FINAL
RADIOLOGICAL CHARACTERIZATION OF SOILS
AREA IV AND THE NORTHERN BUFFER ZONE

AREA IV RADIOLOGICAL STUDY
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

Ag	silver
Am	americium
AOC	Administrative Order on Consent
Ba	barium
bgs	below ground surface
BTV	background threshold value
C	carbon
Cf	californium
Cm	curium
Co	cobalt
Cs	cesium
DOE	Department of Energy
DQO	data quality objective
DTSC	Department of Toxic Substance Control
EDD	electronic data deliverable
ETEC	Energy Technology Engineering Center
Eu	europium
FAL	field action level
FSP	Field Sampling Plan
GEL	GEL Laboratories, LLC
GPS	global positioning system
GRAY	gamma radiation anomaly
H-3	tritium
HGL	HydroGeoLogic, Inc.
HSA	Historical Site Assessment
K	potassium
KEWB	Kinetic Experiment Water Boiler
Lc	critical level
LCRZ	likely chemical remediation zone
LD&DZ	likely decontamination and decommissioning zone
MARLAP	Multi-Agency Radiological Laboratories Analytical Protocols
MDC	minimum detectable concentration
MQO	measurement quality objective
NAA	North American Aviation

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

NASA	National Aeronautical and Space Administration
NBZ	Northern Buffer Zone
Ni	nickel
NORM	naturally occurring radioactive material
NPDES	National Pollutant Discharge Elimination System
pCi/g	picocuries per gram
PGRAY	potential gamma radiation anomaly
Pu	plutonium
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
Ra	radium
RMHF	Radioactive Materials Handling Facility
Rn	radon
RRC	radionuclide reference concentration
RTL	radiological trigger level
RWQCB	Regional Water Quality Control Board
SB990	Senate Bill 990
SMP	Site Management Plan
SNAP	Systems for Nuclear Auxiliary Power
Sr	strontium
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory
STIR	Shield Test and Irradiation Reactor
TAL	TestAmerica Laboratories, Inc.
Te	tellurium
Th	thorium
TM	technical memorandum
TPC	The Palladino Company, Inc.
U	uranium
UCL	upper confidence limit
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
Validata	Validata Chemical Services, Inc.

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (USEPA) conducted an extensive radiological characterization study of the Santa Susana Field Laboratory (SSFL) at Area IV and the Northern Buffer Zone (NBZ) located in Ventura County, California (Figure 1.1). SSFL Area IV consists of 290 acres, and the NBZ consists of a 182-acre tract of naturally vegetated land. The Boeing Company owns both Area IV and the NBZ. Collectively, these areas are referred to as the Area IV Study Area. The USEPA conducted this study pursuant to federal legislative mandate HR2764, the Consolidated Appropriations Act of 2008, and the authority granted under the Comprehensive Environmental Response, Compensation, and Liability Act and subsequently the Administrative Order on Consent (AOC) for Remedial Action (DTSC, 2010). This work was executed by HydroGeoLogic, Inc. (HGL) under a USEPA Region 7 Architect and Engineering Services Contract EP-S7-05-05, Task Order 0038, Amendment 0004, being administered and managed by USEPA Region 9. HGL is USEPA's contractor on this project.

1.1 PURPOSE AND OBJECTIVES

The Area IV Radiological Study was conducted to characterize radionuclide concentrations within the Area IV Study Area. The Area IV radiological study consisted of completing an Historical Site Assessment (HSA); conducting a gamma radiation survey of accessible ground surfaces; conducting a geophysical survey of targeted locations; and collecting and analyzing soil, groundwater, surface water, and sediment samples. The results of the HSA, gamma radiation scanning, geophysical survey, historical aerial photographic analysis, and groundwater sampling are detailed in the following documents for the Area IV Radiological Study:

- Final Historical Site Assessment (HGL, 2012a),
- Final Geophysical Investigation Report (HGL, 2011b),
- Aerial Photographic Analysis of Santa Susana Field Laboratory (USEPA, 2010),
- Final Gamma Radiation Scanning Report (HGL and TPC, 2012b), and
- Final Groundwater Report (HGL, 2012c).

Analytical results for the sediment samples will be documented in the Surface Water and Sediment Sample Results Report to be submitted under separate cover.

This report describes the sampling regime and analytical results of surface soil and subsurface soil samples collected from potential areas of radiological contamination. Sediment analytical data collected from drainages within the Area IV Study Area have also been included in this evaluation. The primary objective of the soil sampling effort was to evaluate the nature of potential radiological contamination in soil and drainage sediment that may have resulted from past nuclear operations and research activities in the Area IV Study Area. To meet this objective, soil and sediment samples were collected during two rounds of sampling. The initial Round 1 sampling event consisted of collecting samples at specific, targeted locations identified from the findings of the HSA, gamma radiation scanning survey, geophysical survey, the aerial photographic analysis, and stakeholder requests. The Round 2 sampling consisted of collecting step-out samples to delineate radionuclide concentrations in soils adjacent to Round 1 sample locations that exhibited concentrations above the project decision levels, called radiological trigger levels (RTL). RTLs were used during the sampling events to identify locations of potential concern in the absence of defined cleanup values. The targeted and step-out soil sampling locations, justification, and supporting lines of evidence were outlined in subarea-specific addendums to the Final Field Sampling Plan (FSP) Soil Sampling (HGL, 2012d). Each subarea-specific addendum detailed the planned soil sampling effort for the subarea and took into account stakeholder input. Soil sampling efforts were conducted in accordance with the Final FSP, the subarea-specific FSP addenda, and the Final Quality Assurance Project Plan (QAPP) for Soil Sampling (HGL, 2012e).

1.2 LIMITATIONS

This report is intended to characterize radiological areas of interest from past site activities within the Area IV Study Area. This report is not intended to identify remedial locations nor indicate areas of contamination. These determinations will be made at a future date by the State of California Department of Toxic Substances Control (DTSC).

The activities described in this report were conducted in general accordance with current regulatory guidelines and the standard-of-care exercised by environmental consultants performing similar work in the project area. The findings discussed in this report were derived from data collection efforts conducted with commercially available sampling and analysis equipment, techniques, and procedures available at the time the investigation was conducted. The samples collected and used for analysis, and the observations made, are believed to be representative of the Area IV Study Area; however, conditions can vary significantly between sampling locations, thus, conditions not observed or described in this report may be encountered during subsequent activities.

1.3 REPORT ORGANIZATION

This report consists of Sections 1.0 through 6.0 and Appendices A through L. Referenced tables and figures are provided in separate, tabbed sections. The Appendices include the soil sampling results technical memoranda (TM) for each subarea, the Development and Use of Radionuclide Reference Concentrations (RRC) paper, and the Background Threshold Values (BTV) and Radionuclide Selection Rationale paper. The contents of each section are summarized below:

- Section 1.0, Introduction. Describes the purpose and objectives, limitations, and organization of this report.

- Section 2.0, Site Background. Describes the site location, site and regulatory history, selection of radionuclides of concern and environmental setting including surface hydrology, soil types, topography, and geology.
- Section 3.0, Study Area Investigation Methodology. Discusses natural and cultural resources, lines of evidence used to identify soil sample locations, sample collection process during the Round 1 and Round 2 soil sampling events, and the quality assurance (QA)/quality control (QC) procedures employed during sample collection and laboratory analysis.
- Section 4.0, Round 1 and 2 Analytical Results. Describes the evaluation approach, and discusses the analytical results, radiological contamination areas, and radiological areas of interest.
- Section 5.0, Summary. Summarizes the radiological contamination areas for the entire Area IV Study Area and general considerations.
- Section 6.0, References. Lists the documents cited in this report.

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2.0 SITE BACKGROUND

2.1 SITE LOCATION AND DESCRIPTION

The SSFL is located in southeastern Ventura County, California, approximately 30 miles northwest of Los Angeles between the Simi and San Fernando valleys in the Simi Hills (Figure 1.1). Residential developments are located near the southern, northern, and eastern boundaries of the site (Figure 2.1). The SSFL occupies 2,850 acres of rocky (sandstone) terrain with approximately 700 feet of topographic relief. Specifically, the study was focused on Area IV and the adjacent NBZ referred as the Area IV Study Area. The Area IV Study Area is composed of approximately 471 acres (290 acres in Area IV and 181 acres in the NBZ) that vary from relatively flat to steep relief and rugged terrain. The elevation of the Area IV Study Area is between 1,880 feet and 2,150 feet above mean sea level.

The Area IV Study Area was initially divided into eight subareas based on existing Resource Conservation and Recovery Act Facility Investigations. For the radiological characterization study, USEPA elected to further subdivide these eight subareas into 12 subareas based on features such as roads, drainage pathways, and building use as follows:

- Subarea 3
- Subarea 5A
- Subarea 5B
- Subarea 5C
- Subarea 5D-North
- Subarea 5D-South
- Subarea 6
- Subarea 7
- Subarea 8-North
- Subarea 8-South
- NBZ East
- NBZ West

The subareas are depicted on Figure 2.2. Results from each sampling event are presented in separate TM by subarea and are included in Appendices A through J. The results for Subareas 5D-North, 5D-South, 8-North, 8-South, NBZ East and NBZ West were presented in three TMs for each sampling event; Subarea 5D, Subarea 8 and NBZ (Appendices E, H and I).

2.2 SITE HISTORY

As a component of this radiological study, USEPA conducted an extensive HSA to document the site history and past facility operations, as well as to provide technical information for selection of soil samples. This section was derived from the USEPA's HSA and provides a very brief summary of the site history (HGL, 2012a).

Before development of the SSFL site, the area was used for ranching. In approximately 1948, North American Aviation, Inc. (NAA) began development of the site for the design, development, and testing of liquid propellant rocket engines. The facilities at the SSFL site supported many major space programs, from the earliest satellite launches to the Space Shuttle. The Rocketdyne Division of NAA operated these portions of the SSFL site until approximately 1996 when Rocketdyne merged into The Boeing Company. Since approximately 1996, operations at the site have been conducted by The Boeing Company (ETEC, 2010 and HGL, 2012a).

The SSFL is separated into four administrative areas. The Boeing Company owns all of Area I, except for 42 acres which are owned by the United States and under the administrative control of the National Aeronautics and Space Administration (NASA). Area II is also owned by the United States and under the control of NASA but operated by The Boeing Company. The Boeing Company owns and operates Areas III and IV. Areas I, II, and III were also used by The Boeing Company, NASA, and the Department of Defense for rocket engine and laser testing.

Under contract to the Department of Energy (DOE), NAA also operated the Energy Technology Engineering Center (ETEC), located exclusively in Area IV, for researching, developing, and constructing nuclear reactors and associated equipment for harnessing nuclear energy through its Atomics International Division (NAA, 1960). Until its closure in 1996, DOE was responsible for operating ETEC. ETEC represented the group of facilities owned by DOE that were used for nuclear research and other experimental activities within Area IV. From the mid-1950s until the mid-1990s, DOE and its predecessor agencies were engaged in or sponsored nuclear operations including the development, fabrication, disassembly, and examination of nuclear reactors, reactor fuel, and other radioactive materials. Associated experiments included large-scale sodium metal testing for fast breeder reactor components. Nuclear operations at ETEC included 10 nuclear research reactors, including the Sodium Reactor Experiment (SRE), seven critical facilities, the Hot Laboratory, the Nuclear Materials Development Facility, the Radioactive Materials Handling Facility (RMHF), and various test and radioactive material storage areas. Each of these facilities has been described in the Final HSA volumes II through VIII (HGL, 2012a).

All nuclear research in Area IV was terminated in 1988 when DOE shifted its focus from research to decontamination and decommissioning activities. Decontamination and decommissioning of the sodium test facilities started in 1996 when DOE determined that the entire ETEC facility was surplus to its mission. DOE began formal cleanup and closure of its facilities in Area IV in preparation for returning the property to The Boeing Company.

The HSA report includes a summary of past operations and activities involving radioactive materials for all subareas. The results of past radiological surveys performed in Area IV are also summarized. Radiological surveys have been performed for several purposes including health and safety, characterization, remedial action support, and release.

2.3 REGULATORY HISTORY

The Atomic Energy Commission was abolished by the Energy Reorganization Act of 1974 and was succeeded by the Energy Research and Development Administration (now part of DOE) and Nuclear Regulatory Commission. Radiological contamination in Area IV has been sampled and analyzed, including radiological surveys conducted in 1988 and again in 1995 as well as radiological release surveys within the footprints of former radiological facilities.

In August 2007, DTSC, as the lead regulatory agency, and The Boeing Company, DOE, and NASA, as potential responsible parties, entered into a Consent Order for Corrective Action governing the remediation of chemical contamination at the SSFL (DTSC, 2007).

In October 2007, California enacted SB990 entitled "Cleanup of Santa Susana Field Laboratory" which became effective on January 1, 2008. SB990 asserted state jurisdiction over the SSFL remediation and required calculating the cumulative risk from radiological and chemical contaminants to the lower of either suburban residential or rural residential (agricultural) land use scenarios, whichever produces the lower permissible residual concentration for each contaminant.

In December 2010, DTSC signed an AOC with DOE to address the federal radiological and chemical remediation of soil in the Area IV Study Area to background values for both radiological and chemical contaminants by the year 2017). The Boeing Company and the USEPA are not a party to the AOCs.

2.4 ENVIRONMENTAL SETTING

2.4.1 Soil Types and Topography

The SSFL is located on a ridge within the Transverse Ranges physiographic province. The facility is approximately 850 feet above the valleys to the north and south. While the laboratories and other facilities within Area IV are generally located on relatively flat ground, local relief can be up to approximately 270 feet. In the Area IV Study Area, the highest elevation (2,150 feet above mean sea level) is along the southern boundary (Figure 2.3). Along the northwest boundary, the land slopes steeply away to undeveloped land. The relatively flat area in the southern part of the Area IV Study Area is called "Burro Flats."

The parent material of the soil in the Area IV Study Area consists of weathered bedrock, colluviums and alluvium derived from the Chatsworth Formation. According to the Natural Resources Conservation Service, approximately 40 percent of the Area IV Study Area is classified as sedimentary rock outcrop. The two predominant soil types in the Area IV Study Area are a sandy loam of the Saugus series and a loam of the Zamora series. The Saugus series soils consists of deep, well drained soils that usually forms on dissected terraces and foothills and are moderately permeable. The sandy loam of the Saugus series usually has slopes of five to 30 percent. The Zamora series soils are typically well drained loam that forms on nearly level grade or on strongly sloping fans and terraces. The Zamora series in the Area IV Study Area has slopes that range from two to 15 percent (USDA, 2003).

2.4.2 Surface Hydrology

Surface water drainage in the northern portion of the Area IV Study Area flows north into Meier Canyon, which is a tributary to the Arroyo Simi, flowing westward and terminating in the Pacific Ocean. Drainage of the majority of the Area IV Study Area flows to the southeast into the Bell Creek drainage system as suggested by the location of the northeast-southwest trending drainage divide (Figure 2.4). Bell Creek is the headwater and tributary of the Los Angeles River, which flows south and eastward terminating in the Pacific Ocean.

Given the topographic divide and topographical rises to the east and west of Area IV, there is no drainage directly to the west or east from the Area IV (USGS, 1952). A site reconnaissance during the Area IV Radiological Study surface water sampling program determined there was no surface water drainage from Area IV to the west into Runkle Canyon. However, a small area, approximately two acres in the southwest corner of the NBZ, was identified where surface water does flow to the west.

The California Regional Water Quality Control Board (RWQCB) has issued waste discharge permits to the SSFL since 1958. Starting in 1984, the RWQCB began issuing surface water discharge permits to the SSFL under the National Pollutant Discharge Elimination System (NPDES). Surface water discharges from the site are monitored at 18 NPDES locations, and according to the RWQCB, from 1998 through 2006 (RWQCB, 2006), discharges from the SSFL have continually exceeded effluent limits for dioxin, heavy metals, and other pollutants. In July 2007, the Los Angeles RWQCB issued an order requiring The Boeing Company to cease and desist all discharges of contaminants that exceed specified effluent limits (Weston Solutions, Inc., 2007).

Of these 18 historical surface water discharge outfall locations there are ten that receive surface water from Area IV or the NBZ. Outfall locations 3, 4, 5, 6, and 7 receive surface water from the northern portion of Area IV. Outfall locations 9 and 10 receive surface water from the NBZ. Outfall locations 17, 18 and 2 receive surface water from the southern portion of Area IV (Figure 2.3). Outfall locations 3, 4, 6, 10, 18 and 2 receive surface water from former operational areas and are specifically designed multimedia filtration systems engineered to filter the surface water before it travels downgradient. Currently, surface water from these outfalls is diverted to the Silvernale settling pond located in Area III as a result of the Los Angeles RWQCB cease and desist order issued in 2007 (Figure 2.3). Outfall locations 5 and 7 are lined settling ponds and are designed to retain surface water so it can be transferred to the Silvernale pond. Outfall location 9 is strictly an NPDES sampling location and is not designed to filter or retain surface water. The NPDES outfall permitting and monitoring program is regulated by the Los Angeles RWQCB.

The majority of surface drainage within Area IV is through man-made and natural ditches and swales that lead to natural streambeds. The drainage from some former operational areas is directed through various settling ponds and outfall locations. The following subsections provide a brief summary of these operational areas and their associated settling ponds and outfalls.

Former Sodium Disposal Facility

Surface water runoff in the vicinity of the Former Sodium Disposal Facility area flows to the east-northeast. Outfall locations 5 and 6 receive water from the former sodium disposal facility before the water flows into the NBZ. Outfall 5 is a settling pond. Outfall 6 is a multimedia filtration system engineered to filter the surface water before it travels downgradient.

Former Building 4373 (Hot Lab) and Building 4055

Runoff from the vicinity of former Building 4373 (Hot Lab) and Building 4055 flows to the east through the ditch on the south side of G street and the ditches on either side of H and I streets. The runoff water flows through these ditches, through the former Space Technology Laboratory IV complex in Area III, and into the R2 settling ponds located in Area II.

Building 4009, Building 4100, and the 56 Landfill

Runoff in the vicinity of Building 4009, Building 4100 and the 56 Landfill drains to the north along the west side of the landfill, into the NBZ. Outfall 7 is located approximately 70 feet north of building 4100 and only receives surface water from the vicinity of Building 4100.

Radioactive Materials Handling Facility

Runoff within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF holding pond (RMHF 4614 Holdup Pond). The Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain storm water runoff and any accidental releases. It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond. The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane aboveground storage tank. After the accumulated storm water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it enters a pipeline that discharges to a lined drainage along 17^{th} Street. Drainage follows 17^{th} Street to G Street and then continues through lined and unlined channels to the 17^{th} Street Drainage.

Sodium Reactor Experiment Complex

The majority of the runoff from the SRE Complex is captured in the SRE pond which is located approximately 400 feet east of the complex. Runoff from the northern portion of the SRE complex flows to the east via a small asphalt-lined ditch, through Outfall 4, and into the SRE Pond. Runoff from the southern portion generally flows to the east via drains and underground culverts. The culverts lead to a concrete-lined ditch that diverts runoff around Outfall 4 and into the SRE Pond. Overflow from the pond is to the east-north east via a natural drainage that leads to Meiers Canyon.

Old and New Conservation Yards

Runoff from the Old and New Conservation Yards flows to the south-southeast via a natural unlined drainage that leads into Area III and, subsequently, into Silvernale Pond. Surface water in the northern portion of the Old Conservation Yard flows to the north and into the Northern Buffer Zone.

2.4.3 Geology

The SSFL is situated within the Transverse Ranges physiographic province, approximately 30 miles north of downtown Los Angeles (Baily and Jahns, 1954). Two geologic formations underlie the Study Area, the Cretaceous Chatsworth Formation and the Tertiary Santa Susana Formation. The Chatsworth Formation underlies approximately 80 percent of the Study Area. The following descriptions are derived from the Preliminary Geologic Map of the Los Angeles 30 feet by 60 feet Quadrangle, Southern California (Yerkes and Campbell, 2005). A geologic map of the area is presented as Figure 2.5.

The SSFL is located on the south flank of an approximately east-west striking, westward plunging syncline. There are three categories of geologic structures present in the SSFL faults/fault zones, deformation bands, and structures (MWH, 2007). The fault zones and deformation features displace primary geologic features, the former showing displacement of at least five feet and the later with minimal located displacement (less than 6 inches). Mapped faults in the SSFL are presented on Figure 2.5. The Burro Flats Fault places the Chatsworth Formation in structural contact with the Santa Susana Formation in the southwest portion of the Area IV Study Area.

2.4.3.1 Chatsworth Formation

The Chatsworth Formation consists of three unnamed members. The members were deposited by turbidity currents in a deep ocean at depths ranging from 4,000 to 5,000 feet. Turbidity currents cause massive submarine landslides from the continental shelf into submarine canyons which are generally more than a half-mile wide and greater than ten miles in length. During periods without turbidity currents, silt and clay particles from runoff filtered to the ocean floor and formed the siltstone strata found in the formation.

Deposited in the late Cretaceous, the Chatsworth Formation is in excess of 6,000 feet thick. The uppermost member is a thick strata of light gray to brown sandstone, which is hard, coherent, arkosic, micaceous, primarily medium grained separated by thin partings of siltstone. The middle member is a gray conglomerate of cobbles of rounded, polished clasts of quartzite, porphyry and granitic rocks in hard rock matrix. The lower member is gray clay shale, crumbly with ellipsoidal fracture where weathered, and may include sandstone strata.

2.4.3.2 Santa Susana Formation

The Santa Susana Formation underlies the southwestern most portion of the Area IV Study Area and consists of four members. The unnamed uppermost layer of the Santa Susana Formation consists of gray micaceous claystone and siltstone with a limited number of thin rock beds. Below the uppermost layer lies a second unnamed layer that is made up of tan coherent fine grained rock, which locally contains thin shell-beds and calcareous concretions. Underlying this layer is the Las Virgenes Sandstone Member, which is composed of tan semi-friable bedded sandstone and is locally pebbly. The oldest member is the Simi Conglomerate Member. This member contains gray to brown cobble conglomerate with smooth cobbles of quartzite, metavolcanic and granitic rocks in sandstone matrix that locally includes thin lenses of red clay. The Santa Susana Formation also was formed by turbidity currents.

3.0 STUDY AREA INVESTIGATION METHODOLOGY

3.1 NATURAL AND CULTURAL RESOURCES MONITORING

Several activities associated with the radiological study of the Area IV Study Area had the potential to impact natural and cultural resources. The following subsections describe the procedures used to protect natural and cultural resources during soil sampling activities.

3.1.1 Natural Resources Monitoring

The Area IV Study Area is home to many federally listed species and their critical habitat, as well as biological resources protected under other Federal and State laws. The activities conducted by USEPA had the potential to impact protected natural resources, including vegetation cutting, gamma scanning survey, geophysical surveys, surface and subsurface soil sampling, groundwater monitoring well sampling, surface water sampling, and sediment sampling. To minimize the impact to natural resources and riparian habitat within the Area IV Study Area, protection measures were developed and implemented during surveys and sampling activities on the project site, including associated vegetation clearance.

USEPA conducted this project pursuant to federal legislative mandate HR2764, the Consolidated Appropriations Act of 2008, and the authority granted under the Comprehensive Environmental Response, Compensation, and Liability Act. Formal consultation under Section 7 of the Endangered Species Act was conducted with the U.S. Fish and Wildlife Service (USFWS), and a Biological Opinion was issued on May 25, 2010 (USFWS, 2010). The USFWS Biological Opinion identified Avoidance and Minimization Measures keyed to each of the proposed activities and federally listed species with potential to occur within the Action Area. USEPA agreed to implement the various components of the Radiological Study in compliance with the Biological Opinion and its requirements. Although not under discretionary approval, USEPA also made efforts to comply with the substantive technical requirements of State of California natural resource protection laws, such as the California Endangered Species Act and California Fish and Game Code Section 1602 for impacts to riparian resources. Additional applicable biological resource laws or regulations to which the project adhered included the Federal Migratory Bird Treaty Act and California Fish and Game Code 3503 and 3503.5 (for protection of nesting birds).

Qualified Biological Monitors from Envicom Corporation were retained to assist with species identification and protection as outlined in the Site Management Plan (SMP) (HGL, 2010a). The Biological Monitors inspected the proposed work area for protected plant or animal species or critical habitats requiring protection. These areas were clearly marked with bright red-and-white-striped or pink flags tied to stakes to cordon off the area and to alert personnel to the presence of the protected biological resource (HGL, 2010a).

