Verification Survey for the Land Area Formerly Supporting the Hot Laboratory (4020), December 2000 , in conjunction with Area 4020 MARSSIM Final Status Survey Report (includes Building 4468) (August 2000) and the Area 4020, Final Status Survey Procedure (August 1999)

Walkover surveys cited in 1,2,and 3 above were "designed in accordance with MARSSIM guidance such that collected survey data can be used to demonstrate compliance with the release criteria for unrestricted use." Each of these surveys incorporate the data quality assessment process and associated QA/QC. The following excerpt from survey report 1 above reflects the approach and equipment used in each of the three above gamma walkover efforts:

> *Gross gamma walkover survey data were collected using a Ludlum Model 2221 scaler/rate meter with a Ludlum Model 44-20 3" x 3" sodium iodide (NaI) gamma scintillation detector. The detector was suspended at a height of approximately 10 centimeters above the ground and moved in parallel lines about 0.5 meters apart at a speed of roughly 0.5 meters per second. The measurements were position correlated using the GPS. Data were automatically logged with the measurement coordinates using a Trimble TDC1 GPS. The GPS link tied survey data to spatial locations using state plane coordinates for California, Zone 5, North American Datum (NAD) 1983. The GPS was checked daily to ensure accuracy and repeatability.*

The survey contractor calculated a scan minimum detectable concentration of 3.7 pCi/g for ^{137}Cs thus these walkover surveys were able to detect the modified ^{137}Cs derived concentration guideline level of 4.7 pCi/g. Gross gamma walkover data, organized by survey unit and presented in Microsoft® Excel data files, is reportedly available for this walkover effort with data files containing location and recorded count rate information along with background population records.

Walkover surveys cited in 4, above, was developed to "follow the protocols of the Multi-Agency Radiation Survey and Site Investigation Manual" and were performed using Ludlum Model 44-2 detectors which incorporate 1" x 1" NaI scintillation crystals. The survey also utilized a TSA Systems Model GPRS-104 Radiation Scanning System that incorporates a 3" wide x 3" long x 1.5" thick plastic scintillation detector interconnected with a global positioning system receiver for location and data logging. The report incorporates the data quality objectives (DQO) process and derives a site specific scan MDC for Eu-152 of 3.1 pCi/g which would be somewhat lower than the stated required MDC (4.0 pCi/g). Although an overview of "Environmental Calibration Site" is contained within paragraph 3.5.2 of the survey report, comprehensive instrument quality assurance/quality control protocols have not been reviewed. Some such procedures may be incorporated in RS-00012, "Methods and Procedures for Radiological Monitoring" Rev A, January 2, 2002" which is incorporated by reference. Verification Surveys were also performed on 50 to 100% of this footprint by ORISE following MARSSIM guidance in 2005.

The walkover survey report cited in 5 above notes that "On June 1, 1999, a MARSSIM final status survey was completed at the 17th Street Drainage Area confirming that the area meets release limits approved by the Department of Energy, and the Department of Health Services." It also notes that "The MARSSIM final status survey for the 17th Street Area followed the guidelines of the Rocketdyne Procedure R21-RF-RS00005"

and calculates required and scan MDCs of 12.9 and 10.3 pCi/g, respectively. Paragraph 4.1.1, Surface Exposure Rate, provides a overview of gamma count rates and exposure levels. The report incorporated "17th Street Drainage Area – Radiation Characterization Surveys and Excavation" dated December, 1998. This enclosure notes that "66 hotspot locations were found during the walkabout survey" and that "a total of 13 representative surface walkabout hotspot locations were sampled and analyzed" with results reflecting a maximum of 2.11 pCi/g or about 22% of the release limit. Brief procedures applicable to "Instrument Performance Check" are contained in paragraph 3.9.3 which requires "periodic checks of the instrument's response to normal background and to a Field Check Source". In addition, paragraph 3.9.4 addresses "Environmental Calibration Site" as the "daily source check area". Although additional quality assurance/quality control provisions may be incorporated into the aforementioned Rocketdyne procedure, comprehensive instrument quality assurance/quality control action levels for performance tests protocols were not located within the survey reports. Verification Surveys were also performed on 100% of this footprint by ORISE following MARSSIM guidance in 2000.

Although limited walkover information is provided in the Area 4020 Final Status Survey Report cited in 6, the ORISE verification survey report augments the report and provides additional detail. The ORISE report notes that "For the Phase III 1999 survey, Rocketdyne had adapted the final status survey methodologies contained in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC 1997)." Phase I and II ESSAP surveys in 1997 and 1998 were performed using other protocols and a 10 m X 10 m grid to facilitate backfill prior to the rainy season. The ORISE verification report also notes that "Surface scans for gamma activity were performed over 100 percent of the RIHL using NaI scintillation detectors coupled to ratemeters with audible indicators"; that "Surface scans for gamma activity did not identify any locations of direct radiation in excess of ambient background levels" and that confirmatory "soils samples were collected from 42 locations within the RIHL areas". The highest ^{137}Cs concentration measured in confirmation survey soil samples was 0.4 pCi/g. An overview of ORISE "Survey and Analytical Procedures" is contained within Appendix B with more detailed "Calibration and Quality Assurance" procedures being contained within their Survey Procedures Manual (October 1997) and Quality Assurance Manual (September 1996). The Boeing "Walk-About Survey" and "Walk-About Hot Spot Survey" are addressed in Section 5.5 and 5.6 of the final status survey report, respectively. Paragraph 5.5.6 requires that the surveyor "Note the approximate maximum and minimum count rate observed during the walk across the survey transit line and approximate average count rate value for the entire pass". In addition, although 5.5.7 notes that "If a gamma count rate exceeds 4300 cpm, the surveyor will mark the potential spot" the rationale for this action level is not specified. Verification Surveys were also performed on 50 to 100% of this footprint by ORISE following MARSSIM guidance in 2005. Verification Surveys were also performed on 100% of this footprint by ORISE following MARSSIM guidance in 2000.

Non-compliant Gamma Walkover Data/Areas
The reference documents containing non-compliant GWS data are discussed below.

Area IV Radiological Characterization Survey, Final Report, Volume I, Santa Susana Field Laboratory, August 15, 1996. A "walk-about survey" of most portions of the Santa Susana Field Laboratory Area IV was performed between March 1994 and September 1995. This survey utilized Ludlum Model 44-2 NaI detectors coupled with Ludlum Model 2221 or Model 2220-ESG scaler/ratemeters and used a Reuter-Stokes Pressurized Ion Chamber for standardization. The Ludlum Model 44-2 uses a 1-inch-by-1-inch (1×1) NaI detector. "The maximum, average, and minimum counting rates observed on the meter during each traverse across the survey block". "A counting rate of 4000 cpm, equivalent to 4-5 μR/hr above the estimated background, was used as the threshold for further review." "When these measurements exceeded estimated background by more than 5 μR/hr, a soil sample was collected."