An information sheet was provided to site personnel containing a list of the federal and state species of concern in the Biological Assessment (HGL and Envicom Corporation, 2009) and the Biological Opinion issued by the USFWS (USFWS, 2010). Species at risk but not considered endangered or threatened from site activities were also monitored for protection through the joint effort of field personnel and the Biological Monitors. The following is a list of plant and animal species that were identified in the field, flagged and avoided:

- Braunton's milk-vetch (*Astragalus brauntonii*)
- Lyon's pentachaeta (*Pentachaeta lyonii*)
- Spreading navarretia (*Navarretia fossalis*)
- California Orcutt Grass (*Orcuttia californica*)
- Conejo dudleya (*Dudleya abramsii* ssp. *parva* [=> *Dudleya parva*])
- Santa Monica Mountains dudleya (*Dudleya cymosa* ssp. *ovatifolia* [inclusive of *Dudleya cymosa* ssp. *agourensis*])
- Marcescent dudleya (*Dudleya cymosa ssp. marcescens*)
- Coastal California gnatcatcher (*Polioptila californica* ssp. *californica*)
- Least Bell's vireo (*Vireo bellii ssp. pusillus*)
- California red-legged frog (*Rana aurora* ssp. *draytonii* [=> *Rana draytonii*])
- Quino checkerspot butterfly (*Euphydryas editha* ssp. *quino*)
- Riverside fairy shrimp (*Streptocephalus woottonii*)
- Vernal pool fairy shrimp (*Branchinecta lynchi*)
- San Fernando Valley spineflower (*Chorizanthe paryii* var. *fernandina*)
- Santa Susana tarplant (*Deinandra minthornii*)

During the migratory season various birds were nesting within the Area IV Study Area. The nesting bird areas were identified, flagged, and continually examined by the Biological Monitor. These areas were avoided until Biological Monitors confirmed the chicks had fledged and left the nest. Once these areas were cleared by the Biological Monitors, the flags were removed and access for field activities was approved.

Quarterly Biological Monitors reports were submitted to the USFWS throughout all field activities identifying protected biological resources encountered and detailing the measures implemented to protect these resources.

Soil sample locations situated within a biologically protected resource were not collected. In some cases the sample location could be moved a few feet to no longer impact the protected resource. In these instances soil samples were collected and new global positioning system (GPS) coordinates were recorded.

3.1.2 Cultural Resources Monitoring

The SSFL was historically occupied by Native Americans and nineteen new archaeological sites and more than 50 isolated artifacts were identified during the course of the EPA Radiological Study. John Minch and Associates, Inc., under subcontract to HGL, provided Archaeological and Native American monitoring for the duration of all ground disturbing activity. Consultation in accordance with Section 106 of the National Historic Preservation Act was conducted throughout the sampling efforts. Cultural Monitors and Native American Advisors/Consultants from local tribes monitored all ground disturbing activity and provided archaeological monitoring support as necessary during the execution of fieldwork. Cultural Monitors were qualified archaeologists who specialized in southern California Native

American artifacts and culture. The Native American Advisors/Consultants were local Southern California tribal representatives from the most likely descendents of the former Native American inhabitants of the SSFL as discussed in the SMP (HGL, 2010a). The consultants were required to have knowledge of local customs, traditions, and religious practices of the Tatavian and/or Fernandeno Indian Tribes and in particular the Eastern Coastal or Ventureno Chumash Indian tribes.

Before initiating any site activities Cultural Monitors and Native American Advisors/Consultants inspected each site for cultural resources that could have been adversely affected by site activities including:

- Archaeological deposits - soils that contained material evidence of human activity including the remains of houses, hearths, cemeteries, and other features,
- Artifacts - objects made by people such as whole or broken grinding stones, bowls and tools of various kinds,
- Rock paintings and carvings that are tied to the landscape, which provide information about the culture of the people who made and used them, and
- Certain plants and sacred sites - natural features of the landscape that are recognized in local traditions and places with religious significance.

Areas of cultural significance were marked with yellow flags tied to wooden stakes to cordon off these areas as protected resources. Identification, avoidance, and protective measures were employed during the execution of field activities at the SSFL site to protect Cultural Resources in accordance with all applicable laws, regulations, and policies as follows:

- HGL and subcontractor field personnel received training for identifying cultural features, archaeological sites, and artifacts. This training was jointly conducted by the Cultural Monitors and Native American Advisors/Consultants before work began.
- Cultural resources protection measures were applied during all ground disturbing field activities. All known cultural resources, as identified through previous surveys, as well as all archeological sites and artifacts discovered through the course of this undertaking were avoided. If potential artifacts were identified, the field crew left them in place and notified a Cultural Monitor and/or Native American Advisors/Consultant immediately.
- All soil samples were inspected by Cultural Monitors and/or Native American Advisors/Consultants to identify and remove any cultural resources from the sample as part of the sample preparation.

Upon the completion of fieldwork the Final Report of Cultural Resources Compliance and Monitoring was prepared, discussing the measures taken to protect and any impacts to archeological findings from the cultural surveys within the Area IV Study Area (John Minch and Associates, Inc., 2012).

3.2 IDENTIFICATION OF RADIONUCLIDES OF CONCERN

USEPA developed a list of radionuclides during the SSFL radiological background study. The initial list included a comprehensive list from the Hanford Site in Hanford, Washington (Washington State Department of Health, 1996), with the understanding that radionuclides of concern for SSFL would contain radionuclides actually used or produced at SSFL. The background study list of radionuclides was selected using the following criteria:

- The radionuclide was or could have been used or produced at SSFL.
- The physical state of the radionuclide is not a gas (if the radionuclide is a gas and its parent was not removed from the list, then it was retained).
- The radionuclide has a half-life greater than one year (if the radionuclide has a half-life of less than one year and its parent was not removed from the list, then it was retained).
- The SSFL Technical Stakeholder Workgroup elected to keep a specific radionuclide on the list.

Recognizing that the background study list of radionuclides contained specific radionuclides highly unlikely to have been used or produced at SSFL or extraordinary radionuclides that were expected to provide limited information at significant cost to the project, in consultation with the Technical Stakeholders, USEPA reduced the total number of radionuclides considered for the radiological study, and proposed two suites of radionuclides for soil analyses. The first was the default suite which included:

- Radionuclides detectable by gamma spectrometry;
- Strontium (Sr)-90 (which includes yttrium-90); and
- Commonly analyzed isotopes of uranium (U), thorium (Th), americium (Am), curium (Cm), and plutonium (Pu).

The second was the site-specific suites, which included more than one possible combination of analyses. The site specific analytes and the criteria for selecting the analyte are summarized below:

- Tritium (H-3) - SRE, Buildings 4010, 4059, 4028, and 4024 and at the site of the H-3 groundwater plume.
- Carbon (C)-14 - SRE, reactor areas which used graphite, and some percentage of random sampling due to potential drift from C-14 which may have been used in rocket fuels.
- Nickel (Ni)-59 and Ni-63 - Reactors, the Hot Lab, the burn pit, and where cobalt (Co)-60 is observed above background.
- Technetium-99 - Reactor buildings, the Hot Lab, and the burn pit. Add a small percentage to random samples.
- Iodine-129 - Hot Lab only.
- Promethium-147 - Hot Lab and Former Sodium Disposal Facility only.

- Radium (Ra)-226 and Ra-228 - Based on excursions of bismuth-214 and lead-214 well above background.
- Uranium-232 - Buildings 4003, 4055, 4093, and the Hot Lab.
- Neptunium-237 - If any default Pu isotopes are found above their RTL or LUT concentrations.
- Plutonium-241 - If any default Pu isotopes are found above their RTL or LUT concentrations.
- Plutonium-236 and Pu-244 - If any default Pu isotopes are found above their RTL or LUT concentrations.
- Americium-243, Cm-245, and Cm-246 - Only where accelerators were used.

During Round 1 soil sampling, all samples were analyzed for the default suite. Round 1 samples collected at specified locations or Round 2 samples meeting the conditions described above were also analyzed for site-specific suite methods based on past facility operations within a given area. Both suites are summarized in Table 2.3 of the Final FSP for Soil Sampling (HGL 2012d). Round 2 sample analyses were conducted to further define exceedances identified during Round 1. The Round 2 analyses were performed using only the method(s) necessary to evaluate the Round 1 exceedance (i.e., a cesium [Cs]-137 exceedance required gamma spectrometric analysis only).

Final adjustments to the Radiological Study list of radionuclides were made between the draft final (October 4, 2010) and final (February 17, 2012) versions of the Final FSP for Soil Sampling (HGL 2012d). One adjustment removed eight radionuclides from the default suite gamma spectrometry method: silver (Ag)-108, Ag-108m, barium (Ba)-133, Ba-137m, californium (Cf)-249, radon (Rn)-220, Rn-222, and tellurium (Te)-125m. The radionuclides Ag-108, Te-125m, Ba-137m, Rn-220, and Rn-222, were removed from consideration because they are redundant and are not measured directly, but are assumed to be in a state of secular equilibrium with their parent or progeny radionuclides. The activity concentrations are calculated directly from the reported parent or progeny activity. For example, Ba-137m is calculated directly from Cs-137 and an exceedance or data quality excursion in one result would be repeated in the other. A second adjustment recommended in the Background Study, removed Ag-108m, Ba-133, and Cf-249 due to spectral interference from naturally occurring radionuclides. Due to the timing of implementation of these changes, analytical results for these radionuclides are reported with some of the early Round 1 data but not Round 2 data.

3.3 LINES OF EVIDENCE USED TO SELECT SAMPLE LOCATIONS

The selection of targeted soil sample locations for Round 1 soil sampling was based on knowledge of the subarea being investigated and on professional judgment. For this study, the selection of targeted sampling locations was based on a combination of existing data from historical sources and new data collection efforts. Information utilized in determining targeted sample locations included the results of the HSA, gamma radiation survey, geophysical survey, aerial photographic analysis, and reconnaissance activities that were conducted within each subarea before sampling commenced.

For each subarea and the NBZ, a subarea-specific Round 1 FSP addendum was prepared with supporting maps showing the following:

- Findings identified in the HSA (HGL, 2012a); Aerial photographic analysis (USEPA, 2010);
- Past radiological surveys and results of past radiological soil sampling and analysis (HGL, 2012a);
- Gamma radiation anomalies identified by the gamma radiation survey (HGL and TPC, 2012b);
- Geophysical anomalies identified by the geophysical survey (HGL, 2011b); and
- Observations identified by field reconnaissance in each subarea.

Each subarea-specific FSP Addendum identified targeted soil sampling locations based on the following:

- The likelihood that potential radiological soil contamination was present,
- The technical information and lines of evidence that led to identifying each targeted sample location; and
- Stakeholder input.

A subarea-specific Round 2 FSP addendum was prepared for subareas requiring further delineation of radionuclides identified in soils at concentrations greater than the RTLs. The Round 2 addenda included the findings from the Round 1 soil sampling activities, justifications, and locations of soil samples.

3.3.1 Historical Site Assessment

As part of USEPA's radiological study, a comprehensive HSA was completed for the Area IV Study Area and was documented in subarea-specific HSA TMs (included as volumes II through VIII of the HSA (HGL, 2012a). The objective of the HSA was to conduct comprehensive historical research to identify, collect, organize, and evaluate historical information relevant to nuclear research operations as it may pertain to potential radiological contamination in the Area IV Study Area. Once each subarea-specific HSA was complete, potential areas possibly associated with radiological contamination were identified for Round 1 targeted soil sampling and analysis. The information in the HSA was obtained from the review of more than 100,000 historical documents that describe past facility operational practices as well as facility processes and systems.

Each HSA TM also includes findings of interviews with former employees who worked in Area IV. During these interviews, former employees were questioned regarding their knowledge of spills or processes that may have resulted in releases of radionuclides, disposal practices for liquid and solid waste, and identification of areas where radiological investigations should be performed. The interviews were used to assist in the identification of potential release areas (HGL, 2012a).

Preliminary findings presented in the HSA TM included:

- Descriptions and locations of potential, likely, or known activities that involved radioactive material, radioactive waste, or mixed waste;
- Initial Multi-Agency Radiation Survey and Site Investigation Manual (USEPA, 2000) classifications (for example, Class 1, 2, 3) of potentially impacted areas;
- A site-by-site assessment of the likelihood or "weight of evidence" of radiologically contaminated media;
- An assessment of the likelihood of potential migration pathways; and,
- Identification and confirmation of potential radiological contaminants of concern (Section 3.3.1).

The information provided in each HSA TM together with comments and recommendations provided by SSFL stakeholders and the general public was used to develop the strategy for surface and subsurface soil sampling and analysis for residual radiological contamination in surface and subsurface soil within each subarea. These recommendations were based only on historical information and not on-the-ground evaluations (HGL, 2012a).

3.3.2 Aerial Photographic Analysis

An analysis of historical aerial photographs of the Area IV Study Area was performed by USEPA and used to support the identification of targeted soil sample locations. The process of photographic analysis involved the visual examination and comparison of many components of the photographic image. These components included shadow, tone, color, texture, shape, size, pattern, and landscape context of individual elements of a photograph. The photo analyst identified objects, features, and "signatures" associated with specific environmental conditions or events. The term "signature" refers to a combination of components or characteristics that indicate a specific object, condition, or pattern of environmental significance. Academic and professional training, photo interpretation experience gained through repetitive observations of similar features or activities, and deductive logic of the analyst as well as background information from collateral sources (e.g., site maps, geological reports, and soil surveys) were critical factors employed in the photographic analysis (USEPA, 2010).

Based on the review of aerial photos, a list of waste disposal areas, processing areas, open storage areas, fill areas, and impoundments was prepared for the Area IV Study Area. Each location was identified as certain, probable, or possible. Other features included in the analysis of aerial photographs included stains, storage tanks, pipelines, disturbed ground, mounded material, smokestacks, ground scars, building foundations, cleared areas, and buildings. Targeted soil sample locations were identified to investigate all features labeled as "certain" in the aerial photographic analysis. Targeted soil sample locations were also identified to investigate "potential" or "possible" features from the aerial photographic analysis that were co-located with information from other technical information sources (USEPA, 2010).

3.3.3 Gamma Scanning

A gamma radiation scanning survey was performed for 100 percent of the accessible ground surfaces in the Area IV Study Area to identify gamma radiation anomalies (GRAY), in accordance with the Gamma Radiation Scanning Sampling and Analysis Plan (HGL and TPC, 2010b). Approximately 265 acres out of 471.64 acres were scanned within the Area IV Study Area.

Gamma radiation emanates from certain man-made and/or naturally occurring radionuclides. Data collected during gamma scanning was evaluated and if a location was found to contain elevated gamma radiation measurements, it was classified as a potential gamma radiation anomaly (PGRAY). The PGRAY was then targeted for further investigation with gamma stationary (static) measurements. The static measurements increased detection sensitivity and the data were analyzed to determine if the PGRAY consisted only of naturally occurring radioactive material (NORM) or man-made radionuclides. PGRAYs consisting of only NORM were identified as "Not a GRAY" and no further action was recommended. PGRAYs consisting of man-made radionuclides were identified as "Confirmed GRAYs" and soil sampling was recommended.

A list of locations of GRAYs was prepared for each of the 12 subareas in the Area IV Study Area. Targeted soil sample locations were identified, collected and analyzed to investigate confirmed GRAYs and some PGRAYs. The results of the gamma radiation survey are presented in the Final Gamma Radiation Scanning Report (HGL and TPC, 2012b) and are maintained in Geographical Information Systems format.

3.3.4 Geophysical Survey

A geophysical survey was performed at targeted locations identified in the Geophysical Investigation Plan (HGL, 2010c) for the Area IV Study Area. Targeted survey areas within each subarea were selected based on information summarized in the corresponding HSA TM (HGL, 2012a) and the aerial photographic analysis (USEPA, 2010). Areas suspected to have subsurface radioactivity with little or no surface indication were selected for geophysical measurements as well. For example, suspected subsurface process piping, leach fields, subsurface disposal areas, or trenches associated with past radiological activities were selected as target areas for geophysical survey. Targeted sample locations were identified from subsurface anomalies identified by the geophysical survey. A list of targeted soil sample locations was developed based on the results of the geophysical survey and was included in each subarea specific FSP Addendum. The results of the geophysical survey are presented in the Final Geophysical Investigation Report (HGL, 2011b).

3.4 SOIL AND SEDIMENT SAMPLING

The primary objective of the soil and sediment sampling effort was to evaluate the nature of potential radiological contamination in soil and sediment within the Area IV Study Area that may have resulted from past nuclear operations and research activities that occurred at SSFL Area IV. Soil and sediment sampling activities were conducted in two rounds in accordance with the procedures outlined in the Final FSP for Soil Sampling (HGL, 2012d) and the Final

FSP for Groundwater Surface Water and Sediment (HGL, 2010d). Round 1 sampling activities included the collection of targeted soil and sediment samples and random surface soil samples. Round 2 sampling activities consisted of step-out sampling based on Round 1 analytical results that exceeded project established RTLs. A total of 3,487 environmental soil samples and 55 sediment samples, not including quality control field duplicates, were collected in the Area IV Study Area with 2,781 environmental samples collected during Round 1 and 761 environmental samples collected during Round 2. Additionally 193 duplicate samples were collected with 147 during Round 1 and 46 during Round 2. Table 3.1 summarizes the total number of soil samples collected and analyzed per subarea, the round it was collected, and the type of sample. The following subsections describe the logic used to identify Round 1 and Round 2 sampling locations.

3.4.1 Round 1 Soil and Sediment Sampling

Round 1 targeted soil sampling locations were identified based on a combination of the findings and results from the HSA, aerial photograph interpretation study, gamma radiation survey, geophysical survey, and direct field observations. Targeted sediment sampling locations were based on the HSA, aerial photograph interpretation study, and direct field observations, because the gamma radiation and geophysical surveys had not been completed at the time Round 1 sediment samples were collected. The targeted sampling locations were presented in draft FSP addenda which were presented to the SSFL Technical Stakeholder Workgroup during regularly scheduled technical review meetings. Technical Stakeholder comments were incorporated into the FSP addenda when possible.

During the technical review meetings, recommendations and action items including those on the topic of Likely Chemical Remediation Zones (LCRZ) and Likely Decontamination and Decommissioning Zone (LD&DZ) were discussed. Specific locations throughout the Area IV Study Area were designated as LCRZs by DOE and DTSC based on the concentrations of chemical analytes detected in samples collected as part of the Resource Conservation and Recovery Act investigation being conducted by DOE. Because the LCRZs will be remediated at a later date, only limited sampling was conducted by USEPA within the LCRZ boundaries. On occasion, a limited number of surface/subsurface samples were placed within the LCRZs and around the LCRZ perimeter to delineate more accurately the potential vertical and lateral extent of areas of interest.

Likely Decontamination and Decommissioning Zones were defined as existing building complexes or existing concrete foundations of former buildings that will likely be considered for decontamination and decommissioning in the future. Soil samples were not collected within the LD&DZs because decontamination and decommissioning operations will remove infrastructure (building structures, concrete slabs, above-ground pipelines and underground pipelines etc.) and any impacted soil associated with the infrastructure.

In accordance with the USEPA's role under the AOC (DTSC, 2010) agreement between DTSC and DOE for the SSFL site, USEPA will conduct confirmation soil sampling to verify that site remediation goals have been achieved at all LCRZ and LD&DZs identified during the Area IV Radiological Study. These follow-on efforts are not included in the current scope of work. It should be noted that if these LCRZ and LD&DZ are not remediated there will be an investigation data gap and these areas will not have been investigated for radiological contamination.

After the locations were finalized with the Technical Stakeholder Workgroup, proposed sampling locations were marked in the field using a SPS 852 handheld Trimble GPS and magnetic survey spikes. Before sampling activities commenced, utility clearances were performed at each location by Underground Service Alert (Dig Alert) and a private utility locator.

3.4.1.1 Targeted Surface and Subsurface Soil Samples

Surface soil samples were collected by first clearing the vegetation from the sampling location. Then a stainless steel trowel or shovel was used to collect the sample. The soil sample was collected from the first six inches of soil.

Subsurface samples were collected using a Geoprobe 6600 Series direct-push technology unit or a hand auger. Continuous soil cores were collected for lithological description at each location. The boreholes were advanced to a depth of 10 feet below ground surface (bgs) or refusal. At specific targeted locations, borings were advanced to a greater depth. Depth intervals to be sampled were determined based on borehole gamma logging results. Soil associated with gamma radiation anomalies was sampled for laboratory analysis. If no gamma radiation anomalies were identified, a soil sample was collected at the upper portion of the boring (1 to 5 feet bgs). The soil within this interval was homogenized and a representative composite sample was collected for analysis. Due to the relatively low mobility of the radionuclides of interest, higher radionuclide concentrations were expected in the upper portion of the soil profile; collecting soil within the upper 5 feet increased the likelihood of detecting radiological contamination at a particular location. This approach for selecting soil sampling intervals was modified to target specific features that were identified through historical records (subsurface pipelines, leach fields, tanks, etc.). These modifications are described in the subarea specific FSP Addendum.

Targeted deep borehole subsurface soil samples were also collected to characterize potential radiological contamination beneath four nuclear reactors; the deep concrete vaults at the Systems for Nuclear Auxiliary Power (SNAP), the Kinetic Experiment Water Boiler (KEWB), and the SRE, and the Shield Test and Irradiation Reactor (STIR) buildings. A roto-sonic drill rig was used to drill through concrete rubble that was placed back in the vault excavations after the reactor vaults had been removed.

The findings of the Round 1 targeted sampling activities and the deep borehole investigation are discussed in individual TMs, which are located in Appendices A through J of this document.

3.4.1.2 Random Surface Sampling

Random surface sample locations were identified within the NBZ in addition to the targeted soil samples. Cost savings incurred during earlier Round 1 sampling activities afforded an allocation of 100 random surface samples for the NBZ to ensure more coverage of the subarea.

Random sample locations were determined using the Create Random Point tool provided in ArcGIS software created by Environmental Systems Research Institute, Inc. In the event a random surface sample location was located on a rock outcrop, the location was moved to the nearest location from which a soil sample could be collected. If a sample location was inaccessible (due to physical constraints) an alternate random surface sampling location was chosen. Results of the random surface sampling are presented in the TM for the NBZ (Appendix I).

3.4.1.3 Sediment Sampling

Potential Round 1 sediment locations were identified by evaluating the HSA findings, historical aerial photographs, and maps showing surface water drainage pathways. The potential sediment sampling locations were verified during a field reconnaissance which was conducted from October 6, 2010 to November 5, 2010. A total of 40 sediment sampling locations were identified during the reconnaissance. Detailed notes and photographs were taken at each location, as well as X-Y survey coordinates, which were recorded using a SPS 852 handheld Trimble GPS unit. Analytical results and RTL exceedances for the Round 1 sediment samples will be documented in the Surface Water and Sediment Sample Results Report.

3.4.2 Round 2 Soil and Sediment Sampling

Round 1 soil analytical results were screened against project established RTLs to identify locations containing concentrations of radionuclides related to SSFL site operations that warranted further characterization. Round 2 sampling locations (step-out locations) were placed in the vicinity of Round 1 sample locations that where concentrations of radionuclides were detected above RTLs. A total of 761 step-out environmental samples were collected during Round 2 sampling activities. The process used to derive the RTLs and how they were used to determine Round 2 step-out sampling locations is summarized below.

3.4.2.1 Radiological Trigger Levels

Analytical results from the Round 1 sampling were compared to the RTLs established specifically for the Area IV Study Area. RTLs were decision levels for the radionuclides of concern used as comparison concentrations for Round 1 analytical data in the absence of established clean up levels. The process used to derive the RTLs is presented in the RTL TM (HGL, 2011c), and is briefly summarized below.

During the SSFL Radiological Background Study (HGL, 2011a), 149 soil samples were collected from off-site locations representing the two geological formations present at the SSFL Site. Based on the results of the Radiological Background Study, BTVs were developed for 64 radionuclides, which represent the upper limits of background concentrations. The rationale for the selection of the 64 BTVs between datasets that represent results across surface and subsurface soil, different geologic formations, separate reference locations, and datasets with very low detection frequency (that is, single detections in a dataset) are summarized in the BTV and Radionuclide Selection Rationale paper (Appendix L).

In some cases, the laboratory data used in the Area IV Study Area did not support the use of the BTVs in the decision-making process, due to practical or technological limitations in data quality. In those cases, where the laboratory minimum detectable concentration (MDC) for a given radionuclide was greater than the associated BTV, that MDC was used as the lowest practical alternative to the BTV. In addition, one radiochemistry laboratory, Pace Laboratories, was selected and contracted for the background study and two radiochemistry laboratories were contracted for the Radiological Study: TestAmerica Laboratories, Inc (TAL) and GEL Laboratories, LLC (GEL). Using three laboratories typically resulted in three different MDCs for each analysis. For consistency in evaluation of analytical results, when the MDC values differed between the laboratories, the higher concentration value was used to form the RTL.

RTLs were only used to determine Round 2 step-out sampling locations, and included the method uncertainty from the analytical techniques. The RTL was based on the BTV (or the associated MDC, whichever was higher) plus a method uncertainty factor and was calculated based on a decision error rate of 5 percent, specified in the Final QAPP for Soil Sampling (HGL, 2012e). A laboratory result that exceeded the RTL indicated that, at the specified confidence interval, the sample was likely to have exceeded the BTV (or MDC). As described in the RRC paper, Appendix K, a calculation error in the RTLs was discovered after the soil and sediment results were reported and verified (and after the analytical results were presented and discussed with the stakeholders). Therefore, to be consistent with all Round 1 TMs and discussions with technical stakeholders, the data presented in all the Round 1 TMs was compared to original RTLs. The analytical results themselves are unaffected by the RTL error and no additional locations are found based on corrected screening levels. Radiological trigger levels exceedances identified during Round 1 soil sampling activities are discussed in the TMs for each subarea (Appendices A through J).

After sample results had been validated, an evaluation of all laboratory results was conducted to provide the most defensible and technically sound advice to project stakeholders, in particular the DTSC regarding the procurement of future laboratory services. Thus, RRCs were developed from the entire dataset of soil and sediment sample analytical results. These RRCs were developed in a similar methodology as the RTLs but with enhancements. The development, appropriate uses, and limitations of the RRCs and the associated calculation parameters are detailed in Appendix K.

3.4.2.2 Surface and Subsurface Soil Step-out Sampling Locations

Step-out locations were identified in areas where additional data was required to fully characterize soil adjacent to a Round 1 soil sample that had concentrations exceeding RTLs. Each location was field verified and drainage patterns, topography, and locations of structural drainage from buildings were considered to characterize potential transport of elevated radionuclide results. Step-out locations were approximately 10 to 40 feet away from their respective Round 1 sample location. Generally four step-out sampling locations were placed around each Round 1 exceedance at 90 degree azimuth intervals where data was needed. Some locations exhibiting Round 1 exceedances required no step-out samples as they were within LRCZs, or were well delineated by neighboring Round 1 sample locations, so fewer than four Round 2 samples were needed. The RTL exceedances and rationale used to place Round 2 step-out locations are documented in each subarea specific FSP addendum. Analytical results of soil samples collected during Round 1 and Round 2 sampling are presented in the subarea specific TMs presented in Appendices A through J.

Round 2 samples were not collected within Subarea 3 as no Round 1 samples exhibited radionuclide concentrations above the RTLs. Additionally, Round 2 samples were not collected within the NBZ, as this activity was not within the scope of this project. Further recommended characterization activities are discussed in Section 4.0 by subarea.

3.4.2.3 Sediment Step-out Locations

Analytical results of 40 sediment samples collected during Round 1 showed two samples containing radionuclide concentrations that exceeded RTLs. One sample was located down gradient of Outfall 3, east of the SRE and one sample was located down gradient of Outfall 4, northwest of the RMHF. Step-out sediment samples were placed within the drainage upgradient and downgradient of each Round 1 RTL exceedances location. A total of 55 step-out samples were collected during the Round 2 sediment sampling event. Analytical results for the Round 2 sediment samples are documented in the Surface Water and Sediment Sample Results Report.

3.5 QUALITY ASSURANCE/QUALITY CONTROL

The QA and QC program implemented during soil sampling and analysis efforts ensured that equipment and instruments functioned properly and the data collection process was performed consistently with project requirements. The QA program ensured that all data collection procedures and measurements were scientifically sound; were of known, acceptable, and documented quality; and were conducted in accordance with the requirements of the project as discussed in the Final FSP for Soil Sampling (HGL, 2012d) and the Final QAPP for Soil Sampling (HGL 2012e). Systematic monitoring of QA processes reduced occurrences of errors during soil collection and analysis.

The QC program focused on testing procedures to verify field methods and laboratory detection systems were functioning correctly and fully operational before data collection commenced, and to ensure collected data were consistent, comparable, accurate, and within specified limits of precision.

Before submission of field samples to the two laboratories, a single-blind performance evaluation was conducted. This evaluation assessed the ability of TAL and GEL to generate results within acceptable limits of analytical accuracy and precision. The single-blind samples were of known concentrations to the manufacturer and HGL but unknown to the laboratories. Performance evaluation sample results were evaluated against the certified values provided by the manufacturer.

3.5.1 Laboratory Quality Control Elements

Laboratory QC samples included calibration verification checks, method blanks, laboratory control samples, carrier and tracer performance, matrix spike analyses, and laboratory duplicates as required by each analytical method. These QC elements were specific to each analytical method and are described in general terms in the selected project laboratory QA manual in Appendix A of the Final QAPP for Soil Sampling (HGL, 2012e) and in more detail in method-specific standard operating procedures.

The laboratory QC elements were based on descriptions presented in the Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) (USEPA, 2004). The acceptance criteria, corrective action, and evaluation protocols associated with these QC elements are presented in Table 3.3 of the Final QAPP for Soil Sampling (HGL, 2012e). Laboratory-specific information on technical approaches to comply with the QC element requirements of this section are presented in the laboratory-specific QAPP addenda (HGL, 2012e). Results of the QC tests were included in the analytical data packages and used during the data validation process to determine data usability.

3.5.2 Quality Control Samples

Field QC samples were collected to gauge the accuracy and precision of field collection and laboratory analytical activities and to assess data usability. QC samples collected in the field and submitted to the laboratory for analysis included field duplicates, equipment rinsates, and decontamination source water blanks. Each subarea specific FSP addendum provided specific information on the number and types of analyses to be performed. Requirements for QC samples were specified in the Final FSP for Soil Sampling (HGL, 2012d) and the Final QAPP for Soil Sampling (HGL, 2012e) and are also summarized in the following subsections.

3.5.2.1 Field Duplicates

Field duplicate samples were collected at a rate of 1 per 20 (5 percent) environmental samples collected. Soil field duplicates were obtained using co-located samples rather than the conventional homogenized and split samples. This method resulted in the collection of representative samples that better suited the project requirements. Surface soil duplicate samples were collected within 2 feet of the location of the parent sample. Subsurface soil duplicate samples were collected from borings offset slightly from the boring advanced to collect the parent sample.

Field duplicate samples were submitted to the laboratory as blind QC samples (with unique sample identifiers) to ensure that they were analyzed in the same manner as all other environmental samples. Field duplicate results were used to estimate of overall precision of sample collection, field sample preparation, site homogeneity, and laboratory analysis (total measurement of sample variability).

3.5.2.2 Equipment Rinsate and Source Water Blanks

Equipment rinsate blank samples were collected to ensure proper decontamination of non-dedicated sampling equipment. One equipment rinsate blank was collected for each type of sampling equipment per field team per day. Following decontamination, the blank was collected by pouring ASTM Type II water (also called organic free water) through or over the equipment and collecting the rinse water in the appropriate container. Each equipment blank sample was analyzed for uranium isotopes and H-3 (on a sample-dependent basis).

A sample of the ASTM Type II decontamination source water used for the equipment decontamination and rinsate blank was collected and analyzed for uranium isotopes and H-3. The decontamination source water blank samples were collected each time a new lot of source water was received. The source water samples were used to document existing radionuclide concentrations in the water. The results of the source water blanks were compared to the equipment rinsate blanks to aid in determining the effectiveness of decontamination procedures. These comparisons are discussed in the TM for each subarea (Appendices A through J).

3.5.3 Data Validation

Data validation ensured that laboratory analytical results met the objectives of the project as documented in the Final QAPP for Soil Sampling (HGL, 2012e). Data validation compared the final dataset against a set of criteria as detailed in the QAPP to ensure the data were usable.

Analytical data packages were received from the laboratories in electronic data deliverable (EDD) formats for uploading into the project database. Data verification and validation services were subcontracted to third parties, The Palladino Company, Inc. (TPC) and Validata Chemical Services, Inc. (Validata), in order to maintain maximum transparency of data quality. A quality check of the laboratory results was performed by reviewing sample numbers against chain-of-custody forms and field sheets for consistency and completeness. Qualifiers were reviewed and added by the validator to determine usability of results.

Data validation was performed in accordance with the DOE guidance documents: Evaluation of Radiochemical Data Usability (DOE, 1997) and MARLAP (USEPA, 2004). Each data validator was a radiochemist with at least two years of experience in radiochemical separations and measurement and did not have any perceived or actual conflict of interest with the laboratory generating data, such as recent prior employment by the same laboratory.

Table 3.3 of the Final QAPP for Soil Sampling (HGL, 2012e) shows data qualification conventions for QC elements associated with the project analyses. These conventions are general, and were supplemented by method-specific QC elements where appropriate. When analytical results were reported in association with QC results that did not meet the performance criteria, the validator applied the appropriate qualifier. Alternative qualification approaches that contradicted the requirements of Table 3.3 were allowed if, in the validator's judgment, the alternative was appropriate for a specific QC issue. Each instance of application of an alternative protocol was documented in the corresponding data validation report to allow for USEPA review and final approval.

3.5.3.1 Data Validation Methods

Laboratory analytical data packages were validated using a two-tiered approach. Tier 1 required Level IV data validation for 100 percent of data packages. Tier 2 required Level IV data validation for 25 percent of data packages and Level II data validation for 75 percent of data packages.

The choice of validation tier was based on the ability of the laboratory to provide data of acceptable quality. A data package was unacceptable if any portion of its contents were considered non-defensible, could not be validated due to insufficient supporting documentation, or data was returned by HGL to the laboratory for repair.

These criteria were applied to 10 consecutive data packages for analytical method for each laboratory. Tier 1 data validation was performed for the first 10 consecutive data packages for a specific analytical method. If nine or more data packages met the quality criteria then Tier 2 data validation was performed. If more than one data package did not meet the quality criteria then Tier 1 data validation was continued until nine of ten consecutive data packages for the specific analytical method passed the criteria.

Tier 2 data validation was conducted as long as nine of 10 consecutive data packages met the quality criterion; else Tier 1 data validation was resumed.

Due to data package discrepancies and deficiencies all TAL data packages were validated using Tier 1, Level IV validation. GEL data packages were initially validated using Tier 1 then for Round 2 soil samples went to Tier 2 to expedite the data throughput.

Level IV and Level II validation requirements are discussed in detail in the Final QAPP for Soil Sampling (HGL, 2012e). Level IV validation required a more in-depth and thorough review of the analytical data package than Level II. Both validation levels consisted of verification and validation checks for the compliance of sample receipt, sample characteristics, and analytical results. Additionally, results were checked for transcription errors from raw data to summary forms and calculation verifications were performed for selected samples.

3.5.4 Evaluation of Split Samples

Six soil samples were analyzed by both TAL and GEL for the purpose of evaluating the comparability of the analytical methodologies between the two laboratories (HGL, 2012f). In order to ensure that representative "split sample" fractions were analyzed, each laboratory sent the other laboratory archived sample fractions from three individual samples that were dried, ground, and appropriately sub-sampled, per the instructions and procedures described in the analytical scope of work and the Final QAPP for Soil Sampling (HGL, 2012e).

Sample selection was based on a subjective review of reported results from each laboratory. One sample was selected based on each of the following criteria:

- A high bias resulting in reported values above the critical level (Lc) and/or MDC (that is, potentially false positive).

- A low bias resulting in reported values below the Lc and/or MDC (that is, potentially false negative).
- A reported result representing the upper limit of observed results for one or more analytes (that is, highest concentration).

The split samples were analyzed using the four primary analytical methods: gamma spectrometry; alpha spectrometry; gas proportional counting; and liquid scintillation counting. The laboratories submitted Level IV data packages for the split sample analyses, in accordance with the analytical subcontract.

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4.0 ROUND 1 AND ROUND 2 ANALYTICAL RESULTS

This section presents the radiological analytical results for the Round 1 and Round 2 soil and drainage/sediment sampling performed in the Area IV Study Area.

As described in Section 3.4.2.1 the RTLs were developed and used as field decision levels in the absence of established clean up levels to determine where Round 2 step-out samples should be located. As noted above, the RTLs (applied to select Round 2 sample locations) included both method uncertainty and the maximum of two project radiochemistry MDC values, hence they are not the most conservative values with which to present study results. These RTLs are not used in the final evaluation of the radiological data.

Currently, Look-up Table values for radionuclides have not been established. These values will be established by DTSC in accordance with the AOC which states that the Look-up Table will "*include both background concentrations as well as minimum detection limits for specific contaminants whose minimum detection limits exceed local background concentrations*." (DTSC, 2010) To satisfy this AOC requirement the final radiological data have been compared to Field Action Levels (FAL) consisting of either the BTVs or the 2σ UCL MDCs, as applicable. The FAL is lower than the RTL or RRC values because they do not consider the method uncertainty as described above. Because DTSC has not yet established Look-up Table values, all analytical results from USEPA's radiological study exceeding the FAL are presented.

The final Look-up Table Values depend on the level of data quality performance to be contracted by DTSC. The FALs (being action levels) are a conservative way to present the radiological study data, i.e., FAL are the lowest values which with to compare soil and sediment results. USEPA provided recommendations for the development of Look-up Table Values in a technical memorandum (HGL, 2012g).

Sample results exceeding the FAL do not necessarily represent locations of contamination. In accordance with the AOC, DTSC will determine Look-up Table values for comparison to all sample results to determine locations of contamination that warrant remediation. Results that exceed USEPA's FAL are potential locations that may require further investigation and/or remediation dependent upon the Look-up Table values. However, these results do not represent areas of contamination or areas of remediation

The following subsections describe the development of FALs in more detail, the results of the data quality evaluation, and summarize the Round 1 and Round 2 analytical results.

4.1 DATA QUALITY EVALUATION

The quality of the analytical data and the applicability of that data for its intended use has been evaluated against the data quality objectives (DQO) and measurement quality objectives (MQO) described in the Final QAPP for Soil Sampling (HGL, 2012e) including applicable revisions and addenda. These DQOs and MQOs include routine criteria such as spike recovery, method blank activity and duplicate precision, as well as non-routine, project-specific criteria such as the required method uncertainty and the use of explicitly defined detection limit calculations.

Field sample data have been thoroughly reviewed, verified, and validated to ensure that any data used to evaluate the nature of areas of interest in the Area IV Study Area either meet the stated DQOs and MQOs described in the Final QAPP for Soil Sampling or was explicitly qualified to describe any limitations impacting the use of the data. Field sample data that was determined to be unsuitable for its intended purpose has been rejected and removed from consideration. Wherever feasible, rejected data was returned to the laboratory, the affected samples were reanalyzed, and the data was either repaired or replaced.

Technical review of field sample results, as well as the field QC sample results discussed below, suggests that in some cases the laboratories' reported uncertainty values, which accompany the sample activity results, may be slightly underestimated. Such an underestimate of the reported uncertainty is considered conservative, as no data is believed to be accepted when it should have been rejected. This small underestimate of the reported uncertainty values appears to be generally associated with very low-level gamma spectrometry and alpha spectrometry results. As those results tend to be well below the levels of concern for this project, the overall data quality is not believed to be significantly affected and the data is acceptable for its intended use.

The quality and integrity of the field sample data was further evaluated by the laboratory analysis of 1,002 field sampling equipment blanks and associated source water samples. The evaluation of equipment blank results indicated that the decontamination of the field sampling equipment was effective and that there was no evidence of sample cross-contamination from the sampling equipment that could have adversely affected the quality or usability of the reported field sample data.

Heterogeneity in the field, i.e. variability in the concentration of the various analytes of interest over relatively small areas, was evaluated by the analysis field duplicate samples. The evaluation of 12,442 results (individual radionuclides from all analyses) from 195 field sample/duplicate pairs suggested (a) a degree of heterogeneity in field sampling locations slightly higher than the 10 percent initially assumed in the development of field duplicate acceptance criteria, and (b) generally supports the assessment of a small underestimate in the laboratories' reported uncertainty values for certain analyses. Neither the degree of heterogeneity observed in the field duplicate sampling locations, nor the potential underestimate of the reported uncertainty was believed to significantly impact the usability of the data.

The evaluation of the split samples for inter-laboratory comparability of radioanalytical results was found to be acceptable (HGL 2012f). Minor concerns were noted regarding the laboratories' reported uncertainties and the observed exceedance rate for the Z_{DUP} evaluation criteria. The underestimate of analytical uncertainty does not raise significant concerns regarding the use of the data for its intended purpose.

Overall, the data were usable for their intended purpose, which was to evaluate the nature and extent of areas of interest within the Area IV Study Area that may have resulted from past nuclear research activities within SSFL Area IV.

4.2 FIELD ACTION LEVELS

Soil and drainage sediment sample analytical results, both surface and subsurface, were compared to FALs (Table 4.1). Sample locations with results equal to or greater than the FAL were considered locations of interest, and are illustrated on Figures 4.1 through 4.15 and are discussed in Section 4.3

The FALs were derived from the Radiological Background Study BTVs and from the Area IV Radiological Study 2 sigma (2σ) (97.7 percent confidence level of the standard normal cumulative probability) upper confidence limit (UCL) MDCs as described in this section. The 2σ UCL MDCs were calculated from 3,772 sample results, which represent all solid matrix samples collected and analyzed during the Area IV Radiological Study. These MDCs are empirical reported MDCs obtained by each laboratory.

The sample analytical results were compiled for each radionuclide for each laboratory. The datasets for each radionuclide ranged from 5 to 2,464 samples. For each radionuclide and each laboratory, the mean MDC and the standard deviation of the mean MDC were calculated. The mean MDC was summed with twice the standard deviation or sigma to determine the UCL for the respective MDC dataset as follows:

$$2\sigma \text{ UCL MDC} = \text{mean MDC} + (2*\text{standard deviation of mean MDC})$$

The greater of the BTV or 2σ UCL MDC was selected as the FAL for each laboratory for each radionuclide. Table 4.1 summarizes the FALs. Sample results were compared to the FALs and results equal to or greater than the FAL were identified as potential Radiological Areas of Interest. To provide enhanced visual analysis of sample data on the figures, results were categorized into five data ranges as follows:

- Less than the FAL,
- Equal to or greater than the FAL and less than twice the FAL,
- Equal to or greater than twice the FAL and less than thrice the FAL,
- Equal to or greater than thrice the FAL and less than four times the FAL,
- Equal to or greater than four times the FAL.

4.3 RADIONUCLIDES EXCEEDING FIELD ACTION LEVELS

Of the 55 radionuclides analyzed, 28 were detected above the FALs in surface and subsurface soils from the Area IV Study Area (Table 4.1).

Of these 17 were identified as NORM. The background study demonstrated that NORM radionuclides are present in unimpacted areas with a degree of variability in concentrations. It is possible that a radionuclide or several radionuclides could exceed FALs but would not be due to SSFL radiological operations.

The remaining 11 radionuclides exceeding the FALs can be attributed to SSFL radiological operations, and are referred to as site-related radionuclides: Am-241, Cs-137, Co-60, Cm-243/244, europium (Eu)-152, Eu-154, Ni-59, Pu-238, Pu-239/240, Sr-90 and H-3. These results are presented in Tables 4.2 and 4.3 and Figures 4.1 through 4.15.

The following subsections discuss the radionuclides detected above FALs frequency of occurrence. The locations are described relative to various features (building, drainage, etc.) within the Area IV Study Area. For simplicity, the feature is described first with the distance and direction of sample locations described second. For example, Subarea 5A describes five Cs-137 sample results that exceeded the FAL, which were located approximately 60 feet west of the Former Building 4064 drainage. Thus, the text is written as "Former Building 4064 drainage, approximately 60 feet west (5 samples)." This allows the reader to focus on the feature, then the distance and direction from the feature to the sample location(s), and finally, the number of samples associated with the feature.

4.3.1 Cesium-137

The FAL for Cs-137 is the BTV of 0.193 picocuries per gram (pCi/g). Cesium-137 was detected in 291 soil samples at concentrations greater than the FAL, ranging from 0.194 to 196 pCi/g. Cesium-137 was part of the default analyte suite; therefore, all Round 1 soil samples were analyzed for Cs-137 during and only select soil samples were analyzed for Cs-137 during the Round 2 soil sampling event.

With the exception of Subarea 3, Cs-137 was detected in every subarea and the NBZ. These concentrations are presented by subarea (surface and subsurface) in Tables 4.2 and 4.3 and are illustrated on Figures 4.1 and 4.2. Details pertaining to each subarea regarding the distribution of Cs-137 are provided in the following subsections.

Subarea 5A

In this subarea, 164 surface soil and 227 subsurface soil samples were collected for Cs-137 analysis. Eight surface soil samples contained Cs-137 at concentrations exceeding the FAL, ranging between 0.2 and 0.993 pCi/g. These samples are located in three areas:

- Former Fuel Element Storage Facility Building 4064 drainage, approximately 60 feet west (5 surface soil samples). Seven additional samples associated with this Key Facility will be discussed in the Subarea 6 section.
- Heavy Metals Likely Chemical Remediation Zone Area, located in the southwest corner of Subarea 5A (2 surface soil samples)
- Storm water channel south of G Street and northwest of Building 4029 (1 surface soil sample)

Cesium-137 was not detected at concentrations exceeding the FAL in subsurface soil samples collected from Subarea 5A.

<u>Subarea 5B</u>
In this subarea, 245 surface soil and 281 subsurface soil samples were collected for Cs-137 analysis. Fourteen surface soil samples contained Cs-137 at concentrations exceeding the FAL ranging from 0.213 to 0.911 pCi/g. These samples were collected from two areas:

- 17th Street Drainage Area (12 surface soil samples)
- Former Building 4010 Area (2 surface soil samples; note that one sample is geographically located in Subarea 7 but is associated with the Former Building 4010 Area)

Cesium-137 was not detected at concentrations exceeding the FAL in subsurface soil samples collected from Subarea 5B.

<u>Subarea 5C</u>
In this subarea, 90 surface soil and 129 subsurface soil samples were collected for Cs-137 analysis. Two surface soil samples contained Cs-137 at concentrations exceeding the FAL at 0.316 and 0.818 pCi/g. These samples were collected from one area:

- Building 4100 Area (Fast Critical Experiment), 15 feet northeast (2 surface samples)

Cesium-137 was not detected at concentrations exceeding the FAL in subsurface soil samples collected from Subarea 5C.

<u>Subarea 5D</u>
In this subarea, 293 surface soil and 303 subsurface soil samples were collected for Cs-137 analysis. Eight surface soil samples contained Cs-137 at concentrations that exceeded the FAL ranging from 0.194 to 1.42 pCi/g. These samples were collected from three areas:

- The portion of 5D-South (6 surface soils samples)
- Former Building 4020 (Hot Lab), approximately 100 feet northwest (1 surface soil sample)
- Isolated location approximately 150 feet northwest of former Building 4353 (1 surface soil sample)

Cesium-137 was not detected at concentrations exceeding the FAL in subsurface soil samples collected from Subareas 5D-North and 5D-South.

<u>Subarea 6</u>
In this subarea, 297 surface soil and 345 subsurface soil samples were collected for Cs-137 analysis. Eighty-two surface and 11 subsurface soil samples contained Cs-137 at concentrations exceeding the FAL ranging from 0.194 to 196 pCi/g. These samples were collected from eight areas:

- SRE Complex (21 surface and 2 subsurface soil samples)

- Liquid and Gas Radioactive Storage Tanks Area, located on the north side of the SRE Complex (22 surface and 3 subsurface soil samples)
- SRE Pond and Drainage (5 surface and 4 subsurface soil samples)
- Hot Oil Sodium Cleaning Facility (8 surface soil samples)
- Former Fuel Element Storage Building 4064 Drainage, in the drainage way leading to the east towards the New Conservation Yard. It should be noted that this area, along the southern side of G Street, is where the highest concentration of Cs-137 was detected during the investigation at a level of 196 pCi/g (8 surface and 1 subsurface soil samples)
- Old Conservation Yard (2 surface and 1 subsurface soil samples)
- New Conservation Yard (12 surface soil samples)
- Former Building 4003 – Engineering Test Building (4 surface soil samples)

Subarea 7

In this subarea, 216 surface soil and 208 subsurface soil samples were collected for Cs-137 analysis. One hundred and thirty surface and 24 subsurface soil samples contained Cs-137 at concentrations exceeding the FAL ranging from 0.195 to 20.2 pCi/g. These samples were collected from six different areas:

- RMHF fence line (34 surface and 9 subsurface soil samples)
- Site 4614 RMHF Holding/Catchment Basin (25 surface and 3 subsurface soil samples)
- RMHF Leach Field located approximately 100 feet north of the RMHF in the northern drainage (27 surface and 8 subsurface soil samples)
- Hazardous Waste Management Facility and adjacent debris field (26 surface soil samples)
- Interim Storage Facility (7 surface and 4 subsurface soil samples)
- Panhandle Area (11 surface soil samples; note one sample is geographically located in the NBZ West but is associated with this feature)

Subarea 8

In this subarea, 209 surface soil and 188 subsurface soil samples were collected for Cs-137 analysis. Eight surface soil samples contained Cs-137 at concentrations exceeding the FAL ranging from 0.197 to 0.878 pCi/g. These samples were collected from four different areas:

- Subarea 8-South, two clusters near the western boundary (4 surface samples)
- Former Sodium Disposal Facility (2 surface soil sample)
- Former Building 4056 Landfill (1 surface soil sample)
- Former Empire State Atomic Development Authority Area (1 surface soil sample)

Cesium 137 was not detected at concentrations exceeding the FAL in subsurface soil samples collected from Subareas 8.