The rationale for Non-compliant Designation includes: 1) Data limited to the maximum, average and minimum counting rates observed for each traverse across the survey block rather than for the count rate and GPS location to be recorded each second (or two) during the survey; 2) The collection of soil samples was limited to areas that exceeded background by more than 5 μR/hr rather than investigating any anomalies that are detected (i.e., 4200 cpm used to designate a "hot spot" could also result in significant potentially elevated areas being overlooked.) Rationale for selection of this action level was not located in the report; 3) Scan MDC for detection for the Ludlum Model 44-2 relative to the site soil DCGL of 9.2 pCi/g above background. NUREG-1507 indicates that the scan MDC for 137Cs is about 6.4 and 10.4 for 2×2 and 1.25×1.5 NaI detectors, respectively. Assuming a linear relationship with the volume of the detector and holding other factors as constant, the 1" × 1" detectors used for the survey would be expected to exhibit a scan MDC of about 20 pCi/g. (Information relative to the required and actual scan MDCs for the 1" x 1" detector were not located within the document, though it is noted that longer residence times and other factors can reduce the 137Cs MDC to the about 10 pCi/g.)

Area 4064, Final Status Survey Report, Release Date April 13, 1999. "In September, 1998, the Final Status Survey was conducted in the entire 2 acres of area 4064, including drainage pathways, former parking lot areas, surrounding areas, and the side yard area." "The entire 2-acre lot was surveyed and sampled including a direct qualitative surface gamma scan (100%) for contamination". "Gamma peaks greater than 4100 cpm, measured at the surface" "were considered radiological suspect locations that required soil sampling and analysis." Surveys were performed with a Ludlum Model 44-2 (1×1 NaI detector).

The rationale for Non-compliant Designation includes: 1) although MARSSIM was published in December, 1997, available information suggests that this survey was performed using radiological survey procedures utilized by DOE prior to publication of MARSSIM; 2) Scan MDC for detection for the Ludlum Model 44-2 relative to the site soil DCGL of 9.2 pCi/g above background. NUREG-1507 indicates that the scan

MDC for ^{137}Cs is about 6.4 and 10.4 for 2×2 and 1.25×1.5 NaI detectors, respectively. Assuming a linear relationship with the volume of the detector and holding other factors as constant, the 1×1 detectors used for the survey would be expected to exhibit a scan MDC of about 20 pCi/g for ^{137}Cs. (Information relative to the required and actual scan MDCs for the 1" x 1" detector were not located within the document, though it is noted that longer residence times and other factors can reduce the ^{137}Cs MDC to the about 10 pCi/g.); 3) The collection of soil samples was limited to areas that exceeded background by more than 4100 cpm, measured at the surface. The rationale supporting this value/approach (or to enable a count rate to soil concentration ratio to be established) was not located in the document. This approach together with the scan MDC could have resulted in an inability to locate elevated areas that would be located using MARSSIM-compliant approaches.

Historical Site Assessment of Area IV, Santa Susana Field Laboratory, Ventura County, California, Sapere Consulting, Inc., and the Boeing Company, May 2005. A walkover survey was performed in September of 1979 of the Building 4010 area by the Formerly Utilized Sites Remedial Action Program (FUSRAP) Survey Group from Argonne National Laboratory. "At the time of the survey, the building had already been demolished and the asphalt parking lot area was already in place."

The rationale for Incomplete Designation includes: The required detection sensitivity would not have been achieved given the existence of cover materials. Further, details with respect to survey protocols and the precise area surveyed were not located.

Confirmatory Radiological Survey of the L-85 Reactor Facility, Final Report, Oak Ridge Associated Universities Radiological Site Assessment Program, December, 1986. This report notes that "ORAU personnel performed walkover surface scans, using gamma scintillation detectors, to a distance of 10 meters from the building (Building T-093) in all directions. Scans were extended to cover the access roads and parking lots to a distance of 80 meters from the building." These surveys were performed with 1.25× 1.5 NaI gamma detectors coupled with PR M-6 rate meters.

The rationale for Incomplete Designation includes: Details with respect to survey protocols were not located for walkover surveys. In addition, given that over 20 years has elapsed, it is not clear that the survey is representative of current conditions.

Radiological Survey of Building T005, February 1988; Radiological Survey of the Sodium Disposal Facility, Building T886, June 1988; et al. A number of survey reports dating prior to 1996 include exposure assessments based on one-minute counts using Ludlum Model 44-2 scintillation detectors at one meter above the ground surface. Such surveys can include hundreds of radiological measurements and thus provide valuable information relative to radiological characteristics and permit establishment of an upper bound on soil concentrations present. They do not, however, provide a basis for determination as to whether areas of activity exceeding remediation criteria may exist. As such, the associated areas are retained for resurvey as part of this data gap assessment.

4.2 Groundwater

Based on a review of the site conceptual model coupled with an evaluation of analytical results and sampling locations, several data gaps were identified for groundwater characterization. This includes data necessary to define nature and extent of contamination and for assessment of groundwater cleanup remedies in the EIS.

The groundwater site conceptual model is illustrated in **Figure 4-2**. As shown in the figure, groundwater occurs in the overburden and bedrock, and downward vertical gradients prevail. Near the center of Area IV a groundwater divide occurs; starting at the divide, the gradient is to the northwest and to the southeast. Low bulk hydraulic conductivities of the rock units provide a resistive pathway for the movement of groundwater. However, where fractures, which appear to be limited, are open and interconnected, groundwater travels more readily. Discharge points are located in the valleys as indicated by the upward vertical gradient beneath the tributary to the northwest. Where open pathways (e.g., fractures) reach to the surface, groundwater is revealed as seeps and springs. Contaminant travel paths will tend to follow the movement of groundwater, but also be controlled by other fate and transport properties of the aquifer and the contaminant. Therefore, typically, the contaminant distribution follows the prevailing hydraulic gradient, but deviates in response to aquifer conditions and chemical properties.