Northern Buffer Zone

In the NBZ, 160 surface soil and 73 subsurface soil samples were collected for Cs-137 analysis. Three surface soil samples contained Cs-137 at concentrations exceeding the FAL ranging fom 0.207 to 0.277 pCi/g. These samples were collected from the following two areas:

- NBZ West (1 surface soil samples)
- NBZ East (2 surface soil samples)

Cesium-137 was not detected at concentrations exceeding the FAL in subsurface soil samples collected from the NBZ.

4.3.2 Strontium-90

The FALs for Sr-90 are the MDC 2σ UCL of 0.387 pCi/g for GEL data and the BTV of 0.0750 pCi/g for TAL data. Strontium-90 was part of the default analyte suite; therefore, all Round 1 soil samples were analyzed for Sr-90 and only select locations were analyzed for Sr-90 during the Round 2 soil sampling event.

Strontium-90 was detected in 153 soil samples at concentrations above the FALs, ranging from 0.01 to 21.3 pCi/g. Strontium-90 was detected throughout the entire Area IV Study Area. These concentrations are presented by subarea (surface and subsurface) in Tables 4.2 and 4.3 and are illustrated on Figures 4.3 and 4.4. Details pertaining to each subarea regarding the distribution of Sr-90 are provided in the following subsections.

Subarea 3

In this subarea, 2 surface soil and 11 subsurface soil samples were collected for Sr-90 analysis. One subsurface soil sample contained Sr-90 exceeding the FAL at a concentration of 0.444 pCi/g. This single sample was located on the south side of the Southern California Edison Substation.

Strontium-90 was not detected at concentrations exceeding the FAL in any of the surface soil samples collected from Subarea 3.

Subarea 5A

In this subarea, 144 surface soil and 206 subsurface soil samples were collected for Sr-90 analysis. One surface and two subsurface soil samples contained Sr-90 exceeding the FAL at concentrations ranging from 0.091 to 2.56 pCi/g. These samples were collected from two areas:

- Former KEWB Reactor Facility (1 surface soil sample)
- Former Building 4093, L85 Nuclear Experimentation Reactor (2 subsurface soil samples)

Subarea 5B

In this subarea, 225 surface soil and 261 subsurface soil samples were collected for Sr-90 analysis. Three surface and two subsurface soil samples contained Sr-90 at concentrations exceeding the FALs ranging from 0.090 to 0.563 pCi/g. These samples were collected from five areas:

- Building 4011 area, southwest of Building 4011 (1 subsurface soil sample)
- Building 4019 area, north of Building 4019 (1 subsurface soil sample)
- Former Building 4010, SNAP Reactor (1 surface soil sample)
- Building 4006, approximately 100 feet southeast (1 surface soil sample)
- Building 4006, approximately 100 feet west in footprint of former Building 4026 (1 surface soil sample)

Subarea 5C

In this subarea, 81 surface soil and 119 subsurface soil samples were collected for Sr-90 analysis. One surface soil sample contained Sr-90 at a concentration of 0.098 pCi/g that exceeded the FAL. This single sample was located in an open area approximately 300 feet southwest of Building 4462, between 22nd and 23rd streets.

Strontium-90 was not detected at concentrations exceeding the FAL in any of the subsurface soil samples collected from Subarea 5C.

Subarea 5D

In this subarea, 274 surface soil and 288 subsurface soil samples were collected for Sr-90 analysis. Fifteen surface and 13 subsurface soil samples contained Sr-90 at concentrations exceeding the FALs ranging from 0.395 to 1.55 pCi/g. These samples were collected from the following ten areas:

- Former Hot Lab Area, former Building 4020 (6 surface and 8 subsurface soil samples)
- Building 4009, in the south ditch along G Street, east of Building 4009 (1 surface soil sample)
- Building 4055 Former Liquid Waste Holdup System (1 surface soil sample)
- Former Building 4373 Leach Field (1 surface soil sample)
- Former Building 4353 Area, in the ponded area approximately 250 feet southeast of Former Building 4353 (3 surface soil samples)
- Former Building 4875 Area (1 surface and 1 subsurface soil samples)
- Former Building 4375 footprint (1 subsurface soil sample)
- Former Buildings 4173/4865 (1 surface soil sample)
- Pond Dredge Area (1 subsurface soil sample)
- Subarea 5D-South (1 surface and 2 subsurface soil sample)

Subarea 6

In this subarea, 211 surface soil and 259 subsurface soil samples were collected for Sr-90 analysis. Eleven surface and 5 subsurface soil samples contained Sr-90 at concentrations exceeding the FALs ranging from 0.185 to 21.3 pCi/g. These samples were collected from the following four areas:

- SRE Complex (3 surface and 1 subsurface soil samples)
- Liquid and Gas Radioactive Storage Tanks Area (5 surface and 1 subsurface soil samples).
- SRE Pond and Drainage (2 surface and 2 subsurface soil samples)
- Fuel Element Storage Facility, in the drainage way leading to the east, towards the New Conservation Yard (1 surface and 1 subsurface soil sample)

Subarea 7

In this subarea, 169 surface soil and 187 subsurface soil samples were collected for Sr-90 analysis. Thirty-three surface and 28 subsurface soil samples contained Sr-90 at concentrations exceeding the FALs ranging from 0.392 to 14.3 pCi/g. These samples were collected from the following nine areas:

- RMHF fence line (5 surface and 1 subsurface soil samples)
- Site 4614 RMHF Holdup Pond/Catch Basin (1 surface and 7 subsurface soil samples)
- RMHF Leach Field and northern drainage (16 surface and 11 subsurface soil samples)
- Hazardous Waste Management Facility and adjacent debris field (1 surface soil sample)
- Interim Storage Facility (4 surface and 3 subsurface soil samples)
- Subarea 7 Northern Panhandle Area (6 surface and 1 subsurface soil samples)
- Southwestern corner of Subarea 7, approximately 200 feet northwest Building 4019 (2 subsurface soils samples)
- STIR Facility (2 subsurface soil sample)
- Outfall 3 (1 subsurface soil sample)

Subarea 8

In this subarea, 190 surface soil and 172 subsurface soil samples were collected for Sr-90 analysis. Fourteen surface and 13 subsurface soil samples contained Sr-90 at concentrations exceeding the FALs ranging from 0.4 to 2.71 pCi/g. These samples were collected from the following five areas:

- Building 4009 area (1 surface and 1 subsurface soil samples)
- Building 4009 Leach Field area (2 surface and 1 subsurface soil sample)
- Sodium Disposal Facility (1 surface and 2 subsurface soil samples)
- Former Empire State Atomic Development Authority Facility (6 surface and 5 subsurface soil samples)
- Subarea 8-South (4 surface and 3 subsurface soil samples)

Northern Buffer Zone

In the NBZ, 160 surface soil and 73 subsurface soil samples were collected for Sr-90 analysis. Nine surface and 2 subsurface soil samples contained Sr-90 at concentrations exceeding the FALs ranging from 0.075 to 0.978 pCi/g. These samples were collected from the following four areas:

- NBZ West Subarea 8 drainages (5 surface and 1 subsurface soil samples)
- NBZ West RMHF drainages (3 surface soil samples)
- NBZ West northern area (1 subsurface soil sample)
- NBZ West, drainage from former Sodium Disposal Facility (1 subsurface soil sample)
- NBZ East SRE drainage (1 surface soil samples)

4.3.3 Plutonium-239/240

The FALs for Pu-239/240 are the MDC 2σ UCL of 0.0369 pCi/g for GEL data and the BTV of 0.0142 pCi/g for TAL data. Plutonium-239/240 was part of the default analyte suite, therefore, all Round 1 soil samples were analyzed for Pu-239/240; however, only select locations were analyzed for Pu-239/240 during the Round 2 soil sampling event.

Plutonium-239/240 was detected in 14 soil samples at concentrations greater than the FAL, ranging from 0.0233 to 0.187 pCi/g. Plutonium-239/240 was detected in soil samples collected from Subareas 5C, 5D, 6, 7, 8 and the NBZ. These concentrations are presented by subarea (surface and subsurface) in Tables 4.2 and 4.3 and are illustrated on Figures 4.5 and 4.6. Details pertaining to each subarea regarding the distribution of Pu-239/240 are provided in the following subsections.

Subarea 5C

In this subarea, 20 surface soil and 124 subsurface soil samples were collected for Pu-239/240 analysis. Two surface soil samples contained Pu-239/240 at concentrations exceeding the FALs at 0.0233 and 0.0487 pCi/g. These two samples were collected from the following two areas:

- Building 4100, approximately 70 feet northwest of Building 4100 (1 surface soil sample)
- Building 4015, approximately 350 feet southeast, along the southern border (1 surface soil sample)

Plutonium-239/240 was not detected at concentrations exceeding the FALs in any of the subsurface soil samples collected from Subarea 5C.

Subarea 5D

In this subarea, 235 surface soil and 248 subsurface soil samples were collected for Pu-239/240 analysis. One surface and 1 subsurface soil sample contained Pu-239/240 at concentrations of 0.0502 and 0.0526 pCi/g above the FALs. These two samples were collected from the following two areas:

- Former Building 4353, in the ditch on the south side of I Street and approximately 60 feet south of Building 4353 (1 subsurface soil sample)
- Southern portion of 5D-South (1 surface soil sample)

Subarea 6

In this subarea, 194 surface soil and 247 subsurface soil samples were collected for Pu-239/240 analysis. Three surface soil samples contained Pu-239/240 at concentrations exceeding the FAL with concentrations of 0.0302, 0.038 and 0.0515 pCi/g. These samples were collected from the following three areas:

- SRE Complex, northwest corner of the complex (1 surface soil sample)
- SRE Pond and Drainage (1 surface soil sample)
- Hot Oil Sodium Cleaning Facility (1 surface soil sample)

Plutonium-239/240 was not detected at concentrations exceeding the FALs in any of the subsurface soil samples collected from Subarea 6.

Subarea 7

In this subarea, 129 surface soil and 138 subsurface soil samples were collected for Pu-239/240 analysis. Three surface and 1 subsurface soil samples contained Pu-239/240 at concentrations of exceeding the FALs ranging from 0.0323 to 0.187 pCi/g. These samples were collected from the following four areas:

- RMHF, western fence line (1 surface soil sample)
- Site 4614 RMHF Holdup Pond/Catchment Basin (1 surface soil sample)
- Outfall 3, north of the RMHF (1 surface soil sample)
- STIR (1 subsurface soil sample)

Subarea 8

In this subarea, 152 surface soil and 131 subsurface soil samples were collected for Pu-239/240 analysis. Two subsurface soil samples contained Pu-239/240 at concentrations of 0.0713 and 0.0873 pCi/g exceeding the FALs. These samples were collected from the following two areas:

- Former Sodium Disposal Facility (1 subsurface soil sample)
- 4056 Landfill (1 subsurface soil sample)

Plutonium-239/240 was not detected at concentrations exceeding the FAL in any of the surface soil samples collected from Subarea 8.

Northern Buffer Zone
In the NBZ, 160 surface soil and 73 subsurface soil samples were collected for Pu-239/240 analysis. One surface soil sample contained Pu-239/240 at a concentration of 0.0384 pCi/g, exceeding the FAL. This sample was located approximately 250 feet north and upgradient of the RMHF Leach Field.

Plutonium-239/240 was not detected at concentrations exceeding the FAL in any of the subsurface soil samples collected from the NBZ.

4.3.4 Cobalt-60

The FALs for Co-60 are the MDC 2σ UCL of 0.0252 pCi/g for GEL data and 0.0228 for TAL data. Cobalt-60 was part of the default analyte suite, therefore all soil samples were analyzed for Co-60 during the Round 1 soil sampling event and only select locations were analyzed for Co-60 during the Round 2 soil sampling event.

Cobalt-60 was detected in four soil samples at concentrations greater than the FALs, ranging from 0.0228 to 0.048 pCi/g. The four samples were collected from Subareas 5B, 5C, 6 and 7, no other subareas or the NBZ contained samples with concentrations above the FAL for Co-60. These concentrations are presented by subarea (surface and subsurface) in Tables 4.2 and 4.3 and are illustrated on Figures 4.7 and 4.8. Details pertaining to each subarea regarding the distribution of Co-60 are provided in the following subsections.

Subarea 5B
In this subarea, 225 surface soil and 275 subsurface soil samples were collected for Co-60 analysis. One subsurface sample contained Co-60 at a concentration of 0.228 pCi/g exceeding the FAL. This sample was collected northwest of Former Building 4356.

Cobalt-60 was not detected at concentrations exceeding the FALs in any of the surface soil samples collected from Subarea 5B.

Subarea 5C
In this subarea, 90 surface soil and 129 subsurface soil samples were collected for Co-60 analysis One subsurface soil sample contained Co-60 at a concentration of 0.0247 pCi/g, which exceeded the FAL. This sample was collected south of Building 4100.

Cobalt-60 was not detected at concentrations exceeding the FALs in any of the surface soil samples collected from Subarea 5C.

Subarea 6

In this subarea, 297 surface soil and 345 subsurface soil samples were collected for Co-60 analysis One surface soil sample contained Co-60 at a concentration of 0.0480 pCi/g, exceeding the FAL. This sample was collected from the northwest edge of the SRE Complex.

Cobalt-60 was not detected at concentrations exceeding the FALs in any of the subsurface soil samples collected from Subarea 6.

Subarea 7

In this subarea, 216 surface soil and 208 subsurface soil samples were collected for Co-60 analysis. One surface soil sample contained Co-60 at a concentration of 0.0264 pCi/g exceeding the FAL. This sample was collected from the RMHF fence line.

Cobalt-60 was not detected at concentrations exceeding the FALs in any of the subsurface soil samples collected from Subarea 7.

4.3.5 Europium-152

The FALs for Eu-152 are the 2σ UCL MDCs of 0.670 pCi/g for GEL and 0.0459 pCi/g for TAL. Europium-152 was part of the default analyte suite, therefore all soil samples were analyzed for Eu-152 during the Round 1 soil sampling event and only select locations were analyzed for Eu-152 during the Round 2 soil sampling event.

Europium-152 was detected in five soil samples at concentrations greater than the FALs, ranging from 0.049 to 0.165 pCi/g. Europium-152 was detected only in soil samples collected from Subareas 5A and 5B; none of the soil samples collected in the remaining subareas within the Area IV Study Area exhibited Eu-152 above the FALs. These concentrations are presented by subarea (surface and subsurface) in Tables 4.2 and 4.3 and are illustrated on Figures 4.9 and 4.10. Details pertaining to each subarea regarding the distribution of Eu-152 are provided in the following subsections.

Subarea 5A

In this subarea, 144 surface soil and 219 subsurface soil samples were collected for Eu-152 analysis. Two surface soil samples contained Eu-152 at concentrations exceeding the FALs ranging from 0.073 to 0.165 pCi/g. These samples were collected from one area, Former Building 4005 at the southwest border.

Europium-152 was not detected at concentrations exceeding the FAL the subsurface soil samples collected from Subarea 5A.

Subarea 5B

In this subarea, 245 surface soil and 275 subsurface soil samples were collected for Eu-152 analysis. One surface and two subsurface soil samples contained concentrations exceeding the FALs ranging from 0.049 to 0.078 pCi/g. All three of these samples were collected from one area, SNAP Reactor Former Building 4010 Area. Note that one surface and one subsurface sample are geographically located in Subarea 6 but are associated with this feature.

4.3.6 Plutonium-238

The FALs for Pu-238 are the 2σ UCL MDCs of 0.0480 pCi/g for GEL data and 0.00921 pCi/g for TAL data. Plutonium-238 was part of the default analyte suite, therefore all soil samples were analyzed for Pu-238 during the Round 1 soil sampling event; however, only select locations were analyzed for Pu-238 during the Round 2 soil sampling event.

Plutonium-238 was detected in two surface soil samples at concentrations greater than the FALs, with concentrations of 0.0137 and 0.0492 pCi/g. Plutonium-238 was detected only in surface soil samples collected from Subareas 5A and 5D. Plutonium-238 was not detected at concentrations exceeding the FALs in any of the subsurface soil samples collected, or in surface soil samples collected from other subareas. Concentrations exceeding FALs are presented by subarea in Tables 4.2 and 4.3 and are illustrated on Figure 4.11. Details pertaining to each subarea regarding the distribution of Pu-238 are provided in the following subsections.

Subarea 5A

In this subarea, 144 surface soil and 207 subsurface soil samples were collected for Pu-238 analysis. One surface soil sample contained Pu-238 at a concentration of 0.0137 pCi/g exceeding the FAL. This sample was collected from the north side of Former Building 4023.

Subarea 5D

In this subarea, 236 surface soil and 251 subsurface soil samples were collected for Pu-238 analysis. One surface soil sample contained Pu-238 at a concentration of 0.0492 pCi/g, exceeding the FAL. This sample was collected from the east side of Former Building 4875.

4.3.7 Americium-241

The FALs for Am-241 are the 2σ UCL MDC of 0.041 pCi/g for GEL data and the BTV of 0.0162 pCi/g for TAL data. Americium-241 was part of the default analyte suite, therefore all soil samples were analyzed for Am-241 during the Round 1 soil sampling event; however, only select locations were analyzed for Am-241 during the Round 2 soil sampling event.

Americium-241 was detected in one surface and two subsurface soil samples at concentrations exceeding the FALs. Americium-241 was detected only in samples from Subareas 5D and 8. These concentrations are presented by subarea (surface and subsurface) in Tables 4.2 and 4.3 and are illustrated on Figures 4.12 and 4.13. Details pertaining to each subarea regarding the distribution of Am-241 are provided in the following subsections.

Subarea 5D

In this subarea, 229 surface soil and 244 subsurface soil samples were collected for Am-241 analysis. One subsurface soil sample contained Am-241 at a concentration of 0.0589 pCi/g, exceeding the FAL. This sample was collected approximately 300 feet southeast of former Building 4173/4865 from a "trench" aerial photo feature.

Americium-241 was not detected at concentrations exceeding the FAL in any of the surface soil samples collected from Subarea 5D.

Subarea 8

In this subarea, 153 surface soil and 136 subsurface soil samples were collected for Am-241 analysis. One surface and 1 subsurface soil samples contained Am-241 at concentrations of 0.0514 and 0.0484 pCi/g, respectively, exceeding the FAL. These samples were collected from the following two areas:

- Former Sodium Disposal Facility (1 subsurface sample)
- Southwest side of 8-North (1 surface sample)

4.3.8 Curium-243/244

The FALs for Cm-232/244 are the 2σ UCL MDCs of 0.0466 pCi/g for GEL data and 0.0162 pCi/g for TAL data. Curium-243/244 was part of the default analyte suite, therefore all soil samples were analyzed for Cm-243/244 during the Round 1 soil sampling event and only select locations were analyzed for Cm-243/244 during the Round 2 soil sampling event.

Curium-243/244 was detected in one surface and one subsurface soil sample at concentrations greater than the FALs, at 0.0178 and 0.0647 pCi/g. Curium-243/244 was only detected above the FAL in Subareas 5B and the NBZ. These concentrations are presented by subarea (surface and subsurface) in Tables 4.2 and 4.3 and are illustrated on Figures 4.14 and 4.15. Details pertaining to each subarea regarding the distribution of Cm-243/244 are provided in the following subsections.

Subarea 5B

In this subarea, 245 surface soil and 275 subsurface soil samples were collected for Cm-243/244 analysis. One surface soil sample contained Cm-243/244 at a concentration of 0.0178 pCi/g exceeding the FAL. This sample was collected from the footprint of the former SNAP reactor Building 4010.

Curium-243/244 was not detected at concentrations exceeding the FAL in any of the subsurface soil samples collected from Subarea 5B.

Northern Buffer Zone

In the NBZ, 160 surface soil and 73 subsurface soil samples were collected for Cm-243/244 analysis. One subsurface soil sample exceeded the FAL for Cm-243/244 at a concentration of 0.0647 pCi/g. This sample was collected from the NBZ-East within the Debris Field north of Subarea 6.

Curium-243/244 was not detected at concentrations exceeding the FAL in any of the surface soil samples collected from the NBZ.

4.3.9 Single Occurrence Radionuclides

Europium-154, Ni-59 and H-3 were detected above FALs in one sample each throughout the Area IV Study Area. Europium-154 and H-3 were detected at concentrations equal to their FALs at 0.136 and 7.38 pCi/g (respectively) in samples with other site-related radionuclide above the FALs. Europium-154 was detected in a sample collected from the 5D-South southern ridge and H-3 from the footprint of former Building 4010. Nickel-59 was detected in an isolated sample location within the footprint of former Building 4023 at a concentration of 23.9 pCi/g. These sample results are presented in Tables 4.2 and 4.3.

4.3.10 Naturally Occurring Radioactive Material

Naturally occurring radioactive materials are present in soils, sediment, and rock in the earth's crust. There are two types of naturally occurring radionuclides in soil: those occurring singly and those occurring as part of a decay series. The most common singly occurring NORM radionuclide is potassium (K)-40. Three primordial decay series ubiquitous in rocks and soil originate from Th-232, U-235, and U-238. Each decay series is composed of a radionuclide parent (listed) and its progeny or radioactive decay product radionuclides. Progeny radionuclides are normally present in uncontaminated soil in secular equilibrium (the concentrations of parent and progeny radionuclides are equal). Secular equilibrium enables the inter-comparison of radionuclides within a series to assess individual radionuclide exceedances.

An examination of the radionuclide concentration ratios within a series aids in assessing whether NORM radionuclide exceedances may be present due to site-related activities. The differences observed between naturally occurring radionuclide concentrations of a particular series are expected to be small if the soil sample does not represent contamination. For example, a U-238 exceedance of 2.5 pCi/g would be recognized as a higher than normal SSFL sample result. When the U-238 decay product radionuclides (bismuth-214 and lead-214) are approximately 2.5 pCi/g this affirms the U-238 result does not indicate site-related contamination, even though it exceeds the FAL (the modifier approximately is appropriate because concentrations reported from different radiochemistry methods are expected to differ, within the error limits of each method). This scenario suggests the sample has a high natural uranium concentration, within the range of natural variability. Conversely, a U-238 exceedance with a concentration that significantly differed from its decay product radionuclides may indicate site–related contamination.

The background study demonstrated that radionuclides are present in unimpacted areas with a degree of variability in concentrations. It is possible that radionuclides could exceed FALs and not be due to SSFL radiological operations. Considering that greater than 3,000 sample analyses were completed for default suite radionuclides, some results will exceed FALs simply due to natural and statistical variability. Natural variability is due to the natural distribution in rock and soil formations. Statistical variability refers to analytical measurements statistics.

One of the most important naturally occurring radionuclides is uranium. It is important because it is present and detectable at naturally occurring concentrations and is the primary radioactive element in most nuclear fuel. The U-235 contained in nuclear fuel is enriched or concentrated to approximately 3 percent versus 0.72 percent U-235 in natural uranium. After uranium nuclear fuel is made, the natural isotopic abundance ratios and secular equilibrium conditions of each nuclide within the respective decay series no longer apply. Thus, comparison between uranium isotopes 234, 235, and 238 is useful to understand whether uranium isotopic ratios indicate enrichment.

To assess NORM concentrations that exceed FALs, several factors were considered including:

- Are U-238 and Th-232 decay series radionuclide activities consistent within each series?
- How does the isotopic ratio of concentrations of U-235 compare with U-238 and U-234?
- Does the gamma scanning line of evidence indicate extensive high surface NORM content in the area?
- Are there rock outcrops immediately adjacent to the location?
- Is the location of the sample being evaluated just above bedrock?
- What information is contained in the borehole gamma scanning?
- Did information provided in the HSA indicate any site operations conducted at the location?
- Were there any lines of evidence, such as geophysical or aerial photograph, that indicated a potential source for site-related NORM?

The answers to these questions, involving site data have been evaluated to determine whether NORM exceedances can be attributed to site-related contamination. For Round 1 sample results, only four NORM RTL exceedances warranted collection of step-out samples during Round 2. Several instances were identified where NORM RTL exceedances were associated with collocated site-related radionuclides. In these instances, Round 2 step-out samples were collected and analyzed to characterize potential site-related contamination.