4.2.1 Groundwater COI Statistics

Table 4-5 presents the statistics that were prepared for the groundwater COIs. The groundwater data presented are for the most recent five-year period (2003 to 2007) available in the database provided by Boeing. This period was chosen so that an accurate representation of current conditions could be evaluated. An evaluation of the statistics is beneficial in identifying prevalent constituents that can be used to assess data gaps. Also, some of the information in the Table 4-3 is used to directly identify data gaps.

As shown in the Table 4-5, the most frequently detected radionuclide is tritium. Tritium was detected 656 times out of 678 samples. The maximum concentration of 117,000 pCi/L (MCL is 20,000pCi/L) was detected at RD-95, which is located in the northwest part of Area IV.

TCE, cis-1,2-DCE and 1,1-DCE are three VOCs that may be of the next most concern as groundwater contaminants. Each of these compounds was detected at a high frequency (1,593 out of 1,594, 450 out of 901, and 279 out of 642 samples, respectively). Their maximum concentrations were at least two orders of magnitude higher than their respective MCLs.

As shows in the Table 4-5, VOCs are the group that was most often analyzed. Most VOCs are listed as being analyzed almost 3,000 times. Tritium and gross alpha under the radiological group are second regarding the number of times a constituent has

been analyzed. These two radiological constituents were analyzed 678 and 732 times, respectively. Many metals were analyzed several hundred times also. Although several constituents have been analyzed several hundred times or more, some constituents have not been analyzed for as often. Some metals, dioxins, and many radionuclides have been analyzed a limited number of times (less than 35 times) during the last five years.

4.2.2 Distribution of Prevalent Groundwater COIs

Figures 4-3 and 4-4 illustrate the distribution of tritium in shallow groundwater and Chatsworth Formation groundwater, respectively. As illustrated in Figure 4-3, no exceedances above the MCL have been recorded in the shallow groundwater. However, in the bedrock (Figure 4-4), tritium has been detected above the MCL in five wells. The wells are located in EU-08; two of the wells, RD-88 and 90, are located within approximately 50 and 150 feet, respectively, of the property boundary. A well is not located directly downgradient (following flowpaths that are perpendicular to the mapped potentiometric contours) of RD-88 and 90, which have reported tritium concentrations above the MCL. Two wells (RD-87 and 94) are located downgradient of the elevated tritium wells, but are offset to the east and west, respectively. Beyond these wells, the next nearest wells that may be considered downgradient of the area are approximately 1,500 feet to the west.

Figures 4-5 and 4-6 summarizes the distribution of TCE in the shallow groundwater and Chatsworth Formation, respectively. TCE has been detected above its MCL (5 ug/L) in several locations in Area IV. The highest TCE concentrations are reported in the southwest portion of Area IV. Elevated TCE concentrations are also reported in shallow groundwater in the central and west-central portions. Elevated TCE concentrations in the bedrock are also identified in the southwest area where the groundwater gradient is to the west. However, the distribution of bedrock wells in the central and east-central portions is limited and TCE occurrence can not be verified. For example, elevated TCE concentrations are detected at PZ-104 in the shallow zone; however, the nearest rock well is RD-20 which is considered an upgradient location. No Area IV bedrock wells are next to or downgradient of PZ-104. A similar limitation is observed at PZ-051 and -052. Lastly, the elevated TCE concentrations in rock near west-central Area IV (e.g., RD-30) are not well defined. No wells are located northwest from this location, which is dowgradient of the area. The well cluster RD-34 B/C is located at the west end of the well group.

Perhaps the most significant observation of the distribution of cis-1,2-DCE, which is shown in **Figures 4-7 and 4-8**, is that elevated concentrations are located downgradient of the southeast end of Area IV, but outside of Area IV. Approximately 300 feet east of Area IV, elevated cis-1,2-DCE concentrations are recorded at RD-55 and -58, but no bedrock wells are located upgradient in Area IV. Also, the available limited shallow groundwater data suggest no shallow source at these rock locations (RD-55 and -58). Therefore, the data suggest that a source may be upgradient in the southeast portion of Area IV where no wells are located.

The distribution of elevated concentrations of 1,1-DCE is similar to TCE and is shown in **Figures 4-9 and 4-10.** The highest concentrations are found in the shallow aquifer in the southwest portion of the area. Elevated concentrations are also detected in bedrock in the southwest and west-central portions of the area.

4.2.3 Soil and Soil Vapor Concentrations

Figures 4-11 and 4-12 illustrate soil DCGLs exceedance locations in relation to groundwater sampling locations, for the 0 to 2 feet bgs and 2 to 10 feet bgs intervals, respectively. As demonstrated in these figures, in some areas where DCGLs are exceeded, groundwater sampling points are absent or minimal. Groundwater sampling points should be available to evaluate whether the constituents have impacted the groundwater. The following locations are where soil exceedances are recorded, but no (or minimal) groundwater sampling points are available.

- Large Class 1 SU in EU-10
- Class 1 SU in EU-03
- Large Class 1 SU in EU-01
- Class 1 SU in EU-02
- Class 1 SU in EU-06
- Class 1 SU in EU-12
- Class 2 SU locations in EU-16
- Class 1 SU in EU-13

In addition to comparing soil criteria exceedances to groundwater sampling locations, soil vapor concentrations were also compared to the sampling locations. **Figures 4-13 and 4-14** present a comparison of TCE in soil vapor and groundwater sampling locations (with detections of TCE). As shown in the figures, no elevated soil vapor samples were detected in areas where elevated concentrations of TCE were detected in groundwater. This observation may be due to a limited number of soil vapor samples being collected. Moreover, where an elevated TCE concentration was detected in groundwater (RS/RD-54), an elevated TCE concentration was detected in soil vapor. However, at some locations, an elevated TCE concentration was detected in the groundwater (e.g., RS-18 in Figure 4-5), but no TCE soil vapor sample was collected. In areas where elevated TCE groundwater concentrations were detected, soil vapor samples should be collected and analyzed.

4.2.4 Data Gaps in Groundwater Monitoring Network

Based on the review of the Area IV hydrogeologic information and the analytical database, the following data gaps have been identified. A recommendation is

provided for filling in each data gap. The data gaps are grouped as installing and testing new wells, collecting groundwater attenuation parameters, and conducting a background study.