In addition, analytical method uncertainty is addressed by the RTLs and not by the FALs. As a result, the RTL concentrations are greater than their respective FAL concentrations. The evaluation of NORM RTL exceedances produced few results considered potentially site-related, while virtually all NORM radionuclide results exceeded their respective FALs.

4.3.11 Likely Chemical and Decontamination and Decommissioning Zones

During the February 22, 2012, technical review meeting recommendations and action items including those on the topic of LCRZs and LD&DZs were discussed. USEPA understands that most, if not all, surface soil and infrastructure (building structures, concrete slabs, above-ground pipelines and underground pipelines etc.) may be excavated and removed from areas identified as LD&DZ and LCRZ. In accordance with the USEPA's role under the AOC for

Remedial Action (DTSC, 2010) agreement between DTSC and DOE for the SSFL site, USEPA will conduct confirmation soil sampling to verify that site remediation goals have been achieved at all such remediation zones. These follow-on efforts are not included in the current scope of work and will be accomplished using additional external funding.

5.0 SUMMARY

USEPA's radiological characterization study of the SSFL at Area IV and the NBZ covered a total of 472 acres. Area IV was historically used for research, development, and construction of nuclear reactors and associated equipment. An exhaustive search of the historical record conducted during the HSA did not find documentation of any former operations or land use associated with Area IV within the NBZ. The characterization consisted of an HSA; a gamma radiation survey; an aerial photograph analysis; a geophysical survey and collecting and analyzing soil, groundwater, surface water, and sediment samples from targeted locations. This report discusses the sampling approach and analytical results for surface soil, subsurface soil, and sediment samples collected from specific targeted locations identified from five lines of evidence.

The sampling was conducted in two rounds; (1) Round 1 targeted samples collected from specific locations identified by the five lines of evidence (HSA, geophysics, gamma scanning, aerial photo analysis, and field reconnaissance) and (2) Round 2 step-out samples collected adjacent to Round 1 samples that contained radionuclide concentrations greater than the RTL. Soil sampling commenced in October 2010 with Round 1 sediment sampling and was completed in July 2012 with Round 2 soil sampling, totaling 3,542 environmental samples. RTLs were developed as temporary field decision levels for the radionuclides of concern, in the absence of established cleanup levels, and were used with other information to identify Round 2 step-out locations.

Look-up Table values for radionuclides have not been established. Look-up Table values will be established by DTSC in accordance with the AOC which states that the Look-up Table will "include both background concentrations as well as minimum detection limits for specific contaminants whose minimum detection limits exceed local background concentrations" (DTSC, 2010). To satisfy the AOC requirement the final radiological data presented in this report were evaluated against either the BTVs or the 2σ UCL MDCs, as applicable. These values are called the FALs. Sample results were compared to FALs to identify Radiological Areas of Interest.

A majority of the Radiological Areas of Interest are congregated within specific areas or are associated with key facilities. Figure 5.1 illustrates all sample locations where one or more radionuclides were identified at concentrations greater than their respective FAL. These locations have been grouped into 48 Radiological Areas of Interest, not including the NBZ East and NBZ West, where no specific key feature was present. The Radiological Areas of Interest, the operational history, and associated analytical results are summarized in Table 5.1.

Approximately 70 percent of soil samples with radionuclide concentrations greater than the FALs are located within five Area IV Radiological Areas of Interest:

- RMHF complex,
- SRE complex,
- 17th Street Drainage,
- Former Fuel Element Storage Facility, and

- New Conservation Yard Drainage Area.

At least some portion of each of these areas has been designated by DOE as a LCRZ.

The remaining Area IV Radiological Areas of interest are characterized by fewer and generally lower concentrations of the radionuclides of concern associate with a former building or some historical operation.

Two groupings of a relatively large number of samples with concentrations greater than the FAL were identified in the southern portion of Subareas 5D and 8. These two areas are on a relatively steep hillside in an area where no operational history was identified during the HSA. Additionally, the soil samples collected from these areas represent the Santa Susana Formation, while the remainder of the samples were collected from soils overlying the Chatsworth Formation, suggesting that these slightly elevated concentrations may be attributable to geologic variations and considered NORM.

Radiological Areas of Interest identified in the NBZ consist of isolated radionuclide detections; however, Round 2 step-out samples were not collected in the NBZ. Four Round 1 samples in the NBZ East and 12 Round 1 samples in the NBZ West were reported to contain radionuclides at concentrations exceeding the respective FALs. There is no pattern or grouping of the exceedances.

Specific locations throughout the Area IV Study Area were designated as LCRZs by DOE and DTSC based on the concentrations of chemical analytes. USEPA understands that these LCRZs will be remediated at a later date; thus, only limited sampling was conducted by USEPA within the LCRZ boundaries. Other areas where limited or no sampling for radiological constituents was conducted included likely LD&DZs which were defined as existing building complexes or existing concrete foundations of former buildings that will likely be removed and remediated as necessary. If these LCRZs and LD&DZs are not remediated additional characterization in these areas may be necessary to identify potential areas of radiological contamination.

In accordance with the AOC, DTSC will determine Look-up Table values for comparison to all sample results for determination of locations of contamination that warrant remediation. Results that exceed the FALs and Radiological Areas of Interest identified in this report are potential locations that may require further investigation and/or remediation depending on the Look-up Table values. Areas of contamination requiring remediation will be determined after DTSC establishes the Look-up Table values, and this process is not within the scope of USEPA's action, nor under EPA purview.

USEPA has provided recommendations to the DTSC regarding the future development of LUT values (HGL, 2012g). LUT values are a metric against which analytical sample results will be compared to determine if a sample contains or does not contain contamination requiring remediation. In addition, guidance is provided for the implementation and application of these LUT values, and for addressing potential challenges in the procurement and use of analytical laboratory data.

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Table 3.1
Soil Samples Collected and Analyzed in Area IV Study Area

Subarea	Round 1 Soil Samples						Round 2 Soil Samples					Round 1 Total	Round 2 Total	Total
	Drainage	Surface	Subsurface[1]	Sediment	Random	Duplicate	Drainage	Surface	Subsurface	Sediment	Duplicate			
3	0	2	11	0	0	1	0	0	0	0	0	**14**	**0**	**14**
5A	27	111	203	0	0	16	0	26	26	0	4	**357**	**56**	**413**
5B	29	193	258	0	0	23	0	23	23	0	3	**503**	**49**	**552**
5C	14	67	122	0	0	10	0	9	10	0	2	**213**	**21**	**234**
5D	15	210	240	0	0	25	2	66	63	0	8	**490**	**139**	**629**
6	24	169	256	4	0	24	3	105	105	8	13	**477**	**234**	**711**
7	9	118	141	2	0	15	4	88	75	0	9	**285**	**176**	**461**
8	17	138	134	5	0	19	0	57	57	0	6	**313**	**120**	**433**
NBZ	30	31	73	29	99	14	0	0	4	7	1	**276**	**12**	**288**
Total	**165**	**1039**	**1438**	**40**	**99**	**147**	**9**	**374**	**363**	**15**	**46**	**2928**	**807**	**3735**

Notes:

[1]Subareas 5A, 5C, 6 and 7 subsurface samples include the deep borehole samples collected in each subarea.

Table 4.1
Radionuclides of Concern
Field Action Levels

Radionuclides	GEL FAL	TAL FAL	Radionuclides	GEL FAL	TAL FAL
Site-related Radiouclides above the FAL			***Radionuclides below the FAL***		
Am-241	4.10E-02	1.62E-02	Ag-108m	NA	NA
Cm-243/Cm-244	4.66E-02	1.62E-02	Am-243	3.72E-02	1.34E-02
Co-60	2.52E-02	2.28E-02	C-14	2.54E+00	2.54E+00
Cs-137	1.93E-01	1.93E-01	Cd-113m	2.95E+03	2.95E+03
Eu-152	6.70E-02	4.59E-02	Cf-249	NA	NA
Eu-154	1.36E-01	1.25E-01	Cm-245/Cm-246	NA	1.62E-02
H-3	9.99E+00	7.38E+00	Cm-248	NA	2.34E-02
Ni-59	7.24E+00	6.48E-01	Cs-134	3.00E-02	6.88E-02
Pu-238	4.80E-02	9.21E-03	Eu-155	1.98E-01	1.98E-01
Pu-239/Pu-240	3.69E-02	1.42E-02	Ho-166m	3.65E-02	3.65E-02
Sr-90/Y-90	3.87E-01	7.50E-02	I-129	1.60E+00	NA
NORM Radionuclides above the FAL			Na-22	3.06E-02	2.95E-02
Ac-227	2.67E-01	1.69E-01	Nb-94	2.13E-02	1.72E-02
Ac-228	2.30E+00	2.30E+00	Ni-63	1.78E+00	8.43E-01
Bi-212	2.04E+00	2.04E+00	Np-236	4.95E-02	3.68E-02
Bi-214	1.57E+00	1.57E+00	Np-237	5.42E-02	NA
K-40	3.05E+01	3.05E+01	Np-239	1.77E-01	1.02E-01
Pa-231	1.11E+00	7.91E-01	Pm-147	8.62E+00	NA
Pb-212	2.67E+00	2.67E+00	Pu-236	5.10E-02	1.84E-02
Pb-214	1.68E+00	1.68E+00	Pu-241	3.73E+00	NA
Ra-226	1.88E+00	NA	Pu-244	2.59E-02	5.26E-03
Th-228	3.67E+00	3.67E+00	Ra-228	NA	NA
Th-230	2.04E+00	2.04E+00	Sb-125	3.21E-01	3.21E-01
Th-232	2.95E+00	2.95E+00	Sn-126	2.33E-02	1.95E-02
Th-234	3.04E+00	3.04E+00	Tc-99	1.75E+00	3.87E-01
Tl-208	9.23E-01	9.23E-01	Th-229	1.35E-01	4.62E-02
U-233/U-234	1.87E+00	1.87E+00	Tm-171	6.59E+01	6.59E+01
U-235/U-236	1.30E-01	1.30E-01			
U-238	1.68E+00	1.68E+00			

Notes:

Refer to Table 2.1 of the Final Field Sampling Plan for Soil Sampling (HGL, 2012d) for a definition of radionuclide symbols.

Reporting units in picocuries per gram.

FAL - field action level

GEL - GEL Laboratories LLC

NA - not available

NORM - naturally occurring radioactive material

TAL - TestAmerica Laboratories, Inc.

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Americium-241									
8-North	Former Sodium Disposal Facility	8N-00085	40162	GEL	0.0514	0.0410	0.0239	0.0123	0.0097
Curium-243/244									
5B	Former Building 4010	5B-00008	20016	TAL	0.0178	0.0162	0.0082	0.0048	0.0026
Cobalt-60									
6	Sodium Reactor Experiment Complex	6-00290	60446	GEL	0.048	0.0252	0.0149	0.00607	0.00834
7	Radioactive Materials Handling Facility	7-00184	70299	GEL	0.0264 J	0.0252	0.0287	0.00978	0.0137
Cesium-137									
5A	Heavy Metals Likely Chemical Remediation Zone	5A-00042	30321	GEL	0.24	0.193	0.0124	0.014	0.00607
5A	Fuel Element Storage Facility	5A-00066	30157	GEL	0.993	0.193	0.0122	0.0529	0.00601
5A	Building 4029	5A-00095	30364	GEL	0.2	0.193	0.0121	0.0125	0.00593
5A	Fuel Element Storage Facility	5A-00278	30477	GEL	0.595	0.193	0.019	0.0343	0.00927
5A	Fuel Element Storage Facility	5A-00279	30479	GEL	0.794	0.193	0.0197	0.0446	0.0096
5A	Fuel Element Storage Facility	5A-00280	30481	GEL	0.734	0.193	0.0208	0.0415	0.0101
5A	Fuel Element Storage Facility	5A-00281	30483	GEL	0.795	0.193	0.0205	0.0485	0.00999
5A	Heavy Metals Likely Chemical Remediation Zone	5A-00282	30485	GEL	0.327	0.193	0.0221	0.0204	0.0107
5B	17th Street Drainage	5B-00211	20455	TAL	0.213	0.193	0.011	0.0094	0.0053
5B	17th Street Drainage	5B-00212	20456	TAL	0.252	0.193	0.019	0.012	0.009
5B	17th Street Drainage	5B-00214	20458	TAL	0.522	0.193	0.014	0.019	0.007
5B	17th Street Drainage	5B-00217	20461	TAL	0.256	0.193	0.0092	0.00996	0.0045
5B	17th Street Drainage	5B-00218	20463	TAL	0.294	0.193	0.017	0.012	0.008
5B	17th Street Drainage	5B-00219	20464	TAL	0.444	0.193	0.014	0.016	0.007
5B	17th Street Drainage	5B-00220	20466	TAL	0.323	0.193	0.009	0.012	0.004
5B	17th Street Drainage	5B-00221	20467	TAL	0.626	0.193	0.013	0.021	0.006
5B	17th Street Drainage	5B-00222	20469	TAL	0.623	0.193	0.01	0.023	0.005
5B	17th Street Drainage	5B-00223	20471	TAL	0.813	0.193	0.011	0.029	0.005
5B	17th Street Drainage	5B-00224	20473	TAL	0.911	0.193	0.015	0.03	0.007
5B	17th Street Drainage	5B-00225	20475	TAL	0.313	0.193	0.011	0.013	0.005
5B	Former Building 4010	5B-00289	20101	TAL	0.282	0.193	0.011	0.011	0.005
5B	Former Building 4010	5B-00348	20726	GEL	0.254	0.193	0.0165	0.0161	0.00801
5C	Building 4100	5C-00056	10081	TAL	0.818	0.193	0.015	0.027	0.007
5C	Building 4100	5C-00149	10252	GEL	0.316	0.193	0.0175	0.0201	0.00851
5D-North	Former Building 4353	5DN-00126	50252	GEL	0.194	0.193	0.0203	0.0149	0.00984
5D-North	Hot Lab - Former Building 4020	5DN-00207	50409	GEL	1.42	0.193	0.0188	0.0778	0.00913
5D-South	Subarea 5D-South	5DS-00003	50444	GEL	0.196	0.193	0.0196	0.0137	0.0096
5D-South	Subarea 5D-South	5DS-00004	50446	GEL	0.227	0.193	0.022	0.0156	0.0107
5D-South	Subarea 5D-South	5DS-00012	50462	GEL	0.204	0.193	0.0278	0.0189	0.0135

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Cesium-137 (Continued)									
5D-South	Subarea 5D-South	5DS-00017	50472	GEL	0.196	0.193	0.0221	0.0143	0.0108
5D-South	Subarea 5D-South	5DS-00043	50640	GEL	0.314	0.193	0.0208	0.0198	0.0101
5D-South	Subarea 5D-South	5DS-00048	50650	GEL	0.213	0.193	0.0208	0.0156	0.0101
6	Former Building 4003 - Engineering Test Building	6-00005	60006	GEL	0.241	0.193	0.0148	0.0155	0.00723
6	Former Building 4003 - Engineering Test Building	6-00028	60037	GEL	0.197	0.193	0.0121	0.0125	0.00593
6	Former Building 4003 - Engineering Test Building	6-00029	60039	GEL	0.225	0.193	0.0132	0.0139	0.00645
6	Sodium Reactor Experiment Pond Area	6-00030	60041	GEL	0.229	0.193	0.017	0.0148	0.00827
6	Sodium Reactor Experiment Pond Area	6-00045	60542	GEL	0.389	0.193	0.0226	0.024	0.011
6	Sodium Reactor Experiment Pond Area	6-00063	60100	GEL	0.198	0.193	0.0148	0.013	0.00721
6	Sodium Reactor Experiment Complex	6-00098	60139	GEL	1.19	0.193	0.0161	0.0673	0.00781
6	Liquid and Gas Radioactive Storage Tanks Area	6-00130	60182	GEL	0.355	0.193	0.0215	0.0231	0.0104
6	Liquid and Gas Radioactive Storage Tanks Area	6-00131	60184	GEL	0.535	0.193	0.0178	0.0313	0.00864
6	Liquid and Gas Radioactive Storage Tanks Area	6-00132	60186	GEL	0.257	0.193	0.0188	0.0169	0.00906
6	Liquid and Gas Radioactive Storage Tanks Area	6-00133	60188	GEL	0.422	0.193	0.0173	0.0243	0.00847
6	Liquid and Gas Radioactive Storage Tanks Area	6-00134	60190	GEL	0.935	0.193	0.0223	0.0537	0.0108
6	Liquid and Gas Radioactive Storage Tanks Area	6-00142	60199	GEL	0.596	0.193	0.0177	0.0341	0.00859
6	Liquid and Gas Radioactive Storage Tanks Area	6-00144	60203	GEL	0.321	0.193	0.0148	0.0197	0.00722
6	Liquid and Gas Radioactive Storage Tanks Area	6-00145	60205	GEL	0.378	0.193	0.0152	0.022	0.00743
6	Liquid and Gas Radioactive Storage Tanks Area	6-00146	60207	GEL	2.33	0.193	0.0173	0.123	0.00843
6	Liquid and Gas Radioactive Storage Tanks Area	6-00147	60209	GEL	0.391	0.193	0.0143	0.0226	0.00692
6	Liquid and Gas Radioactive Storage Tanks Area	6-00148	60211	GEL	1.01	0.193	0.0201	0.0579	0.00982
6	Liquid and Gas Radioactive Storage Tanks Area	6-00149	60213	GEL	4.36	0.193	0.0148	0.228	0.00729
6	Sodium Reactor Experiment Complex	6-00150	60215	GEL	1.03	0.193	0.0129	0.0551	0.00634
6	New Conservation Yard	6-00212	60325	GEL	0.513	0.193	0.0168	0.0302	0.00819
6	New Conservation Yard	6-00215	60330	GEL	0.494	0.193	0.0206	0.0314	0.0101
6	New Conservation Yard	6-00228	60349	GEL	0.21	0.193	0.0138	0.0136	0.00676
6	New Conservation Yard	6-00237	60367	GEL	0.325	0.193	0.0154	0.0194	0.00751
6	Sodium Reactor Experiment Complex	6-00278	60422	GEL	0.405	0.193	0.0172	0.0237	0.0084
6	Sodium Reactor Experiment Complex	6-00281	60428	GEL	0.497	0.193	0.0177	0.0301	0.00855
6	Sodium Reactor Experiment Complex	6-00286	60438	GEL	1.09	0.193	0.0145	0.0602	0.00708
6	Sodium Reactor Experiment Complex	6-00287	60440	GEL	0.882	0.193	0.0224	0.0533	0.0108
6	Sodium Reactor Experiment Complex	6-00288	60442	GEL	1.41	0.193	0.0202	0.0764	0.00985
6	Sodium Reactor Experiment Complex	6-00290	60446	GEL	24.3	0.193	0.0217	1.27	0.0107
6	Sodium Reactor Experiment Complex	6-00291	60448	GEL	2.18	0.193	0.0127	0.115	0.00623
6	Sodium Reactor Experiment Complex	6-00292	60450	GEL	0.894	0.193	0.0131	0.0483	0.0064
6	Liquid and Gas Radioactive Storage Tanks Area	6-00293	60452	GEL	46.4	0.193	0.0336	2.47	0.0166

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Cesium-137 (Continued)									
6	Liquid and Gas Radioactive Storage Tanks Area	6-00294	60454	GEL	11.3	0.193	0.028	0.63	0.0136
6	Sodium Reactor Experiment Complex	6-00296	60458	GEL	1.35	0.193	0.0123	0.0722	0.00604
6	Sodium Reactor Experiment Complex	6-00297	60460	GEL	2.51	0.193	0.0125	0.132	0.00615
6	Sodium Reactor Experiment Complex	6-00298	60462	GEL	3.02	0.193	0.0129	0.158	0.00633
6	Sodium Reactor Experiment Complex	6-00299	60464	GEL	1.02	0.193	0.0223	0.0569	0.0108
6	Sodium Reactor Experiment Complex	6-00300	60466	GEL	1.44	0.193	0.015	0.0771	0.00727
6	Hot Oil Sodium Cleaning Facility	6-00302	60470	GEL	1.86	0.193	0.0119	0.0979	0.00585
6	Hot Oil Sodium Cleaning Facility	6-00303	60472	GEL	1.18	0.193	0.0149	0.0634	0.00729
6	Hot Oil Sodium Cleaning Facility	6-00304	60474	GEL	0.876	0.193	0.0129	0.0476	0.0063
6	Fuel Element Storage Facility	6-00305	60476	GEL	15.4	0.193	0.0206	0.811	0.0101
6	Fuel Element Storage Facility	6-00306	60478	GEL	196	0.193	0.103	10.2	0.0515
6	Fuel Element Storage Facility	6-00307	60480	GEL	2.84	0.193	0.0118	0.149	0.00577
6	Fuel Element Storage Facility	6-00309	60484	GEL	1.27	0.193	0.0133	0.069	0.00652
6	New Conservation Yard	6-00310	60486	GEL	1.31	0.193	0.0134	0.0694	0.00656
6	Old Conservation Yard	6-00311	60488	GEL	3.42	0.193	0.0181	0.181	0.00886
6	Old Conservation Yard	6-00312	60490	GEL	0.201	0.193	0.012	0.0139	0.00578
6	New Conservation Yard	6-00314	60494	GEL	4.61	0.193	0.0178	0.154	0.0178
6	New Conservation Yard	6-00315	60496	GEL	3.29	0.193	0.0154	0.177	0.00754
6	New Conservation Yard	6-00316	60498	GEL	1.49	0.193	0.0129	0.079	0.00631
6	New Conservation Yard	6-00318	60502	GEL	0.622	0.193	0.0143	0.0345	0.00701
6	New Conservation Yard	6-00320	60506	GEL	0.228	0.193	0.0119	0.0134	0.00584
6	Fuel Element Storage Facility	6-00322	60510	GEL	0.485	0.193	0.0144	0.0271	0.00707
6	Liquid and Gas Radioactive Storage Tanks Area	6-00328	60558	GEL	0.23	0.193	0.018	0.0183	0.00873
6	Liquid and Gas Radioactive Storage Tanks Area	6-00329	60560	GEL	0.22	0.193	0.0172	0.0145	0.00835
6	Liquid and Gas Radioactive Storage Tanks Area	6-00330	60562	GEL	0.324	0.193	0.0193	0.0201	0.00938
6	Liquid and Gas Radioactive Storage Tanks Area	6-00333	60568	GEL	0.401	0.193	0.0198	0.0248	0.00962
6	Liquid and Gas Radioactive Storage Tanks Area	6-00334	60570	GEL	0.51	0.193	0.0192	0.0311	0.00937
6	Liquid and Gas Radioactive Storage Tanks Area	6-00335	60572	GEL	1.15	0.193	0.016	0.0632	0.00782
6	Liquid and Gas Radioactive Storage Tanks Area	6-00336	60574	GEL	0.243	0.193	0.019	0.0174	0.00918
6	Liquid and Gas Radioactive Storage Tanks Area	6-00339	60580	GEL	0.224	0.193	0.0149	0.0142	0.00723
6	Sodium Reactor Experiment Complex	6-00340	60582	GEL	0.371	0.193	0.0164	0.0223	0.00798
6	Sodium Reactor Experiment Complex	6-00341	60584	GEL	1.23	0.193	0.0169	0.0661	0.00826
6	Sodium Reactor Experiment Complex	6-00348	60598	GEL	0.256	0.193	0.0178	0.0165	0.00864
6	Sodium Reactor Experiment Complex	6-00350	60602	GEL	0.689	0.193	0.0176	0.0382	0.0086
6	Sodium Reactor Experiment Complex	6-00354	60610	GEL	0.393	0.193	0.0217	0.0248	0.0105
6	Sodium Reactor Experiment Pond Area	6-00357	60616	GEL	0.253	0.193	0.0208	0.0168	0.0102