Installing and Testing New Wells

Data suggest that contamination may occur in, or may be migrating to, areas that are not monitored by wells. Wells need to be installed and groundwater samples need to be collected in these areas so that the nature and extent of contamination can be delineated. Geophysical logs shall be run at each of the boreholes to receive multichannel wells and discrete zone tests (i.e., packer tests) shall be performed to assist in identifying zones to be monitored. The discrete zone tests shall consist of collecting samples to be analyzed for COIs and conducting hydraulic tests (which may be limited to zones producing moderate amounts of water) to characterize the interconnectedness of the water-bearing fractures between the tested well and neighboring wells. The proposed well locations (identified with the prefix DOE) are shown in **Figure 4-15.**

- A well is not located directly downgradient (following flowpaths that are perpendicular to the mapped potentiometric contours) of RD-88 and 90, which have reported tritium concentrations above the MCL. Two wells (RD-87 and 94) are located downgradient of the elevated tritium wells, but are offset to the east and west, respectively.
    - Install one multichannel bedrock well (DOE1) northwest of RD- 88 and RD-90.
- Elevated TCE concentrations are detected at PZ-104 in the shallow zone; however, the nearest rock well is RD-20 which is considered an upgradient location. No Area IV bedrock wells are next to or downgradient of PZ-104.
    - Install one multichannel bedrock well (DOE2) immediately east of PZ104.
- Elevated TCE concentrations are detected at PZ-051 and PZ-052, but no bedrock wells are located nearby.
    - Install one multichannel bedrock well (DOE3) immediately east of PZ051.
- The elevated TCE concentrations in rock near west central Area IV (e.g., RD-30) are not well defined. No wells are located northwest from this location, which is downgradient of the area. The well cluster RD-34 B/C is located at the west end of the well group.
    - Install one multichannel bedrock well (DOE4) northwest of RD-63.
- Data suggest that a contaminant source may be located in the southeast part of Area IV (upgradient of wells RD-55 and 58) where no wells are located.

- Install one multichannel bedrock well (DOE5) in Areas IV west of RD-55 and one multichannel well (DOE6) in Area IV west of RD-58.

- Soil contamination suggests a possible source exists where wells do not monitor groundwater west and northwest of the large Class 1 SU in EU10.
  - Well PZ-124 is near this proposed well location; this shallow well can be used as a sampling point for shallow water. If contamination at concentrations significantly above an MCL is detected, then the multi-channel well (DOE7) in rock shall be installed.

- Soil contamination suggests a possible source exists where wells do not monitor groundwater north of the Class 1 SU in E-U3.
  - Collect a shallow groundwater sample (via a new monitoring well or temporary point); if elevated constituents are detected, install a deeper monitoring well (DOE8).

- Soil contamination suggests a possible source exists where wells do not monitor groundwater north of the large Class 1 SU in EU-01.
  - Collect a shallow groundwater sample (via a new monitoring well or temporary point); if elevated constituents are detected, install a deeper monitoring well (DOE9).

- Soil contamination suggests a possible source exists where wells do not monitor groundwater south of the east end of the Class 1 SU in EU-02.
  - Collect a shallow groundwater sample (via a new monitoring well or temporary point); if elevated constituents are detected, install a deeper monitoring well (DOE10).

- Soil contamination suggests a possible source exists where wells do not monitor groundwater at the east edge of the Class 1 SU in EU-06.
  - Collect a shallow groundwater sample (via a new monitoring well or temporary point); if elevated constituents are detected, install a deeper monitoring well (DOE11).

- Soil contamination suggests a possible source exists where wells do not monitor groundwater south and west of the Class 1 SU in EU-12.
  - Collect a shallow groundwater sample (via a new monitoring well or temporary point); if elevated constituents are detected, install a deeper monitoring well (DOE12).

- Soil contamination suggests a possible source exists where wells do not monitor groundwater in the large Class 3 SU location in EU-16.
    - Collect a shallow groundwater sample (via a new monitoring well or temporary point) at the proposed location; if elevated constituents are detected, install a deeper monitoring well (DOE13).
- Soil contamination suggests a possible source exists where wells do not monitor groundwater west-southwest of the Class 1 SU in EU13.
    - Collect a shallow groundwater sample (via a new monitoring well or temporary point); if elevated constituents are detected, install a deeper monitoring well (DOE14).

Collecting Natural Attenuation Parameter Data
Natural attenuation may have some control in organic compound concentrations in groundwater. However, data on monitored natural attenuation (MNA) parameters are limited in Area IV. Activities for MNA studies are currently proposed by Boeing at some locations at SSFL; one location is in Area IV, and it is a contingent location (MWH 2007). Therefore, there is a need to collect groundwater samples and have them analyzed for MNA parameters to evaluate if the saturated zone chemistry is favorable to natural attenuation.

Conducting a Background Study
A groundwater divide, in general, bisects Area IV. Therefore, no wells are upgradient of Area IV and no traditional upgradient background wells can be selected. A set of groundwater comparison concentrations was developed for metals from reported concentrations at wells located throughout the SSFL (MWH 2005). The concentrations are not specific to Area IV; the concentrations may be used as one set of comparative concentrations, but should not be specifically considered background concentrations for Area IV. Therefore, a study should be performed using available data (i.e., the study is not expected to involve the installation of additional wells for the sole purpose of collecting upgradient/background samples) to identify the background concentrations of the naturally occurring groundwater constituents. This study will need to include wells installed in the both the Chatsworth and Santa Susana Formations since both underlie parts of Area IV.

4.3 Groundwater Seeps

Data for groundwater seeps can aid in the understanding of the fate and transport of contaminants in groundwater and to assess the potential human health and ecological exposure pathways for the respective risk assessments. However, most seeps only exhibit water during and immediately following the rainy season. The requirement to sample seeps will be incorporated into the field sampling investigation designed to address the overall data gaps presented in this report. Therefore, all identified seep locations will be visited during the field program and will be sampled for

radionuclide and chemical COIs should sufficient water be present. A GWS will be performed at all seeps.

4.4 Soil Vapor

Collection of additional soil vapor data will be a consideration for the field sampling investigation, particularly for the potential placement of monitoring wells. It is recognized that under the RFI program, collection of additional soil gas samples is proposed. These data, coupled with the overall needs of the data gap analysis as refined during the development of the FSAP, will be used to determine specific needs for additional soil gas.

4.5 Surface Water

Surface water sampling for most site drainages is being conducted under the NPDES permit program. Data collected under the NPDES program are deemed sufficient for site characterization for some areas of Area IV. As noted under Section 4.7 – "Ecological Receptors", there are internal Area IV drainages leading to ponds in other SFFL areas with limited or no data. If present during the field sampling program, surface water samples will be collected and analyzed for radionuclide and chemical COIs. Any pond or body of water receiving runoff from Area IV will also be proposed for sampling under the field sampling investigation. Also, to produce confirmatory data to the NPDES results, NPDES monitoring points will also be sampled should sufficient rainfall occur during the field sampling investigation.