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Cesium-137 (Continued)									
6	Hot Oil Sodium Cleaning Facility	6-00359	60620	GEL	0.509	0.193	0.0174	0.0304	0.00846
6	Hot Oil Sodium Cleaning Facility	6-00360	60622	GEL	0.459	0.193	0.016	0.0264	0.00777
6	Hot Oil Sodium Cleaning Facility	6-00361	60624	GEL	0.739	0.193	0.0182	0.0458	0.00883
6	Hot Oil Sodium Cleaning Facility	6-00363	60628	GEL	0.307	0.193	0.0143	0.0187	0.00697
6	Hot Oil Sodium Cleaning Facility	6-00364	60630	GEL	2.45	0.193	0.0188	0.131	0.00915
6	Former Building 4003 - Engineering Test Building	6-00366	60634	GEL	0.211	0.193	0.0171	0.0157	0.00835
6	Fuel Element Storage Facility	6-00382	60666	GEL	0.288	0.193	0.0222	0.0221	0.0108
6	Fuel Element Storage Facility	6-00384	60670	GEL	0.219	0.193	0.0167	0.0141	0.00812
6	Fuel Element Storage Facility	6-00385	60672	GEL	0.35	0.193	0.0135	0.0205	0.00657
6	New Conservation Yard	6-00394	60690	GEL	0.334	0.193	0.0165	0.0206	0.00804
6	New Conservation Yard	6-00410	60722	GEL	0.382	0.193	0.0275	0.0256	0.0133
6	Sodium Reactor Experiment Complex	6-00424	60761	GEL	0.407	0.193	0.023	0.0258	0.0112
6	Sodium Reactor Experiment Pond Area	EPASED17	EPASED17	TAL	0.208	0.193	0.02	0.013	0.01
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00003	70005	GEL	2.5	0.193	0.0126	0.135	0.00611
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00004	70007	GEL	2.35	0.193	0.0191	0.126	0.0093
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00005	70009	GEL	1.38	0.193	0.0206	0.075	0.00999
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00006	70011	GEL	0.24	0.193	0.0233	0.022	0.0113
7	Radioactive Materials Handling Facility	7-00007	70013	GEL	2.84	0.193	0.0155	0.152	0.00756
7	Radioactive Materials Handling Facility	7-00008	70015	GEL	0.968	0.193	0.0179	0.0539	0.00871
7	Radioactive Materials Handling Facility	7-00009	70017	GEL	2.66	0.193	0.0144	0.144	0.007
7	Radioactive Materials Handling Facility	7-00010	70019	GEL	9.21	0.193	0.0237	0.496	0.0116
7	Radioactive Materials Handling Facility Leach Field	7-00011	70021	GEL	1.75	0.193	0.0177	0.0958	0.00861
7	Radioactive Materials Handling Facility Leach Field	7-00012	70023	GEL	1.14	0.193	0.0174	0.0639	0.00845
7	Radioactive Materials Handling Facility Leach Field	7-00013	70025	GEL	2.77	0.193	0.0168	0.148	0.00818
7	Radioactive Materials Handling Facility	7-00014	70027	GEL	2.68 J	0.193	0.0184	0.143	0.00896
7	Radioactive Materials Handling Facility Leach Field	7-00015	70029	GEL	4.7	0.193	0.0167	0.157	0.0167
7	Radioactive Materials Handling Facility Leach Field	7-00016	70031	GEL	1.08	0.193	0.0165	0.0584	0.00806
7	Radioactive Materials Handling Facility	7-00017	70033	GEL	6.21	0.193	0.0191	0.325	0.00932
7	Radioactive Materials Handling Facility	7-00018	70035	GEL	0.611 J	0.193	0.0184	0.0353	0.00898
7	Radioactive Materials Handling Facility Leach Field	7-00020	70039	GEL	0.234	0.193	0.0173	0.0173	0.00843
7	Radioactive Materials Handling Facility	7-00021	70041	GEL	0.528 J	0.193	0.0206	0.0312	0.01
7	Radioactive Materials Handling Facility	7-00022	70043	GEL	1.23	0.193	0.0172	0.0698	0.00834
7	Radioactive Materials Handling Facility Leach Field	7-00023	70045	GEL	1.16	0.193	0.0184	0.066	0.00894
7	Radioactive Materials Handling Facility	7-00024	70047	GEL	0.25	0.193	0.0212	0.0174	0.0103
7	Radioactive Materials Handling Facility Leach Field	7-00025	70049	GEL	0.374	0.193	0.0166	0.0235	0.00806
7	Interim Storage Facility - Former Building 4654	7-00026	70051	GEL	0.674	0.193	0.0217	0.0395	0.0105

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Cesium-137 (Continued)									
7	Hazardous Waste Management Facility - Former Building 4133	7-00027	70053	GEL	2.53	0.193	0.0181	0.134	0.00881
7	Interim Storage Facility - Former Building 4654	7-00028	70055	GEL	1.29	0.193	0.0202	0.0707	0.00975
7	Interim Storage Facility - Former Building 4654	7-00029	70057	GEL	1.81	0.193	0.0174	0.0993	0.00849
7	Interim Storage Facility - Former Building 4654	7-00030	70059	GEL	1.45 J	0.193	0.0196	0.0782	0.00954
7	Hazardous Waste Management Facility	7-00031	70061	GEL	0.684	0.193	0.0168	0.0398	0.00815
7	Hazardous Waste Management Facility	7-00032	70063	GEL	1.74	0.193	0.0189	0.0936	0.00921
7	Hazardous Waste Management Facility	7-00033	70065	GEL	0.778	0.193	0.0165	0.0433	0.00803
7	Hazardous Waste Management Facility	7-00034	70067	GEL	1.17 J	0.193	0.0151	0.0629	0.00732
7	Interim Storage Facility - Former Building 4654	7-00036	70071	GEL	0.833	0.193	0.0163	0.0456	0.00791
7	Subarea 7 Northern Panhandle	7-00037	70073	GEL	20.2 J	0.193	0.0246	1.05	0.0121
7	Hazardous Waste Management Facility - Former Building 4133	7-00038	70075	GEL	0.704	0.193	0.0172	0.0393	0.00841
7	Subarea 7 Northern Panhandle	7-00041	70081	GEL	0.214 J	0.193	0.0146	0.014	0.00712
7	Radioactive Materials Handling Facility	7-00045	70089	GEL	3.6	0.193	0.019	0.196	0.00926
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00049	70097	GEL	0.213	0.193	0.0166	0.014	0.00807
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00050	70099	GEL	0.763	0.193	0.0175	0.0437	0.00853
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00051	70101	GEL	0.493	0.193	0.0173	0.0278	0.00846
7	Radioactive Materials Handling Facility	7-00052	70103	GEL	6.59	0.193	0.0191	0.363	0.00932
7	Radioactive Materials Handling Facility	7-00053	70105	GEL	0.885	0.193	0.0174	0.049	0.00846
7	Radioactive Materials Handling Facility	7-00054	70107	GEL	1.42	0.193	0.0162	0.0771	0.00787
7	Radioactive Materials Handling Facility	7-00055	70109	GEL	0.399	0.193	0.016	0.0232	0.00776
7	Subarea 7 Northern Panhandle	7-00070	70129	GEL	6.17 J	0.193	0.02	0.324	0.00979
7	Subarea 7 Northern Panhandle	7-00071	70131	GEL	0.43 J	0.193	0.0177	0.0267	0.00861
7	Interim Storage Facility - Former Building 4654	7-00073	70134	GEL	0.974 J	0.193	0.0151	0.0526	0.00732
7	Interim Storage Facility - Former Building 4654	7-00077	70140	GEL	0.249	0.193	0.0178	0.0172	0.00865
7	Radioactive Materials Handling Facility	7-00083	70148	GEL	1.82	0.193	0.0215	0.0984	0.0105
7	Radioactive Materials Handling Facility	7-00086	70153	GEL	4.55	0.193	0.0169	0.249	0.00823
7	Radioactive Materials Handling Facility	7-00087	70155	GEL	19.8	0.193	0.021	1.03	0.0103
7	Radioactive Materials Handling Facility	7-00090	70161	GEL	6.52	0.193	0.0165	0.342	0.00805
7	Radioactive Materials Handling Facility	7-00091	70163	GEL	0.86	0.193	0.0192	0.0489	0.00932
7	Radioactive Materials Handling Facility	7-00092	70165	GEL	1.5	0.193	0.0174	0.0826	0.00846
7	Radioactive Materials Handling Facility	7-00093	70167	GEL	1.41	0.193	0.0156	0.0771	0.00758
7	Radioactive Materials Handling Facility	7-00094	70169	GEL	0.484	0.193	0.0174	0.0285	0.00849
7	Radioactive Materials Handling Facility	7-00095	70171	GEL	1.78 J	0.193	0.0213	0.0962	0.0103
7	Radioactive Materials Handling Facility	7-00096	70173	GEL	0.344 J	0.193	0.0178	0.021	0.00867
7	Radioactive Materials Handling Facility	7-00097	70175	GEL	1.04 J	0.193	0.0209	0.06	0.0102
7	Radioactive Materials Handling Facility	7-00101	70183	GEL	1.54	0.193	0.0153	0.0819	0.00748

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Cesium-137 (Continued)									
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00122	70208	GEL	0.195	0.193	0.0222	0.0145	0.0108
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00129	70217	GEL	0.464	0.193	0.0158	0.0267	0.00771
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00130	70219	GEL	2.04	0.193	0.0153	0.108	0.00746
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00134	70226	GEL	0.578	0.193	0.0153	0.0327	0.00744
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00135	70228	GEL	1.33	0.193	0.019	0.0736	0.00924
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00136	70230	GEL	1.28	0.193	0.0225	0.0704	0.0109
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00137	70232	GEL	1.05	0.193	0.0156	0.0603	0.00756
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00138	70234	GEL	0.865	0.193	0.0177	0.0477	0.00863
7	Radioactive Materials Handling Facility Leach Field	7-00139	70236	GEL	0.387	0.193	0.0217	0.0271	0.0106
7	Radioactive Materials Handling Facility Leach Field	7-00140	70238	GEL	0.21	0.193	0.0174	0.0151	0.00847
7	Radioactive Materials Handling Facility Leach Field	7-00141	70240	GEL	0.791	0.193	0.0217	0.0443	0.0106
7	Radioactive Materials Handling Facility Leach Field	7-00142	70242	GEL	0.803	0.193	0.0154	0.0438	0.00752
7	Radioactive Materials Handling Facility Leach Field	7-00143	70244	GEL	0.223	0.193	0.0215	0.0161	0.0105
7	Hazardous Waste Management Facility	7-00144	70246	GEL	0.253	0.193	0.0147	0.0155	0.00715
7	Hazardous Waste Management Facility	7-00146	70250	GEL	1.12 J	0.193	0.0173	0.0608	0.00841
7	Radioactive Materials Handling Facility	7-00151	70256	GEL	0.498	0.193	0.0236	0.0316	0.0114
7	Radioactive Materials Handling Facility	7-00157	70263	GEL	2.01	0.193	0.0172	0.109	0.00836
7	Radioactive Materials Handling Facility	7-00176	70286	GEL	1.21	0.193	0.0163	0.0654	0.00795
7	Subarea 7 Northern Panhandle	7-00178	70289	GEL	8.86 J	0.193	0.021	0.466	0.0103
7	Radioactive Materials Handling Facility	7-00179	70291	GEL	0.202	0.193	0.0172	0.0141	0.00837
7	Hazardous Waste Management Facility	7-00183	70297	GEL	0.396	0.193	0.0173	0.0234	0.00837
7	Radioactive Materials Handling Facility	7-00184	70299	GEL	0.253	0.193	0.0243	0.0208	0.0118
7	Subarea 7 Northern Panhandle	7-00189	70423	GEL	0.486 J	0.193	0.0167	0.0281	0.00808
7	Subarea 7 Northern Panhandle	7-00190	70425	GEL	0.199 J	0.193	0.0178	0.0137	0.00867
7	Subarea 7 Northern Panhandle	7-00191	70427	GEL	0.309 J	0.193	0.0154	0.019	0.00747
7	Subarea 7 Northern Panhandle	7-00194	70433	GEL	0.456	0.193	0.0195	0.0277	0.00942
7	Subarea 7 Northern Panhandle	7-00195	70435	GEL	0.277	0.193	0.0176	0.0181	0.00854
7	Hazardous Waste Management Facility	7-00196	70330	GEL	0.38	0.193	0.0153	0.0226	0.00744
7	Hazardous Waste Management Facility	7-00197	70332	GEL	0.244	0.193	0.0151	0.0158	0.00733
7	Hazardous Waste Management Facility	7-00198	70334	GEL	0.324	0.193	0.0166	0.0194	0.00806
7	Hazardous Waste Management Facility	7-00202	70342	GEL	1.91	0.193	0.0166	0.104	0.00808
7	Hazardous Waste Management Facility	7-00204	70344	GEL	0.626	0.193	0.0161	0.0359	0.00783
7	Hazardous Waste Management Facility	7-00205	70345	GEL	0.324	0.193	0.0146	0.0195	0.0071
7	Hazardous Waste Management Facility	7-00206	70346	GEL	0.236	0.193	0.0169	0.0161	0.00821
7	Hazardous Waste Management Facility	7-00210	70351	GEL	0.955	0.193	0.0173	0.0538	0.00841
7	Hazardous Waste Management Facility	7-00212	70353	GEL	0.406	0.193	0.0179	0.0235	0.00873

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Cesium-137 (Continued)									
7	Hazardous Waste Management Facility	7-00213	70354	GEL	0.325	0.193	0.0192	0.02	0.00935
7	Hazardous Waste Management Facility	7-00214	70355	GEL	0.878	0.193	0.0173	0.0482	0.00841
7	Hazardous Waste Management Facility	7-00215	70356	GEL	0.66	0.193	0.0199	0.0392	0.00972
7	Hazardous Waste Management Facility	7-00216	70409	GEL	0.297	0.193	0.0171	0.0186	0.00836
7	Hazardous Waste Management Facility	7-00218	70358	GEL	0.605	0.193	0.019	0.0378	0.0092
7	Hazardous Waste Management Facility	7-00219	70413	GEL	0.348	0.193	0.0189	0.0211	0.00923
7	Hazardous Waste Management Facility	7-00223	70364	GEL	0.556	0.193	0.016	0.0321	0.00779
7	Hazardous Waste Management Facility	7-00224	70366	GEL	0.229	0.193	0.0137	0.0147	0.00665
7	Hazardous Waste Management Facility	7-00225	70394	GEL	0.704	0.193	0.0197	0.0398	0.00956
7	Radioactive Materials Handling Facility Leach Field	7-00232	70372	GEL	0.199	0.193	0.0136	0.0128	0.00662
7	Radioactive Materials Handling Facility Leach Field	7-00233	70437	GEL	0.296	0.193	0.017	0.0182	0.00823
7	Radioactive Materials Handling Facility Leach Field	7-00235	70439	GEL	0.307	0.193	0.0148	0.0185	0.00719
7	Radioactive Materials Handling Facility Leach Field	7-00236	70440	GEL	1.03	0.193	0.0185	0.0566	0.00896
7	Radioactive Materials Handling Facility Leach Field	7-00246	70328	GEL	0.211	0.193	0.0187	0.0158	0.0091
7	Radioactive Materials Handling Facility Leach Field	7-00247	70329	GEL	0.718	0.193	0.0188	0.0403	0.00913
7	Radioactive Materials Handling Facility Leach Field	7-00248	70450	GEL	0.568	0.193	0.0203	0.0342	0.00988
7	Radioactive Materials Handling Facility Leach Field	7-00251	70456	GEL	0.93	0.193	0.0155	0.0517	0.00754
7	Radioactive Materials Handling Facility Leach Field	7-00252	70458	GEL	0.662	0.193	0.0189	0.0406	0.00917
7	Radioactive Materials Handling Facility Leach Field	7-00253	70460	GEL	0.976	0.193	0.0198	0.0592	0.00958
7	Radioactive Materials Handling Facility Leach Field	7-00254	70462	GEL	0.732	0.193	0.0177	0.0406	0.00863
7	Radioactive Materials Handling Facility Leach Field	7-00255	70463	GEL	0.725	0.193	0.0179	0.0418	0.00869
7	Radioactive Materials Handling Facility Leach Field	7-00256	70464	GEL	0.973	0.193	0.0164	0.0534	0.00796
7	Radioactive Materials Handling Facility Leach Field	7-00257	70465	GEL	0.447	0.193	0.0175	0.0274	0.00851
7	Radioactive Materials Handling Facility	7-00263	70398	GEL	0.984	0.193	0.0153	0.0551	0.00741
7	Radioactive Materials Handling Facility	7-00267	70400	GEL	0.652	0.193	0.0171	0.0363	0.00832
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00268	70378	GEL	0.655	0.193	0.0175	0.0364	0.0085
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00269	70380	GEL	0.824	0.193	0.0168	0.0496	0.00815
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00270	70386	GEL	0.858	0.193	0.0171	0.0477	0.00832
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00271	70415	GEL	0.416	0.193	0.0172	0.0244	0.0084
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00272	70382	GEL	0.445	0.193	0.0186	0.0267	0.00908
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00274	70417	GEL	0.233	0.193	0.0151	0.0152	0.00732
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00278	70406	GEL	0.402	0.193	0.0168	0.0236	0.00819
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00279	70390	GEL	0.509	0.193	0.0251	0.0328	0.0121
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00280	70402	GEL	0.283	0.193	0.0204	0.019	0.0099
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00281	70404	GEL	0.237	0.193	0.0146	0.0154	0.00711
8	Former Sodium Disposal Facility	EPASED06	EPASED06	TAL	0.205	0.193	0.014	0.01	0.007

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Cesium-137 (Continued)									
8-North	Former Sodium Disposal Facility	8N-00082	40156	GEL	0.197	0.193	0.0187	0.0138	0.00911
8-North	4056 Landfill	8N-00137	40253	GEL	0.878	0.193	0.0221	0.0533	0.0107
8-North	Empire State Atomic Development Association	8N-00199	40446	GEL	0.206	0.193	0.0175	0.0143	0.00849
8-South	Subarea 8-South	8S-00010	40298	GEL	0.266 J	0.193	0.0158	0.0169	0.00763
8-South	Subarea 8-South	8S-00011	40300	GEL	0.212	0.193	0.0165	0.0137	0.00799
8-South	Subarea 8-South	8S-00026	40414	GEL	0.233	0.193	0.0195	0.016	0.0095
8-South	Subarea 8-South	8S-00037	40425	GEL	0.726	0.193	0.0178	0.0416	0.00862
NBZ	Subarea 7 Northern Panhandle	NBZ-00029	90050	GEL	0.26	0.193	0.0176	0.0188	0.00856
NBZ	Northern Buffer Zone East	NBZ-00111	90169	GEL	0.277	0.193	0.018	0.0179	0.00879
NBZ	Northern Buffer Zone West	NBZ-00154	90212	GEL	0.207	0.193	0.0148	0.0134	0.00717
NBZ	Northern Buffer Zone East	NBZ-00197	90186	GEL	0.212	0.193	0.0189	0.0146	0.00918
Europium-152									
5A	Building 4005	5A-00180	30214	TAL	0.073	0.0459	0.032	0.015	0.016
5A	Building 4005	5A-00181	30216	TAL	0.165	0.0459	0.026	0.015	0.013
5B	Former Building 4010	5B-00332	20701	TAL	0.078	0.0459	0.025	0.011	0.012
Europium-154									
5D-South	Subarea 5D-South	5DS-00023	50484	GEL	0.136 J	0.1360	0.0929	0.0444	0.0457
Plutonium-238									
5A	Former Building 4023	5A-00017	30035	TAL	0.0137	0.00921	0.015	0.0046	0.0033
5D-North	Former 4875	5DN-00117	50234	GEL	0.0492	0.0480	0.0286	0.0148	0.0101
Plutonium-239/240									
5C	Building 4100	5C-00056	10081	TAL	0.0233	0.0142	0.0012	0.0034	0.0012
5C	Building 4015	5C-00141	10242	TAL	0.0487	0.0142	0.0013	0.0053	0.0013
5D-South	Subarea 5D-South	5DS-00006	50450	GEL	0.0502	0.0369	0.0283	0.0131	0.0117
6	Sodium Reactor Experiment Complex	6-00290	60446	GEL	0.0515	0.0369	0.0294	0.0147	0.0111
6	Hot Oil Sodium Cleaning Pad	6-00303	60472	GEL	0.038	0.0369	0.00903	0.0073	0.00285
6	Sodium Reactor Experiment Pond Area	EPASED17	EPASED17	TAL	0.0302 J	0.0142	0.0014	0.0041	0.0013
7	Radioactive Materials Handling Facility	7-00090	70161	GEL	0.0475	0.0369	0.0363	0.0156	0.0143
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00135	70228	GEL	0.0702	0.0369	0.0201	0.0158	0.00622
7	Outfall 3	OF03-003	0F03-003-SS-0	TAL	0.0323	0.0142	0.0048	0.0042	0.0018
NBZ	Radioactive Materials Handling Facility Leach Field	NBZ-00026	90044	GEL	0.0384	0.0369	0.022	0.0109	0.0083

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Strontium-90									
5A	Kinetic Experiment Water Boiler	5A-00134	30150	TAL	0.091	0.0750	0.048	0.017	0.027
5B	Building 4006	5B-00071	20177	TAL	0.125	0.0750	0.056	0.02	0.031
5B	Building 4006	5B-00092	20223	TAL	0.096	0.0750	0.066	0.022	0.038
5B	Former Building 4010	5B-00316	20695	TAL	0.563	0.0750	0.051	0.039	0.029
5C	Former Building 4462	5C-00080	10120	TAL	0.098	0.0750	0.062	0.021	0.035
5D-North	Building 4009	5DN-00006	50010	GEL	1.55	0.387	0.174	0.184	0.102
5D-North	Hot Lab - Former Building 4020	5DN-00008	50014	GEL	0.821	0.387	0.31	0.146	0.189
5D-North	Hot Lab - Former Building 4020	5DN-00023	50046	GEL	0.417	0.387	0.23	0.0989	0.134
5D-North	Hot Lab - Former Building 4020	5DN-00050	50112	GEL	0.45	0.387	0.171	0.0852	0.1
5D-North	Building 4055 - Former Liquid Waste Holdup System	5DN-00065	50139	GEL	0.395	0.387	0.141	0.0731	0.0819
5D-North	Former Building 4373 Leach Field	5DN-00089	50180	GEL	0.52	0.387	0.297	0.127	0.172
5D-North	Former Building 4353	5DN-00143	50286	GEL	1.27	0.387	0.174	0.159	0.105
5D-North	Former Building 4353	5DN-00144	50288	GEL	0.619	0.387	0.317	0.14	0.189
5D-North	Former Buildings 4173/4865	5DN-00162	50322	GEL	0.648	0.387	0.181	0.107	0.105
5D-North	Hot Lab - Former Building 4020	5DN-00207	50409	GEL	0.631	0.387	0.224	0.122	0.129
5D-North	Hot Lab - Former Building 4020	5DN-00213	50528	GEL	0.408	0.387	0.245	0.099	0.146
5D-North	Hot Lab - Former Building 4020	5DN-00228	50558	GEL	0.673	0.387	0.243	0.125	0.142
5D-North	Former Building 4875	5DN-00236	50574	GEL	0.643	0.387	0.327	0.133	0.202
5D-North	Former Building 4353	5DN-00248	50598	GEL	0.422	0.387	0.221	0.0896	0.14
5D-South	Subarea 5D-South	5DS-00023	50484	GEL	0.448	0.387	0.24	0.103	0.141
6	Sodium Reactor Experiment Complex	6-00098	60139	GEL	0.392	0.387	0.181	0.0784	0.11
6	Liquid and Gas Radioactive Storage Tanks Area	6-00131	60184	GEL	0.523	0.387	0.201	0.102	0.116
6	Liquid and Gas Radioactive Storage Tanks Area	6-00134	60190	GEL	1.07	0.387	0.148	0.131	0.0886
6	Liquid and Gas Radioactive Storage Tanks Area	6-00142	60199	GEL	0.56	0.387	0.142	0.0848	0.0847
6	Liquid and Gas Radioactive Storage Tanks Area	6-00149	60213	GEL	0.981	0.387	0.708	0.276	0.412
6	Fuel Element Storage Facility	6-00243	60379	GEL	0.557 J	0.387	0.703	0.235	0.414
6	Sodium Reactor Experiment Complex	6-00283	60432	GEL	0.478	0.387	0.123	0.0761	0.071
6	Sodium Reactor Experiment Complex	6-00290	60446	GEL	21.3	0.387	0.229	1.99	0.135
6	Liquid and Gas Radioactive Storage Tanks Area	6-00294	60454	GEL	2.39 J	0.387	0.187	0.258	0.113
6	Sodium Reactor Experiment Pond Area	6-00358	60618	GEL	0.617	0.387	0.254	0.119	0.152
6	Sodium Reactor Experiment Pond Area	EPASED19	EPASED19	TAL	0.185 J	0.0750	0.06	0.024	0.034
7	Radioactive Materials Handling Facility	7-00009	70017	GEL	0.491	0.387	0.364	0.134	0.223
7	Radioactive Materials Handling Facility	7-00010	70019	GEL	1.19	0.387	0.142	0.145	0.0854
7	Radioactive Materials Handling Facility Leach Field	7-00012	70023	GEL	0.392	0.387	0.277	0.105	0.171
7	Radioactive Materials Handling Facility Leach Field	7-00013	70025	GEL	0.498	0.387	0.215	0.097	0.133
7	Radioactive Materials Handling Facility	7-00014	70027	GEL	0.757	0.387	0.339	0.151	0.209