4.6 Sediment

Contamination extent associated with NPDES monitored drainages appears to be bounded by existing sample results. However, as discussed in Section 4.7, there are internal drainages to Area IV that lack sediment data. These drainages become a data gap and will require sampling for radionuclide and chemical COIs.

4.7 Ecological Receptors

4.7.1 Data Gap Results for Ecological Risk Assessment - Chemicals

The historical chemical data collected from soil (0 to 2 feet, 2 to 4 feet, 4 to 6 feet), sediment, surface water, groundwater seep, sump soil, sump water, and soil gas were reviewed to determine if they were acceptable for use in the ERA. As stated above, if the laboratory detection limit for a chemical in a given medium was higher than the lowest ESL for that chemical in that medium, then the results for that chemical in that medium were not deemed usable for purposes of assessing risk to ecological receptors.

Following an evaluation of the entire data set for usability, the data for soil were subsequently reviewed in an effort to evaluate whether the soil chemical ESLs were as low as or lower than the soil human health PRGs. A significant number of soil samples are proposed to be collected and analyzed for use in the human health risk

assessment. In order to make sure that the same soil chemical results can also be used in the ERA, a comparison of chemical ESLs to the human health PRGs was completed. If an ESL for a particular chemical (or CPEC) was lower than the human health PRG, it was noted. The method of analysis for any chemical found where the ESL is lower than the human health PRG will be evaluated to ensure that the laboratory analytical detection limits used for soil samples collected in the upcoming field event will be lower than the ESL. The data gaps associated with the chemical data are further discussed as part of the screening for preliminary CPECs in Section 4.7.3. Similarly, the MDLs for radionuclides were compared to the ecological PRGs for radionuclides to ensure that the laboratory analytical detection limits used for samples collected in the upcoming field event will be adequate. The data gaps associated with radionuclides are further described below in Section 4.7.2

4.7.2 Data Gaps Results for Ecological Risk Assessment - Radionuclides

4.7.2.1 Soil in Area IV

Analytical data for radionuclides exist for surface soil (0 to 2 feet) from over 14,000 samples collected from Area IV EUs (**Figure 4-16**). However, less than 10 samples have been collected from four EUs (EU-13 through EU-16). More than 10 soil samples with radionuclide data were collected from EU-01 through EU-12. However, only EU-04, -06 and -08 have data from more than 10 samples for most if not all of the radionuclides in the database (**Appendix E Tables E-4, E-5, and E-6**). All other EUs have zero samples for one or more radionuclides potentially related to Area IV operations. Therefore, 10 additional surface soil samples from all EUs, except EU-04, -06 and -08, will be required for the ERA. It is expected that at least this number of additional samples will be required for the human health risk assessment (see Section 4.1) and will be collected as part of the overall soil characterization efforts.

Not all radionuclides detected in surface soil are necessarily related to operations in Area IV. There are sufficient acceptable data for K-40 in surface soil at EU-01 through EU-12 to indicate that concentrations do not exceed the derived background concentration (**Appendix E Table E-4**). Additional samples to be collected in all Area IV EUs can be used to confirm this projection.

There are data for four radionuclides (Cs-137, K-40, Ra-226, and U-235) in six samples from the 2 to 4 feet soil interval collected from two EUs in Area IV; three each at EU-04 and one in EU-07 (**Appendix E Table E-5**). This is an insufficient number of data points for this medium to support the ERA. Additional 2 to 4 feet soil samples are needed for the ERA in all EUs and the adjacent offsite area.

There are data for four radionuclides (Cs-137, K-40, Ra-226, and U-235) in eight samples from the 4 to 6 feet soil interval collected from two EUs in Area IV; three at EU-04 and five at EU-07 (**Appendix E Table E-6**). This is an insufficient number of data points for this medium to support the ERA. Additional 4 to 6 feet soil samples are needed for the ERA in all EUs and the adjacent offsite area.

The MDLs for the soil data in all but two samples are adequate for the ERA. Soil MDLs do not exceed the ecological PRGs for radionuclides. New samples collected for the Area IV ERA will need to have MDLs lower than the ecological PRGs.

4.7.2.2 Surface Water and Sediment in Area IV

During the field visit conducted in April 2008, no bodies of water that support viable aquatic life were found in Area IV. Therefore, no sampling is recommended.

4.7.2.3 Seep Water/Shallow Groundwater

There are approximately 320 shallow groundwater samples from Area IV with radionuclide data (**Appendix E Table E-7**). Shallow groundwater samples are available from EUs -04, -08, -10, and 011, which are adjacent to the Area IV boundary where shallow groundwater potentially daylights at seeps along the west and northwest escarpment (see Figure 4-15). Shallow groundwater also potentially daylights at seeps along the east and southeast escarpment. With the exception of EU-07 and -11, which have more than 10 samples for most analytes, there are no or little data for radionuclides in shallow groundwater at other Area IV EUs, including EUs -02, -05, -09, -012 and -015, which are adjacent to the east and southeast boundary of Area IV. The shallow groundwater data for these EUs are deemed insufficient to evaluate the potential risk for terrestrial animals exposed by drinking seep water and for aquatic biota in downgradient surface water bodies that contain water for sufficient duration to support aquatic life.

The MDLs for the shallow groundwater data are adequate for the ERA. Groundwater MDLs do not exceed the ecological PRGs for radionuclides. Any new groundwater samples collected for the Area IV ERA will need to have MDLs less than the lower of the ecological terrestrial and aquatic PRGs for water.

4.7.2.4 Offsite Surface Water and Sediment

As the site is defined as Area IV, any sampling locations not present within Area IV are defined as "offsite." Data for offsite surface water and sediment have been collected under the NPDES stormwater program. These data and additional data proposed under the human health risk assessment will be used to support the ERA. There is a potential data gap for the ERA for bodies of water located outside the boundaries of Area IV that both contain water for sufficient duration to support aquatic life and are potentially impacted by migration of contaminants from Area IV. Pond R2 in Area II and Silvernale Pond in Area III are potential offsite locations that will require samples to be analyzed for radionuclides.

4.7.2.5 Offsite Soil

There are five surface soil samples with radiological data from locations outside the boundaries of Area IV. These samples are associated with ravines to the west and northwest, which drain surface runoff and groundwater potentially discharging from Area IV (see Figure 2-1**)**. The number of soil samples is insufficient for the ERA, but

they can be combined with surface soil samples to be collected from the buffer areas adjacent to Area IV.