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Strontium-90 (Continued)									
7	Radioactive Materials Handling Facility Leach Field	7-00015	70029	GEL	14.3	0.387	0.223	1.37	0.131
7	Radioactive Materials Handling Facility Leach Field	7-00016	70031	GEL	0.444	0.387	0.154	0.0813	0.0917
7	Radioactive Materials Handling Facility Leach Field	7-00020	70039	GEL	0.445	0.387	0.264	0.104	0.165
7	Interim Storage Facility - Former Building 4654	7-00029	70057	GEL	0.93	0.387	0.264	0.145	0.165
7	Interim Storage Facility - Former Building 4654	7-00030	70059	GEL	0.696	0.387	0.249	0.123	0.154
7	Interim Storage Facility - Former Building 4654	7-00036	70071	GEL	0.435	0.387	0.255	0.103	0.159
7	Subarea 7 Northern Panhandle	7-00037	70073	GEL	4.2 J	0.387	0.375	0.449	0.238
7	Subarea 7 Northern Panhandle	7-00041	70081	GEL	2.12 J	0.387	0.285	0.275	0.167
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00046	70091	GEL	1.64 J	0.387	0.291	0.214	0.175
7	Radioactive Materials Handling Facility Leach Field	7-00067	70123	GEL	2.11	0.387	0.143	0.222	0.0865
7	Subarea 7 Northern Panhandle	7-00070	70129	GEL	0.647	0.387	0.291	0.129	0.18
7	Subarea 7 Northern Panhandle	7-00071	70131	GEL	0.742	0.387	0.224	0.13	0.131
7	Interim Storage Facility - Former Building 4654	7-00078	70142	GEL	0.467	0.387	0.158	0.085	0.0942
7	Radioactive Materials Handling Facility Leach Field	7-00139	70236	GEL	1.25	0.387	0.245	0.178	0.147
7	Radioactive Materials Handling Facility Leach Field	7-00140	70238	GEL	0.996	0.387	0.235	0.15	0.142
7	Subarea 7 Northern Panhandle	7-00143	70244	GEL	0.983	0.387	0.305	0.161	0.189
7	Hazardous Waste Management Facility	7-00146	70250	GEL	0.43	0.387	0.362	0.128	0.229
7	Radioactive Materials Handling Facility	7-00151	70256	GEL	0.608	0.387	0.239	0.111	0.15
7	Radioactive Materials Handling Facility	7-00157	70263	GEL	0.557	0.387	0.224	0.103	0.137
7	Subarea 7 Northern Panhandle	7-00178	70289	GEL	2.31 J	0.387	0.396	0.284	0.253
7	Radioactive Materials Handling Facility Leach Field	7-00181	70294	GEL	0.977	0.387	0.25	0.146	0.155
7	Radioactive Materials Handling Facility Leach Field	7-00238	70442	GEL	0.445	0.387	0.16	0.0869	0.0899
7	Radioactive Materials Handling Facility Leach Field	7-00249	70452	GEL	1.27	0.387	0.167	0.163	0.0949
7	Radioactive Materials Handling Facility Leach Field	7-00251	70456	GEL	5.37	0.387	0.265	0.544	0.159
7	Radioactive Materials Handling Facility Leach Field	7-00252	70458	GEL	5	0.387	0.374	0.534	0.231
7	Radioactive Materials Handling Facility Leach Field	7-00253	70460	GEL	2.35	0.387	0.279	0.285	0.168
7	Radioactive Materials Handling Facility Leach Field	7-00255	70463	GEL	0.864	0.387	0.368	0.172	0.217
7	Radioactive Materials Handling Facility Leach Field	7-00258	70467	GEL	0.502	0.387	0.296	0.118	0.18
8-North	Empire State Atomic Development Association	8N-00006	40011	GEL	0.535	0.387	0.195	0.0966	0.116
8-North	Empire State Atomic Development Association	8N-00014	40027	GEL	0.957	0.387	0.145	0.124	0.0846
8-North	Empire State Atomic Development Association	8N-00029	40057	GEL	1.41	0.387	0.263	0.187	0.158
8-North	Empire State Atomic Development Association	8N-00035	40069	GEL	1.08	0.387	0.208	0.144	0.125
8-North	Empire State Atomic Development Association	8N-00036	40071	GEL	0.449	0.387	0.19	0.0848	0.116
8-North	Empire State Atomic Development Association	8N-00039	40077	GEL	2.34 J	0.387	0.19	0.263	0.111
8-North	Building 4009 Leach Field	8N-00096	40177	GEL	1.26	0.387	0.177	0.159	0.104
8-North	Building 4009 Leach Field	8N-00097	40179	GEL	0.64	0.387	0.155	0.0987	0.0907

Table 4.2
Surface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Strontium-90 (Continued)									
8-North	Building 4009	8N-00110	40197	GEL	0.433	0.387	0.145	0.0785	0.0838
8-North	Former Sodium Disposal Facility	8N-00122	40239	GEL	0.855	0.387	0.133	0.112	0.0777
8-South	Subarea 8-South	8S-00012	40302	GEL	0.903	0.387	0.22	0.141	0.127
8-South	Subarea 8-South	8S-00022	40322	GEL	1.53	0.387	0.211	0.192	0.124
8-South	Subarea 8-South	8S-00031	40419	GEL	0.606	0.387	0.355	0.139	0.218
8-South	Subarea 8-South	8S-00044	40432	GEL	0.447	0.387	0.419	0.146	0.255
NBZ	Northern Buffer Zone West	EPASED02	EPASED02	TAL	0.01 J	0.0750	0.078	0.026	0.044
NBZ	Northern Buffer Zone West	EPASED13	EPASED13	TAL	0.106 J	0.0750	0.06	0.021	0.034
NBZ	Northern Buffer Zone East	EPASED20	EPASED20	TAL	0.075 J	0.0750	0.068	0.022	0.038
NBZ	Northern Buffer Zone West	EPASED47	EPASED47S	GEL	0.886	0.387	0.293	0.149	0.177
NBZ	Northern Buffer Zone West	NBZ-00013	90018	GEL	0.978	0.387	0.279	0.151	0.17
NBZ	Northern Buffer Zone West	NBZ-00090	90143	GEL	0.527	0.387	0.154	0.09	0.0888
NBZ	Northern Buffer Zone West	NBZ-00173	90231	GEL	0.873	0.387	0.228	0.136	0.135
NBZ	Northern Buffer Zone West	NBZ-00176	90234	GEL	0.417	0.387	0.221	0.0924	0.133
NBZ	Northern Buffer Zone West	NBZ-00180	90238	GEL	0.924	0.387	0.173	0.127	0.103

Notes:

Refer to Table 2.1 of the Final Field Sampling Plan for Soil Sampling (HGL, 2012d) for a definition of radionuclide symbols.

Reporting units in picocuries per gram.

FAL - field action level

GEL - GEL Laboratories LLC

ID - identification

MDC - minimum detectable concentration

NBZ - Northern Buffer Zone

TAL - TestAmerica Laboratories, Inc.

TPU - total propagated uncertainty

J - The analyte was detected at the reported concentration; the quantitation is an estimate.

Table 4.3
Subsurface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location ID	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Americium-241									
5D-North	Former Buildings 4173/4865	5DN-00161	50321	GEL	0.0589	0.0410	0.0274	0.0141	0.0111
8-North	Former Sodium Disposal Facility	8N-00059	40112	GEL	0.0484	0.0410	0.0162	0.0108	0.00573
Curium-243/244									
NBZ	Northern Buffer Zone East	NBZ-00051	90087	GEL	0.0647	0.0466	0.0374	0.0156	0.0169
Cobalt-60									
5B	Former Building 4356	5B-00055	20139	TAL	0.0228 K	0.0228	0.011	0.0057	0.0052
5C	Building 4100	5C-00074	10110	TAL	0.0247	0.0228	0.012	0.0061	0.0057
Cesium-137									
6	Sodium Reactor Experiment Pond Area	6-00030	60042	GEL	0.554	0.193	0.0193	0.0326	0.00938
6	Sodium Reactor Experiment Pond Area	6-00034	60047	GEL	1.21	0.193	0.0156	0.0677	0.00757
6	Sodium Reactor Experiment Pond Area	6-00045	60065	GEL	0.475	0.193	0.0181	0.0281	0.0088
6	Liquid and Gas Radioactive Storage Tanks Area	6-00127	60177	GEL	0.194	0.193	0.0118	0.012	0.00577
6	Liquid and Gas Radioactive Storage Tanks Area	6-00142	60200	GEL	0.548	0.193	0.0122	0.0303	0.00597
6	Sodium Reactor Experiment Complex	6-00291	60449	GEL	1.47	0.193	0.0154	0.08	0.00751
6	Liquid and Gas Radioactive Storage Tanks Area	6-00293	60453	GEL	1.19	0.193	0.0116	0.063	0.00571
6	Fuel Element Storage Facility	6-00306	60540	GEL	74.9	0.193	0.0275	3.91	0.0136
6	Sodium Reactor Experiment Complex	6-00343	60589	GEL	0.308	0.193	0.0181	0.0194	0.00881
6	Old Conservation Yard	6-00416	60735	GEL	0.345	0.193	0.0231	0.0237	0.0112
6	Sodium Reactor Experiment Pond Area	EPASED51	EPASED51B	GEL	0.233	0.193	0.0142	0.0146	0.00687
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00002	70004	GEL	0.432	0.193	0.0199	0.0273	0.00968
7	Radioactive Materials Handling Facility	7-00007	70014	GEL	0.407	0.193	0.0145	0.0237	0.00702
7	Radioactive Materials Handling Facility	7-00008	70016	GEL	0.359	0.193	0.0148	0.0215	0.00722
7	Radioactive Materials Handling Facility Leach Field	7-00010	70020	GEL	0.524	0.193	0.0136	0.0298	0.00661
7	Radioactive Materials Handling Facility Leach Field	7-00016	70032	GEL	1.71	0.193	0.021	0.0935	0.0102
7	Radioactive Materials Handling Facility	7-00017	70034	GEL	0.389	0.193	0.0128	0.022	0.00623
7	Radioactive Materials Handling Facility	7-00021	70042	GEL	0.207	0.193	0.0183	0.0142	0.00887
7	Interim Storage Facility - Former Building 4654	7-00026	70052	GEL	0.227	0.193	0.0173	0.0148	0.00844
7	Interim Storage Facility - Former Building 4654	7-00030	70060	GEL	0.211	0.193	0.0152	0.0133	0.00742
7	Radioactive Materials Handling Facility	7-00053	70106	GEL	0.214	0.193	0.0159	0.0143	0.00777
7	Radioactive Materials Handling Facility Leach Field	7-00066	70122	GEL	0.334	0.193	0.0193	0.0208	0.00939
7	Interim Storage Facility - Former Building 4654	7-00078	70143	GEL	0.266	0.193	0.0165	0.0164	0.00804
7	Radioactive Materials Handling Facility	7-00086	70154	GEL	0.364	0.193	0.0148	0.0216	0.00719
7	Radioactive Materials Handling Facility	7-00087	70156	GEL	2.15	0.193	0.0188	0.117	0.00917
7	Radioactive Materials Handling Facility	7-00090	70162	GEL	0.492	0.193	0.0197	0.0304	0.00957

Table 4.3
Subsurface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location ID	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Cesium-137 (Continued)									
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00130	70220	GEL	2.68	0.193	0.016	0.142	0.00782
7	Radioactive Materials Handling Facility Leach Field	7-00139	70237	GEL	2.64	0.193	0.0196	0.14	0.00954
7	Radioactive Materials Handling Facility Leach Field	7-00140	70239	GEL	0.283	0.193	0.0179	0.0182	0.00875
7	Radioactive Materials Handling Facility	7-00157	70264	GEL	0.232	0.193	0.017	0.0159	0.00828
7	Interim Storage Facility - Former Building 4654	7-00225	70395	GEL	0.209	0.193	0.0191	0.0144	0.0093
7	Radioactive Materials Handling Facility Leach Field	7-00251	70457	GEL	1.51	0.193	0.0165	0.0815	0.00801
7	Radioactive Materials Handling Facility Leach Field	7-00252	70459	GEL	0.991	0.193	0.0183	0.055	0.00892
7	Radioactive Materials Handling Facility Leach Field	7-00253	70461	GEL	0.432	0.193	0.0203	0.0266	0.00991
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00269	70381	GEL	0.219	0.193	0.0164	0.0152	0.00798
Europium-152									
5B	Former Building 4010	5B-00326	20691	TAL	0.049	0.0459	0.03	0.012	0.015
5B	Former Building 4010	5B-00332	20702	TAL	0.0544	0.0459	0.02	0.0083	0.0097
Tritium									
5B	Former Building 4010	5B-00326	20691	TAL	7.38	7.380	0.18	0.34	0.09
Nickel-59									
5A	Former Building 4023	5A-00008	30020	GEL	23.9	7.24	5.48	2.97	2.57
Plutonium-239/240									
5D-North	Former Building 4353	5DN-00146	50292	GEL	0.0526	0.0369	0.0268	0.0132	0.0108
7	Shield Test Irradiation Reactor - Former Building 4028	7-00186	70322	GEL	0.187	0.0369	0.00502	0.021	0
8-North	Former Sodium Disposal Facility	8N-00059	40112	GEL	0.0873	0.0369	0.0126	0.014	0.00389
8-North	4056 Landfill	8N-00120	40236	GEL	0.0713	0.0369	0.018	0.013	0.00681
Strontium-90									
3	Southern California Edison Substation	3-00005	80007	GEL	0.444	0.387	0.315	0.123	0.185
5A	Former Building 4093 (L85 Nuclear Experimentation Reactor)	5A-00159	30115	GEL	0.579	0.387	0.142	0.0909	0.0823
5A	Former Building 4093 (L85 Nuclear Experimentation Reactor)	5A-00168	30124	GEL	2.56 J	0.387	0.162	0.272	0.0954
5B	Building 4019	5B-00028	20049	TAL	0.09	0.0750	0.042	0.015	0.024
5B	Building 4011	5B-00158	20351	TAL	0.117	0.0750	0.026	0.012	0.015
5D-North	Hot Lab - Former Building 4020	5DN-00017	50033	GEL	0.49	0.387	0.321	0.125	0.193
5D-North	Hot Lab - Former Building 4020	5DN-00025	50054	GEL	0.486	0.387	0.246	0.109	0.146
5D-North	Hot Lab - Former Building 4020	5DN-00027	50059	GEL	0.654	0.387	0.199	0.112	0.119
5D-North	Hot Lab - Former Building 4020	5DN-00041	50094	GEL	1	0.387	0.32	0.175	0.187
5D-North	Hot Lab - Former Building 4020	5DN-00044	50100	GEL	0.41	0.387	0.23	0.0989	0.136
5D-North	Hot Lab - Former Building 4020	5DN-00045	50103	GEL	1.4	0.387	0.189	0.174	0.111
5D-North	Hot Lab - Former Building 4020	5DN-00073	50152	GEL	0.662	0.387	0.239	0.124	0.143

Table 4.3
Subsurface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location ID	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Strontium-90 (Continued)									
5D-North	Former Building 4875	5DN-00117	50235	GEL	0.545	0.387	0.189	0.1	0.11
5D-North	Former Building 4375	5DN-00120	50241	GEL	1.43	0.387	0.187	0.177	0.11
5D-North	Pond Dredge Area	5DN-00194	50384	GEL	0.487	0.387	0.323	0.125	0.2
5D-North	Hot Lab - Former Building 4020	5DN-00230	50563	GEL	0.579	0.387	0.304	0.132	0.178
5D-South	Subarea 5D-South	5DS-00021	50481	GEL	0.43	0.387	0.292	0.116	0.17
5D-South	Subarea 5D-South	5DS-00039	50511	GEL	0.43	0.387	0.292	0.117	0.169
6	Sodium Reactor Experiment Pond Area	6-00034	60047	GEL	0.641	0.387	0.233	0.115	0.139
6	Liquid and Gas Radioactive Storage Tanks Area	6-00142	60200	GEL	0.934	0.387	0.119	0.104	0.0721
6	Sodium Reactor Experiment Complex	6-00291	60449	GEL	0.405	0.387	0.188	0.0889	0.107
6	Fuel Element Storage Facility	6-00306	60540	GEL	0.882	0.387	0.607	0.23	0.368
6	Sodium Reactor Experiment Pond Area	EPASED52	EPASED52B	GEL	0.698	0.387	0.344	0.142	0.212
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00003	70006	GEL	3.57	0.387	0.101	0.351	0.059
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00005	70010	GEL	1.69	0.387	0.177	0.199	0.103
7	Radioactive Materials Handling Facility Leach Field	7-00016	70032	GEL	2.22 J	0.387	0.281	0.261	0.17
7	Interim Storage Facility - Former Building 4654	7-00026	70052	GEL	0.712	0.387	0.172	0.106	0.102
7	Interim Storage Facility - Former Building 4654	7-00039	70078	GEL	1.36	0.387	0.185	0.171	0.108
7	Shield Test Irradiation Reactor - Former Building 4028	7-00042	70104	GEL	3.24	0.387	0.1	0.32	0.0584
7	Radioactive Materials Handling Facility Leach Field	7-00056	70110	GEL	0.83	0.387	0.354	0.161	0.213
7	Radioactive Materials Handling Facility Leach Field	7-00057	70111	GEL	0.489	0.387	0.299	0.117	0.182
7	Subarea 7 Northern Panhandle	7-00070	70130	GEL	0.782	0.387	0.246	0.127	0.155
7	Interim Storage Facility - Former Building 4654	7-00074	70136	GEL	0.422	0.387	0.207	0.0928	0.12
7	Radioactive Materials Handling Facility	7-00083	70149	GEL	0.504	0.387	0.354	0.13	0.219
7	Shield Test Irradiation Reactor - Former Building 4028	7-00108	70191	GEL	0.524	0.387	0.162	0.0905	0.0966
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00116	70199	GEL	0.44	0.387	0.309	0.12	0.182
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00117	70200	GEL	0.833	0.387	0.415	0.172	0.254
7	Southwest corner of Subarea 7 - North of Building 4019	7-00120	70205	GEL	0.517	0.387	0.443	0.157	0.271
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00135	70229	GEL	3.55 J	0.387	0.175	0.368	0.102
7	Radioactive Materials Handling Facility Leach Field	7-00139	70237	GEL	3.36 J	0.387	0.285	0.369	0.17
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00173	70282	GEL	0.929	0.387	0.258	0.144	0.16
7	Radioactive Materials Handling Facility Leach Field	7-00174	70283	GEL	1.3	0.387	0.331	0.195	0.205
7	Radioactive Materials Handling Facility Leach Field	7-00241	70446	GEL	0.719	0.387	0.338	0.147	0.204
7	Radioactive Materials Handling Facility Leach Field	7-00242	70447	GEL	0.525	0.387	0.399	0.145	0.246
7	Radioactive Materials Handling Facility Leach Field	7-00245	70449	GEL	1.09	0.387	0.33	0.185	0.194
7	Radioactive Materials Handling Facility Leach Field	7-00251	70457	GEL	9.26	0.387	0.143	0.89	0.0811
7	Radioactive Materials Handling Facility Leach Field	7-00252	70459	GEL	5.65	0.387	0.202	0.566	0.117

Table 4.3
Subsurface Soil Analytical Results Exceeding Field Actions Levels

Subarea	Key Locations/Facilities	Location ID	Sample ID	Analyzing Laboratory	Activity	FAL	MDC	TPU	Critical Level
Strontium-90 (Continued)									
7	Radioactive Materials Handling Facility Leach Field	7-00253	70461	GEL	0.9	0.387	0.356	0.17	0.212
7	Radioactive Materials Handling Facility Site 4614 Holdup Pond/Catch Basin	7-00275	70420	GEL	0.471	0.387	0.209	0.0972	0.123
7	Southwest corner of Subarea 7 - North of Building 4019	7-00296	70495	GEL	0.618	0.387	0.244	0.114	0.147
7	Outfall 3	OF03-003	0F03-003-SB-39-H	TAL	0.397	0.0750	0.042	0.026	0.024
8-North	Empire State Atomic Development Association	8N-00003	40006	GEL	0.584	0.387	0.316	0.13	0.197
8-North	Empire State Atomic Development Association	8N-00015	40030	GEL	0.51	0.387	0.388	0.141	0.246
8-North	Empire State Atomic Development Association	8N-00028	40056	GEL	2.51 J	0.387	0.12	0.256	0.0707
8-North	Empire State Atomic Development Association	8N-00050	40092	GEL	1.01	0.387	0.143	0.128	0.0843
8-North	Former Sodium Disposal Facility	8N-00055	40104	GEL	2.71 J	0.387	0.178	0.29	0.105
8-North	Former Sodium Disposal Facility	8N-00084	40161	GEL	0.995	0.387	0.135	0.127	0.0779
8-North	Building 4009 Leach Field	8N-00100	40185	GEL	1.26	0.387	0.169	0.157	0.0994
8-North	Building 4009	8N-00105	40192	GEL	1.39	0.387	0.156	0.165	0.0917
8-North	Building 4100	8N-00129	40201	GEL	0.534	0.387	0.139	0.0858	0.0808
8-North	Empire State Atomic Development Association	8N-00205	40393	GEL	0.628	0.387	0.493	0.173	0.304
8-South	Subarea 8-South	8S-00011	40301	GEL	1.5	0.387	0.238	0.196	0.14
8-South	Subarea 8-South	8S-00013	40305	GEL	0.4	0.387	0.202	0.0906	0.116
8-South	Subarea 8-South	8S-00023	40325	GEL	0.873	0.387	0.282	0.155	0.164
NBZ	Northern Buffer Zone West	NBZ-00032	90057	GEL	0.725	0.387	0.172	0.103	0.105
NBZ	Northern Buffer Zone West	NBZ-00083	90130	GEL	0.586	0.387	0.196	0.1	0.118

Notes:

Refer to Table 2.1 of the Final Field Sampling Plan for Soil Sampling (HGL, 2012d) for a definition of radionuclide symbols.

Reporting units in picocuries per gram.

FAL - field action level

GEL - GEL Laboratories LLC

ID - identification

MDC - minimum detectable concentration

NBZ - Northern Buffer Zone

TAL - TestAmerica Laboratories, Inc.

TPU - total propagated uncertainty

J - The analyte was detected at the reported concentration; the quantitation is an estimate.

K - Analyte present. Reported value may be biased high. Actual value is expected to be lower.