The MDLs for the soil data in all but two samples are adequate for the ERA. Soil MDLs do not exceed the ecological PRGs for radionuclides. New samples collected for the Area IV ERA will need to have MDLs lower than the ecological PRGs.

4.7.3 Results of the Screen for Radionuclides and Chemicals of Potential Ecological Concern

The results of the screens for RPECs and CPECs are summarized below.

Radiological
The results of the RPEC screens are summarized by each analyte and medium for which there are sufficient data to conclude that the radionuclide is present at a concentration that exceeds the PRG. Radionuclides without PRGs are daughter products of longer-lived radionuclides and will be considered RPECs if their parent radionuclides are RPECs. There are insufficient data to conduct a RPEC screen for surface water, sediment, seep water, and offsite soil.

Soil (0 to 2 feet) – In EU-04, -06 and -08, only two radionuclides were detected at a concentration exceeding the ecological PRGs. Strontium-90 exceeded the soil PRG in surface soil at EU-06. Cesium-137 exceeded the PRG in surface soil from all three EUs. Cesium-137 was also detected above the soil PRG in -03, -07, -09 and -11. These two radionuclides, Cs-137 and Sr-90, are Area IV RPECs. Until sufficient data are collected from Area IV EUs and the offsite area for other radionuclides, it is premature to identify a final set of RPECs.

Shallow Groundwater – In EU-04, -06, -07 and -11, only two radionuclides were detected at a concentration exceeding the ecological PRGs for aquatic biota. Lead-210 exceeded the water PRG for aquatic biota in groundwater at EU-06, -07, and -11. Radium-226 exceeded the PRG in shallow groundwater from all four of these EUs. These two radionuclides, Ra-226 and Pb-210, are Area IV RPECs. Until sufficient data are collected from Area IV EUs and the offsite area for other radionuclides, it is premature to identify a final set of RPECs.

Chemical
The results of the CPEC screens, described above in Section 4.7.1, are summarized below by each media type. In all cases, these results only show those chemicals for which ESLs were not available and those for which maximum detected concentrations exceeded available ESLs.

Surface Water – Following the screens described above, surface water data are limited to one sample (**Table 4-6**). Within this sample, the maximum detected concentrations of 15 inorganics and four VOCs exceeded available ESLs. In addition, three TPHs are retained as initial CPECs because ESLs are unavailable. In summary, the review and evaluation of available surface water data indicates that (1) detection limits were too

high in some cases, (2) chemical ESLs were not available in other cases, and (3) additional sampling is required to better define the nature and extent of contaminants in surface water.

Seep Water – The results of the review of available seep water data following the aforementioned screens indicate that 24 chemicals were detected (**Table 4-7**). Many of these are essential nutrients, electrolytes, nontoxic chemicals, or conventional water quality parameters, such as total dissolved solids. For some of these detected chemicals, adverse effects can be observed in certain types of aquatic biota (e.g., daphnids), but only at extraordinarily high concentrations. Because detection limits were sufficiently low in most cases, and because a large number of samples (almost 60) were retained as "acceptable," the results of the seep water screening suggest that seeps pose little significant threat to ecological receptors. Of potential concern is the finding that the maximum concentrations of toluene and chlorobenzene exceed ESLs.

Sediment – Not counting one unidentified SVOC, from 6 to over 60 samples (depending on the individual chemicals detected) are associated with maximum detected concentrations in excess of ESLs or chemicals without ESLs (**Table 4-8**). These individual chemicals include dioxins, inorganics, PCB congeners, SVOCs (mostly PAHs), VOCs, and one pesticide (4,4'-DDD). Because the number of samples in most cases is so limited for important analytes such as dioxins and PCBs, available sediment data are of limited use for describing the nature and extent of contamination across the site. Additional sediment sampling and analyses are recommended to allow for more complete descriptions of the location and magnitude of important contaminants in sediment.

Soil (all depth horizons) – The review of soil chemical data for all three depth horizons (**Tables 4-9, 4-10, and 4-11**) reveals that many chemicals from multiple chemical classes (e.g., dioxins, PCBs, SVOCs, PAHs, metals, and VOCs) were detected in soil, often at concentrations exceeding the lowest ESLs. While most of these data appear usable for ERA purposes, it is recommended that soil samples be collected in association with the collection of terrestrial biota (e.g., plants, invertebrates, small mammals) to confirm the current nature and extent of contaminants in soil and to address data gaps in particular EUs. These recommended soil samples should be analyzed for the full suite of potentially hazardous chemicals, including dioxins, PCBs, pesticides, SVOCs (including PAHs), VOCs, and metals.

Sump Soil

A total of three sump soil samples were evaluated and deemed usable for chemical data (**Table 4-12**) following the completion of the screen described above. Based on the limited number of samples, it appears that sump soil contains several inorganic and organic (primarily VOCs, with some SVOCs and TPHs) chemicals at concentrations exceeding ESLs. The limited number of samples suggests that additional sump soil sampling may be warranted, but this decision will be considered following site surveys to determine the locations and habitats associated with the sump soils.

Sump Water
From 2 to over 50 sump water samples (depending on chemicals detected) remained following the screens described above (**Table 4-13**). These samples contained a large number of chemicals (1 to nearly 30) for which maximum detected concentrations exceeded ESLs or for which no ESLs were available. As with sump soils, decisions regarding the need to sample sump water or decisions on the approach used to evaluate sump water exposures will be based on site surveys and ecological habitat suitability.

Soil Gas
Following the screens described previously, nearly 190 soil gas samples were associated with either maximum chemical concentrations exceeding ESLs or chemicals for which ESLs were unavailable (**Table 4-14**). In nearly all cases, however, only a small fraction (<5 percent) of individual chemicals were detected in soil gas samples. The single exception to this finding was methane, where 12 of 44 samples were associated with detections. No ESL was available for methane in soil gas, so the impact of these results will be determined following further evaluation of the data.

4.7.4 Comparison of Ecological and Human Health Radiological PRGs

The radiological PRGs for the ERA for soil and water for both terrestrial receptors exposed by drinking (water, terrestrial) and aquatic receptors exposed by multiple pathways (water, aquatic) are large compared with radiological PRGs for human health risk assessment (**Table 4-15**). Except for the water (aquatic biota risk) PRGs for Pu-240 and Na-22, all ecological risk PRGs for soil and water are larger than the corresponding human health PRGs. The ecological PRGs for Pu-240 and Na-22 are less than two times smaller than the human health PRGs.

4.7.5 Data Gaps Related to Biological Tissues

The database currently contains a limited number (generally 1 to 4 per sample type and location) of biota tissue samples that were used in the development of BAFs and chemical ESLs, as discussed previously. What is known about these biota data is that the data are relatively old (collected in 2000) and were not collected from Area IV. Also known is that many of these samples were composed of composite samples of different taxa and were used in the SRAM to help develop ESLs and BAFs (MHW 2005). It is possible that some of these biota samples were collected from areas influenced by contamination from Area IV. After specific information is obtained that can relate the specific type of data with the location of the sample, it may be determined that some of these samples are from locations influenced by Area IV. A site visit by members of the ERA team will help determine what tissue sample locations may have been influenced by Area IV. If this is the case, these data may be included for consideration in the ERA.

4.7.5.1 Ecological Survey Data

The addendum to the Biological Conditions Report (BCR) (MWH and AMEC 2005) was prepared for the SSFL in April 2000, and revised in June 2003 and in March 2005, based on additional information gathered since the original biological surveys were completed for the original report (Ogden 1998). The original scope of work only included focused surveys on specific RCRA RFI sites and vegetation mapping for the remainder of the SSFL. The addendum added information regarding Federally listed endangered species and sensitive plant and wildlife species possibly present at the SSFL. Observation points have been mapped based on the surveys summarized in the BCR. These ecological survey points have been mapped and are depicted on **Figure 4-17** (plant and wildlife observations) and **Figure 4-18** (bird observations). The ecological survey information from the BCR will be used in the ERA as appropriate.

4.7.6 Identified Ecological Risk Data Gaps

Data gaps have been identified with regard to biota tissue samples with a full range of analytical results for radiological and chemical constituents. These data gaps are associated with biota tissue samples from Area IV as well as co-located media samples for the full range of radiological and chemical constituents. The specifics and details of the data proposed to be collected for use in the ERA are discussed below and in **Table 4-16.**

4.7.6.1 Proposed Abiotic and Biological Sampling for Ecological Risk Assessment

Sampling of abiotic media (i.e., surface water, sediment, soil, and soil gas) and biological tissues (i.e., selected aquatic and terrestrial plants and animals) is proposed to fill identified gaps in data to be used to assess risks to ecological receptors. This sampling effort is described below. Some modification to the proposed sampling described below is anticipated based on a more complete review of existing stormwater data.

4.7.6.1.1 Purpose of Sampling

The proposed sampling program is intended to address several unique requirements of the ERA. These include the following:

1. Chemical concentrations in abiotic media

2. Chemical concentrations in biota [to assess risks to selected receptors based on body burdens and body burden toxicity reference values (TRVs)]

3. Concentrations of bioaccumulative chemicals in biota (to be used in food web modeling)

4. Concentrations of radionuclides in abiotic media and in biota (to assess risks to ecological receptors from exposure to radionuclides)

5. Concentrations of chemicals in soil gas (to assess inhalation exposures to burrowing mammals)

4.7.6.1.2 Exposure Areas and Related Assumptions

The proposed sampling effort presented in **Table 4-16** is based on designations of unique EUs and on several important assumptions. The exposure areas defined for sampling purposes are in turn based on certain assumptions that will require confirmation via field surveys. However, based on current understanding, the exposure areas of concern are shown in Figure 3-4 and include the following:

- EUs -01 through -016
  - expected to be primarily terrestrial EUs, but may include seeps or stormwater
  - each EU is assumed to be sufficiently large and unique to warrant independent sampling
- Area in EU -03 supporting aquatic plants [cattail (*Typha* sp.)]
- Undeveloped area south of SRE
- Undeveloped area north of SRE
- Arroyo Simi Area I
  - assumed to drain EUs -06, -08, -10, and -11
- Arroyo Simi Area II
  - assumed to drain EUs -01 and -02
- R-2 Pond in Area II
- Silvernale Pond in Area III
- Background area for terrestrial receptors
- Background area for aquatic receptors

Proposed locations for aquatic samples are assumed to contain standing water for sufficient duration to support aquatic life (including intermittent or ephemeral waters used by aquatic or semi-aquatic biota). Also, sampling for specific types of biota assumes those biota are present (and in sufficient numbers to allow adequate sampling). Finally, samples from the two buffer areas are expected to be terrestrial samples unless seeps or stormwater are retained within these areas. If that is found to be the case, then aquatic sampling may be included for these locations (depending in part on persistence of aquatic environments).

4.7.6.1.3 Numbers and Types of Samples

Preliminary recommendations for number of samples to be collected within each exposure area or EU (up to 10 samples per sample type) are based on the fact that none of the historical biotic tissue data are useful for assessing current risks to ecological receptors using Area IV.

The types of samples proposed to be collected are discussed by media type below. For biota samples, COIs include all radionuclides and bioaccumulative inorganic and organic chemicals. For abiota media, COIs include all radionuclides and the full suite of organic and inorganic chemicals. The details of the sample collection process and

related health and safety protocol for the samples recommended below will be described in the FSAP.

Surface Soil – Surface soil samples will be collected from each of the three soil depth horizons (0 to 2, 2 to 4, and 4 to 6 feet bgs). Therefore, three samples will be collected from each soil sampling location (or "hole"). Up to 10 locations will sampled per EU. Each sample (one from each depth horizon) will be analyzed for both radionuclide and chemical COIs.

Soil Gas – Soil gas samples will be collected as described for surface soil samples, except that radionuclide analysis is not required.

Sediment – Sediment samples will be collected from the surface sediments (0 to 6 inches) and analyzed for radionuclide and chemical COIs, and total organic carbon (TOC).

Surface Water – Surface water samples will be collected and analyzed for conventional parameters (e.g., temperature, dissolved oxygen, pH), radionuclide and chemical COIs, and hardness. Both total recoverable and dissolved metals analyses are proposed. Where surface water is deep (e.g., >4 feet), samples will be depth-integrated (i.e., samples will be composites of surface, mid-depth, and near bottom of water column).

Seep Water – The risk to ecological receptors exposed to CPECs and RPECs in water discharging at seeps will be evaluated. Data representative or potentially representative of the water discharging at seep locations include: existing seep data, existing groundwater data, and potential future samples collected from these media. Therefore, an evaluation of seep water quality will likely include one or more of the abovementioned data sets. Thus, water samples from seeps, if present at the time of sampling, are planned to be collected and analyzed for radionuclide and chemical COIs. Additional groundwater data is also planned for collection. New data collection will be dependent, at least in part, on the usefulness of previously collected samples. Both total recoverable and dissolved metals analyses would be proposed for samples collected from seep locations.