Table 5.1
Radiological Areas of Interest

Key Location/Facility	Subarea	Operational History	Radionuclides Detected at Concentrations Equal to or Greater than FAL				
			Radionuclides Detected	Surface Soil		Subsurface Soil	
				Number of Surface Soil Samples	Surface Soil Sample Concentration Range (pCi/g)	Number of Subsurface Soil Samples	Subsurface Soil Sample Concentration Range (pCi/g)
Radioactive Materials Handling Facility Complex							
Radioactive Materials Handling Facility (RMHF)	7	The RMHF was a support facility to the SNAP program, the SRE, and the Hallam Nuclear Power Facility. It was designed to handle the storage, volume reduction, packaging, and shipping of the SNAP and SRE radioactive waste. In general, radioactive wastes handled at the RMHF were residues from chemical and metallurgical laboratory operations, spent reactor fuel decladding operations, maintenance work on contaminated equipment, and decontamination and decommissioning of facilities in which nuclear operations were previously conducted. The RMHF received radioactive water from the Hot Lab, the SRE, and any other DOE facilities that generated radioactive water as a part of operations.	Cs-137	34	0.202 - 19.8	9	0.207 - 2.15
			Pu-239/240	1	0.0475	0	NA
			Co-60	1	0.0264	0	NA
			Sr-90	5	0.491 - 1.19	1	0.504
RMHF Site 4614 Holdup Pond/Catch Basin	7	The RMHF 4614 Holdup Pond/Catch Basin Site area, formerly the Radioactive Material Disposal Facility 4614 Site area, comprises RMHF 4614 Holdup Pond/Catch Basin and the drainage channel that terminates at the pond from the west side of the RMHF complex. The RMHF 4614 Holdup Pond/Catch Basin is often referred to as the Building 4028 Pond or 4028 Pond, and has also been referred to as the RD-621 pond. For purposes of this section, Site 4614 will be referred to as the RMHF 4614 Holdup Pond. The RMHF 4614 Holdup Pond was originally constructed in the early to mid-1960s as a holdup pond for Building 4028.	Cs-137	25	0.195 – 2.5	3	0.219 – 2.68
			Pu-239/240	1	0.0702	0	NA
			Sr-90	1	1.64	7	0.44 – 3.57
RMHF Leach Field	7	Located approximately 100 feet to the northeast of the RMHF, the leach field was used from early 1959 through late 1961 for the disposal of sanitary waste associated with Building 4021. In late 1961, a central sanitary sewer system was constructed at the SSFL and Building 4021 was connected to it. RMHF sanitary waste was subsequently accepted at the Area III sewage treatment plant. The RMHF septic system was abandoned in place.	Cs-137	27	0.199 – 4.7	8	0.283 – 2.64
			Sr-90	16	0.392 – 14.3	11	0.489 – 9.26
Sodium Reactor Experiment Complex							
Sodium Reactor Experiment (SRE) Complex	6	The area comprises Building 4143, concrete pads Nos. 4413, 4894, 4895, 4896, 4897, and 4898, electrical substation Building 4683, and the land surrounding these facilities located at the end of E Street. Building 4143 was constructed between April 1955 and February 1957 and was operated as a nuclear reactor until February 1964. Building 4143 housed a high-temperature reactor with a slightly enriched uranium metal fuel (Core I) and sodium-cooled, hexagonal zirconium clad graphite moderator elements. After an accident in 1959, the enriched uranium fuel was replaced with a 93 percent uranium-thorium metal alloy fuel (Core II). The SRE was developed to demonstrate a sodium-cooled, graphite–moderated reactor for civilian use.	Cs-137	21	0.256 – 24.3	2	0.308 – 1.47
			Pu-239/240	1	0.0515	0	NA
			Co-60	1	0.048	0	NA
			Sr-90	3	0.392 – 21.3	1	0.405

Table 5.1
Radiological Areas of Interest

Key Location/Facility	Subarea	Operational History	Radionuclides Detected at Concentrations Equal to or Greater than FAL				
			Radionuclides Detected	Surface Soil		Subsurface Soil	
				Number of Surface Soil Samples	Surface Soil Sample Concentration Range (pCi/g)	Number of Subsurface Soil Samples	Subsurface Soil Sample Concentration Range (pCi/g)
Sodium Reactor Experiment Complex (Continued)							
SRE Pond Area	6	The SRE pond area (Site 4773) was constructed in 1956 as a retention pond and dam for the SRE. The pond was originally designed for natural seepage and evaporation to control the seasonal water level and provide capacity for winter storm water collection. After 1964, storm water runoff was the only source of water to the SRE pond. The SRE Pond is still in existence and contains surface water runoff from the SRE Complex during the wet season.	Cs-137	5	0.198 – 0.389	4	0.233 – 1.21
			Pu-239/240	1	0.0302	0	NA
			Sr-90	2	0.185 - 0.617	2	0.641 – 0.698
SRE Liquid and Gas Radioactive Storage Tanks Area	6	Also known as Building 4653 area, an interim radioactive waste vault that stored liquid wastes generated from the SRE. Most of the radioactivity was from mixed fission products.	Cs-137	22	0.22 – 46.4	3	0.194 - 1.19
			Sr-90	5	0.523 – 2.39	1	0.934
SRE Hot Oil Sodium Cleaning Facility	6	Also known as Building 4724. Designed for cleaning sodium, in a hot oil bath, from large pipes and assemblies from the secondary loop of the SRE.	Cs-137	8	0.307 – 2.45	0	NA
			Pu-239/240	1	0.038	0	NA
Subarea 7 Northern Panhandle	7	Located in the northeast portion of Subarea 7. The photo interpretation showed "Cleared Area" but no other feature or process was noted in the HSA.	Cs-137	11	0.199 – 20.2	0	NA
			Sr-90	6	0.647 – 4.2	1	0.782
Hazardous Waste Management Facility (HWMF)	7	The HWMF began operation in 1978 as a drum storage yard, and by 1983 was a fully permitted RCRA hazardous waste treatment and storage facility for non-radiological chemical wastes generated on site. In 1997, the HWMF was deactivated and all operations ceased.	Cs-137	27	0.229 – 2.53	0	NA
			Sr-90	1	0.43	0	NA
Interim Storage Facility	7	The Interim Storage Facility (Building 4654) was originally used to store dummy and spent fuel elements, shipping and storage casks, and hot waste generated at the SRE. After the SRE stopped operating, it was also used to store waste from the OMR Experiment and the SNAP. It was taken out of service in 1964 and did not support an active program from 1964 through 1984. Because low-level radiation was released from the storage of containers at this facility it was kept in surveillance and maintenance mode to contain the contamination until decommissioning began in 1984.	Cs-137	7	0.249 – 1.81	4	0.209 – 0.266
			Sr-90	4	0.435 - 0.93	3	0.422 – 1.36

Table 5.1
Radiological Areas of Interest

Key Location/Facility	Subarea	Operational History	Radionuclides Detected at Concentrations Equal to or Greater than FAL				
			Radionuclides Detected	Surface Soil		Subsurface Soil	
				Number of Surface Soil Samples	Surface Soil Sample Concentration Range (pCi/g)	Number of Subsurface Soil Samples	Subsurface Soil Sample Concentration Range (pCi/g)
17th Street Drainage	5B	The 17th Street Drainage is located south of the intersection of G and 17th streets. This area is the site of a storm water channel where a berm was constructed in 1962, permitting the area to serve as a retention pond collecting drainage from upgradient areas in Subareas 5B, 5A, and 7. The former pond measured approximately 30 feet by 30 feet. In 1999 the main drainage system was rerouted along the north side of G Street.	Cs-137	12	0.213 -0.911	0	NA
New Conservation Yard	6	Site 4583-New was developed as the new salvage yard after the ESG salvage yard was closed in 1977. All salvageable, non-radioactive materials were moved to the site in and after 1977. Items included used equipment and drums. In 1988, the site was cluttered with items of large metal equipment and scrap metal.	Cs-137	12	0.21 – 4.61	0	NA
Fuel Element Storage Facility	6	Comprises Building 4064, mechanical equipment slab Site 4864, an extensive side yard, and the land surrounding these areas located on G Street. Building 4064, built in 1958, was the source and special nuclear material storage facility. It was used for storing packaged items of source material (natural uranium, depleted uranium, thorium) and special nuclear materials (enriched uranium, plutonium, and U-233) of various forms and configurations. The facility was demolished in 1997 together with the removal of a septic tank and leach field.	Cs-137	13	0.219 – 196	1	74.9
			Sr-90	1	0.557	1	0.882
Former Building 4010	5B	Building 4010 housed the SNAP Experiment Reactor, also known as the SNAP 2 Experimental Reactor, which was a prototype for the basic SNAP reactor and used for power demonstration and endurance tests. The SNAP Experiment Reactor/SNAP 2 Experimental Reactor operated in Building 4010 from September 1959 to December 1960. The building was demolished in 1978.	Cs-137	2	0.282 - 0.254	0	NA
			Sr-90	1	0.563	0	NA
			Eu-152	1	0.078	2	0.049 – 0.0544
			H-3	0	NA	1	7.38
			Cm-243/244	1	0.0178	0	NA
Hot Lab - Former Building 4020	5D	Constructed in 1959, Building 4020, formerly the Component Development Hot Cell, was constructed for the remote handling and examination of highly radioactive materials. The building was completely demolished between 1995 and 1996, and the site was backfilled in 1997.	Cs-137	1	1.42	0	NA
			Sr-90	6	0.408 – 0.821	8	0.41 - 1.4
Former Sodium Disposal Facility	8	Also known as Site 4886 or Sodium Burn Pit, this facility comprised approximately 2 acres located on the north side of the westernmost end of H Street. It operated as the Sodium Disposal Facility, from 1956 until 1978. It was used extensively during the 1960 to 1970 period for the disposal of combustible materials such as kerosene, Na, and NaK from scrap test components such as pumps, valves, etc., from the SRE, SNAP, and other nuclear program operations.	Cs-137	2	0.197 - 0.205	0	NA
			Am-241	1	0.0514	1	0.0484
			Sr-90	1	0.855	2	0.995 – 2.71
			Pu-239/240	0	NA	1	0.0873

Table 5.1
Radiological Areas of Interest

Key Location/Facility	Subarea	Operational History	Radionuclides Detected at Concentrations Equal to or Greater than FAL				
				Surface Soil		Subsurface Soil	
			Radionuclides Detected	Number of Surface Soil Samples	Surface Soil Sample Concentration Range (pCi/g)	Number of Subsurface Soil Samples	Subsurface Soil Sample Concentration Range (pCi/g)
Former Building 4003 - Engineering Test Building	6	Comprises Building 4003, substation Building 4693, support Building 4825, and the land surrounding these three buildings located near the end of E Street. Building 4003 contained two radioactive waste sinks connected to 5-gallon bottles, and a highly shielded area designed for remote manipulation of radioactive materials, known as the Hot Cave. Building 4003 was used to assemble fuel elements for the SRE from 1957 through 1964. Uranium and thorium metal slugs were loaded into metal tubes, the remaining tube space was filled with sodium and the tubes were sealed. Fuel elements for three SRE cores were prepared in Building 4003, but only two cores were used. The third core was shipped offsite. The Hot Cave was designed and constructed to investigate the chemistry of molten uranium, and to study the separation of fission products and plutonium from uranium systems.	Cs-137	4	0.197 – 0.241	0	NA
Kinetic Experiment Water Boiler (KEWB)	5A	Constructed in 1955, Building 4073 served as the KEWB reactor building and consisted of an underground concrete structure and an above-ground wood and metal changing/workroom. The KEWB reactor was a small graphite-encased research reactor that used a water solution of uranyl sulfate as fuel. Operations in the building halted in November 1966.	Sr-90	1	0.091	0	NA
Old Conservation Yard	6	Also known as Site 4583-Old, it incorporated a barrel storage yard and excess salvageable items were stored in the area. In 1969, the barrel storage yard was converted to a material storage area. The ESG salvage yard was used extensively during the 1960s and 1970s before it was closed in 1977 and cleared of materials.	Cs-137	2	0.201 - 3.42	1	0.345
Subarea 8-South	8	No operational history has been identified for this area.	Cs-137	4	0.212 - 0.726	0	NA
			Sr-90	4	0.447 – 1.53	3	0.4 – 1.5
Subarea 5D South	5D	No operational history has been identified for this area.	Cs-137	6	0.196 – 0.314	0	NA
			Eu-154	1	0.136	0	NA
			Sr-90	1	0.448	2	0.43 - 0.43
			Pu-239/240	1	0.0502	0	NA
Southern California Edison Substation	3	Constructed about 1956 and currently delivers power to SSFL via two overhead high-voltage transmission lines. The site borders the Old Salvage Yard.	Sr-90	0	NA	1	0.444
Former Buildings 4173/4865	5D	Designed for use as a sodium storage pad.	Sr-90	1	0.648	0	NA
			Am-241	0	NA	1	0.589

Table 5.1
Radiological Areas of Interest

Key Location/Facility	Subarea	Operational History	Radionuclides Detected at Concentrations Equal to or Greater than FAL				
				Surface Soil		Subsurface Soil	
			Radionuclides Detected	Number of Surface Soil Samples	Surface Soil Sample Concentration Range (pCi/g)	Number of Subsurface Soil Samples	Subsurface Soil Sample Concentration Range (pCi/g)
Former Shield Test Irradiation Reactor (STIR) Building 4028	7	The building was originally constructed to house a water-cooled, zirconium-hydride moderated reactor, used to perform tests on space reactor shields using a fission plate driven by neutrons from the thermal column of the swimming pool-type reactor. The STIR was fueled with uranium-aluminum alloy clad entirely with aluminum. The STIR was used for reactor physics experiments, studies in radiation damage to electronic and instrumentation components, and neutron radiography. Once testing with the STIR was finished, the fuel elements were removed and the pool water was drained in June 1973.	Pu-239/240	0	NA	1	0.187
			Sr-90	0	NA	2	0.524 – 3.24
Heavy Metal Likely Chemical Remediation Zone (LCRZ)	5A	This area was designated by DOE and DTSC as a LCRZ based on the elevated concentrations of heavy metals that were detected in soil samples collected from this area.	Cs-137	2	0.24 – 0.327	0	NA
Building 4100	5C and 8N	Building 4100 housed the Advanced Epithermal Thorium Reactor, which was a separable half critical experiment operating at less than 200 watts (thermal), Fast Critical Experiment Laboratory, and Radiation Safety and Computed Tomography Laboratory. Twenty reactor core configurations were studied including thorium, uranium, and later, high-energy fast neutrons in the Fast Critical Experiment Laboratory. The Fast Critical Experiment Laboratory operated until about 1974 under NRC License No. CX-17. The NRC terminated License No. CX-17, and released Building 4100 for unrestricted use in October 1980. From the late 1980s until 2008, the high bay was used for high energy Computer Aided Tomography. NASA owned the scanner. The laboratories were used for radioactive sample counting and instrument calibration.	Cs-137	2	0.316 - 0.818	0	NA
			Pu-239/240	1	0.0233	0	NA
			Sr-90	0	NA	1	0.534
			Co-60	0	NA	1	0.0247
Building 4015	5C	Building 4015 was used to store construction materials, currently it is empty. There is no evidence of radiological burial or disposal in the Building 4015 area. A debris disposal area was identified in the northeast region of the Building 4015 area, south of the intermittent stream. The Building 4373 leach field is a potential source of radiological contamination that may have migrated onto the Building 4015 site.	Pu-239/240	1	0.0487	0	NA

Table 5.1
Radiological Areas of Interest

Key Location/Facility	Subarea	Operational History	Radionuclides Detected at Concentrations Equal to or Greater than FAL				
				Surface Soil		Subsurface Soil	
			Radionuclides Detected	Number of Surface Soil Samples	Surface Soil Sample Concentration Range (pCi/g)	Number of Subsurface Soil Samples	Subsurface Soil Sample Concentration Range (pCi/g)
Former Building 4353	5D	Building 4863 is first identified in 1972 Atomic International industrial planning maps as a hydraulic test loop building. The Hydraulic Test Facility was used to conduct preliminary tests on piping, pumps and other loop components. The test facility used water because it has a similar flow rate to liquid sodium. The tests were designed so the researchers could examine descriptors such as fatigue rates and results such as fracturing of components. Building 4863 served as the experimental test loop. According to a 1992 NEPA compliance activities status report included in the 1992 annual site environmental report, Building 4863 was placed on "inactive standby facility maintenance" on September 29, 1992. Building 4863 was demolished in 2003.	Cs-137	1	0.194	0	NA
Empire State Atomic Development Association	8	Used for testing pipe bursting characteristics under sodium-water reaction conditions.	Cs-137	1	0.206	0	NA
			Sr-90	6	0.449 – 2.34	5	0.51 – 2.51
4056 Landfill	8	Used as a landfill for the disposal of loose fill of earth, bedrock, and minor construction debris (asphalt, concrete, scrap metal, etc) from building construction until the early 1970s. After this time, North American Rockwell used the site as a temporary storage location for hazardous and non-hazardous waste materials. In the late 1970s, all items from the landfill and ravine were removed. In 1999, the pit was drained to eliminate the recharge potential to groundwater.	Cs-137	1	0.878	0	NA
			Pu-239/240	0	NA	1	0.0713
Building 4005	5A	Building 4005 was constructed in 1958 for non-nuclear testing of thermodynamic characteristics of proposed coolants for the OMR Experiment and Piqua reactors. During the mid 1960s, Building 4005 was converted into a small-scale production facility, the Uranium Carbide Fuel facility, to study the operations associated with manufacturing reactor fuel assemblies out of uranium carbide. The facility operated for a period of nine months during 1966 and1967, first using depleted uranium, and later enriched uranium and was a radiological controlled access area. Beginning in 1972, Building 4005 was used as the Molten Salt Test Facility, a non-nuclear test facility consisting of the Molten Salt Test Bed and the Process Demonstration Unit. According to the 1997 annual site environmental report, Building 4005 was demolished in 1997.	Eu-152	2	0.073 – 0.165	0	NA

Table 5.1
Radiological Areas of Interest

Key Location/Facility	Subarea	Operational History	Radionuclides Detected at Concentrations Equal to or Greater than FAL				
				Surface Soil		Subsurface Soil	
			Radionuclides Detected	Number of Surface Soil Samples	Surface Soil Sample Concentration Range (pCi/g)	Number of Subsurface Soil Samples	Subsurface Soil Sample Concentration Range (pCi/g)
Building 4023	5A	Served as the Liquid Metals Component Test Building and the Corrosion Test Loop. The second section, constructed in 1976 and known as 23A, served as a storage and setup room as well as an analytical chemistry laboratory. In 1976, a use authorization allowed the use of a small section of activated stainless steel Experimental Boilers Reactor fuel cladding in a small sodium test loop, located in the northwest corner of Building 4023, to gather data on transport characteristics of radiological contamination in sodium loops. The sodium loop tests were halted in 1983 and the loop was dismantled in 1986. According to a 1987 Site Consolidation Assessment, Building 4023 served as a development and demonstration test facility in support of the Rocky Flats Plutonium Recovery Project in 1987. In 1989, reports appear to indicate that Building 4023 served as a support facility for the Transuranic Management by Pyropartitioning – Separation operations in Building 4020, located in Subarea 5D. Building 4023 was demolished in 1999.	Pu-238	1	0.0137	0	NA
			Ni-59	0	NA	1	23.9
Outfall 3	7	Outfall 3 is an NPDES permitted sampling point regulated by the Los Angeles RWQCB. The outfall is a specifically designed multimedia filtration system engineered to filter the surface water before it travels downgradient. In July 2010, Outfall 3 was undergoing maintenance and the filter pack and liner had been removed. six soil samples were collected before the new liner and filter pack was installed.	Pu-239/240	1	0.0323	0	NA
			Sr-90	0	NA	1	0.397
Building 4006	5B	Operated as a non-nuclear sodium laboratory. Use Authorizations provided for minor uses of radioactive materials. Cooling Tower 4616 was removed in the early 1980s to make room for a Power Pak associated substation. Building 4006 closed operations in 1999.	Sr-90	2	0.096 – 0.125	0	NA
Building 4009	5D and 8N	Contained the OMR and SGR critical facilities, which were pilot plants for developing large nuclear power plants for commercial power generation, such as the Hallam nuclear power plant in Nebraska and the Piqua nuclear power plant in Ohio. The OMR was used for testing uranium fueled reactors moderated and cooled by organic liquids. The SGR was used to determine the operating characteristics of reactors with cores cooled by sodium and moderated with graphite. The OMR operated from 1959 to 1965 and the SGR operated from 1960 to 1967. In addition, as-built Drawing No. 303-009-E17 indicates that a Van de Graaff generator was installed in the SGR graphite storage area in August 1960 and was moved to Building 4030 in about May 1962. Following release for unrestricted use in 1999, Building 4009 was used for non-nuclear research and development, including laser research. Operations in Building 4009 ceased in mid-2007.	Sr-90	2	0.433 - 1.55	1	1.39

Table 5.1
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			Radionuclides Detected	Surface Soil		Subsurface Soil	
				Number of Surface Soil Samples	Surface Soil Sample Concentration Range (pCi/g)	Number of Subsurface Soil Samples	Subsurface Soil Sample Concentration Range (pCi/g)
Building 4009 Leach Field	8	A leach field, used for the disposal of both sanitary and radioactive liquid wastes before the central sewage system was installed in 1961, was located approximately 50 feet north of Building 4009. It contained six leach lines ranging in length from 15 to 42 feet. The leach lines extended north from a 2,340-gallon septic tank that was located outside the northwestern portion of Building 4009. The leach field comprised 4-inch diameter terra cotta clay piping surrounded by large gravel and buried at depths ranging from 4 to 5 feet below ground surface. The leach field was reported to include approximately 300 linear feet of leach lines.	Sr-90	2	0.64 – 1.26	1	1.26
Former Building 4353	5D	Information regarding the operations in Building 4353 is limited. The 1957-1958 progress report indicated the purpose of the building was to provide field test facilities for the performance of organic materials testing. A June 24, 1960, Atomics International technical data record indicated that an Advanced OMR Heat Transfer Loop was located at Building 4353 to obtain information on the fouling tendencies of organic coolants. The steel portion of the structure was removed in the late 1970s.	Pu-239/240	0	NA	1	0.0526
			Sr-90	3	0.422 – 1.27	0	NA
Former Building 4373 Leach Field	5D	Used as the first SNAP critical facility where several critical experiments and tests on critical assemblies had been completed. The leach field for 4373 is located southeast of Building 4373 and was replaced with a sewage treatment system in 1960.	Sr-90	1	0.52	0	NA
Former Building 4875	5D	Designed as a "creep loop tower" to support Building 4375.	Pu-238	1	0.0492	0	NA
			Sr-90	1	0.643	1	0.545
Building 4029	5A	Originally constructed to store radioactive source materials for instrument calibration. Building 4029 was later incorporated into the HWMF.	Cs-137	1	0.2	0	NA
Building 4462	5C	A multistory building used as the Sodium Pump Test Facility and tested pumps at high temperatures and pressures.	Sr-90	1	0.098	0	NA
Building 4055	5D	Located outside the ETEC boundary and includes the Nuclear Material Development Facility and used for research, development, and production of nuclear fuels and radioactive sources.	Sr-90	1	0.395	0	NA
Southwest corner of Subarea 7	7	This area is directly north of Building 4019, located in Subarea 5B.	Sr-90	0	NA	2	0.517 – 0.618

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			Radionuclides Detected	Number of Surface Soil Samples	Surface Soil Sample Concentration Range (pCi/g)	Number of Subsurface Soil Samples	Subsurface Soil Sample Concentration Range (pCi/g)
Former Building 4093 (L85 Reactor)	5A	Constructed in 1958 to house the AE-6 Reactor designed to provide a thermal neutron source for evaluating neutron behavior in subcritical exponential-type assemblies, and for irradiating foils and other materials. In 1972, the reactor was renamed L-85 and operated as a commercial operation for central station power plant operator training and for neutron radiography inspection of precision forgings, castings, and electronic and explosive devices for manufacturing defects.	Sr-90	0	NA	2	0.579 – 2.56
Building 4011	5B	Constructed in 1958 as an administration and services building, but later became the Radiation Instrument Calibration Laboratory used to repair and calibrate radiological instruments.	Sr-90	0	NA	1	0.117
Building 4375	5D	Building 4375 was a test shelter for testing SNAP control rod assemblies. Building 4375 was originally designed to perform creep tests on full-size OMR Piqua-type fuel elements.	Sr-90	0	NA	1	1.43
Pond Dredge Area	5D	Historical aerial photographs show excavation activities north of Building 4173(4865) in which no information has been located. RCRA Facility Investigation maps delineate this area as, "Pond Dredge".	Sr-90	0	NA	1	0.487
Building 4019	5B	Constructed in 1962 as the SNAP Flight Systems Nuclear Qualification Test Building to conduct criticality acceptance tests of SNAP reactors before they were delivered to the Atomic Energy Commission for launch as space power systems.	Sr-90	0	NA	1	0.09
Former Building 4356	5B	Constructed in 1959 as the Sodium Component Test Installation High Bay and was development test facility for liquid metal (sodium) system components.	Co-60	0	NA	1	0.0228

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				Number of Surface Soil Samples	Surface Soil Sample Concentration Range (pCi/g)	Number of Subsurface Soil Samples	Subsurface Soil Sample Concentration Range (pCi/g)
Northern Buffer Zone (NBZ)	NBZ-Northeast	The NBZ–northeast area comprises land and drainage channels located north of Area IV extending west to east between the SRE complex and Area I. The NBZ is also commonly referred to as the Northern Undeveloped Land. The southeastern border of the NBZ-northeast adjoins both Subareas 3 and 6. In May 1997, Rockwell purchased the 175 acres, to form the NBZ, from the adjoining Brandeis-Bardin Institute, which had owned the land since 1947. Rockwell purchased this land because radioactive and chemical contamination originating from the SSFL had been found on the property by environmental contractors in the early 1990s.	Cs-137	2	0.212 - 0.277	0	NA
			Cm-243/244	0	NA	1	0.0647
			Sr-90	1	0.075	0	NA
	NBZ-Northwest		Cs-137	1	0.207	0	NA
			Sr-90	8	0.01 – 0.978	2	0.586 - 0.725
			Pu-239/240	1	0.0384	0	NA

Notes:

Refer to Table 2.1 of the Final Field Sampling Plan for Soil Sampling (HGL, 2012d) for a definition of radionuclide symbols.

DTSC - Department of Toxic Substance Control

DOE - Department of Energy

ESG - Energy Systems Group

ETEC - Energy Technology Engineering Center

FAL - Field Action Level

HSA - Historical Site Assessment

NA - not applicable

NASA - National Aeronautical and Space Administration

NEPA - National Environmental Policy Act

NPDES - National Pollutant Discharge Elimination System

NRC - Nuclear Regulatory Commission

OMR - Organic Moderated Reactor

pCi/g - picocuries per gram

RCRA - Resource Conservation and Recovery Act

RWQCB - Regional Water Quality Control Board

SGR - Sodium Graphite Reactor

SNAP - Systems for Nuclear Auxiliary Power

SSFL - Santa Susana Field Laboratory