Soil Invertebrates – Soil invertebrate samples will be composites of all taxa observed in the upper soil horizon (e.g., 0 to 2 feet), with no depuration of earthworms (the likely major component of these samples). Taxa constituting the composite samples will be identified and an approximate percentage of the total sample will be recorded (e.g., 80 percent earthworms, 20 percent grasshoppers). Samples will be analyzed for radionuclides and chemical COIs.

Small Mammals – Small mammal samples will be collected via Sherman live traps baited with peanut butter and will include all small mammalian taxa collected. Composite samples will be used where sample volume requires more than one individual. Otherwise, each sample will comprise a single individual.

Western Fence Lizards – Western fence lizards will be collected by hand or by noosing. Composite samples will be used where sample volume requires more than one individual. Otherwise, each sample will comprise a single individual.

Terrestrial Plants – Two types of terrestrial plant samples are proposed for each sampling location. The first type consists of seeds, flowers, and fruits. These will be composited to meet sample volume requirements. The second sample type will comprise leaves and stems, and these will be composited into individual samples. In both cases, the dominant types of plants will be identified and assigned to the sample (e.g., 75 percent grass seed heads, 25 percent miscellaneous flowers from particular plant type). Only above-ground, unwashed samples will be included (no roots, no rinsing of samples). Samples will be analyzed for radionuclides and chemical COI.

Aquatic Plants – Aquatic plant samples will consist of sufficient volume of a single taxon where possible. The plant taxon constituting the sample will be identified. Samples will be analyzed for radionuclide and chemical COIs.

Aquatic Invertebrates – Aquatic invertebrate samples will be composites of all taxa collected using 500 micrometer D-frame kick nets. Taxa constituting the composite samples will be identified and an approximate percentage of total sample will be recorded (e.g., 80 percent caddisflies, 20 percent oligochaetes). Composite samples will be analyzed for radionuclide and chemical COIs.

Fish – Fish samples will be limited to small fish (approximately 6 inches long), and will be comprise individual whole fish if sample volume requirements can be met. Composites of the same taxon will be used, if necessary, to meet sample volume requirements. In all cases, fish will be identified to species level. Fish will be collected using electroshocking methods and analyzed for radionuclide and chemical COIs, as well as lipid content. Two permanent surface water bodies will be sampled and they are described in Section 4.7.6.1.2 and in Table 4-16.

Background – For all media types and biota types, both an aquatic and terrestrial background location will used for the collection of media and biota tissue samples. The location of these areas will be identified in the FSAP.

4.8 Air

Radiological air data were reviewed from annual Site Environmental Reports from 1991 to 2006; predecessor environmental surveys and environmental monitoring reports from 1955 to 1990; and NESHAP reports for DOE operations in SSFL Area IV from 1991 to 2006. These data are comprised of both effluent air data reflecting the emissions to the environment from a given facility and ambient air sampling information from monitoring stations established in designated locations. These data are reviewed below.

4.8.1 Effluent Air Monitoring

"Atmospherically discharged effluent released to unrestricted areas" was initially monitored beginning approximately 1972 for the stacks at the "Radioactive Materials Disposal Facility", "Engineering Test Building (Main Stack)" and "Engineering Test Building (Hot Cell)." Concentrations were "in all cases less than 10 percent of the average concentrations observed in environmental air throughout the area of the site". (It is notable that reports from as early as 1973 stated that "The level of radioactivity contained in all gaseous effluents is reduced to the lowest practicable by releasing the effluents through certified HEPA filters. These effluents are sampled for particulate radioactive materials by means of continuous stack exhaust samplers. In addition, stack monitors are provided at Building 020, 022 and 055 which provide automatic alarm capability in the event of the release of gaseous activity from Building 020 or 022 or particulate activity from Building 055. The HEPA filters used for filtering gaseous effluents are 99.95 percent efficient for particles of 0.3 micron diameter." Average effluent concentrations released to unrestricted areas as stated in the 1973 *Environmental and Radioactive Effluent Monitoring Annual Report* were reported for the Buildings 003, 020 (Hot Lab), 022 (RMDF) and 055 to range from less than 2.9×10^{-16} to less than 2.1×10^{-15} and less than 2.6×10^{-15} to 1.1×10^{-14} µCi/mL for alpha and beta, respectively. Maximum concentrations were listed as 9.4×10^{-14} and 1.4×10^{-13} µCi/mL for alpha and beta, respectively. Building 021 was subsequently included in building emission reports at approximately the same time and was listed jointly with Buildings 022. Building 055 was dropped from the report in 1987 thus the 1988 report includes only Buildings 020 (Hot Lab) and 021-022 (RMDF).

Beginning in 1988, environmental reports incorporated gross alpha and gross beta activity information with isotopic composition of the radioactivity deposited on the filters, composited for the year. Isotopic analytes included ^{7}Be, ^{40}K, ^{60}Co, ^{90}Sr-Y, ^{137}Cs, ^{210}Po, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, and $^{239/240}$Pu. Reported results included air concentration, release per year, applicable lower limits of detection (LLDs) and percentages of the maximum permissible concentrations (MPCs). In 1989 results included average concentrations for each radionuclide. In addition, beginning in 1989, ^{241}Am was included in the list of analytes (excluding 1993 and 1994). Beginning in 1992, Th-228, ^{230}Th and ^{232}Th were subsequently added as analytes and ^{241}Pu was included beginning in approximately 1995. Average concentrations ranged from 8.3×10^{-19} to 1.0×10^{-14} µCi/mL for the Hot Lab with the highest concentrations being reported for naturally-occurring ^{7}Be, ^{40}K, and ^{210}Po. Isotopic results were commonly reported as several orders of magnitude lower than the stated MPCs. Similar results were reported for the RMDF except that ^{7}Be, ^{238}Pu, and ^{241}Am were reported as "0". In the 1990 report, the "specific facilities are identified as RMDF, T059 and RIHL" with activity detected above LLDs at the RMDF including 57, 38, 5.0, and 0.29 pCi for ^{60}Co, ^{137}Cs, ^{210}Po, and $^{229/240}$Pu, respectively. Concentrations at the Hot Lab which exceeded LLDs consisted of 280, 7.2, 60 and 55 pCi for ^{40}K, ^{90}Sr, ^{137}Cs, and ^{210}Po-210, respectively. The concentration of ^{40}K, a naturally occurring constituent, is elevated relative to commonly encountered concentrations and continued to be detected at relatively high levels in subsequent years with concentrations in 1991 of 56 to 140 pCi.